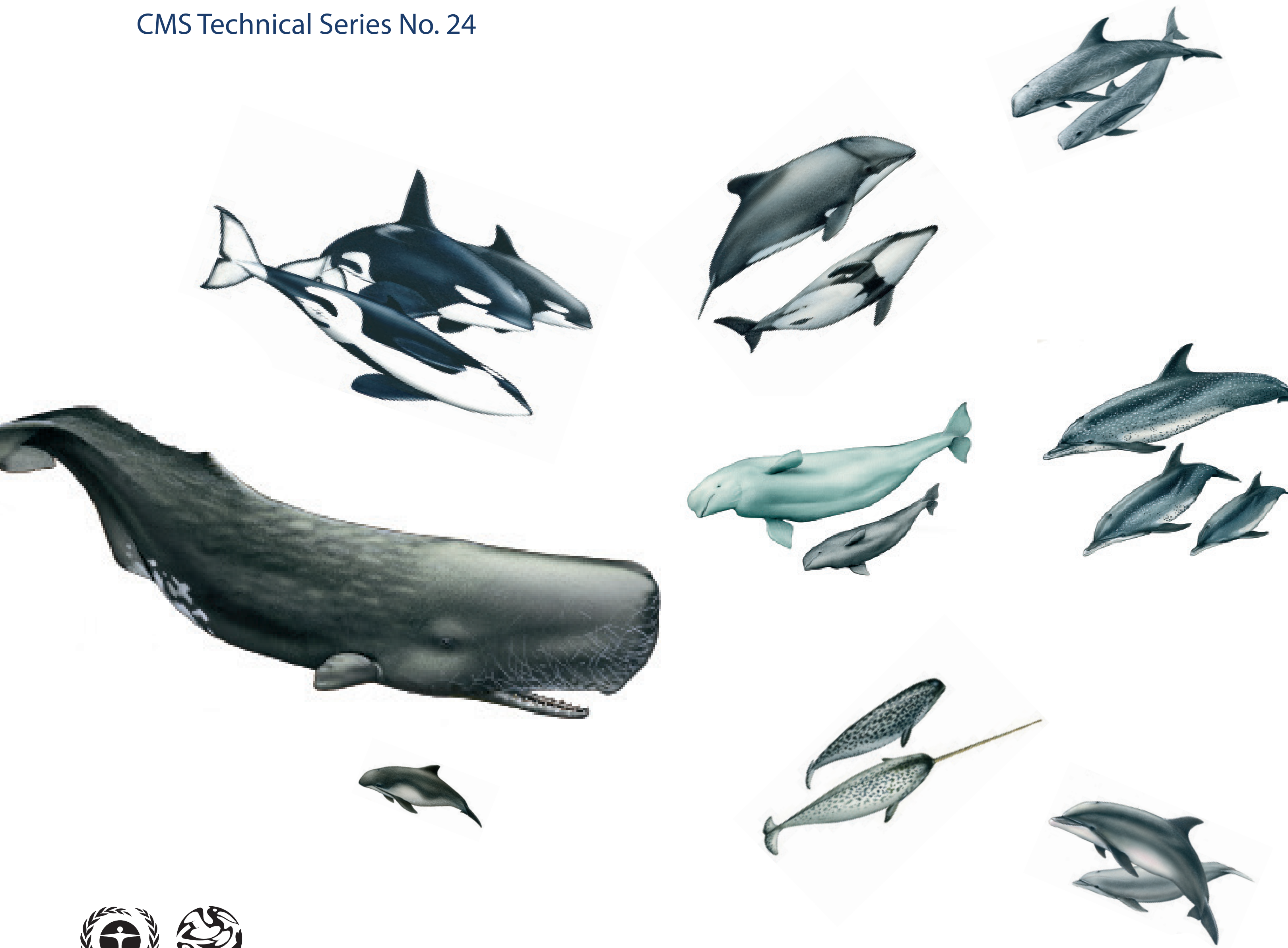
ODONTOCETES
The Toothed Whales

by Boris M. Culik

Illustrations by Maurizio Wurtz, Artescienza

CMS Technical Series No. 24



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Boris M. Culik

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The Toothed Whales

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Foreword by Elizabeth Maruma Mrema, UNEP/CMS Executive Secretary, UNEP/ASCOBANS Acting Executive Secretary

Ranging from the inconspicuous little harbour porpoise to the mighty sperm whale, toothed whales are a group of species that has always fascinated mankind. They are also species under severe pressure from human activities and many are under threat.

Effective conservation can only be achieved based on a good understanding of the biology, distribution and threats of the species concerned. Especially for marine species, these facts are often hard to study, because their way of life and habitat are alien to us and often remote. It is therefore all the more crucial to make the available information readily available, allowing an easy overview over the state of knowledge regarding the distribution, behaviour, migration and threats of each of the toothed whale species. This publication, which now appears in a revised and updated second edition, aims to provide just that – a reference book for policymakers, conservationists, experts in the field of marine biology, students, as well as for interested laypersons. While compiled by a single author, all articles in this publication have been peer reviewed by experts in the field.

Cetacean conservation is a crucial component of the work of the Convention on the Conservation of Migratory Species of Wild Animals (CMS), which aims to conserve and manage avian, aquatic and terrestrial migratory species, as well as their habitats, throughout their range. To maintain these populations in a favourable conservation status, as the Convention requires, it is essential to mitigate the most relevant threats putting pressure upon them and to ensure protection of their habitat, e.g. through the designation of ecologically representative and well connected systems of marine protected areas.

A key instrument of the Convention is the listing of species on one or both of the two Appendices, which can be updated at every meeting of the Conference of Parties. Such species listings require a solid scientific basis and are reviewed by the Scientific Council of the Convention before a decision is made. Appendix I contains migratory species that are endangered and as of 2010 contains seven species/populations of toothed whales. Appendix II contains species with an unfavourable conservation status that would significantly benefit from the international co-operation achieved through an international agreement for their conservation and management. More than 35 species/populations are listed on this appendix. For a number of these, regional agreements have already been concluded, some of which, like ASCOBANS, the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, focus exclusively on small cetaceans, the majority of the toothed whales.

While intergovernmental agreements such as CMS, ASCOBANS and ACCOBAMS and resolutions are important to streamline and coordinate conservation efforts throughout a species' range, implementation must take place at a national and local level. Besides government institutions, non-governmental organizations often play an important role on the ground. We are therefore particularly pleased that this publication has the support of WWF, Loro Parque Fundación, Greenpeace and IFAW. Only if all stakeholders work hand in hand can we hope to preserve these fascinating predators of the oceans and rivers for future generations.

With this publication, we hope to provide an important tool for all those interested in the protection of these magnificent creatures.

Elizabeth Maruma Mrema

Carlos Drews, WWF Director, Global Species Programm, WWF

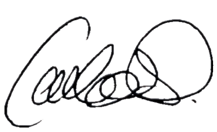
Whales, dolphins and porpoises have captured human imagination since ancient times and are without doubt some of the most fascinating animals on earth. The 72 different species of toothed cetaceans demonstrate a myriad of different characteristics and behaviours, and have adapted to an enormous range of different habitats – from the polar regions to the tropics, from the high seas to rivers and lakes.

Toothed cetaceans are among the most intelligent species on the planet. Bottlenose dolphins have distinct personalities, a strong sense of self, can think about the future, and have the innate ability to learn languages; their own, and – even more remarkably – a rudimentary symbol based language created to bridge the communication chasm between dolphins and the human species.

It is no wonder that one of the fastest growing forms of tourism is whale and dolphin watching, with over 13 million people in 119 countries taking to the seas in 2008 and spending some US$ 2.1 billion, in search of a glimpse of these incredible animals.

However, even if cetaceans hold a special place in human hearts, it is a tragedy that they are also greatly threatened by human activities. Destructive fishing practices, the growing web of global shipping routes, chemical and acoustic pollution, climate change, the expansion of oil and gas exploration in our oceans, and the carving up of river systems through the construction of dams are all taking their toll. Entanglement in fishing nets alone is estimated to kill over 300,000 small cetaceans each year – one animal every 2 minutes. The recent likely extinction of the Yangtze River dolphin, the baiji, is a stark reminder that there is no time to lose - several other cetacean species are on the brink of the same fate.

WWF welcomes this book on toothed cetaceans, which provides an excellent foundation for what is now urgently needed – a combined effort of governments, businesses, civil society and the public working together to ensure these remarkable animals will be able to mystify and amaze us for generations to come.



Carlos Drews

Marie-Christine Grillo-Compulsione, Executive Secretary, ACCOBAMS

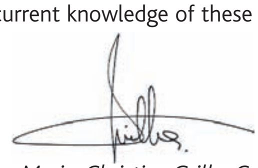
From time immemorial, man has had a special relationship with cetaceans. First considered as a myth during Antiquity, feared by fishermen who ventured out from the coastline by the XVI century, they are the source of many legends in the world oceans. Nowadays, cetaceans are the symbol of intelligence, freedom and wildlife, maybe due to the intensive media coverage or through their heroic roles in several movies during the last decades.

Despite this picture of serenity, cetacean populations are under threats from several sources: incidental bycatch, overexploitation of fish stocks causing the reduction of their food resources, chemical pollution, increasing sea traffic, acoustic disturbance, vessel collisions and unregulated development of whale-watching.

Currently, the status of cetaceans is one of the main symbols of the survival of the world's oceans: being at the top of the food pyramid they play a major role in maintaining the ecological equilibrium of marine ecosystems. Given our present state of knowledge, it is imperative to implement tools for conservation.

Many tasks need to be undertaken to improve the protection of an environment whose complexity and size should encourage cooperative work. Thus, any effort to conserve cetaceans is a proof of our commitment to protect the marine environment and to ensure long-term conservation of cetaceans. By implementing the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS), countries start on the path to cooperation and harmonization of conservation efforts. After all, animals do not recognize state borders… The ACCOBAMS area represents a wide range where humans and cetaceans coexist therefore, socio-economical aspects must be considered when the question of species conservation is brought up.

Supporting the present book, "Odontocetes – The toothed whales", is in harmony with the spirit of ACCOBAMS, whose purpose is to reduce threats to cetaceans notably by improving current knowledge of these animals.



Marie-Christine Grillo-Compulsione

Wolfgang Kiessling, President, Loro Parque Fundación

Loro Parque Fundación of Tenerife, Spain has been protecting nature worldwide since 1994. Its mission is to preserve threatened species and their habitats, by means of education, applied research, responsible breeding programmes, and community-based conservation activities which promote sustainable use of natural resources. The Loro Parque Fundación undertakes these conservation projects by using as "ambassadors" two groups of animals of beautiful appearance and appealing behaviour: cetaceans in the marine environment and parrots in terrestrial habitats.

The Canary Islands constitute a cetacean hotspot, and almost 80% of the cetacean species found in the North Atlantic Ocean have been described in its waters. Loro Parque Fundación promotes the establishment of a marine mammal sanctuary for Macaronesia as integral for the conservation of this high biodiversity, and to this end it partners academic institutions locally and internationally in supporting a range of research activities. These include identifying markers of marine pollution in Common bottlenose dolphins and determining diet and feeding patterns of Killer whales to reduce conflict with fishermen, as well as monitoring Killer whale migration patterns in the Iberian Peninsula. Research with both species includes the identification of pathogens and development of information technology for bio-acoustical analysis. Additional support is given to threatened populations of Harbour porpoises.

The Loro Parque Fundación implements education programmes about cetaceans and the marine environment for the general public and, especially with the Canary Islands' Government, for schools. Such creation of awareness and diffusion of knowledge is vital if we are to have any real hope of saving the world's cetaceans – and the world's oceans. This is particularly why the Loro Parque Fundación welcomes and supports the publication of this important book.

Wolfgang Kiessling

Thilo Maack, Oceans & Biodiversity Campaigner, Greenpeace

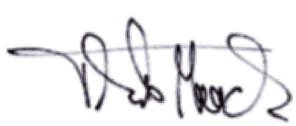
When Greenpeace launched our anti whaling campaign in 1975, with people placing themselves between the harpoon and the whale, the gunner's targets were sperm whales, the largest of the Odontocetes.

Sperm whales are extraordinary creatures. They can dive up to 3 km and stay under water for over an hour, by holding their breath after charging the myoglobin of their muscles with oxygen. They hunt by sound in perfect darkness, living in a world in which sight is a secondary sense. And they possess the largest brains on earth. With the exception of two or three taken each year by Japan for ‚research', sperm whales no longer live in the shadow of the harpoon. But they and the other Odontocetes face equally deadly threats.

Odontocetes are at the top of the food web and so particularly vulnerable to bio-accumulation of toxic compounds that are increasingly finding their way into our oceans. Sperm whale meat from the ‚research' catch is no longer marketed because it is contaminated with PCBs and other organochlorine compounds. In Canada, dead belugas were found to have such high concentrations of these compounds that they would have qualified as toxic waste.

The oceans have changed unimaginably in the lifetime of a person, or a sperm whale. Man made noise obscures the calls of whales, high speed ships hit whales and kill them, fishing gear empties the oceans and kills hundreds of thousands of cetaceans a year, mostly Odontocetes. Oil pollution threatens habitats and oil drilling is expanding into new and riskier areas. Global warming threatens food supplies. There may be more cetaceans dying at the hands of man now than there were half a century ago when whaling was at full swing.

To stop all this will not be easy - it will require a fundamental change in the way we humans treat our planet. But it must be done. If we can't protect the whales we can't protect anything. And if we can't save the whales, how will we save ourselves?



Thilo Maack

Ralf Sonntag, Director, IFAW Germany

Our planet's whales, porpoises and dolphins face more threats today than ever before in history. For the past four decades, the International Fund for Animal Welfare (IFAW) has been saving animals in crisis around the world. Today, much of this important work takes place in, on and around the waters of our ocean planet.

From Antarctica to Zanzibar, from Southern Africa to the North Atlantic, IFAW is working around the clock, around the world to save these gentle marine mammals from a growing array of human-caused threats. Well documented dangers such as entanglement in outmoded fishing gear, marine habitat destruction and debris have been joined by new and emerging challenges including ocean noise pollution, collisions with high-speed vessels and the looming threat of global climate change which, scientists assure us, is already affecting breeding, feeding and migratory patterns of species including the toothed whales, dolphins and porpoises covered in this timely and incisive review.

Since my own early post-doctoral work on small cetaceans at the University of Kiel, I have believed sound science is the soil in which policies to protect marine species must be rooted. Boris Culik's exhaustive research and careful editing have delivered a worthy addition to our baseline knowledge of the amazing creatures known as the odontocetes.

Historically, one of the greatest threats to both the welfare and conservation status of these marine mammals has been commercial hunting, a cruel and unsustainable practice that still continues today. From our international headquarters and 15 country and regional offices around the world, IFAW is working to end the killing of whales, dolphins and porpoises for commercial purposes. We are also pioneering practical solutions to the many other challenges confronting these animals. We are joined in this work by more than one million supporters worldwide and are proud to stand alongside the other fine organizations that have contributed to the book you are holding in your hands.

IFAW is delighted to support the creation of this new volume. We hope it will lead to better understanding and ultimately enhanced protection of toothed whales, dolphins and porpoises worldwide. For that to happen, laws and regulations will also need to have teeth. We look forward to working with you to save these animals. Their future is in your hands too.

Ralf Sonntag

Contents

1 Introduction and Outlook by Boris M. Culik

When I wrote the first online-edition of the "Review on small cetaceans" in 2001, there were 71 dolphin, porpoise and small whale species to consider. The number of recognized small cetacean species has not changed in this second, fully revised edition, but to complete the suborder Odontoceti, the toothed whales, I have now included their largest representative, the sperm whale (*Physeter macrocephalus*).

Sources

This new edition became necessary due to the vast amount of literature published on cetaceans in the past 10 years. An online search on the scientific literature published between 2001 and 2010 yields 4,900 new publications containing the word "whale", "dolphin" or "porpoise" in the title. For the purpose of this review, I have checked an average of approximately 50 - 60 recent articles per species using the Aquatic Science and Fisheries Abstracts (ASFA Silver Platter), the IUCN species reports, the scientific reports of the National Marine Fisheries Service of the USA and many other sources.

Changes in species since 2001

Among the small cetacean species, there have been three additions and several changes. Perrin's beaked whale (*Mesoplodon perrini*) was first described in 2002 on the basis of five animals stranded on the coast of California. The Australian snubfin dolphin (*Orcaella heinsohni*), formerly included in the Irrawaddy dolphin (*Orcaella brevirostris*) and the Guiana dolphin (*Sotalia guianensis*), formerly included in the Tucuxi (*Sotalia fluviatilis*) have now also been recognised as new species.

As opposed to this, two species have been synonymized with others and re-assigned to "only" subspecific status: the Arabian common dolphin (*Delphinus tropicalis*) is now included in the Long-beaked common dolphin (*Delphinus capensis*) and the account on the Indo-Pacific humpback dolphin (*Sousa plumbea*) was merged with that of the Chinese white dolphin (*Sousa chinensis*).

The name of another Odontocete, *Mesoplodon bahamondi,* disappeared from the list, being renamed after a senior synonym for this species idendified in 2002. It is now called *Mesoplodon traversii*. This is the least well known of all cetecan species: only 3 specimens were found to date and no description of external features is available.

Critically endangered or extinct species

But although this new edition now reports on 72 toothed whale species, there are really only 71 species alive today, as opposed to 2001.

The Yangtse river dolphin (*Lipotes vexillifer*) was already considered extremely endangered in 2001 but attempts to save this species have failed and a survey of the Yangtse River in 2006 as well as a subsequent search in 2007 did not detect any live specimens in its former freshwater habitats in China. Several years have passed since then without any positive news and we must therefore consider this species as being extinct.

The Vaquita (*Phocoena sinus*), also called the Gulf of California porpoise, is one of the smallest toothed whale species. The latest survey in its habitat in the northern Gulf of California was conducted in 1997 and from this, a population size of 177 - 1,073 animals was estimated. However, since then, more than a decade has elapsed and no new surveys have been conducted in the wild. A recent statistic (2009), based on these dated estimates and on inferred fisheries by-catch mortalities, assumes that only 71 - 430 animals survive today. The IWC (2008) estimated that the species may become extinct by 2013. However, there is still hope: an expedition in 2008 reported 13 sightings (T. Jefferson, 2010, pers. comm.).

Two other species were classified as endangered by the IUCN Cetacean Specialist Group in 2008: the Hector's dolphin of New Zealand (*Cephalorhynchus hectori*), of which a subspecies, which lives on the North Island (*C. c. maui*) is actually Critically Endangered, its current population size being in the range of only 48 - 252. And the South Asian river dolphin (*Platanista gangetica*), a subspecies of which lives in the Indus and its tributaries (*P. g. minor*) in Pakistan and India with a remaining population ranging between 100 and 1,000. The other subspecies lives in the Ganges-Brahmaputra river system and its tributaries of India, Bangladesh and Nepal, and it´s population ranges also in the low 1,000.

Table 1: *Comparison between 2001 and 2011 listings of toothed whales according to the categories of the IUCN Red List of endangered Species.*

	2001	2011
DD	39	41
LR/LC	10	17
NT	0	5
VU	4	5
EN	2	2
CR	2	2
Sum	57	72

DD: *Data Deficient.* ***LR:*** *Lower Risk.* ***LC:*** *Least Concern.* ***NT:*** *Near Threatened.* ***VU:*** *Vulnerable.* ***EN:*** *Endangered.* ***CR:*** *Critically Endangered. (In 2001, 15 odontocete species were not yet listed by the IUCN).*

Source: Cetacean update of the 2011 IUCN Red List of Threatened Species

Vulnerable and threatened species

As opposed to 2001, five odontocete species are considered as Vulnerable today (Table 1): The finless porpoise (*Neophocaena phocaenoides*), the Irrawaddy dolphin (*Orcaella brevirostris*), the sperm whale (*Physeter macrocephalus*), the Franciscana (*Pontoporia blainvillei*) and the Atlantic humpback dolphin (*Sousa teuszii*).

Another five species are classified as near threatened, a category which contained none in 2001: the Chilean dolphin (*Cephalorhynchus eutropia*), the beluga whale (*Delphinapterus leucas*), the narwhal (*Monodon monoceros*), the Australian snubfin dolphin (*Orcaella heinsohni*) and the Indo-Pacific humpback dolphin (*Sousa chinensis*).

The reason for this can lie in significantly reduced population sizes through massive catches in the past, with a subsequent failure of recovery to pre-whaling population sizes (e.g. in the case of the sperm whale). But in most species, ongoing and unsustainable mortalities through fishery interactions, reduced fitness through massive accumulation of biologically active pollutants, and even ongoing unsustainable catches in local whaling activities are the cause.

Threats

The major threat faced by odontocetes is by-catch in fisheries operations (Table 2). For 62 species (86 % of all toothed whale species) entanglement or capture in gillnets, driftnets, traps, weirs, purse-seine nets, long-lines, trawls and other gear and subsequent anoxia and suffocation as direct cause of death were identified as a major risk. This is a substantial increase as opposed to 2001, when by-catch was only known to affect 50 species (70.4 %).

Although hunting on a commercial scale has largely come to an end, many toothed whales still suffer losses from ongoing local hunting, deliberate killing or live-captures. A total of 50 species (69.4 %) is now affected by such operations, as opposed to 47 (66.2 %) in 2001. And even if the whales are not targeted directly by the fisheries, over-fishing of their predominant prey species was identified as a threat to 13 species (18.1 %) in 2011 as opposed to 11 (15.5 %) in 2001.

Many human activities result in discharge of wastes and subsequent pollution of the environment. Pollution by persistent and often bio-accumulating heavy metals, including mercury and butyltins, the latter used in anti-fouling paint for ships, as well as persistent chemicals such as PCB's, DDT and others, were found to affect 48 (66.7%) of all species, as opposed to 40 (56.3) in 2001. The ingestion of plastic debris and subsequent obstruction of the digestive tract, followed by starvation, is also included in this category.

Anthropogenic activities may also entail habitat degradation through construction of dams, or harbour facilities as well as land reclamation, e.g. for airports, dredging, or exploitation of natural resources such as oil and gas fields. These activities affect 18 (25 %) species. Interactions with shipping, including lethal ship strikes, but also injuries by power boats or significant changes in behaviour by intensive and unregulated whale-watching pose a threat to 14 (19.4 %) species.

Odontocetes rely on sound to communicate under water, to navigate and to find and capture prey. Man-made noise caused by seismic explorations, marine construction projects as well as military sonar now poses an increasing threat to 24 (33.3 %) species of these marine mammals (as opposed to 2 species identified in 2001).

The comparison of these numbers shows two things: Firstly, that our knowledge on the effects of anthropogenic activities has increased considerably over the past 10 years. And secondly, and this is a very alarming result, that the human footprint on the seas and oceans is becoming ever larger, its repercussions being felt by more and more species, in more and more areas around the world.

The Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS) has reacted to this increasing level of threats to toothed whales and has now included 37 species or particular populations of these species into its Appendices I or II (CMS-Appendices; please also see article on "Cetacean Conservation under the Convention on Migratory Species" for details) as opposed to 34 species in 2001.

Data quality

Despite the vast body of new literature published since the first edition, our knowledge on many odontocete species remains fragmentary and has only moderately improved over the course of the last 10 years. There are large "white patches" remaining with respect to our understanding of toothed whales. The whole family of the Mesoplodonts is a prime example for this, and consequently their individual species accounts are often only 1 - 2 pages long. In many cases, we only know these cetaceans from carcasses or bones found on the beach and one, *Mesoplodon traversii*, was actually never recognised alive.

Of the 72 odontocete species, the IUCN considers 41 species (57 %) as Data Deficient. At present we simply do not have enough information on the size of their populations, their distribution, mortality and recovery rates and so on to be able to classify them into one of the other categories (c.f. table 1), including the one expressing "Least Concern". A lot of work remains to be done by field biologists.

Former and repeated recommendations

In the first version of the "Report on small cetaceans" I had suggested the inclusion of a variety of species into the appen-

Table 2: *Number of odontocete species documented as affected by a particular threat type. Comparison of the 2011 with the 2001 edition of the odontocete report. (Catch includes killing in fishery interactions as well as live-capture. Vessel interaction includes ship strikes as well as whale-watching effects. Pollution includes inorganic and organic pollutants and ingestion of plastic debris.)*

	Unknown	Catch	By-catch	Vessel	Noise	Habitat degradation	Pollution	Over-fishing	Climate change
2011	12	50	62	14	24	18	48	13	3
2001	13	47	50	-	2	17	40	11	-

Table 3: *Species classified as "Data Deficient" (DD) by the IUCN with relatively low abundance estimates and/or regional distributions warranting closer assessment with respect to their threat status. (SA: South American population; AS/TS: Arafura/Timor Sea populations).*

Genus	Species	IUCN	CMS	Abundance	Distribution
Indopacetus	*pacificus*	DD		low 1,000	oceanwide
Sotalia	*fluviatilis*	DD	II	low 1,000	regional
Sotalia	*guianensis*	DD	II	low 1,000	regional
Tursiops	*aduncus*	DD	II (AS/TS)	low 1,000	oceanwide
Cephalorhynchus	*commersonii*	DD	II (SA)	low 10,000	regional
Cephalorhynchus	*heavisidii*	DD	II	low 10,000	regional
Inia	*geoffrensis*	DD	II	low 10,000	regional
Mesoplodon	*peruvianus*	DD		low 10,000	regional

dices of CMS, based on the fact that these species showed documented, transnational migratory behaviour. Of these, the West African population of *Stenella clymene* was in the meantime included into Appendix II.

Among the species not considered by CMS so far is the Indus subspecies of the South Asian river dolphin *Platanista gangetica minor*: Because this subspecies occurs, and was recently observed, in riverine systems of both Pakistan and India, inclusion in Appendix II of CMS might be considered (please see individual species account for details).

Outlook

From the series of reports published here, a small statistic was drawn up to determine which species have low population numbers and at the same time a distribution which is restricted locally or regionally (as opposed to ocean wide or global). While several of these species are already included in CMS appendix II, they are considered as Data Deficient by the IUCN. Table 3 lists these species and is intended to further discussion on the assessment of these species by the IUCN Cetacean Specialist Group.

Acknowledgements

I would like to thank all those who have helped to make this book possible:

Heidrun Frisch, Elizabeth Maruma Mrema and Marco Barbieri at the CMS and ASCOBANS Secretariats in Bonn. Thank you for being so supportive of the idea to revise the 2001 report and for your help to get this project off the ground.

David Waugh and Wolfgang Kiessling at Loro Parque Fundacion, Tenerife, Spain; Sue Watson, Dr. Carlos Drews and Volker Homes at WWF, Berlin; Marie-Christine Grillo-Compulsione and Maÿlis Salivas, ACCOBAMS Secretariat, Monaco; Thilo Maack, Greenpeace, Hamburg; and Dr. Ralf Sonntag, IFAW, Hamburg: Thank you all for your kind forewords, for supporting this project financially, and for distributing this report.

Every single species was illustrated by Maurizio Würtz and Nadia Repeto, Artescienza and University of Genova, Italy. Thank you both for these wonderful drawings!

The maps showing the currently known distribution of each species were generated by the IUCN Cetacean Specialist Group headed by Randall Reeves. Those on *Sotalia fluviatilis* and *Sotalia guianensis* were kindly drawn anew by Federica Chiozza at Rome University. Currently, a revision of all the cetacean maps and range lists is underway by the IUCN Cetacean Specialist Group. The work is due to be completed by the end of 2012. However, while the maps will show more detail such as corrected probable range, taking into consideration results of systematic surveys, not too many major changes are expected by comparison to the version published here (William Perrin, La Jolla, 2011, pers. comm. to the author).

Every single species account was critically reviewed either by Koen Van Waerebeek, Lima Peru, or by William Perrin, La Jolla, California, as well as by several additional reviewers, acknowledged separately in the individual species accounts. I am very grateful for your innumerable corrections, comments and suggestions.

Finally, Karina Waedt, Bonn, again layouted this new edition of the "ODONTOCETES - The Toothed Whales". Thank you for the beautiful design and for carefully handling all the elements of this book.

Heikendorf, August 2011

2 Cetacean Conservation under the Convention on Migratory Species, by Heidrun Frisch (UNEP/CMS/ASCOBANS Secretariat)

Cetacean conservation is a crucial component of the work of the Convention on the Conservation of Migratory Species of Wild Animals (CMS), which aims to conserve and manage avian, aquatic and terrestrial migratory species, as well as their habitats, throughout their range.

As a global environmental treaty, CMS organises trans-boundary cooperation for species migrating across or outside national boundaries, such as cetaceans. It provides the legal framework for conservation measures throughout the migratory range and strives to maintain or restore a favourable conservation status of the species and their habitats in order to facilitate, where applicable, sustainable use. The Convention provides a platform to develop and tailor measures according to particular conservation needs. This is achieved through a variety of instruments.

Appendices

A key instrument of the Convention is the listing of species on one or both of the two Appendices, which are updated at every meeting of the Conference of Parties. It is possible a) for a species to be listed on both Appendices of the Convention, b) for the species as a whole to be listed on one Appendix and a particular population to appear on the other or c) for just a particular population to be listed.

Appendix I contains migratory species that are endangered - that means in danger of extinction throughout all or a significant portion of their range. Provided that there is reliable scientific evidence available that a species is endangered, a migratory species may be listed on Appendix I. Parties that are Range States for Appendix I species endeavour to conserve and restore habitats; to prevent, remove, compensate for or minimise, as appropriate, the adverse effects of activities or obstacles, which prevent or impede migration; and to prevent, reduce or control factors that endanger the species. Taking of specimens of Appendix I species is generally prohibited and Parties allowing exceptions must inform the Secretariat.

Following its amendment at the 9th Meeting of the Conference of Parties, held in Rome, Italy, in December 2008, Appendix I lists the following 15 cetacean species:

Toothed whales (Odontoceti):

- Sperm whale (*Physeter macrocephalus*)
- Ganges river dolphin / Susu (*Platanista gangetica gangetica*)
- Franciscana / La Plata dolphin (*Pontoporia blainvillei*)
- Short-beaked common dolphin (*Delphinus delphis*) - only Mediterranean population
- Common bottlenose dolphin (*Tursiops truncatus ponticus*) - Black Sea population
- Irrawaddy dolphin (*Orcaella brevirostris*)
- Atlantic humpback dolphin (*Sousa teuszii*)

Baleen whales (Mysticeti):

- Sei whale (*Balaenoptera borealis*)
- Fin whale (*Balaenoptera physalus*)
- Blue whale (*Balaenoptera musculus*)
- Humpback whale (*Megaptera novaeangliae*)
- Bowhead whale (*Balaena mysticetus*)
- Northern right whale (*Eubalaena glacialis*) - North Atlantic population
- North Pacific right whale (*Eubalaena japonica*) - North Pacific population
- Southern right whale (*Eubalaena australis*)

Appendix II contains species with an unfavourable conservation status that would significantly benefit from the international co-operation that could be achieved through an international agreement for their conservation and management. Parties that are Range States of Appendix II species are therefore encouraged to conclude agreements for the conservation and management of those species or geographically separate populations of those species.

Appendix II, as amended at the 9th Meeting of the Conference of Parties in December 2008, lists the following 43 cetacean species:

Toothed whales (Odontoceti):

- Sperm whale (*Physeter macrocephalus*)
- Ganges river dolphin / Susu (*Platanista gangetica gangetica*)
- Franciscana / La Plata dolphin (*Pontoporia blainvillei*)
- Amazon river dolphin / Boto (*Inia geoffrensis*)
- Beluga / White whale (*Delphinapterus leucas*)
- Narwhal (*Monodon monoceros*)
- Harbour porpoise / Common porpoise (*Phocoena phocoena*) - North and Baltic Sea, western North Atlantic, Black Sea and North West African populations
- Burmeister's porpoise (*Phocoena spinipinnis*)
- Spectacled porpoise (*Phocoena dioptrica*)
- Finless porpoise (*Neophocaena phocaenoides*)
- Dall's porpoise (*Phocoenoides dalli*)
- Indo-Pacific humpback dolphin (*Sousa chinensis*)
- Atlantic humpback dolphin (*Sousa teuszii*)
- Tucuxi (*Sotalia fluviatilis*)
- Guiana dolphin (*Sotalia guianensis*)
- White-beaked dolphin (*Lagenorhynchus albirostris*) - only North and Baltic Sea populations
- Atlantic white-sided dolphin (*Lagenorhynchus acutus*) - only North and Baltic Sea populations
- Dusky dolphin (*Lagenorhynchus obscurus*)
- Peale's dolphin / Black-chinned dolphin (*Lagenorhynchus australis*)
- Risso's dolphin (*Grampus griseus*) - only North Sea, Baltic Sea and Mediterranean populations
- Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) - Arafura / Timor Sea populations
- Common bottlenose dolphin (*Tursiops truncatus*) - North Sea, Baltic Sea, Mediterranean and Black Sea populations
- Pantropical spotted dolphin (*Stenella attenuata*) - eastern tropical Pacific and Southeast Asian populations
- Spinner dolphin (*Stenella longirostris*) - eastern tropical Pacific and Southeast Asian populations
- Striped dolphin (*Stenella coeruleoalba*) - eastern tropical Pacific and Mediterranean populations

- Clymene dolphin (*Stenella clymene*) -West African population
- Short-beaked common dolphin (*Delphinus delphis*) - North and Baltic Sea Mediterranean, Black Sea and eastern tropical Pacific populations
- Fraser's dolphin (*Lagenodelphis hosei*) - Southeast Asian populations
- Irrawaddy dolphin (*Orcaella brevirostris*)
- Australian snubfin dolphin (*Orcaella heinsohni*)
- Commerson's dolphin (*Cephalorhynchus commersonii*) - South American population
- Chilean dolphin (*Cephalorhynchus eutropia*)
- Heaviside's dolphin (*Cephalorhynchus heavisidii*)
- Killer whale / Orca (*Orcinus orca*)
- Long-finned pilot whale (*Globicephala melas*) - only North and Baltic Sea populations
- Baird's beaked whale (*Berardius bairdii*)
- Northern bottlenose whale (*Hyperoodon ampullatus*)

Baleen whales (Mysticeti):
- Antarctic minke whale (*Balaenoptera bonaerensis*)
- Bryde's whale (*Balaenoptera edeni*)
- Sei whale (*Balaenoptera borealis*)
- Omura's whale (*Balaenoptera omurai*)
- Fin whale (*Balaenoptera physalus*)
- Pygmy right whale (*Caperea marginata*)

Resolutions

At the 9th Meeting of the Conference of Parties (COP) a number of Resolutions relevant for the protection of cetaceans were passed.

Resolution 9.1 (2008) identifies species for which the Parties to the Convention decided to carry out concerted and cooperative actions to improve their conservation status during the 2009-2011 triennium. The results of these efforts will be reviewed at the next meeting in 2011.

Concerted actions have been recommended for the Black Sea population of the Bottlenose dolphin (*Tursiops truncatus ponticus*) and the Ganges river dolphin (*Platanista gangetica gangetica*). These two species have thus been highlighted as requiring special attention.

Further, 13 cetacean species have been designated for cooperative actions, namely Peale's dolphin (*Lagenorhynchus australis*), Dusky dolphin (*Lagenorhynchus obscurus*), Burmeister porpoise (*Phocoena spinipinnis*), Spectacled porpoise (*Phocoena dioptrica*), Commerson's dolphin (*Cephalorhynchus commersonii*), Chilean dolphin (*Cephalorhynchus eutropia*), Finless porpoise (*Neophocaena phocaenoides*), Indo-Pacific humpback dolphin (*Sousa chinensis*), Indian or Bottlenose dolphin (*Tursiops aduncus*), Pantropical spotted dolphin (*Stenella attenuata*), Spinner dolphin (*Stenella longirostris*), Fraser's dolphin (*Lagenodelphis hosei*) and Irrawaddy dolphin (*Orcaella brevirostris*).

Resolution 9.2 (2008) supports the development of an appropriate CMS instrument on cetaceans in South-East Asia or the entire Indian Ocean. The Range States of the region have been requested to identify a lead country to support the instrument's preparatory phase and Parties, interested States and partner organizations are encouraged to provide financial and in-kind support to these efforts.

In **Resolution 9.9** (2008), Parties express their concern that migratory marine species face multiple, cumulative and often synergistic threats with possible effects over vast areas, such as by-catch, over-fishing, pollution, habitat destruction or degradation, marine noise impacts, deliberate hunts as well as climate change. The COP consequently urges Parties, the Scientific Council and the CMS Secretariat to identify priority issues, species and habitats in the marine sphere requiring intervention by CMS in the next decade.

In follow-up of **Resolution 8.22** (2005) on Adverse Human Induced Impacts on Cetaceans, the Secretariat was asked to complete a review of the extent to which CMS, CMS cetacean-related agreements and other organizations and bodies are addressing listed impacts through their threat abatement activities. This will be followed by an analysis of the gaps and overlaps between CMS, CMS cetacean-related agreements, IMO, IWC Scientific Committee and Conservation Committee, OSPAR, UNICPOLOS, the UNEP Regional Seas Programme and the identification of priority impacts and regions requiring urgent attention. Based on this, a draft programme of work for cetaceans will be developed and submitted to the CMS Parties.

The Conference of Parties further passed a number of resolutions addressing specific threats that also affect cetaceans, namely **Resolution 9.7** (2008) on Climate Change Impacts on Migratory Species, **Resolution 9.18** (2008) on By-Catch and **Resolution 9.19** (2008) on Adverse Anthropogenic Marine/ Ocean Noise Impacts on Cetaceans and other Biota.

Legally binding Agreements

Primarily for species listed on Appendix II, the Convention encourages the Range States to conclude global or regional Agreements. In this respect, CMS acts as a framework Convention. The development of models tailored according to the conservation needs throughout the migratory range is a unique capacity to CMS. Two legally binding treaties for cetaceans have been concluded to date, which have been adapted to the requirements of their particular regions.

ACCOBAMS

The Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) was concluded in 1996 and entered into force in 2001. It covers an area that includes the Black Sea, Mediterranean Sea and the Atlantic coasts of northern Morocco, southern Portugal and southern Spain. The Agreement Area includes 28 Range States, of which 22 have so far become Party to the Agreement. ACCOBAMS applies to all cetaceans that have a range that lies entirely or partly within the Agreement Area or that accidentally or occasionally frequent it.

The ACCOBAMS Conservation Plan specifies the actions that Parties shall take in the following areas: adoption and enforcement of national legislation; assessment and management of human cetacean interactions; habitat protection; research and monitoring; capacity building; collection and dissemination of information; training and education; and responses to emergency situations.

Resolutions adopted by Parties at the 3rd Meeting of Parties in 2007 cover topics such as collaboration with the fisheries sector, guidelines for research on cetaceans, whale watching, release of cetaceans into the wild and stranding response, as well as topics such as anthropogenic noise, ship strikes, bycatch and other fishery interactions, dolphin interaction programmes, marine protected areas or conservation strategies and plans for individual species.

The ACCOBAMS Scientific Committee is comprised of persons qualified as experts in cetacean conservation science and serves as an advisory body to the Meeting of the Parties. It usually meets every year.

ASCOBANS

The Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) was concluded in 1991 and entered into force in 1994. Originally covering only the North and Baltic Seas, in 2008 an extension of the Agreement Area to include also parts of the North East Atlantic and the Irish Sea came into effect. The Agreement has 17 Range States and currently 10 Parties. ASCOBANS covers all species of toothed whales (Odontoceti) in the Agreement Area, with the exception of the sperm whale (*Physeter macrocephalus*).

The aim of the Agreement is to promote close cooperation amongst Parties with a view to achieving and maintaining a favourable conservation status for small cetaceans in the ASCOBANS Area. A Conservation and Management Plan, which forms part of the Agreement, obliges Parties to engage in habitat conservation and management, surveys and research, pollution mitigation and public information.

The 6th Meeting of the Parties in 2009 adopted two action plans for harbour porpoises, specific to the needs of the populations in the Baltic and North Sea, respectively. The Parties also agreed on the development of guidelines to address the adverse effects of underwater noise on marine mammals, for example caused by construction of offshore windfarms. The new work programme for the triennium 2010-2012 identifies bycatch and disturbance by noise as priorities for the work under the Agreement.

The ASCOBANS Advisory Committee, which meets at least once a year, provides scientific and policy advice to the Parties and the Secretariat on the conservation and management of small cetaceans and on other matters related to the running of the Agreement. The meetings are attended by representatives of the Parties, Non-Party Range States and relevant regional, intergovernmental and non-governmental organizations.

Memoranda of Understanding

Like their legally-binding counterparts, non-binding Memoranda of Understanding (MoU) developed under CMS provide the participating governments with a platform which allows them to coordinate conservation measures for species listed on the Convention's Appendices. Meetings of the Signatory States are dependent on voluntary contributions and therefore occur less regularly. The more informal framework facilitates the participation of developing countries. To date, two MoUs are concerned with cetaceans:

Pacific Island Cetaceans

The Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Islands Region came into effect in 2006. It was negotiated under the auspices of CMS in collaboration with the Pacific Regional Environment Programme (SPREP). Of its 22 Range States, 11 are at present Signatories to the MoU, which serves to protect all cetacean species occurring in its area. A number of collaborating organizations have also signed the MoU.

At the 2nd Meeting of Signatories in 2009 a Conservation Plan for the years 2009-2012 was adopted, which serves as an Annex to the MoU. It is designed to help the people of the Pacific Islands region to conserve whales and dolphins and their habitats by identifying necessary actions and priorities relating to cooperation, threat reduction, ecosystem and habitat protection, capacity building, education and awareness raising, cultural significance and value, legislation and policy, research and monitoring, as well as whale and dolphin-based tourism.

Western African Aquatic Mammals

The Memorandum of Understanding Concerning the Conservation of the Manatee and Small Cetaceans of Western Africa and Macaronesia was signed in 2008 by 17 of the 29 Range States. A number of collaborating organizations have also signed the MoU. It covers all species of small cetaceans (defined as all species of toothed whales (Odontoceti), with the exception of *Physeter macrocephalus*, the sperm whale) occurring in its area, encompassing the entire African Eastern Atlantic Basin from Morocco to South Africa and including the Macaronesian archipelago.

The Small Cetacean Action Plan, which is part of the MoU, contains eight thematic sections: cooperation, legislation and policy, ecosystem/habitat protection, threat reduction, research and monitoring, capacity building, education and awareness raising, as well as tourism based on small cetaceans.

The MoU also applies to the West African manatee (*Trichechus senegalensis*), for which inland countries are included in its area and a separate action plan has been adopted.

3 SPECIES ACCOUNTS

3.1 Berardius arnuxii Duvernoy, 1851

English: Arnoux´s beaked whale
German: Südlicher Schwarzwal
Spanish: Ballenato de Arnoux, ballena picuda de Arnoux
French: Bérardien d'Arnoux, baleine à bec d'Arnoux

Family Ziphiidae

Berardius arnuxii / Arnoux's beaked whale (© Wurtz-Artescienza)

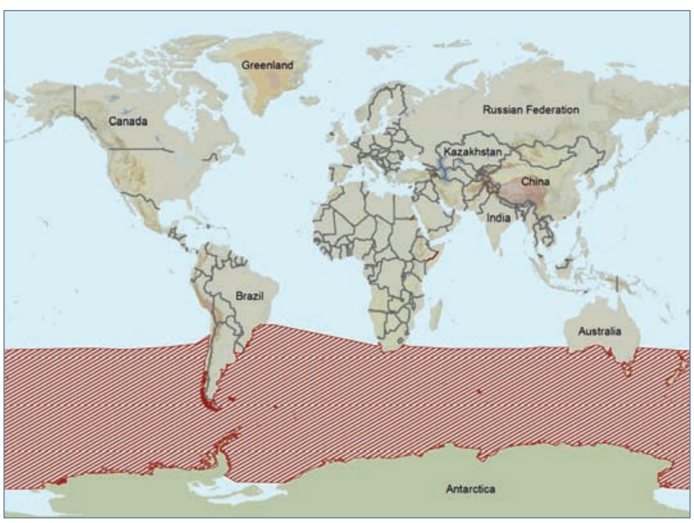
1. Description

The entire body is dark brown but the ventral side is paler and has irregular white patches. Tooth marks of conspecifics are numerous on the back, particularly on adult males. This is one of the largest beaked whales, adult size reaches 8.5-9.75 m. The blowhole is crescent-shaped, the melon is small and has an almost vertical frontal surface, from which a slender rostrum projects (Kasuya, 2002, 2009). Two pairs of triangular teeth are present at and near the tip of the lower jaw and erupt in both sexes (Jefferson et al. 2008).

2. Distribution

Arnoux's beaked whales are found circumpolar in the southern hemisphere from the Antarctic continent and ice edge (78°S) north to about 34°S in the southern Pacific including south eastern Australia (29°S) and northern New Zealand (37°S), southern Atlantic to São Paulo (24°S), and Indian Ocean; but nowhere within this range are they very well known or considered common. Most of the reported sightings are from the Tasman sea and around the Albatross Cordillera in the South Pacific. The overwhelming majority of strandings have been around New Zealand (Balcomb, 1989 and refs. therein; Jefferson et al. 1993; Rice, 1998; Baker, 1999). The species name has frequently been misspelled arnouxi or arnuxi.

The most northerly records are strandings, from the coast of São Paulo state, Brazil (Martuscelli et al. 1995, 1996), the mouth of Rio de la Plata, Argentina, from the Kromme River Mouth, South Africa and from New South Wales, Australia (Paterson and Parker, 1994).



Distribution of Berardius arnuxii: Waters around the Antarctic reaching northward to the shores of the Southern Hemisphere continents (mod. from Jefferson et al. 2008; Taylor et al. 2008; © IUCN Red List).

3. Population size

They are apparently not as numerous as the northern form. Arnoux's beaked whales are usually very 'shy' creatures. Like their northern congeners, they are capable of diving for an hour or more, hence are difficult to observe and positively identify. Indeed, in the Southern Hemisphere, the species could be confused with *H. planifrons* or *T. shepherdi* (Balcomb, 1989).

Arnoux's beaked whales seem to be relatively abundant in Cook Strait during summer (Carwardine, 1995). Sightings of large numbers have been reported along the western Antarctic coastal sector during the austral spring (Ponganis et al. 1995), similar to observations by Rogers and Brown (1999) for the eastern Antarctic sector. However, a more recent survey by Blume et al. (2007) failed to detect any *B. arnuxii* between February and April 2006 in the Amundsen and Bellingshausen Seas of the Western Antarctic. There are no detailed counts available (Barlow et al. 2006, Kasuya, 2009).

4. Biology and Behaviour

Little is known about the life history of Arnoux's beaked whale, but it is presumably similar to that of Baird's beaked whale (Balcomb, 1989).

Habitat: This species generally occurs in deep, cold temperate and subpolar waters, especially in areas with steep-bottomed slopes beyond the continental shelf edge (Kasuya 2002). Sightings have also been associated with shallow regions, coastal waters, continental slopes or sea-mounts (Rogers and Brown, 1999 and refs. therein) and other areas with steep-bottomed slopes (Carwardine, 1995).

Behaviour: Hobson and Martin (1996) observed groups of Arnoux´s beaked whales near the Antarctic Peninsula and found that their breath-hold characteristics confirm *B. arnuxii* as one of the most accomplished mammalian divers, capable of swimming up to an estimated 7 km between breathing sites in sea ice. Whales moved to and from the observed lead, apparently able to find other breathing sites in what appeared to be unbroken ice. The species seems well adapted to life in ice-covered waters and may be able to exploit food resources inaccessible to other predators in the region.

Schooling: Arnoux's beaked whales are gregarious, often gathering in groups of 6-10 and occasionally up to 50 or more. A group of approximately 80 of these whales was observed in Robertson Bay, Antarctica in February 1986 by Balcomb (1989). It was closely followed for several hours, after which it split up into subgroups of 8-15 animals which dispersed throughout the bay among windrows of loose pack ice. While near the surface, the whales frequently changed direction as they swam at about 7 km/h before diving deeply out of sight for long periods. Water depths ranged from 250 - 550 meters, and the sea surface temperature was -0.8°C.

Arnoux's beaked whales have been reported trapped in the ice, which may contribute to natural mortality.

Food: The feeding habits of Arnoux's beaked whales are assumed to be similar to those of their Northern Hemisphere relative, the Baird's beaked whale, consisting of benthic and pelagic fish and cephalopods (Jefferson et al. 1993, Kasuya 2009).

5. Migration

Arnoux's beaked whales are known to enter pack ice and may live very close to the ice edge in summer, but are likely to move away in winter (Carwardine, 1995). However, while they occur both north and south of the Antarctic Polar Front, there is no information available on seasonal shifts (Van Waerebeek et al. 2004).

6. Threats

There has not been any substantial commercial hunting of this species, but some have been taken for scientific study (Jefferson et al. 1993; Kasuya, 2009).

7. Remarks

Known and inferred Range states: Antarctica; Argentina; Australia (South Australia, Tasmania); Brazil (São Paulo); Chile; Falkland Islands (Malvinas); Heard Island and McDonald Islands; New Zealand (Chatham Is.); South Africa (Eastern Cape Province, Western Cape Province); South Georgia; South Sandwich Islands; Uruguay (Taylor et al. 2008).

Very little is known about this species, and it has been classified as "Data Deficient" by the IUCN (Taylor et al. 2008). It is listed in Appendix II of CITES. The species has not been listed by the CMS.

B. arnuxii also occurs in southern South America, therefore the recommendations iterated by the scientific committee of CMS for small cetaceans in that area (Hucke-Gaete, 2000) also apply (see "Appendix 1").

8. Sources (see p. 240)

3.2 Berardius bairdii Stejneger, 1883

English: Baird's beaked whale
German: Baird-Schnabelwal
Spanish: Zifio de Baird, ballena picuda de Baird
French: Baleine à bec de Baird

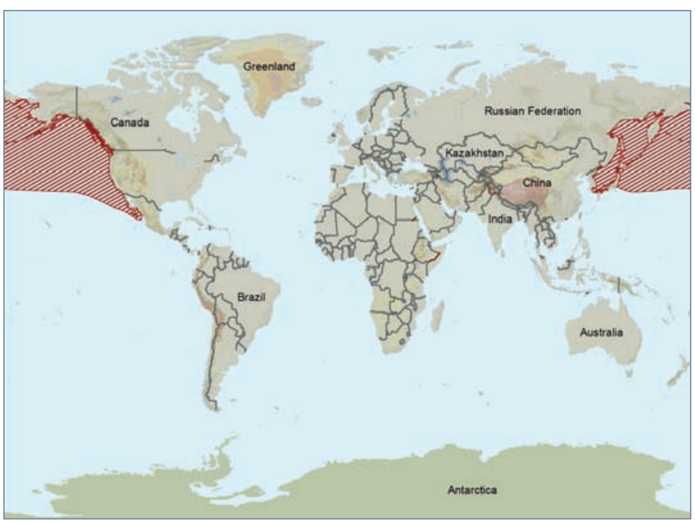
Family Ziphiidae

Berardius bairdii / Baird's beaked whale (© Wurtz-Artescienza)

1. Description

There are few known differences between the two allopatric species in this genus, the most important being the substantially larger size of *B. bairdii* (Kasuya, 2009). The validity of the two species has long been questioned by some authors, but genetic analysis of mitochondrial DNA confirmed they are distinct (Dalebout et al. 2004).

As in *B.arnuxii*, the entire body is dark brown but the ventral side is paler and has irregular white patches. Tooth marks of conspecifics are numerous on the back, particularly in adult males. Adult size reaches from 9.1 to 11.1 m. The blowhole is crescent shaped, the melon is small and has an almost vertical frontal surface, from which a slender rostrum projects. A pair of large teeth erupt on the anterior end of the lower jaw at around sexual maturity (Kasuya, 2002, 2009).



Distribution of Berardius bairdii: across the northern Pacific from Japan, throughout the Aleutians, and southward along the coast to the southern tip of California (mod. from Kasuya, 2002, 2009; Taylor et al. 2008; © IUCN Red List).

2. Distribution

Baird's beaked whale is found in the temperate North Pacific, mainly in waters over the continental slope. Its range extends in the north from Cape Navarin (62°N) and the central Sea of Okhotsk (57°N), where they occur even in shallow waters to the Komandorskiye Ostrova, Olyutorskiy Zaliv, St. Matthew Island, and the Pribilof Islands in the Bering Sea, and the northern Gulf of Alaska (Rice, 1998; Kasuya 2002).

In the south, it ranges on the Asian side as far as 34°N, and to 36°N in the Sea of Japan. The species is not found in the East China Sea, Yellow Sea and western North Pacific (Kasuya and Miyashita, 1997). Alleged sightings of *B. bairdii* across the central Pacific south as far as 25°N have not been verified by examination of specimens (they might be *Hyperoodon* sp. or *Indopacetus* sp.; Rice, 1998).

On the American side it ranges south as far as San Clemente Island (33°N), off Northern Baja California (Rice, 1998; Kasuya, 2002, 2009). It is vagrant to the southwestern Gulf of California.There have been two records of mass strandings in the Sea of Cortez near La Paz (24°N), Baja California (Balcomb, 1989; Reyes, 1991 and refs. therein; Urbán-Ramírez and Jaramillo-Legorreta, 1992).

There may be at least three stocks of Baird's beaked whales in the western North Pacific: a Sea of Japan stock that summers in the Sea of Japan and possibly remains isolated there year-round; an Okhotsk Sea stock distributed in waters near ice floes in that sea, and a Pacific coastal stock that probably inhabits continental slope waters between the fronts of the Kuroshio and Oyashio Currents, north of about 34°N (Balcomb, 1989; Reyes, 1991 and refs. therein). According to Kasuya and Miyashita (1997) there is no evidence to alter this three stock hypothesis, which is also adopted by Taylor et al. (2008). Other possible stocks are found in the Bering Sea and the eastern North Pacific, in the latter ranging from Alaska and Vancouver Island possibly to the Sea of Cortez (Balcomb, 1989; Reyes, 1991 and refs. therein).

The stock hypothesis in the western Pacific is supported by recent chemical analyses of whale "products". Haraguchi et al. (2006) found that Baird's beaked whale "products" from the Pacific Ocean contained significantly higher concentrations of Mixed halogenated dimethyl bipyrroles (HDBPs) than those from the Sea of Japan. Furthermore, the geographical distribution of HDBPs did not resemble those of ubiquitous anthropogenic organochlorines, such as polychlorinated biphenyl (PCBs).

Furthermore, Kishiro (2007) compared 14 measurements of external body proportions of 172 Baird's beaked whales caught by small-type whaling operations off the Pacific coast of Japan, the Sea of Japan and the Sea of Okhotsk from 1988 to 2004. Canonical discriminant analysis allowed to discriminate between whales from the Pacific coast and the Sea of Japan for both males and females, although some overlap was observed. The flipper size (maximum width and straight length) of the Pacific coast whales was significantly larger (3.9-8.3%) than that of the Sea of Japan whales. The canonical variates of the Sea of Okhotsk whales were located in the middle area between the Pacific coast and the Sea of Japan and a significant difference was not observed (however this may have been caused by sampling errors). Kishiro (2007) concludes that morphological differences observed between the Pacific coast and the Sea of Japan whales suggest different stocks occur in these two waters.

3. Population size

There are no recent population estimates or information on trends in global abundance (Taylor et al. 2008). In the past, sighting surveys on the whaling grounds indicated a population of several thousand Baird's beaked whales available to the fishery (Reeves and Mitchell, 1994). For Japanese waters estimates were 5,029 for the Pacific coast, 1,260 for the eastern Sea of Japan and 660 for the southern Okhotsk Sea (IWC 1992). There are an estimated 1,100 Baird's beaked whales in the eastern North Pacific, including about 228 off the US west coast (Ferguson and Barlow, 2001; Barlow, 2003; both cited in Barlow et al. 2006).

4. Biology and Behaviour

Habitat: Though they may be seen close to shore where deep water approaches the coast, their primary habitat appears to be over or near the continental slope and oceanic seamounts (Jefferson et al. 1993). Baird's beaked whales are found in pelagic, temperate waters over 1,000 to 3,000 m deep, on the continental slope. Off the Pacific coast of Japan, these whales have been recorded in waters ranging between 23°C and 29°C, with a southern limit lying at the 15°C isotherm at a depth of 100 m. In the northern Okhotsk Sea the species has been recorded in waters less than 500 m deep, which could be explained by the availability of prey species in shallower waters at higher latitudes (Reyes, 1991 and refs. therein).

The prey species found in the stomachs of the whales were almost identical to those caught in bottom-trawl nets at depths greater than about 1000 m in the western North Pacific, which suggests that whales reach these depths during foraging dives. Baird's beaked whales in the western North Pacific migrate to waters of 1,000-3,000 m deep, where demersal fish are abundant, which also reflects these feeding preferences (Ohizumi et al. 2003).

Minamikawa et al. (2007) confirmed this hypothesis using a depth and temperature data logger on an individual Baird's beaked whale off the Pacific coast of Japan. The retrieved data logger recorded 81 dives over approximately 29 h. The maximum recorded depth and the longest dive duration were 1,777 m and 64.4 min, respectively.

Behaviour: They are deep divers, capable of staying down for up to 67 min, but 85% of dives are shorter than 30 min. During surface schooling, individuals blow continuously while swimming slowly and are easily identifiable from shipboard (Kasuya, 2002, 2009). From Japanese whaling data, it appears that males live longer than females and that females have no post-reproductive stage. There is a calving peak in March and April (Jefferson et al. 1993).

Schooling: Baird's beaked whales live in larger groups than any other species of beaked whale, with pods of 5 to 20 whales, although groups of up to 50 are occasionally seen. They often assemble in tight groups drifting along at the surface. At such times, snouts are often seen as animals slide over one another's backs (Jefferson et al. 1993). Dominance of adult males in the catches off Japan has been interpreted as an indication of segregation by sex and age. It was hypothesised that females and calves stay in offshore waters and that only adult males approach the coast. However, this is unlikely because of the lack of offshore sightings during summer fishing seasons. Other speculation referring to higher female mortality as well as to composition and behaviour of schools need to be verified with additional studies (Reyes, 1991 and refs. therein).

Food: Prey identification using fish otoliths and cephalopod beaks reveal that Baird's beaked whales feed primarily on deep-water gadiform fishes and cephalopods. Off the Pacific coast of Honshu the whales fed primarily on benthopelagic fishes (81.8%) and only 18.0% on cephalopods. Eight species of fish representing two families, the codlings (Moridae) and the grenadiers (Macrouridae), collectively made up 81.3% of the total. Thirty species of cephalopods representing 14 families made up 12.7%. In the southern Sea of Okhotsk, cephalopods accounted for 87.1% of stomach contents. The families Gonatidae and Cranchiidae were the predominant cephalopod prey, accounting for 86.7% of the diet. Gadiform fish accounted for only 12.9% of the diet. Longfin codling, *Laemonema longipes*, was the dominant fish prey in both regions (Walker et al. 2002).

This is supported by Ohizumi et al. (2003) who examined the stomach contents of Baird's beaked whales caught off the coast of Japan by small-type coastal whalers. The main prey for these whales was rat-tails and hakes in the western North Pacific. Pollock and squids were also important food in the whales collected from the southern Sea of Okhotsk.

5. Migration

Information gathered from sightings on both sides of the North Pacific indicate that Baird's beaked whale is present over the continental slope in summer and autumn months, when water temperatures are highest. The whales move out from these areas in winter (Reyes, 1991 and refs. therein).

Tomilin (1957); in Balcomb, 1989) reported that in the Sea of Okhotsk and the Bering sea, Baird's beaked whales arrive between April and May, and are particularly numerous in summer. He reported they are not averse to travelling among the ice floes, going as far north as Cape Navarin (63°N).

Along the Pacific coast of Japan, a migrating population appears near the Boso Penninsula in May, reaches Hokkaido some time between July and August, and comes back again to Kinkazan offshore in the fall and then leaves Japan (Balcomb, 1989 and refs. therein). Kasuya (1986) noted that the Pacific coast population occurs predominantly from May to October along the continental slope north of 34°N in waters 1,000-3,000 m deep. Ohisumi (1983) and Kasuya and Ohisumi (1984; both in Balcomb, 1989) concluded that there is an apparent migration away from coastal Japan in winter months. Acording to Kasuya and Miyashita (1997) they appear in May along the Pacific coast of Japan, increase in density during summer on the continental slope (1,000-3,000 m depth) and north of 34°N and apparently leave in December, although there has been little sighting effort in December-April in their coastal summering ground. They are not confirmed in the deeper offshore waters in any season of the year and their wintering ground is still unknown.

In the eastern North Pacific, along the California coast, Baird's beaked whales apparently spend the winter and spring months far offshore, and move in June onto the continental slope off central and northern California, where peak numbers occur during the months of September and October. They have been seen or caught off Washington State between April and October and they were frequently seen by whalers operating off the west coast of Vancouver Island from May through October, with their peak occurrence being in August (Balcomb, 1989 and refs. therein).

6. Threats

Direct catches: Until the 1960s and 1970s, Baird's beaked whales in the eastern North Pacific were taken only by United States and Canadian whalers (in relatively small numbers). In the western North Pacific, there has been heavier exploitation by the Soviet Union and Japan. In the past, Japan's coastal whaling stations took up to 40 Baird's beaked whales per year. Some Baird's beaked whales have been caught in Japanese salmon driftnets (Jefferson et al. 1993). In 2001 the industry operated with a quota of 8 for the Sea of Japan, 2 for the southern Okhotsk Sea and 52 for the Pacific coasts (Kasuya 2002), and these numbers were slightly raised to 10, 4 and 52, respectively, in 2007 (Kasuya, 2009). Although the IWC does not control the annual quota of Baird's beaked whales, it is assumed that the present catch levels over a short period would not seriously affect the subpopulation, but research is needed to obtain information that will allow a full assessment of its status (Taylor et al. 2008).

Incidental catch: Incidental catches have been recorded, but are generally not common. Some Baird's beaked whales have been caught in Japanese salmon driftnets (Reeves and Mitchell 1993).

Deliberate culls: None reported (Reyes, 1991; Kasuya, 2009).

Habitat degradation: Heavy boat traffic to and from Tokyo Bay is said to disturb the migration of Baird's beaked whales off the Pacific coast of Japan (Reyes, 1991 and refs. therein).

Pollution: The values of PCB/DDE ratios in specimens from the western North Pacific were found to be relatively lower than in offshore cetaceans from the same area. Although this led to suggestions about the restriction of offshore migration in Baird's beaked whales, the low level of pollutants could be related to the feeding habits of this deep-diving whale (Subramanian et al. 1988; Reyes, 1991 and refs. therein).

Overfishing: Some squid stocks have been overexploited off Japan, and fisheries for other squid species are expanding, which means that conflicts could arise with respect to food availability (Reyes, 1991 and refs. therein).

Noise: US government scientists presented a paper at the 2004 IWC meeting that analysed mass strandings of Cuvier's beaked whale and Baird's beaked whale in Japan from the late 1950s until 2004 (Brownell et al. 2004). The paper reported that there were 11 mass strandings (a total of 51 animals) involving these species, all of which occurred in Suruga Bay or Sagami Bay on the central Pacific coast of Honshu. Both of these bays are adjacent to the command base for operations of the US Navy's Pacific 7th Fleet (Brownell et al. 2004).

7. Remarks

Known and inferred range states: Canada; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Mexico; Russian Federation; United States of America (Taylor et al. 2008).

Berardius bairdii is considered as Data Deficient by IUCN (Taylor et al. 2008). It is listed in Appendix II of the CMS (unfavourable conservation status, would benefit from international cooperation; 2009). It is also listed in appendix I&II of CITES.

Migration: In particular, the migration between waters of Japan and Russia occurs in the southern Okhotsk Sea and in waters off the Pacific coast of Hokkaido and the Kuril Islands. Further studies on stock identity, distribution, abundance, school structure and behaviour are needed to resolve some aspects of life history and migrations (Reyes, 1991 and refs. therein).

8. Sources (see page 240)

3.3 Cephalorhynchus commersonii (Lacépède, 1804)

English: Commerson's dolphin
German: Commerson-Delphin
Spanish: Delfín de Commerson
French: Dauphin de Commerson

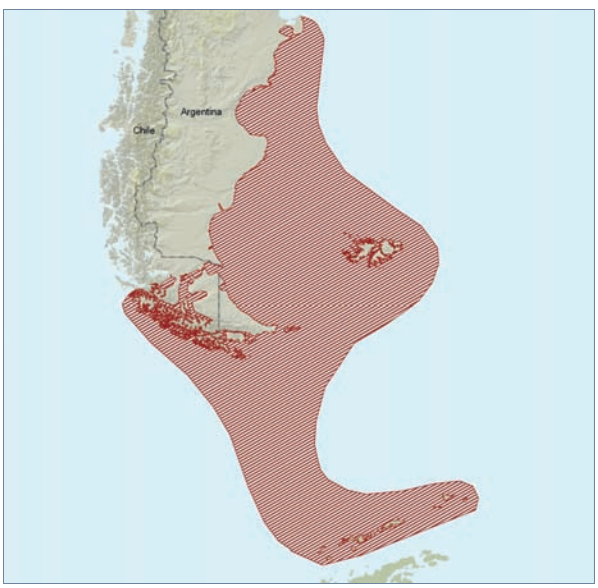
Family Delphinidae

Cephalorhynchus commersonii / Commerson's dolphin (© Wurtz-Artescienza)

1. Description

Small, blunt-headed chunky dolphins without beak (and therefore often wrongly called porpoises) with rounded, almost paddle-shaped flippers. The dorsal fin is proportionally large and with a rounded, convex trailing edge (Dawson, 2009). Body colour is muted grey on black in the young, often appearing uniform. Later, this grey pales into white in the South American form (Jefferson et al. 2008).

The head is black, with a white throat. The dorsal area from the fin backward is also black, and a black patch is located on the undersides, linking the flippers, which are also dark. The rest of the body is white apart from a black genital patch. Size ranges to 1.4 m in South America and to 1.7 m in the Kerguélen Islands; the heaviest animals recorded weighed 45 and 86 kg, respectively (Dawson, 2009).



Distribution of Cephalorhynchus commersonii: southern South America, including the Falkland/Malvinas Islands, (Reeves et al. 2008; © IUCN Red List) and Kerguélen Islands in the Indian Ocean (not shown).

2. Distribution

There are two populations separated by 130° of longitude, or 8,500 km. The animals at Kerguélen (not shown on map) differ markedly from those in South America and merit designation as a separate subspecies (Rice, 1998; Goodall, 1994; Robineau et al. 2007).

C. commersonii commersonii – Falkland Islands / Islas Malvinas and the coastal waters of southern South America. The northernmost reliably documented limit of the South America population is on the Brazilian coast between 31 and 32°S (Pinedo et al. 2002). Range extends south into Drake Passage (61°50'S) as far as the South Shetland Islands, well within the range of *C. eutropia* (Rice, 1998). On the west coast of South America, specimens have been reported from Isla Chiloé, Chile (42°45 'S; Rice, 1998).

C. commersonii kerguelenensis – Shallow coastal waters around all of the Iles Kerguélen (not shown on map) in the southern Indian Ocean (Rice, 1998; Robineau et al. 2007). No sightings or specimens have yet been reported from islands between South America and Kerguélen, such as Crozet, Heard, Amsterdam or St Paul (Goodal, 1994 and refs. therein). However, de Bruyn et al. (2006) reported sighting a single specimen over the South African continental shelf in 2004. This is the first record of this species in these waters, over 4,000 km from the known distribution limits.

3. Population size

It seems that Commerson's dolphin, despite the impacts it suffers (see below), is probably the most abundant member of the genus *Cephalorhynchus* (Dawson, 2009).

Single dolphins and groups of hundreds of animals have been sighted in the late 1980's and early 1990's from shores along the north coast of Tierra del Fuego. In other areas of Patagonia, concentrations seem to be near towns, probably a reflection of research effort rather than patchy distribution

(Goodall, 1994 and refs. therein).
Leatherwood et al. (1988) conducted aerial surveys in the northern Strait of Magellan and estimated a minimum of 3,221 dolphins for that area. However, they did not observe Commerson 's dolphins in some areas where they had previously been recorded. When Venegas (1996) estimated the density of Commerson's dolphin during early summer (1989-1990) in the eastern sector of the Strait of Magellan, they estimated a population size of only 718 individuals, which was attributed to methodological factors as well as to the time of year. However, Lescrauwaet et al. (2000) et al. estimated population size in the same sector in summer of 1996 to be 1,206 (95% CI 711 – 2,049) individuals.

Recent aerial surveys suggest that there are approximately 21,000 Commerson's dolphins along the entire South American coast, with 7,000 between 42-48°S and 14,000 in Tierra del Fuego (Pedraza et al. in review).

The status of the population at the Kerguélen Islands is unknown, although Commerson's dolphins are now being reported frequently, owing to recent emphasis on research. By 1985, over 100 sightings were known, and the largest group seen near the edge of the shelf contained about 100 dolphins (Goodall, 1994 and refs. therein; Robineau, 1989).

4. Biology and Behaviour

Habitat: Commerson's dolphins are found in cold inshore waters on open coasts and in sheltered fjords, bays, harbours and river mouths, and they occasionally enter rivers. The offshore limit of the species range is said to be the 100 m isobath (Reyes, 1991; Carwardine, 1995; Dawson, 2009), however, Pedraza et al. (in rev.) have sighted Commerson's dolphins in waters over 1,000 m deep.

Off South America, Commerson's dolphins appear to prefer areas where the continental shelf is wide and flat, the tidal range is great, and temperatures are influenced by the cool Malvinas Current. Water temperatures in areas frequented in these areas range from 4°C to 16°C. Commerson's dolphins are often seen swimming in or at the edge of kelp beds (Reyes, 1991 and refs. therein). Within the Strait of Magellan, they prefer the areas with strongest currents, such as the Primera and Segunda Angostura (First and Second Narrows), where the current can reach or exceed 15 km/hr (Goodall, 1994, Lescrauwaet et al. 2000).

Kerguélen sightings are most common within the Golfe du Morbihan, where human activity is greatest and observation programmes are under way. There, the dolphins inhabit open waters, kelp-ringed coastlines and protected areas between islets (Goodall, 1994). Preferred temperature range around Kerguélen is 1°C to 8°C (Reyes, 1991 and refs. therein).

Reproduction: The breeding season is in the southern spring and summer, September to February (Jefferson et al. 1993). Females bear their first calf at between 6-9 years and gestation lasts 10-11 months. Males reach sexual maturity at between 5-9 years (Dawson, 2009). Calves were observed between mid-September and mid-March, which suggests that calves are born in the austral spring and early summer (Iniguez and Tossenberger, 2007).

Schooling: Groups are generally small, one to three animals being most common, although the dolphins do sometimes aggregate into groups of over 100. These are quick, active animals. They are known to ride bow waves and to engage in various types of leaps. Commerson's dolphins often swim upside down (Jefferson et al. 1993; Goodall, 1994; pers. obs.).

Food: Feeding is on various species of fish, squid, and shrimp. In South America, animals taken incidentally in shore nets were coastal feeders on at least 25 food items: mysid shrimp (22.5% of total diet), three species of small fish (20.4%), squid (14.1%), 17 species of other invertebrates, four species of algae, and miscellaneous plant remains. At Kerguélen, specimens taken in January (summer) were found to have been feeding mainly on 15 – 25 cm semipelagic chaennichthyid fish (*Champsocephalus gunnari*) and to a lesser extent on coastal benthic notothenids. Pelagic crustaceans (amphipods, hyperiids and euphausiids), benthic crustaceans (*Halicarcinus planatus*), and, in one specimen, numerous annelid tubes and asciadians, were also found in stomachs (Goodall, 1994 and refs. therein). Commerson's dolphins thus appear to be opportunistic, feeding primarily near the bottom (Jefferson et al. 1993; Reyes, 1991; Goodall, 1994; Clarke and Goodall, 1994, Iniguez and Tossenberger, 2007).

5. Migration

South America: There are few data on movements or migrations. Off Patagonia, the abundance of Commerson's dolphins is higher during the colder months (May-December), when schools are larger, than in the warmer months (Coscarella et al. 2003). There, dolphins are seen throughout the year. Further South, fishermen claim that most disappear during the winter to return in November. The dolphins may follow the fish (róbalo (*Eteginops macrovinus*), merluza (*Merluccius sp*.) which move offshore during winter. A low count of Commerson's dolphins in the Strait of Magellan in late autumn may be accounted for by such movements. Certainly the number observed is larger in summer (Goodall, 1994 and refs. therein; Venegas, 1996). The largest documented movements are of about 300 km (Mora et al. 2001).

Kerguélen: Preliminary observations carried out throughout the year indicate that although some dolphins stay, most move out of the Golfe du Morbihan from June to December (winter and spring). Nevertheless, as dolphins were seldom found over the adjacent continental shelf, they may move to other parts of the archipelago (Goodall, 1994 and refs. therein).

6. Threats

Direct catch: In the past, various species of small cetaceans, mainly Commerson's dolphins, have been harpooned and used as bait in the southern king crab ("centolla"; *Lithodes santolla*) fishery in both Argentina and Chile. Because the centolla is overfished in the Magellan region, the fishing effort has shifted to the false king crab, which is exploited principally farther west in the channels where Commerson's dolphins are not found. However, in Argentina the crab fishery operates in the Beagle Channel, which is also Commerson's dolphin habitat. In addition, some animals have been killed for sport (Reyes, 1991 and refs. therein). Some Commerson's dolphins have been captured live, and the species appears to have done relatively well in captivity (Jefferson et al. 1993).

Incidental catch: Off southern South America, this is the odontocete species most frequently taken in gill nets, perhaps due to its coastal habits and narrow-band sounds. It is taken most often in fairly large-mesh nets and is apparently able to avoid nets with fine mesh. Although the exact size of the by-catch is unknown, at least 5-30 Commerson's dolphins die each year in nets set perpendicular to the shore in eastern Tierra del Fuego alone. Dolphins are also taken in this type of fishery in the Argentinean provinces north of Tierra del Fuego and in the eastern Strait of Magellan and Bahía Inútil in Chile. A few are taken by trawlers offshore in northern Patagonia (Goodall, 1994 and refs. therein; Crespo et al. 1995), especially pelagic trawls in the anchovies fishery (Crespo et al. 2007). Because the dolphins are used as bait, the fishers have no motive to avoid areas where captures occur and may favour them (Dawson, 2009).

Pollution: Low levels of chlorinated hydrocarbons (DDT, PCB and HCB) were found in blubber of Kerguélen dolphins, confirming the presence of contaminants in oceans far from the main sources of pollution. However, these levels were 10-100 times lower than those of cetaceans in the North Atlantic (Goodal, 1994).

Tourism: Dolphin-watching activities have increased in Patagonia; the number of tourists increased from 532 in 1999 to 2,113 in 2001. Dolphins show short-term reactions to the presence of whale-watching boats, performing aerial displays which are otherwise rarely seen. (Coscarella et al. 2003).

7. Remarks

Range states (Reeves et al. 2008): Antarctica; Argentina; Chile; Falkland Islands (Islas Malvinas); French Southern Territories (Kerguelen)

Cephalorhynchus commersonii is listed in the IUCN Red list as "Data deficient" (Reeves et al. 2008) and it is listed in Appendix II of CITES. The South American population is listed in Appendix II of CMS.

Commerson 's dolphins may have been seriously affected by the illegal take for bait in the crab fishery. It seems that the pressure on this species has been reduced in the late 1980s. However, the incidental mortality in gillnets and other fishing operations continues and now represents the major threat to this dolphin (Reyes, 1991, Dawson, 2009).

Regulations for small cetaceans in Argentina and Chile date back to 1974 and 1977, respectively. Permits are required for any taking, but in practice enforcement applies only to live-captures. In particular, enforcement is difficult in southern Chile, where the characteristics of the area preclude appropriate control. There does not appear to be any legislation protecting small cetaceans in the Falkland/Malvinas Islands, although some proposed conservation areas may protect the habitat. In the case of live-captures, Argentina banned this activity until more information on the species would be available (Reyes, 1991 and ref. therein, Dawson, 2009).

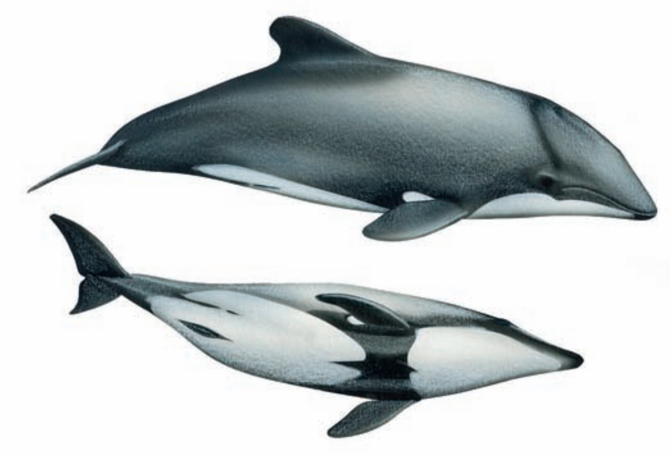
The main reasons for a regional conservation agreement on southern South-American small cetaceans including *C. commersonii* were developed in a CMS-review (Hucke-Gaete, 2000; Appendix 1).

8. Sources (see page 241)

3.4 Cephalorhynchus eutropia (Gray, 1846)

English: Chilean dolphin
Spanish: Delfín Chileno
German: Chile-Delphin
French: Dauphin du Chili

Family Delphinidae

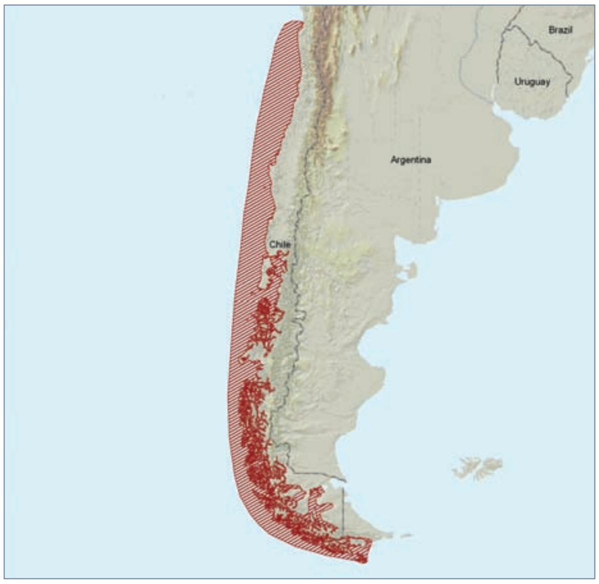


Cephalorhynchus eutropia / Chilean dolphin (© Wurtz-Artescienza)

1. Description

Small, chunky and blunt-headed dolphins without beak (and therefore often wrongly called porpoises). The flippers are rounded and almost paddle-shaped. The dorsal fin is proportionally large and with a rounded, convex trailing edge, like a "Mickey Mouse" ear (Dawson, 2009). Basically grey, with a lighter grey 'cap' over the melon. The lips are white, as is the throat and belly, and behind each flipper there is a white 'armpit'.

The flippers are linked by a grey band across the throat, which is often shaped like a rhombus in the centre. Around 1.7 m long; mass reaches 63 kg (Dawson, 2009).



Distribution of Cephalorhynchus eutropia: coastal waters of Chile and southern Argentina (Reeves et al. 2008; © IUCN Red List).

2. Distribution

Chilean dolphins occur in coastal waters of the west coast of southern South America from Valparaiso, Chile (33°S), south to Isla Navarino, Beagle Channel, and Cape Horn, Argentina (55° 15'S; Rice, 1998). *C. eutropia* is restricted to cold, shallow, coastal waters. Its distribution seems to be continuous, though there seem to be areas of local abundance, such as off Playa Frailes, Valdivia, Golfo de Arauco, and near Isla de Chiloé (Dawson, 2009). The species is known to enter Rio Valdivia and other rivers (Carwardine, 1995).

The easternmost sighting of *C. eutropia* was near the eastern mouth of the Strait of Magellan. Although it is mostly allopatric with Commerson's dolphin, *C. commersonii*, the ranges of the two species may overlap slightly in the Strait of Magellan and Beagle Channel, on the border with Argentina (Goodall, 1994).

3. Population size

The total population appears to be very small (low thousands at most). Suggestions that the species is becoming very rare are worrying and impossible to refute without dedicated survey work (Dawson, 2009). *C.eutropia* has been called a rare dolphin, but perhaps it has been seen rarely because of the lack of boat traffic and of trained observers in the channels and because of its shy, evasive behaviour.

Chilean dolphins represented 16% of the cetacean sightings, captures, and strandings in an 8-year study between Coquimbo (30°S) and Tome (36°37'S). However, most sightings occurred on an opportunistic basis, as few ship surveys and no aerial surveys have been carried out (Goodall, 1994). Overlapping with this area, and north of the Maule River (36 °N), a zone more influenced by the estuarine system, Perez-Alvarez et al. (2007) saw Chilean dolphins in 83% of the surveys . The relative abundance was significantly higher than to the south (13.6 dolphins/h versus 3.5 dolphins/h, respectively).

While it may appear to be locally abundant in areas such as Valdivia, the Golfo de Arauco and near Chiloé, where groups of 20-50 or more animals have been seen (Goodall, 1994), a recent study (Heinrich, 2006) showed that local populations may be very small; at southern Chiloé, the size of the local population amounted to only 59.

Finally, a boat survey conducted between the southern tip of Chiloe and Ushuaia made only few sightings of Chilean dolphins (Dawson 2009), confirming the general decrease in abundance from north to south.

4. Biology and Behaviour

Habitat: The Chilean dolphin inhabits two distinct areas: (1) the channels from Cape Horn to Isla Chiloé and (2) open coasts, bays and river mouths north of Chiloé, such as waters near Valdivia and Concepción. It seems to prefer areas with rapid tidal flow, tide rips, and shallow waters over banks at the entrance to fjords. The dolphins readily enter estuaries and rivers (Goodall, 1994). In Yaldad Bay, southern Chile, shallow waters (5-10 m) near the coast and rivers were the most significant environmental features determining fine-scale dolphin distribution patterns (Ribeiro et al. 2007). Although most sightings have been near shore and therefore it is considered a coastal species, little scientific survey effort has been made in offshore waters (Goodall, 1994).

Schooling: The usual group size is from two to 10 dolphins; most observers have reported sighting only two or three animals at one time. Nevertheless, groups of 20-50 or more dolphins are seen at times, especially in the northern part of the range, and early investigators wrote of "great numbers". Such observations may represent occasional aggregations of smaller groups. The largest concentration ever reported was 15 miles long, possibly 4,000 animals, which moved north past Queule (39°22'S), hugging the shore (Goodall, 1994). The species may associate with *Lagenorhynchus australis* (Goodall, 1994; Jefferson et al. 1993).

Food: *C. eutropia* feeds on crustaceans (*Munida subrugosa*), cephalopods (*Loligo gahi*), and fish, such as sardines (*Strangomera bentincki*), anchoveta (*Engraulis ringens*), róbalo (*Eteginops macrovinus*) and the green alga *Ulva lactuca*. Dolphins near a salmon hatchery on Chiloé played with salmon and may have eaten young released salmon (Goodall, 1994 and refs. therein).

Behaviour: Off central Chile, three behaviour categories were recorded (feeding, socialising, and travelling) in both areas (Perez-Alvarez et al. 2007). Foraging was the most frequently observed activity. Aquaculture activities in the area were observed to affect habitat use patterns, by restricting space available for biologically important dolphin behaviours (Ribeiro et al. 2007).

In the southern part of the range the dolphins tend to be more wary of boats and difficult to approach; in the north, they have been known to swim over to boats and may bow-ride Carwardine (1995).

5. Migration

The Chilean dolphin is thought to occur more or less continuously throughout its range, and nothing is known of its movements or migration. Numerous observations in the Valdivia area suggest that there is at least one resident pod, but individual animals have not been identified to confirm this. Sightings occur throughout the year in the northern part of the range (north of Chiloé) (Perez-Alvarez et al. 2007) and during most months in the central and southern section (Goodall, 1994).

6. Threats

Direct catch: Although killing of dolphins is prohibited by law, they are taken for bait, and it has been claimed that they were also used for human consumption. Fishermen in coastal areas north of Chiloe harpooned them or used those taken incidentally in their nets, as bait for fish caught on long lines with many hooks, for swordfish fished with individual hooks, or for crab ring nets. From Chiloé south, and especially in the Magellan region, dolphins are taken along with sheep, seals, sealions, penguins, other marine birds, and fish for bait for the lucrative "centolla" (southern king crab, *Lithodes santolla*) and "centolion" (false king crab, *Paralomis granulosa*) fishery. The larger crab-processing companies provide bait (in insufficient quantities) for their fishermen, but independent fishermen who supply smaller companies harpoon or shoot their own bait and claim that the crab prefer dolphins over other animals and birds. It has been estimated for the 1980's that two Chilean dolphins were taken per week per boat, and that as many as 1,300-1,500 dolphins were harpooned per year in the area near the western Strait of Magellan. Fishing areas since then have moved farther north and south, but the captures of dolphins for bait continue (Goodall, 1994). Although hunting is now illegal, fishermen in the area are poor and enforcement of the law in remote areas is practically impossible. A dependable alternative supply of inexpensive bait is needed (Dawson, 2009). Current take remains unknown.

Incidental catch: Incidental catch probably occurs throughout its range, especially in the north, where dolphins can become entangled in several kinds of nets. At Queule, near Valdivia, Chilean dolphins accounted for 45.8% of the dolphins taken in gillnets set from some 30 boats. This implies a catch of some 65-70 animals per year at this one port alone (Goodall, 1994, and refs. therein). Around Chiloe, where gillnets are employed to catch escaped salmon, bycatch may cause a significant population decline (Dawson, 2009).

Mariculture: Aquaculture farms for salmon and shellfish also may have negative effects on Chilean dolphins, e.g. by restricting their movements and eliminating important habitat, e.g. along the east coast of Isla Grande de Chiloé. Finally, there is evidence that Chilean dolphins are sometimes caught incidentally in anti-sea lion nets set up around salmon farms in the fjords and channels (Reeves et al. 2008). They also react negatively to boat traffic disturbance (Ribeiro et al. 2005).

7. Remarks

Range states (Reeves et al. 2008): Argentina, Chile

C. eutropia is included in Appendix II of the CMS: its range may extend beyond the Chilean border into Argentinean waters in the Beagle channel and at the entrance of the Strait of Magellan. It is listed in Appendix II of CITES.

C. eutropia is listed as "Near Threatened" by the IUCN: Total population size appears to be low (in the low thousands) and decline via catches and bycatch seems to be continuing, although the decline rate is unknown. Collection of by-catch and sighting data is therefore strongly needed (Dawson, 2009).

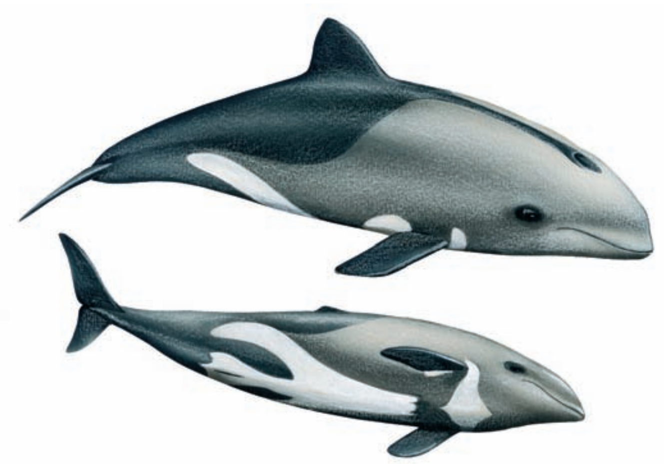
In a CMS review (see Appendix 1), Hucke-Gaete (2000) exposes priorities for research and actions on southern South-American small cetaceans including *C. eutropia*.

8. Sources (see page 241)

3.5 Cephalorhynchus heavisidii (Gray, 1828)

English: Heaviside's dolphin
German: Heaviside-Delphin
Spanish: Delfín del Cabo
French: Céphalorhynque du Cap

Family Delphinidae

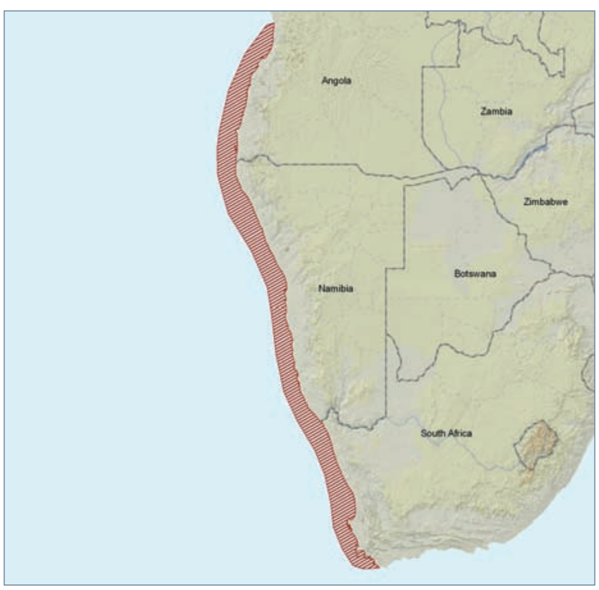


Cephalorhynchus heavisidii / Heaviside's dolphin (© Wurtz-Artescienza)

1. Description

All dolphins of the genus are small, blunt-headed and chunky. Because they don't have a beak, they are often wrongly called porpoises. Their flippers are rounded and almost paddle-shaped. The dorsal fin is proportionally large and triangular (Dawson, 2009). The fore half of the body is uniformly grey, with the dorsal cape, fin, flanks and keel being dark blue-black. A similarly-coloured stripe runs from the blowhole to the cape. The flippers and eye patch are the same colour.

The underside is white, with white 'armpits' behind the flippers and a rhombus shape on the chest. A finger-shaped patch extends from the belly along each flank. Adults grow to around 1.7 m long and weigh around 75 kg (Dawson, 2009).



Distribution of Cephalorhynchus heavisidii (Reeves et al. 2008): cold coastal waters from central Namibia to southern South Africa (© IUCN Red List).

2. Distribution

Heaviside's dolphins range in close inshore waters of south-western Africa, from northern Namibia (17°09'S) south to Cape Point in Cape Province (34°21'S) (Rice, 1998; Dawson, 2009). The range is restricted and fairly sparsely populated throughout (Carwardine, 1995). There are no authenticated sightings or beach-cast specimens of the species east of Cape Point, and this seems to mark the southern and eastern limit of distribution. According to Best and Abernethy (1994) the northern limit is less well defined, as records extend along the entire west coast of South Africa and Namibia. As the cetacean fauna of Angola is very poorly known, it is uncertain how much farther north the distribution of Heaviside's dolphin might extend.

3. Population size

No reasonable estimate is possible from the available data. Griffin and Loutit (1988, in Best and Abernethy, 1994) stated that Heaviside's dolphins are the cetaceans most frequently seen in the northern part of their range, off the Namibian coast. In the southern portion of the range, within a coastal area from Cape Town to 390 km north west, 6,345 animals (95% CI = 3,573-11,267) have recently been estimated (Elwen et al. 2009).

4. Biology and Behaviour

Habitat: As other species in the genus, it is a coastal, shallow water animal (Jefferson et al. 1993; Reyes, 1991). Dolphins fitted with satellite transmitters varied in their use of the inshore areas from 39.5% to 94.7% of transmission days (38-51 total) (Elwen et al. 2009). It is mostly seen within 8-10-km of shore and in water less than 100 m deep. Surveys within 8 km of the coast have shown low population densities of around 5 sightings per 160 km; sightings dropped dramatically further offshore, and no animals were seen in water deeper than 200 m. *C. heavisidii* seems to be associated with the cold, northward-flowing Benguela Current. Some populations may be resident year-round (Carwardine, 1995; Reyes, 1991; Rice and Saayman, 1984). Heaviside's dolphins have been found within a wide range of surface temperatures (9-19°C), but most sightings (87.2%) were in water of 9-15°C (Best and Abernethy, 1994).

Behaviour: Little is known about the behaviour of this species. It is generally undemonstrative and appears to be shy. Reactions to vessels vary, but it is known to approach a range of boats and to bow-ride and wake-ride; some animals have been seen "escorting" small vessels for several hours at a time. Limited observations suggest that at least some groups have restricted home ranges and probably do not stray far from these areas (Carwardine, 1995).

Schooling: Heaviside's dolphins are usually found in small groups of from one to 10 animals, with two being the most common number. Mean group size for 149 confirmed sightings made on scientific cruises was 3.2 animals. On some occasions two groups can be found in close association, and it is possible that amalgamation into larger groups may occur occasionally; the sighting of 30 animals may represent such an occasion (Best and Abernethy, 1994 and refs. therein).

Food: Stomach contents are available from 17 animals, and included a minimum total of 4,928 identifiable food items. Demersal fish such as hake (*Merluccius capensis*) and kingklip (*Genypterus capensis*) formed 49% and octopods 22% by weight of the organisms identified, while gobies (*Sufftogobius bibarbatus*) and squid (*Loligo rejnaudi*) were also important components. Heaviside's dolphin seems to feed on bottom-dwelling organisms, demersal species that may migrate off the bottom (even to the surface) at night, and pelagic species that can be found from the surface to near the sea floor on the continental shelf (Best and Abernethy, 1994 and refs. therein).

5. Migration

Movements of this species are not well known. Repeated sightings of individually recognisable specimens (including a pure white animal) over a long period indicate that certain groups may be resident in some areas (Reyes, 1991 and refs. therein). However, Best and Abernethy (1994) concluded "whether Heaviside's dolphins reside year-round in particular areas is an open question". An immature male *C. heavisidii* marked with a spaghetti tag was recaptured 17 month later about 85 nautical miles north of the marking position. Although little can be deduced from a single incident, this record suggests a relatively small amount of overall movement (Best and Abernethy, 1994 and refs. therein).

Home-range (may easily extend across international boundaries) and estimates ranged from 302 to 1,028 km² (90% isopleths). Although the distance from shore and depth at which individual dolphins moved varied greatly, all dolphins showed a strong onshore-offshore diurnal movement pattern, generally being closest inshore between 0600 h and noon, and farthest offshore between 1500 h and 0500 h. This pattern is assumed to be related to the movements of their principal prey, juvenile shallow-water hake (*Merluccius capensis*), which migrates into the upper water column at night. Movements inshore may be associated with rest, socializing, and predator avoidance (Elwen et al. 2006).

6. Threats

Direct catch: Although fully protected legally, directed takes with hand-thrown harpoons or guns of about 100 dolphins per year, including Heavisides dolphin and two other species, have been reported (Reyes, 1991 and refs. therein).

Incidental catch: Some Heaviside's dolphins become entangled in a variety of inshore fishing nets off South Africa and Namibia each year (Carwardine, 1995). Estimated total kills of dolphins in 7,013 sets off Namibia in 1983 were 67 (*C. heavisidii* and *Lagenorhynchus obscurus* combined), whereas 57 were killed in South Africa. Other reported sources of incidental mortality were set nets in waters close to the shore of Namibia, although data on catch rates and mortality are lacking.

There are unconfirmed reports of specimens taken in a bottom trawl fishery, but a drift net shark fishery does not seem to pose a threat to the dolphin population (Reyes, 1991 and refs. therein). Heaviside's dolphins are also known to be caught accidentally in beach-seine nets. Up to seven dolphins have been reported to be entrapped and beached during one net haul, and although it is likely that many of the animals landed in this fishery are returned to the sea alive, some mortality may occur (Best and Abernethy, 1994).

Although probably able to sustain some mortality following interactions with commercial fishing gear, Heaviside's dolphins may become negatively impacted should fishing activities increase (Peddemors, 1999; Dawson, 2009).

Deliberate culls: None reported (Reyes, 1991).

Habitat degradation: Taking into account the relatively small home range of the species and its restricted distribution in coastal waters, pollution and boat traffic may be causes for concern (Reyes, 1991).

7. Remarks

Range states: Angola; Namibia; South Africa (Northern Cape Province, Western Cape Province) (Reeves et al. 2008).

C. heavisidii is included in Appendix II of the CMS, listed as "Data Deficient" by the IUCN (Reeves et al. 2008) and listed in Appendix II of CITES.

More information on the nature and extent of catches is required to assess its status (Reyes, 1991).

For Namibia, such data is currently being gathered through the Namibian Dolphin Project (Elwen, pers. comm.).

Heaviside's dolphin is protected within the 200-mile Exclusive Fishery Zone (EFZ) of South Africa, where all delphinids are protected under the Sea Fisheries Act of 1973. Similar protection is given In Namibia's 12-mile EFZ. Permits were formerly given for the operation of set netting off the Namibian coast but this has been prohibited by the Government since 1986. Although its range is restricted to a small part of the southwestern African coast, observations by Rice and Saayman (1989) show that relatively large groups are present regularly in waters involving the national boundaries of Namibia and South Africa, the two known Range States (Reyes, 1991 and refs. therein).

Further information is needed on the distribution of the species in Angola, whose status as a Range State requires further consideration.

More research emphasis should in future also be placed on possible detrimental interactions due to overfishing of prey stocks. Increased commercial fishing pressure will inevitably also increase interactions between the fishery and Heaviside's dolphins (Peddemors, 1999).

8. Sources (see page 242)

3.6 Cephalorhynchus hectori (van Beneden, 1881)

English: Hector's dolphin
German: Hector-Delphin
Spanish: Delfín de Héctor
French: Dauphin d'Hector

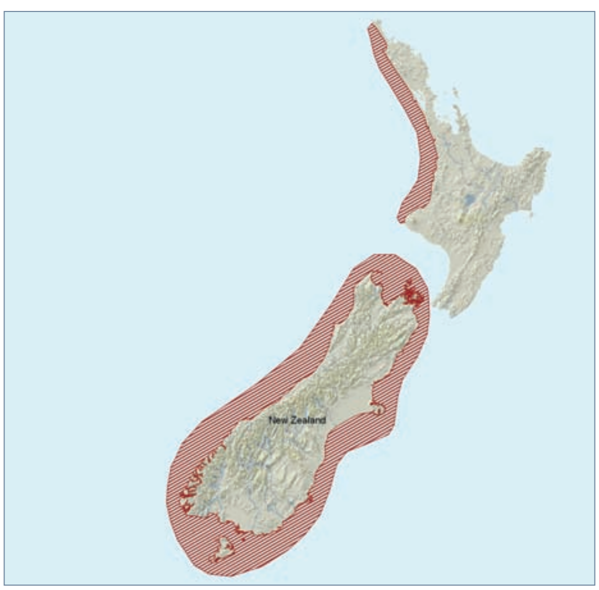
Family Delphinidae

Cephalorhynchus hectori / Hector's dolphin (© Wurtz-Artescienza)

1. Description

Similar to the other representatives of the genus, these are small, blunt-headed chunky dolphins without a beak (and therefore often wrongly called porpoises) with rounded, almost paddle-shaped flippers. The dorsal fin is proportionally large and with a rounded, convex trailing edge, like a "Mickey Mouse ear". The colour scheme of the Hector's dolphin is well defined with areas of grey, black and white. Mass and size of the two subspecies found in New Zealand vary: North Island 152 cm, 65 kg, South Island 145 cm, 50 kg (Dawson, 2009).

The sides of the head, the flippers, dorsal fin and the tail are all gray to black. The belly is white except for a small area between the flippers. There is also a distinctive finger-like swoosh of white that extends from the belly, along the flanks towards the tail. (Jefferson et al. 2008).



Distribution of Cephalorhynchus hectori (Reeves et al. 2008): coastal waters of New Zealand, especially South Island and the western coast of North Island (Reeves et al. 2008; © IUCN Red List).

2. Distribution

Hector's dolphin is endemic to inshore waters of the main islands of New Zealand. Pichler et al. (1998) used mitochondrial DNA analysis to determine that *C. hectori* was subdivided into sub-populations, which total four (Pichler, 2002): North Island, East Coast South Island, West Coast South Island, and South Coast South Island—with only little or no female dispersal. The North Island subpopulation of Hector's Dolphin was subsequently recognized as a subspecies, *C. h. maui* (Baker et al. 2002).

Cephalorhynchus hectori hectori: most common along the east and west coasts of South Island between 41° 30' and 44° 30'S, with hot spots of abundance at Banks Peninsula and between Karamea and Makawhio Point. An apparently isolated population exists in Te Wae Wae Bay, on the Southland coast (Dawson, 2009).

Cephalorhynchus hectori maui: occurs on the west coast of North Island between 36°25' and 39°'S, but is generally only seen between the entrance of Manuaku Harbour and Port Waikato (Dawson, 2009).

3. Population size

North Island: Slooten et al. (2006a) from 2004 data, estimated the total *C. h. maui* population size at 111 individuals (95% confidence interval = 48-252). The small population size confirms its critically endangered IUCN status and the suggestion that it is vulnerable to extinction (Dawson et al. 2001). It has been suggested that one dolphin every 6.4 years is the maximum level of human-caused mortality to maintain the population, therefore, considerable steps need to be taken to allow for population recovery.

South Island: Line-transect surveys of Hector's dolphins on the East Coast of the South Island conducted prior to the year 2000 in the coastal zone to 4 nm offshore yielded an abundance estimate of 1,880 individuals (CV=15.7%; Dawson et al. 2004). Maximum densities peaked at 5-18 individuals per nautical mile of coastline between Cape Foulwind and Hokitika (Braeger and Schneider 1998).

Aerial surveys prior to 2002 suggested that the populations of *C. h. hectori* numbered ca. 1,900 (east coast) and ca. 5,400 (west coast) animals (Slooten et al 2002). In 2000 - 2001 the total population estimate for South Island Hector's dolphins was 7,270 (CV = 16.2%; Slooten et al. 2002; 2004). The most recent estimate was 7,873 (Slooten, 2007), showing little change for the past 7 years.

4. Biology and Behaviour

Habitat: The most consistent factor influencing the distribution of Hector's dolphins appears to be their preference for shallow waters. This may explain their apparent absence from Fiordland, where depths in excess of 300 m are very common, and their apparent reluctance to cross Cook Strait to North Island waters. Hector's dolphins inhabit a wide range of water temperatures (surface temperature 6.3-22 °C;) and water turbidity (< 10 cm to > 15 m) (Slooten and Dawson, 1994).

Bräger et al. (2003) encountered most dolphins in waters < 39 m depth, with < 4 m Secchi disk visibility and > 14 °C temperature. Habitat selection by dolphins differed between study areas, particularly between east and west coasts, in summer (December-February) and winter (June-August). Dolphin abundance appeared to change seasonally in some study areas. This was so especially in summer (the main reproductive season), when dolphins (frequently with calves) occupied shallow and turbid waters, whereas in winter less use was made of this habitat, possibly due to a more offshore distribution of their prey.

Behaviour: Large groups often show eyecatching behaviour such as leaps, chases and lobtailing. Hector's dolphins are strongly attracted to boats and readily bow-ride (Dawson, 2009). Mothers with newborn calves are shy and seldom approach stationary or moving boats. Except in ports and other areas of very intensive boat traffic, it seems unlikely that the presence of boats will greatly affect the behaviour and distribution of this species (Slooten and Dawson, 1994, and refs. therein).

Schooling: Hector's dolphins live in groups of 2 to 8 individuals. Larger aggregations of up to 50 can be seen at times (Jefferson et al. 1993). Braeger and Schneider (1998) reported that small to medium-sized groups of Hector's dolphins with 1-60 individuals were observed in almost all areas of the west coast of South Island in winter as well as in summer. Groups rarely stay in tight formation, though several individuals may swim and surface together in a row. Most active when small groups join together (Carwardine, 1995).

Reproduction: Females bear their first calf at age 6-9 years, and males reach sexual maturity at 5-9 years. Mating and calving occur in spring to late summer and gestation lasts 10-11 months. Females calve every 2-4 years. At Banks peninsula, six photographically identified Hector's dolphins attained a maximum age of at least 22 years (Dawson, 2009).

Food: Hector's dolphins appear to feed mostly in small groups. The dolphins feed opportunistically, both at the bottom and throughout the water column, and take a wide variety of species. Surface-schooling fish (e.g. yellow-eyed mullet, *Aldrichetta forsteri*, kahawai, *Arripis trutta*) and arrow squid, *Nototadarus* sp., are taken along with benthic fishes such as ahuru, *Auchenoceros punctatus*, red cod, *Pseudophycis bacchus* and stargazer, *Crapatalus novaezelandiae*. Crustaceans are occasionally found among the stomach contents, including *Ovalipes catharus*, *Hymenosoma depressum* and *Macroptkalmus hirtipes*, but these appear to be from the stomach contents of fish taken by the Hector's dolphins. In summer, dolphins occasionally follow inshore trawlers, apparently stationing themselves behind the cod-end of the net. The dolphins themselves are rarely caught in trawl nets (Slooten and Dawson, 1994, and refs. therein).

5. Migration

Despite wide-ranging surveys over more than 20 years, no sightings of the same Hector's dolphin were more than 106 km apart (Dawson, 2009). Most individuals ranged over less than 60 km (Mean 31.0 km, SE = 2.43) of coastline. Site fidelity was high: e.g. in Akaroa Harbour individuals were seen for about two thirds of the years they were known to be alive (Bräger et al. 2002).

Stone et al. (1998) confirmed short-range movement patterns via radio-telemetry and found them to be remarkably consistent. Dolphins remained in Akaroa Harbor for a period of between one and five hours, after which they left in a westerly direction, always in the late afternoon or early evening. Two dolphins returned to Akaroa Harbor the next morning. These patterns support previous studies which described a diurnal movement pattern for this species (Stone et al. 1995).

A similar picture was obtained from a theodolite tracking and boat-based photo-identification survey in Porpoise Bay, on the south-east corner of South Island. Results are consistent with the model of a small resident population (48 dolphins; 95% CI = 44-55 in 1996/97) that is visited occasionally by members of neighbouring populations. Dolphins spent a large proportion of their time in a small area inside the bay. There, no pattern of diurnal movement into and out of the bay was observed (Bejder and Dawson, 2001).

6. Threats

Direct catch: Hector's and Maui's dolphins are protected under the Marine Mammals Protection Act (1978) therefore any direct take is illegal.

Incidental catch: Total population size today (7,873) was estimated at 27% of the population size estimated for 1970 (29,316, CV 0.16), before a major expansion of commercial gillnetting (Slooten, 2007). The catch of Hector's dolphins in coastal gillnets, many of them used by recreational fishermen, has been repeatedly documented. It is believed that the effects of fishing are the greatest cause of human induced mortality on the dolphins (MoFNZ, 2010). One example is that strandings are exclusively of single animals and many beach-cast dolphins bear cuts and abrasions consistent with being caught and killed in gill nets (Slooten and Dawson, 1994). Due to evidence that the catches were seriously threatening the population, the N.Z. government created a marine mammal sanctuary in 1989 to protect them (Jefferson et al. 1993; Slooten and Dawson, 1994).

Stone et al. (1997) showed that Hector's dolphin distributions were affected by 10 kHz pingers and that dolphins avoided the immediate area where the pingers were active. This suggests that pinger use could reduce mortality in gill nets. A pilot study to test the use of electronic monitoring (EM) systems to examine interactions between protected species and fishing gear (McEldeny et al. 2007) such as inshore set net and trawl fisheries was shown to effectively monitor retrieval operations and encounters with protected and endangered species.

Clearly, these efforts are promising: Reducing fisheries mortality to levels approaching zero shows the strongest promise of meeting national and international guidelines for managing dolphin bycatch, with a 59% probability of reaching 50% of estimated 1970 population size by 2050 (Slooten, 2007).

Slooten et al. (2006b) suggested a size extension of the Banks Marine Sanctuary beyond the 4 nm from shore: In summer, the proportion of sightings inside the 4-nautical-mile offshore boundary of the sanctuary was 79%. This dropped to just over 35% in winter. The authors suggest that appropriate modifications to the sanctuaries extension could significantly reduce mortality due to bycatch. Since then, alterations to the Banks Peninsula marine mammal sanctuary have been notified, extending the northern and southern boundaries significantly while at the same time extending the seaward boundary to 12 nautical miles. Furthermore, a series of additional marine mammal sanctuaries have been put in place (Dept. Cons. NZ, 2010).

Pollution: The strictly coastal distribution of this species makes it vulnerable to accumulation of pollutants such as heavy metals and pesticide residues. Although their precise biological effects are poorly known, the level of some of the contaminants gives some cause for concern. Moderate to high levels of DDT, PCBs and Dioxin have been found in the tissues of Hector's dolphins. These compounds are known to interfere with reproduction and their effects are worsened by synergism between compounds. Mercury, cadmium and copper levels are also relatively high when compared to other species. It is not known to what extent pesticide contamination or other forms of pollution contribute to mortality or to the low reproductive rates observed in Hector's dolphins (Slooten and Dawson, 1994).

Tourism: There has been a rapid growth in marine mammal-based tourism around the world, because marine mammals have a wide appeal for many people and are readily found around many coastal areas and are therefore readily accessible. Marine mammal-based tourism in New Zealand is a wide-ranging, species-diverse industry with an increasing demand for permits from land, boat and air-based platforms. One publication cites that e.g. a total of 74 permits at 26 sites have been issued from Maunganui to Stewart Island (Constantine, 1999).

Hector's Dolphins are not displaced by boats or by human swimmers. Swimmers cause only weak, non-significant effects, perhaps because the dolphins can very easily avoid them. Reactions to dolphin-watching boats are stronger. Analyses of relative orientation indicate that dolphins tend to approach a vessel in the initial stages of an encounter but become less interested as the encounter progresses. (Bejder et al. 1999).

7. Remarks

The endemic New Zealand Hector's dolphin is considered one of the rarest species of marine dolphin (WWF, 2009).

The North island population of *C. h. maui* is considered "Critically Endangered" by the IUCN (Reeves et al. 2008): it is assumed that there are fewer than 250 mature animals, and the principal cause for the population decline has not been stopped; gillnetting and trawling continue in areas occupied by the subspecies, with bycatch rates exceeding recovery rate. Its vulnerability is further increased by its fidelity to local natal ranges and the genetic isolation of regional populations. Given its small size, reproductive isolation and reduced genetic diversity, the North Island population is likely to become extinct. The time-series of reduction in genetic variation provides independent evidence of the severity of population decline and habitat contraction resulting from fisheries and perhaps other human activities (Pichler and Baker, 2000).

The South Island population of *C. h. hectori* is listed as "Endangered" by the IUCN (Reeves et al. 2008): the decline due to fisheries bycatch seems to be ongoing (but see above) and projected to be larger than 50% over 3 generations. Furthermore, the range of the species is very limited.

New Zealand Hector's dolphin is not included in Appendix II of the CMS because it is endemic to New Zealand.

Both subspecies are listed in CITES Appendix II.

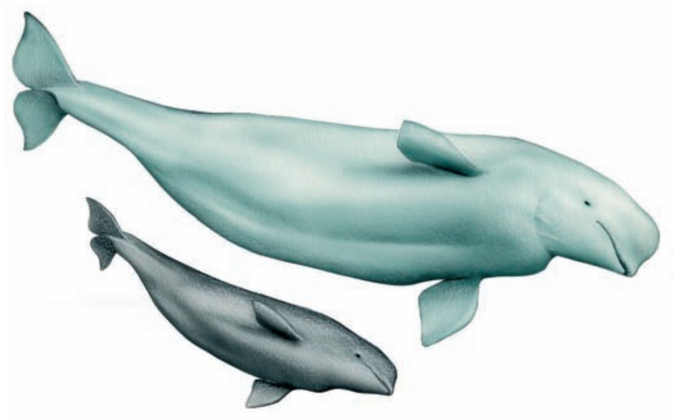
Acknowledgement: We are grateful to Laura Boren, New Zealand Dept. of Conservation, for kindly reviewing this species summary.

8. Sources (see page 242)

3.7 Delphinapterus leucas (Pallas, 1776)

English: White whale, beluga
German: Weißwal, Beluga
Spanish: beluga, ballena blanca
French: belouga, dauphin blanc, marsouin blanc

Family Monodontidae



Delphinapterus leucas / White whale (© Wurtz-Artescienza)

1. Description

The common name of the beluga refers to its most striking feature and is derived from the Russian word "beloye" meaning "white". The white whale is a medium-sized odontocete, 3.5-5.5 m long and reaches a mass of up to 1,500 kg. Males are more robust and 25% longer than females (O'Corry Crowe, 2009). They lack a dorsal fin, which may be an adaptation to life in the ice also reducing heat loss. Instead, they possess a predominant dorsal ridge which is used to break through thin sea ice. Unlike most other cetaceans, they have unfused cervical vertebrae, allowing lateral flexibility of the head and neck. The young are about 1.6 m long and are born a grey-cream colour, which then turns to dark brown or blue-grey. The distinctive pure white colour of beluga whales is reached in 7 year old females and 9 year old males (O'Corry Crowe, 2009). Maximum recorded age is 80 years (Stewart et al. 2006).

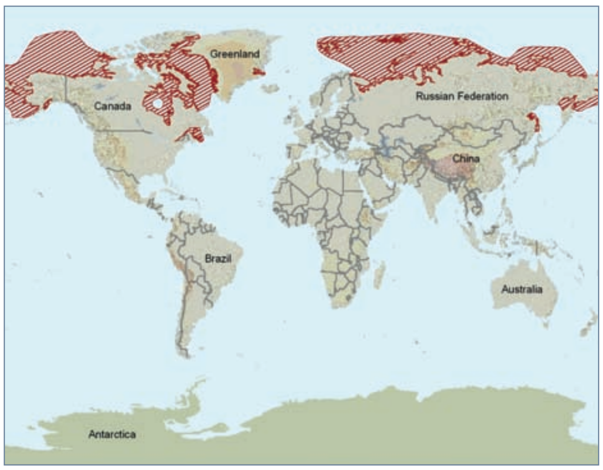
2. Distribution

Beluga whales are widely distributed around the Arctic Ocean and adjacent seas, and occur mainly in shallow shelf waters. Their range covers Hudson and James Bay; Somerset Island, Devon Island, the east coast of Baffin Island, and Ungava Bay; the northwest coast of Greenland from Inglefield Bredning south to Julianehab; the vicinity of Scoresby Sund on the East-central coast of Greenland; the Arctic coast of western and central Eurasia, from the Barents and White Seas east to the Laptev Sea, including Svalbard, Zemlya Frantsa Iosifa, Novaya Zemlya, Severnaya Zemlya, and Novosibirskiye Ostrova; the Arctic coast of eastern Siberia from Ostrov Vrangelya to Bering Strait; the Bering Sea south to Anadyrskiy Zaliv and Bristol Bay; the Arctic coast of Alaska and Northwestern Canada from the Chukchi Sea and Kotzebue Sound east to the Beaufort Sea. Vagrants were observed off New Jersey, Iceland, the Faroes, Ireland, Scotland, the Atlantic coast of France, the Netherlands, Denmark, Japan and Washington State (Rice, 1998).

A number of independent stocks have been identified based on differences in body size between different distribution areas, non-uniform distribution pattern, return to predictable, specific coastal areas, differences in contaminant signatures, and geographic variation in vocal repertoire (O'Corry Crowe, 2009). Although dispersal among separate summering concentrations is limited (Brown Gladden et al. 1997; O'Corry Crowe et al. 1997), it is possible that many sub-populations overwinter in the same area, where interbreeding may occur (de March et al. 2002).

According to Rice (1998), there are five widely disjunct populations a) in the Saint Lawrence estuary, b) in the northern and c) western Sea of Okhotsk including Tatarskyi Zaliv, d) in Cook Inlet and e) in the Northern Gulf of Alaska.

In particular, beluga from western North America (Bering Sea) can be clearly distinguished from beluga from eastern North America (Hudson Strait, Baffin Bay, and St. Lawrence River). Based upon a combined data set (mitochondrial and



Beluga distribution (Jefferson et al. 2008; © IUCN Red List): the northernmost extent of its known distribution is off Alaska and northwest Canada and off Ellesmere Island, West Greenland, and Svalbard (above 80°N). The southern limit is in the St. Lawrence river in eastern Canada (47°-49° N; O'Corry-Crowe, 2009).

nuclear DNA), Gladden et al. (1999) divided the population of North American beluga whales into two evolutionarily significant units.

3. Population size

The beluga population is subdivided into management units to reflect distinct groups of beluga at summering locations. In its 2000 report, the IWC recognises 29 putative stocks for:
1) Cook Inlet, 2) Bristol Bay, 3) E. Bering Sea, 4) E. Chukchi Sea, 5) Beaufort Sea, 6) North Water, 7) W. Greenland, 8) Cumberland Sound, 9) Frobisher Bay, 10) Ungava Bay, 11) Foxe Basin, 12) W. Hudson Bay, 13) S. Hudson Bay, 14) James Bay, 15) E. Hudson Bay, 16) St. Lawrence, 17) Svalbard, 18) Franz Josef Land, 19) Ob Gulf, 20) Yenesy Gulf, 21) Onezhsky Bay, 22) Mezhenskyi Bay, 23) Dvinskyi Bay, 24) Laptev Sea, 25) W. Chukchi - E. Siberian Seas, 26) Anadyr Gulf, 27) Shelikov Bay, 28) Sakhalin-Amur, and 29) Shantar. Stock boundaries sometimes overlap spatially and in such cases the geographical delineation of white whale stocks must have a temporal component (IWC, 2000).

Alaska:

1. Cook Inlet: The most recent abundance estimate resulting from a 2007 aerial survey is 375 (CV = 0.21) animals (NMFS unpubl. data). While this estimate is larger than the estimates of 278 for 2005 and 302 for 2006, it is equivalent to the average of 370 for the years 1999-2004 (Angliss and Allen, 2008a). Whereas a review of the status of the population indicated that there is a 65% chance that the population will decline (Hobbs et al. 2005), a trend line fit to the estimates for 1999 to 2007 estimates an average rate of decline of 2.8% per year, which is not significantly different (CI = 95%) from a constant population level (Angliss and Allen, 2008a). Killer whale predation on belugas in Cook Inlet, Alaska, has become a concern since the decline of these belugas was documented during the 1990s. Shelden et al. (2003) suggest a minimum estimate of roughly 1 death per year due to killer whale predation.
2. Bristol Bay: The maximum counts for 2004 and 2005 give corrected population estimates of 2,455 and 3,299 (L. Lowry, University of Alaska Fairbanks, pers. comm. to Angliss and Allen, 2008b). Data from 28 complete counts of Kvichak and Nushagak bays made in good or excellent survey conditions were analyzed, and results showed that the population had increased by 65% over the 12-year period between 1993 - 2005 (Lowry et al. 2008).
3. East Bering Sea: The population size estimated for Norton Sound from aereal surveys conducted in 2000 is 18,142 (CV = 0.24). Data currently available do not allow an evaluation of population trend for the Eastern Bering Sea stock (Angliss and Outlaw, 2005). The 2000 IWC abundance estimate was 12,675 .
4. Eastern Chuckchi Sea: The abundance estimate from the 1989-91 surveys (3,710 whales) is still considered to be the most reliable for the eastern Chukchi Sea beluga whale stock (Angliss and Allen, 2008c).
5. Beaufort Sea: The most recent aerial survey was conducted in 1992 and resulted in a corrected estimate of 39,258 (CV = 0.46) (Angliss and Allen, 2008d). The population was designed as Not at Risk by COSEWIC (2004).

Canada and West Greenland (IWC, 2000):

6. North Water (Baffin Bay): A survey in 1996 estimated 21,213 belugas (95% CI 10,985 to 32,619) in the waters surrounding Somerset Island: Barrow Strait, Peel Sound and Prince Regent Inlet (Innes et al. 2002). The IWC (2000) estimate was 28,000 animals.
7. West Greenland: Surveys conducted in 1998 and 1999 found 7,941 (95% CI: 3650-17278) belugas in West Greenland (Heide-Jørgensen and Acquarone, 2002). The IWC (2000) estimate was only 2000 animals.
8. Cumberland Sound: This stock numbers about 1,500 animals and is thought to have increased since the 1980s (COSEWIC 2004): the IWC (2000) estimate was only 485 animals. The population was designed as Threatened by COSEWIC (2004).
9. Frobisher Bay: no data available
10. Ungava Bay: < 50 (Hammill et al. 2004). These animals may be remnants of the former stock, or transient or recolonising animals. Ungava Bay was formerly a summering area for a group of beluga, but these appear to have been extirpated by over-harvesting. Only very small numbers of belugas are observed there now, and are sometimes harvested (Heide Jørgensen, 2005). The population was designed as Endangered by COSEWIC (2004).
11. Foxe Basin 1,000 (IWC, 2000). This stock is listed as "Endangered" by COSEWIC (2004).
12. West Hudson Bay 25,100 (IWC, 2000). There is no recent data available (Jefferson et al. 2008). The population was designed as Special Concern by COSEWIC (2004).
13. South Hudson Bay 1,299 (IWC, 2000).
14. James Bay 3,300 (IWC, 2000).
15. East Hudson Bay: Belugas in Eastern Hudson Bay have declined from 4,200 (SE 300) in 1985 to 3,100 (SE 800) in 2004 (corrected estimates; Hammill et al. 2005). The population was designed as endangered by COSEWIC (2004).
16. St Lawrence River: Recent population estimates for 1998-2000, corrected for submerged animals and rounded to the nearest 100, range from 900 to 1300. 1,238 (COSEWIC, 2004). This compares positively with the estimate of Lesage and Kingsley (1998) of between 600 and 700 who found that the population was slowly increasing. Reproductive rates, survival rates at each age, and population age structure were similar to those of other beluga populations. The population was designed as Threatened by COSEWIC (2004).

Svalbard:

17. Svalbard: Belugas have never been surveyed around Svalbard (Jefferson et al. 2008). Pods numbering into the thousands are sighted irregularly around the archipelago, and pods ranging from a few to a few hundred individuals are seen regularly (Kovacs and Lydersen 2006). The IWC (2000) estimates population size at between few hundreds to low thousands.

Former Soviet Union (Bjoerge et al. 1991; IWC, 2000):

18-24. W. Siberia: 500-1,000 (Barents - Laptev Sea)
25. East Siberia: 2,000-3,000 (W Chukchi - E Siberian Sea)
26. Anadyr Delta: 200-3,000
27-29. Sea of Okhotsk: 18,000-20,000

The data for the former Soviet Union differ somewhat from the population estimates given in Reyes (1991). According to the IWC (2000) report, stocks 18 - 23 number in the low hundreds, whereas there is no information on stock 24. Another estimate yields 15,000 to 20,000 beluga inhabiting the White, Barents and Kara Seas (Boltunov and Belikov 2002).

4. Biology and Behaviour

Habitat: White whales seem to prefer shallow coastal waters and river mouths, although they may migrate through deep waters. In some areas they are reported to spend most of their time in offshore waters, where feeding and calving may take place (Reyes, 1991 and refs. therein).

In Alaska's Cook Inlet, mudflats are a significant predictor of beluga distribution during early summer months (Goetz et al. 2007). In the north-eastern Chukchi Sea, the presence of near-shore gravel beds and warm, low-salinity water probably combine to make this region important as a place for belugas to moult (Frost et al. 1993). In the eastern Beaufort Sea, satellite-tagged beluga females with calves and smaller males select open- water habitats near the mainland; large males select closed sea ice cover in and near the Arctic Archipelago; and smaller males and two females with calves (not newborn) selected habitat near the ice edge (Loseto et al. 2006). The authors conclude that summer habitat segregation of belugas reflects differences in foraging ecology, risk of predation, and reproduction.

Barber et al. (2001) found beluga distribution in the Canadian Arctic to be bimodal with respect to bathymetry, with a larger mode in shallow water and a smaller mode in water approximately 500 m deep. There is a general tendency for males in the eastern Arctic to be associated with shallow water during the summer and deeper water (modes at 100 and 500 m) in the fall (Barber et al. 2001).

Food: Feeding habits vary, depending on geographical location and season. Belugas dive regularly to the sea floor at depths of 300-600 m. In the deep waters beyond the continental shelf, belugas may dive in excess of 1,000 m and may remain submerged for more than 25 min (Richard et al. 2001a, Martin et al. 1998). In the Beaufort Sea, beluga feed predominantly on Arctic cod (*Boreogadus saida*) collected from near shore and offshore regions (Loseto et al. 2009). In western Hudson Bay they feed on capelin (*Mallotus villosus*), river fish such as cisco (*Leucichthys artedi*) and pike (*Esox lucius*), marine worms and squids.

Further north, belugas rely on crustaceans, arctic char (*Salvelinus alpinus*), Greenland cod (*Gadus ogac*), and arctic cod. In the St.-Lawrence, capelin, American sand lance (*Ammodytes americanus*), marine worms and squid are eaten, while in Alaskan waters they feed on fish, mainly salmon. Evidence for offshore feeding comes from finding offshore squid (*Gonatus fabricii*) in the stomach of whales in the Beaufort Sea (Reyes, 1991 and refs. therein).

Schooling: Beluga whales are highly gregarious. They are found in groups of up to about 15 individuals, but aggregations of several thousand can be observed at times. Pods are often segregated by age and sex (Jefferson et al. 1993).

Reproduction: Calves are born in spring to summer, between April and August, depending on the population (Jefferson et al. 1993).

5. Migration

General patterns: Not all white whales are migratory. Some populations are resident in well-defined areas, for example in Cook Inlet, the St. Lawrence estuary and possibly in Cumberland Sound (Reyes, 1991). As determined by radio-telemetry, whales use waters e.g. in the upper Cook Inlet intensively between summer and late autumn and disperse to mid-inlet offshore waters during winter months (Hobbs et al. 2005). They remain in the inlet for the whole year (Rugh et al. 2004).

Other populations are strongly migratory and their migration shows a seasonal pattern. In the winter, they move to offshore waters, staying at the edge of the pack ice or in polynyas. Although these migrations occur regularly, routes and dates are poorly known (Reyes, 1991). The basic migratory schedule, however, is quite consistent and seems to be governed primarily by photoperiod rather than by other physical or biological factors, including sea-ice conditions (Heide-Jørgensen and Reeves, 1996).

White whales that spent the winter in the central and south-western Bering sea along the Russian coast move north along the west coast of Alaska and the east coast of Russia from April through early summer. There are indications that populations from western Hudson Bay, eastern Hudson Bay and Ungava Bay overwinter together in the pack ice in Hudson Strait. In spring the whales from each population separate and migrate to their distinct summering grounds. Populations from the White, Kara and Laptev Seas overwinter in the Barents Sea (Reyes, 1991 and refs. therein).

Genetic studies of white whales suggest that there is limited movement between major summering grounds and therefore that colonisation of depleted areas by whales from other summer concentrations would be slow. Recent satellite tracking data show white whales to be less ice-limited than previously thought; they travel long distances into the permanent polar ice during the summer. Thus, ideas about the physical barriers to movement and hypotheses concerning the convergence of several summering stocks on a single wintering ground may need to be reconsidered (IWC, 2000).

In the spring, migrating whales from different stocks may approach and move past a given site in 'waves', while a summer 'resident' stock moves into that same area for an extended period. For example, the Eastern Chukchi Sea stock is temporally delineated as the group of whales that arrives in Kotzebue Sound or Kasegaluk Lagoon as the ice begins to break up and remains there for at least several weeks. Earlier in the year, whales from the Beaufort Sea stock move through this area in the spring lead system. Thus, the annual catch at villages such as Point Hope, Kivalina and Barrow can consist of whales from both of these stocks (IWC, 2000).

In summer, belugas ascend rivers: the Severnaya Dvina, Mezen', Pechora, Ob' Yenisey in Asia, the Yukon and Kuskokwim Rivers in Alaska and the St. Lawrence River in eastern Canada (Rice, 1998). A study by Aubin (1989) demonstrated that occupation of river estuaries is an important metabolic stimulus to belugas, and facilitates epidermal renewal in a manner analogous to a moult. There are a few records of solitary individuals ranging hundreds of kilometres up various rivers, including the Rhine in Germany (c.f. Gewalt, 1994).

Detailed accounts: Several studies involving satellite-transmitters were conducted in recent years. The following accounts are sorted from east to west, beginning in the Bering and Chukchi Seas.

Richard et al. (2001b) satellite-tagged beluga whales of the eastern Beaufort Sea during summer and autumn between 1993 and 1997. Whales occupied the Mackenzie estuary intermittently and for only a few days at a time. They spent much of their time off-shore, near or beyond the shelf break and in the polar pack ice of the estuary, or in Amundsen Gulf, Mc'Clure Strait, and Viscount Melville Sound. Their movements into the polar pack ice and into passages of the Canadian Arctic Archipelago suggest that aerial surveys conducted in the southeastern Beaufort Sea and Amundsen Gulf may have substantially underestimated the size of the eastern Beaufort Sea stock. Conclusions from this study about beluga ecology challenge conventional wisdom, in that estuarine occupation appears to be short-lived, belugas travel long distances in summer to areas hundreds of kilometres from the Mackenzie Delta, and they do not avoid dense pack ice in summer and autumn (Richard et al. 2001a).

Suydam et al (2001) satellite-tracked five belugas in Kasegaluk Lagoon, eastern Chukchi Sea in summer. Two tags transmitted for only about two weeks, during which time one animal remained in the vicinity of Icy Cape, 80 km north of the capture site, and the other travelled to Point Barrow, about 300 km north. The other three tags operated for 60-104 days, and those belugas travelled more than 2,000 km, reaching 80°N and 133°W, almost 1,100 km north of the Alaska coast. This journey required them to move through 700 km of more than 90% ice cover. Two of the whales then moved southward into the Beaufort Sea north and east of Point Barrow. Two whales later moved to an area north of the Mackenzie River delta, where they spent 2-3 weeks before once again heading southwest towards Barrow (Suydam et al. 2001).

Richard et al. (2001b) live-captured and instrumented 21 adult belugas (8M, 13F) with satellite-linked transmitters in the summer and fall of 1996 on the Canadian north-east coast: Twelve were captured in estuaries along the coast of Somerset Island in July and nine were captured in September in Croker Bay, SE Devon Island. Most of the animals moved rapidly to southern Peel Sound, where they all spent the month of August, making frequent deep dives, some of which were to depths near or at the seabed of the Franklin Trench. The belugas also used several bays along the coast of Prince of Wales Island and another one on Melville Peninsula. They left southern Peel Sound between late August and early September and moved rapidly to the south coast of Devon Island, many using Maxwell Bay and Croker Bay for several days. All belugas instrumented in Croker Bay in September, as well as the summer-tagged individuals that were still transmitting, moved east and north along the south and east coasts of Devon Island, eventually reaching Jones Sound and north Baffin Bay. They used many bays along the east coast of Devon Island and dove to depths often exceeding 200 m in the surrounding waters. Fifteen of the tags continued to transmit during the period when belugas are normally observed migrating along the West Greenland coast (late September-early October). However, only one of the tagged animals moved to Greenland waters in late September. The others remained in the area known in winter as the North Water. The autumn tracking results suggest that the North Water may harbour a larger winter population of belugas than was previously suspected (Richard et al. 2001b).

Of five belugas tracked by satellite from Creswell Bay, Somerset Island, in the Canadian high Arctic in October (Heide-Jørgensen et al. 2003) three stayed in the North Water polynya and the other two whales moved to West Greenland. One of the whales that moved to Greenland migrated south along the west coast. Based on the total number of belugas satellite-tracked in Canada between 1995 and 2001 with tags that lasted beyond 1 October, approximately 15 % (95% CI 0.06-0.35; n=26) of the summering stock of belugas in the Canadian high Arctic move to West Greenland for the winter (Heide-Jørgensen et al. 2003).

In eastern Hudson Bay belugas tagged in summer made no directed or long-distance movements (Kingsley et al. 2001). All animals showed dive depth characteristics that were consistent with diving usually to the bottom. However, all belugas always — even in deep water — made dives that usually lasted less than 10 min and very seldom lasted more than 12-min. Belugas tagged as pairs of adults and young showed striking correlations of dive behaviour. According to Kingsley et al. (2001) the data obtained indicate that it would be appropriate to correct aerial surveys by adding 85% to aerial counts.

In Svalbard, satellite-tagged beluga spent most of their time relatively stationary, close to different glacier fronts in the area and foraging is the probable reason for this behaviour (Lydersen et al. 2001). When the whales changed location, they did so in an apparently directed and rapid manner. Average horizontal swimming speed was at least 6 km/h during long-distance movements. Movements between glacier fronts were extremely coastal in nature and took place in shallow waters. This behaviour has probably developed as a means of avoiding predators (Lydersen et al. 2001). K. Kovacs (U. Tromsø, pers. comm.) found that none of these tagged animals left Norwegian waters. If they are "linked" to any population it is likely with Russia.

As opposed to these high-tech approaches, traditional ecological knowledge (TEK) has been used opportunistically in biological studies of beluga whales in Alaska (Huntington, 1999) and Russia (Mymrin and Huntington, 1999). Their results are consistent with those of previous studies but add considerable detail, including descriptions of avoidance and habituation responses to anthropogenic noise, which appear to depend in part on association with hunting activities.

6. Threats

Direct catches: A permit for a catch quota of 1,000 beluga whales has been issued by the Russian Commission for Fisheries in 2002. The Small Cetacean Subcommittee of the IWC expressed concern over such takes of small cetaceans when there was insufficient information to adequately assess the impact, and recommended an assessment of the size of the affected populations and the impacts of the removals (W. Perrin, pers. comm., 2003).

The most immediate concerns relate to continuing harvests from small and depleted populations (IWC, 2000), e.g. in Eastern Hudson Bay and Ungava Bay in the Canadian Arctic (COSEWIC, 2004). A dramatic decline is recorded in West Greenland since 1981, but surveys to estimate the total abundance are either incomplete, have wide confidence limits or are too old to be used to adjust present catches to sustainable levels (Heide-Jørgensen, 1994). Alvarez-Flores and Heide Jørgensen (2004) find that current catches are still unsustainable and that continuation of this situation represents a 90% probability that the population will become extinct in 20 years. Their analyses suggest that the harvest should be reduced to no more than 130 animals, or about 25 % of current catches (606 in 2000 and 399 in 2002; Heide- Jørgensen, 2005).

Beluga have long been a vital food resource for Canadian Inuit. The top layer of skin, called muktuk, is a good source of Vitamin C and other nutrients. Management of beluga and other marine mammals in Canada are a federal responsibility. Canada discontinued all commercial whaling in 1972, and hunting of beluga today is allowed for subsistence purposes only (Heide- Jørgensen, 2005). Between 1988 and 1996, the total annual subsistence harvest of beluga varied between 400 and 700 (DFO 2002).

Whereas direct takes are mostly from aboriginal hunting, indirect takes are primarily from incidental catch in fishery operations.

Global warming: As recent decreases in ice coverage have been more extensive in the Siberian Arctic (60° E-180° E) than in the Beaufort Sea and western sectors, Tynan and De Master (1997) speculate that marine mammals in the Siberian Arctic may be among the first to experience climate-induced geographic shifts or altered reproductive capacity due to persistent changes in ice extent. Alteration in the extent and productivity of ice-edge systems may affect the density and distribution of important ice-associated prey of marine mammals, such as arctic cod (*Boreogadus saida*) and sympagic ("with ice") amphipods. The timing of the phytoplankton bloom, driven by the break up and melting of ice, is critical to the immediate success of first-feeding larvae of Arctic cod. Alteration in the extent, timing and productivity of ice-edge systems may therefore affect the density and distribution of Arctic cod, and in turn the foraging success and nutritional condition of dependent species such as beluga and narwhal (Tynan and DeMaster, 1997; Everett and Bolton, 1996; IWC, 1997).

Beluga distribution is divided into a number of non-contiguous areas in northern polar and sub-polar waters. In addition, there is a reliance on shallow coastal areas in summer months. As a result, their ability to move their range poleward as water temperatures increase and ice coverage decreases may be limited by the absence of suitable shelf and coastal waters further north in the Arctic Ocean. In addition, isolated populations at the southern edge of the current species range, such as in the Gulf of St. Lawrence, may be limited in their ability to shift their range northward and these populations may become extinct as a result of changes in water temperature (MacLeod, 2009).

Ambient noise: Movements of belugas through the mouth of the Saguenay river have been monitored by several researchers during the last decade. After selecting comparable data from each research group, Caron and Sergeant (1988) noted a decline in beluga passage rate of more than 60% over this period (from 3.9 belugas/hour to 1.3 belugas/hour in the later years). The decline occurred over a relatively short period, between 1982 and 1986, which coincided with an increase in recreational boat activities in the area. Without excluding other influencing factors inside or outside the Saguenay area, a link between boat traffic and beluga passage was hypothesized.

Cosens and Dueck (1993) found that the ice breaker MV Arctic generated more high frequency noise than did comparable vessels and that belugas should be able to detect the vessel from at least as far as 25 to 30 km. This may explain why belugas in Lancaster Sound seem to react to ships at longer distances than do other stocks of arctic whales. Typically, belugas moved rapidly along ice edges away from approaching ships and showed strong avoidance reactions to ships aproaching at distances of 35-50 km when noise levels ranged from 94-105 dB re 1 µPa in the 20-1000 Hz band. The "flee" response of the beluga involved large herds undertaking long dives close to or beneath the ice edge; pod integrity broke down and diving appeared asynchronous. Belugas were displaced along ice-edges by as much as 80 km (Finley et al. 1990). The magnitude of this avoidance reaction was attributed to the animals being mostly "naïve" to anthropogenic sound pollution.

Habitat degradation: Potential threats further include oil and gas development, over-harvesting, fisheries, hydroelectric development in Hudson Bay, industrial and urban pollution and climate change. Reyes (1991 and references therein) summarised that hydroelectric development is one of the most important effect of human activities on white whales, which rely on warmer waters in estuaries and rivers for calving and early growth of young.

Areas such as the McKenzie Delta and others are subject to oil exploration, which implies seismic ship surveys, offshore drilling or artificial island construction. These activities are undertaken in the summer months in the same areas occupied by belugas at this time of year. Frost et al. (1993) suggest that activities associated with oil, gas, coal, and mineral resource development should be regulated to minimise their potential impacts on important beluga habitats.

Pollution: A small geographically isolated sub-Arctic population of belugas reside year-round in a short segment of the St. Lawrence river estuary. For more than 50 years the belugas have been exposed to industrial pollutants including organochlorines, polycyclic aromatic hydrocarbons (PAH), and heavy metals. Studies have found that concentrations of both total PCBs and highly chlorinated PCB congeners were much higher in St. Lawrence belugas than Arctic belugas. Scientists believe that the increased occurrence of opportunistic bacterial infections, parasitic infestation, gastric ulcers and other disorders in St. Lawrence beluga whales was evidence of a link between immune system dysfunction and PCB exposure (Martineau et al. 1994). Belugas feed significantly on bottom invertebrates, and have been observed partially covered by mud when surfacing, suggesting that they dig into contaminated sediments (Dalcourt et al. 1992). However, between 1987 and 2002 concentrations of most of the bioaccumulative and toxic chemicals (PBT) examined have exponentially decreased by at least a factor of two while no increasing trends were observed for any of the PBTs measured. This was attributed to a decline in contamination of beluga diet following North American and international regulations on the use and production of these compounds or by a change in its diet itself or by a combination of both (Lebeuf et al. 2007).

Beluga whales have been hunted for food by Native People in the Canadian Arctic since prehistoric time. While earlier analyses suggested that whales in the western Canadian Arctic had higher levels of mercury than those from the eastern Canadian Arctic, such regional differences have diminished and are no longer statistically significant. Nevertheless, mercury levels in muktuk still exceed the consumption guideline in most instances (Lockhart et al. 2005). But although mercury levels in the Beaufort Sea beluga population increased during the 1990s, levels have since declined (Loseto et al. 2008).

However, further contaminants such as PCBs, OC pesticides, polybrominated diphenyl ether (PBDE) flame retardants, methylsulfonyl- and hydroxy -PCB metabolites, and PBDEs were determined in the liver of beluga whales the St. Lawrence Estuary and western Hudson Bay. The results suggest a complexity of contaminant exposure that may be impacting the health of Canadian beluga whale populations (McKinney et al. 2006).

In the northeast Atlantic, the concentrations of toxaphene congeners in white whales from Svalbard are at the high end of the range for concentrations of these compounds compared to other populations suggesting exposure to high levels (Andersen et al. 2006). And the concentrations and patterns of polychlorinated biphenyls (PCBs), chlorinated pesticides, and polybrominated diphenyl ethers (PBDEs) were among the highest levels ever measured in marine mammals from the same area (Wolkers et al. 2006).

7. Remarks

Range states (Jefferson et al. 2008): Canada; Greenland; Russian Federation; Svalbard and Jan Mayen; United States of America.

D. leucas is listed in Appendix II of CMS. The species is listed in Appendix II of CITES. The IUCN species experts group classifies the beluga as "Near Threatened" (Jefferson et al. 2008). This is based on substantial uncertainty about numbers and trends for at least some parts of the range, and on the cessation of national and international, taxon-specific conservation programs which could result in the beluga's qualifying for threatened status within five years. Some subpopulations qualify for threatened status but only one of these - the Cook Inlet subpopulation - has been assessed in detail (as Critically Endangered; Lowry et al. 2006).

The IWC (2000) expressed concerns about the conservation status of a number of stocks because of their:

(1) depleted status relative to historical abundance (Cook Inlet, West Greenland, Ungava Bay, Cumberland Sound, East Hudson Bay, St Lawrence River);
(2) likely depleted status relative to historical abundance (Svalbard, Ob Gulf, Yenesy Gulf, Onezhsky Bay, Dvinsky Bay, Mezhensky Bay, Shelikov Bay, Shantar Bay, Sakhalin-Amur);
(3) current small population size or reduced range (Cook Inlet, Ungava Bay, Cumberland Sound, West Greenland, Ob Gulf, Yenesy Gulf);
(4) recent decline (Cook Inlet, West. Greenland).

8. Sources (see page 243)

3.8 Delphinus capensis Gray, 1828

English: Longbeaked common dolphin
German: Langschnäuziger Gewöhnlicher Delphin
Spanish: Delfín común a pico largo
French: Dauphin commun à long bec

Family Delphinidae

Delphinus capensis / Longbeaked common dolphin (© Wurtz-Artescienza)

1. Description

Until 1994 all common dolphins were classified as a single species, *D. delphis*, but research by Heyning and Perrin (1994), later confirmed by Kingston and Rosel (2004), led to the recognition of two distinct species: the long-beaked and the short-beaked common dolphins.

The taxonomic status of *D. capensis* has been further clarified in a morphometric study (Jefferson and Van Waerebeek 2002). The authors suggest that the Indian Ocean form called by some *Delphinus tropicalis* (as reviewed in van Bree and Gallagher, 1978) is actually a long-beaked subspecies of *D. capensis*, which may hybridize or intergrade with the standard capensis-form in Southeast Asia and possibly along the east coast of Africa. The appropriate name is *Delphinus capensis tropicalis* (van Bree, 1971).

D. capensis may be difficult to distinguish from *D. delphis*, especially at sea. Its body is more slender and it has a longer beak than the short-beaked common dolphin. The beak is sharply demarcated from the melon, which is somewhat flat in appearance. The coloration is somewhat muted and the chin-to-flipper stripe, which often merges with the lip patch, thus darkening the lower jaw, is broader. In addition, white is absent from the dorsal fin and flippers (occurs in some short-beaked common dolphins). There are 47-67 sharp pointed teeth in each tooth row, more than in any other delphinid. Body size reaches 2.54 m and body mass 235 kg (Jefferson et al. 2008).

2. Distribution

Disjunct populations of *D. capensis* are found in warm temperate and tropical coastal waters around the world. The overall distribution remains imperfectly known because of past confusion with *D. delphis* (Rice, 1998; Sanino et al. 2003).

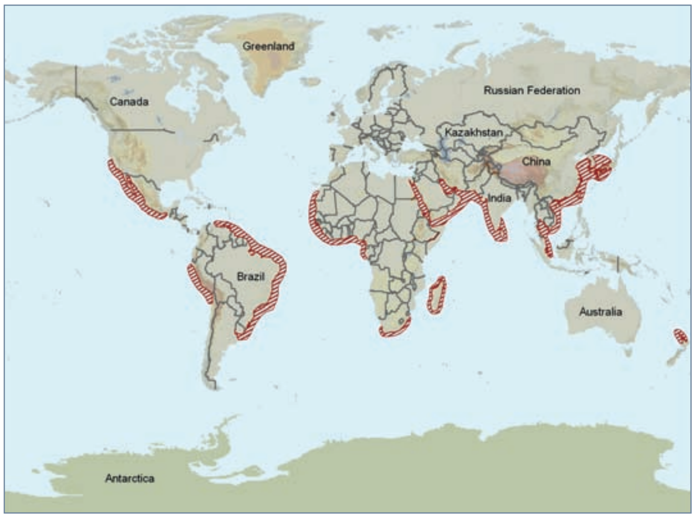
D. c. capensis – occurs in the Atlantic and Pacific Oceans on the east coast of South America, West Africa, southern Japan, Korea and northern Taiwan (and possibly China), central California to southern Mexico, Peru, and South Africa (Hammond et al. 2008). However, Bernal et al. (2003) report on the long-term residency of two long-beaked common dolphins in two small bays off the central coast of Chile, extending the eastern South Pacific range southward by 800 nm.

D. c. tropicalis – Ranges in the Indo-Pacific from at least the Red Sea/Somalia to western Taiwan/southern China and Indonesia, and including the Persian Gulf and Gulf of Thailand (Hammond et al. 2008).

Beware that some authors have haphazardly applied the name *D. bairdii* or *D. delphis bairdii* to all Pacific Ocean *Delphinus* (Rice, 1998).

3. Population size

There is no estimate of global abundance for *D. capensis* and few local abundance estimates. The distribution and abundance of long-beaked common dolphins off California appears to be variable on interannual and seasonal time scales (Heyning and Perrin 1994). As oceanographic conditions



Distribution of Delphinus capensis: disjunct populations in warm temperate and tropical coastal waters (Hammond et al. 2008; © IUCN Red List).

change, long-beaked common dolphins may spend time in Mexican waters, and therefore a multi-year average abundance estimate is the most appropriate for management within the U.S. waters. The most recent estimate of abundance in waters of California, Oregon and Washington is 15, 334 (Barlow and Forney, 2007). Gerrodette and Palacios (1996) estimated 55,000 within Pacific coast waters of the Mexican EEZ and 69,000 in the Gulf of California. About 15,000-20,000 are estimated to occur off South Africa. The *tropicalis* subspecies is widespread in the Indian and western Pacific oceans, but there are no estimates of abundance for any portion of its range (Hammond et al. 2008).

4. Biology and Behaviour

Habitat: *D. capensis* seems to prefer shallower and warmer water and occurs generally closer to the coast than *D. delphis* (Perrin, 2009). It is found mostly over continental shelf water depths (< 180 m), and generally does not occur around oceanic islands far from mainland coasts (Jefferson and Van Waerebeek 2002, Sanino et al. 2003).

Food: Off Brazil, *D. capensis* seems to prefer cephalopods (De Oliveira-Santos et al. 2002). *D. capensis* off southern California feed on sardines (*Sardinops coerulea*), anchovies (*Engraulis mordax*), sauries (*Cololabis saira*), small bonitos (*Sarda chiliensis*), and squids (*Loligo opalescens*). Long-beaked common dolphins off southern Africa feed mainly on pilchards (*Sardinops ocellatus*), anchovies (*Engraulis capensis*), and squids (*Loligo v. reynaudii*) but had many other prey species of fishes and squids, including myctophids in their stomachs (Ohizumi et al. 1998). While these authors find that there seems to be no obvious difference in the diet between *C. delphis* and *C. capensis*, recent investigations on fatty acid composition of blubber tissue of animals from the coast of California reflect dietary differences (Smith and Worthy, 2006).

5. Migration

Unknown

6. Threats

Fisheries interactions: Miscellaneous lesions of the head, skull, teeth, trunk, appendages, skin and genital tract were observed in 120 of 930 long-beaked common dolphins taken in fisheries off Peru between 1985 and 2000. The majority of traumas encountered were diagnosed as caused by violent, fisheries-related interactions, and the skin in 20.4% of specimens (n = 54) showed healed scars from such interactions. There is concern that total fisheries-related dolphin mortality may be higher than can be accounted for by the tallying of landed specimens. In Peru, long-beaked common dolphins were frequently captured by industrial purse-seiners, including in directed sets, at least until 1994 (Van Bressem et al. 2006).

A total of 44 specimens were reported as incidental marine mammal bycatch in the California drift gillnet fishery for broadbill swordfish *Xiphia gladius* and common thresher shark, *Alopias vulpinus*, in the 7-year period, 1996 to 2002 (Carretta et al. 2004). Hammond et al. (2008) report that recently they are only occasionally involved as bycatch in the eastern tropical Pacific tuna fishery. There are anecdotal reports of potentially large numbers of dolphins, including long-beaked common dolphins, killed for bait in some coastal fisheries off Baja California, Mexico.

Long-beaked common dolphins have been taken opportunistically by harpoon in northeastern Taiwan and are caught incidentally by oceanic driftnets off eastern Taiwan. In Indian Ocean and Chinese waters, they are taken in gillnets, trawls, and purse seines. They are present off Japan, and some have been taken in drive fisheries there. Incidental catches of *Delphinus* sp. in pelagic driftnets in southern and southeastern Brazil have been recorded, but no current estimates of bycatch are available. There is a large direct kill around Margarita Island, off eastern Venezuela, in which dolphins are harpooned in large numbers (Hammond et al. 2008).

Pollution: Wide ranges of organochlorine residues were determined in the blubber of long-beaked common dolphin incidentally caught in Brazilian coastal waters (Kajiwara et al. 2004). Concentrations of DDTs and PCBs were the highest, followed by CHLs, TCPMOH, dieldrin, TCPMe, heptachlor epoxide, HCB, and HCHs. Unexpectedly, significant contamination by PCBs, DDTs, TCPMe, and TCPMOH was observed, implying the occurrence of local sources in the Southern Hemisphere comparable to those in the Northern Hemisphere, probably due to high industrialization in Brazil.

7. Remarks

Range states: Argentina; Brazil; Chile; China; Côte d'Ivoire; Djibouti; Egypt; Eritrea; Gabon; Guyana; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Kuwait; Madagascar; Malaysia; Mauritania; Mexico (Baja California, Sinaloa, Sonora); New Zealand; Oman; Pakistan; Peru; Saudi Arabia; Senegal; South Africa; Sri Lanka; Sudan; Suriname; Taiwan, Province of China; Thailand; United Arab Emirates; United States (California); Uruguay; Venezuela; Viet Nam; Western Sahara; Yemen (Hammond et al. 2008).

Because of past confusion with *D. delphis*, very little is known about this species. Overall distribution, behaviour at sea, movements, reproduction and other key parameters, such as abundance, are poorly known. Threats are presumably similar to those affecting *D. delphis*. The lower density, however, could reflect that this species is not as abundant as *D. delphis* and thus could be more strongly affected by by-catch in fisheries. See further recommendations on South American stocks in Hucke-Gaete (2000; Appendix 1) and on Southeast Asian stocks in Perrin et al. (1996; Appendix 2).

D. capensis is categorized as "Data Deficient" by the IUCN. The species is listed in Appendix II of CITES. Not listed by CMS.

8. Sources (see page 245)

3.9 Delphinus delphis Linnaeus, 1758

English: Short-beaked common dolphin
German: Gewöhnlicher Kurzschnabel-Delphin
Spanish: Delfín común a pico corto
French: Dauphin commun à court bec

Family Delphinidae

Delphinus delphis / Common dolphin (© Wurtz-Artescienza)

1. Description

Common dolphins of both species are slender and have a long beak sharply demarcated from the melon. The dorsal fin is high and moderately curved backwards. Common dolphins are distinguished from other species by a unique crisscross colour pattern formed by interaction of the dorsal overlay and cape. This yields a four-part pattern of dark grey to black dorsally, buff to pale yellow anterior thoracic patch, light to medium grey on the flank and a white abdominal field. In the short-beaked species, *D. delphis*, the colour pattern is more crisp and colourful than in *D. capensis*. Body size ranges from 164 to 201 cm and body mass to about 200 kg (Perrin, 2009).

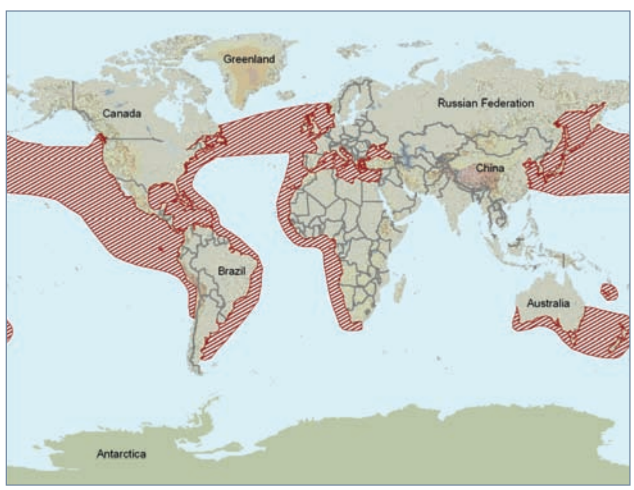
The population in the Black Sea is separable from those in the Mediterranean and the eastern North Atlantic and has been described as an endemic subspecies *D.d. ponticus* Barabash, 1935. In the northeastern Pacific, three populations separated by latitude can be distinguished by body length and cranial features. A rare morph with a deviant pigmentation pattern has been found in several areas of the Atlantic and Pacific oceans (Rice, 1998 and refs. therein).

2. Distribution

Delphinus delphis is widely but discontinuously distributed in warm temperate and tropical waters of the Atlantic and Pacific oceans. Its total distribution is uncertain because of past taxonomic confusion (Rice, 1998 and refs. therein). It regularly occurs in some enclosed seas, such as the Okhotsk Sea and Sea of Japan, and separate subpopulations exist in the Mediterranean and Black seas. Short-beaked common dolphins may occur in parts of the Indian Ocean around southeastern Africa and southern Australia, but previous records of this species in other parts of the Indian Ocean and in waters of Taiwan are now thought to have been of long-beaked common dolphins (*D. capensis*; Jefferson and Van Waerebeek 2002). The most northerly record from the North Pacific is from British Columbia, Canada, and in the North Atlantic, from the northern waters of Norway and Sable Island off Nova Scotia (Evans, 1994; Lucas and Hooker, 2000; Syvertsen et al. 1999).

The distribution of the species in the Western Atantic Ocean is curently debated. Jefferson et al. (2009) critically re-examined records of the genus *Delphinus* and plotted only validated records (n = 364), finding evidence of populations in only three disjunct areas:

1. Off the east coast of the US and Canada, from the Georgia/South Carolina border (32°N) north to about 47-50 °N off Newfoundland.
2. In the Caribbean, only off central-eastern Venezuela (a coastal *D. capensis* population).
3. Off eastern South America, south of 20°S. There is a coastal long-beaked population found in the South Brazil Bight, and one or more short-beaked populations south and offshore of this (ranging south to at least northern Argentina).



Distribution of Delphinus delphis: warm temperate, subtropical, and tropical waters worldwide (Hammond et al. 2008; © IUCN Red List).

The genus *Delphinus* is apparently absent throughout much of the tropical/subtropical region in the Atlantic. Since the 1960s, they have apparently been absent from Florida waters, and there is no evidence that dolphins of the genus occur in the Gulf of Mexico. Reports of common dolphins from most of the Caribbean Basin are also rejected. Most areas of distribution coincide with moderate to strong upwelling, and common dolphins appear to avoid warm, tropical waters. Their study shows that great care must be taken in identification of similar-appearing long-beaked delphinids, and that uncritical acceptance of records at face value can lead to incorrect assumptions about the ranges of the species involved (Jefferson et al. 2009).

3. Population size

According to most records, the species is very abundant, with many available estimates for various areas.

For the eastern tropical Pacific, Gerrodette et al. (2008) estimated 3,127,000 (CV=26%) in 2006 as opposed to 1,197,000 (CV 35.5%) in 2003 and 2,466,000 (CV 31.3 %) in 2000.

Aguayo et al. (1998) reported that in the South Pacific one of the species mostly sighted between Valparaiso and Easter Island (Rapa Nui), during five cruises made during the winter seasons of 1993 to 1995 was *D. delphis* (1.01 sightings per day amounting to 213 animals per day).

The western North Atlantic stock was estimated from two 2004 US Atlantic surveys covering most completely the species' habitat at 120,743 (Waring et al. 2007).

In the North Sea, Hammond et al. (2002) found common dolphins almost exclusively in the Celtic Sea. Abundance was estimated as 75,450 (95% CI = 23,000-149,000). A sighting survey conducted in the Bay of Biscay in 1993 led to a population estimate of 62,000 short-beaked common dolphins in the fishing grounds of the albacore tuna driftnet fishery (Goujon, 1996).

De Boer et al. (2008) provided estimates from winter pelagic trawl fishing grounds in the English Channel with a mean abundance of 3,055 dolphins (95% CI = 1,425-6,544). The relative index for abundance (number of schools per 100km effort, mean school size 5.1) was the highest recorded from comparable surveys in the North Atlantic and shows that the Channel is a very important winter habitat for common dolphins.

Gannier (1998) conducted 22,769 kilometres of visual line transect on a small boat in the Ligurian basin (Mediterranean Sea), confirming that common dolphins accounted for only 0,3% of cetacean sightings. A large-scale population decline is believed to have occurred during the last century, and the Alboran Sea is now the most important remaining habitat for the species. Canadas and Hammond (2008) estimated an abundance of 19,428 (95% CI = 15 277 to 22 804) dolphins in this area. While no overall trend in abundance was observed in the Alboran area, further decline was observed in the Gulf of Vera, with a summer density 3-fold lower in the period from 1996 to 2004 than in 1992 to 1995.

The most recent survey in the northern part of the Black Sea was carried out in 1987 in an area of 70,000 square kilometres between the USSR and Bulgarian borders (Sokolov et al. 1997). The extrapolated population density for the whole area of the Black Sea led to an estimated total number of *D. delphis* of 96,000. Stanev (1996), however, reported that the number of sightings in the Bulgarian sector of the Black sea declined between 1992 and 1995.

4. Biology and Behaviour

Habitat: *D. delphis* is usually found where surface water temperature is 10°C-20°C, which limits the distribution north and south of the range, but it may follow warm water currents beyond the normal range. It is less commonly seen in water shallower than 180 m. *D. delphis* occurs over the continental shelf, particularly in areas with high seafloor relief, but mainly offshore (Carwardine, 1995).

Off southern California the offshore form is associated with conspicuous features of the bottom relief such as sea mounts and escarpments, preying at night on organisms associated with the deep-scattering layer. In the eastern tropical Pacific it prefers equatorial and subtropical waters with a deep thermocline, relatively large seasonal changes in surface temperature and seasonal upwelling (Reyes, 1991 and refs. therein).

Waring et al. (2008) found that common dolphin distribution and density along the mid-Atlantic ridge was highest south of the Charlie Gibbs Fracture Zone in areas with warmer (12-22 °C) surface water temperatures and higher salinity (34.8-36.7 ppt). Morato et al. (2008) found that *D. delphis* associate with seamounts shallower than 400 m depth in the Azores, suggesting that these may reflect feeding stations.

Bourreau and Gannier (2003) found that Mediterranean common dolphins were more frequent in coastal and upper slope waters, the mean depth for sighting being 480 m. Common dolphins were likely to be observed in areas where the continental shelf had some extension and was delimited by a gentle slope, whatever the temperature, a habitat type also favourable to small epipelagic fishes such as anchovies and sardines. In the Ligurian Sea, common dolphins seem to prefer pelagic areas (Azzelino et al. 2008).

In the Black Sea, common dolphins may be found either in inshore waters or in the open sea (Reyes, 1991 and refs. therein).

Schooling: Often found in large, active schools: jumping and splashing can be seen and even heard from a considerable distance. Several members of a group often surface together. School size often varies seasonally and according to time of day. Animals bunch tightly together when frightened (Carwardine, 1995). Herds range in size from several dozen to over 10,000. Associations with other marine mammal species are not uncommon (Jefferson et al. 1993). Braeger and Schneider (1998) found that in summer common dolphins off the West Coast of New Zealand's South Island occurred almost exclusively in groups of 2-150 individuals, often with calves.

Reproduction: Breeding peaks in spring and autumn or summer have been reported for some stocks (Jefferson et al. 1993). Ferrero and Walker (1995) found that calving in the offshore waters of the North Pacific appeared to peak in May and June. Females in the eastern tropical Pacific average 197.2 cm at asymptotic body length. The estimated age at attainment of sexual maturity is 7.9 years and the oldest animal in the study was 25 years. Calving occurred throughout the year, with females producing a calf approximately every 2.1 years after a gestation period of approximately 11.4 months, an average lactation period of 16.5months, and an average resting period of 2.8 months. A relatively high percentage (30.4%) of lactating females were simultaneously pregnant, which effectively shortens the average calving interval. No clear evidence of senescence was found (Danil and Chivers, 2007).

Food: The prey of common dolphins consists largely of small schooling fish (e.g. sardines) and squid. Co-operative feeding techniques are sometimes used to herd fish schools (Jefferson et al. 1993; Silva, 1999).

Off southern California, common dolphins eat mainly anchovies and squids during the winter, but in spring and summer deep-sea smelt and lanternfish are preferred (Reyes, 1991, and refs. therein). Based on radio-telemetric studies and analysis of stomach contents, short-beaked common dolphins off southern California start feeding at dusk and continue to feed throughout the night. They feed primarily on organisms in the migrating deep scattering layer, especially myctophiids and bathylagids (Evans, 1994).

Scott and Cattanach (1998) used data collected by scientific technicians aboard tuna purse seiners in the eastern Pacific Ocean since the early 1970s to study the biology and herd dynamics of pelagic dolphins. A pattern of increasing group size in the morning and subsequent decline in the late afternoon or night was evident for common dolphins, as well as for large yellowfin tuna that associate with dolphins. It appears that these diel patterns are produced by an interaction of predation pressure and prey distribution.

For the western North Pacific off northern Honshu in Japan, Ohizumi and Watanabe (2004) found that prey species composition in the stomach contents was nearly identical to that of net samples taken from waters 1,000-1,300 m deep. In summer, common dolphins fed mainly on *Certoscopelus warmingi* which is distributed along a front of the Kuroshio Current facing the subarctic boundary.

On the east coast of New Zealand, common dolphins show preference for jack mackerel (*Trachurus novaezelandiae*), kahawai (*Arripis trutta*), yellow-eyed mullet (*Aldrichetta forsteri*), flying fish (*Cypselurus lineatus*), parore (*Girella tricuspidata*), and garfish (*Hyporamphus ihi*; Neumann and Orams 2003).

In the pelagic North Atlantic Ocean, diet was dominated by fish (90% by number and 53% by mass of total diet), while cephalopods played a secondary role (9%, 46%, respectively). Crustaceans were of minor importance. At the species level, the myctophid fish (*Notoscopelus kroeyeri*) largely dominated the diet. Prey size ranged from 1 to 68 cm, but the majority of prey were from 2 to 30 cm long. Common dolphins forage preferentially on small schooling, vertically migrating mesopelagic fauna in the surface layer at dusk and early night (Pusineri et al. 2007).

Meynier et al. (2008) analysed stomach contents from 71 common dolphins stranded along the French coast between 1999 and 2002. The most important prey species were sardine, anchovy, sprat and horse mackerel, which represented 44.9, 22.6, 8.0 and 5.0% by mass of the fresh diet, respectively. In spite of the main prey species varying extensively, estimated daily food intakes changed relatively little, because all diets included a high proportion of fat fish (73 to 93% by mass).

Young and Cockroft (1994) reported that in Natal, southern Africa, the occurrence of common dolphins is strongly associated with an annual northward fish migration, the sardine run, along the east coast. Thirty-six fish and four cephalopod prey species were identified in stomach samples. Though 86.9% by weight of the diet was made up of only five prey species, common dolphins appeared to feed opportunistically, their diet reflecting local prey abundance and availability. Prey were primarily small, easily-caught, pelagic shoaling species, the main prey being South African pilchard (*Sardinops ocellatus*).

Epi- and mesopelagic fishes and squids are eaten in the western Mediterranean. In the Black Sea the diet consists of horse mackerel, anchovy, sprat, mullet and jack mackerel. Other organisms such as crustaceans and benthic molluscs are considered of minor importance (Reyes, 1991, ad refs. therein).

Kastelein et al. (2000) published food consumption data from common dolphins held in a delphinarium. The food intake quantities should be viewed as rough weight estimates of what wild conspecifics might eat (depending on their diet). Annual food intake of two dolphins increased to 3,300kg at around 12 years of age, after which it decreased, stabilising at around 2,200kg between the ages of 16 and 25 years.

5. Migration

Clear seasonal shifts in distribution are observed off southern California, where peaks of abundance are recorded in June, September through October, and in January. Sighting data also suggest seasonal movements of common dolphins in the eastern tropical Pacific (Reyes, 1991 and refs. therein). Delgado-Estrella (1994) reported that strandings on the Gulf of California coasts of Mexico peak in spring. Radio-telemetric and other studies (see Evans, 1994 for details) have indicated that common dolphins preferentially travel over underwater escarpments. In the Pacific Ocean off southern California and Baja California, Mexico, the main movement patterns are north-south, along the prominent bottom topographic features such as escarpments and sea mounts.

Neumann (2001) reported a seasonal offshore-shift in short-beaked common dolphins in New Zealand, which appears to be correlated with sea surface temperature. *D. delphis* moved from a mean distance of 9.2 km from shore in spring and summer to a mean distance of 20.2 km from shore in autumn. During warmer La Niña conditions, mean distance from shore was reduced to only 6.2 km, and offshore movement was delayed by a month. It is hypothesised, that Sea Surface Temperature (SST) influences the distribution of *D. delphis* prey, which in turn affects seasonal movements.

In the western North Atlantic, Gowans and Whitehead (1995) reported on seasonality of common dolphin abundance in the Gully off Nova Scotia. The animals arrive in July, when water temperatures have increased.

In the eastern North Atlantic, Goold (1998) used passive acoustic monitoring of common dolphins off the west Wales coast during the months of September, October, November and December 1994 and 1995. Distributions of common dolphins within the survey area showed a marked decrease in dolphin contacts between September and October of both years. These observations suggest offshore migration of the populations at that time of year. It is hypothesised that offshore migration of common dolphins coincides with a break-up of the Celtic Sea Front, a distinct oceanographic feature which crosses the survey area. Goold (1996) reported on southwesterly migratory behaviour of common dolphins monitored acoustically in the North Sea in the fall of 1995. Collet (1981, in Collet, 1994) supposed that *D. delphis* spends the winter on the French coast of the Bay of Biscay and leaves this area after March. Goncalves et al. (1996) reported on a strong seasonality of *D. delphis* strandings on the Azores between February and April 1996.

Common dolphins spend the winter in the southern part of the Black Sea, between Trabzon and Batumi, and perform annual migrations from these wintering grounds to the waters of Crimea and back. Seasonality in prey availability may explain these movements (Reyes, 1991 and refs. therein).

Sightings in the western Mediterranean also indicate seasonal patterns in distribution. Common dolphins are more frequently observed in the southern part of the Mediterranean during the first half of the year. In the northern part of the Sea, sightings increase during the second half of the year (Reyes, 1991 and refs. therein). Goffman et al. (1995) surveyed wild dolphins along the Mediterranean coast of Israel. Common and striped dolphins as well as calves accompanying adults were reported mainly during the summer and early fall. Seventy-one percent of the reports came from the southern portion of the Mediterranean coast of Israel (south of Netanya). Finally, on a day- to day basis, Evans (1994) observed large herds of *Delphinus* (>200) from the Straits of Gibraltar to the Azore Platform moving west at sunrise and east at sunset, relating this to topographic features being oriented east-west.

6. Threats

Direct catch: A fishery for common dolphins operated in the USSR and Turkey coasts of the Black Sea from 1870 to 1983. However, the full extent of this fishery is unknown. Direct catches of common dolphins are also reported from several other areas. In Peru, where dolphins are used for food, about 15,000 - 20,000 were landed in 1993. After direct killing was banned by law in 1996, and following a public campaign of environmental education, dolphin meat consumption has diminished dramatically and the meat is no longer sold in supermarkets (Mundo Azul, 2009).

In the western Mediterranean, small numbers were taken off Spain up to 1988 when this practice was banned. Off the Atlantic coast of France, some were harpooned by fishermen for consumption at sea. Other reported takes come from Japan and elsewhere in the range (Reyes, 1991 and refs. therein; Jefferson et al. 1993).

Incidental catch: The common dolphin is one of the most prominent by-catches of both the world-wide pelagic purse-seine and drift net fisheries. This is due in part to its abundance and possibly because of a shared feeding ecology with the targets of those fisheries, large migratory pelagic fish (e.g. tuna). The largest impacts have been in the eastern Pacific and the Indian Ocean and Mediterranean, with some takes associated with the tuna purse-seine fishery off the west coast of Africa.

In 1988 an estimated 16,189 common dolphins were killed in the eastern tropical Pacific tuna purse-seine fishery. Although this is less than 0.5% of the total population, the catch could be highly detrimental if each herd is a genetically discrete breeding population (Evans, 1994 and refs. therein). The average herd size for common dolphins (approx. 500) is greater than that for the other stocks or species, and their more active diving behaviour in the net makes them more susceptible to becoming trapped or tangled. In the 1980's, 4.9% of the sets in the fishery involved common dolphins, but in the 1990's this proportion increased. This indicates that the fishing effort concentrated in areas where the species was more abundant, mainly as a result of enlargement of the Mexican fleet. A large part of the sets on common dolphin schools occurs in coastal waters, where stock structure and movements are poorly understood, and three or more populations may be involved (Reyes, 1991 and refs. therein).

Bratten and Hall (1997) summarised that in the tuna purse seine fisheries, tuna and dolphins are herded and captured together in the net. Prior to retrieving the entire net and the tuna, the crew attempt to release the dolphins by a procedure called "backdown," while utilising various dolphin safety gear. Though a great majority of the dolphins are released unharmed, some die during the fishing operation. Since 1986, dolphin mortality has been reduced by 97%. Analyses of observer data show that many factors cause dolphin mortality, such as fishing areas; dolphin species and herd sizes; environmental factors; gear malfunctions; and crew motivation, skill, and decision-making. Given this, it is clear that there can be no simple solution to this problem. A combination of major and minor technological developments, training in their use, better decision-making skills, and constant pressure to improve performance are the basis of the current success.

More recently, Carretta et al. (2004) estimated incidental mortality in the California drift gillnet fishery for broadbill swordfish, *Xiphias gladius*, and common thresher shark, *Alopias vulpinus*, for the 7-year period, 1996 to 2002. A total of 861 common dolphins were taken during this period. An experiment to test the effectiveness of acoustic pingers on reducing marine mammal entanglements in this fishery began in 1996 and resulted in statistically significant reductions in marine mammal bycatch.

Drift net fishery for swordfish in the waters surrounding the Italian Peninsula is estimated to kill thousands of dolphins and it is likely that common dolphins are caught in these nets. Silvani et al. (1999) calculated that by-catch rates of the illegal Spanish driftnet fishery operating since 1994 on the Mediterranean side of the Gibraltar Straits, aimed at swordfish (*Xiphias gladius*) amounted to 366 dolphins for the 1993 fishing season and 289 for that of 1994. Tudela et al. (2005) reported that illegal, large-scale driftnets are still used in several Mediterranean areas. Morocco harbours the bulk of this fleet targeting swordfish in the Alboran Sea and the Strait of Gibraltar. The active driftnet fleet was conservatively estimated at 177 units. Estimated average net length ranges from 6.5 to 7.1 km, depending on the port, though actual figures are suspected to be much higher (12-14 km). Most boats perform driftnet fishing all year round, resulting in very high annual effort levels. A total of 237 dolphins (short-beaked common dolphin and striped dolphins) were killed by the boats between December 2002 and September 2003. Estimates for a 12-month period by the whole driftnet fleet yielded 3,110-4,184 dolphins (both species) in the Alboran Sea alone; a further 11,589-15,127 dolphins may be killed annually around the Straits of Gibraltar. Dolphins suffer from annual take rates exceeding 10% of their population sizes in the Alboran Sea; this unsustainable impact is particularly worrying for *D. delphis*, because its last remnant healthy population in the Mediterranean occurs in this area. The average catch rate for swordfish, the main target species, amounted to 0.8 individuals/km net set.

Small-scale incidental catches in gillnets occur elsewhere in the range. Some are taken in trawl and purse seine fisheries, particularly in the Black Sea and waters off Northwest Africa, South America and New Zealand (Reyes, 1991, and refs. therein). This is confirmed by by-catch assessments from various sources: Antoine et al. (2001), from the north-east Atlantic, Chivers et al. (1997) from California, Berrow and Rogan (1998) and Couperus (1997) from Irish waters, Goffman et al. (1995) from the Mediteranean coast of Israel, and Kuiken et al. (1994) from the coast of Cornwall, England and Crespo et al. (2000) for Argentinian waters.

In northern Portuguese waters the common dolphin accounted for 60% of all reported strandings. Confirmed bycatch was responsible for 34% of all strandings, and up to 18% of the deaths were suspected to have been caused by interactions with artisanal fishing gear (Ferreira et al. 2003). Silva and Sequeira (2003) found that larger numbers of strandings were recorded in the northern and central Atlantic portuguese coast and showed a significant degree of seasonality, with 37% occurring in the spring and 33% in the winter months. Their stranding data suggest that fishery interactions could be responsible for up to 44% of mortality for this population. Goujon (1996) reported that in 1992 and 1993 on average 1.7 common dolphins were incidentally caught per trip by the French driftneters targetting albacore tuna off the Bay of Biscay. The annual additional mortality linked to the driftnets was estimated at 0.8%. By-catch in the Albacore tuna (*Thunnus alalunga*) drift net fishery in the eastern North Atlantic was estimated at 11,723 common dolphins during the period 1990-2000 (Rogan and Mackey 2007).

Tregenza and Collet (1998) found that pelagic trawl bycatches of dolphins are widespread in the Bay of Biscay, Western Approaches and Celtic Sea and are likely to be the largest of several fishery bycatches of common dolphins which together probably exceed 1% of the local summer population. Tregenza et al. (2003) analysed stranding records in the southwest of England and found a disproportionate increase in the first four months of the year since 1970. Parsons et al. (2007) found high dolphin bycatch rates in the UK pelagic pair trawl fishery for sea bass in the western English Channel. The small UK fishery is estimated to have killed over 900 common dolphins in the five years from 2000 to 2005.

Interactions between short-beaked common dolphins and the fishing industry of South Australia have lead to serious concerns over the long-term viability of the local dolphin population. Bilgmann et al. (2008) detected marked differentiation between dolphins from South Australia and south-eastern Tasmania, suggesting a minimum of two genetic populations. These findings have important consequences for developing conservation management strategies, because Southern Australia has the largest purse-seine fishery by weight in Australia, and substantial numbers of fatal common dolphin interactions have occurred: In 2004/2005 alone, an estimated 1,728 common dolphins were encircled and 377 died over a 7-month period. If these impacts lead to a reduction in population size, it is unlikely that dolphins from the adjacent south-eastern Tasmanian population will replace the lost individuals (Bilgmann et al. 2008).

Baker et al. (2006) reported on common dolphins found via molecular monitoring of 'whalemeat' markets in the Republic of (South) Korea based on nine systematic surveys from February 2003 to February 2005. As Korea has no programme of commercial or scientific whaling and there is a closure on the hunting of dolphins and porpoises, the only legal source of these products was assumed to be incidental fisheries mortality ('bycatch') as reported by the government to the International Whaling Commission.

Culling: In the western Mediterranean, in particular off the coast of Spain, fishermen use harpoons to kill common dolphins and other small cetaceans that cause damage to fishing gear. Dolphins are considered a nuisance in the Black Sea, where they are said to consume an amount of fish greater than Turkey's annual fish production (Reyes, 1991).

Common dolphins have been reliably reported to occur in the shallow northern Adriatic Sea since the 17th century. However, the species has progressively declined and is now rare in the region. The systematic culling campaigns and other takes that occurred between the second half of the 18th century and the 1960s and habitat degradation in subsequent years are the most likely causes of the decline (Bearzi et al. 2004). Ross (2006) reported on deliberate and illegal killing of *D. delphis* for sport, crayfish bait or as a perceived competitor in fisheries in Australian waters.

Competition with fisheries: Cañadas and Hammond (2008) observed a decline of common dolphins in the Gulf of Vera, with a summer density 3-fold lower in the period from 1996 to 2004 than in 1992 to 1995. Prey depletion due to the exponential growth of aquaculture in the area was seen as the most likely cause. Negative impacts of mariculture on common dolphins is also reported from Australia, where four animals were killed entangled in salmonid farms in south-eastern Tasmania. A further 29 dolphins (*T. aduncus* and *D. delphis*) were entangled and killed at southern blue-fin tuna feedlots (Ross, 2006).

Pollution: Pollution has increased dramatically in the Azov Sea, and this is the reason why common dolphins are no longer found there. Large amounts of domestic and industrial effluents have been dumped in the Mediterranean, and some areas are under severe ecological stress. High concentrations of PCBs were found in one common dolphin stranded on the French Mediterranean coast, showing the level of contamination of these waters (Reyes, 1991 and refs. therein). Viale (1994) even suggests using cetaceans as indicators of the progressive degradation of Mediterranean water quality.

Pierce et al. (2008) reported on high concentrations of polychlorinated biphenyls (PCBs) in blubber of 40% of female common dolphins from the Atlantic coast of Europe, above the threshold at which effects on reproduction could be expected. However, the average pregnancy rate recorded in common dolphins (25%) was similar to that of the western Atlantic population and only a few of the common dolphins sampled had died from disease or parasitic infection. Bioaccumulation of this family of man-made contaminants has also been recorded from *Delphinus* stranded in US waters (Evans, 1994 and refs. therein). Moessner and Ballschmiter (1997) found that animals from the western North Atlantic were contaminated about 15 times more with organochlorines than their conspecifics from the eastern North Pacific and the Bering Sea/Arctic Ocean. The total organochlorine burden and the 4,4'-DDE-percentage as well as the metabolic PCB patterns correlate with the trophic levels of the marine mammals studied.

Long et al. (1997) analysed cadmium levels in *D. delphis* from South Australia. Cadmium was accumulated mainly in the kidneys (range 0-38 µg/g), with levels in many individuals exceeding 20 µg/g (wet weight). On histological examination, 32% of adult dolphin kidneys showed pathological changes, proteinuria being the most common abnormality. High levels of cadmium were found in dolphins from widely spaced locations in South Australia. Holsbek et al. (1998) investigated heavy metal concentrations (total and organic Hg, Ti, Cr, Cu, Zn, Cd and Pb) in 29 common dolphins stranded on the French Atlantic coast and found no difference in contamination between the 1977-1980 and 1984-1990 periods.

Noise pollution: Evans (1998) feared that the development of the offshore petroleum industry is likely to have a negative effect on pelagic cetacean species such as *D. delphis*, and

Goold (1996) as well as Stone and Tasker (2005) confirm this, describing the avoidance reaction of *D. delphis* to airguns used in the corresponding seismic surveys.

Overfishing: In many areas, including the Mediterranean and Black Seas, common dolphins feed on schooling fish that are also the target for commercial fisheries. In the Black Sea, concern has been expressed about the recent increase in the anchovy and sprat fisheries, the main food supplies of the isolated population of common dolphins already overexploited by a direct fishery (Reyes, 1991 and refs. therein). According to Bourreau and Gannier (2003) the apparent rarefaction of common dolphins in the Mediterranean Sea may be due to heavy exploitation of peri-coastal stocks of pelagic fishes. This suggests that suitable conservation policies for the near future in regions where the species is still well represented may be necessary. Bearzi et al. (2005) concluded that the present unfavourable status of common dolphins in eastern Ionian Sea coastal waters is largely a consequence of prey depletion.

Tourism: Neumann and Orams (2006) found that common dolphins can be affected by tourism, but that adherence to New Zealand's Marine Mammals Protection Regulations and the current low level of tourism appears to minimise the impact on this species. In tourist operations on the eastern coast of New Zealand, common dolphins responded with a relatively predictable pattern to approaching boats. Initial attraction typically was followed by neutral behaviour and eventually replaced by boat avoidance. Smaller dolphin groups showed boat avoidance sooner and more frequently than larger groups. When swimmers entered the water, dolphins only spent an average of 2 min in their vicinity. Throughout encounters, they maintained a distance of at least 3 m from the nearest swimmer.

7. Remarks

Range states: Albania; Algeria; Argentina; Australia; Belgium; Bosnia and Herzegovina; Brazil; Bulgaria; Canada; Chile; China; Colombia; Costa Rica; Croatia; Cyprus; Denmark; Ecuador; Egypt; El Salvador; France; Gabon; Gambia; Georgia; Germany; Gibraltar; Greece; Guatemala; Guinea; Guinea-Bissau; Honduras; Ireland; Israel; Italy; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Lebanon; Libyan Arab Jamahiriya; Malta; Mauritania; Mexico; Monaco; Montenegro; Morocco; Namibia; Netherlands; New Caledonia; New Zealand; Nicaragua; Norway; Palestinian Territory, Occupied; Panama; Peru; Poland; Portugal; Romania; Russian Federation; Senegal; Slovenia; South Africa; Spain; Syrian Arab Republic; Tunisia; Turkey; Ukraine; United Kingdom; United States; Western Sahara (Hammond et al. 2008).

Tighter fishery management is needed urgently for at least some populations of short-beaked common dolphins (Reeves et al. 2003). Tregenza et al (2003) summarized that a) strandings are still substantially under-reported, b) a recent real rise in common dolphin bycatch is likely, c) a mark-recapture or body loss rate approach to strandings might provide a useful basis for assessing true strandings rates, d) rigorously recording the reliability status of species, length, and sex data will enhance the long term value of these records, e) marking of discarded cetaceans by fisheries observers would be immensely valuable but is still not routinely practised, and f) accessible data on fishery location, effort and method would be valuable.

See further recommendations for South American stocks in Hucke-Gaete (2000) and for Southeast Asian stocks in Perrin et al. (1996) in Appendix 1 and Appendix 2, respectively.

The common dolphin is categorized as "least concern" by the IUCN. The species is listed in Appendix I of CITES. The North and Baltic Sea populations, the Mediterranean sea population, the Black Sea population and the eastern tropical Pacific population of *Delphinus delphis* are listed in Appendix II of CMS.

However, recent data indicate that the species may also migrate in the Strait of Gibraltar area (range states: Spain, Portugal, Algeria, Morocco), along the coast of southern California (range States US, Mexico), and in the Nova Scotia area (range states US and Canada). It is therefore recommended that the species as a whole should be included in App. II of CMS, without restriction to particular stocks.

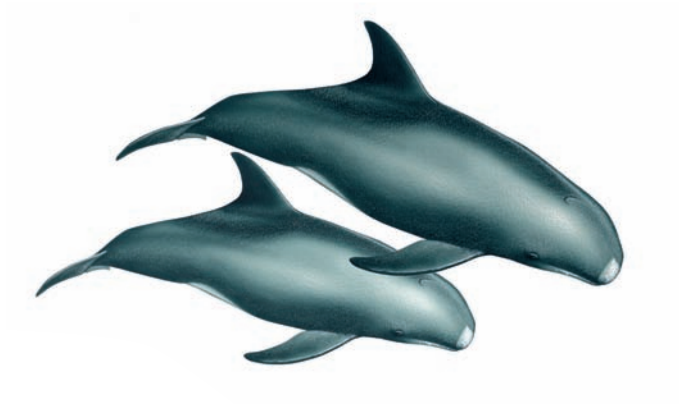
The Black Sea population of *D. d. ponticus* is considered endangered (Birkun 2006) based on a generation time of 20 years and very large take prior to 1983, a mass mortality by morbilivirus in 1994 and a significant degradation of the environment. Bearzi (2003) classified the Mediterranean subpopulation also as endangered, based on a reduction in population size of more than 50% over a three-generation period (30-45 years with a generation time of 15 years) and habitat deterioration.

8. Sources (see page 245)

3.10 Feresa attenuata Gray, 1874

English: Pygmy killer whale
German: Zwerggrindwal
Spanish: Orca pigmea
French: Orque pygmée

Family Delphinidae



Feresa attenuata / Pygmy killer whale (© Wurtz-Artescienza)

1. Description

Pygmy killer whales have a robust body that narrows towards the dorsal fin, hence the name "*attenuata*" (Latin) meaning "thinning". The head is round and blunt and lacks a beak typical of many dolphin species. The moderately long flippers are rounded at the tips with convex leading and concave trailing edges. Pygmy killer whales are mostly grey to black, with a subtle dark cape on the side, below the high, falcate dorsal fin. There is a paler grey area on each flank and an irregularly white patch on the ventral side between the flippers, around the genitals and occasionally the tail stock. The lips are also edged with white. Body size ranges from 2.1 to 2.6 m (Donahue and Perryman, 2009). Maximum known weight is 225 kg (Jefferson et al. 2008).

2. Distribution

This is a tropical and subtropical species that inhabits oceanic waters around the globe, generally not ranging north of 40°N or south of 35°S (Jefferson et al. 1993; Taylor et al. 2008). It ranges north to the Gulf of Mexico, east coast of Florida, Senegal, Arabian Sea, Sri Lanka, Honshu, Hawaii, and Gulf of Tehuantepec, and south to Buenos Aires, Cape Province, Queensland, and Peru (Rice, 1998).

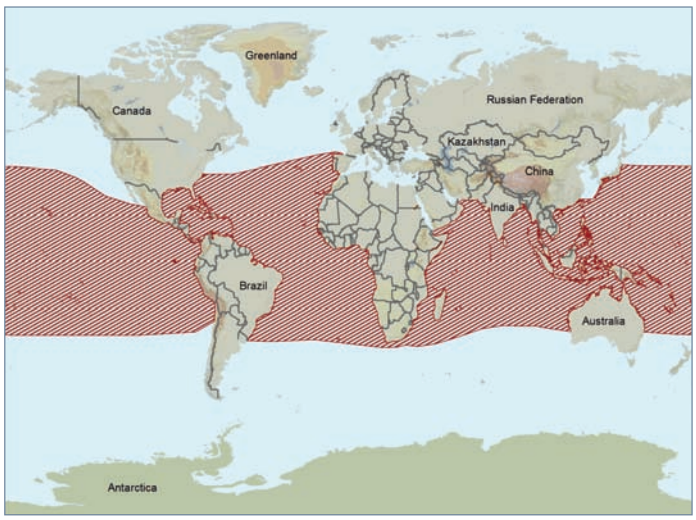
The distribution of *F. attenuata* is poorly known from sparse but widely distributed records worldwide. It is seen relatively frequently in the eastern tropical Pacific, Hawaii, and Japan, though it is not particularly abundant anywhere. Because it tends to avoid boats it may be more common than the records suggest (Carwardine, 1995).

It is notable that most of the records outside the tropics are associated with strong, warm western boundary currents which effectively extend tropical conditions into higher latitudes (Ross and Leatherwood, 1994 and ref. therein). Williams et al. (2002) e.g. observed two groups in the north-eastern Atlantic in the Bay of Biscay at 45°16'N, 30°56'W and at 45°26'N, 40°26'W, respectively. In both cases the cetaceans were in close proximity to newly born or first-year calves.

Records of whales on the cool west coasts of southern Africa and Peru are exceptions, though these could well have originated in far warmer waters comparatively close by (Ross and Leatherwood, 1994 and ref. therein).

3. Population size

There is very little information on population size, and the species appears to be uncommon. The population size of the western north Atlantic stock is unknown. The population size for the Northern Gulf of Mexico stock is 408 (Reviewed in Waring et al. 2007). Wade and Gerrodette (1993) estimated that there were about 38,900 (CV=31%) in the eastern tropical Pacific. There are an estimated 956 pygmy killer whales (CV=83%) in the Hawaiian portion of the US EEZ (Barlow 2006).



Distribution of Feresa attenuata (Taylor et al. 2008; © IUCN Red List). The species prefers tropical and subtropical offshore waters around the world between 40°N and 35°S .

4. Biology and Behaviour

Habitat: Occurs in deep, warm waters, rarely close to shore (except near oceanic islands). Mainly tropical, but occasionally strays into warm temperate regions (Carwardine, 1995).

Behaviour: *F. attenuata* may be difficult to approach and is known to avoid boats, though there are reports of bow- and wake-riding (Carwardine, 1995). Castro (2004) e.g. observed pygmy killer whales off Machalilla National Park, Ecuador, "The school of dolphins was travelling at a speed of around 30 km/h. During the whole length of the observation, while the animals were travelling, they conducted running leaps and hard splash with their whole bodies outside of the water. On some occasions, their heads were outside of the water and they were bowriding in the waves produced by the boat".

Schooling: Groups generally contain 50 or fewer individuals, although herds of up to several hundred have been seen (Jefferson et al. 1993; Ross and Leatherwood, 1994). Pods often swim abreast in perfectly co-ordinated "chorus lines" and, when alarmed, bunch together to rush away. Growling sounds may be heard above the surface. Herds often strand (Carwardine, 1995), e.g. at Hawaii (Mazzuca et al. 1999) or in Brazil (Zerbini and de Oliveira 1997). A record mass stranding of pygmy killer whales in the British Virgin Islands was documented by Mignucci-Giannoni et al. (2000), who associated the stranding process with the meteorological and oceanographic disturbance of hurricane Marilyn, which devastated the Virgin Islands a day prior to the stranding.

Food: Pygmy killer whales eat mostly fish and squid, although they occasionally attack other dolphins, at least when those dolphins are involved in tuna fishery interactions in the eastern tropical Pacific (Jefferson et al. 1993; Carwardine, 1995). Santos and Haimovici (1998) found mainly squids of the families Onychoteuthidae and especially Ommastrephidae in the stomach contents of *F. attenuata*.

Pygmy killer whales use similar echolocation clicks as similar sized, whistling delphinids, suggesting comparable diets. Recorded clicks are directional, short (25 μs) transients with estimated source levels between 197 and 223 dB re. 1 μPa (pp). Spectra of clicks recorded close to or on the acoustic axis were bimodal with peak frequencies between 45 and 117 kHz, and with centroid frequencies between 70 and 85 kHz (Madsen et al. 2004).

5. Migration

No migrations are known (Carwardine, 1995). Incidental catches by Sri Lankan fishermen have been reported in all months except September, November and December, indicating that pygmy killer whales are present almost throughout the year in this region. Similarly, whalers of St Vincent, Lesser Antilles, indicated that they might encounter pygmy killer whales at any time of the year, implying residency (Ross and Leatherwood, 1994). Jefferson et al. (2008) confirmed this for Hawaiian waters, where pygmy killer whales show high fidelity to specific islands, with strong and stable association patterns.

6. Threats

Direct catch: A few individuals are known to be taken in drives and in driftnets in various regions, most notably Japan and Sri Lanka (Jefferson et al. 1993). Reports on the small-cetacean fisheries of St Vincent and Lamelera suggest that pygmy killer whales form a very small proportion of the catch and that catches probably have little impact on the populations in those areas. In Sri Lanka, there has been additional mortality of this and other species due to harpooning of dolphins for use as bait on long-lines for sharks, billfish, and other oceanic fishes (Ross and Leatherwood, 1994 and refs. therein).

Incidental catch: Although they comprise less than 2% of all cetaceans in monitored by-catches in gillnet fisheries in Trincomalee, Sri Lanka and in villages on the south-west coast of Sri Lanka, this may amount to 300-900 of the 15,000-45,000 dolphins estimated to die each year in such fisheries (Ross and Leatherwood, 1994, and refs. therein). The numbers of animals killed incidentally in net fisheries, such as those in Sri Lanka, may be much higher than is so far documented because monitoring of these widespread activities is incomplete. In the long term, such takes may have a significant impact on stocks resident in areas where pygmy killer whales (and other small cetaceans) and extensive gillnetting operations overlap (Ross and Leatherwood, 1994). Small incidental catches are known in fisheries in other areas (Jefferson et al. 1993), e.g. the Philippines (Dolar et al. 1999) or Indonesia (Rudolph and Smeenk, 2009).

Pollution: There have been reports on the presence of hydrocarbon residues, including DDT, Dieldrin and PCBs in various tissues of three pygmy killer whales from the Gulf and Atlantic coasts of Florida (Ross and Leatherwood, 1994 and refs. therein).

Noise pollution: In early 2004 and in 2005, several unusual stranding events occurred in Taiwan during a period of large-scale naval exercises. Gross examination of the partial remains of a pygmy killer whale revealed internal injuries to structures associated with or related to acoustics or diving, suggestive that nearby naval exercises may have contributed to or caused the death of at least one cetacean in this region and that species other than beaked whales may also be susceptible to such activities. With an increasing number of military exercises in this region, more attention to the impacts of such activities on cetaceans is needed (Wang and Yang, 2006).

7. Remarks

Range states (Taylor et al. 2008): Algeria; Anguilla; Antigua and Barbuda; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Brazil; Brunei Darussalam; Cambodia; Cameroon; Cayman Islands; China; Cocos (Keeling) Islands; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Cuba; Côte d'Ivoire; Djibouti; Dominica; Dominican Republic; Ecuador; El Salvador; Equatorial Guinea; Fiji; France; French Guiana; French Polynesia; Gabon; Gambia; Ghana; Grenada; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; India; Indonesia; Iran, Islamic Republic of; Italy; Jamaica; Japan; Kenya; Kiribati; Korea, Republic of; Liberia; Madagascar; Malaysia (Peninsular Malaysia, Sabah, Sarawak); Maldives; Marshall Islands; Mauritania; Mayotte; Mexico; Micronesia, Federated States of; Morocco; Mozambique; Myanmar; Nauru; Netherlands Antilles (Bonaire, Curaçao, Netherlands Leeward Is.); New Caledonia; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal; Puerto Rico; Saint Kitts and Nevis; Saint Vincent and the Grenadines; Samoa; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Spain; Sri Lanka; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tokelau; Tonga; Trinidad and Tobago; United States; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen.

Feresa attenuata is considered as "Data Deficient" by the IUCN (Taylor et al. 2008). The species is not listed by CMS. The species is listed on Appendix II of CITES.

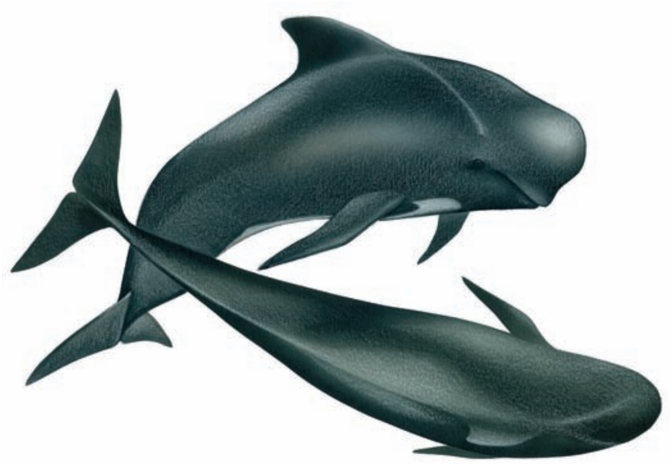
There is very little knowledge about this species, its abundance, migratory behaviour or by-catch rates in offshore fisheries. For South American populations, see recommendations in Hucke-Gaete (2000; Appendix 1). General recommendations on Southeast Asian stocks can be found in Perrin et al. (1996; see Appendix 2).

8. Sources (see page 248)

3.11 Globicephala macrorhynchus Gray, 1846

English: Short-finned pilot whale
German: Kurzflossen Grindwal
Spanish: Calderón de aletas cortas
French: Globicéphale tropical

Family Delphinidae



Globicephala macrorhynchus / Short-finned pilot whale (© Wurtz-Artescienza)

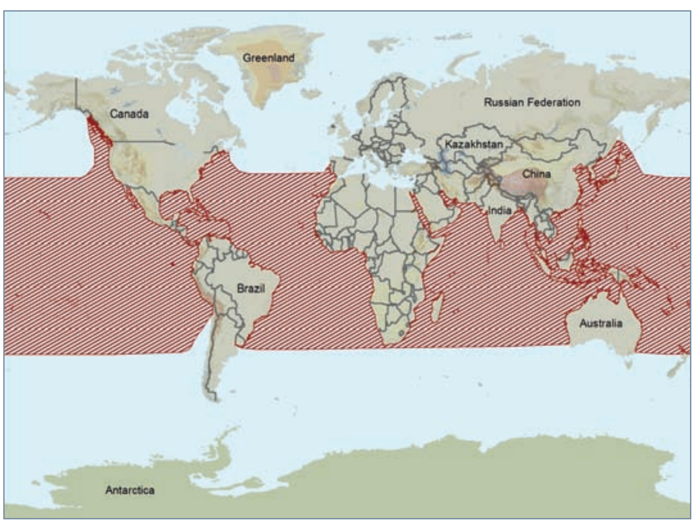
1. Description

The body in pilot whales is robust, with a deep tail stock. The melon is exaggerated and bulbous and the beak is barely discernible or non-existent. The dorsal fin is wide, broad-based, falcate and set well forward on the body. The flippers are long, slender, and sickle-shaped.

A faint grey saddle patch may be visible behind the dorsal fin. A grey midventral line extends to the front into an anchor-shaped chest patch and widens posteriorily to a genital patch. The short-finned pilot whale has a shorter and wider skull than the long-finned species, with the pre-maxillae covering the maxillary bones (Olson, 2009).

Long- and short-finned pilot whales (*G. melas* and *G. macrorhynchus*) are difficult to distinguish at sea. However, the species differ, as the name suggests, in flipper length, skull shape and number of teeth. On average, the pectoral fins of the short-finned pilot whales are 1/6 the body length (Olson, 2009). Adult females reach a body length of approx. 5.5 m and males 7.2 m, with a body weight of up to 3,200 kg (Jefferson et al. 2008).

G. macrohynchus appears to vary geographically, but no comprehensive study has been undertaken. Off the Pacific coast of Japan, a northern and a southern population differ sharply in colour pattern and in body size and shape and also in cranial features. However, their taxonomic status remains unsettled (Rice, 1998 and refs. therein; Olson and Reilly, 2002). Water temperature seems to be the primary factor determining the relative distributions of these two populations (Fullard et al. 2000).



Distribution of Globicepahala macrorhynchus (Taylor et al. 2008; © IUCN Red List): tropical, subtropical, and warm temperate oceans round the world.

2. Distribution

Short-finned pilot whales are found in deep offshore areas and usually do not range north of 50°N or south of 40°S (Jefferson et al. 1993). There is some overlap in range between the two species (Olson, 2009). *G. macrorhynchus* is probably circumglobal in tropical and warm temperate waters. In the Atlantic it ranges north to New Jersey and to Charente-Maritime in France (it is not present in the Mediterranean); in the Pacific, its range extends north into cooler temperate waters as far as Hokkaido (50°N, 145°W), and Vancouver Island. It is vagrant to the Alaska Peninsula (57°N, 156°W). The southern limits of the range are not fully determined due to past confusion with *G. melas*, but *G. macrohynchus* is known to range south to São Paulo, Cape Province, Western Australia, Tasmania, and Cape Farewell on North Island in New Zealand (Rice, 1998). There is an hypothesis that the short-finned pilot whale is in the process of expanding to fill the former range of long-finned pilot whales in the North Pacific (Bernard and Reilly, 1999 and refs. therein).

3. Population size

Olson (2009) summarizes population estimates obtained from various researchers via line-transect methods between the 1990's and 2005. In the western Pacific off Northern Japan, the population amounts to 5,300, whereas off southern Japan numbers reach 53,608 (Miyashita, 1993 in Olson, 2009). Dolar (1999) estimated a total of 7,700 individuals in the eastern Sulu Sea (Philippines). Around Hawaii, 8,806 were estimated (Barlow, 2006) and in the Eastern tropical Pacific, the most recent estimate from 2000 gives 589,000 (CV=0,26), with a significant increase of abundance estimates from 1986-1990 to 1998-2000 (Gerrodette and Forcada, 2002). In the US Golf of Mexico, Waring et al. (2007) estimate 2,388, and their best estimate for the western North Atlantic stock is 31,139 whales (CV=0,27). Tenerife's (Spain) resident population of *G. macrorhynchus* is estimated at 350 individuals (Glen, 2003). However, the current population trend in the Atlantic Ocean is unknown.

4. Biology and Behaviour

Behaviour: Hindell (2008) used sophisticated telemetry logging devices to show that short-finned pilot whales employ energetic sprints to chase down their deep-dwelling prey. These sprints are costly in terms of energy and therefore oxygen, which has to be taken into account in foraging models. Baird et al. (2003), using suction-cup attached time-depth recorders (TDRs) and video camera systems (Crittercam), recorded deep dives at dusk and dawn following vertically migrating prey, and near-surface foraging at night. The deepest dives recorded (typically 600-800 m, max. 27 minutes) were during the day. However, long bouts of shallow (<100 m) diving also occurred only during the day. Video footage from the Crittercams during these shallow dive bouts indicated the whales were engaged in social, rest and travel behaviours, but no feeding was documented.

Habitat: The species prefers deep water and occurs mainly at the edge of the continental shelf and over deep submarine canyons (Carwardine, 1995). Davis et al. (1998) found that *G. macrorhynchus* in the Gulf of Mexico preferred water depths between 600 and 1,000 m.

Schooling: Pods of up to several hundred short-finned pilot whales have been reported, and members of this highly social species are almost never seen alone. Strong social bonds may partially explain why pilot whales are among the species of cetaceans that most frequently mass-strand. Although detailed studies of behaviour have only begun recently, pilot whales appear to live in relatively stable female-based groups (Jefferson et al. 1993).

Three types of social organisation for pilot whale pods off southern California were described: travelling/hunting groups, feeding groups, and loafing groups. The travelling/ hunting groups have also been appropriately described as "chorus lines" as the animals in these are oriented in a broad rank of up to 2 miles in width, but only a few animals deep. Sexual and age-class segregation also have been observed in chorus lines. In the second type of group described, the feeding group, there was sometimes general movement of whales in a given direction, but individuals tend to remain fairly independent of one another. The third type of pod, the "loafing group", was described as an almost stationary aggregation of 12-30 or more individuals, floating at the surface, nearly or actually touching one another. A wide variety of types of behaviour, including mating, was reported to occur in loafing groups (Bernard and Reilly, 1999 and refs. therein).

In the eastern tropical Pacific, approximately 15% of pilot whale sightings include other cetaceans. They are sighted with bottlenose dolphins (*Tursiops truncatus*) and with tuna-dolphin aggregations (*Thunnus albacares* and *Stenella* spp.)and *S. coeruleoalba*). The most common associate in coastal waters is the common bottlenose dolphin; pilot whales have been sighted also with short-beaked common dolphins (*Delphinus delphis*), Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), gray whales (*Eschrichtius robustus*), fin and sperm whales (*Balaenoptera physalus* and *Physeter catodon*) and killer whales (*Orcinus orca*; Bernard and Reilly, 1999 and refs. therein).

Mazzuca et al. (1999) found that in the Hawaiian Archipelago, short-finned pilot whales stranded in the largest groups and experienced the greatest number of stranding events (mean 14 animals, 5 events) of all cetaceans recorded from 1957 through 1998. The greatest incidence of odontocete mass strandings occurred on the Island of Maui during the month of June. Mass strandings occurred on all the high Hawaiian Islands, except Hawaii; none were reported on the islands or atolls northwest of Kauai. Two-thirds of the events occurred on the leeward sides of the islands with similar bottom topography, coastal configuration, and geomagnetic characteristics in all events.

Mignucci et al. (1999) reported that in waters off Puerto Rico and the US and British Virgin Islands, short-finned pilot whales were one of the most frequently stranded species. A high number of strandings occur in the winter and spring.

Food: Although they also take fish, pilot whales are thought to be primarily adapted to feeding on squid (Hacker, 1992). They show the tooth reduction typical of other squid-eating cetaceans (Jefferson et al. 1993). Hernandez-Garcia and Martin (1994) found that stomach contents of two short-finned pilot whales found on the Canary Islands were made up entirely of cephalopods: *Todarodes sagittatus*, *Cranchia* and juveniles of *Megalocranchia*.

Mintzer et al. (2008) examined the stomach contents of short-finned pilot whales from the North Carolina coast in January 2005. *Brachioteuthis riisei* (numerical abundance 28%), an oceanic species, was the most important cephalopod prey, but *Taonius pavo* (12%) and *Histioteuthis reversa* (9%) also represented a substantial part of the diet. A large number of otoliths belonging to the fish *Scopelogadus beanii* were present (25%), indicating that the whales fed primarily off the continental shelf prior to stranding. Stomach content composition differed from those of short-finned pilot whales from the Pacific coast in which neritic species dominate the diet. These findings also suggest that there is a considerable difference between the diet of short- and long-finned pilot whales (*Globicephala melas*) in the western North Atlantic. The latter feed predominantly on the long-finned squid (*Loligo pealei*), whereas the former feed on deep-water species.

Reproduction: Females become post-reproductive at around 35 years but may continue to suckle young for up to 15 additional years, suggesting a complex social structure in which older females may give their own or related calves a "reproductive edge" through prolonged suckling. Calving peaks occur in spring and autumn in the Southern Hemisphere and vary by stock in the Northern Hemisphere (Jefferson et al. 1993).

5. Migration

The species appears to be generally nomadic, with no fixed migrations, but some north-south movements are related to prey movements or incursions of warm water. Inshore-offshore movements are determined by spawning squid (outside the squid season, *G. macrorhynchus* is usually found offshore). Some populations are present year-round, such as in Hawaii and the Canary Islands (Carwardine, 1995).

A marked seasonality in the distribution of pilot whales has been observed in at least three areas: off southern California; in the eastern tropical Pacific; and off the coast of Japan. In southern California, the seasonal abundance of pilot whales appears to be correlated with the seasonal abundance of spawning squid. E.g. during years of low squid abundance, fewer pilot whales were sighted near Catalina Island. In both the coastal and pelagic waters of the eastern tropical Pacific, the density of population centres appears to change seasonally in response to major changes in the current structure of the area. In the southern California Bight, the occurrence of short-finned pilot whales was associated with high relief topography. There seems to also be a seasonal distribution with depth: pilot whales were found in significantly shallower water during winter (depth 375 m) than summer (800 m) (Bernard and Reilly, 1999 and refs. therein).

There have been no systematic studies of home range or migration of individuals of this genus. Opportunistic observations in the southern California Bight have indicated that a pod of 20-30 individuals, identified by scars, unusual marks, etc., lived in the area year-round in the 1970's. Following the strong El Niño event in 1982-83, subsequent surveys throughout the 1980s turned up few sightings, and documented the absence of all but one pod of pilot whales near Catalina Island. Shipboard surveys along the entire California coast using line-transect methodology were conducted in 1991 and 1993 within 550 km of shore, documenting an apparent return of this stock. The calculated abundance estimate was 1,004 individuals (Shane, 1995; Bernard and Reilly, 1999 and refs. therein).

6. Threats

Direct catch: The short-finned pilot whale has been exploited for centuries in the western North Pacific. The largest catches have occurred off Japan, where small coastal whaling stations and drive fisheries took a few hundred annually (Jefferson et al. 1993). Between 1982 and 1985, 519 of the northern form and 1,755 whales of the southern form were killed. From 1985 to 1989, Japan took a total of 2,326 short-finned pilot whales. This fishery is ongoing: In 1997, Japan recorded a catch of 347 short-finned pilot whales (Olson and Reilly, 2002), which was reduced to 63 specimens in 2004 (Olson, 2009). The current national quota is 50 (Taylor et al. 2008).

Elsewhere, a small, intermittently active fishery takes around 220 pilot whales per year in the Lesser Antilles in the Caribbean at St. Vincent Island, and there are indications of a small fishery at St. Lucia Island (Bernard and Reilly, 1999 and refs. therein).

Dolar et al. (1994) reported on illegal fisheries for marine mammals in central and southern Visayas, northern Mindanao and Palawan, Philippines, where hunters took dolphins and short-finned pilot whales for bait or human consumption. These are taken by hand harpoons or, increasingly, by toggle-head harpoon shafts shot from modified, rubber-powered spear guns. Around 800 cetaceans were taken annually.

Incidental catch: There are probably more pilot whales taken incidentally than is presently documented. In US Atlantic waters, pilot whales have been taken in a variety of fisheries, but not exceeding the allowable annual take under US law (Olson, 2009). Based on preliminary data, the squid round-haul fishery in southern California waters is estimated to have taken 30 short-finned pilot whales in one year.

In the California drift gill net fishery between 1993 and 1995, the mean annual take of short-finned pilot whales was 20 (Bernard and Reilly, 1999 and refs. therein). Since the take in US waters exceeded the allowable limit, a take reduction plan was implemented, and currently the annual take is lower than the allowable limit (Olson, 2009).

Forney and Kobayashi (2007) reported two catches in 24,542 observed sets in the Hawaii-based longline fishery, corresponding to about 1-2 casualties per year in this fishery.

In the western Pacific ocean, an estimated 350-750 *G. macrorhynchus* died annually in passive nets and traps set in Japanese fisheries (Bernard and Reilly, 1999 and refs. therein).

Systematic surveys of 'whalemeat' markets in the Republic of (South) Korea (Baker et al. 2006) using molecular monitoring also revealed products from short-finned pilot whales. As Korea has no programme of commercial or scientific whaling and there is a closure on the hunting of dolphins and porpoises, the only legal source of these products was assumed to be incidental fisheries mortality ('bycatch') as reported by the government to the International Whaling Commission.

In the Caribbean, the most common human-related cause of death categories off Puerto Rico and the US and British Virgin Islands were entanglement and accidental captures, followed by animals being shot or speared (Mignucci et al. 1999).

Pollution: There is a wide variation in contaminant loads in short-finned pilot whales. High concentrations of DDT and PCB were found in whales off the Pacific coast of the USA in the mid 70s, while low levels were found in whales from the Antilles and off Japan (Bernard and Reilly, 1999 and refs. therein). The latter is confirmed by Bustamante et al. (2003), who investigated trace element concentrations in liver, muscle and blubber tissues of two short-finned pilot whales in New Caledonia in the southwestern Pacific and found that values for Al, Cd, Co, Cr, Cu, Fe, organic and total Hg, Mn, Ni, Se, V, and Zn were below levels for concern.

Noise pollution: Weir (2008) report on the reactions of a pod of 15 short-finned pilot whales to a ramp-up procedure employed in a 2-D seismic survey off Gabon. The movement away from the source was limited in time and space, and the authors suggest that further research into the efficiency of the ramp-up procedure for marine mammal mitigation is necessary. Hohn et al. (2006) investigated a multispecies mass stranding involving short-finned pilot whales in North Carolina in early 2005. The event was associated in time and space with naval activity using mid-frequency active sonar, inferred from features such as the "atypical" distribution of strandings involving multiple offshore species, all stranding alive, and without evidence of common infectious or other disease process.

Tourism: The presence of whale watching vessels can potentially cause short-term disturbance in the natural behaviours of several cetacean species. Off Teneriffe, Spain, Glen (2003) found a significant difference between *G. macrorhynchus* avoidance behaviour and the number of whalewatching vessels around a pod. In the presence of one or two vessels, 28% of sightings involved avoidance behaviours, rising to 62% of sightings in the presence of three or more vessels. The author concludes that any impacts from whale-watching vessels should be minimised until it is shown that they are not detrimental to the status of the population.

7. Remarks

Range states (Taylor et al. 2008): American Samoa; Anguilla; Antigua and Barbuda; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Bouvet Island; Brunei Darussalam; Cambodia; Cameroon; Canada; Cayman Islands; China; Cocos (Keeling) Islands; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Cuba; Côte d'Ivoire; Djibouti; Dominica; Dominican Republic; Ecuador; Egypt; El Salvador; Equatorial Guinea; Fiji; French Guiana; French Polynesia; Gabon; Gambia; Ghana; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; India; Indonesia; Iran, Islamic Republic of; Jamaica; Japan; Kenya; Kiribati; Korea, Democratic People's Republic of; Korea, Republic of; Liberia; Madagascar; Malaysia (Peninsular Malaysia, Sabah, Sarawak); Maldives; Marshall Islands; Martinique; Mauritania; Mayotte; Mexico; Micronesia, Federated States of; Morocco; Mozambique; Myanmar; Namibia; Nauru; Netherlands Antilles; New Caledonia; New Zealand; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines, Pitcairn; Portugal; Puerto Rico; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Saudi Arabia; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Sudan; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; Tuvalu; USA; Vanuatu; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen

G. macrorhynchus is listed as "Data Deficient" by the IUCN, and world-wide only one population, off northern Japan, is currently considered at risk. Insufficient information is available to accurately evaluate the species' status elsewhere (Stacey and Baird, 1994).

The species is listed on Appendix II of CITES.

For recommendations on South American stocks, see Hucke-Gaete (2000; Appendix 1). See also general recommendations on Southeast Asian stocks in Perrin et al. (1996; Appendix 2).

This species is not listed by CMS, but inclusion in Appendix II is recommended. Recent results indicate a marked seasonality in the distribution of pilot whales in at least three areas: off southern California; in the eastern tropical Pacific; and off the coast of Japan. Range states concerned are the US, Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Columbia, Ecuador and Peru, as well as Russia, Japan, North and South Korea and China.

8. Sources (see page 248)

3.12 Globicephala melas (Traill, 1809)

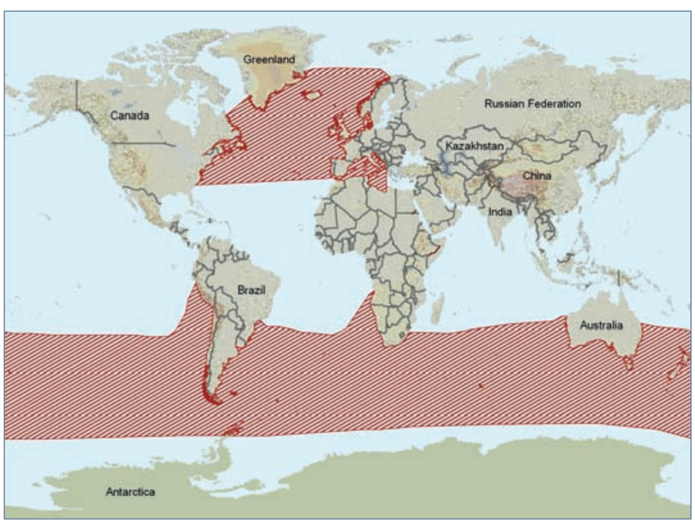
English: Long-finned pilot whale
German: Langflossen-Grindwal
Spanish: Calderón negro
French: Globicéphale noir

Family Delphinidae

Globicephala melas / Long-finned pilot whale (© Wurtz-Artescienza)

1. Description

The body in pilot whales is robust, with a deep tail stock. The melon is exaggerated and bulbous and the beak is barely discernible or non-existent. The dorsal fin is wide, broad based, falcate and set well forward on the body. The flippers are long, slender, and sickle-shaped. A faint grey saddle patch may be visible behind the dorsal fin in southern Hemisphere specimens. In the North Atlantic, a thin whitish stripe can be visible in less than half of all adult pilot whales. A pale eye blaze is visible in one fifth of all adult pilot whales, most often in males (Bloch et al. 1993a). A grey midventral line extends to the front into an anchor-shaped chest patch and widens posteriorily to a genital patch. Sexual dimorphism exists with longer flippers and larger flukes in males (Bloch et al. 1993a). The long-finned pilot whale has a narrower skull than the short-finned species, with the maxillary bones exposed laterally along the full length of the rostrum (Olson, 2009).



Distribution of Globicephala melas: the species is "antitropical" in cold temperate and subpolar waters of all oceans except the North Pacific (Taylor et al. 2008; © IUCN Red List).

Long- and short-finned pilot whales (*G. melas* and *G. macrorhynchus*) are difficult to distinguish at sea. However, the species differ, as the name suggests, in flipper length, skull shape and number of teeth. On average, the flippers reach 18-30% of the body length in long-finned pilot whales, but only 14-19% in short-finned pilot whales (Bloch et al. 1993a). Adults reach a body length of approx. 6.5 m, males being 1 m larger than adult females (Bloch et al. 1993b; Olson, 2009). Body mass reaches up to 1,300 kg in females and up to 2,300 kg in males (Jefferson et al. 2008).

2. Distribution

Two subspecies are recognized in some classifications (Rice, 1998):

G. m. melas: This subspecies ranges in the North Atlantic from Ungava Bay, Disko in western Greenland, 68°N in eastern Greenland, Iceland, the Faroes, and Nordland in Norway, south to North Carolina, the Azores, Madeira, and Mauritania, including the western Mediterranean (Rice, 1998 and refs. therein). It occurred as recently as the 8th to 12th century in northern Japanese waters (Olson, 2009).

According to Bloch and Lastein (1993) pilot whales on the western (Newfoundland) and eastern (Faroes) sides of the North Atlantic are distinguishable by minor external morphometric characters and may be geographically isolated from each other. However, Fullard et al. (2000) concluded that despite genetic, morphometric, physiological and observational studies, it remains unclear whether any population substructure exists. They used eight highly polymorphic microsatellite loci to analyse samples from the US East Coast (Cape Cod), West Greenland, the Faeroe Islands and the UK. Although their results indicate that substructure does exist, and is particularly pronounced between West Greenland and other sites, the magnitudes of the various pairwise comparisons do not support a simple isolation-by-distance model. Instead, the patterns of genetic differentiation suggest that population isolation occurs between areas of the ocean which differ in sea surface temperature (Fullard et al. 2000).

G. m. edwardii (A. Smith, 1834): This subspecies is circumglobal in the Southern Hemisphere, ranging north to São Paulo in Brazil, Cape Province in South Africa, Iles Crozet, Heard Island, the southern coast of Australia, Great Barrier Island in New Zealand, and Arica (19°S) in Chile. Southward it extends at least as far as the Antarctic Convergence 47°S to 62°S and has been recorded near Scott Island (67°S, 179°W) and in the central Pacific sector at 68°S, 120°W (Rice, 1998 and refs. therein).

3. Population size

There is little information on stocks within the species, and there is no information on global trends in abundance (Taylor et al. 2008). The best northwestern Atlantic abundance estimate for *Globicephala* sp. covering most of the species' habitat stems from two 2004 U.S. Atlantic surveys: 31,139 whales (CV= 0,27; Waring et al,. 2007). Based on surveys in the 1980's there are about 13,000 short-finned pilot whales off eastern Newfoundland. In the north-eastern Atlantic the number of pilot whales inhabiting the area between East Greenland, Iceland, Jan Mayen, Faroe Islands and off the western coasts of the British Islands and Ireland was estimated at around 778,000 by Buckland et al. (1993). However, in a more recent meeting, the North Atlantic Marine Mammal commission (NAMMCO, 2006) noted that there had been no assessment of pilot whales since 1994.

Estimates for the southern hemisphere are in the order of 200,000 long-finned pilot whales in Antarctic waters (Bernard and Reilly, 1999 and refs. therein).

4. Biology and Behaviour

Habitat: The typical temperature range for the species is 0-25°C (Martin, 1994) and it may be found in inshore but mostly in offshore waters (Reyes, 1991 and refs. therein).

Around the Faroe Islands, pilot whales show a preference for the region over the border of the continental shelf (Bloch et al. 1993c; Bloch et al. 2003). In the the Alboran Sea, between the Mediterranean and the Atlantic Ocean, the average depth of encounters was 849 m, ranging from 300 to 1,800 m, and reflecting the distribution of their preferred diet, pelagic cephalopods (Cañadas and Sagarminaga, 2000).

In the southern hemisphere, off the coast of Chile, Aguayo et al. (1998) mainly sighted *G. melas* close to the coast, reflecting its preference for the edge of the continental shelf. Goodall and Macnie (1998) reported sightings in the south-eastern South Pacific, which were clustered from 30-35°S, 72-78°W, the maximum being about 160 nm from shore.

In the southwestern South Atlantic, sightings clustered in two areas, 34-46°S and off Tierra del Fuego, 52-56°S. Here schools were found up to 1,000 nm from shore. Fifteen sightings were from waters south of the Antarctic Convergence, from December to March. Only one sighting was made south of 44°S in winter, probably due to lack of effort in southern seas during the colder months (Goodall and Macnie 1998).

Behaviour: Mate (1989) tracked a pilot whale with a satellite tag for 95 days in the western North Atlantic. Virtually all deep dives occurred at night, when the whale was likely feeding on squid. Surface resting occurred most often immediately after sunrise on a four- to seven-day cycle.

Bloch et al. (2003) tagged three long-finned pilot whales off the Faroe Islands (62 °N, 7°W) with satellite transmitters. After tagging, the whales separated and went in different directions. After 10 days, two of the whales were observed together in a pod, and after 19 days two were located at positions determined to be within 2.3 km of each other. The swimming speed of the whales was estimated at 0.2-14.5 km/hour, and they travelled average distances of 70-111 km with a maximum of 200 km per day.

Baird et al. (2002) radio-tagged 5 long-finned pilot whales in deep (>2000 m) waters of the Ligurian Sea, off the NW coast of Italy. During the day all 5 whales spent their time in the top 16 m of the water column, and visible surface activities consisted primarily of rest and social behaviour. Shortly after sunset two whales made several deep dives (max. 360 and 648 m) at high velocity, at a time when vertically migrating prey become more readily available.

Schooling: Pilot whales are highly social; they are generally found in pods of 110, but some groups contain up to 1,200 individuals (Zachariassen, 1993; Bloch, 1998). Based on photo-identification and genetic work, pilot whales appear to live in relatively stable pods like those of killer whales, and not in fluid groups characteristic of many smaller dolphins (Jefferson et al. 1993; Cañadas and Sagarminaga, 2000). They are social animals, with close matrilineal associations with 60% females.

The pods are often mixed with Atlantic white-sided dolphins (*Lagenorhynchus acutus*) and bottlenose dolphins (*Tursiops truncatus*) (Bloch et al. 1993c). When travelling, pods may swim abreast in a line several kilometres across. Short-finned pilot whales are often found in the company of bottlenose dolphins and other small cetaceans, although they have been known to attack them (Carwardine, 1995). Baraff and Asmutis (1998) described the association of an individually identified long-finned pilot whale with Atlantic white-sided dolphins over six consecutive years. Pilot whales were also observed in close association with fin, sperm and minke whales, and common, bottlenose, hourglass and possibly dusky dolphins (Goodall and Macnie, 1998).

Off the northwest coast of Nova Scotia, Canada, Ottensmeyer and Whitehead (2003) distinguished individuals on the basis of distinctive marks on their dorsal fin. Animals formed short-term associations over hours to days and long-term associations over years. Jankowski (2006) found that groups consisted of 14.5 whales on average, with a typical group size of 23 whales, which largely disassociates into its component units (typically 8 whales) within a day. Within-unit relationships typically lasted 4 years, but this is likely an underestimate.

G. melas is one of the species most often involved in mass strandings, e.g. on Cape Cod (Massachusetts, USA) beaches from October to January. Their tight social structure also makes pilot whales vulnerable to herding, and this has been taken advantage of by whalers in drive fisheries off Newfoundland, the Faroe Islands, and elsewhere (Jefferson et al. 1993). If a whale of extreme social importance or strong filial bond strands due to pathological or navigational problems, others in the pod may strand also and then be unable to remain off the beach once removed due to a secondary social or "caring" response. This social response, however, was used successfully to keep a pod of long-finned pilot whales from repeated strandings by researchers in New Zealand: Because the "distress calls" of the beached young of the pod appeared to evoke a stranding response from the older whales, the younger whales were towed offshore and moored to buoys, an action which lured the older animals back out to sea (Bernard and Reilly, 1999 and refs. therein).

Reproduction: Mating occurs primarily in May-June and again at a lower rate in October in the North Atlantic (Desportes et al. 1993; Martin and Rothery, 1993). Calving and breeding can apparently occur at any time of the year, but peaks occur in summer in both hemispheres (Jefferson et al. 1993).

Goodall and Macnie (1998) reported that young were present in all areas of the south Pacific and South Atlantic, including the sub-Antarctic, where they were seen in January (summer), March and April (autumn) and October (spring), when a birth occurred, and in the Antarctic in summer, with a birth occurring at South Georgia in March (autumn).

Food: Primarily squid eaters, pilot whales will also take small medium-sized gregarious fish, when available (Desportes and Mouritsen, 1993; Jefferson et al. 1993). They feed mostly at night, when dives may last for 18 minutes or more and reach 828 m depth (Carwardine, 1995, Heide-Jørgensen et al. 2002). In the western North Atlantic the main prey is the squid *Illex illecebrosus*, although cod (*Gadus morhua*) or Greenland turbot (*Rheinhardtius hippoglossoides*) may be eaten when squid is not available. Off the northeastern United States, Atlantic mackerel (*Scomber scombrus*) is thought to be an important prey item, at least during winter and early spring (Abend and Smith, 1997). Olson (2009) described the diet in the northwest Atlantic; it includes cod (*Gadus morhua*), turbot (*Scomber scombris*), herring (*Clupea harengus*), hake (*Merluccios bilinearis*; *Urophysis* spec.) and dogfish (*Squalus acanthias*). Mintzer et al. (2008), however, found that long-finned pilot whales off North Carolina feed predominantly on the long-finned squid (*Loligo pealei*).

The squid *Todarodes sagittatus* and species of the genus *Gonatus* are reported prey items of long-finned pilot whales in the eastern North Atlantic (Olson, 2009). Although squids are the predominant prey around the Faroe Islands, some fish, such as *Argentina silus* and *Micromesistius poutassou*, are taken too. The whales in this region do not appear to select cod, herring or mackerel, although they are periodically abundant (Reyes, 1991 and refs. therein; Desportes and Mouritsen, 1993; Bernhard and Reilly, 1999 and refs. therein).

Off the South Island of New Zealand, longfinned pilot whales feed exclusively on cephalopods, mainly arrow squid, *Nototodarus* spp., and common octopus, *Pinnoctopus cordiformis* (Beatson and O'Shea, 2009).

Werth (2000) described the feeding mechanism in captive juvenile long-finned pilot whales: Depression and retraction of the large, piston-like tongue generated negative intraoral pressures for prey capture and ingestion. Food was normally ingested without grasping by teeth, yet was manipulated with lingual, hyoid, and mandibular movement for realignment; suction was then used to transport prey into the oropharynx.

5. Migration

In the Northwest Atlantic, pilot whales move towards the shelf edge during mid winter through early spring, then move northward along the edge to George's Bank and Nova Scotia, arriving off Newfoundland in summer. The peak of the breeding season is said to be in August in Newfoundland waters, where the whales remain until late autumn. The inshore-offshore movements of pilot whales in the western North Atlantic have been correlated with movements of their preferred prey, squid (Reyes, 1991 and ref. therein; Bernard and Reilly, 1999 and refs. therein). Jankowski (2006) used photo-identification data from two study sites 40 km apart, off the northwest coast of Nova Scotia, Canada, between 1998 and 2003, to investigate habitat utilisation. On average, individuals visit the study area for 1-2 days but may return over a 5 year period. Individuals are well-mixed between the two study sites. A satellite-monitored whale tracked for 95 days in the western North Atlantic was located during movements of at least 7,588 km and sighted from an aircraft several times in the company of other pilot whales (Mate 1989).

Site fidelity is also reported from the the Faroe Islands, where pilot whales occur all year round with a peak abundance in July-September. New tracking studies show a preference for the area over the border of the continental shelf (Bloch et al. 1993c; Bloch et al. 2003).

6. Threats

Direct catch: Drive fisheries for long-finned pilot whales in the Faroe Islands date back to the Norse settlement in the 9th century. Catch statistics exist from the Faroes since 1584, unbroken from 1709-today and show an annual average catch of 850 pilot whales (range: 0 - 4,480) with a cyclic variation correlated with North-Atlantic climatic variations (Bloch and Lastein, 1995; Bloch, 1998). Considering the mobility of these animals, it seems likely that these catches are recruited from a larger area in the North Atlantic than previously assumed. This suggests that the whales are taken from a larger population than that estimated from coastal areas around the Faroe Islands, hence increasing the probability that the harvest is sustainable (Bloch et al. 2003). In Greenland, fisheries are minor (Butterworth, 1996).

Incidental catch: Incidental catches are reported from Newfoundland, the Mediterranean and the Atlantic coast of France, and according to Bernard and Reily (1999 and refs. therein) there are probably more pilot whales taken incidentally than presently documented. On the east coast of the USA, the foreign Atlantic mackerel fishery was responsible for the take of 141 pilot whales in 1988. This fishery was suspended in early May of that year as a direct result of this high take. More recently, most of the estimated marine mammal bycatch is from U.S. Atlantic EEZ waters between South Carolina and Cape Cod in the pelagic longline fishery. The average annual *Globicephala* spp. mortality in 2000-2004 was 70 animals (CV=0.37). The average annual estimated fishery-related mortality in the northeast mid-water trawl fishery during 2002-2004 was 8.9 (CV= 0.35) (Waring et al. 2007).

In British waters, long-finned pilot whales are accidentally caught in gillnets, purse seines and in trawl fisheries (Reyes, 1991 and refs. therein). The seas around Cornwall, SW Britain, are one of the most heavily fished areas of the UK, and Leeney et al. (2008) found that strandings of pilot whales around Cornwall have increased significantly since the mid-1970s, with seasonal peaks in stranding frequencies between November and January. 61% of investigated individuals were determined to have died due to bycatch in fishing gear.

A 1990 workshop to review mortality of cetaceans in passive nets and traps documented an annual kill of 50-100 *G. melas* off the Atlantic coast of France. Furthermore, pilot whales are also known to be taken incidentally in trawl and gillnet fisheries in the western North Atlantic and in swordfish driftnets in the Mediterranean (Jefferson et al. 1993). This seems to be still ongoing, as Lopez et al. (2003) report that around 200 cetaceans might be caught annually in inshore waters and around 1,500 in offshore waters of Galicia (NW

Spain), mainly small dolphins, as well as *Tursiops truncatus* and *Globicephala melas*.

Very few were reported taken incidentally in fisheries in the southern hemisphere (Reyes, 1991 and refs. therein). However, Zerbini and Kotas (1998) reported on cetacean-fishery interactions off southern Brazil. The pelagic driftnet fishery is focused on sharks (families Sphyrnidae and Carcharinidae) and incidentally caught species include 15 *G. melas* in 1995 and 1997. Authors conclude that the driftnet fishery may be an important cause of cetacean mortality and that a systematic study should be carried out in order to evaluate the impact of this activity.

Overfishing: Commercial fisheries for squid are widespread in the western North Atlantic. Target species for these fisheries are squid species which form a large part of the diet of pilot whales, making these vulnerable to prey depletion (Taylor et al. 2008).

Ship strikes: Since high speed ferries were introduced in the Canary Islands in 1999, their number has grown steadily, and collisions with cetaceans have been reported ever since. While true numbers of collisions remain unknown, estimates range from approx. 10 to 30 cetaceans killed every year. Present knowledge indicates that the sperm whale is the species most frequently hit, but baleen, beaked and pilot whales are affected as well (Weinrich et al. 2005).

Pollution: Long-finned pilot whales off the Faroes, France, UK and the eastern US appear to be carrying high levels of DDT and PCB in their tissues, and where whales are consumed by humans, this leads to high-level burdens of organohalogens among residents, e.g. at the Faroes (Faengstroem et al. 2005). In other parts of their distributional range, e.g. off Newfoundland and Tasmania, very low levels of DDT were detected. Heavy metals such as cadmium and mercury also have been found in pilot whales from the Faroes. Because these contaminants accumulate in tissues over time, older animals and especially adult males tend to have higher concentrations (Borell and Aguilar, 1993; Caurant et al. 1993; Caurant and Amiard-Triquet, 1995). Combinations and levels of these pollutants may one day play a role in stock differentiation (Reyes, 1991 and refs. therein; Bernard and Reilly, 1999 and refs. therein; Frodello et al. 2000; Nielsen et al. 2000).

Weisbrod et al. (2000) characterised organochlorine bioaccumulation in pilot whales collected from strandings in Massachusetts and caught in nets. Whales that stranded together had more similar tissue-levels than animals of the same gender or maturity, reflecting pod-fidelity. The high variation in tissue concentrations among individuals and pods, and the similarity within a stranding group suggest that pilot whale pods are exposed to a large range of pollutant sources, such as through different prey and feeding locations (Desportes et al. 1994).

Noise pollution: The military makes extensive use of underwater sound in order to find targets such as ships and submarines, and some active military sonar systems are known to use very loud sources. However, in part because these systems are classified, the characteristics of such sound sources have rarely been published, and there have been few studies of their effects on cetaceans. Although Rendell and Gordon (1999) could not show any deleterious consequences for the species, recordings of vocalisations indicated short-term vocal responses of long-finned pilot whales to these sound sources. However, in 2005, three mass stranding events occurred in Tasmania, Australia, involving approximately 145 long-finned pilot whales. The first occurred six hours before the arrival of two Royal Australia naval vessels, the second event began just over an hour after the vessels began using high frequency (50-200 kHz) sonar in the vicinity of the stranding. A behavioral reaction to the sonar facilitating the second and third stranding events could not be ruled out (Parsons et al. 2008).

7. Remarks

Range states (Taylor et al. 2008): Algeria; Argentina; Australia; Belgium; Brazil; Canada; Chile; Denmark; Falkland Islands (Malvinas); Faroe Islands; France; French Southern Territories (the) (Crozet Is.); Germany; Greenland; Heard Island and McDonald Islands; Iceland; Ireland; Italy; Libyan Arab Jamahiriya; Malta; Morocco; Namibia; Netherlands; New Zealand (Antipodean Is., Chatham Is., North Is., South Is.); Norway; Peru; Portugal (Azores, Madeira); South Africa (Marion-Prince Edward Is., Western Cape Province); South Georgia and the South Sandwich Islands; Spain; Sweden; Tunisia; United Kingdom; United States (North Carolina); Uruguay.

The only current fishery for long-finned pilot whales is undertaken in the Faroe Islands. Although this fishery has been actively pursued since the 9th century, catch levels have not shown evidence of depletion of the stock as occurred off Newfoundland. ICES and NAMMCO as well as the IWC, have concluded that with an estimated population size of 778,000 in the eastern North Atlantic and approximately 100,000 around the Faroes (Buckland et al. 1993; NAMMCO, 1997) the Faroese catch will not deplete the population. Pilot whales seem to utilise a larger area around the Faroes (Desportes et al. 1994; Bloch et al. 2003), which according to these sources also reduces any threat.

Globicephala melas is considered as "Data Deficient" by the IUCN. The species is listed on CITES Appendix II.

The North and Baltic Sea populations have been listed in Appendix II of CMS. However, data on long-range movements in the NW and NE Atlantic suggest that these stocks also should be included in App. II of CMS. Range states concerned are the US, Canada, Greenland, Iceland, Norway, Ireland and the UK.

Attention should also be paid to the western North Atlantic population(s), in particular migration between US and Canadian waters, formerly depleted by overhunting and now facing increasing incidental mortality in trawl fisheries (Reyes, 1991 and refs. therein).

As noted above, pollution (including noise pollution) by-catch and mass strandings may be a threat to the species and warrant further investigation. Population size and migratory patterns, including home-range sizes are insufficiently known. For recommendations on South American stocks, please see Hucke-Gaete (2000) in Appendix 1.

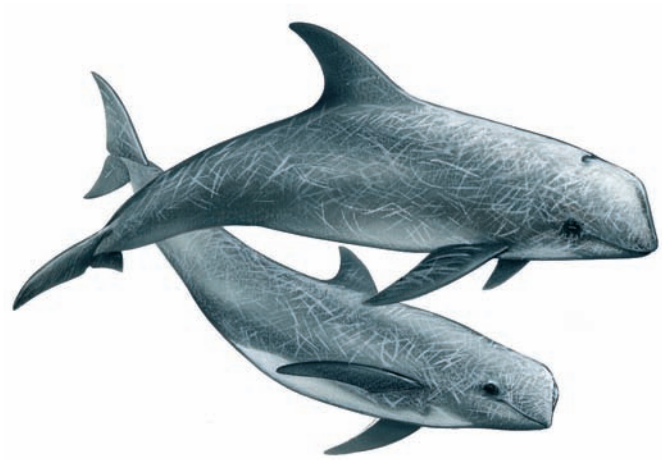
Please also see a report on the long-finned pilot whale posted on the web by the North Atlantic Marine Mammal Commission: http://www.nammco.no

8. Sources (see page 249)

3.13 Grampus griseus (G. Cuvier, 1812)

English: Risso's dolphin
German: Rundkopfdelphin
Spanish: Delfín de Risso
French: Dauphin de Risso

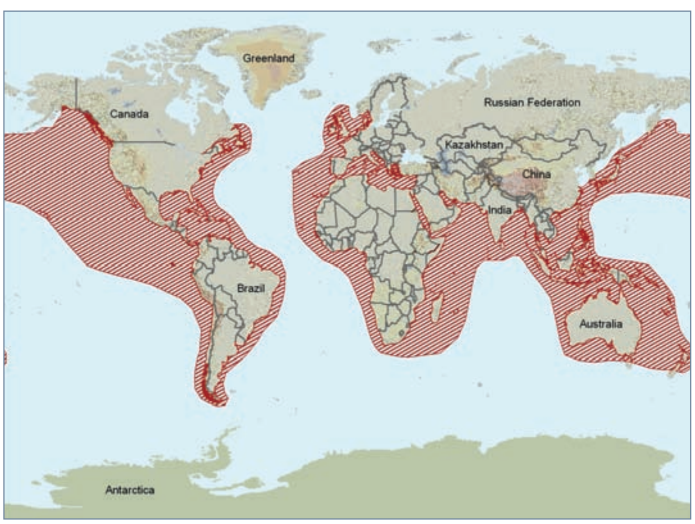
Family Delphinidae



Grampus griseus / Risso's dolphin (© Wurtz-Artescienza)

1. Description

Risso's dolphin is the fifth largest of the delphinids. Adults of both sexes reach 4 m in length. The anterior body is extremely robust, tapering to a relatively narrow tail stock and the dorsal fin is one of the tallest in proportion to body length of any cetacean, exceeded only by that of the adult male killer whale (*Orcinus orca*). The bulbous head has a distinct vertical crease or cleft along the anterior surface of the melon. Colour patterns change dramatically with age. Infants are dorsally grey to brown, then darken to nearly black and lighten while maturing (the dorsal fin remaining dark). In ageing animals, the majority of the dorsal and lateral surfaces become covered with distinctive linear scars. Older animals can appear completely white on the dorsal surface (Baird, 2002). Risso's dolphins are often confused with killer whales, due to the size of their dorsal fin (Baird, 2009). Adult size ranges up to 3,8 m long and body mass may reach 500 kg (Jefferson et al. 2008).



World-wide distribution of Grampus griseus (Taylor et al. 2008; © IUCN Red List): tropical and warm temperate waters in both hemispheres.

2. Distribution

This is a widely distributed species, inhabiting deep oceanic and continental slope waters 400-1,000 m deep (Baird, 2002) from the tropics through the temperate regions in both hemispheres (Jefferson et al. 1993). Sighting records indicate this species occurs roughly between 60°N and 60°S latitudes, where surface water temperature are above 10 °C (Kruse et al. 1999). It ranges north to Newfoundland, the Shetland Islands, the North Sea (Weir et al. 2001), the Mediterranean Sea, Ostrov Iturup in the Ostrova Kuril'skiye, Koman-dorskiye Ostrova, 56°, 146° in the northern Gulf of Alaska, and Stuart Island (50°N) in British Columbia; and south down eastern South America as far as Cabo de Hornos in Chile, to Cape Province in South Africa, Geographe Bay (33°S) in Western Australia, Sydney in New South Wales, North Island in New Zealand, and Valparaiso in Chile (Rice, 1998).

3. Population size

There are examples of long term changes in abundance and distribution, e.g. in the Southern California Bight (Kruse et al. 1999 and refs. therein). In the late 1950s, Risso's dolphins were rarely encountered in this area, and between 1975 and 1978 they were still considered to be a minor constituent of the cetacean fauna of the Bight, representing only 3% of the cetaceans observed. Since the El Niño of 1982/83, however, numbers of Risso's dolphins have increased, especially around Santa Catalina Island where they are now considered to be common. Forney and Barlow (1998) observed that the abundance of Risso's dolphins off California was almost an order of magnitude higher in winter (n = 32,376) than in summer (n = 3,980). The 2001-2005 geometric mean abundance estimate for California, Oregon and Washington waters based on the two most recent ship surveys, however, is 11,621 (CV = 0.17; Barlow and Forney 2007, Forney, 2007). Currently, there is no evidence of a trend in abundance for this stock. In the EEZ waters around Hawaii, Barlow (2006) estimated abundance at 2,375 (CV=0,65). An earlier estimate for the entire eastern Tropical Pacific was 175,000 (Wade and Gerrodette, 1993).

In the eastern Sulu Sea, Dolar (1999) estimated the population size at 950 individuals. Population estimates off Sri Lanka ranged from 5,500 to 13,000 animals (Kruse et al. 1999 and refs. therein). In three areas of concentrated occurrence off Japan, abundance is estimated at 83,300 (Taylor et al. 2008).

In the western North Atlantic, Waring et al. (2007) estimated the stock from 2004 data at 20,500 (CV = 0,59). In the northern Gulf of Mexico oceanic waters the estimate of abundance pooled from 1996 to 2001, is 2,169 (CV=0.32; Mullin and Fulling 2004).

In the Pelagos Sancuary in the North-Western Mediterranean Sea, Risso's dolphin was not very abundant, accounting for only 4.3% of all cetacean encounters (Moulins et al. 2008). In the central Spanish Mediterranean, Gomez de Segura et al. (2006) determined a surface- estimated density of 0.015 dolphins / km² (95% CI = 0.005-0.046) and a mean abundance of 493 (95% CI = 162-1,498).

4. Biology and Behaviour

Habitat: Risso's dolphins are pelagic, mostly occurring seaward of the continental slope. They frequent subsurface sea-mounts and escarpments where they are thought to feed on vertically migrant and mesopelagic cephalopods. In Monterey Bay, California, Risso's dolphins are concentrated over areas with steep bottom topography. Currents and upwelling causing local increases in marine productivity may enhance feeding opportunities, resulting in the patchy distribution and local abundance of this species worldwide (Kruse et al. 1999 and refs. therein). Davis et al. (1998), Baumgartner (1997) and Baumgartner et al. (2001) reported that in the Gulf of Mexico, Risso's dolphins were mostly found over the steeper sections of the upper continental slope (200-1000 m) concentrating along the upper continental slope, which may reflect squid distribution.

In the western Ligurian Sea, Mediterranean, Azzelino et al. (2008) found that Risso's dolphins were strongly associated with depth and slope gradient characteristics of the shelf-edge and the upper and lower slope. Their data showed clear and not overlapping habitat preferences for Risso's dolphin and Cuvier's beaked whale. A temporal segregation in the use of the slope area was also observed for sperm whales and Risso's dolphins. In the Spanish Mediterranean, Risso's dolphins preferred waters more than 1500 m deep (Gomez de Segura et al. 2008) and depths of around 1000 m were hot spots in the Pelagos Sanctuary (north-western Mediterranean Sea; Moulins et al. 2008). Blanco et al. (2003) assumed that due to distribution records of prey in the western Mediterranean, Risso's dolphins more frequently inhabit the outer continental slope and shelf break region. Their preference for this habitat may be explained by the high marine productivity with enhanced feeding opportunities, which is in accord with results from other sightings in the area.

Behaviour: *G. griseus* are often seen surfacing slowly, although they can be energetic, sometimes breaching or porpoising, and occasionally bowriding (Jefferson et al. 1993).

Reproduction: In the North Atlantic and western Pacific, there appears to be a summer calving peak (Jefferson et al. 1993) and a winter calving peak in the eastern Pacific (Baird 2009).

Schooling: Herds tend to be small to moderate in size (1-100 individuals), averaging 30 animals, but groups of up to 4,000 have been reported, presumably in response to abundant food resources. Limited data on subgroup composition obtained from mass strandings and observations of captive animals suggest that cohesive subgroups may be composed of same-sex and similar-age individuals. Risso's dolphins commonly associate with other species of cetaceans such as gray whales, Pacific white-sided dolphins, northern right whale dolphins, Dall's porpoises, sperm whales, short-finned pilot whales, bottlenose dolphins, common dolphins, striped dolphins, spotted dolphins, false killer whales, and pygmy killer whales (Kruse et al. 1999 and refs. therein).

Hartman et al. (2008) found that individuals at the Azores, central Atlantic, formed stable, long-term bonds organised in pairs or in clusters of 3-12 individuals. Social structure showed strong associations between adult males and between adult females. Males were organised in stable, long-term associations of varying size that occurred throughout the complete range of behavioural states observed. For females, associations could be of similar strength, but the time scale could vary depending on the presence of nursing calves. As subadults, associations also occurred (pair formation), but were less stable than those observed for adults.

Frantzis and Herzing (2002) observed in the Gulf of Corinth, an almost-enclosed sea in Greece in the eastern Mediterranean, that Risso's dolphins associated with striped and common dolphins. However, in all mixed-species sightings, Risso's dolphins and common dolphins were always, and by far the minority species. To date, no single-species groups of Risso's or short-beaked common dolphins have been observed in the Gulf of Corinth. Interspecific rake marks on Risso's dolphins and behaviours observed through video analysis indicated potentially complex and regular interspecific interactions.

Food: Kruse et al. (1999) reported that Risso's dolphins prey on a mix of neritic, oceanic, and occasionally bottom dwelling cephalopods. From daily activity patterns observed off Santa Catalina Island, California, they are presumably mainly nocturnal feeders. Santos et al. (2001) found *Octopus vulgaris* in the stomachs of animals stranded in NW Spain.

Blanco et al. (2003) analysed stomach contents of 13 Risso's dolphins stranded on the western Mediterranean coast between 1987 and 2002 and found only cephalopod remains: 25 species belonging to 13 families were found in the samples, mostly Argonautidae, Ommmastrephidae, Histioteuthidae and Onychoteuthidae. Despite the numerical importance and high frequency of small pelagic octopods, mainly *Argonauta argo*, Blanco et al. (2003) assumed that greater nutritional content came from of ommastrephids, mainly *O. bartrami* and *T. sagittatus* because of the larger size of some specimens. The prey were mainly oceanic and pelagic species with a muscular mantle.

In the eastern Mediterranean Sea off the Turkish coast, Risso's dolphins also feed only on cephalopods; *Histioteuthis reversa* was the most common species (60.9 % of all beaks found), and all the other species comprised less than 10 %. Most of the prey species are oceanic cephalopods, with wide vertical distribution and diurnal movement. Many of the cephalopods identified in their diet are bioluminescent, suggesting that these dolphins use bioluminescence as a target when feeding on cephalopods (Oeztuerk et al. 2007).

Philips et al. (2003) monitored a trained Risso's dolphin and established that the species echolocates, and that, aside from slightly lower amplitudes and frequencies, the clicks emitted are similar to those emitted by other echolocating odontocetes.

5. Migration

Although *Grampus* is present year-round in most of its range, there may be seasonal onshore-offshore movements in some areas (Carwardine, 1995). In more constant environments, e.g. the Azores, Hartman et al. (2008) found strong site fidelity for at least part of the population. In seasonally more variable areas, *G. griseus* seems to show annual changes in abundance, being e.g. more abundant around northern Scotland in the summer and in the Mediterranean in the winter (e.g. Gannier, 1998; Evans, 1998).

Similar seasonal shifts in abundance have been reported from the Northwest Atlantic, British coastal waters, and the south-east coast of South Africa. Summer "reproductive migrations" (characterised by schools of 20-30 animals with empty stomachs and females carrying large foetuses), and winter "feeding migrations" (characterised by schools of nearly 200 animals with full stomachs and females carrying smaller foetuses) have been observed off Japan. Because some authors maintain that the species is equally abundant in some areas throughout the year, systematic studies of the distribution and abundance of Risso's dolphins in localised areas are required to resolve this conflict (Kruse et al. 1999 and refs. therein).

Water temperature appears to be a factor that affects the distribution of Risso's dolphins, the acceptable temperature range for the species being 7.5°C-35°C (Kruse et al. 1999 and refs. therein). In California, increasing numbers and a shoreward shift in their distribution have been observed during periods of warm water, suggesting that seasonal patterns of distribution and abundance are associated with changing sea surface temperatures (Kruse et al. 1999).

However, Forney and Barlow (1998) found no significant seasonal difference in distribution of Risso's dolphins in Californian waters. In both summer and winter, they were seen most frequently in the Southern California Bight and were also observed off central California. Seasonal movement from California into Oregon and Washington waters in spring and summer has been suggested, and there is an indication that they were also common in offshore waters of northern California. The degree of movement into Mexican waters is unknown (Forney and Barlow, 1998).

6. Threats

Direct catch: In Sri Lanka, Risso's dolphins were apparently the second most commonly taken cetacean in fisheries, providing fish and meat for human consumption and fish bait; stocks there may be adversely affected (Jefferson et al. 1993). An estimated 1,300 Risso's dolphins may have been landed annually as a result of this fishery and population estimates in these waters range only from 5,500 to 13,000 animals (Kruse et al. 1999). In Japan, Risso's dolphins are taken periodically for food and fertiliser in set nets and as a limited catch in the small-type whaling industry (Kruse et al. 1999 and refs. therein). However, Endo et al. (2005) surveyed the total mercury (T-Hg) and methyl mercury (M-Hg) levels in red meat products from small cetacean species, including Risso's dolphins, sold for human consumption in markets throughout Japan. Due to high levels in all species, the consumption of red meat from small cetaceans could pose a health problem for not only pregnant women but also for the general population.

Incidental catch: Although they have never been the basis of a large-scale fishery, Risso's dolphins have been taken periodically as by-catches in other fisheries throughout the world. There are reports from the North Atlantic, the southern Caribbean, the Azores, Peru, and the Solomon Islands. They are also a rare by-catch in the US tuna purse seine industry, and are taken occasionally in coastal gill net and squid seining industries off the US coast, or shot by aggravated fishermen (Kruse et al. 1999 and refs. therein).

Baker et al. (2006) reported on identifying Risso's dolphins via molecular monitoring of 'whalemeat' markets in the Republic of (South) Korea based on nine systematic surveys from February 2003 to February 2005. As Korea has no programme of commercial or scientific whaling and there is a closure on the hunting of dolphins and porpoises, the only legal source of these products was assumed to be 'bycatch'.

The U.S. East Coast pelagic longline fishery has a history of interactions with Risso's dolphin, one of the primary species that interact with longline gear. Waring et al. (2007) found that the annual average combined mortality and serious injury for 2000-2004 was 46 Risso's dolphins (CV =0.37). They concluded that the total U.S. fishery mortality and serious injury for this stock was not less than 10% of the calculated PBR and, therefore, could not be considered to be insignificant and approaching a zero mortality and serious injury rate. Garrison (2007) found that incidental bycatch of marine mammals is likely associated with depredation of the commercial catch and is increased by the overlap between marine mammal and target species habitats. Altering gear characteristics and fishery practices may mitigate incidental bycatch and reduce economic losses due to depredation.

Culling: Off Japan, Risso's dolphins were killed in the drive fishery (*oikomi*) in response to competition with commercial fisheries (Kruse et al. 1999 and refs. therein).

Pollution: Accumulation of butyltin compounds, organochloride and DDT levels have been analysed in tissue samples from various specimens (Kruse et al. 1999 and refs. therein). Mercury levels have been reported by Frodello et al. (2000). Increasing levels of plastics and other refuse at sea may pose a threat to wild populations: Necropsies of specimens from Japan revealed that they had eaten foreign materials such as plastic bags, soda cans, and pieces of rope, which may have been fatal (Kruse et al.1999 and refs. therein).

Chou and Li (2004) analysed blubber samples of cetaceans from Taiwan coastal waters for polychlorinated biphenyls (PCB). Total concentrations of 19 PCB congeners were 0.23 µg/g lipid weight of Risso's dolphin with pentachlorobiphenyls, hexachlorobiphenyls and heptachlorobiphenyls the predominant PCB congener species. Stranded cetaceans had significantly higher PCB levels than by-caught cetaceans because of their higher lipid consumption during starvation or illness. However, by comparison cetaceans from Taiwan waters had relatively lower PCB concentrations than those from high-latitude areas.

Chen et al. (2002) analysed total mercury (Hg), organic-Hg and selenium bioaccumulations in small cetaceans distributed in Taiwanese waters of the Taiwan Strait and the southwestern Pacific. Volcanic activities are possibly the major source of mercury to the environments. Muscle samples of Risso's dolphins had the highest mean concentrations of Se (1.77 mg/kg +-1.29), while mercury concentrations were low compared to the other cetaceans.

For data from Japan, see "Direct catch" above.

In a specimen stranded on the Mediterranean coast of Israel, high concentrations of trace metals (Hg, Cd, Zn, Fe and

Se) were found in the various tissues analysed, while Cu and Mn concentrations were naturally low. Plastic bags found in its stomach contributed to the dolphin's poor physical condition (Shoham-Frider et al. 2002).

Noise pollution: In early 2004 and in 2005, several unusual stranding events including Risso's dolphins occurred in Taiwan during a period when large-scale naval exercises were conducted in and on nearby waters. The findings of the gross post mortem examination of the only specimens that were available for study suggested that nearby naval exercises may have contributed to or caused the death of at least one cetacean in this region and that species other than beaked whales may also be susceptible to such activities. With an increasing number of military exercises in the area, more attention to the impacts of such activities on cetaceans is needed (Wang and Yang, 2006).

7. Remarks

Range states (Taylor et al. 2008): Algeria; American Samoa; Anguilla; Antigua and Barbuda; Argentina; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belgium; Belize; Benin; Bermuda; Brazil; British Indian Ocean Territory; Brunei Darussalam; Cambodia; Cameroon; Canada; Cape Verde; Cayman Islands; Chile; China; Cocos (Keeling) Islands; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Croatia; Cuba; Denmark; Djibouti; Dominica; Dominican Republic; Ecuador; Egypt; El Salvador; Equatorial Guinea; Estonia; Fiji; France; French Guiana; French Polynesia; Gabon; Gambia; Germany; Ghana; Greece; Greenland; Grenada; Guadeloupe; Guam; Guatemala; Guernsey; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Iraq; Ireland; Isle of Man; Israel; Italy; Jamaica; Japan; Jersey; Jordan; Kenya; Kiribati; Kuwait; Lebanon; Liberia; Madagascar; Malaysia; Maldives; Malta; Marshall Islands; Martinique; Mauritania; Mayotte; Mexico; Monaco; Morocco; Mozambique; Myanmar; Namibia; Netherlands; Netherlands Antilles; New Caledonia; New Zealand; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Norway; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal; Puerto Rico; Qatar; Russian Federation; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Sao Tomé and Principe; Saudi Arabia; Senegal; Serbia; Sierra Leone; Singapore; Slovenia; Solomon Islands; Somalia; South Africa; Spain; Sri Lanka; Sudan; Suriname; Sweden; Syrian Arab Republic; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; Turkey; Turks and Caicos Islands; United Arab Emirates; United Kingdom; United States of America; United States Minor Outlying Islands; Uruguay; Vanuatu; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen.

This is a circumglobal species which migrates between summering and wintering grounds. Off California, where these movements are best known, they may involve US and Mexican waters. In other areas, the species is insufficiently known with respect to basic biological parameters. Abundance, by-catch and behavioural data at sea are needed in order to enable protection of the natural habitat of Risso's dolphins. For South American stocks, see further recommendations in the Hucke-Gaete (2000) report (Appendix 1).

General recommendations on Southeast Asian stocks can be found in Perrin et al. (1996; Appendix 2).

The IUCN lists *G. griseus* as "Least Concern" (Taylor et al. 2008). The Mediterranean, North and Baltic Sea populations are included in Appendix II of CMS. However, as described above, populations off the East and West coasts of North America (Range states US, Mexico, Canada) also seem to migrate along the coast, and this is also the case for animals off SE South Africa. It is therefore suggested not to restrict the inclusion into CMS App. II to the populations mentioned, but to include *G. griseus* as a species.

The species is listed in Appendix II of CITES.

8. Sources (see page 250)

3.14 Hyperoodon ampullatus (Forster, 1770)

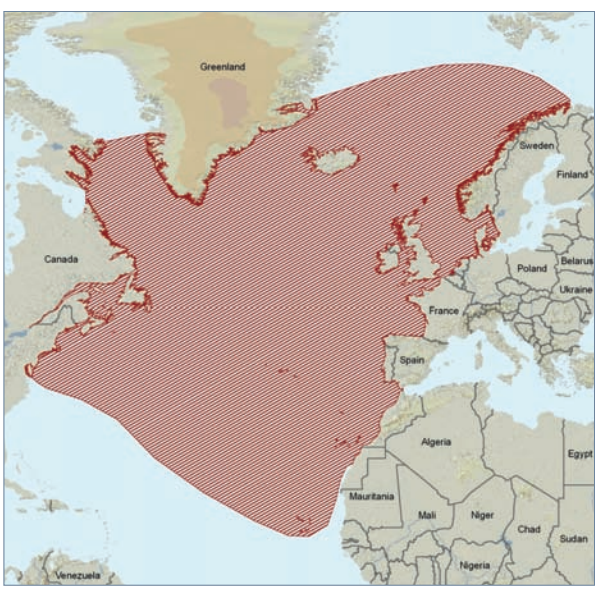
English: North Atlantic bottlenose whale, Northern bottlenose whale
German: Nördlicher Entenwal, Dögling
Spanish: Zifio calderón boreal
French: Hyperoodon boréal

Family Ziphiidae

Hyperoodon ampullatus / North Atlantic bottlenose whale (© Wurtz-Artescienza)

1. Description

Northern bottlenose whales are the largest beaked whales in the North Atlantic and reach 10 m (and possibly up to 11.2 m) body length. Their body mass can reach 7,500 kg (Jefferson et al. 2008). Body shape is robust and they have a large, bulb-shaped forehead and short, dolphin-like beak. Their colour is chocolate brown to yellowish-brown, being lighter on the flanks and belly. Some of this colouration is believed to be caused by a thin layer of diatoms. Mature males have a squared-off forehead, which turns white after sexual maturity is reached, whereas in females and immature males it is rounded and brown (Bloch et al. 1996). Older females have a white band around the neck (Jefferson et al. 2008). Males possess a single pair of conical teeth at the tip of the lower jaw, rarely visible in live animals, especially if the mouth is closed (Gowans, 2002).



Distribution of Hyperoodon ampullatus: North Atlantic Ocean, normally in waters deeper than 1,000 m (Taylor et al. 2008; © IUCN Red List).

2. Distribution

The North Atlantic bottlenose whale is found in the subarctic North Atlantic from Davis Strait, Jan Mayen, west coast of Spitsbergen, and Bjornøya, and south to Nova Scotia (Rice, 1998).

In the western North Atlantic, Lucas and Hooker (2000) report recent strandings from Sable Island, Nova Scotia and further strandings have been reported from as far south as Rhode Island (Mead, 1989; Reyes, 1991).

In the eastern part of their distributional range, there are no confirmed records from Novaya Zemlya, the Barents Sea or the coast of Finnmarken in northern Norway (Mead, 1989). There are few records east of the Norwegian Sea and from the Mediterranean (Rice, 1998). One specimen was reportedly caught in the North Sea during the period 1938-1972 and Kastelein and Gerritis (1991) observed an animal off The Netherlands, however the shallow southern North Sea may not be part of its native range. Strandings are reported from the coasts of Belgium, The Netherlands, Denmark, France and England (Boschma, 1950; De Smet, 1974; Duguy 1990, Van Gompel 1991, Kinze et al, 1998). Lick and Piatkowski (1998) report on a stranding in the southern Baltic Sea. Gowans (2002) also includes the Azores into the range of the species.

Past reports of *H. ampullatus* in the temperate and subarctic North Pacific seem to have been due to confusion with *Berardius bairdii*, because both species are known colloquially as "bottle-nose whales" (Rice, 1998).

3. Population size

Stocks: There seem to be certain pockets of abundance, for example: around "the Gully", between Sable Island and Nova Scotia; in the Arctic Ocean, between Iceland and Jan Mayen, southwest of Svalbard and east off Iceland-north off the Faroes; and in Davis Strait, off northern Labrador, especially around the entrance to Hudson Strait and Frobisher Bay (Carwardine, 1995).

For statistical consideration Christensen (1976, in Reyes, 1991) assumed that all the bottlenose whales caught east of Greenland belonged to a single population, while Mitchell (1977, in Reyes, 1991) defined Cape Farewell (Greenland) to divide west and east North Atlantic catches. Recently some limited evidence for stock structure is emerging. Animals in The Gully, off Nova Scotia seem to be largely or totally distinct from the population off northern Labrador: they are smaller and appear to breed at a different time of year (Whitehead et al. 1997). Gowans (2009) suggests that different length distributions in whales found in different areas of the Atlantic indicates possible geographical isolation. Furthermore, genetic studies indicate reproductive isolation between bottlenose whales in the Gully and Labrador, the latter seem to be more related to their conspecifics from Iceland (Dalebout et al. 2006).

Population size: The total number of northern bottlenose whales off the eastern U.S. coast is unknown (NEFSC 2007) and this holds true for most of their range. Barlow et al. (2006) list the reasons: mostly unknown population structure, a knowledge gap with respect to distribution, difficulties in estimating correction factors for missed animals due to long dive times and a lack of dedicated surveys.

Whitehead et al. (1997) estimate that approximately 230 *H. ampullatus* use the Gully, a prominent submarine canyon on the edge of the Nova Scotia Shelf, throughout the year. Approximately 57% of the population reside in a 20 x 8 km core area at the entrance of the canyon at any time. Gowans et al. (2000) analysed data from 11 years of photo-identification records to estimate the population size using mark-recapture techniques and found no significant change in population size over time. Sex ratio was roughly 1:1, with equal numbers of sub-adult and mature males. The population was recently estimated to contain about 163 animals (95% confidence interval 119-214), with no statistically significant temporal trend (Whitehead and Wimmer, 2005).

Estimates for Icelandic and Faroese waters are 3,142 and 287 whales respectively, although allowance was not made in the analysis for animals not observed because of their long dives (Reyes, 1991). Gunnlaugsson and Sigurjonsson (1990) estimate 5,827 whales at high latitudes in the Northeastern Atlantic and NAMMCO has calculated the population size of this species in the eastern part of the North Atlantic to be around 40,000 individuals (NAMMCO Annual Report 1995).

A study by Christensen and Ugland (1984, in Reyes, 1991) resulted in an estimated initial (pre-whaling) population size of about 90,000 whales, reduced to some 30,000 by 1914. The population size by the mid-1980's was estimated to be about 54,000, nearly 60% of the initial stock size.

4. Biology and Behaviour

Habitat: *H. ampullatus* is most common beyond the continental shelf and over submarine canyons, in deep water (>1,000 m). It sometimes travels several kilometres into broken ice fields, but it is more common in open water. Few whales were caught over the continental shelf off Labrador and in waters less than 1,000 m deep off the west coast of Norway. In the surrounding waters of Iceland, the whales were sighted at surface temperatures between -1.3°C and +0.9°C (Reyes, 1991).

Behaviour: The northern bottlenose whale is a curious animal: it will approach stationary boats and seems to be attracted by unfamiliar noises, such as those made by ships' generators. This, combined with its habit of staying with wounded companions, made it especially vulnerable to whalers. These deep divers can remain submerged for an hour, possibly as long as 2 h (Reeves et al. 1993, Bloch et al. 1996). Hooker and Baird (1999) showed that northern bottlenose whales in a submarine canyon off Nova Scotia exhibit an exceptional diving ability, with dives approximately every 80 min to over 800 m (maximum 1,453 m) depth, and up to 70 min in duration. Sonar traces of non-tagged, diving bottlenose whales in 1996 and 1997 suggest that such deep dives are not unusual. This shows that they may make greater use of deep portions of the water column than any other mammal so far studied. Many of the recorded dives of the tagged animals were to, or close to, the sea floor, consistent with benthic or bathypelagic foraging.

Reproduction: Northern bottlenose whales have a peak in calving in April (Jefferson et al. 1993).

Schooling: Most pods contain at least 4 whales, sometimes with as many as 20, and there is some segregation by age and sex (Mead, 1989, Jefferson et al. 1993). Northern bottlenose whales in the Gully also form small groups. Associations within age/sex classes (female /immature, subadult male and mature male) were significantly higher than associations between different classes. Females and immature bottlenose whales formed a loose network of associations, showing no preferential associations with particular individuals or those from specific age/sex classes nor any long-term bonds. Mature and subadult males had stronger associations with individuals in their own class, and associations between some males lasted for several years, although males also formed many short-term associations. Overall the social organization of northern bottlenose whales in the Gully appears to resemble that of some bottlenose dolphins, *Tursiops truncatus*, living in shallow, enclosed bays (Gowans et al. 2001).

Food: Although primarily adapted to feeding on squid, these whales also eat fish, sea cucumbers, starfish, and prawns. They apparently do much of their feeding on or near the bottom (Jefferson et al. 1993; Mead, 1989). Hooker et al. (2001) found a high proportion of the squid *Gonatus steenstrupi* in the stomachs of two bottlenose whales stranded in eastern Canada. They also collected remote biopsy samples from free-ranging bottlenose whales off Nova Scotia and determined fatty acid composition. Overall, the results of these techniques concurred in suggesting that squid of the genus *Gonatus* may form a major part of the diet of bottlenose whales in the Gully (Hooker et al. 2001).

Stomach content analysis by Clarke and Kristensen (1980) on a specimen stranded on the Faroe Islands showed that while the cephalopods found included six cold water species which were probably taken in deep water within the vicinity of the Faroes, they also included one species, *Vampyroteuthis infernalis*, which is a warmer water species and probably ranges little further north than 40°N. This suggests the whale had been much further south in the Atlantic than the Faroes at 62°N just before its stranding or that the distribution pattern of this cephalopod is not that well known. The stomach contents examined in the Faroes show more diversity with 13 species eaten than those from a whale stranded in Denmark (Clarke and Kristensen, 1980) and from whales shot off Labrador and Iceland, which contained only one species, *Gonatus fabricii*. Santos et al. (2001) report on stomach contents of bottlenose whales stranded in the North Sea. Their results are in agreement with those of previous authors in that cephalopods in general, and *G. fabricii* in particular, are the main prey of the northern bottlenose whale.

5. Migration

Migratory movements are poorly documented, as are stock relations among the animals found in apparently disjunct centres of spring and summer abundance (Reeves et al. 1993). In the eastern part of the range *H. ampullatus* probably moves north in spring and south in autumn; in the west, at least some animals are believed to overwinter at lower latitudes. There may also be some inshore-offshore movements (Carwardine, 1995).

In the western North Atlantic, bottlenose whales are present during much of the year in The Gully and in the Labrador Sea. Bottlenose whales in The Gully appear to be largely non-migratory, and this population of a few hundred whales might be vulnerable to the environmental degradation associated with nearby oil and gas production (Reeves et al. 1993). However, Gowans et al. (2000) found that over the summer field season, individuals emigrated from, and re-immigrated into the Gully, spending an average of 20 days within the Gully before leaving. Approximately 34% of the population was present in the Gully at any one time. Individuals of all age and sex classes displayed similar residency patterns although there were annual differences as individuals spent less time in the Gully in 1996 than in 1990 and 1997. Sighting rates were similar in all years with extensive fieldwork, indicating little variability in the number of whales in the Gully each summer.

Mitchell (1977, in Reyes, 1991) suggested that in the western North Atlantic, *H. ampullatus* may forage into the Northeast Channel and the Gulf of Maine in winter months.

A southward migration, better known in the eastern North Atlantic begins in July, when animals are moving south from the Norwegian Sea, and continues to September. The increase of strandings on the British coasts and on the North Sea coasts probably reflects part of this summer migration, which remains unknown in the northwest Atlantic. There is evidence from the distribution of catches that a northward migration occurs in the eastern North Atlantic in April-July (Reyes, 1991 and refs. therein). Bottlenose whales occur all year round in the Faroes, but with a distinct peak a fortnight around 1 September pointing at a very synchronized southernly migration route (Bloch et al. 1996).

This is further supported by MacLeod et al. (2004): Strandings of northern bottlenose whales on the coasts of the UK and the Republic of Ireland were lowest in April and highest in September. The number of strandings between months differed significantly from an even spread, with more strandings between July and October. Most strandings in late summer and autumn occurred on North Sea coasts and their stomach contents included the squid *Gonatus fabricii*, which is found only in more northern waters. This suggests that these whales may be migrating southward at this time of year.

Evidence of migratory movements of beaked whales in the Northeast Atlantic was confirmed from an examination of historical strandings data from the United Kingdom and the Republic of Ireland, and from whaling records from the Faroes, Iceland and the Norwegian Sea. There is strong evidence to suggest that northern bottlenose whales undertake regular migrations, moving south-west in late summer and autumn and moving north-east in late winter and spring (MacLeod and Reid, 2003).

6. Threats

Direct catch: Northern bottlenose whales have traditionally been the most heavily hunted of the beaked whales. Some hunting has been done by the British and Canadians, but by far the major bottlenose whaling nation was Norway: 65,800 were caught by Norway in the period 1882-1972 (Reeves et al. 1993, Bloch et al. 1996). Early on, they were hunted primarily for oil, but later mainly for animal feed. The northern bottlenose whale is said to have been twice overexploited by Norwegian hunting, in the periods 1880-1920 and 1938-1973. No hunting has been conducted by Norway since 1973 (Jefferson et al. 1993, Reyes, 1991, Mitchell, 1977). It was included in the IWC schedule in 1977 and classified as a provisional protected stock with zero catch limits (Reyes, 1991).

They have also been hunted in a drive fishery in the Faroe Islands, with over 800 taken there (Bloch et al. 1996). Some are still taken, on average 2.2 whales per year until 2002. However, this limited catch probably does not constitute a significant threat to the species (Reyes, 1991; NAMMCO, 1995).

Incidental catch: None reported (Reyes, 1991).

Overfishing: There are no major fisheries for squid in the Northeast Atlantic, but future developments could represent some threat for a population which is still recovering from heavy losses due to whaling.

Pollution: In 2003, five years after major oil and gas development near The Gully, a Marine Protected Area on the Scotian Shelf, eastern Canada, skin and blubber biopsy samples of bottlenose whales showed an increase in cytochrome P4501A1 (CYP1A1) protein expression, potentially coincident with recorded oil spills. A range of PCB congeners and organochlorine compounds were detected, with concentrations similar to other North Atlantic odontocetes. Concentrations were higher in whales from The Gully than from the Davis Strait, with significant increases in 4,4'-DDE and trans-nonachlor in 2002-2003 relative to 1996-1997 (Hooker et al. 2008).

Habitat degradation: Whitehead et al. (1997) report that threats to the population in The Gully include commercial shipping, fishing and oil and gas developments. One discovery of commercial interest, the Primrose Field, lies about 5 km from the core area of this population. The population is vulnerable because of its small size, location at the extreme southern limit of the species' range, and year-round dependence on a small and unique sea area.

Noise pollution: McQuinn & Carrier (2005) report that noise levels from 3-D seismic oil & gas exploration reached highest average sound pressure level (RMS) in the Sable Island Gully Marine Protected Area (MPA) of 145 dB re 1 µPa at 90 m depth, 50 km from the seismic array. It was estimated that sound levels in the MPA would have been between approximately 153 and 157 dB when the vessel was at its closest approach to the Gully in the eastern portion of the survey block. The "worst case" sound level at the Gully MPA boundary, i.e., 0.8 km from the source, extrapolated from near-field measurements would have been approximately 178 dB, 14 dB higher than originally predicted in the Environmental Impact Assessment and close to the 190 dB safety criteria. Measured sound levels were also significantly higher than the model predictions at several other stations and showed significant variability around the mean values. This demonstrates the importance of using accurate model input data, of using field validation to verify the model predictions and of the need to measure the variability around the mean sound level estimates (McQuinn and Carrier, 2005).

There seem to be two important areas for beaked whales on the East Atlantic Frontier: The Shetland-Faroes Channel and an area to the south-west of the Faroes, including the northern end of the Rockall Trough. These areas are linked by a corridor of suitable beaked whale habitat approximately 80 km long and 50 km wide at its narrowest point. During movements between the two areas, this narrow corridor may form a bottleneck through which the beaked whales must pass. Noise pollution, which has the potential to impact a large area simultaneously, in this bottleneck area during migrations may have a disproportionately large impact on beaked whales on the Atlantic Frontier (MacLeod and Reid, 2003).

There are a number of exercise areas for submarine and other naval vessels in UK waters, particularly in the coastal waters of Scotland, including a submarine testing site in Gairlochhead, near Glasgow. A number of northern bottlenose whale strandings over the past few decades were clustered around this particular site. A torpedo testing range in the Sound of Raasay in Scotland is also adjacent to the site of an unusual occurrence in shallow waters (less than 10 m) of two northern bottlenose whales (a deepwater species, see above) in 1998 (Parsons et al. 2007).

7. Remarks

Range States: Azores; Belgium; Canada; Cape Verde; Denmark; Faroe Islands; France; Germany; Greenland; Iceland; Ireland; The Netherlands; Norway; Portugal; Spain; Svalbard and Jan Mayen; Sweden; United Kingdom; United States of America (mod. from Taylor et al. 2008).

H. ampullatus is categorised as "Data Deficient" by the IUCN (Taylor et al. 2008). It is listed in appendix II of CMS as well as in Appendix I & II of CITES.

8. Sources (see page 252)

3.15 Hyperoodon planifrons Flower, 1882

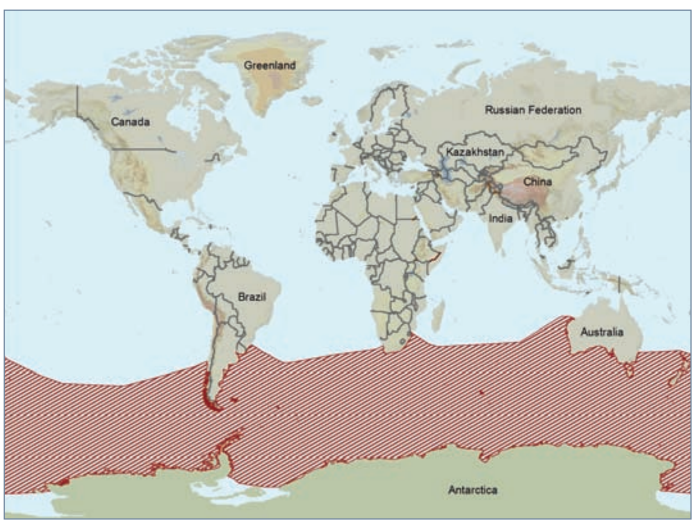
English: Southern bottlenose whale
German: Südlicher Entenwal
Spanish: Zifio calderón austral
French: Hypéroodon austral

Family Ziphiidae

Hyperoodon planifrons / Southern bottlenose whale (© Wurtz-Artescienza)

1. Description

H. planifrons resembles the northern bottlenose whale, with a robust body. It reaches a body length of up to 7.8 m (Jefferson et al. 2008), maximum weight is about 4,000 kg (Ross 2006). Southern bottlenose whales have a large, bulb-shaped forehead and short, dolphin-like beak. Their colour is chocolate brown to yellow, being lighter on the flanks and belly. Some of this colouration is believed to be caused by a thin layer of diatoms. Mature males have a squared-off forehead, whereas in females and immature males it is rounded. Males possess a single pair of conical teeth at the tip of the lower jaw, rarely visible in live animals (Gowans, 2009). Juveniles have diagnostic, bold, cream-white facial fields separated by a distinct dark blowhole stripe (Van Waerebeek et al. 2005).



Distribution of H. planifrons (Taylor et al. 2008; © IUCN Red List): The species inhabits the cold, deep waters of the Southern Hemisphere, circumpolar from Antarctica North to about 28°40'S (Van Waerebeek et al. 2004).

2. Distribution

Southern bottlenose whales are thought to have a circumpolar distribution in the Southern Hemisphere, south of 30°S (Mead, 1989; Jefferson et al. 1993). They occur from Rio Grande do Sul in Brazil, Cape Province in South Africa, 31°S in the western Indian Ocean, Dampier Archipelago in Western Australia, Ulladulla in New South Wales, North Island in New Zealand, and Valparaiso in Chile, south to the Antarctic continent (Rice, 1998).

Sightings off Durban, South Africa, show strong seasonality with peaks in February and October, the February peak possibly suggesting a general movement northward out of the Antarctic in late summer (Sekiguchi et al. 1993; Van Waerebeek et al. 2004).

The records from north-western Australia and from Brazil indicate that *H. planifrons* also occurs in warm temperate waters.

3. Population size

Southern bottlenose whales are the most common beaked whales sighted in Antarctic waters. In 1995, Kasamatsu and Joyce (1995) published abundance estimates for south of the Antarctic Convergence in January: 599,300 beaked whales, more than 90% of which are southern bottlenose whales (Kasamatsu et al. 1988). However, according to Gowans (2009) there are no known areas of concentration.

4. Biology and Behaviour

Habitat: *H. planifrons* is most common beyond the continental shelf and over submarine canyons, in water deeper than 1,000 m. It is rarely found in water less than 200 m deep. In summer, this species is most frequently seen within about 100 km of the Antarctic ice edge, where it appears to be relatively common (Carwardine, 1995). Cockcroft et al. (1990) report sightings in the steep thermocline between the Agulhas current and cold Antarctic water masses.

Behaviour: The southern bottlenose whale is poorly known and rarely observed at sea. It lives far from shipping lanes, and has never been commercially exploited, so it has not been as well studied as its northern counterpart. There are few reports of swimming near boats, but this may be due to lack of observation rather than shyness. After long dives, it may remain on the surface for 10 minutes or more, blowing every 30 to 40 seconds. It can stay underwater for at least an hour, but typical dive time is shorter. When swimming fast, especially under stress, it may raise its head clear of water on surfacing. Probably a deep diver, though it does not tend to travel much horizontal distance while submerged (Carwardine, 1995). There is essentially nothing known of the reproductive biology of this species (Jefferson et al. 1993).

Schooling: Pods of less than 10 are most common, but groups of up to 25 have been seen, exceptionally up to 40 (Bastida and Rodríguez, 2003).

Food: Diet analyses compiled by MacLeod et al. (2003) for *H. planifrons* report 41 species of cephalopods from 17 families. Where information on prey was available, Onychoteuthid, Cranchiid, Gonatid and Histioteuthid species contributed almost all of the biomass in *H. planifrons*. The largest individual prey item reported was 4,080 g. Fish were reported only once, in small numbers. However, this may be attributed to differential digestion rates of cephalopod and fish remains as the stomachs examined came from stranded animals (e.g. Slip et al. 1995).

5. Migration

Southern bottlenose whales apparently migrate, and are found in Antarctic waters during the summer. Like other beaked whales, they are deep-water oceanic animals (Jefferson et al. 1993). Kasamatsu and Joyce (1995) investigated the spatial distribution of various cetacean species during mid-summer in Antarctic waters and found different peaks of occurrence for each species by latitude, suggesting possible segregation. Killer whales occur mainly in the very southernmost areas, sperm whales in the southern half of the study area, whereas beaked whales (mostly southern bottlenose whales) ranged over a wide area.

Sightings of southern bottlenose whales off Durban between February and October showed a strong seasonality with peaks in February and October. The beaks of Antarctic and subantarctic squids in the stomachs of two specimens stranded in South African waters, plus the presence of cold water skin diatoms *Bennettella* (= *Cocconeis*) *ceticola* suggest that the animals had arrived comparatively recently from higher latitudes (Sekiguchi et al. 1993).

6. Threats

Although never taken commercially, some southern bottlenose whales have been killed during whaling operations by Soviet and Russian whalers and others based at South Shetlands and South Georgia, some of these for research purposes (Bastida and Rodríguez, 2003; Van Waerebeek et al. 2004). Several have been recorded as accidental victims of driftnet fishing in the Tasman Sea. Numbers taken annually are not known (Jefferson et al. 1993).

7. Remarks

Range states: Antarctica; Argentina; Australia; Brazil; Chile; Falkland Islands (Malvinas); New Zealand; South Africa; Uruguay (Taylor et al. 2008).

H. planifrons is categorised as "Least concern" by the IUCN (Taylor et al. 2008) and is listed in Appendix I & II of CITES. It is not listed by CMS.

H. planifrons also occurs in southern South America. Recommendations iterated by the scientific committee of CMS for small cetaceans in that area (Hucke-Gaete, 2000) also apply (Appendix 1). For recommendations on south-east Asian stocks, see Perrin et al. (1996) in Appendix 2.

8. Sources (see page 253)

3.16 Indopacetus pacificus (Longman, 1926)

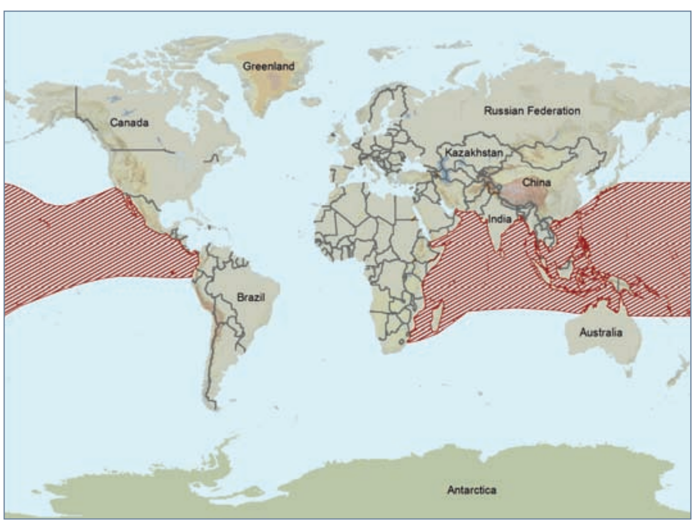
English: Indo-Pacific beaked whale
German: Pazifischer Schnabelwal
Spanish: Zifio de Longman
French: Baleine à bec de Longman

Family Ziphiidae

Indopacetus pacificus / Indo-Pacific whale (© Wurtz-Artescienza)

1. Description

Longman's beaked whale is relatively large, measuring up to 6.5 m in length (Pitman, 2009). It has a prominent melon set off from a fairly long beak. The dorsal fin is located two-thirds back from the beak and is more prominent than in other beaked whales, resembling a dolphin's dorsal fin. Colouration on the dorsal side ranges from brown to blueish-grey, with light areas on the sides and on the head. In young animals, a diffuse dark band including both eyes and delimited by the blowhole extends down to the flippers (Jefferson et al. 2008). Adult females have very few of the linear scars found in adult males and both sexes have white oval scars stemming form cookie-cutter shark bites. One pair of teeth presumably only erupts at the tip of the lower jaw in males (Pitman, 2009).



Distribution of Indopacetus pacificus: tropical waters throughout the Indo-Pacific, from the west coast of Mexico to the east coast of Africa and the Gulf of Aden (Pitman, 2009; Taylor et al. 2008; © IUCN Red List).

2. Distribution

This was one of the least known cetaceans, whose existence was first derived from only two skulls (Queensland, Australia, 1882 and Somalia, 1955). Before 2003 there were no confirmed live sightings in the wild. Since then however, there have been 65 at-sea sightings and 8 new stranding records, and *I. pacificus* has now become one of the more frequently identified beaked whales. It is rare in the eastern Pacific and appears to be more common in the western Pacific and tropical Indian Ocean (Pitman, 2009).

Originally described as a species of *Mesoplodon*, this distinctive but poorly known whale has erroneously been thought to be a race of *Mesoplodon mirus* or a synonym of *Hyperoodon planifrons* (Rice, 1998). However, while a more recent molecular genetics analysis found support for species level differences and verified morphological characters, it failed to confirm the validity of the genus, yet concluded that the genus should be retained pending further evidence to the contrary (Dalebout et al. 2003).

3. Population size

There have been two population estimates (Barlow et al. 2006), one for the waters around Hawaii (1,007 animals, density 0.4 per 1,000 km²) and one for the Eastern Tropical Pacific (291 animals, density 0.2 - 0.4 per 1,000 km²) confirming that the species is uncommon or rare throughout most of its range.

4. Biology and Behaviour

Habitat: Most sightings have been in water more than 2,000 m deep, where sea surface temperatures exceed 26°C (Pitman, 2009).

Behaviour: When travelling fast at the surface, Longman's beaked whales bring their head and beak far out of the water and may even porpoise like large dolphins. Diving and surfacing is mostly synchronous within groups. Dive times from 11 - 33 minutes and as long as 45 minutes have been recorded (Pitman, 2009).

Schooling: Group size tends to be larger than in other beaked whales and averages from 7.2 in the western Indian Ocean to 8.6 in the eastern Pacific and 29.2 in the western Pacific, with a range of 1-100 animals per group. Travelling is in close groups consisting of adult males and females as well as calves. While most groups are composed of Longman's beaked whales only, associations with short-finned pilot whales, spinner dolphins, and common bottlenose dolphins have also been observed (Anderson et al. 2006; Pitman, 2009).

Food: Many beaked whales are mostly squid-eaters and Longman's beaked whale seems to make no exception: a specimen stranded in the Philippines had only squid in its stomach and another, stranded in Japan, also contained only squid beaks and no fish in its stomach, 83% of which were *Taonius pavo* (Pitman 2009).

5. Migration

unknown.

6. Threats

By-catch: Dayaratne and Joseph (1993) recorded the by-catch of 3 juvenile "southern bottlenose whales", but possibly *I. pacificus*, during a study of cetacean by-catch in the gillnet fishery of Sri Lanka. However, as large cetaceans are cut free or cut-up and used as longline bait for sharks (Leatherwood and Reeves, 1988; Dayaratne & Joseph, 1993) the number of takes may be larger than superficially estimated. Sri Lankan fishing boats range widely in the Indian Ocean, presently at least as far as Seychelles. Furthermore, according to Anderson et al. (2006) there are currently thousands of vessels of several nations carrying out pelagic gillnetting across large swathes of the northern Indian Ocean, although much of this fishing effort is poorly documented. These vessels are likely to pose some threat to Indian Ocean population(s) of *I. pacificus*, but the extent of this threat is unknown.

Pollution: A specimen stranded in Japan and another in the Philippines had ingested plastic debris (Pitman, 2009).

Noise: An apparently healthy female and calf stranded in Taiwan in 2005 together with several other cetaceans following naval exercises (Parsons et al. 2008), presumably due to sonar deployment. "Bubble-like lesions" were reported in at least one of these whales by Yang et al (2008).

7. Remarks

Known and inferred Range states: Australia; Comoros; Japan; Kenya; Malaysia; Maldives; Mayotte (France); Mexico; New Caledonia; Philippines; Saudi Arabia; Somalia; South Africa; Sri Lanka; Taiwan, Province of China; Hawaii (United States of America) (Taylor et al. 2008).

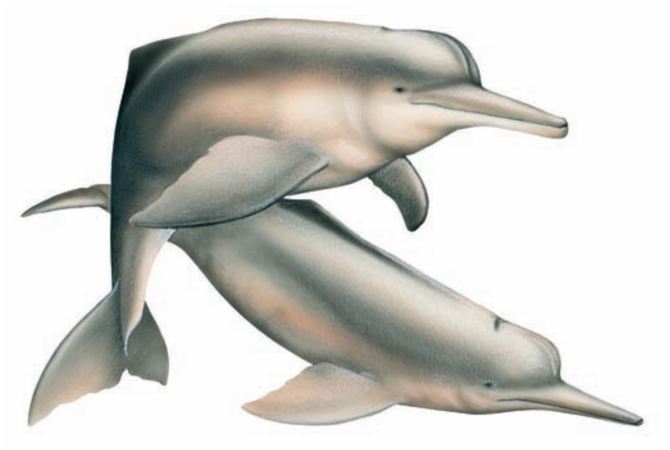
Longman's beaked whale is listed by the IUCN as "Data Deficient" and is not listed by CMS. It is listed in Appendix II of CITES.

8. Sources (see page 253)

3.17 Inia geoffrensis (de Blainville, 1817)

English: Amazon river dolphin, Boto, Inia
German: Amazonas-Delphin
Spanish: Bufeo
French: Dauphin rose de l'Amazone, Inie de Geoffroy

Family Iniidae



Inia geoffrensis / Amazon river dolphin (© Wurtz-Artescienza)

1. Description

The boto is the largest of the river dolphins. Males reach a maximum body length of 255 cm and a mass of 185 kg, the smaller females reach 215 cm and 150 kg. The body is corpulent and heavy but extremely flexible: the head can be moved in all directions. The flukes are broad and triangular, the dorsal fin is low, keel-shaped and long, extending from the midbody to the caudal peduncle. The flippers are large, broad and paddle-like. Whereas swimming speed is not very high, botos are capable of manoeuvring very well between trees in the flooded forest. The rostrum and mandible are long and robust and the melon is small and flaccid. Its shape can be muscularly controlled. Whereas young animals are dark grey, older botos are completely pink or blotched pink and may have a darker back (da Silva, 2002).

General distribution of Inia geoffrensis in the Amazon-Orinoco river systems (Reeves et al. 2008; © IUCN Red List).

2. Distribution

The boto has a very wide distribution and can be found almost everywhere it can physically reach without venturing into marine waters (da Silva, 2002). There are three morphologically distinguishable populations, which are best recognised at the subspecific level (Rice, 1998):

I. g. humboldtiana (Pilleri and Gihr, 1977): ranges in the Orinoco River system, including the Apure and Meta rivers, upstream as far as the rapids at Puerto Ayacucho (Rice, 1998). Contact between this race and the next is restricted, at least during low water, by waterfalls on the upper Rio Negro, by the rapids on the Orinoco river between Samariapo and Puerto Ayacucho, and by the Casiquiare Canal itself (da Silva and Martin, 2000).

I. g. geoffrensis: found throughout most of the Amazon River and its tributary rivers (below an elevation of about 100 m), including the Tocantins, the Araguaia, the lower Xingu up to the rapids at Altamira, the lower Tapajós up to the rapids at Sao Luis, the Madeira as far as the rapids at Porto Velho, the Purús, the Juruá, the Ica, the Japura, the Branco, and up the Negro through the Canal Casiquiare into the headwaters of the Orinoco, from whence in ranges as far downstream as San Fernando de Atabapo, including its tributary the Guaviare (Rice, 1998).

I. g. boliviensis (d'Orbigny, 1834): occurs in the upper Rio Madeira drainage in Bolivia, where it is confined to the Rio Mamoré and its main branch the Rio Iténez (= Rio Guaporé), including lower reaches of their larger tributaries (at an elevation of 100-300m). There are no credible reports from the Rio Beni or any of its tributaries above Riberalta. This subspecies appears to be isolated from the previous one by 400 km of rapids from Porto Velho on the Rio Madeira in Brazil upstream to Riberalta on the Rio Beni in Bolivia. However, *Inias* of undetermined subspecies live in the Rio Abuna and its tributary the Rio Negro, which enters the Madeira/Beni an the border between Brazil and Bolivia (Rice, 1998 and references therein). Botos in the Beni system may, in fact, constitute a separate species (da Silva 1994).

Although, at present, a single species is recognised, Banguera-Hinestroza et al. (2002) compared samples from specimens in the Orinoco basin (four rivers), the Putumayo River, a tributary of the Colombian Amazon and the Mamoré, and the Tijamuchy and Ipurupuru rivers in the Bolivian Amazon. From mitochondrial DNA and mitochondrial cytochrome b gene analysis, a subdivision of the *Inia* genus was proposed into at least two evolutionarily signifcant units: one connected to the Bolivian river basin and the other widely distributed across the Amazon and Orinoco basins. However, the IWC sub-committee (IWC, 2000) and more recently, da Silva (2009) recognised that this was still an unresolved issue.

3. Population size

The boto is the most common river dolphin and population densities appear to be relatively high throughout much of its range (IWC, 2000). Its current distribution and abundance apparently do not differ from the past, although relative abundance and density are highly seasonal and appear to vary among rivers (da Silva, 2002, 2009). Overall population size, however, is unknown and precise data on trends are insufficient for any of the three subspecies.

Differences in density exist between different river systems. Pilleri and Gihr (1977) report an average of one dolphin per 4 km over 130 km on Rio Ichilo, one per 0.9 km on Rio Ipurupuru, and one per 1.0 km on Rio Ibare. On the Amazon River bordering Colombia, Peru, and Brazil Vidal et al. (1997) found that Inia density was highest in tributaries with 4.8 dolphins/km, followed by areas around islands 2.7 dolphins/km and along main banks 2.0 dolphins/km.

Aliaga-Rossel et al. (2006) investigated encounter-rates in the Mamoré River of the Bolivian Amazon and four of its tributaries during the low water season. Inia encounter rates were in the range 1.6-5.8 km^{-1} and are the highest recorded anywhere in its broad geographic range. Mean group size was greatest in the Tijamuchi River (3.3 ± 2.96) and smallest in the Yacuma River (1.8 ± 0.75).

In absolute numbers, Aliaga-Rossel (2002) counted 208 bufeos in the Tijamuchi River of Bolivia. Surveys in a 1,200 km section of the Amazon River between Manaus and Santo Antonio de Ica yielded estimates averaging 332 dolphins (Best and da Silva, 1989). Martin and da Silva (2004a) found the boto population of the central Amazon, to be structured on the basis of floodplain lake systems, with extensive animal movement between systems. They estimate that 13,000 botos occur in the 11,240 km² Mamiraua Sustainable Development Reserve, which covers an estimated 11%-18% of varzea (see below) habitat in Brazil.

4. Biology and Behaviour

Habitat: The Amazon river dolphin is an exclusively freshwater species. In the Orinoco and Amazon basins, the species is found in a variety of riverine habitat types, including rivers, small channels and lakes, excepting the estuaries and strong rapids and waterfalls. Concentrations occur mainly at the mouth of rivers, below rapids and smaller channels running parallel to the main river. During the high-water season dolphins may utilize both the flooded forest and grasslands, throughout most of Amazon River and its tributary rivers (Reyes, 1991).

Martin and daSilva (2004b) investigated habitat use in and around the Mamiraua Reserve, Brazil. Largely forested with numerous channels and lakes, Mamiraua comprises a variety of seasonal floodplain habitats known collectively as varzea. The annual cycle of flooding in this region (amplitude 11-15 m) dominates all life. Profound seasonal differences in dolphin density between habitats were consistent with known fish movements, in turn dictated by changes in water level and dissolved oxygen. An exodus of botos from floodplains to rivers at low water prevents dolphins being trapped in areas that become entirely dry. Densities of botos in floodplain channels were seasonally higher (up to 18 per km²) than reported for any cetacean worldwide. Adults were largely segregated by sex except at low water. Some 80% of botos occurring on rivers were within 150 m of the margins. The reliance of adult females and calves on varzea in a region with exceptional dolphin densities demonstrates the importance of floodplain habitats for the boto, and may be the key determinant of this species' distribution.

In Peru's Pacaya-Samiria National Reserve McGuire (2002) found that boto encounter rates were highest in confluences, intermediate in lakes, and lowest in rivers. Encounter rates for botos in rivers and lakes did not differ among seasons. During low water, boto persisted longer in the confluences throughout the sampling day, and occurred in higher densities than in any other season; the reverse pattern was observed during high water.

Schooling: Although rarely seen in groups of four or more, *Inia* is most often observed as solitary individuals. Loose aggregations have been observed at feeding areas. Most groups of two are apparently mothers and calves. In a survey conducted by Magnusson et al. (1980), from Manaus to Tefé, 81% of the sightings were of a single individual and only 3% of sightings of four or more animals. Of 407 sightings from Manaus to Tabatinga, 69% were of one animal and 3% were of four or more. In surveys from Leticia, 58% of sightings were of one animal while 14% were of four or more (Best and da Silva, 1989). In the Tijamuchi River, Beni, Bolivia 42% of observations were of solitary dolphins, 32% were of pairs, and maximum group size was 19. Calves were seen most often during falling and low waters (Aliaga-Rossel , 2002). In Peru's Pacaya-Samiria National Reserve, botos were seen most often as single animals and seasonal differences in group size were not detected (McGuire, 2002).

Although more often a solitary feeder, *Inia* sometimes form loose groups that fish in a coordinated fashion to herd and attack shoals. These groups may also include the tucuxi *(Sotalia fluviatilis*) and the giant otter (*Pteronura brasiliensis*). Similar group relationships can develop with man in his fishing canoe. Fishermen, on their part, use dolphins to localise shoals of fish and the dolphins use the human fishing operation as a means of disrupting the shoal to their advantage (Best and da Silva, 1989).

Food: *Inias* may frequent shallow waters primarily for feeding (Best and da Silva, 1989). About 50 species of fish have been reported as the food of Amazon river dolphins in the central Amazon. Sciaenids, cichlids and characins are the preferred prey; some of them are of commercial value (Best and da Silva, 1989).

Reproduction: Reproduction of Amazon River Dolphins, based on observations of live dolphins from the Orinoco, Amazon, and Mamoré river basins (in Venezuela, Peru and Bolivia, respectively) indicate that reproduction in Inia often occurs year-round, with seasonal peaks varying according to geographic location. Inia neonates in Peru and Bolivia were seen in all seasons, and were observed most often in falling water (season was defined by relative water level). Conversely, neonates in Venezuela were seen at the end of low water and in rising water, yet were never observed during falling water. Inia mating behavior in Peru was observed in all seasons, while mating was observed only during falling and low water in Bolivia (McGuire and Aliaga-Rossel, 2007). The authors suggest variation in reproductive seasonality, with year-round reproduction in some areas. Seasonality of peaks in births varies according to study area, and may be more closely associated with local environmental and prey conditions than with taxonomic relatedness, relative seasonal differences in water levels, or broad geographic distribution. Gestation lasts 10-11 months (Best and da Silva, 1989).

5. Migration

McGuire and Henningsen (2007) used photo-identification to recognize Inia from scars, cuts, nicks, pigmentation patterns, and abnormal beaks in Peru's Pacaya-Samiria Reserve. 72 Inia were identified, and 25 were resighted between 1991 and 2000. Sighting histories ranged from 1 d to 7.6 y. Maximum range of movement was 220 km, with a mean range of 60.8 km. The greatest rates of movement observed were 120 km/d, with a mean rate of movement of 14.5 km/d. Identified dolphins were always observed within the same tributary system. 90% of all Inia resighted in one river system were seen in the same lake at least once, and 33% of dolphins resighted in the lake were never seen outside of the lake. This confirms earlier work by Da Silva and Martin (2000) in the central Amazon of Brazil, where most animals moved only a few tens of kilometres between high and low water seasons. Of more than 160 marked animals, however three had been resighted more than 100 km from the tag site.

Seasonal migrations seem to represent slight extensions of more or less stable home ranges. Some of these migrations, mostly during flood seasons, are known to cross international boundaries: in the Casiquiare Canal and Upper Rio Negro (Venezuela, Colombia and Brazil); in the Rio Madeira-Guapore system (Brazil and Bolivia); in the Takatu River (Brazil and Guyana) and at Leticia (Peru, Colombia and Brazil) (Best and da Silva, 1989).

6. Threats

Direct Catch: Parts of stranded or incidentally caught dolphins may be sold as love charms. In the Beni district, Bolivia, hunting with rifles and nets was previously reported (Pilleri, 1969; Pilleri and Gihr, 1977). Da Silva and Best (1996) conducted interviews with fishermen in boats, in the fishmarket and in the shops supposedly selling dolphin products in an attempt to quantify the overall incidental kill attributed to commercial fisheries operations. The results showed that in the Central Amazon, dolphin catches are incidental and only a very small number of these carcasses are used for commercial purposes. In the Colombian Amazon some fishermen have killed Inia (including harpooning, shooting and deliberate poisoning) to deter gear interactions. In the Orinoco system and Peruvian Amazon there are also reports of some deliberate killings apparently due to interactions with fisheries (IWC, 2000).

Incidental catches: The main causes of man-made mortality of dolphins in Bolivia were identified as collisions with outboard motors and entanglement in fishing nets (Aliaga-Rossel, 2002). In Peru's Pacaya-Samiria National Reserve major threats are related to human fishing activity, and include entanglement in fishing gear and possibly poisoning to reduce net damage and predation on fish. Potential threats include boat strikes, oil spills, water and noise pollution, and overfishing of prey (McGuire, 2002).

By-catch is also reported in the Amazon and Orinoco Rivers, but there are no estimates of the magnitude of these catches. However, fish landings have increased several fold in some areas, representing an increase in fishing effort. A major reason for this increase was the introduction of nylon gillnets in the 1960s. Lampara seine nets, fixed and drift gillnets are responsible for the majority of dolphin deaths. A yet unknown number of dolphins are killed by explosions during illegal fishing operations (Best and da Silva, 1989).

Martin et al. (2004) found that Inia's most preferred habitat type was where a channel of sediment-rich white water meets one carrying acidic black water; the resultant mixing producing particularly productive, and obviously attractive, conditions for dolphins. These areas are also known to be favored for gill net deployment by local fishermen, and may explain why entanglement is apparently a common cause of mortality.

In general, incidental mortalities of this species appear to be seasonal and patchily distributed throughout the range. There are no estimates of total incidental mortality, and all accounts are anecdotal. The IWC Scientific Committee (2000) agreed that, in the absence of any information on total numbers taken or total population size, it was impossible to assess the significance of this source of mortality. The subcommittee recognised that it would be extremely difficult to obtain reliable estimates of incidental mortality because of the small-scale nature of the fisheries involved. A more sensible approach to the issue might be, in the first instance, to try to determine the scale of incidental mortalities in different types of fishing gear in different regions (IWC, 2000).

Deliberate killing: Amazon river dolphins have learned to take advantage of some fishing activities. They may tear fish from nets (in particular from lampara seine nets) causing considerable loss of fish catch and damage to fishing gear. Also, these dolphins congregate to eat fish stunned by dynamite used illegally by some fishermen. In both instances, fishermen may decide to kill the dolphins. Best and da Silva (1989) mention that at least two reports of harpooned dolphins exist, probably due to this interference with fishing operations.

Overfishing: According to da Silva and Best (1996) the use of nylon gill nets in the Amazon fishery is widely spread throughout the whole region, and with increasing fisheries pressure the potential for dolphin/fisheries interactions is much greater. Competition between man and dolphin for commercial fish, however, is still minimal in the Central Amazon. Dietary analysis has shown that only 43% of 53 identified prey species are of commercial value and that the dolphins generally prey on size-classes of fish below those of commercial interest.

Habitat degradation: Human populations are expanding rapidly in many areas of the boto´s range, especially in Colombia and Brazil. Such population increases result in increased agriculture, deforestation, cattle ranching and the establishment of plantations (IWC, 2000). Deforestation in flood plains for agriculture and the timber industry affects the hydrological cycle and the riverine ecosystem as a whole. One of the major effects of deforestation is the reduction of fish productivity, and hence reduction of food supply for river dolphins and other aquatic animals. Hydroelectric development is at present not a great threat, but several dams are projected for the next few years in the river systems of both Brazil and Venezuela (Best and da Silva, 1989, IWC, 2000). Dams may prevent migrations, breaking the populations into very small units with insufficient genetic variability, and reduce food supply (Ralls, 1989, in Reyes, 1991). Strandings in the Formosa River have been reported as resulting from changes in the water level produced by the deviation of waters for irrigation (Best and da Silva, 1989). Furthermore, the water areas behind dams provide an impoverished environment for *Inia*, with lower oxygen concentrations, lower pH levels and fewer fish (IWC, 2000).

Recently (IWC, 2000) oil exploration and production were also identified as a potential threat to Inia. In Colombia there had been many oil spills in recent years as a result of the ongoing guerrilla war in the upland regions. Some of these had been very extensive, and represented a potential threat that has not yet been quantified. Anecdotal accounts of a decline in numbers were reported in Ecuador and were also linked to oil spills in the region, though the subcommittee noted that fluctuations in numbers would also be expected due to water level fluctuations.

Pollution: According to Reyes (1991), large quantities of pesticides are being used increasingly in agriculture in the Amazon and Orinoco Basins. Pollution by heavy metals in the Amazon comes from gold mining and associated indiscriminate use of mercury. Effluents from pulp mills are also a potential source of pollution (Best and da Silva, 1989). However, Rosas and Lethi (1996) report that the mercury concentration (176 ng/ml) found in the milk of a lactating Inia caught in the Amazon River near Manaus, Brazil was very close to the minimum level of methylmercury toxicity for non-pregnant human adults. This suggests that at least in this part of the river system, contamination is low.

7. Remarks

Range states (Reeves et al. 2008): Bolivia; Brazil; Colombia; Ecuador; French Guiana; Peru; Venezuela

Inia geoffrensis is categorised as "Data defficient" by the IUCN (Reeves et al. 2008). The species was previously listed as "Vulnerable" but is now considered Data Deficient due to the limited amount of current information available on threats, ecology, and population numbers and trends. However, the IWC (2008) has expressed concern over the capture of boto for bait in the central Brazilian Amazonas, which is considered to be an emergent, but already large-scale, problem (Reeves et al. 2008).

The species is listed in appendix II of CITES and it is also listed in Appendix II of CMS.

According to an evaluation by the Scientific Committee of the IWC (2000), populations of the boto appear to be large and there is little or no evidence of any decrease in numbers or range. The sub-committee noted the increasing human pressures on the region, and recognised that future anthropogenic effects are to be expected, with declines in range and population fragmentation the most likely consequences. The Asian river dolphins provide a model for the possible effects of increased human populations and dam construction. The subcommittee therefore agreed that there is a need for appropriate monitoring schemes and formulated its recommendations accordingly.

The IWC sub-committee (IWC, 2000) recommended:

- that work on stock structure of Inia be conducted and existing studies should be brought to publication as soon as possible,
- that a registry of the distribution of this species should be established, recording in which waterways botos are present, and that the locations of all existing and proposed dams and other large-scale engineering works should be included. Information on other potential threats, such as the scale of fishing operations and the locations of oil pipelines might also usefully be included where practicable,
- that for each population, research should be directed towards detecting trends in abundance or any diminution of range, and identifying causes of any declines. Trends in abundance should be documented by making repeatable, statistically rigorous estimates of density in a range of regions and habitats.

The most significant anthropogenic impact on this species at present appears to be mortalities in fishing operations. These are either entirely incidental (entanglement) or to a greater or lesser extent deliberate, as fishermen are reportedly poisoning botos with baited fish, to limit net depredation, and also shooting and otherwise killing animals found in or near to nets. The sub-committee recommends that information should be collected to allow evaluation of the relative levels of mortality, both indirect and direct, associated with different fishing methods (IWC, 2000).

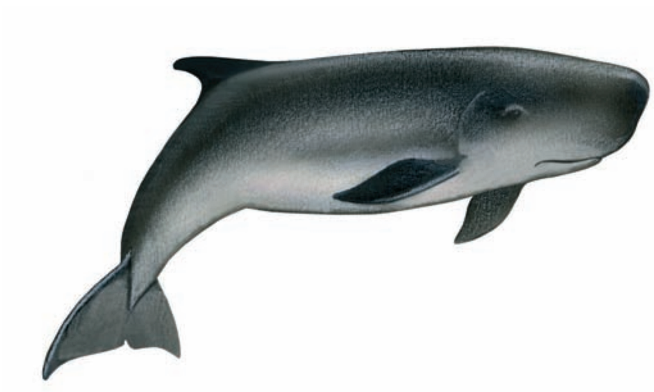
The management of renewable natural resources in developing countries has been hampered by a mix of socioeconomic and political difficulties that in turn have resulted in insufficient scientific knowledge, limited environmental awareness and education, and limited commitment to conservation (Vidal, 1993). Aquatic mammals provide good examples. Because many aquatic mammal populations are shared by several Latin American countries, international co-operation is critical to ensuring their long-term conservation.

8. Sources (see page 253)

3.18 Kogia breviceps (de Blainville, 1838)

English: Pygmy sperm whale
German: Zwergpottwal
Spanish: Cachalote pigmeo
French: Cachalot pygmée

Family Kogiidae

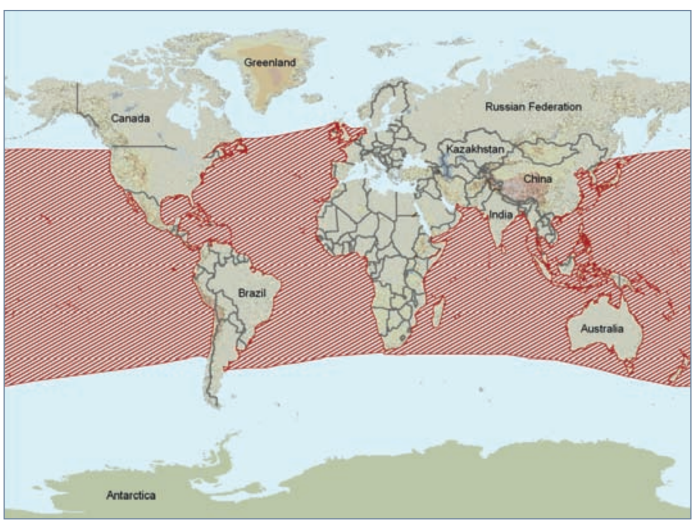


Kogia breviceps / Pygmy sperm whale (© Wurtz-Artescienza)

1. Description

Pygmy sperm whales are somewhat porpoise-like in body shape, and robust, with a distinctive underslung jaw, not unlike sharks. They have the shortest rostrum among cetaceans and the skull is markedly asymmetrical. Pygmy sperm whales reach a maximum size of about 3.8 m total length and a body mass of 450 kg and are larger than dwarf sperm whales. Colouration in adults is dark bluish grey to blackish brown on the back with a light venter. On the side of the head, between the eye and the flipper, there is often a crescent-shaped, light-coloured mark often referred to as a "false gill". Teeth are only found in the lower jaw and are very sharp and thin, lacking enamel (McAlpine, 2002).

Although the two currently recognized *Kogia* species are not so obvious to distinguish at sea by non-specialists , the morphological evidence backed by recent genetic analyses confirm species-level differences (Chivers et al. 2005). Duffield et al. (2003) developed a method to distinguish both species based on myoglobin and hemoglobin differences.



Distribution of Kogia breviceps: deep temperate, subtropical, and tropical waters beyond the continental shelf (Taylor et al. 2008a; © IUCN Red List).

2. Distribution

While the precise distribution of the pygmy sperm whale is unknown (Mcalpine, 2009), it is evidently an oceanic species that lives mostly beyond the edge of the continental shelf in tropical and temperate waters around the world. It ranges north to Nova Scotia, the Azores, The Netherlands, Miyagi on the east coast of Honshu, Hawaii, and northern Washington State. It ranges south to the Cape Province, the Tasman Sea, Islas Juan Fernández, and Chile (Rice, 1998), and Argentina (Bastida and Rodríguez, 2003). It appears to be relatively common off the southeastern coast of the USA and around southern Africa, south-eastern Australia, and New Zealand (Carwardine, 1995).

A total of 28 strandings were reported for Europe until 1991 (Duguy, 1994). Further strandings were recorded in Hawaii (Mazzuca et al. 1999), Sable Island, Nova Scotia (Lucas and Hooker, 2000), Spain (Abollo et al. 1998), Veracruz, Mexico (Delgado et al. 1998), Chile (Sanino and Yañez, 1997), France (Duguy, 1991), Micronesia (Eldredge, 1991) and South Australia (Kemper and Ling, 1991). There was a sighting off Vietnam (Smith et al. 1997).

It is unknown whether the populations are isolated (Carwardine, 1995). However, Martin and Heyning (1999) reported the cyamid amphipod species *Isocyamus kogiae* Sedlak-Weinstein, 1992 for the first time from a *K. breviceps* stranded in southern California, extending the known range of this amphipod from Moreton Island, Queensland, Australia, to the northeastern Pacific. Their cosmopolitan ectoparasite suggests that pygmy sperm whales from both sides of the Pacific are not isolated from each other.

3. Population size

In areas where they frequently strand, members of the genus *Kogia* are considered to be one of the most common species to come ashore. While many large males strand, many

Kogia strandings also consist of a female and small calf or a female that has given birth only recently. However, as with *K. sima*, there are no real estimates of abundance (Caldwell and Caldwell, 1989). Mcalpine (2009) summarizes that neither population size or trend are known.

The best U.S. Atlantic abundance estimate for both *Kogia* sp., 395 (CV=0.40), stems from two 2004 surveys, where the estimate from the northern U.S. Atlantic is 358 (CV=0.44), and from the southern U.S. Atlantic is 37 (CV=0.75). This joint estimate is considered the best because together these two surveys had the most complete coverage of the species' habitat. A separate estimate of pygmy sperm whale abundance could not be provided due to the uncertainty of species identification at sea. Furthermore, the available information was judged insufficient to evaluate trends in population size for the western North Atlantic (Waring et al. 2007). Barlow (2006) estimates that a total of 7,138 pygmy sperm whales are found in the outer EEZ of Hawaii. Using corrections for missed animals, Ferguson and Barlow (2001) re-estimated the abundance as approximately 150,000 for both species in the eastern tropical Pacific.

4. Biology and Behaviour

Habitat: *K. breviceps* seems to prefer warmer waters: there are records from nearly all temperate, subtropical, and tropical seas. It is rarely seen: it tends to live a long distance from shore and has inconspicuous habits. It is often confused with the dwarf sperm whale (*K. sima*), with which it had been synonymized until Handley in 1966 again recognised and re-described them as separate species. With few field records, it was long uncertain whether the two can be distinguished reliably except at very close range (Caldwell and Caldwell, 1989).

Caldwell and Caldwell (1989) suggested that *K. breviceps* lives in oceanic waters beyond the edge of the continental shelf while *K. sima* lives over or near the edge of the shelf. Wang et al. (2002) compared the diet of both *Kogia* spp. off coastal Taiwan and conclude that pygmy sperm whales fed on much larger cephalopods such as *Taonius pavo* compared to those ingested by dwarf sperm whales, while dwarf sperm whales ingested more *Histioteuthis miranda* than did pygmy sperm whales. These results support the view that pygmy sperm whales live seaward of the continental shelf and that dwarf sperm whales live more in coastal waters.

However, this spatial segregation was not apparent in the study of Mullin et al. (1994) who, by aerial observation, found both species over water depths of 400-600 m in the North-Central Gulf of Mexico. These waters of the upper continental slope were also characterised by high zooplankton biomass (Baumgartner et al. 2001).

Behaviour: When seen at sea, they generally appear slow and sluggish, with no visible blow (Jefferson et al. 1993). *K. breviceps* is said to be very easy to approach, lying quietly at the surface practically until touched although it will not approach boats by itself and is rather timid, slow moving and deliberate. Like its congener, *K. breviceps* spends considerable time lying motionless at the surface with the back of the head exposed and the tail hanging down loosely. *K. breviceps* is reported to float higher in the water with more of the head and back exposed than *K. sima* (Caldwell and Caldwell, 1989). Dive times of up to 18 minutes were recorded from a rehabilitated animal, although most dive durations are shorter (Scott et al. 2001).

Schooling: Most sightings of pygmy sperm whales around Hawaii were of single individuals (Barlow, 2006), but Mcalpine (2009) summarizes that group size ranges between 1-6.

Food: Studies of feeding habits, based on stomach contents of stranded animals, suggest that this species feeds in deep water on cephalopods and, less often, on deep-sea fishes and shrimps (Caldwell and Caldwell, 1989; Jefferson et al. 1993; Santos and Haimovici, 1998).

Beatson (2007) investigated the stomach contents of pygmy sperm whales stranded on New Zealand beaches between 1991 and 2003. The diet was found to include fish and crustaceans, but is comprised primarily by 23 species of cephalopods, dominated by juvenile individuals of the families Histioteuthididae and Cranchiidae.

5. Migration

Stranding data of both Kogiidae do not seem to bear out any strong seasonal changes in distribution nor any migrations, although some writers have suggested such in very general terms (Caldwell and Caldwel, 1989). Duguy (1994) suggests that the species may migrate from the coast to the open sea in summer, since most strandings e.g. in Florida occurred during winter and fall. In Europe, there are more strandings in winter, which supports this hypothesis: Mcalpine (2009) remarks that in the NE Atlantic, most strandings occur in autumn and winter.

6. Threats

Direct catch: Pygmy sperm whales have never been hunted commercially. Small numbers have been taken in coastal whaling operations off Japan and Indonesia (Jefferson et al. 1993).

Incidental catch: A few have been killed in Sri Lanka's gillnet fisheries, and it is likely they are killed in gillnets elsewhere as well (Jefferson et al. 1993). Perez et al. (2001) report on occasional by-catches in fisheries in the north-east Atlantic. Waring et al. (2007) summarize that total annual estimated average fishery-related mortality and serious injury to this stock in the Western North Atlantic during 1999-2003 was 6 (CV=1.0) *Kogia* sp. Total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated Potential Biological Removal (PBR = 2 in the western North Atlantic) and therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because the 1999-2003 estimated average annual fishery-related mortality to pygmy sperm whales exceeds PBR.

Pollution: Watanabe et al. (2000) present data on organic pollutants found in small cetaceans stranded on the coast of Florida and Marcovecchio et al. (1994) summarise the available knowledge on environmental contamination in marine mammals off Argentina. However, Bustamante et al. (2003) analysed 12 trace elements (Al, Cd, Co, Cr, Cu, Fe, organic and total Hg, Mn, Ni, Se, V, and Zn) in two stranded specimens and conclude that trace elements in whales on New Caledonia beaches, South Pacific, are below levels for concern.

Tarpley and Marwitz (1993) report on a young male pygmy sperm whale stranded alive on Galveston Island, Texas, USA, which died in a holding tank 11 days later. During necropsy, the first two stomach compartments (forestomach and fundic chamber) were found to be completely occluded by various plastic bags. Gastro-Intestinal blockage and subsequent death caused by plastic debris has also recently been documented by Stamper et al. (2006). Waring et al. (2007) also list that remains of plastic bags and other marine debris have been retrieved from the stomachs of 13 stranded pygmy sperm whales in the southeastern U.S.

Noise: Two pygmy sperm whales stranded in the Outer Banks, North Carolina, between 15 and 16 January 2005. Coincident with the stranding, one US Navy vessel was known to have used sonar for seven minutes about 90 nautical miles southeast of the stranding area (Kaufman, 2005, in Parsons, 2008).

7. Remarks

Known and hypothetical Range States (Taylor et al. 2008a) : American Samoa; Angola; Anguilla; Antigua and Barbuda; Argentina; Aruba; Australia (Tasmania); Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil; Brunei Darussalam; Cambodia; Cameroon; Canada (Nova Scotia); Cape Verde; Cayman Islands; Chile (Juan Fernández Is.); China; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Cuba; Denmark; Djibouti; Dominica; Dominican Republic; Ecuador; El Salvador; Equatorial Guinea; Fiji; France; French Guiana; French Polynesia; Gabon; Gambia; Germany; Ghana; Gibraltar; Grenada; Guadeloupe; Guam; Guatemala; Guernsey; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Ireland; Isle of Man; Jamaica; Japan (Honshu); Jersey; Kenya; Kiribati; Liberia; Madagascar; Malaysia; Maldives; Marshall Islands; Martinique; Mauritania; Mexico; Micronesia, Federated States of; Morocco; Mozambique; Myanmar; Namibia; Nauru; Netherlands; Netherlands Antilles; New Caledonia; New Zealand; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal (Azores); Puerto Rico; Réunion; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Sao Tomé and Principe; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa (Eastern Cape Province, KwaZulu-Natal, Northern Cape Province, Western Cape Province); Spain; Sri Lanka; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; United Arab Emirates; United Kingdom; United States of America (Hawaiian Is., Washington); Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Western Sahara; Yemen.

Classified as "Data deficient" by the IUCN. Not listed by CMS. Listed in Appendix II of CITES.

This species is insufficiently known with respect to all aspects of its biology and potential threats. Collection of by-catch and sighting data is strongly needed. For recommendations on Southeast Asian stocks, see Perrin et al. (1996 in Appendix II).

8. Sources (see page 254)

3.19 Kogia sima (Owen, 1866)

English: Dwarf sperm whale
German: Kleiner Pottwal
Spanish: Cachalote enano
French: Cachalot nain

Family Kogiidae

Kogia sima / Dwarf sperm whale (© Wurtz-Artescienza)

1. Description

Kogia spp. are superficially porpoise-like in body shape, and robust, with a distinctive underslung jaw, not unlike sharks. They have the shortest rostrum among cetaceans and the skull is markedly asymmetrical. Dwarf sperm whales are smaller than pygmy sperm whales and reach a maximum size of only about 2.7 m total length and a body mass of 272 kg. Colouration in adults is dark bluish grey to blackish brown on the back with a light venter. On the side of the head, between the eye and the flipper, there is often a crescent-shaped, light-coloured mark referred to as a "false gill". The teeth (up to three pairs of vestigial teeth are also found in the upper jaw) are very sharp and thin, lacking enamel (McAlpine, 2002). Baird (2005) found that photographs of several individual dwarf sperm whales showed distinctive marks on the dorsal fins, demonstrating that individual photo-identification is possible with this species.

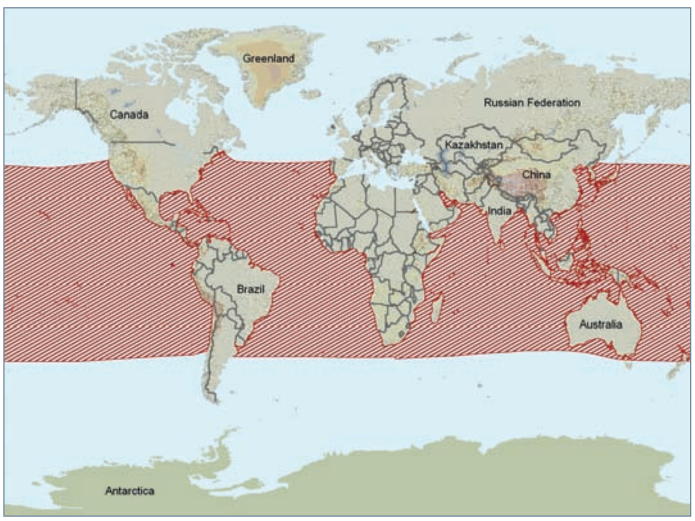
Chivers et al. (2005) found that the results of comparisons of mitochondrial DNA and morphological differences are consistent with species- level differences between **two** *K. sima* clades, one in the Atlantic and one in the Indo-Pacific: The combined gene sequence haplotypes have accumulated 44 fixed base pair differences between these two clades compared to 20 fixed base pair differences between the recognized sister species *K. sima* and *K. breviceps*. However, recognition of a third Kogia species awaits supporting evidence that these two apparently allopatric clades represent reproductively isolated groups of animals.

2. Distribution

Kogia spp. are not easy to positively distinguish at sea (Caldwell and Caldwell, 1989), as a consequence, most reliable records of either species are based on stranded individuals or occasionally on ones taken in fisheries.

Rice (1998) summarises that *K. sima* lives mainly over the continental shelf and slope off tropical and temperate coasts of all oceans. Range includes the western Atlantic from Virginia south to Rio Grande do Sul in Brazil, including the Antilles; the eastern Atlantic from the Mediterranean Sea south to Cape Province; the Indian Ocean from Cape Province north to Oman, east at least as far as Lomblen in Indonesia, and south to South Australia; the western Pacific from Chiba prefecture on the east coast of Honshu, and the Mariana Islands, south to Hauraki Gulf in New Zealand; and the eastern Pacific from Vancouver Island south to Valparaiso in Chile (Rice, 1998). Mcalpine (2009) summarizes that *K. sima* prefers warmer seas than *K. breviceps*.

Recent strandings have been reported from Sable Island, Nova Scotia (Lucas and Hooker, 2000), the Gulf of Mexico (Delgado et al. 1998), British Columbia, Canada (Willis and Baird, 1998), the Azores (Goncalves et al. 1996), Ecuador (Felix et al. 1995), the Antilles (Debrot and Barros, 1992), the coast of France (Duguy, 1990) and Japan (Sylvestre, 1988), supporting the notion of a wide distribution in temperate zones of the world oceans.



Distribution of Kogia sima: deep temperate, subtropical, and tropical waters of the northern and southern hemispheres (Taylor et al. 2008b; © IUCN Red List).

3. Population size

Because of the lack of sightings at sea, which may be more because of its inconspicuous behaviour than true abundance, and the fact that *Kogia* spp. are only rarely encountered in commercial fisheries where such records may be kept, there are no real estimates of abundance for either *Kogia* species (Caldwell and Caldwell, 1989, Mcalpine, 2009).

The best U.S. Atlantic abundance estimate for both *Kogia* spp., 395 (CV=0.40), stems from two 2004 surveys, where the estimate from the northern U.S. Atlantic is 358 (CV=0.44), and from the southern U.S. Atlantic is 37 (CV=0.75). This joint estimate is considered the best because together these two surveys had the most complete coverage of the species' habitat. A separate estimate of dwarf sperm whale abundance could not be provided due to the uncertainty of species identification at sea. Furthermore, the available information was judged insufficient to evaluate trends in population size for the western North Atlantic (Waring et al. 2007).

Barlow (2006) estimates that a total of 17,519 dwarf sperm whales are found in the outer EEZ of Hawaii. Dolar (1999) estimated the population size in the eastern Sulu Sea at 650. Using corrections for missed animals, Ferguson and Barlow (2001) re-estimated the abundance as approximately 150,000 of both species in the eastern tropical Pacific.

4. Biology and Behaviour

Habitat: The dwarf sperm whale is an inconspicuous animal and generally lives a long way from shore (Jefferson et al. 1993). Being the smallest of the whales and even smaller than some dolphins, it is rarely seen at sea, except in extremely calm conditions.

Mullin et al. (1994) sighted dwarf sperm whales in the Gulf of Mexico over water depths between 400 and 600 m. The species accounted only for 1% of the cetaceans seen and occurred in 12% of the herds observed during the aerial survey. These waters of the upper continental slope were also characterised by high zooplankton biomass (Baumgartner et al. 2001).

Caldwell and Caldwell (1989) suggested that *K. breviceps* lives in oceanic waters beyond the edge of the continental shelf while *K. sima* lives over or near the edge of the shelf. Wang et al. (2002) compared the diet of both *Kogia* spp. off coastal Taiwan and conclude that pygmy sperm whales fed on much larger cephalopods such as *Taonius pavo* compared to those ingested by dwarf sperm whales, while dwarf sperm whales ingested more *Histioteuthis miranda* than did pygmy sperm whales. These results support the view that pygmy sperm whales live seaward of the continental shelf and that dwarf sperm whales live more in coastal waters.

Behaviour: Rises to the surface slowly and deliberately and, unlike most other small whales (which roll forward at the surface), simply drops out of sight. Probably does not approach boats. May occasionally breach; leaping vertically out of the water and falling back tail-first or with a belly flop. Some records suggest that, when resting at the surface, it floats lower in the water than the pygmy sperm whale. Probably dives to depths of at least 300 m (Carwardine, 1995).

One of the few reported behavioural observations at sea stems from Scott and Cordado (1987) who report sighting a mother and calf after a purse-seine set was deployed on yellowfin tuna, *Thunnus albacares*, associated with a mixed school of spotted dolphins, *Stenella attenuata*, and spinner dolphins, *S. longirostris*. The dwarf sperm whales were accidentally encircled. While inside the net, the female released into the water a cloud of reddish material, presumably faeces, 6-8 times during the course of the set. The mother released the faeces whenever a dolphin approached the calf; she then appeared to hide herself and the calf in the middle of the opaque cloud.

In Hawaiian waters *Kogia* sp. were sighted most frequently in deeper portions of the study area (mean depth 1,425 m) and in calm sea conditions (mean Beaufort sea state < 1). One group of six dwarf sperm whales containing two mother-infant pairs did not dive for more than a few minutes at a time (Baird, 2005).

Schooling: Group sizes tend to be small, most often less than 5 individuals, although groups of up to 10 have been recorded (Jefferson et al. 1993; Mcalpine, 2009).

Reproduction: In at least one area, there appears to be a calving peak in summer (Jefferson et al. 1993).

Food: Dwarf sperm whales appear to feed primarily on deep-water cephalopods (Jefferson et al. 1993) as well as on fish and crustaceans (Caldwell and Caldwell, 1989).

5. Migration

Duguy (1994) suggests that the species does not migrate extensively, since it can be observed year-round off African coasts.

6. Threats

Direct catch: Some small scale catches of dwarf sperm whales have been reported (Caldwell and Caldwell, 1989 and refs. therein). *K. sima* was encountered in a small harpoon fishery for pilot whales at St. Vincent in the Lesser Antilles, in Japan and occasionally in an aboriginal industry on Lomblen Island in Indonesia, and has been reported from fish markets in Sri Lanka.

Incidental catch: Caldwell and Caldwell (1989) suppose that it is unlikely that *Kogia* spp. are significantly affected by humans. When taken in commercial fisheries the numbers are so few that either species is considered rare. This is confirmed by Waring et al. (2007): Total annual estimated average fishery-related mortality and serious injury to the North West Atlantic stock during 1999-2003 was zero.

However, Jefferson et al. (1993) believe that substantial numbers are taken each year in gillnets in the Indian Ocean, and possibly elsewhere. Zerbini and Kotas (1998) report on by-catch in the Brazilian driftnet fishery. Because of their small size and habit of often lying at the surface, apparently oblivious to approaching vessels, a few *Kogia* are probably run down and injured or killed (Caldwell and Caldwell, 1989).

Pollution: Both species have been reported with plastic bags in their stomachs that may have prevented digestion of food and ultimately brought death. Perhaps the textural or visual quality of the plastic was similar to that of squid and thus enticed the whales to devour it (Caldwell and Caldwell, 1989).

7. Remarks

Range states (Taylor et al. 2008b):

American Samoa; Angola; Anguilla; Antigua and Barbuda; Argentina; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil (Rio Grande do Sul); Brunei Darussalam; Cambodia; Cameroon; Canada (British Columbia); Cape Verde; Cayman Islands; Chile (Valparaíso); China; Colombia; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Cuba; Côte d'Ivoire; Djibouti; Dominica; Dominican Republic; Ecuador (Galápagos); El Salvador; Equatorial Guinea; Fiji; France; French Guiana; French Polynesia; Gabon; Gambia; Ghana; Gibraltar; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Jamaica; Japan (Honshu); Kenya; Kiribati; Kuwait; Liberia; Madagascar; Malaysia; Maldives; Marshall Islands; Martinique; Mauritania; Mexico; Micronesia, Federated States of; Morocco; Mozambique; Myanmar; Namibia; Nauru; Netherlands Antilles; New Caledonia; New Zealand (Kermadec Is., North Is.); Nicaragua; Nigeria; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal (Azores, Madeira); Puerto Rico; Qatar; Réunion; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Sao Tomé and Principe; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Sudan; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; United Arab Emirates; United States of America (Hawaiian Is.); Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen

Classified as "Data Deficient" by the IUCN. Not listed by CMS. The species is listed in Appendix II of CITES.

Both kogiid species also occur in southern South America. Recommendations iterated by the scientific committee of CMS for small cetaceans in that area (Hucke-Gaete, 2000) also apply (see Appendix 1). For recommendations on south-east Asian stocks, see Perrin (1996) in Appendix 2.

8. Sources (see page 254)

3.20 Lagenodelphis hosei Fraser, 1956

English: Fraser's dolphin
German: Borneo-Delphin
Spanish: Delfín de Fraser
French: Dauphin de Fraser

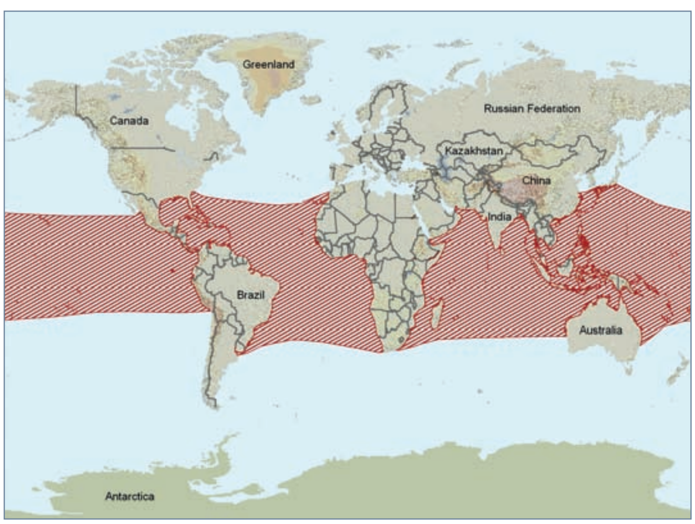
Family Delphinidae

Lagenodelphis hosei / Fraser's dolphin (© Wurtz-Artescienza)

1. Description

The body of Fraser's dolphin is stocky, the beak short but distinct and the dorsal fin small, triangular and slightly falcate. The flippers and flukes are also comparatively small. The striking colouration varies with age and sex: a distinctive black stripe extending from the eye to the anus is absent or faint in juveniles, wider and thicker in adult males and variable in adult females. A similar pattern is observed with the facial stripe or "bridle". The back of *L. hosei* is brownish grey, the lower side cream-coloured and the belly is white or pink. The largest male recorded was 2.7 m and the largest female 2.6 m long. Large males can weigh up to 210 kg (Dolar, 2009).

The one species in this genus was not recognized until 1956, when it was described from a single skull which had been picked up on a beach in Sarawak in 1895. It remained unknown to science as a living animal until 1971, when the species was "rediscovered". Once its external features became known, it turned out that tuna fishermen in the eastern tropical Pacific were already familiar with it (Rice, 1998). Based on cytochrome b mtDNA it is more closely related to *Stenella*, *Tursiops*, *Delphinus*, and *Sousa* than to *Lagenorhynchus*, while skull morphology shows similarities with *D. delphis*, *S. longirostris*, *S. coeruleoalba* and *S. clymene* (Dolar, 2009).



Distribution of Lagenodelphis hosei: deep tropical and warm temperate waters of the Pacific, Atlantic and Indian Oceans between 30°S and 30°N (Hammond et al. 2008; © IUCN Red List).

2. Distribution

L. hosei is pantropical and ranges north to the Gulf of Mexico, Islas Canarias, West Africa (van Waerebeek et al. 2000) Sri Lanka, Taiwan, southern Honshu, and Jalisco in Mexico and south to Uruguay and Brasil, Natal, Queensland, and Peru (Rice, 1998).

The distribution of this species is poorly known. It appears to be most common near the equator in the eastern tropical Pacific and at the southern end of Bohol Strait in the Philippines. It seems to be relatively scarce in the Atlantic Ocean, where it is known from the Lesser Antilles and the Gulf of Mexico (e.g. Mignucci-Giannoni et al. 1999) and recently from Venezuela (Bolaños and Villarroel-Marín, 2003).

L. hosei may range across the Indian Ocean, with confirmed sightings from the east coast of South Africa, Madagascar, Sri Lanka, and Indonesia. It also occurs away from the equator as far north as Taiwan and Japan and, in small numbers, off Australia (Perrin et al. 1994). Recently (Weir et al. 2008), the species was identified at sea and from strandings off Angola, Ghana and Nigeria, confirming southern and eastern distribution limits for the species within the Atlantic Ocean. Dolar et al. (1997) reported sightings between the Philippines and Malaysia, which, however, were so infrequent that they did not allow estimation of population density.

Strandings in temperate areas (Britanny in France, Victoria in Australia, and Uruguay) may represent extralimital forays connected with temporary oceanographic anomalies such as the world-wide El Niño phenomenon in 1983-84, during which a mass stranding occurred in France (Perrin et al. 1994). Bones et al. (1998) reported a stranding on the coast of Scotland.

3. Population size

Estimates of abundance are only known for a few areas. They include 289,500 (CV = 0,34) Fraser's dolphins in the eastern tropical Pacific (Wade and Gerodette, 1993). In the Eastern Sulu Sea, Dolar et al. (2006) estimated a total abundance of 13,500 (CV = 0,26). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 10,226 (CV=1.11) Fraser's dolphins (Barlow 2006). This is currently the best available abundance estimate for this stock (Caretta et al. 2008). Current population size in the US Atlantic is unknown (Waring et al. 2007).

4. Biology and Behaviour

Habitat: This is typically a high-seas animal; it has not been observed close to shore in shallow water. E.g., off Angola and Nigeria all records of Fraser's dolphins (Weir et al. 2008) occurred in deep water (>1000 m), and in the Sulu Sea , Philippines, and off the coast of Mexico, sighting rates are also highest at these water depths. However, it may approach very close to shore (100 m) of some islands surrounded by deep water, e.g. Lesser Antilles, Indonesia and Philippines (Dolar, 2009).

In the eastern tropical Pacific, in equatorial-southern subtropical surface water and other waters typified by upwelling and generally more variable conditions, it forms part of a cetacean community that also includes *Physeter macrocephalus*, *Globicephala macrorhynchus*, *Delphinus delphis*, *Stenella coeruleoalba* and *Peponocephala electra*. Off South Africa, records are associated with the warm Agulhas Current that moves south in the summer (Perrin et al.1994 and refs. therein).

This community is more or less complementary in occurrence to another group of species, found primarily in so-called tropical surface water, where a stable, shallow mixed layer and thermocline ridging are dominant features, that includes *Stenella attenuata*, *Stenella longirostris* and *Steno bredanensis* (Perrin et al.1994 and refs. therein).

Behaviour: Analysis of prey suggests that Fraser's dolphin is a deep diver, hunting at depths of at least 250-500 m (Carwardine, 1995) or more. Myoglobin concentrations in muscle reach 7.1 g Mb / 100 g, similar to values recorded from deep-diving weddell seals (*Leptonychotes weddellii*) and bottlenose whales (*Hyperoodon ampullatus*; Dolar, 2009). In some areas, it is considered shy and difficult to approach; in others it is a bit more approachable. It does not bowride in the eastern tropical Pacific, but it does in most other areas. Running herds create a great deal of white water (Jefferson et al. 1993).

Reproduction: The life history of Fraser's dolphin was examined by Amano et al. (1996) based on 108 specimens from a school captured by the drive fishery in Japan. The sex ratio was approximately 1:1. The annual ovulation rate was 0.49. The estimated neonatal length (110 cm) predicts a gestation period of about 12,5 months and calving peaks in spring and probably also in fall. The calving interval was estimated to be about 2 years. Life history parameters are similar to those of the striped and pantropical spotted dolphins, but reproductive rate of this species may be lower than that of other pelagic delphinids, if the observed shorter longevity is real.

Schooling: Herds tend to be large, consisting of hundreds or even thousands of dolphins, often mixed with other species, such as melon-headed whales (*Peponocephala electra*), short-finned pilot whales (*Globicephala macrorhynchus*), Risso's dolphins (*Grampus griseus*), spinner dolphins (*Stenella longirostris*) pantropical spotted dolphins (*S. attenuata*), bottlenose dolphins (*Tursiops truncatus*) and sperm whales (*Physeter macrocephalus*; Perrin et al.1994 and refs. therein; Dolar, 2009). Weir et al. (2008) observed a pod of 150 probable Fraser's dolphins 130 km south of Nigeria and schools of 120 and 60 animals 170 km and 140 km respectively off the coast of Angola.

Food: In the eastern Pacific, Fraser's dolphin feeds on mesopelagic fish, shrimps and squids. It rarely associates there with bird flocks or tuna schools, which correlates well with the absence of surface-dwelling prey from its diet. In other regions, e.g. the southern Indian Ocean and the western Pacific, it may also feed far below the surface. The stomachs of animals stranded in Brittany contained only the remains of fish (4-24 cm long; four species) and the cephalopod *Sepia* sp., indicating benthic or mesopelagic feeding preferences (Perrin et al. 1994). Santos and Haimovici (1998) reported on the preference for loliginid squids in the diet of *L. hosei* stranded in southern Brazil.

Dolar et al. (2003) examined the stomach contents of Fraser dolphins in the Sulu Sea and found mesopelagic fishes, particularly myctophids (mainly *Ceratoscopelus warmingi*, *Diaphus* spp. and *Myctophum asperum*), to be equally important as mesopelagic cephalopods (*Abraliopsis, Onychoteuthis*, *Histioteuthis*, and *Chiroteuthis*), and crustaceans (*Notostomos elegans*, *Acanthephyra quadrispinosa*, and *Acanthephyra carinata*). Vertical distributions of the prey items summarized from published literature indicate that Fraser's dolphins cover a wide vertical foraging range, from near the surface to probably as deep as 600 m. Watkins et al. (1994) reported on co-operative hunting techniques observed in the Caribbean.

5. Migration

There are no detailed reports on migratory behaviour, although this pelagic species regularly approaches islands where it is captured for human consumption (see below).

6. Threats

Direct catch: Small numbers of Fraser's dolphins are taken in local subsistence harpoon fisheries in the Lesser Antilles, Indonesia, the Philippines and probably elsewhere in the Indopacific. A few are taken in drive fisheries in Taiwan and Japan (Perrin et al. 1994 and refs. therein). Dolar et al. (1994) investigated directed fisheries for marine mammals in central and southern Visayas, northern Mindanao and Palawan, Philippines, from archived reports and visits to sites where such fisheries are conducted. Some of the hunters take only dolphins for bait or human consumption, and the species taken include Fraser's dolphins. These are taken by hand harpoons or, increasingly, by togglehead harpoon shafts shot from modified, rubber-powered spear guns. Around 800 cetaceans are taken annually by hunters at the seven sites, mostly during the intermonsoon period of February-May. Dolphin meat is consumed or sold in local markets and some dolphin skulls are cleaned and sold as curios (Dolar et al. 1994).

Incidental catch: Some are killed incidentally in the tuna purse-seine fishery in the eastern tropical Pacific: 26 were estimated taken during the period 1971-75 (Gerrodette and Wade 1991). A few are also taken in gill nets in Sri Lanka, the Philippines, and likely in other tropical gillnet fisheries as well. Some are killed in anti-shark nets (Perrin et al. 1994 and refs. therein; Dolar et al. 1999; Cockroft, 1990).

More recently, Weir et al. (2008) monitoring bycatch at six artisanal Ghanaian fishing ports between 1998 and 2000 found four Fraser's dolphins comprising one adult, one juvenile and two calves at two ports. Drift gillnets were identified as the probable cause of mortality for at least two specimens.

Pollution: In an investigation on the global distribution and toxicological impacts of polychlorinated biphenyls (PCBs) on cetaceans, Minh et al. (2000), found residues to be the highest in Fraser's dolphins collected off Kii Peninsula, Japan, reflecting serious marine pollution by PCBs in industrialized Asian countries. Values exceeded the levels associated with immunosuppression in harbour seals.

7. Remarks

Range states (Hammond et al. 2008): American Samoa; Anguilla; Antigua and Barbuda; Argentina; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil; Brunei Darussalam; Cambodia; Cameroon; Cayman Islands; China; Colombia; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Cuba; Djibouti; Dominica; Dominican Republic; Ecuador; El Salvador; Equatorial Guinea; Fiji; French Guiana; French Polynesia; Gabon; Gambia; Ghana; Grenada; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Jamaica; Japan; Kenya; Kiribati; Liberia; Madagascar; Malaysia; Maldives; Marshall Islands; Mauritania; Mexico; Micronesia, Federated States of; Morocco; Mozambique; Myanmar; Namibia; Nauru; Netherlands Antilles; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Puerto Rico; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Suriname; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; United States; United States Minor Outlying Islands; Uruguay; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen.

On 16 December 1992 the Department of Agriculture of the Philippines issued Fisheries Administrative Order No. 185, 'banning the taking or catching, selling, purchasing, possessing, transporting and exporting of dolphins'. The order did not stop dolphin and whale hunting but seems to have decreased the sale of dolphin meat openly in the market. Investigations are encouraged to ensure that these artisanal whale fisheries operate within sustainable limits and do not export products illegally (Dolar et al. 1994). This recommendation can also be extended to other populations of Fraser's dolphins.

For South American stocks, see further recommendations in Hucke-Gaete (2000) in Appendix 1; for Southeast Asian stocks see general recommendations in Perrin et al. (1996) in Appendix 2.

The species is poorly known with respect to its distribution, migratory behaviour and abundance and by-catch rates are poorly documented.

L. hosei is listed as "Least Concern" by the IUCN (Hammond et al. 2008). The southeast Asian populations are listed in Appendix II of CMS. The species is listed in Appendix II of CITES.

8. Sources (see page 256)

3.21 Lagenorhynchus acutus (Gray, 1828)

English: Atlantic white-sided dolphin
German: Weißseitendelphin
Spanish: Delfín de costados blancos
French: Dauphin à flancs blancs

Family Delphinidae

Lagenorhynchus acutus / Atlantic white-sided dolphin (© Wurtz-Artescienza)

1. Description

Atlantic white-sided dolphins are robust and , with a maximum girth of up to 60% of total length. The tail stock is laterally compressed into vertical keels and the beak is short (Jefferson et al. 2008). These dolphins are impressively patterned and more colourful than most dolphins. Below the black or very dark grey back and dorsal fin a narrow, bright white patch on the side extends back from below the dorsal fin, overlaying a yellow blaze above a thin dark stripe running towards the flukes. The belly and lower jaw are white, and the sides of the body are light grey. A black eye ring extends in a thin line to the upper jaw and a very thin stripe extends backward from the eye ring to the external ear. A faint grey stripe may connect the leading edge of the flipper with the rear margin of the lower jaw. Male Atlantic white sided dolphins reach 270 cm and 230 kg, whereas adult females are about 20 cm shorter and 50 kg lighter (Cipriano, 2002).

2. Distribution

L. acutus is a deepwater species which ranges across the North Atlantic, from Cape Cod in the western North Atlantic to southern Greenland, across the Barents Sea to Svalbard and from there south to the North and Irish Seas as far south as Brittany (France) (Reeves et al. 1999; Cipriano, 2009). The species rarely enters the Baltic sea (Kinze et al. 1997 and pers. obs.). It has been seen as far south as Strait of Gibraltar (Hammond et al. 2008).

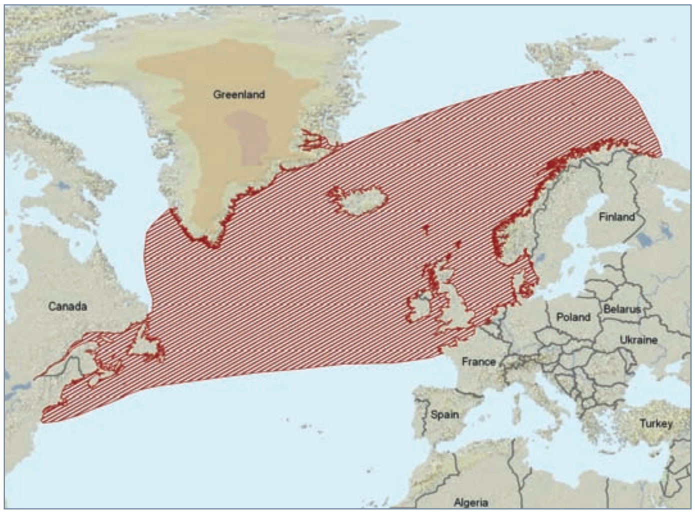
Mikkelsen and Lund (1994) found no evidence of separate populations based on a study of metrical and non-metrical skull characters of 123 Atlantic white-sided dolphins from much of the species' range.

3. Population size

Evans (1987, in Reeves et al. 1999) suggested a total population throughout the North Atlantic of tens of thousands to low hundreds of thousands, which is supported by Kaschner (2004). Compton et al. (2007) found that *L. acutus* was the second most commonly sighted species during a crossing of the North Atlantic covering waters between the UK, Iceland, Greenland and Canada.

The best available current abundance estimate for white-sided dolphins in the US western North Atlantic is 63,368 (CV=0.27), an average of surveys conducted in August of 2002 and 2006, with no apparent trends compared to earlier estimates. An abundance estimate of 109,141 (CV=0.30) white-sided dolphins was obtained from an aerial survey conducted in July and August 2002 which covered 7,465 km of trackline over waters from the 1,000-m depth contour on the southern edge of Georges Bank to Maine (Waring et al. 2009). There are at least 12,000 in the Gulf of St. Lawrence (Kingsley and Reeves, 1998).

In the Eastern North Atlantic, Weir et al. (2001) carried out surveys to the north and west of Scotland (UK) and found that Atlantic white-sided dolphins were the most abundant species in the region with a total of 6,317 animals recorded. However,



Distribution of Lagenorhynchus acutus (Hammond et al. 2008; © IUCN Red List): cool, temperate and subarctic waters of the northern North Atlantic.

based on data obtained during a shipboard survey conducted in 1998 within an area to the west of Scotland commonly known as the Atlantic Frontier, MacLeod (2004) estimated an uncorrected Atlantic white-sided dolphin abundance of 27,194 (CV = 0.29). After correction for g(0), the abundance was re-estimated as 21,371 (CV = 0.54) to the west of the Outer Hebrides and 74,626 (CV = 0.72) in the Faroe Shetland Channel.

The first SCANS (Small Cetacean Abundance in the North Sea) survey, conducted in summer 1994, yielded a *Lagenorhynchus* spp. abudance of 11,760 (95% CI 5,900-18,500; Hammond et al. 2002), while SCANS II (2005) yielded an abundance of only 1,860 (95% CI 611 - 5,661) for pooled common, striped, white-sided and white-beaked dolphins (Burt et al. 2006).

4. Biology and Behaviour

Habitat: *L acutus* seems to prefer areas with high seabed relief along the edge of the continental shelf (Carwardine, 1995). It is more pelagic than the white-beaked dolphin, occurring mainly along edges or seaward of continental shelves, over depths of 100-300 m. However, it sometimes does come onto the continental shelf and may enter fjords and inlets with depths of less than 50 m (Evans, 2009).

Along the Mid-Atlantic Ridge from Iceland to the Azores, white-sided dolphins tend to aggregate in areas of steep slopes, but actual bottom depth appears to be less important. Based on spatial correlations between dolphin occurrence and candidate prey organisms recorded acoustically and by midwater trawling, mesopelagic fishes and squids were assumed to be important prey items, with *Benthosema glaciale* probably being their most important prey (Doksaeter et al. 2008). Waring et al.(2008) sighted white-sided dolphins mainly in the cold (5-16°C) and less saline (34.8-36.7 PSU) water masses along the Reykjanes Ridge.

From the Sea Watch database, 75% of sightings in NW European seas were recorded at Sea Surface Temperatures of 7-13°C (total range including outliers 6-17.5°C) (Anderwald, 2002). In eastern United States, the species occupies waters of 1-13 °C in spring and autumn, but mostly occurs in waters of c. 5-11° C (Selzer and Payne, 1988).

Behaviour: *L. acutus* is an acrobatic and fast swimmer and frequently breaches (though not as often as white-beaked or common dolphins) and lobtails. It surfaces to breathe every 10 to 15 seconds, either leaping clear of the water or barely breaking the surface and creating a wave over its head. *L. acutus* is wary of ships in some areas (Palka and Hammond, 2001) but will swim alongside slower vessels and may bow-ride in front of faster ones. Sometimes it can be observed riding the bow-waves of large whales. Individual and mass strandings are relatively common (Carwardine, 1995; Jefferson et al. 1993). The species is presumably not a deep diver, as maximum recorded dive times were 4 min and most dive times were shorter than 1 min (Cipriano, 2009).

Schooling: Herds of up to several hundred are seen, and there is some age and sex segregation among these. Older immature individuals are not generally found in reproductive herds of mature females and young (Jefferson et al. 1993; Reeves et al. 1999). Gaskin (1992) hypothesized that Atlantic white-sided dolphins split into small groups for feeding and that such small groups merge into large aggregations "while migrating". Groups often associate and probably feed with fin whales (*Balaenoptera physalus*), humpback whales (*Megaptera novaeangliae*) and long-finned pilot whales (*Globicephala melas*). Mixed herds of Atlantic white-sided dolphins and white-beaked dolphins have been observed in the North Sea (Reeves et al. 1999, and refs. therein).

Reproduction: Females reach sexual maturity between 6 and12 years of age, males 7-11 years. Maximum recorded ages were 27 and 22 years, respectively (Cipriano, 2009). Parturition in the western North Atlantic usually takes place between May and August, with a peak in June and July, following an estimated 11-month gestation period. The timing of parturition is apparently similar in the eastern North Atlantic, where sightings have been interpreted to suggest "breeding areas" offshore in the North Sea and in the Atlantic to the north and west (Reeves et al. 1999 and refs. therein).

Food: Atlantic white-sided dolphins feed on small schooling fish and squid. These include herring (*Clupea harengus*), small mackerel (*Scomber scombrus*), silvery pout (*Gadiculus argenteus*), blue whiting (*Micromesistius poutassou*), American sand lance (*Ammodytes americanus*), smelt (*Osmerus mordax*), silver hake (*Merluccius bilinearis*) and short-finned squid (*Illex iilecebrosus*) (Jefferson et al. 1993; for details see Reeves et al. 1999). In the North Sea, oceanic cephalopods seem to be their main diet (Das et al. 2001). Different prey species may predominate at different times of year, representing seasonal movements of prey, or in different areas, indicating prey and habitat variability in the environment (Cipriano, 2002). For instance off the coast of New England, pelagic Atlantic herring (*Clupea harengus*) was the most important prey in summer but was rare in winter. (Craddock et al. 2009). Atlantic white-sided dolphins apparently co-operate in their efforts to contain and attack schools of fish, a behaviour which is similar to that described for dusky dolphins off Argentina (Reeves et al. 1999 and refs. therein).

5. Migration

There may be inshore-offshore movements with the seasons in some areas (Carwardine, 1995). Selzer and Payne (1988) suggested that *L. acutus* moves south along the continental shelf edge in winter and spring, in association with the relatively cold, less saline Gulf of Maine water flowing southwards through Northeast Channel during these seasons. Seasonal variation in sea-surface temperature and salinity and local nutrient upwelling in areas of high sea floor relief may affect preferred prey abundances, which in turn may affect dolphin distribution. The occurrence of Atlantic white-sided dolphins off Newfoundland seems also to be seasonal, mainly from July to October (Reeves et al. 1999). Data from one satellite-monitored dolphin indicated an ability to travel long distances at a speed of at least 14 km/hr (Mate et al. 1994).

Weinrich et al (2001) reported that off New England they sighted 1,231 groups of Atlantic white-sided dolphins between April and October from 1984 through 1997, primarily on Stellwagen Bank and Jeffreys Ledge (two shallow glacial deposits along the coasts of Massachusetts, New Hampshire, and Maine). Mean group size was 52 and was significantly larger from August through October (71.9) than April through June (35.0).

Couperus (1997) investigated the occurrence of incidental cetacean catches in the Dutch pelagic trawl fishery. These are largely restricted to late-winter early-spring in an area along the continental slope southwest of Ireland. Available evidence indicates that annual variations are large. It seems that the Atlantic white-sided dolphin is normally a more oceanic species but will actively search for mackerel (*Scomber scombrus*) closer to shore in early spring. Fresh mackerel remains were found in the stomachs of nearly all white-sided dolphins taken as by-catch, whereas deep-water fish otoliths suggested that the dolphins had a completely different diet before moving to the southwest of Ireland.

6. Threats

Direct catch: Some hunting for this species occurred in the past, especially in Norway. Some are still taken in Greenland, the Faeroe Islands, and eastern Canada (Jefferson et al. 1993; Reeves et al. 1999 and refs. therein). There is still a substantial hunt in the Faroe Islands today, with 310 animals landed in 2005 and 617 in 2006. Furthermore, the drive hunt is far from perfect, with animals "struck and lost", e.g. in Fuglafjord (29 animals in 2006) (NAMMCO, 2006).

Incidental catch: Incidental mortality in fishing gear has been documented off Canada, the United States, the United Kingdom and Ireland. Total annual estimated average fishery-related mortality or serious injury to the western North Atlantic stock during 2002-2006 was 352 (CV=0.10). These occurred in northeast sink gillnet (34 mortalities p.a.), northeast bottom trawl (193), northeast midwater trawl (19), mid-Atlantic midwater trawl (77), and mid-Atlantic bottom trawl (29). Numbers for Canadian fisheries are unknown (Waring et al. 2009).

Starting in 1990, a deep water trawl fishery for Greenland halibut (*Reinhardtius hippoglossoides*) in the NAFO Regulatory Area was developed by Spain. 42 cetaceans were caught, which included Atlantic white-sided dolphins. It seems that the Greenland halibut fishery has a relatively low level of incidental marine mammal mortality (Lens, 2001).

Morizur et al. (1999) investigated marine mammal by-catch in 11 pelagic trawl fisheries operated by four different countries in the Northeast Atlantic. One of the main marine mammal species identified in by-catches was *L. acutus*. Mean dolphin catch rate for all fisheries combined was 0.048 per tow (one dolphin per 20.7 tows), or 0.0185 per hour of towing (one dolphin per 98h of towing). All dolphin by-catches occurred during the night. White-sided dolphins were observed feeding around the net during towing, and this behavior may make them more vulnerable to capture. Substantial numbers have also been by-caught in pelagic trawl fisheries for horse mackerel and mackerel southwest of Ireland (Reeves et al. 1999 and refs. therein).

Pollution: A juvenile dolphin from the north-west coast of Ireland was found to have a relatively high concentration of mercury in its liver (44 ng per g wet weight). An adult male from Nova Scotia had moderately high levels of organochlorines in its blubber (Reeves et al. 1999 and refs. therein).

Hexabromocyclododecane (HBCD), a brominated flame retardant used primarily in expanded polystyrene foams and other styrene resins, was found in blubber and liver samples of Atlantic white-sided dolphins stranded on the eastern coast of United States between 1993 and 2004. However, concentrations were lower than in cetaceans from Western Europe (Kucklick et al. 2008), which is not really reassuring.

7. Remarks

Range states (Hammond et al. 2008): Belgium; Canada; Denmark; Faroe Islands; France; Greenland; Iceland; Ireland; Netherlands; Norway; Russian Federation; Sweden; United Kingdom; United States of America.

The North and Baltic Sea populations are listed in Appendix II of CMS, but inclusion of the NW Atlantic stock in CMS Appendix II is recommended on the basis of observed migrational behaviour: Atlantic white-sided dolphins seem to be migratory in North America, where range states are the USA, Canada and France (St. Pierre et Miquelon).

IUCN Status: "Least Concern" (Hammond et al. 2008).

The species is listed in appendix II of CITES.

8. Sources (see page 256)

3.22 Lagenorhynchus albirostris (Gray, 1846)

English: White-beaked dolphin
German: Weißschnauzendelphin
Spanish: Delfín de pico blanco
French: Dauphin à bec blanc

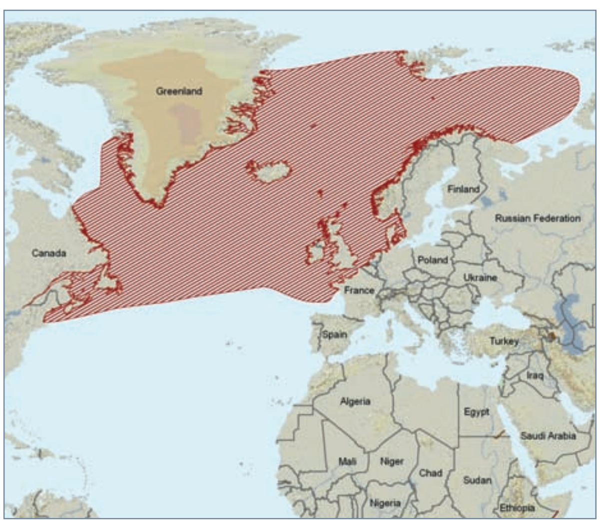
Family Delphinidae

Lagenorhynchus albirostris / White-beaked dolphin (© Wurtz-Artescienza)

1. Description

The white-beaked dolphin has a robust appearance. The dorsal fin is in the middle of the back, erect and strongly curved. Adults grow between to 2.4 and 2.1 m long and may weigh between 180 and 350 kg. Males usually grow larger than females. The coloration is typically black on the back, with a white saddle behind the dorsal fin and whitish bands on the flanks that vary in intensity from a shining white to ashy grey. Belly and beak are normally white, but the beak may be ashy grey or even darker; it may appear that a white beak is missing. The beak is only 5-8 cm long (Kinze, 2009).

Populations in the eastern and western North Atlantic are separable on the basis of skull characters (Mikkelsen and Lund, 1994) as well as on the basis of the control region of the mtDNA and microsatellites (Banguera-Hinestroza et al. 2010). Based on these and other data, four distinct management units have recently been suggested: western North Atlantic, Iceland, Northern Norway, British Isles and North Sea (Evans and Teilmann, 2009).



Distribution of Lagenorhynchus albirostris: cool temperate and subarctic waters of the North Atlantic (Hammond et al. 2008; © IUCN Red List).

2. Distribution

This is the most northerly member of the genus Lagenorhynchus and has a wide distribution. Animals in the northernmost part of the range occur right up to the edge of the pack-ice (Carwardine, 1995). The species is found in the immediate offshore waters of the North Atlantic, off the American coast from Cape Chidley, Labrador, to Cape Cod, Massachusetts; the Southwest coast of Greenland north to Godthab; off the European coast from Nordkapp in Norway south through the North Sea to the British Isles, Belgium, the Netherlands and Denmark. *L. albirostris* is vagrant to France, the north coast of Spain, the Strait of Gibraltar, and the Mediterranean Sea (Rice, 1998). It is only seen occasionally in inner Danish waters (Reeves et al. 1999) and the Baltic proper (Kinze, 2002).

Kinze (2009) identified four principal centers of high densities: the Labrador Shelf including south-western Greenland, Icelandic waters, the small stretch along the Norwegian coast extending north into the white Sea, and the waters around Scotland including the northern Irish Sea and the North Sea.

The main concentrations around the British Isles are off northern Scotland (including the Outer and Inner Hebrides, Orkney and Shetland islands) and along portions of the Atlantic coast of Ireland. It is common in the northern and central North Sea and in the Kattegat and Skagerrak between Jutland (Denmark), Norway and Sweden. It is the most common delphinid stranded and sighted in Dutch waters and is common around the Faroe Islands. (Reeves et al. 1999; Kinze et al. 1997).

3. Population size

In portions of the north-western Atlantic published estimates indicate a population of at least several thousand white-beaked dolphins shoreward of the 200 m contour between St. Anthony, Newfoundland, and Nain, Labrador (Alling and Whitehead, 1987) and in coastal and offshore waters east of Newfoundland

and south-east of Labrador. In the Gulf of St. Lawrence for instance, 2,500 white-beaked dolphins were counted solely (in 1995 and 1996) in the Strait of Belle Isle and the extreme north-eastern Gulf (Kingsley and Reeves, 1998).

It seems that at least a few thousand white-beaked dolphins inhabit Icelandic waters and up to 100,000 the northeastern Atlantic including the Barents Sea, the eastern part of the Norwegian Sea and the North Sea north of 56°N. The total number of white-beaked dolphins throughout the North Atlantic thus may be in the high tens or low hundreds of thousands (Reeves et al. 1999 and refs. therein).

The most recent total abundance estimate for European Atlantic continental shelf waters was 22,665 (CV = 0.42) in 2005 (Hammond and Macleod 2006). The highest densities occurred in the waters of western Scotland. In the North Sea and adjacent waters, the population reached 10,562 (CV=0.29) with no statistical difference from previous estimates of 7,856 (CV = 0.30) obtained in the 1994 SCANS survey (Hammond et al. 2002).

However, when evaluating genetic variation in the species using a fragment of the control region of the mtDNA, Banguera-Hinestroza et al. (2010) found that it was extremely low (p =0.0056 ± 0.0004), comparable only to values reported in cetacean populations with historically small population sizes or which had been strongly affected by human activities. Among the populations that were analysed, the highest variability was found in the population from the western North Atlantic (Canada) and the lowest in eastern North Atlantic populations.

4. Biology and Behaviour

Habitat: This species is found mostly in continental shelf waters of depths between 50 m and 100 m and rarely out to the 200-m isobath (Northridge et al. 1997). Distribution has been linked to sea-surface temperature, local primary productivity and prey abundance (Weir et al. 2007). Along the Aberdeenshire (UK) coast, most sightings were over depths of 20-30 m (Canning et al. 2005).

Behaviour: *L. albirostris* may bow-ride, especially in front of large, fast-moving vessels, but usually it loses interest quickly. Sometimes they are acrobatic (especially when feeding) and when breaching they normally falls onto the side or back. They are typically fast, powerful swimmers (Carwardine, 1995).

Reproduction: Females reach sexual maturity at 8.7 years. The mating season is in July and August, and the gestation period lasts about 11 months. Maximum recorded age was 37 years (Kinze, 2009).

Food: In all areas where stomach contents have been examined, clupeids (e.g. herring), gadids, e.g. Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), poor-cod (*Trisopterus minutus*, *T. luscus*), whiting (*Merlangius merlangus*), capelin (*Mallotus villosus*) and hake (*Merluccius merluccius*) have been found to be the principal prey of white-beaked dolphins. Others consumed include Scomber, Pleuronectes, Limanda, Eleginus and Hyperoplus as well as squid, octopus and benthic crustaceans (Reeves et al. 1999 and refs. therein).

Schooling: Along the Aberdeenshire (UK) coast, average group size was 4.6, rising to 5.9 when calves were present (Caning et al. 2005). Generally, groups of less than 50 are most common, but herds of many hundreds have been seen. While feeding they sometimes associate with large whales such as fin and humpback whales but also with herds of pilot whales, sei whales, killer whales, bottlenose dolphins, white-sided dolphins and common dolphins (Jefferson et al. 1993; Reeves et al. 1999 and refs. therein). In contrast to the Atlantic white-sided dolphin, which sometimes mass strands, the white-beaked dolphin usually strands singly or in small groups. Co-operative feeding has been described. Dolphins herd the fish into a tight cluster and trap them against the surface (Reeves et al. 1999 and refs. therein).

5. Migration

Sightings of white-beaked dolphins are common around Newfoundland during the winter and spring, and fishermen along the Labrador coast claim that they approach the coast in late June and remain until October (Ailing and Whitehead, 1987). Densities on the Southeast Shoal of the Grand Banks decreased from mid June to mid July (Reeves et al. 1999 and refs. therein).

Northridge et al. (1997) concluded that white-beaked dolphins around the British Isles have a fairly consistent distribution throughout the year, although during spring they appear to aggregate around two areas of concentration to the north of Scotland and off the Yorkshire coast. At a coastal North Sea study area in Aberdeenshire, Scotland, a peak in occurrence was found during August (Weir et al. 2007).

Migrations over longer distances are poorly known. However, photo-ID pilot studies conducted in the Skagerrak and Northern North Sea established matches between these areas and the Scottish coast (Kinze, 2009).

6. Threats

Direct catch: There is a history of hunting for white-beaked dolphins in Norway, the Faeroe Islands, Greenland, and Labrador. During the early 1980s an estimated 366 white-beaked dolphins were taken annually by the residents of 12 Labrador harbours (Alling and Whitehead, 1987). Hunting in some areas continued in recent years e.g. in southwest Greenland (Kinze, 2002). There is no evidence of any major threat to this species in zones under Canadian jurisdiction. However, careful monitoring of hunting activities in Labrador is recommended and fisheries by-catches should be carefully monitored (Lien et al. 2001).

Incidental catch: White-beaked dolphins have been taken in fishing gear in many areas, and at least the Newfoundland/Labrador by-catch is substantially under-reported in published accounts (Reeves et al. 1999). However, incidental catches are not thought to be high enough to represent a threat to this species (Jefferson et al. 1993). De Haan et al. (1998) outlined possible mitigation measures for the pelagic trawl fishery.

Pollution: Like other North Atlantic marine mammals, white-beaked dolphins are contaminated by organochlorines, other anthropogenic compounds and heavy metals (Reeves et al. 1999 and refs. therein). Siebert et al. (1999) reported concentrations of total mercury and methylmercury in muscle, kidney and liver samples of three white-beaked dolphins, stranded or by-caught from the German waters of the North and Baltic Seas.

Noise pollution: Nachtigall et al. (2008) showed that high frequency hearing in white-beaked dolphins is the most sensitive of any known dolphin and as sensitive as in the harbor porpoise. Stone and Tasker (2006) demonstrated that cetaceans can be disturbed by airguns used in seismic exploration. Small odontocetes showed the strongest lateral spatial avoidance (extending at least as far as the limit of visual observation) in response to active airguns. Responses to active airguns were greater during those seismic surveys with large volume airgun arrays than those with smaller volumes of airguns.

7. Remarks

Range states (Hammond et al. 2008): Belgium; Canada; Denmark; Faroe Islands; France; Germany; Greenland; Iceland; Ireland; Netherlands; Norway; Russian Federation; Sweden; United Kingdom; United States of Amrica.

The North and Baltic Sea populations are listed in Appendix II of CMS. However, white-beaked dolphin abundance seems also to vary throughout the year off north-eastern North America, suggesting possible seasonal migrations. Therefore this stock (Range states US and Canada) should also be included in CMS App. II.

IUCN Status: "Least Concern" (Hammond et al. 2008). The species is listed in Appendix II of CITES.

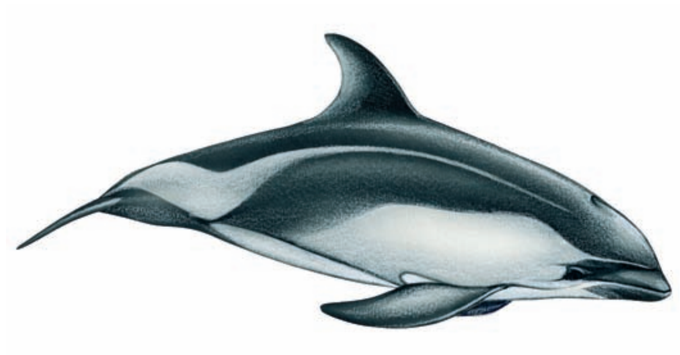
According to JNCC (2007) the species is expected to survive and prosper. However, sudies of genetic variability of white-beaked dolphins show that its populations are highly vulnerable; the extremely low nucleotide diversity is probably due to a reduction in population sizes in the past, combined with the restricted habitat of this species to coastal areas highly affected by human activities (for example pollution and/or fisheries). It should be a priority to study and protect populations of *L. albirostris* on both sides of the North Atlantic (Evans and Teilmann, 2009).

8. Sources (see page 257)

3.23 Lagenorhynchus australis (Peale, 1848)

English: Peale's dolphin
German: Peale-Delphin
Spanish: Delfín austral
French: Dauphin de Peale

Family Delphinidae



Lagenorhynchus australis / Peale's dolphin (© Wurtz-Artescienza)

1. Description

L. australis is a stocky dolphin with the barest indication of a beak. Length reaches 210 cm in females and 218 cm in males; the heaviest animal weighed 115 kg. Colour is dark grey or black on the back, with two areas of lighter shading on the flanks. A curved white-to-grey flank patch angles forward from the vent, narrowing to a single line ending below or in front of the dorsal fin. The posterior curves of the flank patch almost meet above the tail stock. The larger thoracic patch is light to medium grey, outlined with a narrow dark line on its lower surface. A black double eye-ring extends forward onto the inconspicuous snout. Flippers of older animals may have a series of small knobs on the leading edge. The ventral surface behind the throat patch is white, with a few dark streaks in the genital area. Younger animals are lighter grey than adults. Peale's dolphins can be confused with dusky dolphins (*L. obsucurus*) through much of their range (Goodall, 2002).

2. Distribution

Peale's dolphin mainly ranges in coastal waters of southern South America from Valdivia, Chile (38°S) and Golfo San José, Argentina (44°S), south to Beagle Canal and the Falkland Islands / Islas Malvinas (Goodall et al. 1997a; Goodall, 2009). *L. australis* may occur farther north on both the Atlantic and Pacific coasts of South America; it has been recorded as far north as Provincia Buenos Aires, Argentina (33°S), and Concón, Chile (38°S; Brownell et al. 1999; Goodall et al. 1997a). Records from southern Brazilian waters (41-32°S) have been reported by Pinedo et al. (2002; not shown on the map). A group of dolphins closely observed and photographed near Palmerston Atoll (18°S, 163°W) in the Cook Islands also appear to be of this species (Brownell et al. 1999). The southernmost sightings were 57°S and at 59°10'S in the Drake Passage (Goodall et al. 1997b).

3. Population size

No substantial information is available about the abundance of *L. australis*. It is most common south of Puerto Montt, Chile, and particularly common around the Falkland Islands and Tierra del Fuego (especially the Straits of Magellan and Beagle Channel). It is one of the most frequently sighted cetacean species in the Straits of Magellan. The distribution may be continuous between Argentina and the Falklands (Carwardine, 1995; Brownell et al. 1999; Goodall et al. 1997a).

4. Biology and Behaviour

Habitat: Peale's dolphins are often seen near the coast and so are easily observed. They occupy two major habitats: open, wave-washed coasts over shallow continental shelves to the north; and deep, protected bays and channels to the south and west. In the channels, this is an 'entrance animal', associated with the rocky coasts and riptides at the entrance to fjords, where the highest water temperature recorded was 14.7°C.

Distribution of Lagenorhynchus australis: cool, coastal waters of southern South America including the Falkland / Malvinas Islands (Hammond et al. 2008; © IUCN Red List).

Throughout the northern part of its range, they inhabit the waters of the wide continental shelf off Argentina and the narrower shelf off Chile. Although Peale's dolphins have been observed in waters at least 300 m deep, they appear to prefer shallower coastal waters (Brownell et al. 1999 and refs. therein).

Peale's dolphins show a high degree of association with kelp beds (*Macrocystis pyrifera*), especially in the channel regions. They swim and feed within, inshore and offshore of the kelp forests, using natural channels for movement (Goodall et al. 1997b; de Haro and Iniguez, 1997). Because kelp forests appear to be a fundamental habitat for them in coastal ecosystems, kelp protection might be crucial for the conservation of Peale's dolphin populations (Viddi and Lescrauwaet, 2005).

Behaviour: Peale's dolphin is known to ride bow-waves of large vessels and may swim alongside smaller ones. It sometimes swims slowly but can be energetic and acrobatic, frequently leaping high into the air and falling back into the water on its side with a splash. It has been observed playing in surf in the company of Risso's Dolphins (Carwardine, 1995).

Reproduction: The young are born from spring to autumn, October to April (Goodall et al. 1997a).

Schooling: Peale's dolphins have been seen in small groups of 2-30 and may associate with Risso's and Commerson's dolphins (Jefferson et al. 1993; Brownell et al. 1999 and refs. therein). Over much of its range Peale's dolphin is sympatric with the dusky dolphin, *L. obscurus*, although their usages of habitats are slightly different (Goodall et al. 1997b; de Haro and Iniguez, 1997).

Food: The stomachs of three *L. australis* incidentally killed in fishing gear off southern Patagonia, Argentina contained molluscs, crustaceans and fish. The most frequently encountered prey were the kingklip fish (*Genypterus blacodes*), the shrimp *Pleoticus muelleri* and the squid *Loligo gahi* (Brownell et al. 1999). Schiavini et al. (1997) studied the stomach contents of nine specimens recovered from Tierra del Fuego which included eight species of fish, three cephalopods, one bivalve mollusc, two crustaceans, and one species of salp. Of these, the most important prey species were bottom fish, namely hagfish (*Myxine australis*), southern cod (*Salibota australis*) and Patagonian grenadier (*Macruronus magellanicus*), as well as octopus (*Enteroctopus megabocyatizus*) and squid (*Loligo gahi*). The feeding ecology of *L. australis* appears to be associated with demersal and bottom species taken in or near kelp beds. Dive times range from 3-157 s, with an average of 28 s (Goodall 2002 and refs. therein).

5. Migration

Evidence from photoidentification studies suggests that some dolphins spend the entire year in limited areas close to shore, in the Strait of Magellan (Jefferson et al. 1993; Carwardine, 1995). Although there is no published information on the movements of this species (Brownell et al. 1999), some of the population appears to move offshore in winter (Goodall et al. 1997b).

On the west coast of the Strait of Magellan, Chile, land-based surveys indicate that higher total animal counts are registered during summer months (December to February) compared to winter periods. Land-based surveys showed an increase in abundance in the southern compared to the central portion of the area during spring and a more homogeneous distribution during the rest of the year. Although total abundance increases in summer compared to the winter period, both seasons show less marked preference for a specific sector. Concentration in the southern part of the study area during spring appears to be related to the calving season that can be observed as early as October. Individual identification shows at least part of the population to be residential throughout the year, while another observation of one individual documents a range of at least 300 km (Lescrauwaet, 1997).

6. Threats

Direct catch: Unknown numbers of Peale's Dolphins became accidentally entangled in fishing nets and were hunted with harpoons in the Strait of Magellan and around Tierra del Fuego; the meat was used as bait in crab traps (Carwardine, 1995; Jefferson et al. 1993). Although direct hunting of dolphins has been prohibited in Chile since 1977, crab traps for centolla (southern king crab), *Lithodes antarctica* and centollon (false king crab), *Paralomis granulosa*, may still be set with dolphin meat (Brownell et al. 1999). There are no recent estimates on dolphin mortality in this region (Lescrauwaet, pers. comm.) but it is thought to be lower than in the past due to overfishing of the target species (Goodall, 2009). Dolphin takes in the Argentinian sector were stopped after the early 1980's (Goodall, 2002).

Incidental catch: Peale's dolphins are incidentally entangled and drowned in nets (Jefferson et al. 1993). There are reports from Queule and Mehuin (Chile), southern Patagonia, north-eastern Tierra del Fuego and southern Santa Cruz (Argentina) (Brownell at al. 1999, Reyes, 1991 and refs. therein). In the northern part of their Pacific range, Peale's dolphins seem to be rarely taken in gillnets (Goodall 2002), but there are reports of entanglements in anti-pinniped nets associated with salmon aquacultures around Isla Chiloé (Goodall, 2009).

Pollution: Some residues of organochlorine contaminants were found in a single specimen of *L.australis* from Argentine waters. Dieldrin (0.620 ppm), Heptachlor (0.050ppm), HCB (0.094 ppm), HCH (0.067 ppm) and DDT (0.405 ppm) were present in the blubber of this specimen (Brownell et al. 1999 and refs. therein).

7. Remarks

Range states (Hammond et al. 2008): Argentina; Chile; Falkland Islands (Malvinas)

Included in Appendix II of CMS: movements of dolphins through the Beagle Channel and through the Strait of Magellan are likely to involve the national boundaries of Argentina and Chile.

IUCN Status: "Data Deficient" (Hammond et al. 2008). The species is on Appendix II of CITES.

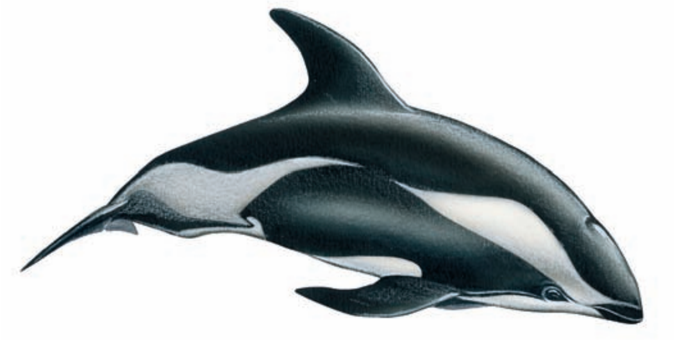
L. australis is poorly known with respect to abundance, migratory behaviour and mortality in anthropogenic operations. Offshore fishing represents a potential danger that should be monitored (Goodall et al. 1997a). Although the potential impact of crab-fisheries must have diminished considerably (there is more control and better availability of legal bait like fish and slaughterhouse wastes), there is still a-not analysed nor estimated-indication that small amounts of wildlife are still being taken for these fisheries. New research in the field is needed to update these data (Lescrauwaet, pers. comm.; recommendations in Hucke-Gaete (2000); Appendix 1).

8. Sources (see page 258)

3.24 Lagenorhynchus cruciger (Quoy & Gaimard, 1824)

English: Hourglass dolphin
German: Stundenglas-Delphin
Spanish: Delfín cruzado
French: Dauphin sablier

Family Delphinidae



Lagenorhynchus cruciger / Hourglass dolphin (© Wurtz-Artescienza)

1. Description

Hourglass dolphins are rather stocky, with a large, re-curved dorsal fin. The tail stock is often keeled. Body length ranges from 142 to187 cm, and males and females are of equal size. Body mass reaches 90 - 100 kg (Goodall, 2009). Colouration is mainly black or dark with two elongated white areas covering the flanks, in some animals joined with a fine white line, giving it its common name. The forward patch extends onto the face above the eye (Goodall, 2009).

2. Distribution

The hourglass dolphin is the only small delphinid that is commonly observed south of the Antarctic Convergence. It is probably circumpolar in pelagic waters of the Subantarctic and Antarctic zones; south of the Subtropical Convergence most records fall between 45°S and 65°S (Rice, 1998).

In the South Atlantic, there are no sightings southeast of the Antarctic Peninsula: The largest concentration of sightings has been in the Drake Passage, an area with considerable ship traffic in summer. Most sightings of these dolphins were in an area north and south of the Antarctic Convergence between South America and Macquarie Island (Goodall, 1997). Single records as far north as Valparaiso, off the coast of Chile at 33° 40'S, 74° 55'W and at 36° in the South Atlantic seem to be exceptional (Carwardine, 1995; Goodall, 2009). The southernmost sighting is 67°38'S, 179° 57 'E in the South Pacific (Brownell and Donahue, 1999 and refs. therein; Goodall, 1997).

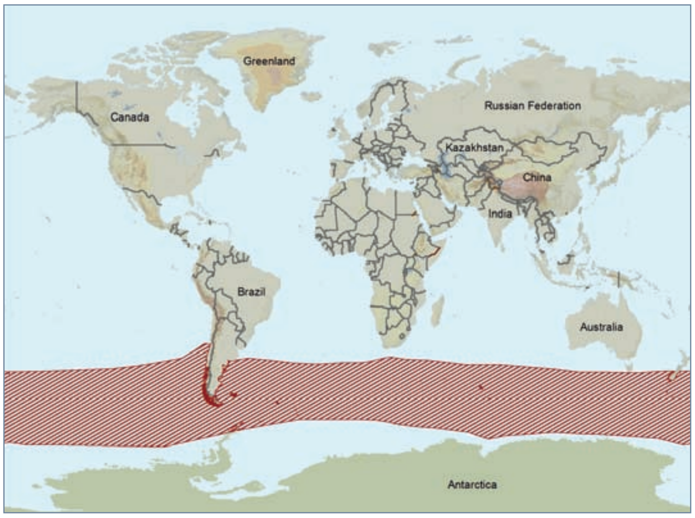
3. Population size

Kasamatsu and Joyce (1995) combined data gathered in sighting surveys conducted from 1976/77 to 1987/88 to produce an abundance estimate of 144,300 for waters south of the Antarctic Convergence. This still seems to be the best population estimate to date (Goodall, 2009; Hammond et al. 2008).

4. Biology and Behaviour

Habitat: Normally seen far out to sea, *L. cruciger* has also been observed in fairly shallow water near the Antarctic Peninsula and off southern South America. It occurs within 160 km of the ice edge in some areas in the southern part of its range (Carwardine, 1995; Jefferson et al. 1993). The species seems to prefer surface water temperatures between 0.6°-13°C (mean 4.8°C; Goodall, 1997) or even down to -0.3°C (Goodall 2009). Although oceanic, sightings are often near islands and banks. High observer effort, i.e. in the Drake Passage, reflected in high sighting rates (Goodall 2009).

Behaviour: This is a boisterous swimmer capable of speeds exceeding 12 knots. It rides bow-waves and stern-waves of fast boats and ships, swimming with long, low, leaps. From a distance, this undulating motion makes it look like a swimming penguin. It will also swim alongside slow vessels. When swimming fast, hourglass dolphins may travel very close to the surface, without actually leaving the water, creating a great deal of spray when rising to breathe (Carwardine, 1995).



Distribution of Lagenorhynchus cruciger: cold waters of the Southern Hemisphere, predominantly between 45° and 65°S, i.e. fairly near the pack-ice (Hammond et al. 2008;© IUCN Red List).

Schooling: Groups tend to be small, which is unusual for a small oceanic delphinid. Although herds of up to 100 have been seen, groups of 1 to 14 are more common (Brownell and Donahue, 1999 and refs. therein). Hourglass dolphins have been encountered with several other species of cetaceans, and may associate with fin whales, sei whales, southern bottlenose shales, Arnoux's beaked whales, killer whales, long-finned pilot whales, and southern right whale dolphins (Carwardine, 1995).
Food: Prefers fish (e.g. the myctophid *Krefftichtys andersonii*), squid (Onychoteuthidae and Enoploteuthidae) and crustaceans. Feeding often takes place in large aggregations of sea birds and other cetaceans and in plankton and krill slicks (Goodall et al. 1997; Goodall, 2009; Reid et al. 2000).

5. Migration

Goodall (1997) reported that in the South American sector of the Antarctic and Subantarctic there were no sightings from May to September, probably a reflection of observer effort. From September to February, 480 hourglass dolphins were counted around the Falkland Islands but none were seen in July or August (White at al. 1999). The range of the species thus probably shifts north and south with the seasons (Carwardine, 1995).

6. Threats

Direct catch: It is likely that their numbers are at or near original levels. There has never been any systematic exploitation (Jefferson et al. 1993). One scientific specimen was collected during commercial whaling operations, and several other specimens have been collected during research cruises (Brownell and Donahue, 1999).
Incidental catch: At least one hourglass dolphin was incidentally caught in an experimental Japanese drift net fishery for squid around 53°13'S, 106°20'W (Brownell and Donahue, 1999). Goodall et al. (1997) and Goodall (2009) report on 4 known casualties in net fisheries in the South Pacific.
Tourism: Increased tourist activity from southern South America to the Antarctic Peninsula should produce increased awareness and further sightings of this species.

7. Remarks

Range states (Hammond et al. 2008):
Antarctica; Argentina; Australia; Chile; Falkland Islands (Malvinas); French Southern Territories (the) (Crozet Is., Kerguelen); New Zealand; South Africa (Marion-Prince Edward Is.); South Georgia and the South Sandwich Islands

IUCN status: "Least concern" (Hammond et al. 2008). Not listed by CMS. The species is listed in Appendix II of CITES.

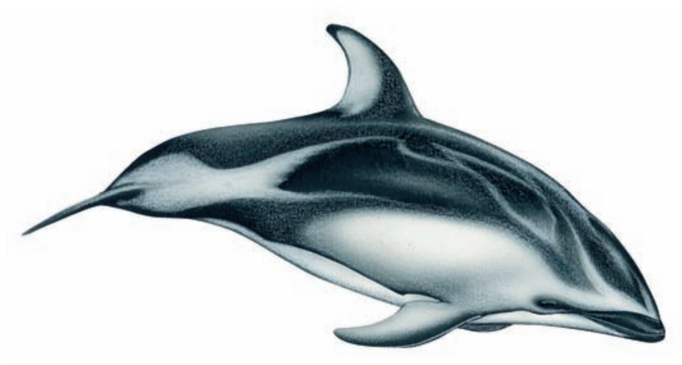
This is a poorly known species with a flexible range, which seems to be influenced in its extent by the seasons. Vagrants off Chile suggest that *L. cruciger* may follow cold currents farther North. More information on abundance, area of higher concentrations, home range size, the effect of climate on movements and migrations is needed. For South American populations, see also recommendations in Hucke-Gaete (2000) in Appendix 1.

8. Sources (see page 259)

3.25 Lagenorhynchus obliquidens Gill, 1865

English: Pacific white-sided dolphin
German: Weißstreifendelphin
Spanish: Delfín de costados blancos del Pacífico
French: Dauphin à flancs blancs du Pacifique

Family Delphinidae



Lagenorhynchus obliquidens / Pacific white-sided dolphin (© Wurtz-Artescienza)

1. Description

The boldly coloured Pacific white-sided dolphin is black or dark grey on the back and posterior sides, as well as on the short snout, the leading edge of the tall dorsal fin, and the pointed flippers. The light grey thoracic patch is sharply delineated from the white belly by a thin dark line, in contrast with the dusky dolphin (*L. obscurus*) which lacks this line and the sharp demarcation. Grey, linear dorsal flank blazes, often called "suspender stripes", project forward from the grayish flank patches along the back and disappear above the eyes. Average adult size is 2.1-2.2 m and body mass reaches 75-90 kg (van Waerebeek, 2002).

Specimens from Korea Strait are on average larger than those from far offshore in the western North Pacific (35°-46°N, 158°-180°E). A tiny proportion of individuals exhibit an alternate colour phase (Rice, 1998, and refs. therein), e.g. in Volcano Bay, Hokkaido, Japan, individuals with anomalous white colour patterns exhibiting various degrees of lack of pigmentation were identified (Tsutsui et al. 2001). Furthermore, investigation of genetic diversity and differentiation (Hayano et al. 2004) suggests that Pacific white-sided dolphins in Japanese coastal waters and offshore North Pacific belong to different populations between which gene flow has been severely restricted.

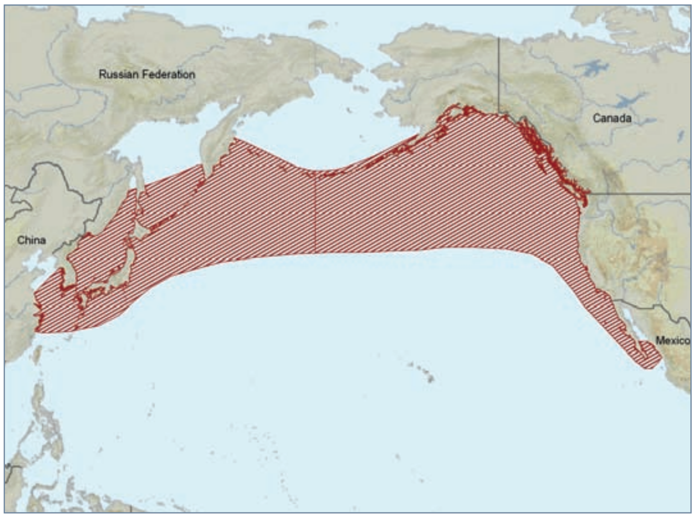
Animals off Baja California have consistently larger crania than the ones from northern California northward, with inter-grading populations occupying the intervening area off southern and central California (Rice, 1998, and refs. therein). However, Lux et al. (1997) found that population-by-population mtDNA comparisons of four geographic populations in the eastern Pacific indicated that all could be considered isolated, but likely incompletely, from one another. Black (2009) concluded that 6 populations can be differentiated: coastal Japan, offshore Japan, North Pacific, British Columbia, Oregon to California, Baja California.

Close scrutiny of morphological and life history parameters as well as recent cytochrome c sequence analysis supports the premise that *L. obscurus* and *L. obliquidens* are sister species which diverged 1.9-3 million years ago (van Waerebeek, 2002).

2. Distribution

L. obliquidens is found in the cool temperate waters of the North Pacific. It ranges in the west from the South China Sea northward, throughout Japanese waters, and around the Kuril Islands, extending north to the Commander Islands, and also occurs in the Sea of Japan and in the southwestern Okhotsk Sea. In the eastern Pacific, the species occurs primarily in shelf and slope waters from the southern Gulf of California, Mexico along the western coast of North America north to the Gulf of Alaska and as far west as Amchitka in the Aleutian Islands. Across the North Pacific, the species is generally found to have a relatively narrow distribution between 38°N and 47°N (Brownell et al. 1999, Black, 2009).

Vagrant to Bahia de La Paz in the south-western Golfo de California (Rice, 1998) and infrequently, in the southern Bering Sea (Brownell et al. 1999).



Distribution of Lagenorhynchus obliquidens: deep temperate waters of the northern North Pacific, predominantly off-shore (Hammond et al. 2008; © IUCN Red List).

3. Population size

Buckland et at. (1993) estimated the abundance of Pacific white-sided dolphins in the North Pacific at 931,000 animals. This is in close agreement with the estimate of 989,000 by Miyashita (1993). However, precision is low for both estimates, and vessel attraction probably resulted in overestimation of population size (Buckland et al. 1993).

For the eastern North Pacific, there are separate abundance estimates for different regions and seasons. Off Oregon and Washington, a peak abundance of 23,400 animals was estimated in May 1992 (Forney et al. 1995). The 2001-2005 geometric mean abundance estimate for California, Oregon and Washington waters based on two ship surveys was 20,719 (CV =0.22) Pacific white-sided dolphins (Barlow and Forney 2007; Forney 2007). No long-term trends in abundance were suggested based on historical and recent surveys (Caretta et al. 2008).

In February-April 1991 and 1992, aerial surveys conducted along the continental shelf and slope of California resulted in a population estimate of 122,000 (Forney et al. 1995). This contrasts with a ship-based estimate of only 5,900 in August-November 1991 for the same study area (Forney and Barlow, 1998), a discrepancy which may be explained by seasonal migrations (Brownell et al. 1999).

In the coastal waters of British Columbia, Canada, the Pacific white-sided dolphin is probably the most abundant cetacean (Heise, 1997a): In the inshore coastal waters of the Inside Passage, between the British Columbia (BC)-Washington and the BC-Alaska borders, Williams and Thomas (2007) estimated the population size in 2004-2005 at 25,900 (95% CI = 12,900-52,100).

4. Biology and Behaviour

Habitat: *L. obliquidens* is mainly found offshore, as far as the edge of the continental shelf, but does come closer to shore where there is deep water, such as over submarine canyons (Carwardine, 1995). It is known to occur close to shore in regions such as the inshore passes of Alaska, British Columbia, and Washington, and seasonally off southern California (Brownell et al. 1999, and refs. therein).

Investigation of habitat segregation between various species of small cetaceans in the central North Pacific Ocean revealed that sea-surface temperature was the most influential habitat parameter examined, with *L. borealis* occupying the warmest waters, *P. dalli* the coolest, and *L. obliquidens* in between but with greater preference overlap with *P. dalli*. (Ferrero,1998; Ferrero et al. 2002).

Associations between cetacean distributions, oceanographic features, and bioacoustic backscatter were examined in the northern California Current System (CCS) during late spring and summer 2000. Pacific white-sided dolphin were the most numerous small cetacean in early June but were rare during August. Up to 45% of the variation in their occurrence pattern was described by distance to the upwelling front and acoustic backscatter at 38 kHz (Tynan et al. 2005).

Behaviour: *L. obliquidens* is very inquisitive and may even approach stationary boats (Carwardine, 1995). It is highly acrobatic and playful, commonly bowriding, and often leaping, flipping, or somersaulting (Jefferson et al. 1993).

Reproduction: Calving occurs from May to September. Females become sexually mature at 8-11 years (175-186 cm length) and males at 9-12 years (170-180 cm length). Gestation lasts 11-12 months. Males may live to 42 years and females to 46 years (Heise 1997b).

Schooling: Often seen in large herds of hundreds or even thousands, these highly gregarious dolphins are also commonly seen with other species, especially northern right-whale dolphins (*L. borealis*) and Risso's dolphins (Jefferson et al. 1993) as well as other cetaceans (Brownell et al. 1999). The interspecific relationship with the northern right-whale dolphin appears to be a unique association in which large groups of both species are frequently observed to form heterogeneous herds and subgroups. The reason for this close association may be food related, particularly in the oceanic environment, as there is considerable overlap in preferred mesopelagic prey (Brownell et al. 1999 and refs. therein). Large schools of Pacific white-sided dolphins may split into smaller groups when feeding but re-assemble when resting or travelling (Carwardine, 1995).

Food: Pacific white-sided dolphins consume a wide variety of fish and cephalopods. However, considerable differences in feeding preference are evident between animals from coastal and offshore regions. Off British Columbia, Canada, herring (*Clupea harengus*) was the most commonly occurring prey species (59%), followed by salmon (*Oncorhynchus* spp.; 30%), cod (Family Gadidae; 6%), shrimp (Order Decapoda; 3%) and capelin (*Mallotus villosus*; 1%; Heise, 1997a). In the North Pacific they feed primarily on epipelagic fish and cephalopods: northern anchovy (*Engraulis mardax*), Pacific hake (*Merluccius productus*), Pacific saury (*Cololabis saira*), juvenile rock fish (*Sebastes* spp., and horse mackerel (*Trachurus symmetricus*). The market squid (*Loligo opalescens*) is also frequently ingested. In the central North Pacific *L. obliquidens* feeds heavily on mesopelagic fish and cephalopods and in coastal waters of northern Japan on both mesopelagic and epipelagic fish and cephalopods (Brownell et al. 1999 and refs. therein).

5. Migration

Some seasonal shifts occur; while more common in coastal waters during fall and winter, *L. obliquidens* move offshore during spring and summer, in rough synchrony with the movements of anchovies and other prey (van Waerebeek, 2002 and refs. therein).

Seasonal abundance estimates off the entire coast of California are an order of magnitude higher in February-April than in August-November, while peak abundances off Oregon and Washington are observed during May. This pattern strongly suggests seasonal north-south movements in the eastern North Pacific (Forney and Barlow, 1998). Aurioles et al. (1989) also noted that the species is found seasonally, in spring and summer, in the southwestern Gulf of California. Off San Clemente Island, California, Pacific white-sided dolphins were present only during the cold-water months of November-April (Carretta et al. 2000). Brownell et al. (1999) suggested that the occurrence of the southern form of *L. obliquidens* off Southern California appears to be variable, possibly relating to changes in oceanographic conditions on seasonal or inter-annual time scales (i.e. El Niño events).

In Alaskan waters, published sighting records are sparse, but the occurrence of Pacific white-sided dolphins may be related to periods of warmer water (Dahlheim and Towell, 1994). Off Japan, Pacific white-sided dolphins occupy the Korean Strait and waters of western Japan in the winter and appear to move to the east from March to July. Nothing is known about the movements of the two forms described from Japanese coastal waters (Brownell et al. 1999 and refs. therein; Tsutsui et al. 2001).

6. Threats

Direct catch: According to Jefferson et al. (1993), Japanese drive and harpoon fisheries took hundreds or even thousands of Pacific white-sided dolphins in most years, but Brownell et al. (1999) reported that only "small numbers" are taken annually. Black (2009) confirmed that dolphins are still harpooned in Japan today for human consumption, whereas the drive fishery in Taiji does not generally catch Pacific white-sided dolphins. However, the Japanese government has considered a renewed direct harvest of this species (Hammond et al. 2008). Few live captures have been reported in the past, the most recent one in 1992 when 3 animals were take for public display (Forney, 1994).

Incidental catch: In the eastern Pacific a total of 363 animals were estimated to have been killed in the shark and swordfish drift net fishery in California during the period from April 1988 to December 1995. Additional mortality has been documented for trammel and set nets in California coastal waters, for drift gill nets in British Columbia and Alaska, and for trawl fisheries in Alaska. Pacific white-sided dolphins were rarely taken in the tuna purse seine fishery in the eastern tropical Pacific because most of the fishing takes place south of the range of these dolphins (Brownell et al. 1999 and refs. therein). The most recent average estimate of fishery-related mortality of Pacific white-sided dolphins in US eastern Pacific waters is very low. Including mortality from drift gillnet, groundfish trawl, and unknown fisheries, 1.4 (CV = 0.86) animals are removed annually. Similar low levels of mortality have also been documented in the California/Oregon/ Washington domestic groundfish trawl fisheries (Caretta et al. 2008). By-catch mortality estimates for 2004-2005 in salmon gillnet fisheries off British-Columbia, Canada, were also below precautionary limits (Williams et al. 2008).

In the western Pacific, Pacific white-sided dolphins were one of the most commonly caught cetaceans in the Japanese and Korean high seas squid drift net fisheries (Hobbs and Jones, 1993). They were also taken in the Japanese large-mesh and Taiwanese squid and large-mesh fisheries. In 1989, the estimated total by-catch for only the Japanese squid drift net fishery was about 6,100; in 1990, the total estimate for all drift net fisheries combined was 5,759 animals (Hobbs and Jones, 1993). Effort for these fisheries was estimated to have increased during the late 1970s and early 1980s and then remained relatively stable at least until 1990 (Hobbs and Jones, 1993). In January 1993 a United Nations moratorium on these high seas drift net fisheries went into effect.

Smaller catches (e.g. at least 194 in 1987) are reported from the Japanese land-based salmon drift net fishery. Small numbers are taken yearly in seines, set nets, and trap nets around Japan (Brownell et al. 1999 and refs. therein).

Molecular monitoring of 'whalemeat' markets in the Republic of (South) Korea between 2003 and 2005 revealed that Pacific white-sided dolphins were for sale there. As Korea has no programme of commercial or scientific whaling and there is a closure on the hunting of dolphins and porpoises, the only legal source of these products was assumed to be incidental fisheries mortality (Baker et a. 2006).

Killing: Japanese government-supported "cull" programmes to control several small cetaceans, including Pacific white-sided dolphins, were initiated during the 1970s. Between 1976 and 1980, which were the peak years of this programme, at least 466 *L. obliquidens* are reported to have been killed (Brownell et al. 1999 and ref. therein).

Pollution: The maximum concentrations of DDT and PCBs reported in the blubber of Pacific white-sided dolphins in Japanese waters were 99 ppm and 71 ppm wet weight, respectively. Organochlorine levels in the blubber of two stranded animals from Californian waters were 2.08 ppm and 99.5 ppm DDT, and 0.23 ppm and 4.88 ppm PCBs. Overall, pollutant loads for this species appear to be variable (Brownell et al. 1999 and refs. therein).

7. Remarks

Range states (Hammond et al. 2008): Canada; China; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Mexico; Russian Federation; United States of America

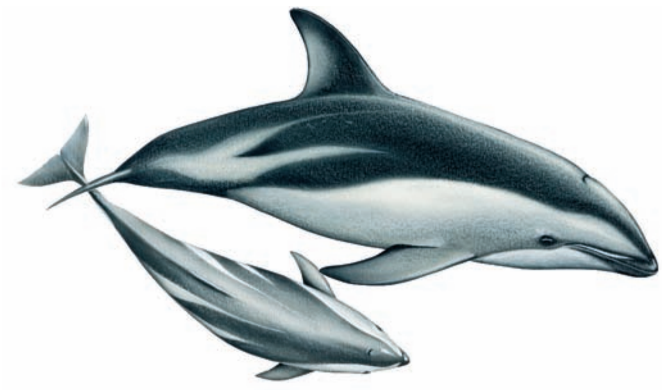
IUCN Status: "Least Concern" (Hammond et al. 2008). The species is listed in Appendix II of CITES. CMS status: "not listed". However, the Pacific white-sided dolphin is a migratory species which presumably crosses the boundaries of several countries on the east and west coasts of the Pacific Ocean. The species should therefore be included in Appendix II of the CMS.

8. Sources (see page 259)

3.26 Lagenorhynchus obscurus (Gray, 1828)

English: Dusky dolphin
German: Schwarzdelphin
Spanish: Delfín oscuro
French: Dauphin obscur ou sombre

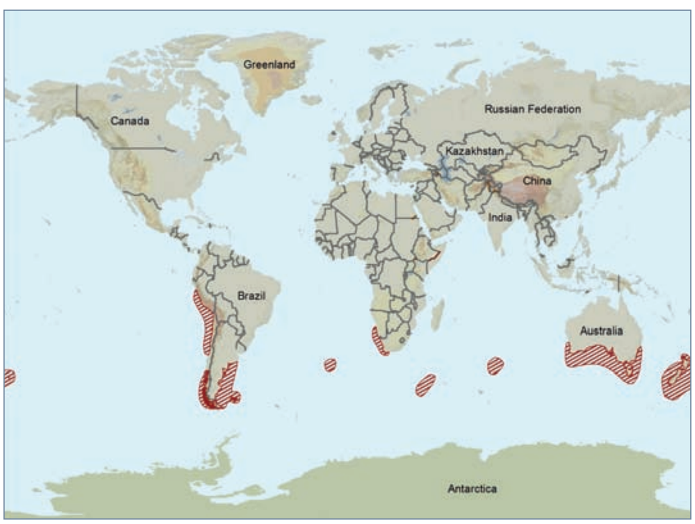
Family Delphinidae



Lagenorhynchus obscurus / Dusky dolphin (© Wurtz-Artescienza)

1. Description

Dusky dolphins are small and moderately robust. They have virtually no beak, as the head slopes evenly down from the blowhole to the tip of the beak. The tip of the dorsal fin is rather blunt and is not markedly hooked. The tail and back are bluish-black, and a dark band runs diagonally across the flanks from below the dorsal fin towards the vent and along the tailstock. The underside of the body is white, and a whitish-grey colour extends over the flanks. The tips of the snout and lower jaw are dark. A grey area extends from the eye down to the flipper. Two diagonal whitish streaks run forward from the tail up past the base of the dorsal fin (Baker, 1990, Jefferson et al. 2008). The largest dusky dolphin males and females reach 211 and 205 cm, respectively, attaining a body mass of rarely higher than 100 kg (van Waerebeek and Würsig, 2009).



Distribution of the various subspecies of Lagenorhynchus obscurus: coastal temperate waters off Australia, New Zealand, South America and Southern Africa and oceanic islands (Hammond et al. 2008; © IUCN Red List).

Yazdi (2002) reports a possible hybrid between a dusky dolphin and a southern right-whale dolphin (*Lissodelphis peronii*), south of Peninsula Valdés in Golfo Nuevo, Argentina.

2. Distribution

Lagenorhynchus obscurus is widespread in the southern hemisphere, but its distribution is probably not continuous. Populations in the South American, African, and New Zealand sectors of the range are sufficiently distinct to be regarded as subspecies, according to Van Waerebeek et al. (1993), although he did not apply scientific names to them. However, Cassens et al. (2005) found only low levels of genetic differentiation among most dusky dolphin populations. Only the Peruvian dusky dolphin stock is highly differentiated.

Rice (1998) listed three subspecies which are still recognized (Hammond et al. 2008; Jefferson et al. 2008):

L. o. fitzroyi (Waterhouse, 1838), ranges in coastal waters of South America from Isla Mazorca to Mar del Plata. However, Cassens et al. (2003) using genetic analysis found no evidence for recent female gene flow between Atlantic and Pacific waters, indicating that the eastern South Pacific dusky dolphins stock (e.g. the Peruvian stock) should be considered a separate management unit.

L. o. obscurus ranges in coastal waters of southern Africa from Lobito in Angola south to Cape Agulhas in Cape Province. It has been reported from Prince Edward Islands (subspecies?) and Ile Amsterdam (subspecies?). Purported sightings and specimens from Iles Crozet and Iles Kerguelen are erroneous or unverified (Rice, 1998).

L. o. subsp.: Ranges on the east coast of New Zealand from Whitianga on North Island south to Stewart Island and is also found on Campbell, Auckland and Chatham Islands (Rice, 1998).

In addition, there may be an unrecognised subspecies at the Falkland Islands/Islas Malvinas, and another around Gough Island in the South Atlantic Ocean (Rice, 1998), a melanistic form of *L. o. obscurus* (van Waerebeek, 2002).

Gill et al. (2000) report the sighting of a school of 15 dusky dolphins off eastern Tasmania, suggesting that the species does, in fact, also occur in Australian waters. However, The low rates of observation or stranding, compared to those of other inshore dolphins such as *Delphinus delphis*, which is well-known along the southern Australian coast, strongly suggest that dusky dolphins occur rarely in coastal waters of southern Australia and are unlikely to be resident. Dusky dolphins may occur far offshore, visiting coastal waters in response to unusual oceanographic conditions. Another possibility is that members of the population around St Paul and Amsterdam Islands may visit Australian waters (Gill et al. 2000).

Based on mitochondrial and nuclear DNA sequence data, Harlin-Cognato et al. (2007) propose a Pacific/Indian Ocean origin of the species, with a relatively early and continued isolation of Peru from other regions. Dispersal of the dusky dolphin into the Atlantic would be correlated with the history of anchovy populations, including multiple migrations from New Zealand to South Africa. They suggest that changes in primary productivity and related abundance of prey played a key role in shaping the phylogeography of the dusky dolphin, coincident with periods of ocean change.

3. Population size

The population off Kaikoura, New Zealand was estimated at 12,000 (Markowitz, 2004). In the southern Ocean, during the Southern Hemisphere minke whale assessment cruises between 1978/79 and 1987/88, a total of 2,665 dusky dolphins were observed in 27 schools. These observations were made while in transit between home ports and the Antarctic, but no abundance estimates were calculated (Brownell and Cipriano, 1999 and refs. therein). The total number of dusky dolphins in the fishing area off the Patagonian cost was estimated to be close to 7,252 individuals (Dans et al. 1997), and the number given by Schiavini et al. (1999) for the area between Punta Ninfas and Cabo Blanco, Argentina is 6,628. Off the Peruvian coast, dusky dolphins were the third most abundant cetacean species sighted (Sanchez et al. 1998).

4. Biology and Behaviour

Habitat: This coastal species is usually found over the continental shelf and slope (Jefferson et al. 1993; Aguayo et al. 1998), in waters up to 2,000 m deep (Würsig et al. 2007). The distribution of dusky dolphins along the west coast of South Africa and both coasts of South America is associated with the continental shelves and cool waters of the Benguela, Humboldt and Falkland Currents. Around New Zealand these dolphins are associated mainly with various cold water currents (Brownell and Cipriano, 1999; Würsig et al. 2007). Off Argentina, dusky dolphins have been sighted from the coast to just before the 200 nautical miles Exclusive Economic Zone border (Crespo et al. 1997). They seem to prefer waters with sea surface temperatures between 10°C and 18°C (Brownell and Cipriano, 1999).

Behaviour: Dusky dolphins are highly inquisitive and usually easy to approach. They seem to enjoy the contact with boats and people and readily bow-ride (Carwardine, 1995). They are one of the most acrobatic of dolphins, frequently leaping high out of the water, at times tumbling in the air (Jefferson et al. 1993). Mean dive time for 10 radio tagged dolphins off Argentina was only 21.0 sec, and the number of long dives (>90 sec), probably associated with feeding, peaked in mid-day to afternoon in summer (Würsig, 1982).

Subgroups of dusky dolphins within larger schools off New Zealand sometimes were observed to dive synchronously, and occasionally almost the entire group would be underwater for several minutes (Brownell and Cipriano, 1999 and refs. therein). Group sizes, behaviours, social affiliations and general habitat-use patterns differ between Kaikoura and Admiralty Bay, South Island, even though some of the same animals utilise both habitats in different seasons. Off Kaikoura, there are daily and seasonal differences in behaviours and movement patterns, with daytime rests around midday, social activities in the mornings and afternoons, and feeding in deeper oceanic waters at night (Würsig et al. 2007).

Schooling: The species is highly gregarious and seems to welcome the company of other species as well as its own: it is often seen with seabirds and frequently associates with other cetaceans. Its own group sizes vary according to the time of year, with larger numbers living together during the summer (Carwardine, 1995). School size is fairly variable, with a range of 2-500 and a mean of 98.7 individuals. During the winter months, groups of less than 20 are more common than at other times of the year.

Stable subgroups were observed within a more fluid society of changing group size (Würsig and Würsig, 1980) and probably displayed a high degree of individual-to-individual fidelity (Würsig and Bastida, 1986).

In Argentina large groups are more efficient at herding schools of anchovy than small ones, and it appears that methods for calling in distant groups evolved because the food benefit for each dolphin is increased when groups join forces. Cooperative herding appears essential in their effort to feed on small schooling fish. An original group of eight to 10 dolphins often increases to more than 200 by the time feeding is completed. After they have fed, high levels of social and sexual activity take place in the large group (Würsig et al. 1989).

In New Zealand, the feeding and social behaviour of dusky dolphins are very different. Instead of traveling, as their Argentine kin do, in a widespread school with small groups some distance apart, New Zealand dusky dolphins move in closely knit schools, made up of subgroups of about ten individuals. There is usually an unbroken and tight perimeter surrounding an entire school so that two- or three hundred animals cover an area generally no larger than one square kilometer. The entire school travels in search of food as a directed unit rather than meandering in groups. Like the dusky dolphins of Argentina, they split into small groups to rest near shore during the day (Würsig et al. 1989).

Off Kaikoura, thousands of dusky dolphins gather, feeding nocturnally on deep scattering layer prey, resting and socializing diurnally. Group size, distance from shore, ranging along shore, traveling, inter-individual distance, and noisy leaping peak in winter; during the spring- summer-autumn reproductive seasons dolphins maintain closer proximity to each other in smaller, more quiescent groups, closer to shore (Markowitz, 2004). In the same area, mother-calf pairs are often found in small groups with other mother-calf pairs, with calves of roughly the same age. Nursery groups are encountered in shallow waters (=20 m) significantly more often than in deeper waters, thus effectively avoiding marine predators such as sharks and killer whales (Weir et al. 2008).

Dusky dolphins have been observed in mixed cetacean schools with southern right-whale dolphins (*Lissodelphis* *peronii*) off Namibia. In summer, *L. obscurus* groups off Kaikoura, New Zealand were occasionally accompanied by small groups of common dolphins (*Delphinus delphis*), which travelled as a cohesive subgroup within the larger dusky dolphin group. Dusky dolphins were also observed with pilot whales (*Globicephala* sp.) off Southwest Africa and the Prince Edward Islands (Brownell and Cipriano, 1999, and refs. therein). Off Argentina, dusky dophins were also observed in association with 2 *Delphinus capensis* females and one *Tursiops truncatus* male (Yazdi, 2000).

Reproduction: In New Zealand and Argentina, calving is believed to peak in summer (November to February; Jefferson et al. 1993). In Peruvian waters most births ocurred in late winter (August, September, and October; Van Waerebeek & Read, 1994). In Peru, sexual maturity in females is estimated at 4.3 - 5 years and in males at 3.8-4.7 years (Van Waerebeek and Würsig, 2009).

Food: *L. obscurus* take a wide variety of prey, including southern anchovy and mid-water and benthic prey such as squid and lanternfishes. They may also engage in nocturnal feeding. Co-operative feeding is practised commonly in some areas (Jefferson et al. 1993).

Their most important prey in Peruvian coastal waters is anchoveta (*Engraulis ringens*). It constitutes almost 90% of dusky dolphin diet by percent gross energy (Mc Kinnon 1994). Other prey species commonly found in dolphin stomachs are horse mackerel (*Trachurus symmetricus*), hake (*Merluccius gayi*), sardine (*Sardinops sagax*), Patagonian squid (*Loligo gahi*) and jumbo flying squid (*Dosidicas gigas*) (Mc Kinnon, 1994).

The most important prey of Patagonian dusky dolphins off Argentina is the southern anchovy (*Engraulis anchoita*), representing 39% of prey by number and 46% by weight (Alonso et al. 1998). The most frequent prey is the patagonian squid (*Loligo gahi*), which was present in 84% of stomachs. Other prey species found were hake (*Merluccius hubbsi*), the "pampanito" (*Stromateus brasiliensis*), the southern cod (*Nothotenia* sp.), shortfin squid (*Illex argentinus*), a sepiolid (*Semirossia tenera*) and an octupus (*Octupus tehuelches*).

Stomachs from 24 dusky dolphins incidentally killed in fishing operations in New Zealand waters contained remains of mesopelagic fishes, mainly myctophids and hoki (*Macruronus novaezelandiae*), and squids (*Nototodarus* spp., *Moroteuthopsis* spp. and *Teuthowenia* spp.; McKinnon, 1994; Brownell and Cipriano, 1999). In Admiralty Bay and Current Basin, New Zealand, dolphin feeding tactics were different from May through July than from August to November. From May through July, dolphins fed on mobile prey at depth; from August to November, they herded small schools of fish (including pilchard *Sardinops neopilchardus*) to the surface (Vaughn et al. 2007).

5. Migration

Dusky dolphin may cover large distances: Würsig and Bastida (1986) equipped two animals with spaghetti tags in Jan. 1975 off Golfo San José Argentina. The two dolphins were sighted approximately 20 km (1 day after tagging) and 35 km (5 days after tagging) from the tagging site, respectively. In December 1982, both dolphins were observed swimming side by side in a school of approximately 150 dusky dolphins about 10 km off Mar del Plata, approximately 780 km north-east of the original tagging location.

In New Zealand, photographic identification data indicate a seasonal shift in residency of dolphins between Kaikoura and the Marlborough Sounds (approx. 200 km apart) (Harlin et al. 2003; Markowitz, 2004).

On a smaller scale, the Argentinian and New Zealand populations exhibit inshore-offshore movements both on a diurnal and on a seasonal rhythm (van Waerebeek, 2002). They were found during most of the year in Golfo San José, Argentina, with a seasonal low in abundance during winter and a peak in summer (Würsig and Würsig, 1980). In summer, these dolphins were also found more often in deeper water near the mouth of the bay, at a time when southern anchovy (*Engraulis anchoita*) was probably moving into deeper water.

In the Kaikoura area off South Island, New Zealand, dolphins moved from nearshore to off-shore waters during the course of the day, apparently feeding on mesopelagic fishes in deep water during evening and night but consistently remained closer to shore than during winter months (Brownell and Cipriano, 1999 and refs. therein). Residence in Kaikoura is seasonal, with 1,969 from a population of 12,626 dolphins spending 103 consecutive days in the area per year (Markowitz, 2004). Mark-recapture data indicate that more than 1,000 dusky dolphins used Admiralty Bay, Marlborough Sound, over the course of a 5-year study, with an average of 220 individuals inhabiting the bay on any given week during the winters of 1998-2002. As many as 55% of individuals returned to Admiralty Bay in consecutive winters (Markowitz et al. 2004). Off the west coast of South Island, dusky dolphins occurred almost exclusively in summer in groups of 2-150 individuals, often with calves, especially at Cape Foulwind and Jackson Head (Braeger and Schneider, 1998).

The intermittent nature of 12 records in Tasmania, Australia, over 175 years is puzzling. Setting aside concerns about identification, the dates of records are quite seasonal, occurring from October/November (8) through January (1) and March/April (3). Such seasonality suggests a causal link with changes in one or more oceanographic features in this region, perhaps, for example, in the position of the Subtropical Convergence, a feature which appears to coincide with the northern limit of distribution for this species off eastern New Zealand, and/or ENSO events (Gill et al. 2000).

6. Threats

Direct catch: Large catches (approximately 10,000) of small cetaceans were reported from the coastal waters of central Peru in 1985 (Read et al. 1988). In the 1991-1993 period, an estimated 7,000 dusky dolphins were captured per year, an exploitation thought to be unsustainable. It is believed, but not confirmed, that this level of exploitation has diminished since dolphin hunting was banned by law in 1996 and due to depletion of the population (van Waerebeek, 2002). Captured dusky dolphins and other small whales are still used in Peru as shark bait in long-line and gillnet fisheries and landed illegally to be sold in public markets, largely due to a lack of law enforcement (Van Waerebeek and Würsig, 2009).

Incidental catch: Of 722 cetaceans captured mostly in multifilament gillnets and landed at Cerro Azul, central Peru, in 87 days during January-August 1994, 82.7% were dusky dolphins. The total kill estimate for a seven-month period, stratified by month, was 1,567 cetaceans. Data collected at 16 other ports showed that high levels of dolphin and porpoise mortality persisted in coastal Peru at least until August 1994 when an unimplemented 1990 ban on small cetacean exploitation was renewed. Circumstantial evidence suggests that, thereafter, increasing enforcement reduced direct takes and illegal trade in meat but also hampered monitoring. The absence of abundance data precludes any assessment of impact on populations (van Waerebeek et al. 1997).

Dusky dolphins continue to be affected by the trawl fishery off Patagonia (Crespo et al. 2007) and mortality estimates for 1994 reached a minimum value of 36 dolphins per year, mostly females and young matures (Dans et al. 1997). Dans et al. (2003) concluded that this incidental mortality could be, or may become, a threat for the regional dusky dolphin population.

In New Zealand, some dusky dolphins are entangled in gill nets. Incidental mortality at one fishing port was estimated to be 100 to 200 animals per year (Jefferson et al. 1993) and within the range of 50-150 during the mid-1980s (Würsig et al. 1997). However, this is not repeated in the recent literature (Würsig et al. 2007), whereas in Australian waters the pelagic drift-net fishery in the Tasman Sea as well as entanglement in drift-nets set outside Australian Economic Exclusion Zone and in lost or discarded netting are a cause for concern (Ross, 2006).

Aquaculture: Aquaculture may threaten dusky dolphin foraging habitat in Admiralty Bay, Marlborough Sound, New Zealand, where an estimated 220 dolphins gather to feed each winter. Overlap of dusky dolphin habitat use with proposed marine farms is high, and dolphins rarely used areas within the existing farms (Markowitz et al. 2004).

Pollution: The maximum concentration (ppm wet weight) of DDT reported in the blubber of this species in New Zealand waters was 175 (Brownell and Cipriano, 1999 and refs. therein).

Tourism: Commercial dolphin watching and swim-with-dolphin operations started in the late 1980s and are a major industry in Kaikoura, New Zealand. During summer, boats approach the same dolphin groups throughout the day. While there are behavioural reactions by the dolphins, no large-scale or long-term adverse reactions to human tourism have been documented to date. It is presently unknown whether more subtle chronic effects could be detrimental to the population (Würsig et al. 1997). The discovery of midday resting has led to a voluntary 'down-time' of no tourism boats by a local dolphin tourism enterprise, Dolphin Encounter (Würsig et al. 2007). Since 1997, dusky dolphin watching activities have also increased in Patagonia, from 1,393 tourists in 1997 to 1,840 in 2000, with unknown effects on the animals (Coscarella et al. 2003).

7. Remarks

Range states (Hammond et al. 2008): Argentina; Australia; Chile; Falkland Islands (Malvinas); French Southern Territories (the) (Amsterdam-St. Paul Is.); Namibia; New Zealand; Peru; South Africa (Marion-Prince Edward Is., Northern Cape Province, Western Cape Province).

L. obscurus is included in Appendix II of CMS. IUCN Status: "Data Deficient" (Hammond et al. 2008) . The species is listed in Appendix II of CITES.

Bycatch in gillnets occurs at an unknown and ins some regions like Peru and Patagonia, presumably intolerable level. This needs to be investigated. For South American stocks, see recommendations in the Hucke-Gaete (2000) report in Appendix 1.

8. Sources (see page 260)

3.27 Lipotes vexillifer Miller, 1918

English: Yangtse river-dolphin, baiji, whitefin dolphin
German: Chinesischer Flussdelphin
Spanish: Baiji, Delfín de China
French: Baiji, Dauphin de Chine

Family Lipotidae

Lipotes vexillifer / Yangtse river-dolphin (© Wurtz-Artescienza)

1. Description

The baiji has been the rarest and most endangered cetacean in the world (Smith et al. 2009); it is currently thought to probably be extinct. It was a very graceful animal, with a very long, narrow and slightly upturned beak. The baiji could easily be identified by the rounded melon, longitudinally oval blowhole, very small eyes, low triangular dorsal fin and broad, rounded flippers. The coloration was bluish-grey to grey above and white to ashy-white below. Females were larger than males, reaching 253 cm as opposed to 229 cm (Zhou, 2002).

2. Distribution

The baiji was an exclusively freshwater species and ranged in the lower and middle reaches of the Chang Jiang (Yangtze River), from its estuary upstream for 1,600 km as far as the gorges above Yichang (20 m above sea level). At least one record was reported from the lower Fuchun Jiang at Tonglu (Rice, 1998). Individuals may have entered some tributary lakes during intense flooding (Zhou, 2002).

Former distribution of the possibly extinct Lipotes vexilifer in the Chang Jiang (Yangtse River) and its tributaries (Smith et al. 2009; © IUCN Red List).

3. Population size

Zhou et al. (1998) report that boat surveys conducted along a 500 km section of the Yangtze River between Zhenjiang and Hukou in 1989-1991 resulted in identification of seven individual baiji based on natural markings. There were 7 sightings of baiji in May 1989, 4 sightings in March 1990 and 6 sightings in April-May 1990, resulting in an estimated population size of about 30 individuals in the 500-km river study area. If the baiji was still inhabiting its historical 1,600 km range in the Yangtze River, and population density was similar throughout this habitat section, there may have been 100 baiji left in the river at that time.

However, results of subsequent surveys of almost all the species' previous range, Shanghai to Yichang, suggested that the population was very small and in further decline. In 1998 only a few dozen animals may have still been alive (Zhou, 2002). From observations between 1997-1999, Zhang et al. (2003) concluded that 13 individuals could be considered as a minimum number of the baiji in the Yangtse River at that time. The annual rate of population decrease was roughly estimated as 10%. The distribution range of the baiji was less than 1,400 km in length in the Yangtze main river. Distances between the two nearest groups of baiji appeared to be increasing.

In Dongting Lake and Boyang Lake, the baiji became extinct by 1999 (Yang et al. 2000). Finally, an intensive six-week multi-vessel visual and acoustic survey carried out in November-December 2006, covering the entire historical range of the baiji in the main Yangtze channel, failed to find any evidence that the species survives (Turvey et al. 2007). The authors concluded that the baiji is now likely to be extinct, probably due to unsustainable by-catch in local fisheries. This represents the first global extinction of a large vertebrate for over 50 years, only the fourth disappearance of an entire mammal family since AD 1500, and the first cetacean species to be driven to extinction by human activity. There are no baiji in either natural reserves or in dolphinariums (Smith et al. 2008).

4. Biology and Behaviour

Habitat: Baiji were generally found in eddy countercurrents below meanders and channel convergences. The Yangtze River is turbid, and visibility from the surface downward is about 25-35 cm in April and 12 cm in August. Baiji eyes were correspondingly reduced, much smaller than those of other dolphins and placed higher on the head. However, they were functional, and baiji could distinguish objects placed on the surface (Zhou, 2002). Zhang et al. (2003) reported that baiji showed a significant attraction to confluences and sand bars with large eddies.

Schooling: They generally lived in small groups of 3-4 animals, largest observed group size being 16 animals (Zhou, 2002). Two typical sightings are described (Zhang et al. 2003), in which surfacing and movements of baiji were recorded. Baiji were often found swimming together with finless porpoises. In the surveys they occurred in the same group in 63% of occurrences.

Behaviour: Baiji would surface without splashing and breathe smoothly. Short breathing intervals of 10-30 s alternated with a longer one of up to 200 s (Zhou, 2002).

Reproduction: The baiji probably bred and gave birth in the first half of the year. The peak calving season appeared to be February to April (Zhou, 2002).

Food: Any available species of freshwater fish was taken, the only selection criterion appears to have been size (Zhou, 2002).

5. Migration

Reyes (1991) classified the species as "non-migratory". Peixun (1989) reported movements within home ranges but not migratory behavior. However, baiji also made long-range movements. Hua et al. (1994) recorded a single individual moving more than 300 km from March 1989 to January 1992, implying that the baiji's distribution range may have been dynamic. Anecdotal information from fishermen in the river during the surveys indicated that baiji moved upstream when water rose in the spring and downstream when water receded in winter (Zhang et al. 2003).

Zhou et al. (1998) showed from photographic identifications and sighting records that baiji groups made both local and long-range movements. The largest recorded movement of a recognisable baiji was 200+ km from the initial sighting location.

6. Threats

As summarized by Zhou (2002), the threats faced by the baiji included river traffic, fishing gear, reduction of fish stocks, and water pollution. Zhang et al. (2003) added to this list illegal electrical fishing, accounting for 40% of known mortality during the 1990s, and engineering explosions for maintaining navigation channels, which became another main cause of baiji deaths.

Furthermore the Yangtze was suffering massive habitat degradation that likely added to the onset of the baiji's demise:

- The banks of the river have been modified extensively to prevent destructive flooding of agricultural areas, thus reducing the floodplain area (Zhou, 2002).
- Wastewater volume discharged into the Yangtze is about 15.6 billion cubic meters per year. Approximately 80% of these wastewaters are discharged directly into the environment without treatment (Zhou, 2002).
- Dudgeon (1995) reported that in the Zhujiang, dam construction has caused reductions in fisheries stocks but here, as elsewhere in China (e.g. Zhang et al. 2001), the ecologically damaging consequences of river regulation are exacerbated by overfishing and increasing pollution of rivers by sewage, pesticides and industrial wastes.
- In addition, deforestation and soil erosion in the Chang Jiang basin have given rise to siltation and degradation of floodplain habitats (Dudgeon, 1995).

Finally, Rosel and Reeves (2000) pointed out another, equally threatening effect. These animals faced an additional suite of potentially serious problems that were often overlooked, perhaps because they were not so obvious. The genetic and demographic consequences associated with very small population size can result in extinction even when effective measures are in place to protect the animals and their habitat. Small populations tend to harbor less genetic variation than large populations. In addition, small populations are more strongly affected by processes of genetic drift and inbreeding, both of which can further reduce genetic variability. Genetically depauperate populations may have lower fitness, a reduced ability to adapt to changes in their environment over time, and decreased evolutionary potential. Finally, small populations may also be more vulnerable to demographic stochasticity, which can accelerate the process of extinction. Awareness of the genetic and demographic consequences of small population size should be integral to planning for conservation of endangered river cetacean species and populations.

7. Remarks

Range state (Smith et al. 2009): China

Huan and Chen reported as early as 1992 that "the distribution density of baiji in the river section of Ouchikou-Chenglingji (158 kilometres) was gradually diminishing. Its distribution density in the section under research diminished from 3.67 km/ per dolphin in 1986 to 10.36 km/per dolphin in 1991. The baiji has been listed as First-Class Animal under the protection of the Chinese Government, but its population size decreases further and human activities still severely endanger its existence. With further human exploitation of the Yangtse River, new key water-control projects will be built. Hence, a conservation strategy must be adopted to rescue this species."

The IUCN lists the species as "critically endangered and possibly extinct" (C2a(ii); D). It was a relict species and the only living representative of the family Lipotidae and met the definition of a Critically Endangered (CR) species, as it is facing an extremely high risk of extinction in the wild (Smith et al. 2009).

L. vexilifer is listed in appendices I and II of CITES. Because it was not an internationally migrating species, it was not listed by CMS.

8. Sources (see page 261)

3.28 Lissodelphis borealis (Peale, 1848)

English: Northern right-whale dolphin
Spanish: Delfín liso del norte
German: Nördlicher Glattdelphin
French: Dauphin aptère boréal

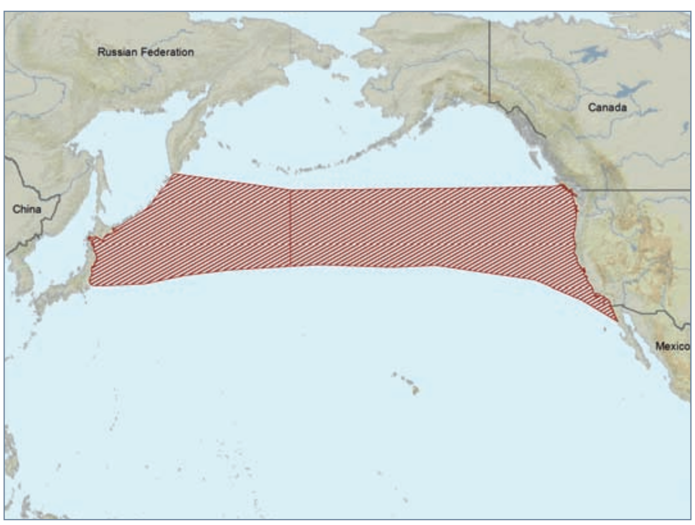
Family Delphinidae

Lissodelphis borealis / Northern right-whale dolphin (© Wurtz-Artescienza)

1. Description

Right-whale dolphins are easy to identify at sea because of their distinctive black and white colour and lack of a dorsal fin. The northern right-whale dolphin is mainly black, with a white ventral patch that runs from the fluke to the throat region. There is a further small white patch on the tip of the rostrum, and the undersides of the flippers are also white (Lipsky, 2009). Size reaches ca. 3.1 m in males and 2.3 m in females, and body mass reaches up to 115 kg (Jefferson et al. 2008).

A few individuals possess an alternate colour pattern with a more extensive white area below. These animals were first referred to the Southern Hemisphere *L. peronii*. Later it was decided that they represented a new race of the northern species, *L. b. albiventris*. However, such individuals occur sporadically in schools of normally-patterned *L. borealis* throughout the species' range, and they do not constitute a taxonomically recognisable population: Dizon et al. (1994), found no evidence of geographically concordant population structuring by pairwise examination of geographic and genetic distances among samples (Rice 1998, and refs. therein).



Distribution of Lissodelphis borealis: cool, deep temperate waters of the northern North Pacific (Hammond et al. 2008; © IUCN Red List).

2. Distribution

Lissodelphis borealis ranges in temperate and subarctic waters of the North Pacific, from the Kuril Islands (Russia) south to the Sanriku coast of Honshu (Japan), thence eastward across the Pacific between 34° and 47°N, extending north to 55°N, 145°W, in the Gulf of Alaska, to the west coast of North America from British Columbia, Canada, to northern Baja California, Mexico (Rice, 1998; Lipsky, 2009).

Movements beyond the normal range occur occasionally, as evidenced by sightings as far south as 29°S off Baja California, Mexico, and as far north as 59°N in the Gulf of Alaska and just south of the Aleutian Islands in the central Pacific. The northernmost sightings are generally from summer months and the southernmost from winter months (Jefferson et al. 1994 and refs. therein; Carwardine, 1995). *L. borealis* may also occur in the northern Sea of Japan (Carwardine, 1995).

3. Population size

Recent abundance estimates for all California, Oregon, and Washington waters from 1996, 2001, and 2005 surveys were 11,347 (CV = 0.27), 14,937 (0.21), and 11,100 (0.60), respectively (Barlow and Forney 2007 , Forney 2007). Currently, there is no evidence of a trend in abundance for this stock (Caretta et al. 2008). However, these values are much lower than peak population size, which was estimated at 17,800 off southern California, and at around 61,500 off central and northern California, making them the second or third most abundant cetacean off California, after *Delphinus delphis* and *Lagenorhynchus obliquidens* (Jefferson et al. 1994). Forney et al. (1995) reported 21,300 animals from Californian waters in winter/spring. Carretta et al. (2000) counted 754 animals off San Clemente Island during winter. Buckland et al. (1993) estimated 68,000 in the North Pacific, and Hiramatsu (1993) estimated the entire population there at 400,000. However, the latter figure may have been positively biased and there are no more recent counts available (Hammond et al. 2008).

4. Biology and Behaviour

Behaviour: The animals are easily startled. When fleeing, a group typically gathers in tight formation, with many animals leaping simultaneously and often working the sea into a froth. They may also swim slowly, causing little disturbance of the water and exposing little of themselves at the surface. Breaching, belly-flopping, side-slapping, and lobtailing are fairly common. They may bow-ride but usually avoid boats (Carwardine, 1995).

Habitat: Northern right-whale dolphins are observed most often in cool, deep, offshore waters over the continental shelf and beyond, in sea-surface temperatures of 8-9°C. They are sometimes seen near shore, especially where deep water approaches the coast (underwater canyons), and apparently prefer "coastal-type" waters in the California Current system (Jefferson et al. 1994 and refs. therein; Carwardine, 1995). Ferrero (1998) concluded that in the central North Pacific, sea surface temperature was the most influential habitat parameter examined, *L. borealis* occupying the warmest waters, *P. dalli* the coolest, and *L. obliquidens* in between. Habitat partitioning was best expressed by mature female *L. borealis* in July, during their calving period, when they associated with a consistent assemblage of other marine organisms.

Schooling: Northern right whale dolphins are highly gregarious. They are occasionally seen singly but more often in groups of up to 2,000-3,000. Average herd sizes are about 100 in the eastern Pacific and 200 or more in the western Pacific (Jefferson et al. 1994 and refs. therein). These groups commonly mix with other marine mammals, especially Pacific white-sided dolphins, with which they share a nearly identical range (Jefferson et al. 1993). They also associate with pilot whales and Risso's dolphins. Travelling speed may reach 40 km per hour (Lipsky, 2009).

Reproduction: Males become sexually mature at about 9.9 years and females at 9.7 years (Ferrero and Walker, 1993). There appears to be a calving peak in winter to early spring (Jefferson et al. 1993). Iwasaki and Kasuya (1997), however, observed a calving peak between June and August.

Food: Although squid and lanternfish are the major prey items for right-whale dolphins off southern California, a variety of surface and mid-water species are taken (Jefferson et al. 1993). Chou et al. (1995) reported that stomach contents in two *L. borealis* consisted of 89% myctophid fish. Other prey species include hake, saury and mesopelagic fish (Lipsky, 2009 and refs. therein). Ohizumi and Kato (2004) find that the prey of northern right-whale dolphins and Pacific white-sided dolphins are closely similar; both feeding mainly on myctophids in the central North Pacific. Both species are distributed in the transitional zone, suggesting a potential competition for food.

5. Migration

Movements south and inshore in winter months and north and offshore in summer months have been reported for both sides of the Pacific. Peak periods of abundance off southern California coincide with peak occurrence there of market squid (*Loligo opalescens*; Jefferson et al. 1994 and refs. therein).

Forney and Barlow (1998) studied seasonal abundance and distribution of cetaceans within 185-280 km of the California coast during 1991 and 1992. Northern right-whale dolphins were significantly more abundant in winter than in summer, and significant inshore/offshore differences were identified. In winter, northern right-whale dolphins were widespread throughout the continental shelf region of the Southern California Bight, but no sightings were made there in summer. This is in agreement with Carretta et al. (2000), who found that off San Clemente Island, *L. borealis* were only present between November and April. During both seasons they were commonly observed off central and northern California, and in summer they were also observed off Southern California near the offshore edge of the study area. This evidence for a winter influx of northern right whale dolphins into shelf waters of the Southern California Bight in 1991-1992 is consistent with similar findings made during the late 1970s (Barlow, 1995).

6. Threats

Direct catch: In the western Pacific, coastal fisheries off Japan have taken them for many years, with 465 reported killed in the harpoon fishery in 1949. Although this fishery mainly targets other small cetaceans, northern right-whale dolphins continue to be taken (Jefferson et al. 1994 and refs. therein; Lipsky, 2009).

Incidental catch: Northern right-whale dolphin mortality in the California drift gillnet fishery for broadbill swordfish, *Xiphias gladius*, and common thresher shark, *Alopias vulpinus*, was estimated at 151 individiuals in 1996 to 2002 (Caretta et al. 2004). However, in recent years, the mortality has dropped drastically and the average estimate is now 3.8 (CV=0.83) taken annually in commercial fisheries in eastern US Pacific waters (Caretta et al. 2008).

L. borealis has experienced very high levels of fishery-induced mortality in international high-seas, large-scale driftnet fisheries, from about 38°N to 46°N, and 171°E to 151°W. Assessing the impact of this mortality is difficult, however, because of the possible existence of a coastal population off California and the Pacific Northwest that is separate from offshore populations (Dizon et al. 1994). Northern right-whale dolphins have also been observed entangled in net debris in the western Pacific (Jefferson et al. 1994 and refs. therein).

Total numbers killed by the North Pacific squid driftnet fleets of Japan, Taiwan, and South Korea in the late 1980s were estimated at about 15,000-24,000 per year, and this mortality is considered to have depleted the population to 24-73% of its pre-exploitation size (Mangel, 1993). This order of magnitude was confirmed by Ferrero et al. (2002), who reported on having analysed biological specimens collected by observers monitoring Japanese squid driftnet fishing operations, consisting of 805 northern right-whale dolphins incidentally taken in 800 observed gillnet sets.

The UN moratorium on large-scale high-seas driftnets that came into effect in 1993 is likely to have relieved this pressure to a considerable extent, but the continued use of driftnets to catch billfish, sharks, squid, and tuna inside the exclusive economic zones (EEZ) of North Pacific countries presents an ongoing threat. Furthermore, continued illegal fishing on the high-seas results in the killing of unknown numbers of northern right-whale dolphins each year (Hammond et al. 2008). This is especially concerning, as catches of driftnets are highly aggregated. Reporting a kill rate of a fraction of an animal per unit of effort assumes that driftnets "cull" the population of animals and masks the more important effect of large, simultaneous kills of large fractions of pods, families, or other reproductive units. In addition, aggregated catches may lead to underestimates of the necessary level of observer effort (Mangel, 1993).

Pollution: The effects of habitat degradation and pollution on right-whale dolphins are largely unknown, but their pelagic habitat is probably safer from contaminant effects than coastal areas are. The seasonal shoreward movements of right whale dolphins may put them at increased risk during certain times of the year (Jefferson et al. 1994; Lipsky, 2009). For example, Minh et al. (2000) found concentrations of polychlorinated biphenyls (PCBs) in one individual, at higher levels than those found to lead to immunosuppression in harbour seals.

7. Remarks

Range states (Hammond et al. 2008): Canada; Japan; Mexico; Russian Federation; United States of America.

L. borealis is categorized by the IUCN as "Least Concern" (Hammond et al. 2008). However, the enormous variability associated with the estimates of population size create difficulties for "statistically sound analysis" of management plans, as called for by the U.N. resolutions. In addition, depletion caused by high-seas driftnet fisheries could even be greater than the worst-case estimate (Mangel, 1993).

The species is not listed by CMS. However, south-north as well as inshore-offshore movements have been reported from both sides of the Pacific, so *Lissodelphis borealis* seems to be a good candidate for inclusion in App. II of CMS. The species is listed in Appendix II of CITES.

8. Sources (see page 261)

3.29 Lissodelphis peronii (Lacépède,1804)

English: Southern right-whale dolphin
German: Südlicher Glattdelphin
Spanish: Delfín liso austral
French: Dauphin aptère austral

Family Delphinidae

Lissodelohis peronii / Southern right-whale dolphin (© Wurtz-Artescienza)

1. Description

Right whale dolphins are easy to identify at sea because of their distinctive black and white colour and lack of dorsal fin. The southern right whale dolphin has a white ventral patch, which extends high on the posterior flanks. Its back is black, and the white area reaches a high point midway along the body, dipping down at the flipper insertion and covering most of the head and rostrum. Newborn calves are first brown or dark grey and attain adult coloration after the first year of life (Lipsky, 2009). Rarely, melanistic southern right-whale dolphins are observed, e.g. off Kaikoura, New Zealand (Visser et al. 2004), and there have also been observation of all white and partial white, dark or grey animals. Size reaches ca. 3 m, males growing larger than females, and body mass reaches up to 116 kg (Lipsky, 2009).

2. Distribution

The southern right whale dolphin is circumpolar in the Subantarctic Zone, mainly between 40°S and 55°S. It ranges north to 25°S off São Paulo in Brazil, 23°S in the Benguela Current off Walvis Bay in Namibia, the Great Australian Bight, the Tasman Sea, the Chatham Islands, and 12°30'S in the Humboldt Current off Pucusana in Peru (Rice, 1998; Clarke, 2000).

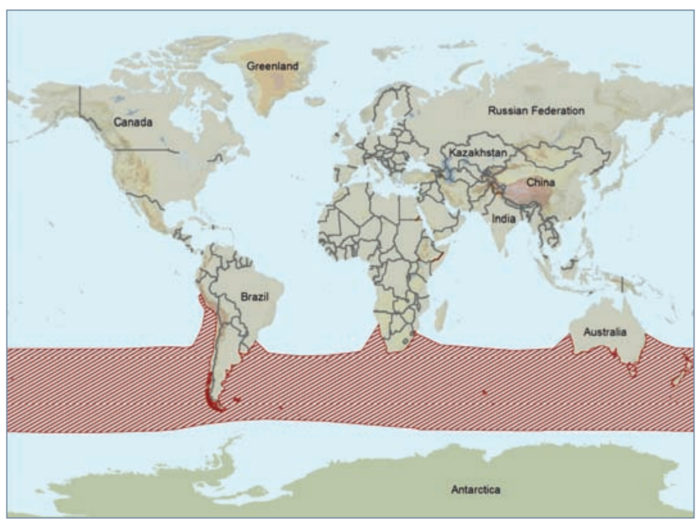
L. peronii remains almost exclusively in temperate waters, with most records from north of the Antarctic Convergence. It frequently follows the cold Humboldt Current into subtropical latitudes, as far north as the northernmost record of 12°S off Peru. The southernmost limit of the range varies with sea temperatures from year to year. The species seems to be fairly common in the Falklands Current between Patagonia and the Falkland Islands (Malvinas) and is believed to occur across the southern Indian Ocean following the West-wind Drift (Jefferson et al. 1994; Carwardine, 1995; Jefferson et al. 1993).

3. Population size

There are no estimates of abundance for the southern right whale dolphin, and virtually nothing is known of the subpopulation structure or status of the species (Hammond et al. 2008). Preliminary boat surveys and the rapid accumulation of stranding and fishery interaction records in northern Chile suggest that it may be one of the most common cetaceans in this region (Jefferson et al. 1994 and refs. therein; Van Waerebeek et al. 1991). Aguayo et al. (1998) reported that *L. peronii* is very common between Valparaiso and 76°W, i.e. just off the Chilean coast. Ross (2006) observed the species at sea many times to the southeast of New Zealand.

4. Biology and Behaviour

Behaviour: *L. peronii* often travels very fast in a series of long, low leaps; the overall impression is of a bouncing motion rather like a fast-swimming penguin. It sometimes swims slowly, causing little disturbance of the water and exposing only a small part of its head and dark back when surfacing to breathe. Breaching (but with no twisting or turning in the air), belly-flopping, side-slapping, and lobtailing have been observed. Dives may last 6 minutes or more. Some schools will



Distribution of Lissodelphis peronii: deep, cold temperate waters of the southern hemisphere (Hammond et al. 2008; © IUCN Red List).

allow close approach, but others flee f rom boats. Small groups will bow-ride on rare occasions (Carwardine, 1995).

Habitat: Southern right whale dolphins are observed most often in cool, deep, offshore waters with temperatures of 1-20°C. *L. peronii* is seldom seen near land except in sufficiently deep water; however, it is known to occur in coastal waters off Chile and near New Zealand where water is deeper than 200 m (Jefferson et al. 1994; Carwardine, 1995; Jefferson et al. 1993).

Schooling: Large schools are characteristic. Some estimates of group size range to over 1,000 animals. Associations with other marine mammal species are common, especially dusky dolphins and pilot whales (Jefferson et al. 1993). Mean herd size is 210 individuals for southern right whale dolphins off Chile (Van Waerebeek et al. 1991).

Off Kaikoura, New Zealand, mixed-species groups included common dolphins (*Delphinus delphis*), dusky dolphins (*Lagenorhynchus obscurus*) long-finned pilot whales (*Globicephala melas*), and bottlenose dolphins (*Tursiops truncatus*) (Markowitz, 2004).

Food: A variety of fish and squid have been reported as prey; lanternfish are especially common (Jefferson et al. 1993).

Reproduction: In Golfo Nuevo, Peninsula Valdes, Argentina, an unusual dolphin was sighted several times, always associated with dusky dolphins (*L. obscurus*). Photographic and behavioural evidence showed that the anomalous dolphin shared characteristics of the southern right whale dolphin and the dusky dolphin and may have been a hybrid (Yazdi, 2002).

5. Migration

There is some suggestion of inshore and northward summer movements by southern right whale dolphins from sighting records off South Africa; however other authors suggested that southern right whale dolphins may be year-round residents off Namibia, southern Africa (Rose and Payne, 1991). Although the sample size is still small, more fresh specimens and sighting records have been registered north of 25°S off western South America in July-September than in all other months combined, suggesting a northern migration in the austral winter and spring (Jefferson et al. 1994 and refs. therein; van Waerebeek et al. 1991).

6. Threats

Direct catch: Southern right whale dolphins are reported to be infrequently caught off the coasts of Peru and Chile, where they are used for human consumption or crab bait (Jefferson et al. 1994 and refs. therein).

Incidental catch: The only incidental catch of any magnitude that is known is in the swordfish gillnet fishery off Chile (Hammond et al. 2008), an ongoing problem. Peddemors (1999) reported that *L. peronii* appears to be extremely localised in distribution within southern Africa, and any future planned expansion of commercial driftnet fisheries off Namibia should be carefully monitored for incidental catches which may impact this population.

7. Remarks

Range states (Hammond et al. 2008): Argentina; Australia; Bouvet Island; Brazil; Chile; Falkland Islands (Malvinas); French Southern Territories (the); Mozambique; Namibia; New Zealand; Peru; Saint Helena (Ascension, Tristan da Cunha); South Africa; South Georgia and the South Sandwich Islands; Uruguay.

L. peronii is listed as "Data Deficient" by the IUCN (Hammond et al. 2008). It is not listed by CMS. The species is listed on Appendix II of CITES.

Migrations along the coast of South America and Southern Africa suggest that national boundaries might be crossed. Therefore, inclusion in CMS Appendix II is recommended.

This is a poorly known species which seems to be threatened mainly by driftnet fisheries in Chilean and South African waters. Because no population estimates are available, mortality rates and their effect on the population are unknown. More research is clearly needed.

For South American stocks, see further recommendations in Hucke-Gaete (2000 in Appendix I).

8. Sources (see page 262)

Genus Mesoplodon - Beaked whales: Introduction

Mesoplodont whales are relatively small, ranging in size between 3.9 and 6.2 m. Their body is spindle-shaped, with a small, triangular dorsal fin located about two thirds between the beak and the tail. The flippers are small and narrow and fit into pigmented depressions in the body. The unnotched flukes are usually straight across the trailing edge or even slightly convex. A single pair of external throat groves may aid in suction feeding. The head is small and tapered and the melon is also small, blending into the beak without a crease. The blowhole is semicircular with the ends pointed forward. Most species show sexual dimorphism, as only adult males have functional teeth (tusks) and show excessive and conspicuous body scarring resulting from the usage of these teeth by other males in intraspecific fights (Pitman, 2009).

The distribution of many *Mesoplodon* species is known almost entirely from records of stranded individuals. This situation is due to the difficulty in making specific identifications of these animals at sea and the relative rarity of sighting them at all (Mead, 1989). Until today, *M. bowdoini*, *M. perrini*, *M. traversii*, *M. ginkgodens* and *M. hectori* have almost never been identified alive in the wild (Pitman, 2009).

Furthermore, the distributional conclusions that are drawn from stranded animals are tentative due to the likelihood that these animals were diseased and strayed from their normal range. It is only when there is a large sample of strandings that have come from the same area that relatively firm distributional conclusions can be drawn. Care must also be taken in the weight which one gives to negative distributional data. In some cases there may be animals frequenting the waters and stranding upon the shores but there has not been enough cetological research in the area to bring the strandings to the attention of scientists (Mead, 1989).

Unfortunately, correct identification of mesoplodont specimens also seems to be fraught with difficulties. Dalebout et al. (1998) report that to assist in the species-level identification of stranded and hunted beaked whales, they compiled a database of 'reference' sequences from the mitochondrial DNA control region, for 15 of the 20 described ziphiid species. Reference samples for eight species were obtained from stranded animals in New Zealand and South Australia. Sequences for a further seven species were obtained from a previously published report. This database was used to identify 20 'test' samples obtained from incompletely documented strandings around New Zealand. Their analyses showed that four of these specimens (20% !) had initially been misidentified.

Much of the research on mesoplodont whales is fairly recent: *M. peruvianus* was first described in 1991, *M. perrini* in 2002 and *M. bahamondi*, described in 1995, turned out to be the same species described by John Gray in 1874 , as *M. traversii* (Gray, 1874) then forgotten by science since 1875 upon being registered equivocally as a mere synonym of *M. layardii*. There are surely more surprises to be expected.

Population sizes

According to Pitman (2002) so few mesoplodonts have been reliably identified at sea that it is impossible to accurately determine the population status of any species, although, based on stranding data, at least some species may not be as rare as the sightings records suggest. *M. grayi*, *M. layardii* and *M. densirostris* seem to be widespread and fairly common, whereas e.g. *M. bowdoini*, *M. perrini*, *M. traversii* and *M. hectori* are rather rare (Pitman 2009).

The best available abundance estimate of beaked whales for the western North Atlantic stock is 3,196, whereas the estimate for the northern US Atlantic is 2,600 and for the southern US Atlantic 596 (data from 1998, in Waring et al. 2001).

Most published estimates of abundance or density are based on visual line-transect studies that found narrower effective strip widths and lower trackline detection probabilities for beaked whales than for most other cetaceans. Published density estimates range from 0.4 - 44 whales per 1,000 km² for small beaked whales and up to 68 whales per 1,000 km² for large beaked whales (Barlow et al. 2006).

Habitat

According to Pitman (2002) mesoplodont whales normally inhabit deep ocean waters (>2000 m deep) or continental slopes (200-2000 m) and only rarely stray over the continental shelf. Whereas *M. densirostris* is found in all tropical and warm temperate oceans, most species are restricted to one or two broad ocean areas. The distribution of *M. perrini* could be considered localized (C.D.MacLeod, pers. comm. to author, 2003).

Migration

M. layardii may undertake some limited migration to lower latitudes during winter (Pitman, 2002) and *M. bidens* may undergo migration in the eastern Atlantic (MacLeod et al. unpublished).

Food

Mead (1989) reports that all beaked whales feed primarily on deep-water mesopelagic squid, although some fish may also be taken (Pitman, 2002; MacLeod et al. 2003). Most prey are probably caught at depths exceeding 200 m via suction, as the dentition is much reduced and the mouth and tongue are highly adapted for this feeding method (Pitman, 2002). Diving durations of 20-45 min have been reported, after which groups of animals surface together and stay within one body length of each other (Pitman, 2002).

Stomach samples of three beaked whale genera *Hyperoodon*, *Mesoplodon* and *Ziphius* primarily contained cephalopod and fish remains, although some also contained crustaceans. *Mesoplodon* spp. were found to contain the most fish, with some species containing nothing but fish remains, while the southern bottlenose whale (*Hyperoodon planifrons*) and Cuvier's beaked whale (*Ziphius cavirostris*) rarely, if ever, contained fish. Of the cephalopods identified, Histiotheutid, Gonatid, Cranchiid and Onychoteuthid species usually contributed most to prey numbers and biomass. There was a wide range of species and families of cephalopods recorded from stomach contents, with no obvious preference for bioluminescent prey species, vertical migrating prey species or prey species with specific body conditions. Whales of the genus *Mesoplodon* generally contained smaller prey, such as cephalopods under 500 g in weight, compared with other beaked whales. *Hyperoodon* and *Ziphius* frequently contained much larger cephalopods with many important species having a mean weight of over 1000 g. This suggests that the genus *Mesoplodon* occupies a separate dietary niche from *Hyperoodon* and *Ziphius*, which may be an example of niche separation. In contrast, *Hyperoodon* and *Ziphius* appear to occupy very similar dietary niches but have geographically segregated distributions, with *Hyperoodon* occupying cold-temperate to polar waters and *Ziphius* occupying warm-temperate to tropical waters (MacLeod et al. 2003; 2006b).

Threats

Although there has never been a directed fishery, some animals are occasionally taken by opportunistic whalers, or die in drift nets and lost fishing gear, as well as in longline fisheries (Pitman, 2002; 2009). Off the north-east US coast, 46 fishery-related mortalities were observed in the pelagic drift gillnet fishery between 1989 and 1998: 24 Sowerby's, 4 True's and 17 unidentified beaked whales (Waring et al. 2001).

Currently, the biggest threat to mesoplodonts may be anthropogenic noise sources associated with airgun arrays (seismic exploration) and military mid-frequency sonar (2-10 kHz). Necropsies of mass-stranded beaked whales exposed to these sound sources lead to the hypothesis that mortality may be caused by gas-bubble disease induced by behavioural responses to acoustic exposure (Cox et al. 2006; see also p. 238). The authors conclude further that current monitoring and mitigation methods for beaked whales are ineffective for detecting and protecting them from adverse sound exposure. New methods are needed: Moretti et al. (2006) tested passive acoustic detection of beaked whales (*M. densirostris*) using distributed bottom-mounted hydrophones in the Bahamas, a first promising step in that direction.

Evidence from stranded individuals of several similar species indicates that they have swallowed discarded plastic items, which may lead to starvation and eventually death (Taylor et al. 2009).

Individual species accounts see below.

Sources (see page 263).

3.30 Mesoplodon bidens (Sowerby, 1804)

English: Sowerby's beaked whale, North Atlantic beaked whale
German: Sowerby-Zweizahnwal
Spanish: Zifio de Sowerby, ballena picuda de Sowerby
French: Mésoplodon de Sowerby, Baleine à bec de Sowerby

Family Ziphiidae

Mesoplodon bidens / Sowerby's beaked whale (© Wurtz-Artescienza)

1. Description

Adults are bluish grey or slate coloured, with grey to white flanks and belly. Young are generally paler and have fewer scars than adults. The two flattened, triangular tusks of adult males erupt from the lower jaw, at about 37% of mandible length from the tip of the rostrum (Macleod and Herman, 2004; Jefferson et al. 2008). The largest specimen was 5.5 m long (Reidenberg and Laitman, 2009).

M. bidens has one of the most northerly distributions of all the beaked whales, which should help with identification. However, parts of its range overlap with other *Mesoplodon* species, especially Gervais' beaked whale, Blainville's beaked whale, and True's beaked whale, and it is likely to be difficult to distinguish it from these with any certainty at sea (Carwardine, 1995), however documented sightings are reported (Hooker and Baird, 1999).

2. Distribution

Sowerby's beaked whale occurs in the temperate North Atlantic, the distribution range being delimited clockwise from Massachusetts to the Labrador Sea, Iceland, northern Norway south to the Azores, Madeira and the Canary Islands (Jefferson et al. 2008). There are no records off the NW African continent (K. van Waeebeek, pers. comm. 2011).

According to C.D. MacLeod (pers. comm. 2011) Sowerby's beaked whale is known mainly from approx. 150 strandings, an exceptionally high number for the genus. In the western North Atlantic, 11 strandings were reported (Lien and Barry, 1990). Most records stem from the eastern North Atlantic, especially around Britain. However, Carlstroem et al. (1997) observed two Sowerby's beaked whales at 71° 30'N, 04°00'E in the Norwegian Sea. Kinze et al. (1998) reported a stranding from the Danish North Sea coast and Smeenk (1995) found a stranded specimen on the Dutch coast.

Sowerby's beaked whale is unlikely to live in the Baltic Sea, where the water is too shallow (Carwardine, 1995). There is one stranding report from Italy (Carwardine, 1995), but the species is only vagrant in the Mediterranean (Jefferson et al. 2008). Stray specimens have also been recorded from Florida (C.D. MacLeod, pers. comm. 2011). Although there are more recorded strandings of this whale on British and European coasts, its range appears to be generally offshore throughout the cooler parts of the North Atlantic.

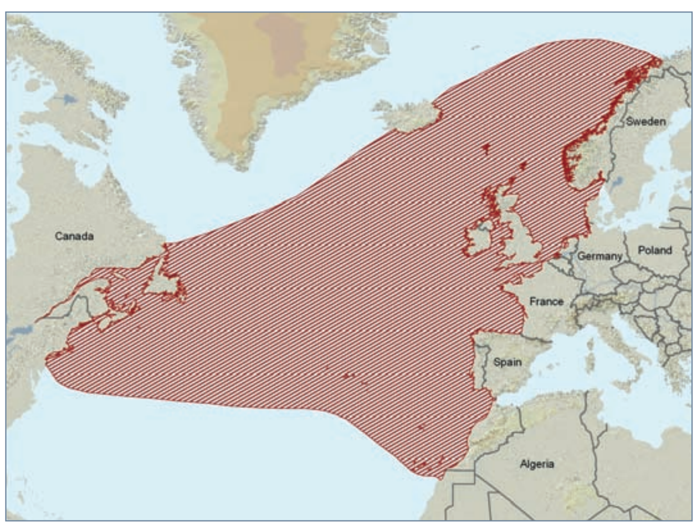
M. bidens is the most northerly recorded mesoplodont species in the North Atlantic, followed by *M. mirus*. The distribution of *Mesoplodon* species may relate to variations in water temperature (MacLeod, 2000).

3. Population size

unknown.

4. Biology and Behaviour

Habitat: Although it is one of the most commonly stranded *Mesoplodon* species, there have been few sightings at sea, and it is poorly known. De Buffrénil (1995b and references therein)



Distribution of Mesoplodon bidens (Taylor et al. 2009; © IUCN Red List): temperate and subarctic waters in the eastern and western North Atlantic (Pitman, 2002).

mentions that two sightings north of Scotland and west of the Orkney Islands were in waters several hundreds of meters deep. Hooker and Baird (1999) observed groups of Sowerby's beaked whales in the Gully, a submarine canyon off eastern Canada, on four occasions in water depths of between 550 and 1500 m.

Behaviour: Hooker and Baird (1999) observed Sowerby's beaked whales to dive for between 12 and 28 minutes. Blows were either invisible or relatively inconspicuous. During all surfacings the long beak projected from the water well before the rest of the head or back was visible. While surfacing behaviour was generally unremarkable, one individual tail-slapped repeatedly.

Schooling: According to De Buffrénil (1995b and references therein) stranded animals usually occur singly. In those cases where two animals stranded together, these were mother-calf pairs. However, at least occasional formation of larger groups is supported by two strandings of *M. bidens* in Newfoundland; one in 1986 with 6 individuals and a second stranding in 1987 which involved 3 whales (Lien et al. 1990). Hooker and Baird (1999) found that group size in the Gully varied from 3 to 10 individuals. A mixed-composition group was observed on one occasion, consisting of at least two female-calf pairs and 2 to 4 adult males (based on the presence of visible teeth and extensive scarring). Another group consisted of three quite heavily scarred, and therefore presumably male, animals.

Food: Stomachs of freshly killed *M. bidens* primarily contained bottom-dwelling deep-water (greater than 400m) fish of between 100 and 200 mm length (Gannon et al. 1998). Ostrom et al. (1993) evaluated the diet of Sowerby's beaked whales based on isotopic comparisons among north-western Atlantic cetaceans and found that the species feeds mostly on small, offshore squid.

5. Migration

Little is known about migration; most northerly animals may migrate with advancing and retreating ice, and some populations may move towards the coasts during summer. Year-round strandings are recorded, but most occur from July to September. Animals probably live some distance offshore (Carwardine, 1995; de Buffrénil, 1995b and references therein).

According to Mead (1989) there does not seem to be any seasonality in the European stranding records. The only country for which enough records exist (n =41) to allow an analysis of seasonality is the United Kingdom. Strandings have been reported in every month except February, with a tendency towards a broad peak in the summer (July-September). According to C.D. MacLeod (pers. comm. 2011) most strandings of Sowerby's beaked whales on eastern coasts of the UK occurred in late summer and autumn which may coincide with a southward movement.

6. Threats

Occasionally, individuals were caught incidentally in fishing gear (De Buffrénil, 1995b), e.g. in Newfoundland small-scale fishery (Jefferson et al. 1993). A number have been incidentally killed by whalers off Newfoundland, Iceland and in the Barents Sea (Jefferson et al. 2008).

Waring et al. (2001) report that for 1989-1998 observed by-catch rates in pelagic drift gillnets along the US East Coast amount to 24 Sowerby's beaked whales. These were caught exclusively in the area from Georges Canyon to Hydrographers Canyon along the continental shelf break and continental slope during July-October. Catches of other beaked whale species were significantly lower.

7. Remarks

Range states (Taylor et al. 2009): Belgium; Canada; Canary Islands (Spain), Denmark; France; Germany; Gibraltar; Iceland; Ireland; The Netherlands; Norway; Portugal; Spain; Sweden; United Kingdom; United States of America (USA).

The species is categorised as "Data Deficient" by the IUCN and is not listed by CMS. Listed in CITES Appendix II.

8. Sources (see page 263)

3.31 Mesoplodon bowdoini Andrews, 1908

English: Andrews' beaked whale
German: Andrews-Zweizahnwal
Spanish: Zifio de Andrews, ballena picuda de Andrews
French: Mésoplodon de Andrews

Family Ziphiidae

Mesoplodon bowdoini / Andrews' beaked whale (© Wurtz-Artescienza)

1. Description

Adult males are black to dark blue all over, except for the tip of the rostrum and the lower jaw, which are white. The two teeth located in the lower jaw are set in raised sockets at about the middle of the beak in the flesh; these erupt only in males. Body scarring indicates fighting between males. A relatively small mesoplodont, body length reaches at least 4.38 m, and one female was estimated to measure 4.87 m (Baker, 2001). The species resembles Blainville's beaked whale, but as opposed to this species, the lower jaw arch is white, less massive and wider (Jefferson et al. 2008). The length at birth is estimated at about 2.20 m (Reidenberg and Laitman, 2009).

2. Distribution

M. bowdoini is known only from 35 specimens and has a southern, circumpolar distribution north of the Antarctic convergence, between 32°S and 54°30'S (Baker, 2001; Van Waerebeek et al. 2004). Most of these have come from the South Pacific and Indian oceans and well over half are from New Zealand (Mead, 1989; Baker, 2001). Strandings have occurred in southern Australia, New Zealand, Tristan de Cunha, the Falkland Islands, Macquarie Island, Argentina and Uruguay. A presumed specimen from Tasmania was re-identified as *M. grayi* (Baker, 2001; Van Waerebeek et al. 2004). The overall range may be circumpolar in the Southern Hemisphere; however, there is a gap in the known distribution between the Chatham Islands, east of New Zealand and the west coast of South America (Taylor et al. 2009).

3. Population size

unknown.

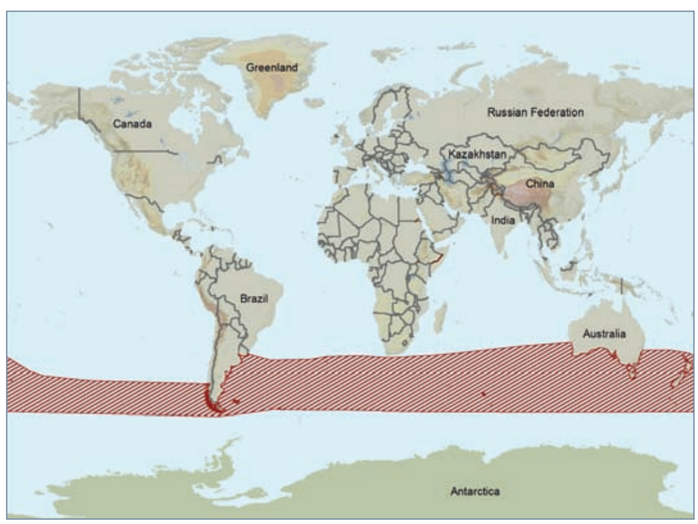
4. Biology and Behaviour

Almost nothing is known about the behaviour of *M. bowdoini*. Lack of sightings in the wild suggests that Andrew's beaked whales are unobtrusive or live away from well-studied areas and possibly both. Their close relationship with Hubbs' beaked whale suggests the two species may have similar behaviour patterns. They are probably extremely difficult to identify at sea, and even stranded animals have been misidentified in the past. The occurrence of fetuses of *M. bowdoini* in May and September, and perinatal juveniles in May and June, indicates a summer-autumn breeding season in the New Zealand region (Carwardine, 1995).

Andrews' beaked whales are assumed to feed primarily on cephalopods, like other members of the genus (Baker 2001). Based on the concentration of stranding records, the waters around New Zealand may represent an area of concentration for the species (Baker, 2001).

5. Migration

Unknown.



Distribution of Mesoplodon bowdoini (Taylor et al. 2009; © IUCN Red List): cool temperate circumpolar waters of the Southern Hemisphere (Jefferson et al. 2008).

6. Threats

Unknown

7. Remarks

Range states: Argentina; Australia; Falkland Islands (Malvinas); New Zealand; Saint Helena (United Kingdom); Uruguay (Taylor et al. 2009).

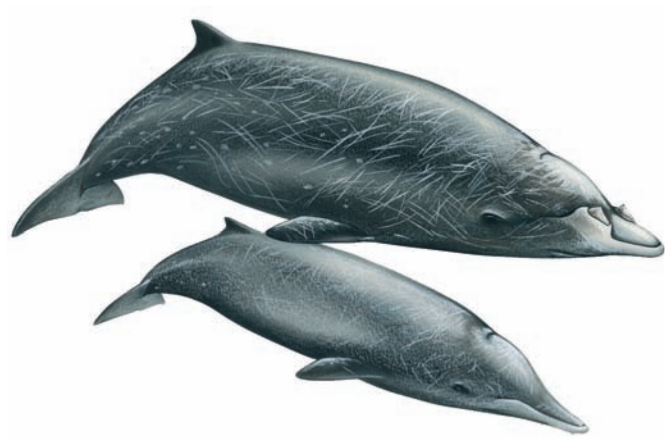
The species is categorised as "Data Deficient" by the IUCN. *M. bowdoini* is not listed by CMS. The species is listed in Appendix II of CITES.

8. Sources (see page 263)

3.32 Mesoplodon carlhubbsi Moore, 1963

English: Hubbs' beaked whale
German: Hubbs-Zweizahnwal
Spanish: Zifio de Hubbs, ballena picuda de Hubbs
French: Mésoplodon de Hubbs, baleine à bec de Hubbs

Family Ziphiidae



Mesoplodon carlhubbsi / Atlantic white-sided dolphin (© Wurtz-Artescienza)

1. Description

Adult females and the young are medium grey which fades through lighter grey to white on the flanks and undersides. Males are dark grey to black, save for a white region from the rostrum's tip and lower jaw to the back of the teeth, and another around the blow hole and over the melon. The beak is fairly short with a strong arch to the lower jaw in adult males. Two prominent teeth erupt in the middle of the lower jaw, but remain concealed in females. The skin may have many scratches from other males' teeth. Both the longest male and the longest female specimens measured 5.3 m. The body mass may attain over 1500 kg (Moore, 1963; Mead et al. 1982; Jefferson et al. 2008).

2. Distribution

Hubbs' beaked whale is found in temperate waters of the North Pacific. In the west it has been recorded from the northeastern coast of Honshu; in the east it is found from Prince Rupert in British Columbia south to San Diego in California (Rice, 1998). According to Houston (1990b) it is known from only 31 stranded specimens and one possible live sighting. Most strandings have been along the North American coast from Prince Rupert, British Columbia to La Jolla, California. Four strandings are recorded from Ayukawa, Japan.

3. Population size

Unknown.

4. Biology and Behaviour

Hubbs' beaked whales feed on squid (including the genera *Gonatus*, *Onychoteuthis*, *Octopoteuthis*, *Histioteuthis*, and *Mastigoteuthis*) and some deepwater fishes (Mead et al. 1982).

5. Migration

Unknown.

6. Threats

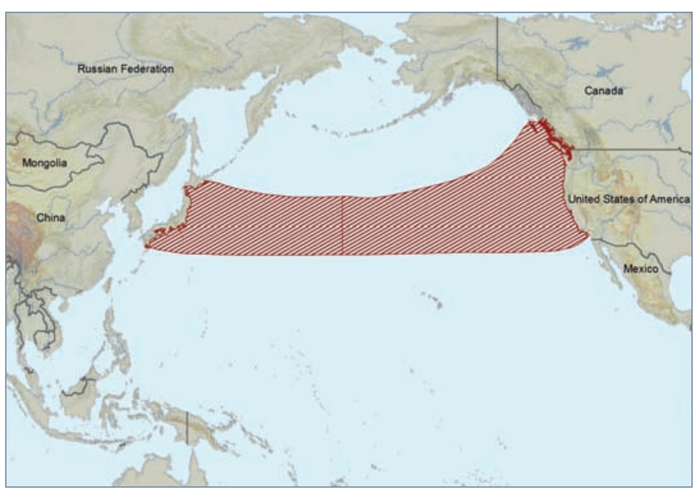
Houston (1990b) assumed that the species is not known to have been, or to be, of interest to commercial fisheries. It was probably protected by its rarity and regional occurrence in North Pacific waters, which are less frequented by fisheries. As opposed to this, Jefferson et al. (1993, 2008) report that some Hubb's beaked whales have been taken by harpoon off Japan. Whale meat products from this species are occasionally found for sale on the Japanese market (Baker et al. 2008). Incidental catches in drift gillnets occur sporadically off the coast of California (Jefferson et al. 2008, Taylor et al. 2009).

7. Remarks

Range states: Canada, USA, Japan (Taylor et al. 2009).

Hubbs' beaked whale is categorised as "Data Deficient" by IUCN and is not listed by CMS. Listed in Appendix II of CITES.

8. Sources (see page 263)

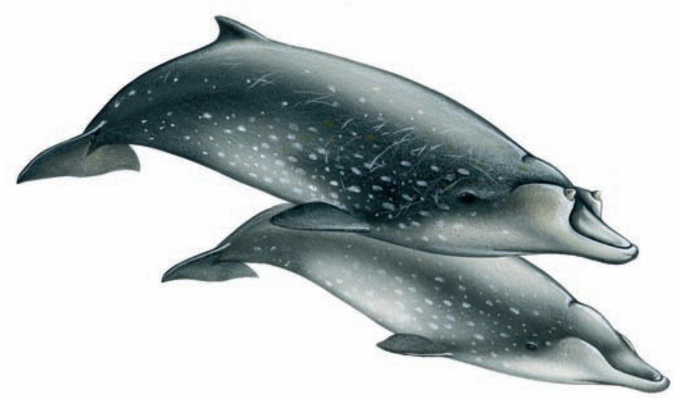


Distribution of Mesoplodon carlhubbsi (Taylor et al. 2009; © IUCN Red List). Hubbs' beaked whale is found in the oceanic temperate North Pacific from California to Japan (Pitman, 2002).

3.33 Mesoplodon densirostris (de Blainville, 1817)

English: Blainville's beaked whale
German: Blainville-Zweizahnwal
Spanish: Zifio de Blainville, ballena picuda de Blainville
French: Mésoplodon de Blainville

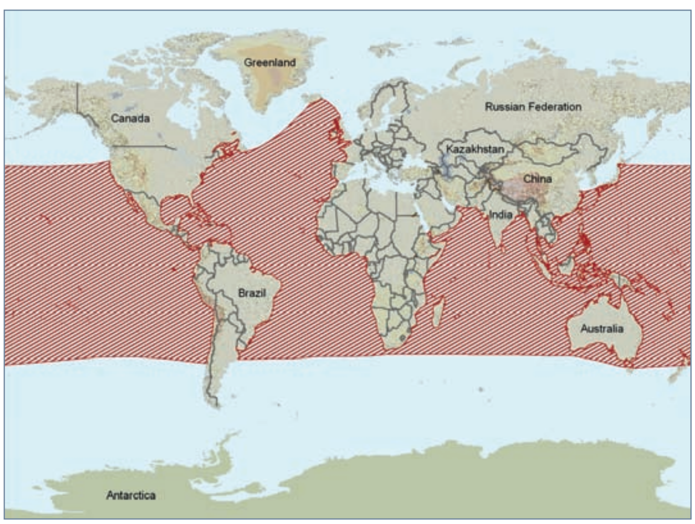
Family Ziphiidae



Mesoplodon densirostris / Blainville's beaked whale (© Wurtz-Artescienza)

1. Description

The main colour pattern of this species is rather inconspicuous, dark above, light below. There is an eye patch which is also dark, with females alone developing both white upper and lower jaws. The lower jaw is highly arched in the same fashion as the Right Whales', with a prominent tooth erupting at the peak of this arch in males, making it very distinctive among mesoplodonts. The dark areas of larger animals tend to have round or oval white scars and widely separated, paired scratches, presumably in males. There often is an orangish sheen (presumably due to diatoms) covering the head. Maximum recorded length has been 4.7 m and body mass reaches up to 1,000 kg (Jefferson et al. 2008; Wang et al. 2006). Females seem to reach sexual maturity at about 9 years age (Pitman, 2009).



Distribution of Mesoplodon densirostris (Taylor et al. 2009; © IUCN Red List). It is found in all tropical and warm temperate oceans and is probably the most widespread and perhaps most abundant Mesoplodont (Pitman, 2009).

2. Distribution

In tropical oceans, *M. densirostris* is one of the more widespread and common beaked whales (Pitman, 2002). Blainville's beaked whale ranges north to Nova Scotia, Wales, Portugal, the western Mediterranean, Japan, Midway Islands, and central California; and south to Rio Grande do Sul in Brazil, South Africa, Tasmania, and central Chile (Rice, 1998). Baker and van Helden (1999) also indicate its presence in New Zealand waters. McAlpine and Rae (1999) report on a stranding in New Brunswick, Canada. Aguayo et al. (1998) report on sightings between Valparaiso and Easter Island in the south-eastern Pacific Ocean.

3. Population size

M. densirostris appears to be widespread and fairly common in tropical oceans, and Pitman (2009) suggests it may be one of the most common mesoplodont species. Estimates of abundance are generally not available for most areas, but there are an estimated 2,138 in Hawaiian waters. In the northern Gulf of Mexico, an estimated 106 mesoplodonts occur, and these are considered to be either *M. densirostris* or *M. europaeus*.

In the eastern Pacific the total abundance is estimated around 30,000 beaked whales of the genus *Mesoplodon* (Taylor et al. 2009 and references therein). Pitman and Lynn (2001) believe that the majority of these are *M. peruvianus* and *M. densirostris*.

4. Biology and Behaviour

Habitat: Macleod and Zuur (2005) investigated habitat utilization in Blainville's beaked whale in the northern Bahamas associated with seabed gradient. The whales preferred gradients from 68 to 296 m/km and depths from 136 to 1,319 m. The authors hypothesize that the relationships between habitat utilization and these topographic variables relates to interactions between a deepwater current and the seabed topography on preferred prey. Locally, prey animals may be concentrated in areas with a northeast aspect, intermediate gradients and depths between 200 and 1,000 m where the Deep Western Boundary Current is forced towards the surface by the local topography. These are the areas where Blainville's beaked whales preferentially occurred.

According to Casinos and Filella (1995 and references therein) *M. densirostris* seems to prefer water depths of 700-1,000 m. Ritter and Brederlau (1999) sighted *M. densirostris* off La Gomera, Canary Islands over mean depths of 320 m, with mean distance from shore of 4.4 km.

McSweeny et al. (2007) investigated site fidelity, patterns of association, and movements of Blainville's beaked whales using a 21-yr photographic data set from the west coast of Hawaii. Resightings of individuals spanned 15 years, suggesting long-term site fidelity to the area. Long-term resightings were documented primarily from adult females: Although repeated associations occurred up to 9 years apart, individuals were seen separately in intervening years. Individuals seen on multiple occasions were typically documented in multiple months-seasons, suggesting they may use the study area throughout the year. Such long-term site fidelity has implications both for potential population structure and for susceptibility of beaked whale populations to anthropogenic impacts.

Behaviour: Baird et al. (2008) investigated diel variation in diving behaviour using time-depth recorders deployed on six Blainville's beaked whales. Deep foraging dives (>800 m) occurred at similar rates during the day and night. Series of progressively shallower 'bounce' dives were documented to follow deep, long dives made during the day; at night whales spent more time at shallow (<100 m) depths. Dives to mid-water depths (100-600 m) occurred significantly more often during the day. This diel variation in behaviour was explained by beaked whales spending less time in surface waters during the day to avoid near-surface, visually oriented predators such as large sharks or killer whales (*Orcinus orca*).

Tyack et al. (2006) used sound-and-orientation recording tags (DTAGs) to show that *M. densirostris* hunt by echolocation in deep water between 222 and 1,885 m, attempting to capture about 30 prey/dive. The food source is so deep that the average foraging dives were deeper (835 m) and longer (47 min) than reported for any other air-breathing species. A series of shallower dives, containing no indications of foraging, followed most deep foraging dives. The average interval between deep foraging dives was 92 min. This duration may be required for beaked whales to recover from an oxygen debt accrued in the deep foraging dives, which last about twice the estimated aerobic dive limit.

These results confirm earlier findings by Baird et al. (2006) who investigated beaked whales in Hawaiian waters using suction-cup-attached time-depth recorders. Blainville's beaked whales were found over median depth of 922 m and regularly dove for 48-68 min to depths greater than 800 m (maximum 1408 m).

Schooling: Group sizes are small and most groups had only a single adult male present. Repeated associations between adult females and adult males were documented for all resightings of adult males over periods from 1 to 154 d (McSweeny et al. 2007).

Most strandings involved single individuals, although groups between 3 and 7 animals were observed in tropical waters (Jefferson et al. 1993). Ritter and Brederlau (1999) estimated group size to range from 2 to 9 individuals (mean 3.44). Adult males and calves were both observed during many encounters.

Food: Individual Blainville's beaked whales stranded on the Canary Islands had eaten both fish and cephalopod prey. The most numerous prey remains belonged to gadid fish. This is consistent with the limited published data on diet in these species, with *Mesoplodon* species having a relatively higher proportion of fish in the diet whereas *Ziphius* specialises on cephalopods (Santos et al. 2007).

5. Migration

Unknown.

6. Threats

Direct catches: According to Houston (1990c), the species is of no commercial interest. However, Dolar et al. (1994) investigated directed fisheries for marine mammals in the Philippines, where small cetaceans, including *M. densirostris* are taken around Pamilacan Island by hand harpoons or togglehead harpoon shafts shot from modified, rubber-powered spear guns. Around 800 cetaceans are taken annually at seven sites, mostly during the inter-monsoon period of February-May. The meat is consumed or sold in local markets and some skulls are cleaned and sold as curios. Although the Department of Agriculture issued Fisheries Administrative Order No. 185 on 16 December 1992: 'banning the taking or catching, selling, purchasing, possessing, transporting and exporting of dolphins', the order did not stop dolphin and whale hunting but seems to have decreased the open sale of dolphin meat in the market (Dolar et al. 1994).

Similarly, Baker et al. (2006) report the results of molecular monitoring of 'whalemeat' markets in the Republic of (South) Korea based on nine systematic surveys from February 2003 to February 2005. The only legal source of these products was assumed to be incidental fisheries mortalities ('bycatch') as reported by the government to the IWC. Species identification of 357 products using mitochondrial DNA control region or cytochrome b sequences and the web-based programme "DNA-surveillance" also included Blainville's beaked whales.

Incidental catches: Jefferson et al. (1993) report that some specimens have been taken in the North Pacific by Taiwanese whalers, and accidentally by Japanese tuna fishermen in the Indian ocean. Forney and Kobayashi (2007) report on by-catch of a Blainville beaked whale in the Hawaii-based longline fishery.

Pollution: Concerns regarding the impact of man-made debris in the marine environment are increasing. Pollution in the form of plastic debris has been recognised as a major threat to marine wildlife, in terms of ingestion and entanglement. In 1993, a 419 cm adult female Blainville's beaked whale stranded near Sao Jose do Norte, southern Brazil had a bundle of plastic threads occupying a large part of the main stomach chamber. Both stomach and intestines were completely free of parasites as well as food remains and faeces, indicating that the whale had not fed for some time. Mistaken ingestion of debris due to its resemblance to preferred prey is usually not thought to occur in odontocete cetaceans because of their echolocation capabilities. The ingested plastic may have resulted in a false sensation of satiation for the animal, which could have reduced the whale's appetite and meal size. In turn, this would have compromised the energy consumption and health of the animal and subsequently (at least indirectly), led to the death of the whale (Secchi and Zarzur, 1999).

One individual stranded in the Mediterranean sea was investigated with respect to chlorinated hydrocarbons. Levels found were lower than in other cetacean species (Jefferson et al. 1993).

Naval exercises: At least one animal died in September 2002 during a naval exercise conducted around Gran Canaria, Spain (Martin et al. 2003). Another two specimens live stranded during a naval exercise off The Bahamas in March 2000 (Waring et al. 2001). High intensity Low Frequency Active Sonar (LFAS) was used by US and NATO vessels in both these areas, respectively, which led to a multi species mass stranding also including *Ziphius cavirostris*.

As a preventiv measure, Moretti et al. (2006) report that passive sonar detection of beaked whales has become increasingly important as part of the Office of Naval Research (ONR) Marine Mammal Monitoring on Navy Range (M3R) program. There is hope that based on these real-time data, trained observers can verify the species on site and in time to avoid further impacts.

7. Remarks

Confirmed and inferred Range states (Taylor et al. 2009): Angola; Australia; Bahamas; Belize; Brazil; Cameroon; Canada; Cape Verde; Cayman Islands; Chile; China; Cocos Islands; Colombia; Comoros; Costa Rica; Ecuador; Fiji; Guam; Guatemala; Guyana; Honduras; India; Indonesia; Japan; Kenya; Kiribati; Madagascar; Malaysia; Marshall Islands; Mauritania; Mauritius; Mayotte; Micronesia, Federated States of; Morocco; Mozambique; Myanmar; Namibia; Nauru; New Caledonia; New Zealand; Nicaragua; Nigeria; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Portugal; Réunion; Saint Helena; Sao Tomé and Principe; Seychelles; Solomon Islands; Somalia; South Africa; Spain; Sri Lanka; Taiwan, Province of China; Tanzania; Tokelau; Tonga; United Kingdom; United States of America; Uruguay; Vanuatu; Venezuela; Viet Nam; Wallis and Futuna; Western Sahara; Yemen.

For recommendations on South American stocks, please see Hucke-Gaete (2000) in Appendix 1 and for south-east Asian stocks Perrin et al. (1996) in Appendix 2.

IUCN status: "Data Deficient". The species is not listed by CMS. Listed in Appendix II of CITES.

8. Sources (see page 263)

3.34 Mesoplodon europaeus (Gervais, 1855)

English: Gervais' beaked whale
German: Gervais-Zweizahnwal
Spanish: Zifio de Gervais, ballena picuda de Gervais
French: Mésoplodon de Gervais, baleine à bec de Gervais

Family Ziphiidae

Mesoplodon europaeus / Gervais' beaked whale (© Wurtz-Artescienza)

1. Description

Gervais' beaked whales are generally dark grey, with pale grey on the undersides. The triangular teeth of the male are found one third behind the tip of the beak on the lower jaw (Norman and Mead, 2001; Jefferson et al. 2008). *M. europaeus* measures 3.7 - 5.2 m and reaches a body mass of at least 1,200 kg (Reidenberg and Laitman, 2009).

2. Distribution

Gervais' beaked whale occurs mainly in the North Atlantic from Cape Cod to Ireland and the English Channel south to southern Brasil, Guinea Bissau and as far south as Angola (Norman and Mead, 2001; Jefferson et al. 2008, Macleod, 2000).

While the distribution is inferred mainly from 54 strandings (Mead, 1989), newer records seem to indicate a larger distribution in the temperate waters of the North Atlantic, not only near Florida and on the eastern coast of central America, but also in the Gulf Stream, the Canary Islands and in currents north of the equator. According to Robineau (1995) European seas seem to mark the end of the distributional area, but stranded specimens are reported from the Canary Islands (Martin et al. 2001), the Azores (Reiner et al. 1993), Guinea Bissau (Reiner, 1980) and Mauritania (Robineau and Vely, 1993) which confirms the wider distributional range. Moore et al. (2004) report on a stranded specimen in Cape Cod Bay, which in the western North Atlantic seems to mark the northernmost limit of the distribution.

3. Population size

Unknown.

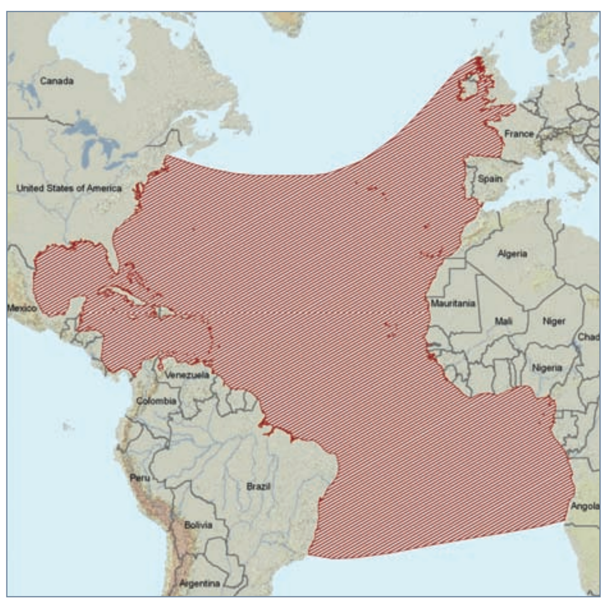
4. Biology and Behaviour

Mead (1989) suggests that Gervais' beaked whale prefers deep waters, which is deduced from lack of sightings nearshore. However, there are few observations at sea to test this hypothesis. Strandings suggest that the species prefers tropical and subtropical waters. There are only a few sightings in the wild (Jefferson et al. 2008).

According to Jefferson (1993) Gervais' beaked whale seems to feed on squid. However, Santos et al. (2007) report that a stranded animal from the Canary Islands had eaten both fish and cephalopod prey. The most numerous prey remains belonged to viperfish (*Chauliodus* sp.). These results are consistent with the limited published data on diet in *Mesoplodon* species which suggest a relatively higher proportion of fish in their diet whereas e.g. *Ziphius cavirostris* specialises on cephalopods.

5. Migration

Unknown.



Distribution of Mesoplodon europaeus (Jefferson et al. 2008; Taylor et al. 2009; © IUCN Red List). Gervais' beaked whale prefers warm temperate and tropical waters mostly in the North Atlantic but also somewhat south of the equator.

6. Threats

There is a record of one specimen having been taken in a pound net off New Jersey and others may have been taken in Caribbean small cetacean fisheries (Jefferson et al. 1993).

From 1992 to 1998 a total of 49 beaked whales stranded along the US Atlantic coast between Florida and Massachusetts (NMFS unpublished data). This included 28 Gervais' beaked whales, which was the most frequently affected species (Waring et al. 2001). Furthermore, several unusual mass strandings of beaked whales, including also Gervais' beaked whales, were associated with naval activities: Mid to late 1980's on the Canary Islands (Waring et al. 2001), and again in September 2002 during a naval NATO manoeuvre involving low frequency sonar around the Canaries (Martin et al. 2003).

Cook et al. (2006) confirm, that *M. europaeus* is most sensitive to high frequency signals between 40 and 80 kHz, but produced smaller evoked potentials to 5 kHz, the lowest frequency tested. The beaked whale hearing range and sensitivity are similar to other odontocetes that have been measured.

Evidence from stranded individuals of several species, including *M. europaeus*, indicates that they have swallowed discarded plastic items, which may eventually lead to death (e.g. Scott et al. 2001).

7. Remarks

Known and inferred Range states (Taylor et al. 2008): Bahamas; Brazil; Cape Verde; Cuba; France; Guinea-Bissau; Ireland; Jamaica; Mauritania; Saint Helena; Spain; Trinidad and Tobago; United Kingdom; United States of America.

Categorised as "Data Deficient" by IUCN. Gervais' beaked whale is not listed by CMS but is listed in Appendix II of CITES.

8. Sources (see page 263)

3.35 Mesoplodon ginkgodens Nishiwaki and Kamiya, 1958

English: Ginkgo-toothed beaked whale
German: Japanischer Schnabelwal
Spanish: Zifio de Nishiwaki, Ballena picuda de Nishiwaki
French: Mésoplodon de Nishiwaki, baleine à bec de Nishiwaki

Family Ziphiidae

Mesoplodon ginkgodens / Ginkgo-toothed beaked whale (© Wurtz-Artescienza)

1. Description

The species has almost never been identified in the wild (Pitman 2009). Adult males are dark grey but females are lighter with pale undersides. The teeth on the lower jaw are found towards the middle of the beak, posterior to the mandibular symphysis, and barely break the gumline in mature males. Thus, the teeth are not involved in fights (Nishiwaki and Kamiya, 1958; Jefferson et al. 2008). This is reflected by a lack of scarring in males, which may not stem from a lack of aggression between males as suggested by Carwardine (1995). It is unclear whether females share the pale beak. Adults show white spots on the back and ventral surfaces, presumably marks of parasitic fishes (lampreys, cookie-cutter sharks). Maximum known sizes are 5.3 m for both males and females (Jefferson et al. 2008).

2. Distribution

Ginkgo-toothed whales are found in the tropical and warm temperate waters of the Indopacific; they have been recorded from Sri Lanka, the Strait of Malacca, Taiwan, Kyushu, the Pacific coast of Honshu, New South Wales, the Chatham Islands, southern California, the west coast of northern Baja California Sur, and the Galapagos Islands (Rice, 1998).

Palacios (1996) summarised that *M. ginkgodens* is only known from 15 stranding records. Of these, eight are from the western North Pacific (Japan and Taiwan), three from the South Pacific (one from the Chatham Islands and two from Australia), and two from the Indian Ocean (Sri Lanka and Indonesia). The remaining two records are from the eastern North Pacific: a female stranded at Del Mar, California, US, in 1954 and a skull collected on 30 December 1980 at Playa Malarrimo, outside Laguna Ojo de Liebre (Scammon's Lagoon), Baja California, Mexico. There is an additional record of a specimen from the Galapagos Islands, Ecuador, eastern tropical Pacific (Palacios, 1996).

Furthermore, Anderson et al. (1999) report on recent strandings on the Maldives in the Indian Ocean. However, Baker and van Helden (1999) showed that a tooth collected from the Chatham Islands that was considered to be *M. ginkgodens* was in fact *M. grayi*. And a specimen from White Island (New Zealand) thought to be *M. ginkgodens* was subsequently shown to be *M. traversii* (van Helden et al. 2002).

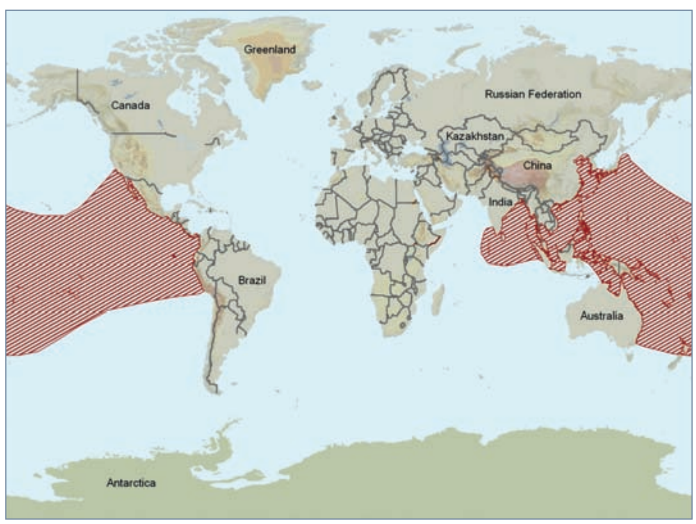
Nevertheless, two confirmed strandings of *M. ginkgodens* have occurred in New Zealand, the first at Onaero Beach, Taranaki, in 2003 and the second at Puponga, Golden Bay, in 2004. Both animals were mature males measuring 4.8 m (A. van Helden, pers. comm.).

3. Population size

Unknown.

4. Biology and Behaviour

The Ginkgo-toothed beaked whale is very poorly known. Nothing is known about its behaviour, but it is likely to be unobtrusive. Probably *M. gingkodens* occurs in small groups. Confusion is most likely with other beaked whales, such as



Distribution of Mesoplodon ginkgodens (Taylor et al. 2009; © IUCN Red List): tropical and warm temperate waters of the Indian and Pacific Oceans (Pitman, 2002).

Blainville's, Andrews', Hubbs', Stejneger's and Cuvier's beaked whales (Carwardine, 1995).

Food presumably consists of squid and fish (Jefferson et al. 2008).

5. Migration

Unknown.

6. Threats

A few animals have been taken off the coast of Japan (Jefferson et al. 1993) by Japanese and Taiwanese whalers (Taylor et al. 2009) and some have been taken in deep water drift gillnets (Jefferson et al. 2008).

Liu et al (2009) report that blubber samples from one specimen of *M. ginkgodens* collected from Honghai Bay, Guangdong Province, China, showed high PCB toxicity equivalent quantities, in comparison to cetaceans from other marine areas. The mean composition of PCBs in this whale was similar to the chemical Acroclor1254 found in industrial products, which might root in the illegal demolition and stacking of abandoned paint, transformer or electronic equipment.

Wang and Yang (2006) report on several unusual stranding events in Taiwan in early 2004 and in 2005 during large-scale naval exercises in nearby waters. Results of gross post-mortem examination were suggestive that nearby naval exercises may have contributed to or caused the death of at least one cetacean in this region and that species other than beaked whales may also be susceptible to such activities. With an increasing number of military exercises in this region, more attention to the impacts of such activities on cetaceans, as well as preventive measures such as passive acoustic beaked whale detection (e.g. Moretti el at. 2006) followed by acoustic alerting and temporal displacement are needed.

For recommendations on south-east Asian stocks, see also Perrin et al. (1996) in Appendix 2.

7. Remarks

Confirmed and inferred **range states** (Taylor et al. 2009): American Samoa; Australia; Chile; China; Colombia; Cook Islands; Ecuador; Fiji; French Polynesia; India; Indonesia; Japan; Kenya; Kiribati; Marshall Islands; Mexico; Micronesia, Federated States of; Nauru; New Caledonia; New Zealand; Niue; Northern Mariana Islands; Palau; Papua New Guinea; Peru; Philippines; Pitcairn; Samoa; Sri Lanka; Taiwan; Tanzania; Tokelau; Tonga; Tuvalu; United States of America; Vanuatu; Wallis and Futuna.

IUCN status: "Data Deficient". Not listed by CMS. Listed in Appendix II of CITES.

8. Sources (see page 263)

3.36 Mesoplodon grayi von Haast, 1876

English: Gray's beaked whale
German: Gray-Zweizahnwal
Spanish: Ballena picuda de Gray, Zifio de Gray
French: Mésoplodon de Gray

Family Ziphiidae

Mesoplodon Grayi / Gray's beaked whale (© Wurtz-Artescienza)

1. Description

Adults are dark grey, with pale patches on the under-sides. The small head leads to a narrow beak which becomes white in adulthood. The tips of two relatively small, triangular teeth erupt from the lower jaw in males, about one half from the tip of the beak. There are 17-22 pairs of small teeth in the posterior half of the upper jaw. Maximum body size is 5.6 m in males and 5.3 m in females (Jefferson et al. 2008). Body mass in adults reaches 1,100 kg; size of newborn calves ranges between 2.1 and 2.4 m (Reidenberg and Laitman, 2009).

2. Distribution

Gray's beaked whale is circumglobal in cool-temperate waters of the Southern Hemisphere, with specimen records from Argentina (Tierra del Fuego, Chubut, and Buenos Aires), Brazil, Falkland Islands/Islas Malvinas, the Estrecho de Magallanes in Chile, Peru (Paracas), Cape Province in South Africa, 31°S, 47°E, in the Indian Ocean, Western Australia, South Australia, Victoria, New South Wales, Tasmania, New Zealand, Chatham Islands, (Rice, 1998).

There are many sighting records from Antarctic and sub-Antarctic waters, and in the summer months they appear near the Antarctic Peninsula and along the shores of the continent (sometimes in the sea ice; Van Waerebeek et al. 2004; Taylor et al. 2009). Gray's beaked whale is the most common beaked whale species to strand in New Zealand and a cluster of sightings in the area between the South Island of New Zealand and the Chatham Islands may indicate a distributional "hot spot" (Dalebout et al. 2004). There is a record from Brazil (Soto and Vega, 1997), which extends the northern limit of the distribution (Pinedo et al. 2001).

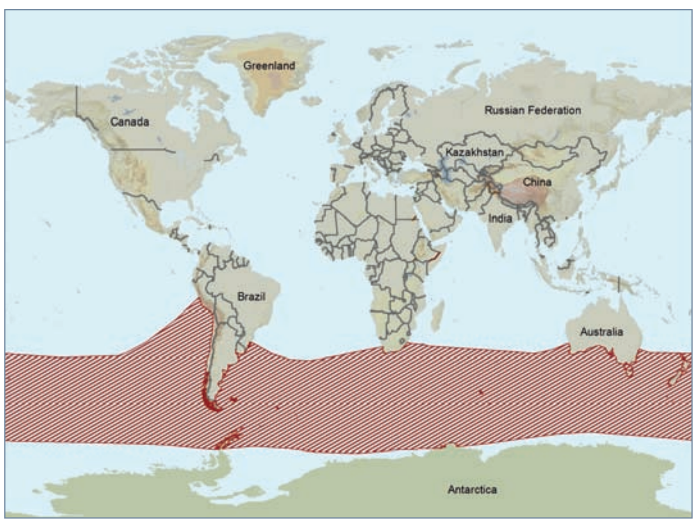
3. Population size

Unknown, although this is one of the more common and widespread mesoplodont whales in the Southern Ocean (Pitman, 2002, 2009). In New Zealand, it is known from both North and South Islands, where it is the second commonest single stranding species after *Kogia breviceps*, with 180 recorded specimens (Van Waerebeek et al. 2004).

4. Biology and Behaviour

The species is rarely seen at sea due to their oceanic distribution, deep diving ability, elusive behaviour, and possible low abundance (Dalebout et al. 2004). There are an increasing number of confirmed sightings reported from the Southern Ocean in a circumpolar distribution (Van Waerebeek et al. 2004), although most available information is still from stranded animals.

M. grayi appears to be social, which is unusual for beaked whales (but see other species accounts). The limited number of sightings suggests that *M. grayi* may be more conspicuous at the surface than other beaked whales: it seems to be more



Distribution of Mesoplodon grayi (Taylor et al. 2009; © IUCN Red List). The species is found in cold temperate waters of the Southern Hemisphere and ranges south into Antarctic waters (Pitman, 2002, Jefferson et al. 2008).

active and may live in larger groups. Most animals were observed singly, in pairs, and in small groups, but a mass stranding of 28 animals in the Chatham Islands, east of New Zealand, in 1874 suggests that fairly large numbers may be encountered together (Carwardine, 1995).

The occurrence of early foetuses in May, near-term foetuses in September, and mother with calves in January-February indicates summer breeding in the New Zealand region (Van Waerebeek et al. 2004).

5. Migration

Unknown, however strandings between 30°S and 50°S occur most frequently from December through March, suggesting an inshore movement in summer (Van Waerebeek et al. 2004).

6. Threats

Ship strike: An adult female observed in Mahurangi Harbour, near Warkworth, on the North Island of New Zealand had a series of deep corrugated scars behind her dorsal fin, likely the result of a ship strike (Dalebout et al. 2004).

7. Remarks

Range states: Argentina; Australia ; Brazil; Chile; Falkland Islands (Malvinas); Heard Island and McDonald Islands; Maldives; New Zealand; Peru; South Africa; South Georgia and the South Sandwich Islands ; Uruguay (Taylor et al. 2009).

The species is categorised as "Data Deficient" by the IUCN. Gray's beaked whale is not listed by CMS, but because it also occurs in southern South America, the recommendations listed in Hucke-Gaete (2000) also apply (see Appendix 1). The species is listed in Appendix II of CITES.

8. Sources (see page 263)

3.37 Mesoplodon hectori (Gray, 1871)

English: Hector's beaked whale
German: Hector-Schnabelwal
Spanish: Zifio de Héctor, ballena picuda de Héctor
French: Mésoplodon de Hector, baleine à bec de Hector

Family Ziphiidae

Mesoplodon hectori /Hector's beaked whale (© Wurtz-Artescienza)

1. Description

Hector's beaked whale appears to be dark grey to brown, with pale grey undersides. Single as well as closely paired scratches and round scars (presumably from cookie-cutter sharks) are common on the flanks. Adult males have a white beak and white forehead, with a small triangular tooth on either side of the lower jaw near the tip. The longest specimens measured 4.3 m (Jefferson et al. 2008).

2. Distribution

Hector's beaked whale appears to be circumglobal in cold temperate waters of the Southern Hemisphere. Specimens were recorded from Tierra del Fuego and Chubut in Argentina, the Falkland Islands/Islas Malvinas, Rio Grande do Sul in Brazil, Cape Province in South Africa, Tasmania, North Island and South Island in New Zealand, and Isla Navarino in Chile (reviewed by Rice, 1998). Previously, it was supposed that this species may also be vagrant in southern California, where several strandings and sightings were reported from 1975 to 1979 (Rice, 1998). However, the California specimens have subsequently been assigned to the new species *M. perrini*, found in the eastern North Pacific (Dalebout et al. 2000, 2002), which confines *M. hectori* to the Southern Hemisphere.

3. Population size

Unknown.

4. Biology and Behaviour

According to Carwardine (1995), with only 2 probable sightings in the wild, there is little information on behaviour. However, this species may be unusual for a *Mesoplodon* because, in both instances, one of the animals seemed inquisitive and actually approached the boat. If this is normal behaviour, it seems strange that there have not been more sightings (unless the species is rare). Pairs may be the typical group size. Hector's beaked whales are known to feed on squid (Jefferson et al. 1993).

5. Migration

Unknown.

6. Threats

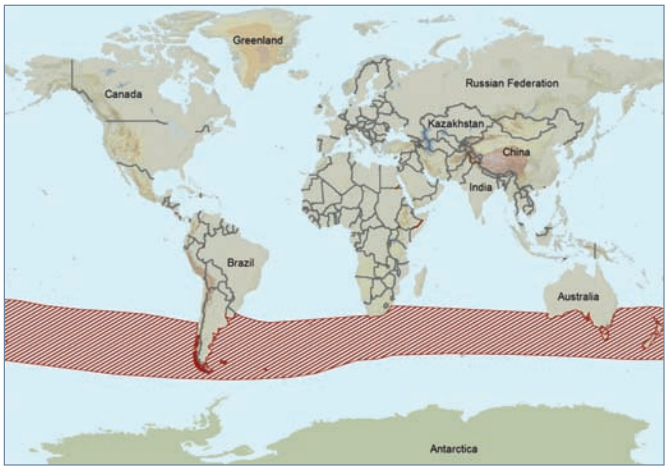
Unknown.

7. Remarks

Range states: Argentina, Australia, Brazil, Chile, Falkland Islands (Malvinas), New Zealand , South Africa, United States of America, Uruguay (Taylor et al. 2009).

Categorised as "Data Deficient" by IUCN. Hector's beaked whale is not listed by CMS. The species is listed in Appendix II of CITES. See recommendations for southern South American cetaceans in Hucke-Gaete (2000) in Appendix 1.

8. Sources (see page 263)

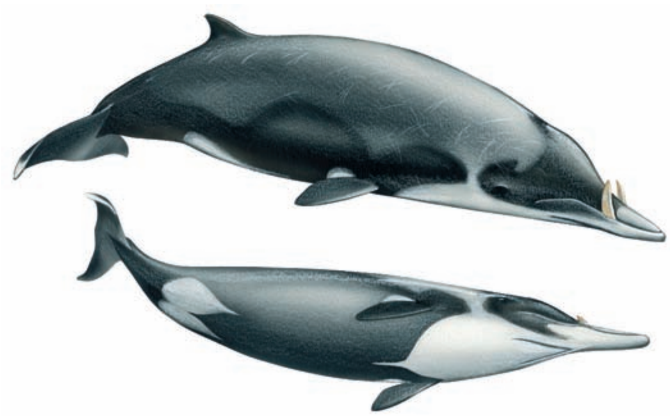


Distribution of Mesoplodon hectori (Taylor et al. 2009; © IUCN Red List): circumpolar in cool-temperate waters of the southern hemisphere (Pitman, 2002; Jefferson et al. 2008).

3.38 Mesoplodon layardii (Gray, 1865)

English: Layard's beaked whale, Strap-toothed whale
German: Layard-Zweizahnwal
Spanish: Zifio de Layard, ballena picuda de Layard
French: Mésoplodon de Layard, baleine à bec de Layard

Family Ziphiidae



Mesoplodon layardii / Layard's beaked whale (© Wurtz-Artescienza)

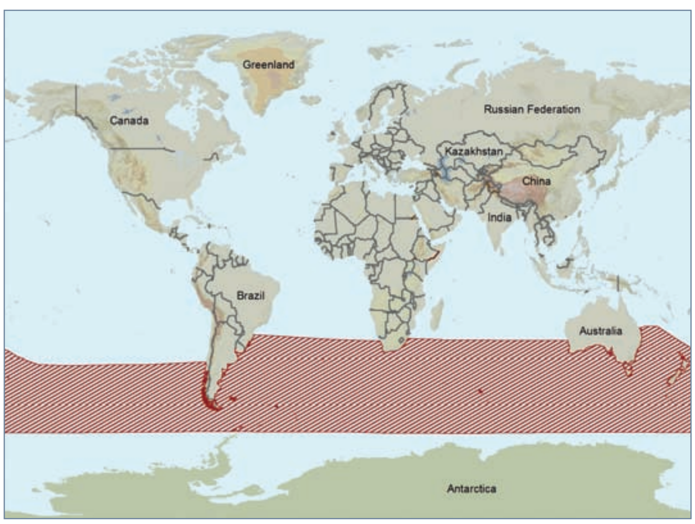
1. Description

M. layardii has a very distinctive black and white pattern (Pitman, 2009): adults are mainly black with patches of grey and white that largely occur in the genital area, around the front of the upper jaw, the lower jaw, throat and chest. There is a grey blaze from the melon to almost two-thirds of the way to the dorsal fin. The long tusks emerge in males in the middle of the lower jaw and curve over the upper jaw, preventing it from opening fully. This bizarre dentition does not, however, seem to interfere with feeding and prey size (see below). Body size reaches 6.2 m and body mass up to 1,300 kg (Jefferson et al. 2008). It is possible that *M. layardii* could be confused with the spade-toothed beaked whale *M. traversii*, due to their very similar dentition (Van Waerebeek et al. 2004).

2. Distribution

Layard's beaked whale occurs throughout the Southern Ocean; it has been recorded from Tierra del Fuego and Chubut in Argentina, Uruguay, the Falkland Islands/lslas Malvinas, Namibia, Cape Province, Iles Kerguélen, Western Australia, South Australia, Victoria, New South Wales, Queensland, Tasmania, New Zealand, and Isla Navarino and the Estrecho de Magallanes in Chile (Rice, 1998). In recent years, several sightings have been reported from Antarctic waters, as well as strandings from Macquarie Island and Heard Island (Van Waerebeek et al. 2004).

The northernmost records of Layard's beaked whale stem from strandings along the southern Brazilian coast (31-32°S; Pinedo et al. 2002).



Distribution of Mesoplodon layardii (Taylor et al. 2009; © IUCN Red List): circumpolar in temperate and sub-Antarctic southern waters (Pitman, 2002).

3. Population size

According to Pitman (2002, 2009) it is one of the more widespread and common beaked whales in the Southern ocean, however some sightings of *M. traversii* may have been equivocally attributed to *M. layardii*.

4. Biology and Behaviour

Behaviour: One of the largest of the beaked whales, the strap-toothed whale is also one of the few *Mesoplodon* species that can be readily identified at sea. It may bask at the surface on calm, sunny days. Generally the animals are hard to approach, especially in large vessels. Their flukes do not normally show above the surface at the start of a dive. Limited observations suggest that strap-toothed whales sink slowly beneath the surface, barely creating a ripple, then rise and blow again 150-200 m away. Typical dive time is 10 to 15 minutes (Carwardine, 1995).

Food: The food habits of strap-toothed whales were examined in detail by Sekiguchi et al. (1996) using stomach contents from 14 whales found stranded on South African and New Zealand coasts. Although a few unidentified fish otoliths and crustacean remains were found in two of these stomachs, 24 species of oceanic squids (some of which occur at great depth) accounted for 94.8% of counted prey items. *Histioteuthis* sp. and *Taonius pavo* were the predominant prey species. The presence of sub-Antarctic squid species suggested a concurrent northward migration to South African waters in late summer/ autumn.

Sekiguchi et al. (1996) also compared prey sizes between males with fully grown strap-teeth and females/immature males without erupted teeth. Although females/immature males ate longer squids than males, there was no significant difference in estimated squid weights eaten by both groups. The presence of fully erupted teeth in adult males, therefore, did not seem to influence the size of prey ingested, even though an adult male could only open its jaws about half as wide as a female.

5. Migration

The seasonality of strandings suggests that this species may migrate (Taylor et al. 2009, Pitman, 2009)

6. Threats

No exploitation of *M. layardii* has been reported (Jefferson et al. 1993; Van Waerebeek et al. 2004).

7. Remarks

Range states (Taylor et al. 2009): Argentina; Australia; Brazil; Chile; Falkland Islands (Malvinas); French Southern Territories (Kerguélen); Heard Island and McDonald Islands; New Zealand; South Africa; Uruguay

IUCN status: "Data Deficient". Not listed by CMS. Listed on CITES Appendix II.

See also recommendations listed in Hucke-Gaete (2000; appendix 1).

8. Sources (see page 263)

3.39 Mesoplodon mirus True, 1913

English: True's beaked whale
German: True-Zweizahnwal
Spanish: Zifio de True, ballena picuda de True
French: Mésoplodon de True, baleine à bec de True

Family Ziphiidae

True's beaked whale / Mesoplodon mirus (© Wurtz-Artescienza)

1. Description

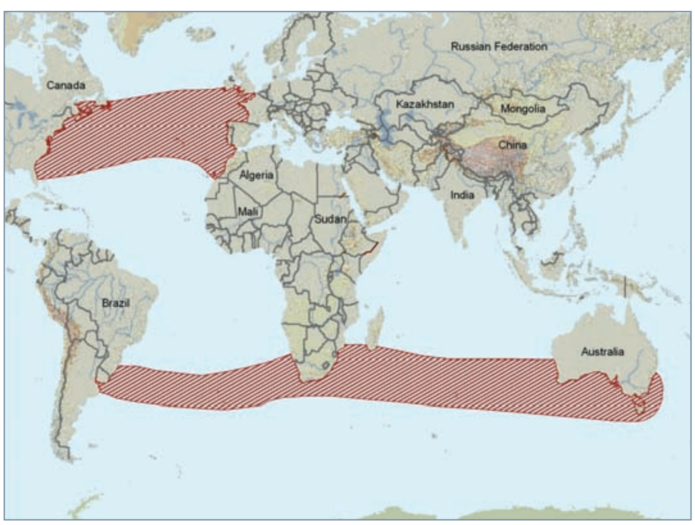
True's beaked whales from the Northern Hemisphere are grey fading to light grey on the undersides. Adults have a dark ring around the eye and some areas of white (Jefferson et al. 2008). Southern Hemisphere adults have an all white tail stock, dorsal fin and flukes (Pitman, 2009). There is little scarring, and observed scars occur in closely spaced parallel lines. The small mandibular teeth are closely spaced almost at the tip of the lower jaw (True, 1913). Adults measure between 4.8 - 5.3 m and reach a body mass of 1400 kg (Reidenberg and Laitman, 2009).

2. Distribution

True's beaked whale is found in the North Atlantic from Nova Scotia and Ireland south to Florida, San Salvador Island in the Bahamas, and Islas Canarias. An often repeated record from the Outer Hebrides (Islands) in Scotland was based on a misidentified *Ziphius cavirostris*. In the Southern Hemisphere it is known from Cape Province in South Africa, Western Australia, and Victoria (Rice, 1998).

True's beaked whales were believed to be found only in the North Atlantic until a specimen was discovered along the Indian Ocean coast of South Africa in 1959. Several other Southern Hemisphere records were noted since then, from South Africa, Australia, and an unconfirmed report from New Zealand. These may represent geographically separate stocks or, alternatively, the range may be more widespread than the few records suggest. Most strandings stem from the western North Atlantic, but a few from the eastern side: mainly from the west coast of Ireland, but also Britain, France, and the Canary Islands. Thus, the species may be associated with the Gulf Stream (Carwardine, 1995; de Buffrénil, 1995a).

The species does not seem to occur within 30° north or south of the equator (antitropical distribution), which may indicate that the northern and the southern populations are reproductively separate, as supported by slight morphological differences (de Buffrénil, 1995a). This suggests subspecific or even specific differentiation, which remains to be confirmed (Jefferson et al. 2008; also see "Genus *Mesoplodon* - Beaked Whales: Introduction and Sources").



Distribution of Mesoplodon mirus (Taylor et al. 2009; © IUCN Red List): warm temperate North and South Atlantic and southern Indian Ocean.

3. Population size

Since there are only about 20 stranding records worldwide, the species seems to be rather rare (de Buffrénil, 1995a, Taylor et al. 2009). However, this may also be explained by its offshore habitat and the difficulty to identify *M. mirus* at sea.

4. Biology and Behaviour

Habitat: Known mainly from stranded specimens, *M. mirus* is probably pelagic, but it can occasionally be seen in coastal waters (Houston, 1990a). Although its preferred habitat is unknown, de Buffrénil (1995a and references therein) suggests that by analogy to other *Mesoplodon* species, it is most likely a pelagic animal. This is supported by the fact that no observations were made close to shore and that stranding events are very rare.

Tove (1995) observed a pod of what he identified as three True's beaked whales 32 nm southeast of Hatteras Inlet, North Carolina and successfully tracked the animals, obtaining photographs that document live coloration and surface swimming habits. The location was in about 600 fathoms (1,100 m) of water, but along a very steep portion of the continental shelf that drops rapidly to just over 1,000 fathoms (1,800 m) before levelling out. Upon discovery, the pod was swimming slowly (ca. 5 km/h) to the SSW, roughly parallel with the fall line of the slope. The location was well within the Gulf Stream, but at an atypically cooler than normal water temperature of 25.4°C. Jefferson et al. (2008) cautioned however that these animals were indistinguishable from Gervais' beaked whale.

Behaviour: Groups observed at sea have consisted of up to three individuals. They may show their beaks when surfacing. In the Bay of Biscay, energetic breaching behaviour with up to 17 repetitions has been observed (Jefferson et al. 2008).

Food: According to Jefferson et al. (1993), stranded animals had squid in their stomachs, but Pitman (2009) suggests that fish may comprise the most important prey items. The species is likely to be a deep diver (Carwardine,1995).

5. Migration

Unknown.

6. Threats

The species is not known to have been commercially exploited (Houston, 1990a; Jefferson et al. 1993). However, there are reported by-catches. The pelagic drift gillnet fishery off the US east coast recorded 46 beaked whale mortalities between 1989 and 1998, 4 of which were True's beaked whales (Waring, 2001).

7. Remarks

Confirmed and inferred **range states** (Taylor et al. 2009): Australia; Bahamas; Bermuda; Brazil; Canada; France; Ireland; Madagascar; Morocco; Mozambique; Portugal; South Africa; Spain; United Kingdom; United States of America.

Categorised as "Data Deficient" by the IUCN. Not listed by CMS but listed in Appendix II of CITES.

8. Sources (see page 263)

3.40 Mesoplodon perrini Dalebout, Mead, Baker, Baker and van Helden, 2002

English: Perrin's beaked whale
German: Perrin-Zweizahnwal
Spanish: Zifio de Perrin, ballena picuda de Perrin
French: Mésoplodon de Perrin, baleine à bec de Perrin

Family Ziphiidae

Mesoplodon perrini / Perrin's beaked whale (© Wurtz-Artescienza)

1. Description

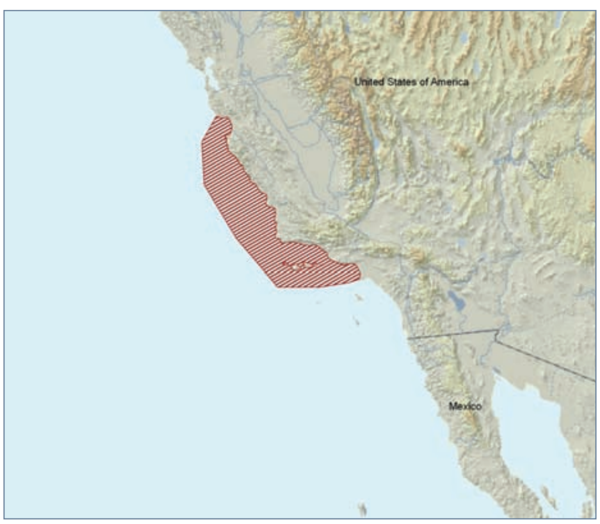
The beak is shorter than in other mesoplodonts and the two tusks erupt in males just behind the tip of the lower jaw. The mouthline is relatively straight. Apparently counter-shaded with a dark-grey back and a whitish belly. Adult males have a white patch around the umbilicus and dark grey mask joining the eyes dorsally. Externally very similar to Hector's beaked whale, with which it was confused until its description in 2002 (Dalebout et al. 2002; Jefferson et al. 2008).

2. Distribution

Dalebout et al. (2002) describe *M. perrini* on the basis of five animals stranded on the coast of California (between 33°55'N, 117°15'W and 36°37'N, 121°55'W) from May, 1975 to September, 1997. Four of these animals were initially identified as Hector's beaked whales (*M. hectori*) based on cranial morphology (Mead, 1989). A fifth specimen was initially identified as a neonate Cuvier's beaked whale (*Ziphius cavirostris*) based on external features.

These specimens were first recognised as representatives of an undescribed species through phylogenetic analysis of mitochondrial DNA control region and cytochrome b sequence data. Although similar morphologically, the genetic data do not support a close evolutionary relationship between *M. perrini* and *M. hectori*. Instead, these data suggest a possible sister-species relationship with the lesser beaked whale *M. peruvianus* (Dalebout et al. 2002).

Dalebout et al. (2002) suggest that *M. hectori* is confined to the Southern Hemisphere, while *M. perrini* is known to date only from the North Pacific.



Possible distribution of Mesoplodon perrini (Taylor et al. 2009; © IUCN Red List): all known specimens stem from the central and southern Californian coast (Jefferson et al. 2008).

3. Population size

Unknown.

4. Biology and Behaviour

Based on a limited sample of stomach contents, Perrin's beaked whale probably feeds mainly on squids (including *Octopoteuthis* sp.). The remains of an unidentified invertebrate have been found in the stomach of an animal stranded in California (Taylor et al. 2009).

5. Migration

Unknown.

6. Threats

Unknown.

7. Remarks

Range states: USA and possibly Mexico (Taylor et al. 2008).

Categorised as "Data Deficient" by IUCN and is not listed by CMS. The species is listed in Appendix II of CITES.

8. Sources (see page 263)

3.41 Mesoplodon peruvianus Reyes, Mead and Van Waerebeek, 1991

English: Peruvian-, lesser- or pygmy beaked whale
German: Peruanischer Schnabelwal
Spanish: Ballena picuda peruana
French: Mésoplodon du Pérou

Family Ziphiidae

Mesoplodon peruvianus / Peruvian beaked whale (© Wurtz-Artescienza)

1. Description

M. peruvianus is the smallest of all *Mesoplodon* species. It has a small, triangular dorsal fin and a short, narrow beak. The head is also narrow and the melon not as bulbous as in some other species. There are two teeth on the middle of the lower jaw (gape) in males and the mouthline has a slight to moderate arch. Peruvian beaked whales are dark grey in colour, which fades to light grey on the undersides. Maximum known body length is 3.7 - 3.9 m (Reyes et al. 1991, Urbán-Ramírez and Aurioles-Gamboa 1992). According to Pitman (2009) adult males have a broad white swathe across the body that forms a conspicuous chevron when viewed from above, however no such individuals sighted at sea have been validated as *M. peruvianus* by a specimen or molecular genetic analysis.

2. Distribution

The Peruvian beaked whale was first described in 1991, based on captured and stranded specimens collected in 1976-1989 from the coast of Peru, between Playa Paraiso (11°12'S) and San Juan de Marcona (15°19'S) (Reyes et al. 1991). Recent findings of Sanino et al. (2007) extend the southernmost known distribution in the Eastern Pacific to 29°17'S, or 14° of latitude (1,550 km) farther south than the most austral, published record in Peru.

Several dozen sightings of *Mesoplodon* species "A" , tentatively identified as probable *M. peruvianus* by Pitman and Lynn (2001), from the eastern tropical/warm temperate Pacific including the Gulf of California, extend from about 10°S to 28°N and have led several authors to suggest that the species may be an eastern Pacific endemic (Urbán-Ramírez and Aurioles-Gamboa 1992, MacLeod et al. 2006a; Pitman, 2009). The New Zealand (at 42°31'S) specimens (Baker and Van Helden, 1999), sightings near Choros, Chile (23°S), and the species' common occurrence in Peru's cool coastal waters (Sanino et al. 2007) question the hypothesis by Urbán-Ramírez and Aurioles-Gamboa (1992) who proposed the Eastern Tropical Pacific (ETP) as the core distribution area of *M. peruvianus*, believing that the records on the Peruvian coast are 'close to the limit of their southern range (15°S).

3. Population size

Ferguson and Barlow (2001) estimate a total abundance of 32,678 beaked whales in the genus *Mesoplodon* in the eastern Pacific (corrected for missed animals). The majority of these they argued were *M. peruvianus* and *M. densirostris*.

4. Biology and Behaviour

Sanino et al. (2007) report on three sightings (5 individuals) off north-central Chile in waters 20-70 m deep, suggesting at least occasional nearshore presence of lesser beaked whales in

Distribution of Mesoplodon peruvianus (Taylor et al. 2009; © IUCN Red List): eastern Pacific, from northern Mexico to central Chile and off New Zealand (Pitman, 2002; Jefferson et al. 2008; Sanino et al. 2007).

neritic habitat, an unusual ecological trait for ziphiids, considered to be almost exclusively oceanic. It is unclear whether the sighting of a neonate in February, suggesting calving in summer may be the key to this inshore occurrence. Sightings attributed to *M. peruvianus* consisted of small groups of 1-3 individuals (n=5), consistent with typical ziphiid behaviour.

5. Migration

Unknown.

6. Threats

The neritic distribution (see above) would explain why lesser beaked whales are so often captured in Peru's artisanal drift gillnet fishery for sharks (Reyes et al. 1991).

Sanino et al. (2007) report on a specimen off north-central Chile showing bullet injuries in the skull presumably originating from a high-powered handgun, which is the first circumstantial evidence of such a case. Entanglement in fishing gear, especially gillnets in deep water (e.g., for billfish and tuna), is probably another significant threat in the ETP (Taylor et al. 2009). Furthermore, cetaceans inhabiting waters surrounding the coastal islands off north-central Chile are facing threats that include direct catches and unregulated whale-watching operations (Sanino et al. 2007).

7. Remarks

Documented **range states**: Peru, Chile, Mexico, New Zealand (based on: Reyes et al. 1991; Urbán-Ramírez and Aurioles-Gamboa, 1992; Baker and van Helden, 1999; Sanino et al. 2007). Inferred range states: Colombia; Costa Rica; Ecuador; El Salvador; Guatemala; Honduras; Mexico; Nicaragua; Panama (Taylor et al. 2009).

The species is categorised as "Data Deficient" by the IUCN. *M. peruvianus* is not listed by CMS but is listed in Appendix II of CITES.

8. Sources (see page 263)

3.42 Mesoplodon stejnegeri True, 1885

English: Stejneger's beaked whale
German: Stejneger-Zweizahnwal
Spanish: Zifio de Stejneger, ballena picuda de Stejneger
French: Mésoplodon de Stejneger, baleine à bec de Stejneger

Family Ziphiidae

Mesoplodon stejnegeri / Stejneger's beaked whale (© Wurtz-Artescienza)

1. Description

Stejneger's beaked whale appears to be dark above and pale below, with the beak and neck areas being paler. However, a dark cap extending from both eyes over the top of the head appears to be characteristic. In adult males two large erupted teeth point forwards near the peak of the arched lower jaw, about halfway from the gape . The largest male measured 5.7 m and 1,600 kg (Jefferson et al. 2008). Females and young males have no erupted teeth and, at sea, are probably impossible to distinguish from other *Mesoplodon* species (Carwardine, 1995).

2. Distribution

Stejneger's beaked whale ranges in subarctic waters of the North Pacific from the Bering Sea south to Japan and central California (Loughlin and Perez, 1985; Rice, 1998). The center of its distribution seems to be the Aleutian Islands, where *M. stejnegeri* has been known to strand in small groups. There are also sighting records from the central Aleutian Islands (Mead, 1989 and references therein).

3. Population size

Unknown.

4. Biology and Behaviour

Schooling: Small groups sometimes travel abreast, almost touching one another, and may surface and submerge in unison. There are reports of 5 or 6 shallow dives, followed by long dives of 10 to 15 minutes. Diving involves a slow, casual roll at the surface. Groups usually include both small and large animals, suggesting a mixing of ages and/or sexes (Carwardine, 1995).

Walker and Hanson (1999) also concluded that Stejneger's beaked whales travel in small groups, as 4 animals stranded within short range of one another at Kuluk Bay, Adak Island (51°54'N, 176°34'W) in August 1994.

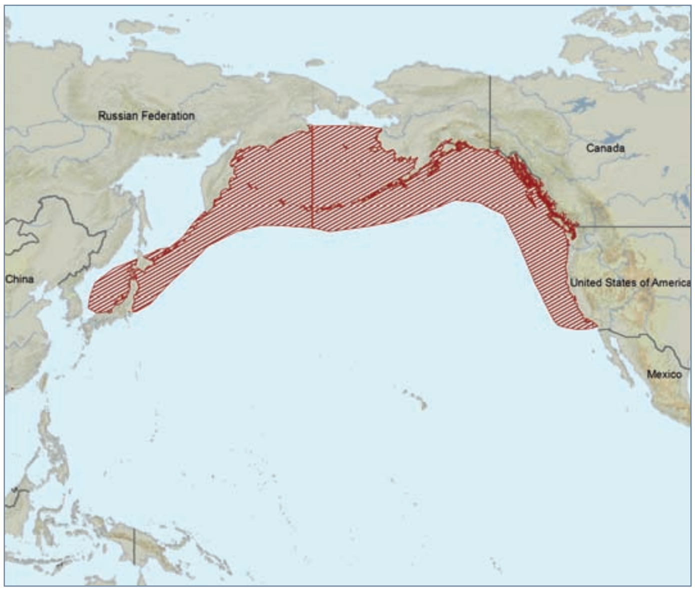
Food: Stejneger's beaked whales feed on squid of the family Gonatidae and Cranchiidae in mesopelagic and bathypelagic depths. Fish are also taken (Walker and Hanson, 1999; Jefferson et al. 2008).

5. Migration

There have been numerous strandings from the coasts of Japan within the Sea of Japan, and many fewer along the Pacific coast. The large peak in strandings in this area in winter and spring suggests that the species may migrate north in summer (Mead, 1989). *M. stejnegeri* in the Bering Sea sometimes bear fresh cookie-cutter shark bites, also suggesting that they probably moved north from warmer waters (Pitman, 2009).

6. Threats

Entanglement in fishing gear, especially gillnets in deep water, is probably the most significant threat (Taylor et al. 2009). Several Stejneger's beaked whales are known to have been



Distribution of Mesoplodon stejnegeri (Taylor et al. 2009; © IUCN Red List). It lives over continental slopes and in oceanic waters of the sub-Arctic and temperate North Pacific from California to Japan (Pitman, 2002).

taken in salmon driftnets off Japan and on the west coast of North America. There have been occasional direct catches of this species off Japan and possibly elsewhere (Jefferson et al. 1993).

Baker et al. (2006) report on whale meat from *M. stejnegeri* found in a systematic survey of whalemeat markets in South Korea between 2003 and 2005. The meat originated presumably from by-catch.

Honma et al. (1999) report on one specimen having died after a strike from a jetfoil operating for the Sado Line (Niigata-Ryotsu route) in the Sea of Japan.

7. Remarks

Range states (Loughlin and Perez, 1985 ; Taylor et al. 2009): Canada; Japan; Russian Federation; United States of America

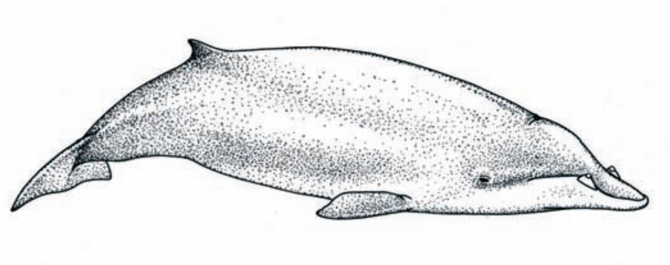
IUCN status: "Data Deficient". Not listed by CMS. Listed in Appendix II of CITES.

8. Sources (see page 263)

3.43 Mesoplodon traversii (Gray, 1874)

English: Spade-toothed beaked whale
German: Travers-Zweizahnwal
Spanish: Zifio de Travers, ballena picuda de Travers
French: Baleine à bec de Travers

Family Ziphiidae



Lagenorhynchus acutus / Spade-toothed beaked whale (© Wurtz-Artescienza)

1. Description

Only 3 specimens were found to date and no description of external features is available. The skull of a subadult specimen from Chile was estimated to belong to an animal of ca. 5.0 - 5.5 m length (Reyes et al. 1995). Described in 1874 based on a damaged mandible and teeth, *M. traversii* was synonymized in 1878 with Layard's beaked whale *M. layardii* by James Hector, leading to the species vanishing from scientific literature for almost 120 years (van Helden et al. 2002).

In 1995, researchers in South America who collected an enigmatic skull from Isla Mas a Tierra in Chile's Juan Fernández Archipelago concluded that it belonged to an unrecognized mesoplodont which they described as Bahamonde's beaked whale *M. bahamondi* Reyes, Van Waerebeek, Cárdenas and Yañez, 1995. Further comparative morphological and mt-DNA studies revealed that *M. bahamondi* was in fact the long-forgotten *M. traversii*, which name, a senior synonym, was then resurrected (van Helden et al. 2002). The teeth alveoli straddle the posterior end of the mandibular symphysis and the broad teeth carry a prominent denticle (van Helden et al. 2002)

2. Distribution

Probably a South Pacific and possibly even circumantarctic species (Jefferson et al. 2008). The three specimens identified to date stem from Isla Robinson Crusoe (Isla Más a Tierra) in the Juan Fernández Archipelago, Chile (Reyes et al. 1995), White Island (New Zealand) and Pitt Island (Chatham Islands; van Helden et al. 2002). *M. traversii* is the name originally given to a mandible and teeth recovered in New Zealand in 1874 (van Helden et al. 2002).

3. Population size

Unknown.

4. Biology and Behaviour

Unknown.

5. Migration

Unknown.

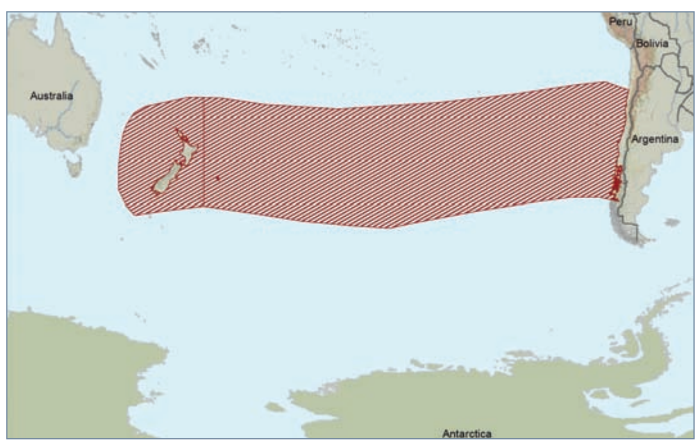
6. Threats

Unknown.

7. Remarks

Range states: Chile and New Zealand (Taylor et al. 2009).
The species is categorised as "Data Deficient" by IUCN and is not listed by CMS. Listed in Appendix II of CITES.

8. Sources (see page 263)



Possible distribution of Mesoplodon traversii (Taylor et al. 2009; © IUCN Red List). All known specimens stem from the South Pacific (van Helden et al. 2002).

3.44 Monodon monoceros Linnaeus, 1756

English: Narwhal
German: Narwal
Spanish: Narval
French: Narval

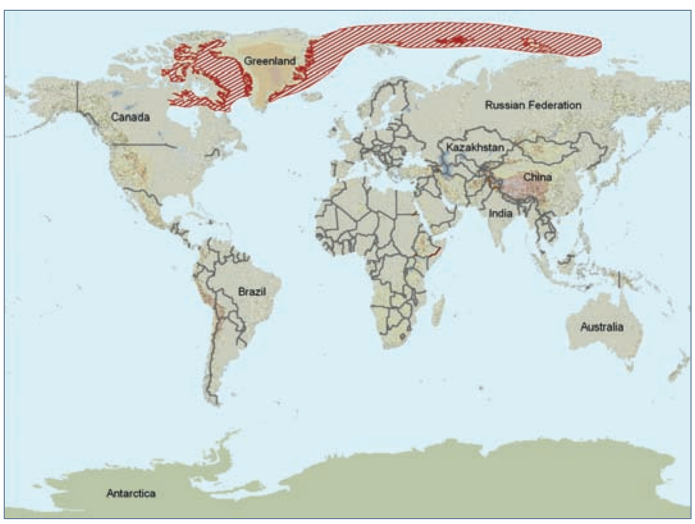
Family Monodontidae

Monodon monoceros / Narwhal (© Wurtz-Artescienza)

1. Description

Narwhals are completely mottled on the back with white ventral and lateral fields that increase with age. Old males only maintain a narrow dark spotted pattern on the top of the back, whereas the rest of the body is white. Newborns are grey to brownish and develop the mottled pattern after 2 years. The rear margin of the tail flukes is markedly convex and the fin is replaced by a low ridge. Average Body length is 400 cm and 450 cm in adult males and females, respectively, and mass reaches 1000 kg and 1600 kg, respectively (Heide- Jørgensen, 2009).

In males, usually the left one of two elongated maxillary teeth grows and protrudes through the maxillary bones and skin of the rostrum. Some males lack the tusk whereas others may develop two. Females may sometimes have a tusk as well. The largest tusk measured was 267cm long, normal size is 200 cm. The tusk is believed to be a secondary sexual character determining social rank among males (Heide- Jørgensen, 2009). During growth, the tusk spirals and grooves to the left. However, the tusk as a whole does not seem to revolve during growth (Heide-Jørgensen et al. 2008).



Narwhal (Monodon monoceros) distribution in the Arctic Ocean and adjacent Greenland Sea, Baffin Bay, Davis and Hudson Strait (Jefferson et al. 2008; © IUCN Red List).

2. Distribution

The narwhal is discontinuously circumpolar and arctic. It is observed very infrequently south of 65°N in Greenland. However, during spring, when distributional ranges may overlap north of Greenland, its range may become circumpolar (Born, 1994). The main part of the population occurs in the eastern Canadian Arctic and west Greenland. Observations by Gjertz (1991) suggest that off Svalbard narwhals concentrate in the north-west area of Spitzbergen.

Narwhals are vagrant south to the coast of Labrador (Rice, 1998), rare to accidental south to Iceland, the Norwegian Sea, the North Sea (south to the British Isles, The Netherlands and Germany), the White Sea, and the arctic coast of mainland Eurasia, and east into the Chukchi Sea and the Bering Sea, as far south as Komandorskiye Ostrova and the north side of the Alaska peninsula (Rice, 1998).

3. Population size

The most recent population estimates come from Nunavut waters in Canadian Arctic waters, where the highest narwhal concentrations are found (Jefferson et al. 2008). Abundance estimates for Somerset (45,358; CV = 0.35; Innes et al. 2002); Admiralty (5,362; CV = 0.5); Eclipse (20,225; CV = 0.36); East Baffin Bay (10,0073; CV=0.31) and North Hudson Bay (5,053; CV = 0.4) sum up to a total of 86,000 individuals (DFO, 2008).

Abundance in Inglefield Bredning and adjacent fjords in northwest Greenland was estimated using aerial digital photographic techniques in August 2001 and 2002, resulting in abundance estimates of 2,297 (95% CI: 1,472-3,122) and 1,478 (95% CI 1,164-1,793) in these two years, respectively (Heide-Jørgensen, 2004). This corresponds to a 10% decline as opposed to line- transect surveys conducted in 1985 and 1986 (Born et al.1994).

In the Eurasian sector of the Arctic the only known estimate of narwhal numbers is from Scoresby Sound and King Oscar Fjord in eastern Greenland. A conservative figure of only 176 was obtained from an aerial line-transect survey carried out in September 1983 by F. Larsen (cited in Hay and Mansfield, 1989). Born (1994) confirms that more detailed data is lacking. He suggests that in this sector, narwhals prefer areas distant from the coast and may number at most a few thousand individuals. There is no recent data available for any of the northeast Atlantic waters (Jefferson et al. 2008; Heide-Jørgensen, 2009).

4. Biology and Behaviour

Habitat: Narwhals are considered deep-water cetaceans, associated with the pack ice (Hay and Mansfield, 1989). Other investigators, however, dispute their characterization as deep-water species, noting that they occur in waters of different depths. Born (1994) suggests that the occurrence of narwhals and belugas (*Delphinapterus leucas*) is mutually exclusive, since summering and wintering grounds differ both in location and time, which seems to exclude competition for food. When both species do occur in the same areas, they seem to reduce competition by foraging at different depths.

Behaviour: Whales occupying one wintering ground spent most of their time diving to between 200 and 400 m whereas narwhals in a separate wintering ground spent less time at shallow depths and most of their time diving to at least 800 m (Laidre et al. 2003). The deepest recorded diving depth was 1,864 m, and dive times usually amounted to 25-30 min (Heide-Jørgensen, 2009).

Schooling: Most pods consist of 2-10 individuals but they may aggregate to form larger herds of hundreds or even thousands of individuals (Jefferson et al. 1993).

Reproduction: The gestation period is estimated to be 15.3 months. The season of conceptions is March to May and calving occurs during July and August. Since the lactation period exceeds 12 months, the interval between successive conceptions is usually three years, but about 20 % of females conceive at the first breeding season following birth of their calves. The annual population birth rate is calculated to be about 0.07. The basic life history features of the narwhal are similar to those of other medium-sized toothed whales (Hay, 1985). Narwhals can reach very high ages: Age estimates based on the racemization of l-aspartic acid to d-aspartic acid in the nucleus of the eye lens yield a maximum estimated age of 115 years in a female specimen. Age at sexual maturity is estimated to be 6-7 years for females and 9 years for males (Garde et al. 2007).

Food: Narwhals feed heavily during migrations, but very little during the open water season (Hay and Mansfield, 1989; Reyes, 1991 and refs. therein). Consequently, stomachs collected from narwhal summer harvests were mostly empty with little evidence of recent feeding. Stomachs collected in late fall and winter harvests had considerable amounts of undigested material with evidence of recent feeding. In summer, Arctic cod (*Arctogadus glacialis*), polar cod (*Boreogadus saida*), and *Gonatus* squid spp. constituted the narwhal diet.

In the fall, *Gonatus fabricii* was the only prey item observed. In late fall and winter, Greenland halibut (*Reinhardtius hippoglossoides*) and *G. fabricii* were the dominant prey items, observed in 51% and 73% of stomachs collected, respectively. Greenland halibut taken by narwhals were on average 39 cm and 556 g and *G. fabricii* were on average 23 g with mean mantle lengths of 85 mm. The low diversity of prey species indicates narwhals have a restricted diet across all seasons (Laidre and Heide-Jørgensen, 2005).

Further prey items include the shrimps *Pasiphaea tarda* and *Hymenodora glacialis* (Hay and Mansfield, 1989; Reyes, 1991 and refs. therein). In Baffin Bay, narwhals fitted with satellite-linked time-depth recorders selected bottom temperature ranges and gradients in their wintering grounds which often coincided with areas of concurrent high density of Greenland halibut and predictable open water in winter pack ice (Laidre et al. 2004). Stomach content analyses suggest that they feed over a wide range of depths, at least in the Baffin Bay area (Hay and Mansfield, 1989).

5. Migration

Throughout the year, narwhals live in close contact to the Arctic pack ice (Born, 1994). They follow the distribution of the ice and move towards coastal areas when these are ice free. During freeze-up, the coastal areas are abandoned and the narwhals move offshore (Heide-Jørgensen, 2002). Observations from airplanes suggest that narwhals overwinter in small groups within heavy pack ice, whereas only a few animals were observed in loose pack ice and open water (Koski and Davis, 1994).

Narwhals instrumented with satellite transmitters in Tremblay Sound, northeast Canada went northwest visiting adjacent fjords before moving south, along the east coast of Baffin Island. The narwhals arrived on the wintering ground in northern Davis Strait in late October. Speed and range of movements declined once the wintering ground was reached. Late summer and winter kernel home ranges were approximately 3,400 km² and 12,000 km², respectively. (Heide-Joergensen et al. 2002). Female narwhals tracked by satellite from their summering ground near Somerset Island in the Canadian High Arctic went to wintering grounds in central Baffin Bay. The area of the summering ground was approximately 9,464 km² and the area of the wintering ground was 25,846 km² (Heide-Jørgensen et al. 2003). Resighting of a tagged narwhal 10 years after tagging confirms evidence for site fidelity and for the same migratory schedule and route over large time periods (Heide-Jørgensen et al. 2008).

At summering grounds in West Greenland and Canada, narwhals moved back and forth between glacier fronts, offshore areas and neighbouring fjords (Dietz et al. 2001). When fast ice formed, the whales moved out to deeper water, usually up to 1,000 m water depth. In October, the whales moved southward toward the edge of the continental shelf where water depth increases over a short distance from 1,000 to 2,000 m. This slope in central Baffin Bay was also used as a wintering ground, and even though the whales seemed stationary in this area, they still conducted shorter movements along the steep continental slope. Narwhals satellite-tracked from Canada and West Greenland were within a few kilometres from each other at these wintering grounds. The importance of this wintering ground in central Baffin Bay has also been confirmed by aerial surveys (Heide-Jørgensen, 2002).

The regular occurrence of narwhals at Repulse Bay in northwestern Hudson Strait suggests that they may overwinter there as well, or possibly in Hudson Strait (Hay and Mansfield, 1989).

The migratory cycle in east Greenland waters is not well known. Apparently narwhals migrate to the north and northeast into the ice fields of the Greenland Sea during May-July. Some whales migrate eastwards to the vicinity of Franz Josef Land and as far east as the new Siberian Islands. A few whales also visit the fjords of north-western Greenland. Their southward migrations in autumn lead them to the southern Greenland Sea, Barents Sea and Denmark Strait (Hay and Mansfield, 1989).

Genetic data shows that narwhals from the eastern Canadian Arctic have little contact with animals from eastern Greenland, and even between geographically close areas, which is attributed to their site fidelity to specific summer and autumn feeding grounds (Born, 1994; Palsboll et al. 1997).

6. Threats

Direct catch: The narwhal has been hunted since the earliest times by the Inuit (Reyes, 1991), with an annual take in the order of 1,000 animals. Recent data confirms that these levels are still maintained today, with annual catch rates at 535 and 433 between 2000-2004 in West Greenland and Canada, respectively (Heide-Jørgensen 2009). However, while male narwhals compose most of the landed catch, annual harvest statistics underestimate total numbers of narwhals killed due primarily to the non-reporting of struck-and-killed but lost whales. The estimated total kill of narwhals may exceed the reported landed catch by 40% (Roberge and Dunn, 1990).

The North Atlantic Marine Mammal Commission (NAMMCO) has repeatedly expressed grave concern on the apparent decline of stocks in West Greenland, and while commending Greenland for the recent introduction of quotas, there is still serious concern that present takes of narwhals in West Greenland, according to the advice of both the NAMMCO Scientific Committee and the Canada/Greenland Joint Commission on Narwhal and Beluga Scientific Working Group are not sustainable and will lead to further depletion of the stocks. The quota for Greenland was 385 animals in the 2006/2007 season, again well above the recommended level of 135. In east Greenland, around 100 are assumed to be taken annually, without quotas nor a harvest sustainability assessment (NAMMCO, 2006).

Narwhals supply various staples in the traditional subsistence economy. Today the main products are muktaaq and ivory. The large tusks of adult males are sold in the speciality souvenir market both inside Canada and in the global marketplace. The price of narwhal ivory has increased substantially over the past years. Canadian narwhal ivory traditionally was exported to the United Kingdom, then often re-exported. The EU ban closed the direct link with the United Kingdom. Consequently, new markets developed in Japan and Switzerland. Narwhal hunting remains an important source of food and cash income for residents of some coastal communities in the eastern Canadian Arctic and Greenland. The international ivory trade provided an incentive to procure large tusks, and this may have strongly influenced the nature and intensity of the hunt (Reeves, 1992). However, international trade is now regulated through the Convention on International Trade in Endangered Species (CITES), requiring national permits for import and export (all Cetacea are listed in either CITES Appendix I or II). Furthermore, Greenland installed a ban on all narwhal product exports in 2006 (Heide-Joergensen, 2009).

Natural enemies: Natural enemies include Greenland sharks (*Somniosus microcephalus*), orcas, polar bears and walrus, although the mortality rates inflicted by these species do not seem to be very high (Born, 1994). The same author reports that narwhals do occasionally become trapped in fast forming ice and may die during the winter because of exhaustion in an attempt to keep the breathing hole open.

Habitat degradation: Because of their prevalence for high-density pack-ice, narwhals are susceptible to man-made as well as natural climatic changes influencing the water currents and ice formation in the Arctic (Heide-Jørgensen, 2002).

Pollution: Anthropogenic threats include pollution via heavy metals and organochlorines (Heide-Jørgensen, 2009). Cadmium concentrations seem to be significantly higher in narwhals than in other cetaceans (Born, 1994 and references therein). Highest Cadmium concentrations were reported from narwhals living along the Canadian coast, whereas lead concentrations were higher in west Greenland animals. Narwhal skin as a whole (in Inuktitut known as "muktuk") is considered to be a delicacy by native Canadian and Greenland people. However, concentrations and patterns of polychlorinated biphenyls (PCBs), chlorinated pesticides, and polybrominated diphenyl ethers (PBDEs) in narwhal blubber from Svalbard, Norway showed a broad range of pollutants in relatively high concentrations. PCBs and pesticide levels in lipid were approximately 9 µg/g and 24 µg/g, respectively, while PBDEs 47 levels were approximately 170 ng/g. Compared with other marine mammals from the same area, contaminant levels are among the highest ever measured, indicating a low capacity for contaminant metabolism. These high levels are further explained by substantially high contaminant levels in the benthic diet of narwhals (Wolkers et a. 2006). While PCB and DDT concentrations in West Greenland narwhals were half those found in East Greenland and Svalbard (Dietz et al. 2004), the concentration of total mercury is 0.59 µg/g (wet wt) in narwhal skin as a whole (muktuk), exceeding Canadian Government's Guideline (0.5 µg/g wet wt) for fish export and consumption (Wagemann and Kozlowska, 2005). To conclude, human consumption of narwhal muktuk seems to bear a significant health risk.

7. Remarks

Range states (Jefferson et al. 2008) :
Canada; Greenland; Russian Federation; Svalbard (Norway) and Jan Mayen (Norway).

The species is included in Appendix II of CMS and in Appendix II of CITES. The narwhal is categorized as "Near Threatened" by the IUCN (Jefferson et al. 2008), because there is clear evidence for the ongoing decline of several subpopulations of the species, also attributed to intensive hunting of the species in Canada and Greenland.

The IWC Scientific Committee (2000) recommended that genetic and telemetric studies are needed to identify stocks, and improved catch-reporting (including estimation of hunting loss) should be conducted in Canada and Greenland.
Information on life history, distribution, abundance and actual hunting loss rates are needed to assess and manage the stocks. The probable effects of pollution, industrial development and climatic change should be fully studied, since these may represent a potential threat.

8. Sources (see page 265)

3.45 Neophocaena phocaenoides (G. Cuvier, 1829)

English: Finless porpoise
German: Indischer Schweinswal
Spanish: Marsopa lisa
French: Marsouin aptère

Family Phocoenidae

Neophocaena phocaenoides / Finless porpoise (© Wurtz-Artescienza)

1. Description

The finless porpoise is a small porpoise and lacks a dorsal fin. This is replaced by a ridge with small bumps which runs down the middle of the back. The head is rounded and there is no apparent beak. The colour is uniformly dark- to pale grey and somewhat lighter on the ventral side. Body size reaches 170 cm and mass 70 kg, with maxima of 200 cm and 100 kg (Jefferson and Hung, 2004; Amano, 2009).

2. Distribution

The warm, coastal Indo-Pacific waters, both fresh and marine, are home to the finless porpoise (Jefferson et al.1993). There are three well-marked regional populations which warrant subspecific rank. Even within these, significant differences in skull morphology have been found among local populations (Rice, 1998 and refs. therein, Amano, 2009):

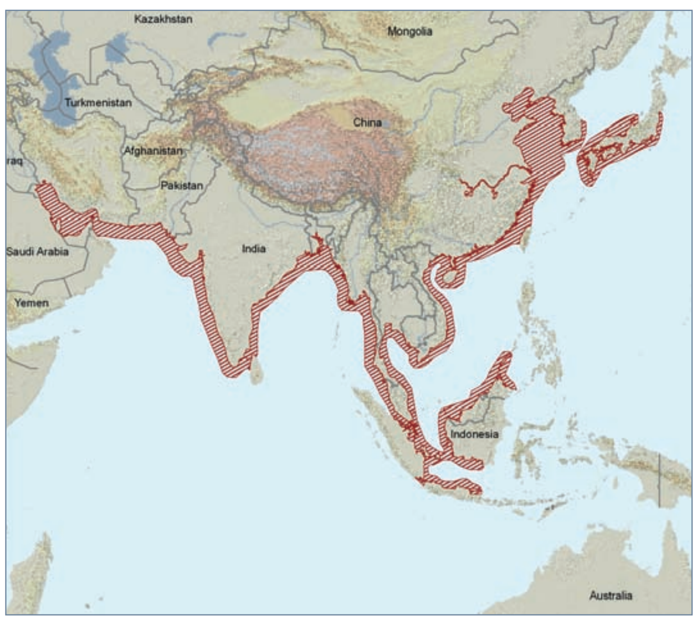
N. p. phocaenoides inhabits coastal waters along the mainland of southern Asia from the Persian Gulf east to the South China Sea and southern part of the East China Sea; also the coasts of south-eastern Sumatra, Bangka, Belitung, Sarawak, Palawan, the Turtle Islands in the Sulu Sea, and northern Java. The species has not been found in South African waters, or anywhere else in Africa (Rice, 1998 and refs. therein). It penetrates into the Indus River for 60 km, and into the Brahmaputra River for 40 km from the mouth. (Kasuya, 1999). The border between this and the next subspecies seems to be around Taiwan Strait (Amano, 2009).

N. p. sunameri (Pilleri and Gihr, 1975) ranges in coastal waters from the southern East China Sea north to the Liaodong Wan in China, Korea, and Kyushu in Japan, thence along the Pacific coast of Japan from the Setonaikai north to Sendai-wan in northern Honshu (Rice, 1998). They seem to be absent from Sulawesi, Halmahera and Timor, the Philippines, and the northern coast of Australia (Kasuya, 1999). Five local populations are identified in Japanese waters based on skull morphology and mt DNA variability (Amano, 2009). However, no obvious phylogeographical pattern was revealed between Chinese and Japanese waters, including between saline and fresh water populations (Yang et al. 2008a). The border between this and the next subspecies seems to be the mouth of the Yangtse River, but this is uncertain (Amano, 2009).

N. p. asiaeorientalis (Pilleri and Gihr, 1972) is found in the lower and middle reaches of the Chang Jiang (Yangtse River), where it ranges 1,600 km upstream as far as the gorges above Yichang (200 m above sea level), and including Poyang Hu and Dongting Hu and their tributaries, the Gan Jiang and the Xiang Jiang (Rice, 1998).

3. Population size

There have been several population abundance estimates, both qualitative and quantitative for the three subspecies over the course of the last decade. From west to east:



Distribution of the three subspecies of Neophocaena phocaenoides: coastal waters and some major rivers of the Indian ocean and the Western Pacific (Reeves et al. 2008; © IUCN Red List).

In the Persian Gulf waters between Kuwait and Oman, the finless porpoise accounted for only 2% of all cetacean sightings. Estimates of cetacean abundance in the UAE differed significantly between 1986 and 1999 and indicate a population decline of 71%. (Preen, 2004).

In the Gulf of Kachchh, Gujarat State, India Marine Protected Area, a wedge-like extension of the Arabian Sea,14 finless porpoises were recorded (Singh, 2003).

In the nearshore waters of Bangladesh, 11 finless porpoises were observed at sea during a vessel-based line-transect survey conducted in 2004. From these, a 'Distance' analysis resulted in an abundance estimate of 1,382 (CV=54.8%) animals (Smith et al. 2008).

Only two cetacean species are regularly observed in Hong Kong waters and are considered residents: the Indo-Pacific humpback dolphin (*Sousa chinensis*) and the finless porpoise (Jefferson and Hung, 2007). An earlier estimate yielded a minimum 217 (CV= 21-150%) finless porpoises (Jefferson et al. 2002).

Abundance estimates of the Yangtze finless porpoise *N. p. asiaeorientalis* from surveys conducted in 2006 and including independent estimates from the two lakes yield a total of approximately 1,800 animals. However, the population continues to decline and its distribution is becoming more fragmented. No animals were sighted e.g. in the 150 km stretch between Yueyang and Shishou, where sightings had previously been common (Zhao et al. 2008). This compares well with an estimate obtained during a visual survey concurrent with acoustic observations in a total of 774 km in the Yangtze River, yielding 588 sighted animals (Akamatsu et al. 2006). However, both values are significantly lower than the previous estimate by Zhang et al. (1993) estimated the Yangtse population at about 2,700 individuals.

In the western Sea of Korea, line-transect abundance estimates from surveys conducted in 2003 to 2005 resulted in 36,475 individuals (Park et al. 2006).

In the Inland Sea of Japan, aerial sighting surveys conducted in 2000 yield an abundance of 7,572 individuals, with a low density of 0.506 individuals/km² (CV = 17.3%). Distribution was clumped and restricted to inshore waters or near islands (Shirakihara et al. 2007). Abundance off the Pacific coast of eastern Japan between Sendai Bay (38°23'N) and the mouth of Tokyo Bay (35°13'N) was estimated at 3,387 animals (CV = 32.7%) from a survey conducted in 2000. Two distributional gaps observed at around 35°N and 37°N suggest the possibility of population subdivision (Amano et al. 2003). Further known subpopulations number 3,807 (CV=16%) in Ariake Sound/Tachibana Bay (Shirakihara and Shirakihara 2002); 289 (CV=19%) in Omura Bay (Shirakihara and Shirakihara 2002) and 3,743 (CV=24%) in Ise/Mikawa Bay (Yoshida 2002).

4. Biology and Behaviour

Habitat: The finless porpoise is mainly an inshore species, occurring both in salt and fresh water. *N. phocaenoides* appears to prefer murky or turbid conditions and can be found in warm rivers, lakes (if connected to rivers), mangroves, estuaries, deltas, and saltmarshes (Carwardine, 1995). In the Yangtse River, finless porpoises are found up to 1,600 km from the sea and in Japanese waters, they prefer shallow depths (<40m) while proximity to the shore is not so important (Amano et a. 2003). In Chinese waters, water depth and food availability are the main factors limiting inshore distribution. The porpoises prefer to concentrate in confluences of several currents, where boat traffic is light and small-sized fish prey are more abundant. However, porpoises have no apparent preference for water clarity and water velocity. The Balijiang section of the Yangtze possesses many adequate microhabitats and is proposed as a site to create a protected area (Wei et al. 2003).

Behaviour: Like other porpoises, their behaviour tends to be not as energetic and showy as that of dolphins. They do not ride bow waves, and in some areas appear to be shy of boats. Mothers have been seen carrying calves on the denticulated area on their backs. In the Yangtse River, however, finless porpoises are known to leap from the water and perform "tail stands" (Jefferson et al. 1993).

Schooling: Finless porpoises are generally found as singles, pairs, or in groups of up to 12, although aggregations of up to about 50 have been reported (Jefferson et al. 1993). Recent data suggest that the basic unit of a finless porpoise school is a mother/calf pair or two adults, and that schools of three or more individuals are aggregations of these units or of solitary individuals. Social structure seems to be underdeveloped in the species, and the mother/calf pair is probably the only stable social unit (Kasuya, 1999).

Reproduction: Reproduction in most areas has not been well studied. Reports indicate that calving in the Yangtse River occurs between April to May; on the Pacific coast of Japan between April and June; in western Kyushu between November-December and March. Animals form Kyushu live 25 years and attain sexual maturity at 4-6 years of age. Gestation lasts 11 months and lactation 7 months. Calving may occur every two years. Longevity was 33 years in the oldest specimen recorded from the South China Sea (Amano, 2009).

Food: In stomach contents investigated in western Kyushu, Japan, fish (Gobiidae and Atherinidae) were the most numerous and most frequently occurring prey in Omura Bay, whereas both cephalopods (Octopodidae, Sepiidae, Sepiolidae/Sepiidae, and Loliginidae) and fish (Clupeidae, Engraulidae, and Sciaenidae) were equally important in Ariake Sound-Tachibana Bay. There were no differences between day or night in stomach contents (Shirakihara et al. 2008). In the Yangtse River, finless porpoises are reported to eat fish and shrimp, and fish, shrimp and squid in the Yellow Sea/Bohai area and off Pakistan. To summarise, finless porpoises are opportunistic feeders utilising various kinds of available food items available in their habitat (Kasuya, 1999).

5. Migration

Available information suggests that finless porpoises are probably found year-round throughout their range, and show various degrees of seasonal movement and density change which are not well documented in most areas (Kasuya, 1999).

In the Indus delta, finless porpoises move to the sea in April and return to the creeks and delta in October, following the movements of prawns (Reyes, 1991 and refs. therein).

Parsons (1998a) reports on strandings in Hong Kong territorial waters, where finless porpoises were more frequently found in winter. They were more frequently sighted during the winter months, mostly south of Lantau Island. Abundance was negatively correlated with water temperature and positively with salinity. Seasonal distribution appears to be linked with reproductive cycles and hydrography. Diurnal patterns and tidal state also seem to affect abundance (Parsons, 1998b).

Along the Chinese coast, finless porpoises are present all year, but reported to have some seasonal density changes in Bohai and on the Yellow Sea coast (low in winter and high in summer/autumn). There, they apparently move from shallow to deeper water in winter. While movements between the Yangtse and the ocean have not been confirmed (Kasuya, 1999), the Yangtse population is not sedentary: Akamatsu et al. (2002) documented daily horizontal travel distances in two porpoises of 94.4 km and 90.3 km.

Annual migration is reported in the Inland Sea of Japan, where porpoises are faced with drastic seasonal changes in surface water temperature between 6°C (March) and 28°C (September). Their density is lowest (40% of the peak season) in early winter, and starts to increase in January, reaching its peak in April. Finless porpoises migrate to and from the Pacific coast mainly through two passes at the eastern Inland Sea of Japan. From observations in the fluctuation of the proportion of mother-calf pairs, it is suggested that porpoises use the Inland Sea of Japan as a breeding ground. In summer, the animals move out to the Pacific coast (Reyes, 1991 and refs. therein; Kasuya, 1999). In Kanmon Strait, Japan, the presence of finless porpoises was monitored acoustically. On average, one individual was detected every two days. Most of the finless porpoises appeared at night, and the animals presumably swam along the current direction, passing through the strait rather than searching for prey (Akamatsu et al. 2008). In other areas around Japan, they are known to occur year-round, e.g. in Ise and Mikawa Bays with a peak abundance in April-June, and also off western Kyushu.

6. Threats

Direct catch: No direct catches of small cetaceans existed in China in 1994-95. Incidentally captured small cetaceans did not occupy an important place in the daily life of people in coastal China, and they were discarded in the sea or sold at a very low price in fish markets (Yang et al. 1999). According to Reyes (1991 and refs. therein), the species has been hunted in Japan, in particular in the East China Sea, although direct catches were not large and have not been reported since the mid-1980's. There is some controversy about the usefulness of this species for human consumption (Kasuya, 1999). People in Ayukawa on the Oshika Peninsula at the northern limit of *N. Phocaenoides*, for instance, do not eat them, believing that they have a strong purgative effect, which was confirmed by a small experiment. However, finless porpoise is known to be sold for human consumption in Korea (IWC, 2000), although the source of these animals is unknown. This has been confirmed more recently through molecular monitoring of 'whale-meat' markets in the Republic of (South) Korea between 2003 and 2005 (Baker et al. 2006).

Incidental catch: Finless porpoises are accidentally caught in nets along most of their distributional range although there is no recent estimate of the magnitude of these catches (Amano, 2009). Of a total of 114 specimens collected between 1985-1992 off western and north-eastern Kyushu, Japan, including part of the western Inland Sea of Japan, 84 were killed incidentally by fisheries. The main threats were bottom gill net (58 deaths), surface gill net (17), trap net (7), trawl net (1) and drifting (ghost) net (1). The operation of such fishing gear is common in other parts of Japan and probably is killing finless porpoises off other coasts, although usually such catches remain unreported (Kasuya, 1999 and refs. therein). In Chinese waters, by-catch rates were estimated at 2,132 in 1994 and 1,484 in 1995, predominantly in trawl-, gill-, and stow nets (Yang et al.1999).

Concentrations of gill netters/long liners are particularly high in shallow nearshore waters of many distributional areas, e.g. off the Mergui (Myeik) Archipelago of southern Myanmar, where at least 150 vessels were operating in the same bay where the only sightings of finless porpoises in the area were obtained (Smith and Tun, 2008). Similarly, in the nearshore waters of Bangladesh a potentially excessive bycatch in gillnet fisheries targeting elasmobranches was detected (Smith et al. 2008). And in the Yangtze finless porpoises bycatch in unregulated and unselective fishing constitutes a continued threat (Zhao et al. 2008).

Detecting deadly obstacles such as nets in their paths in time is fundamental for cetaceans and other marine animals. However, free-ranging finless porpoises do not use their biosonar constantly. Instead, they inspect the area ahead of them before swimming silently into it. They were found to inspect distances of up to 77 m, and then swim laps without using sonar of less than 20 m (Akamatsu et al. 2005). Although the inspection distance is long enough to ensure a wide safety margin before facing most risks, the low echo-reflection of monofilament gill nets (approx. 3-6 m for harbour porpoises; Kastelein et al. 2000), ensures that the distance they swim quietly is quite sufficient for entanglement. Safety margins could be increased by a change in net material: e.g. nylon twine enriched with barium sulfate can increase echolocation distance by 4.4 m (Koschinski et al. 2006).

Habitat degradation: Habitat degradation through dredging, pollution and noise, vessel strikes (Van Waerebeek et al. 2007) and water development threatens finless porpoises everywhere in their range, and this is especially true for the Yangtze River (Zhao et al. 2008), where they face the same threats as the baiji (*Lipotes vexillifer*). Increasing development requires construction of dams for hydroelectric power and diversion of water for agriculture. Dams prevent movements of dolphins between sections or reduce food availability (Reyes, 1991). In the Tongling River Sever Section, with many zigzag river channels and well-developed sandbars, the construction of dams and bridges has fragmented and isolated the habitat (Zhang et al. 2001). However, these effects are also noticeable at sea: In the Inland Sea of Japan, no individuals were observed in waters between 132°51' and 133°11'E, and between 133°43' and 133°59'E, where sand dredging and other human activities were held responsible for habitat fragmentation (Shirakihara et al. 2007). Habitat degradation by land reclamantion and deforestation of mangrove areas is also a severe problem (Amano, 2009).

Pollution: Pollution is very possibly a threat to the species. For instance, finless porpoises disappeared from Ise Bay, Japan, during a time of high pollution and returned when pollution was reduced (Reyes, 1991 and refs. therein). Blubber samples from the Inland Sea of Japan and Pacific area contained DDT isomers and metabolites at levels up to 10 times the concentration found in striped dolphins, and similar to those found in Baltic ringed seals with stenosis and uterus occlusion (Kasuya, 1999 and refs. therein). Le et al. (1999) report concentrations of butyltin and Minh et al. (1999) of persistent organochlorines in finless porpoises.

Specimens collected in 1990 and 2000/01 from the South China Sea also showed high levels of DDT and PCB concentrations (Ramu et al. 2006). And the same was found in tissue samples from Hong Kong waters, suggesting that PBDEs should be classified as priority pollutant in Asia. Elevated residues of PCBs and DDTs suggests the species may be at risk (Ramu et al. 2005). Parsons (1999) reports that mercury levels were high enough in some individuals as to pose a health risk and Parsons (1998a) noted that the number of reported small cetacean strandings in Hong Kong had increased dramatically: possibly due to escalating levels of anthropogenic pollution.

In the Yangtse River, damage to the riverine ecosystem comes from the high level of pollution produced by several industries. In Yangtse river dolphins polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) were determined in tissue samples.The hazard quotients based on toxic equivalency were determined to be greater than one in all individuals for these contaminants, suggesting that a reduction of environmental contamination would contribute greatly to protecting this highly endangered species (Yang et al. 2008b). Finally, in Eastern Dongting Lake, mercury concentrations in some key tissues were much higher than those reported for other Phocoenidae species (Dong et al. 2006).

7. Remarks

Range states (Reeves et al. 2008): Bahrain; Bangladesh; Brunei Darussalam; Cambodia; China; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Iraq; Japan; Korea, Republic of; Kuwait; Malaysia; Myanmar; Pakistan; Philippines; Saudi Arabia; Singapore; Sri Lanka; Taiwan, Province of China; Thailand; United Arab Emirates; Viet Nam.

The species is listed in Appendix II of CITES. *N. phocaenoides* is listed in Appendix II of CMS. The IUCN considers the species as being "Vulnerable" (Reeves et al. 2008). This is justified on the basis of taxonomic uncertainty, range discontinuity, a 70% decline over the past 30 years (qualifying for "Endangered") for the two population where some abundance data is available (Sea of Japan, Yangtse River and adjacent lakes), and a suspected overall decline of 30% over the last 3 generations.

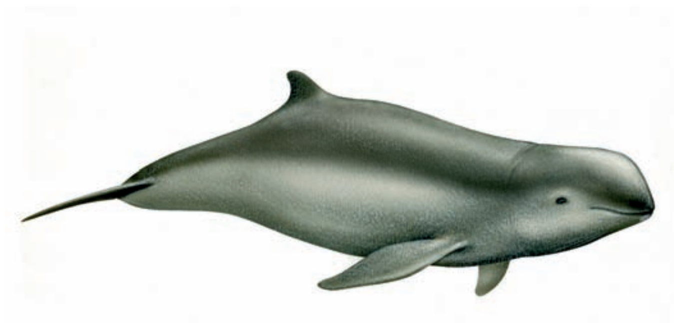
The species as a whole is in no immediate danger of extinction, but several populations (possibly representing separate taxa) are apparently declining (Jefferson and Hung, 2004). The IWC sub-committee discussed, in particular, the Inland Sea of Japan, where the finless porpoise declined in abundance (IWC, 2000). The causes of this decline are not fully understood. Incidental mortality in various kinds of fisheries is the only documented anthropogenic factor affecting the survival of finless porpoises. However, a number of anthropogenic influences such as chemical pollution, depletion of prey species, loss of habitat due to construction or extraction of sand, and ship strikes may all have contributed to the decline. Here, as elsewhere in the species' range, human populations adjacent to the finless porpoise's habitat are increasing in size and becoming more industrialised, so the expectation should be that anthropogenic pressures will continue and intensify. See also Perrin et al. (1996) for recommendations (Appendix II).

8. Sources (see page 266)

3.46 Orcaella brevirostris (Owen in Gray, 1866)

English: Irrawaddy dolphin
German: Irrawaddy-Delphin
Spanish: Delfín del Irrawaddy
French: Dauphin de l'Irrawaddy

Family Delphinidae



Orcaella brevirostris / Irrawaddy dolphin (© Wurtz-Artescienza)

1. Description

The Irrawaddy dolphin resembles the beluga whale *Delphinapterus leucas* in general appearance and certain anatomical features. However, recent morphological and genetic studies consistently place it in the family Delphinidae, and its closest relative might be the killer whale *Orcinus orca* (Arnold, 2002). Rice (1998) pointed out that *O. brevirostris* shares more morphological similarities with the other Delphinidae than with the Monodontidae, based on morphological features, isozyme and immunological distance studies, by studies of satellite DNA, and by sequencing the cytochrome b gene.

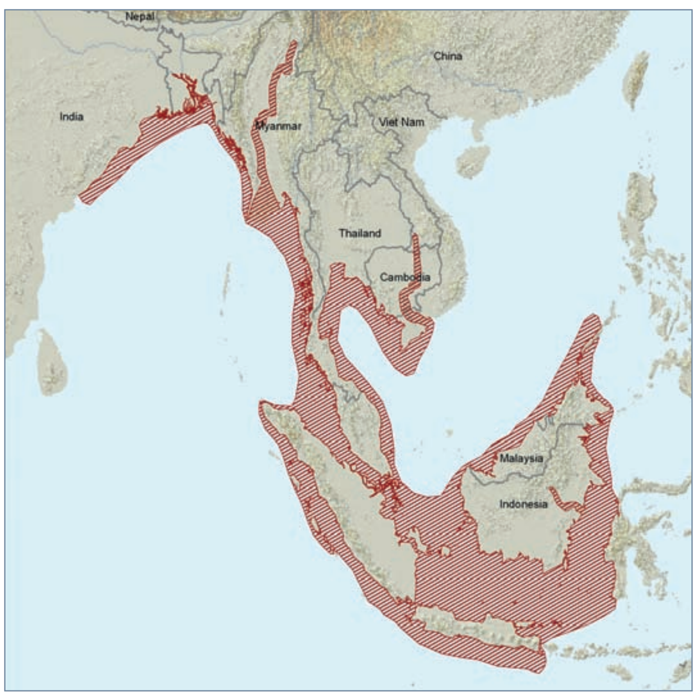
Recently, a previously considered sub-population of the Irrawaddy dolphin found in Australia and Southern Papua New Guinea was re-classified as a different species of the same genus, *O. heinsohni*, based on differences in coloration, morphology and genetics (Beasley et al. 2005).

The mobile head of the Irrawaddy dolphin is broadly rounded, and there is no sign of a beak. A shallow dorsal groove extends to the dorsal fin, which is small; the flippers are broad, paddle-like, with a convex leading edge and highly mobile. The colour pattern varies regionally between dark grey to light grey. Maximum recorded length is 275 cm, but average length is only 210 cm. Adult body mass is 115-130 kg (Arnold, 2002).

2. Distribution

Irrawaddy dolphins are discontinuously distributed mostly in the coastal, shallow, brackish, or fresh turbid waters at the mouths of rivers in southeastern Asia. On the Asian mainland they range from Vishakhapatnam, Andhra Pradesh, India, around the Bay of Bengal to the Strait of Malacca and the Gulf of Thailand. There are freshwater populations in the tributaries at the mouths of the Ganges, in the Irrawaddy as far as 2,300km upstream to Bhamo, and in the Mekong and Sekong Rivers as well as in the Ayeyarwady River (Marsh et al. 1989; Jefferson et al. 1993; Rice, 1998; Baird and Mounsouphom,1997, Smith et al. 1997a, 1997b).

The presence of *O. brevirostris* has not been fully confirmed in China, but it is likely to occur there (Reyes, 1991 and refs. therein). It occurs in Malampaya Sound, Palawan, in the Philippines (Reeves et al, 2008); on the Sunda shelf; it is known from the Sungai Belawan Deli in northeastern Sumatra; Belitung; north coast of Jawa Timur (East Java); south coast of Jawa Tengah (Central Java); Kepulauan Bunguran (Natuna Islands); river mouths along the coast of Sarawak, Brunei, and Sabah; the Seruyan and Mahakam river systems, including Semayang, Melintang, and Jempang lakes, in Kalimantan Timur (East Kalimantan); Sungai Kumai in Kali-mantan Tengah (Central Kalimantan); south-western Sulawesi (mod. from Rice, 1998).



Distribution of Orcaella brevirostris: warm coastal waters and rivers from the Bay of Bengal to western Sulawesi, Indonesia (Reeves et al. 2008; © IUCN Red List).

3. Population size

Various populations have recently been assessed from India to Indonesia. Most of these are very small (< 100 individuals) with the exception of the population off Bangladesh. These are discussed here moving from west to east.

In Chilika lake, Orissa, India, which forms the largest brackish water lagoon in Asia, there are about 80-90 Irrawaddy dolphins (Sarkar, 2007).

The largest population occurs in the nearshore waters of Bangladesh. A vessel-based line-transect survey conducted in 2004 along 1,018 km of systematic trackline resulted in an abundance estimate of 5,383 (CV=39.5; Smith et al. 2008). In waterways of the Sundarban mangrove forest of Bangladesh, Smith et al. (2006) estimated an abundance of 452 (CV = 10%) individuals.

Off the Mergui (Myeik) Archipelago of southern Myanmar a vessel-based line-transect survey of nearshore waters (to a depth of 40-60 m) conducted in 2005 searching along 955 km of trackline resulted in 30 cetacean sightings, only one of which was an Irrawaddy dolphin (Smith and Tun, 2008).

In the South China Sea, Smith et al. (1997b) reported that they had only four cetacean sightings during 1,121 km of transect. There were no sightings during 224 km of search effort in the Mekong River. However, a subsequent survey in the Mekong River (Baird and Beasley, 2005) reports a 'best' estimate of 40 animals. These authors confirm that the Mekong River dolphin population is apparently declining rapidly.

In eastern Borneo's Semayang Lake, Pela River and adjacent Mahakam River, a survey undertaken in the late 1970s reported between 100 and 150 dolphins. (Reyes, 1991, and refs. therein). A 1999-2002 survey in the Mahakam River (East Kalimantan) estimated a total population size of 33-55 dolphins (95% confidence limits 31-76); no changes in abundance >8% were detected over 2.5 years (Kreb and Budiono, 2005).

A geographically isolated population of Irrawaddy dolphins recently discovered in Malampaya Sound, Palawan, Philippines was estimated at 77 (CV = 27.4%) individuals. This is the only known population of the species in the Philippines; the nearest known other population is in northern Borneo, some 550 km to the south (Smith et al. 2004).

4. Biology and Behaviour

Habitat: Irrawaddy dolphins seem to prefer coastal areas, particularly the muddy, brackish waters at river mouths, and do not appear to venture far offshore, since all sightings were within only a few kilometres of the coastline. Some populations are apparently restricted to fresh water, e.g. Chilika Lake, India and Songhkla, Thailand (Reyes, 1991 and refs. therein).

Most sightings were made at confluences and river bends (Kreb in IWC, 2000).

In the Mekong River these dolphins are often observed near sand banks where streams flow into lakes (Reyes, 1991 and refs. therein). During the dry season, they are generally confined to sections of the river with water levels >8-10 m (Baird and Beasley, 2005). In the Mekong River of Laos, sightings were most common in the morning and decreased throughout the day. This could indicate diurnal feeding, given that foraging is suggested by repeated direction changes, lack of through travel, and observed fish consumption. Habitat use was most intense off a tributary mouth and adjacent Sandy Island. Mean water depth at the study site was 18.4 m, current speed in the main channel was 0.15 m/s, and water temperature was 31°C. In the nearshore waters of Bangladesh they prefer low salinity and shallow depth (Smith et al. 2008). In Malampaya Sound, Palawan, Philippines mean water temperature was 30.2 °C, depth 6.5 m, salinity 28.3 ppt and turbidity 2.2 NTUs (Smith et al. 2004). However, salinity preferences seem to reflect ecological (prey availability) rather than physiological constraints (Smith, 2009).

Behaviour: Surfacing is quite inconspicuous, with only the uppermost part of the back becoming visible in slow rolling dives. Leaps are infrequent, as are spy-hopping, tail slaps and body rubbing (Smith, 2009).

Mean dive duration of dolphins was 115.3 s, independent of group size (Stacey and Hvenegaard 2002).

Schooling: Groups of fewer than 6 individuals are most common, but sometimes up to 15 dolphins are seen together (Marsh et al. 1989; Jefferson et al. 1993; Stacey and Hvenegaard 2002). They have been seen in the same area as bottlenose and Indo-Pacific humpback dolphins (Jefferson et al. 1993).

Food: Fish, cephalopods, and crustaceans are taken as food. Irrawaddy dolphins sometimes spit water while feeding, apparently to herd fish (Marsh et al. 1989; Reyes, 1991; Jefferson et al. 1993).

In the upper reaches of the Ayeyawady River (formerly known as Irrawaddy River), Myanmar, fishermen practice cast-net fishing with the help of Irrawaddy dolphins. Dolphins and fishermen communicate by audio and visual signals during fishing (Tun, 2008). Catch per cast, defined by the number of fish, their weight and economic value, was higher while the fishermen were cooperating with dolphins, the differences being primarily explained by the much higher frequency of zero catches in non-cooperative casts (Smith et al. 2009a).

Reproduction: The calving season is not well known. Some calves appear to have been born from June to August, but 1 captive female gave birth in December (Jefferson et al. 1993). In the Northern Hemisphere, mating is reported from December to June (Arnold, 2002). In Chilika Lake, Irrawaddy dolphins have a very low rate of breeding, producing only one young in three years, with a gestation period of nine months (Sarkar, 2007).

5. Migration

In Semayang Lake, eastern Borneo, Irrawaddy dolphins perform daily migrations from the lake to the Mahakam River, returning to the lake in the evening. They may be found at distances up to 1,300 km upstream in major rivers, an indication of movements of considerable extent (Reyes, 1991). The distribution changes seasonally and is influenced by water levels and presumably variation in prey availability. Dolphins move into tributaries during high water and back into the main river when water levels recede.

6. Threats

Direct catch: Some small-scale hunting by local people probably occurs in many areas of the range (Jefferson et al. 1993). In some parts of Kampuchea and India, they are taken for food, but in most of the range they are protected by local beliefs (Marsh et al. 1989; Reyes, 1991 and refs. therein). Khmer and Vietnamese fishermen regard *Orcaella* as sacred animals and release them if they become entangled in fishing nets. By contrast, Khmer-Islam fishermen kill them for food.

The dolphins are reputed to have learnt to distinguish between the languages of these different communities, and are much more cautious about approaching the Khmer-Islam fishermen (Marsh, 1989 and refs. therein). Kreb and Beasley (in IWC, 2000) informed the IWC sub-committee that live captures have occurred for the oceanarium trade in the Mahakam River and coastal regions of Indo-Malaysia. In both these areas there are also reports of direct killing.

Incidental catch: Irrawaddy dolphins are accidentally caught in fishing nets in Bangladesh, India, and the Gulf of Papua New Guinea (IWC, 2000; Smith et al. 2008). In some areas animals are released, but in the case of drowned dolphins, the oil may be used for medicinal purposes. Because of their presence in coastal and riverine areas, incidental catches in fishing nets are likely to occur elsewhere in the range (Reyes, 1991; Jefferson et al. 1993). There have been no systematic observer schemes in freshwater or coastal regions, but evidence of bycatch and the increase in the use of gillnets are causes for concern. In addition, fishing with explosives may adversely affect this species in some areas (IWC, 2000).

Recent data suggests that the threats are ongoing: In Malampaya Inner Sound (Philippines) 29 deaths due to bycatch were recorded between 2001 and 2006. The distribution of fishing gear shows that almost all of the Inner Sound is harvested and that there is almost complete overlap with preferred dolphin habitat. Irrawaddy meat is consumed by the community members after accidental death, but the dolphins are not directly hunted for food. It is expected that this population will continue to decline and will be lost within 7 years if current fishing practices continue (Gonzales and Matillano, 2008; Smith et al. 2004). Similarly, the concentrations of gill netters/long liners of the Mergui (Myeik) Archipelago of southern Myanmar were particularly high in shallow nearshore waters and at least 150 were operating in the bay where the only sightings of Irrawaddy dolphins were obtained (Smith and Tun, 2008).

In the Mekong River anthropogenic mortality is also high, and there is considerable risk that the dolphin population will become locally extinct in the near future. The establishment of community-managed deep water Fish Conservation Zones with government support may represent the best opportunity for reducing dry season dolphin mortality from large-meshed gillnet entanglement (Baird and Beasley, 2005).

In the Mahakam River in East Kalimantan, Borneo, dolphins die mainly from entanglement in gillnets (73% of deaths). Their main habitats are also important fishing grounds and subject to intensive motorized boat traffic. Sixty-four percent of deaths (1995-2001) with known location (n = 36) occurred in these areas. Primary conservation strategies would require the introduction of alternative fishing techniques (Kreb and Budiono, 2005).

Habitat degradation: Habitat degradation may limit the distribution and abundance of Irrawaddy dolphins, particularly in fresh water. Dams (Baird and Mounsouphom, 1997), gold mining using mercury abstraction techniques, increased sedimentation as a result of deforestation and other changes in river catchments, overfishing, harmful fishing techniques (poison and electrofishing), vessel traffic and noise pollution are all potential threats to this species. Coastal development with concomitant eutrophication is also cause for concern (IWC, 2000; Smith et al. 2009b). Most reports come from the eastern distributional range of the species and show ongoing habitat reduction caused by anthropogenic activities.

In Indonesia, Irrawaddy dolphins were formerly observed in the Makam River up to Tengagarong and Samararinda. Since the 1980's, probably due to the intense activity related to the timber industry, they are no longer observed near these towns but only above Muarakamen (Reyes, 1991 and refs. therein). In East Kalimantan, Indonesia, Irrawaddy dolphins reacted to boats and surfaced less in the presence of speed boats and tugs (Kreb and Rahadi, 2004).

In Lao People's Democratic Republic, large hydro-electric dams planned for the Sekong River sub-basin and the mainstream of the Mekong River are a threat to the dolphins, fish populations, and local people (Baird and Mounsouphom, 1997). Stacey and Leatherwood (1997) concluded that the apparent low abundance and recent declines in numbers of the Irrawaddy dolphin are cause for serious concern. Deep pools existing in some of the major tributaries of the Mekong and in the Mekong itself are refuges during the dry season. In some tributaries, where dams have been constructed, some deep pool habitats have been affected by siltation as a result of changed hydrological conditions. In some areas, the pool habitats and the fishes they sustained have virtually disappeared (Poulsen et al. 2002).

Overfishing: The population inhabiting Chilka Lake in India is said to be declining because of reduction in food supply and silting of the lake due to agricultural development. Reduction of fish populations in Indonesian rivers by illegal fishing methods is a serious threat (Reyes, 1991 and refs. therein). Cast-net fishermen in the Ayeyarwady River, Myanmar consistently report dramatically depleted catches in recent years due to illegal electric fishing. Elimination of electric fishing in a recently established protected area will be crucial for conserving the dolphins and the cooperative cast-net fishery (Smith et al. 2009a).

Tourism: In Chilka Lake, India the population of *O. brevirostris* (locally known as 'Bhuasuni Magar') is threatened due to the "plying of mechanised boats in the lake" (Sarkar 2007).

Pollution: Since Irrawaddy dolphins are found in rivers, they are likely to be affected by pollution and other habitat encroachment associated with the development of their tropical habitat (Reyes, 1991 and refs. therein). In Chilika Lake, India, dichlorodiphenyltrichloroethane (DDTs) and its metabolites were the predominant contaminants, the highest concentration found was 10,000 ng/g lipid weight in blubber. Hexachlorocyclohexanes (HCHs) were the second-most prevalent contaminants in dolphin tissues. Efforts should be made to decrease the sources of these pollutants (Kannan et al. 2005).

7. Remarks

Range states (Reeves et al. 2008) :

Bangladesh; Brunei Darussalam; Cambodia; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; Viet Nam.

Listed in Appendix I and II of CMS. Listed in Appendix I of CITES. The World Wide Fund for Nature (WWF) considers *O. brevirostris* as one of the most endangered small cetaceans world wide (WWF, 2009).

The IUCN categorizes *O. brevirostris* as "Vulnerable" (Reeves et al. 2008). The justification is that wherever there is available data, subpopulations are low, ranging in the tens to one-hundreds, except for Bangladesh; There have been significant range declines; threats including by-catch and habitat degradation are well documented, are persisting and cause unsustainable mortality resulting in an estimated 30% reduction in population size over the next 3 generations. Given the vast area and complexity of coastline inhabited by this species, it is unlikely that a more quantitative assessment of the global population will be feasible in the near future (Reeves et al. 2008).

The IUCN marine mammal specialists group considers the populations of the Ayeyarwady (formerly Irrawaddy) of Myanmar (formerly Burma), with 59 individuals (2003 data; Smith, 2004); the Mahakam River, East Kalimantan, Indonesia, with 59-79 individuals (Jefferson et al. 2008); Malampaya Sound, Palawan, Philippines, with 77 individuals (Smith and Beasley, 2004); Mekong River (Viet Nam, Laos, Cambodia), with 69 individuals (Smith and Beasley, 2004); and Songkhla Lake in Thailand, with less than 50 mature individuals (Smith and Beasley, 2004) as Critically Endangered (Reeves et al. 2008). And although a few areas where the species occurs have been designated as protected, little has been done to conserve dolphin habitat (Smith, 2009).

As pointed out by Rosel and Reeves (2000), genetic and demographic consequences associated with very small population size can result in extinction even when effective measures are in place to protect the animals and their habitat. This is explained by low genetic variation, genetic drift, inbreeding and lower fitness.

Possible strategies for conserving the population include that: (1) socioeconomic alternatives be developed to reduce dolphin mortality by fishing gear; (2) fishery free zones be established in core areas of dolphin distribution; (3) Irrawaddy dolphins be promoted as a flagship species of environmental health in their habitat; (4) a long-term programme be established to monitor local dolphin populations; and (5) additional investigations be conducted to determine other areas of occurrence in the respective range stated (mod. from Smith et al. 2004). For additional recommendations, see also Perrin et al. (1996).

8. Sources (see page 267)

3.47 Orcaella heinsohni (Beasley, Robertson and Arnold, 2005)

English: Australian snubfin dolphin
German: Australischer Stupsflossen-Delphin
Spanish: Delfín a aleta chata de Australia
French: Dauphin à aileron retroussé d'Australie

Family Delphinidae

Orcaella heinsohni /Australian snubfin dolphin (© Wurtz-Artescienza)

1. Description

The Australian snubfin dolphin resembles the Irrawaddy dolphin (*O. brevirostris*), but, as opposed to its congener, the dorsal groove is absent. Furthermore, its back has a gray-brown cape, the sides are lighter and the belly is whitish. However, this colour pattern can be much brighter, almost white on the sides and light grey / ebony on the back. The head of the snubfin dolphin is blunt, round and bulbous and there is no beak. The line of the mouth is straight, and there is a distinct neck crease. Its dorsal fin is small and rounded and set somewhat behind mid-back. The large flippers have curved leading edges and their tips are rounded. Adult size reaches 2.3 m in females and 2.7 m in males, and body mass reaches 130 kg (Robertson and Arnold, 2009).

This species was previously considered as a sub-population of the Irrawaddy dolphin. However, clear differences in coloration, morphology and genetics are consistent with species-level differences (Beasley et al. 2005).

2. Distribution

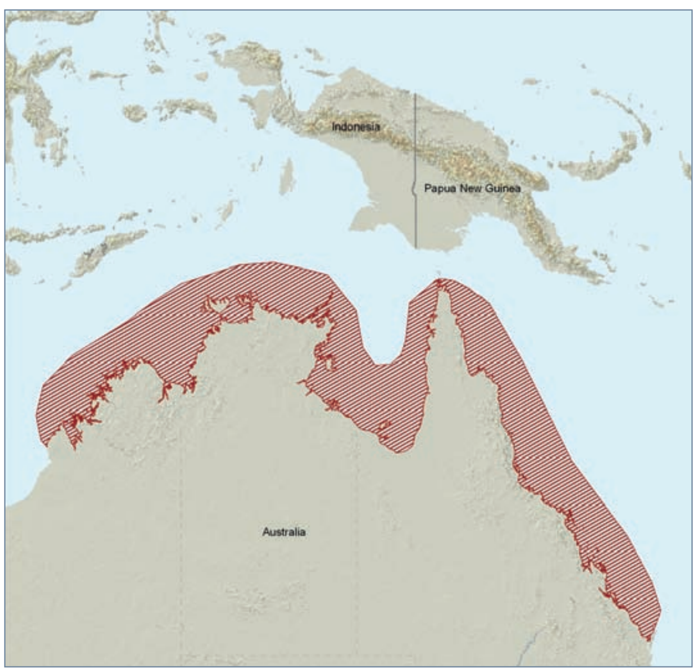
Snubfin dolphins are discontinuously distributed mostly in the coastal, shallow, brackish, or fresh turbid waters at the mouths of rivers. The species occurs in northern Australia where it ranges from Broome in Western Australia around to the Brisbane River in Queensland. The snubfin dolpfin occurs on the Sahul shelf of Australia and Papua New Guinea and is separated from the Irrawaddy dolphin (Sunda shelf of South and Southeast Asia) by the deep oceanic waters in between (Robertson and Arnold, 2009).

Occurence in northwestern New Guinea; southern New Guinea from the coast of Merauke east to the Gulf of Papua is speculative (W. Perrin, R. Reaves, pers. comm. to author 2011) and not shown on map.

3. Population size

Very little is known about the population size of this species (Reeves et al. 2008; Robertson and Arnold, 2009). Standard aerial survey techniques were used to survey coastal waters adjacent to the Northern Territory, Australia. Relatively few snubfin dolphins were observed in waters off the north-west coast. Substantial populations were located in the western Gulf of Carpentaria yielding a total estimate of approximately 1,000 individuals on the surface. The major concentration was located in Blue Mud Bay (Freeland and Bayliss, 1989). This is the largest population known in Australia (Reeves et al. 2008), however, this data is now more than 20 years old and requires confirmation.

More recent abundance estimates were obtained by Parra et al. (2006b) who used photo-identification data collected between 1999 and 2002 in Cleveland Bay, northeast



Distribution of Orcaella heinsohni: warm coastal waters and rivers in Northern Australia (Reeves et al. 2008; © IUCN Red List).

Queensland to estimate an abundance of 76 (CV = 0.08) individuals in 2000, 64 (CV = 0.11) in 2001 and 67 (CV = 0.14) in 2002. Due to low sample size and high CV, the authors estimated that it wouldl take six years to detect a population change of 5% p.a., and two years to detect a 20% p.a. change. Parra et al. (2006b) estimated that population estimates at a regional level are likely to be in the order of thousands rather than tens of thousands; during aerial surveys covering most of the east Queensland Coast between 1987 and 1995, only 29 sightings of snubfin dolphins were recorded (Corkeron et al. 1997; Parra et al. 2002) and during boat-based line transect surveys in selected areas of northeast Queensland there were only 22 sightings (Parra, 2005).

4. Biology and Behaviour

Habitat: In Australian waters, snubfin dolphins appear to avoid waters less than 2.5 m and greater than 18 m deep (Freeland and Bayliss 1989). Preference for nearshore, estuarine waters is likely related to the productivity of these tropical coastal areas (Parra et al. 2006a). Off Cleveland Bay there is evidence that animals occur mainly in waters close to the coast. Most sightings of snubfin dolphins during aerial surveys (Corkeron et al. 1997; Parra et al. 2002) and boat-based line transect surveys including offshore waters (waters >10 km from the coast) of different areas along the Queensland coast, occurred in waters within 6 km of the nearest coastline. In summary, shallow coastal areas adjacent to river and creek mouths and sea grass beds form the preferred habitat.

Behaviour: Surfacing is inconspicuous, with a low roll showing very little of the back and small dorsal fin. Therefore the species is easily missed in the field (Robertson and Arnold, 2009).

Schooling: Mean group size was 5.6 (Parra and Corkeron in IWC, 2000); group sizes of up to 14 animals have been observed (Parra et al. 2002). The species is observed to co-occur with the Indo-Pacific humpback dolphin, towards which it shows aggressive and sexual behaviour (Robertson and Arnold, 2009).

Food: Snubfin dolphins appear to be opportunistic-generalist feeders, eating a wide variety of fish and cephalopods associated with coastal-estuarine waters. Bottom-dwelling and pelagic fishes are consumed, indicating snubfin dolphins capture fish throughout the water column. The most important prey in numerical terms for snubfin dolphins was the cardinal fish (*Apogon* sp.), followed by the cuttlefish (*Sepia* sp.), the squid *Uroteuthis* (*Photololigo*) sp. and the toothpony fish (*Gazza* sp.; Parra and Jedensjö, 2009)

Reproduction: The calving season is not well known. Gestation may last approximately 14 months. Maturity seems to be reached at 4-6 years of age and longevity is around 30 years (Robertson and Arnold, 2009).

5. Migration

Freeland and Bayliss (1989) reported significant seasonal changes in distribution. Parra and Corkeron (in IWC, 2000) found that all animals identified during 1998 in Cleveland and Bowling Green Bays in Northern Queensland, Australia, were resighted in 1999, suggesting some degree of residency. More recently, Parra et al. (2006b) found that 68% of the snubfin dolphins photo-identified in Cleveland Bay were identified in more than one calendar year.

6. Threats

Incidental catch: Snubfin dolphins are accidentally caught in fishing nets and in anti-shark nets in Australia (IWC, 2000). They occurr close to river mouths; drowning in nearshore gillnets set across creeks, rivers, and shallow estuaries represents one of the major threats to nearshore dolphins along the Queensland coast (Parra et al. 2006a).

Habitat degradation: Habitat degradation is seen as an important conservation concern (Parra et al. 2006a; Robertson and Arnold, 2009). According to Hale (1997) the habitats in Australia include estuaries and near-shore coastal areas which are utilised for resource extraction and recreation and have been degraded in many areas as a result of urban, industrial and agricultural development. Conservation problems include loss of prey from over-fishing and destruction of fish habitat, vessel disturbance, possibly pollution and maybe directed killing. Long-term conservation will require a mixture of regulation, education and community involvement.

7. Remarks

Range states (Reeves et al. 2008): Australia; Possibly Indonesia and Papua New Guinea

O. heinsohni is listed in appendix II of CMS. The species is also listed in Appendix II of CITES.

IUCN categorises *O. heinsohni* as "Near Threatened". It is assumed that there are fewer than 10,000 mature individuals, that the range is limited, that densities in surveyed areas are low and that vulnerability, especially due to by-catch, is high. Reassessment of the species requires more extensive surveys and the outcome may be to classify the species as Vulnerable or even Endangered (Reeves et al. 2008).

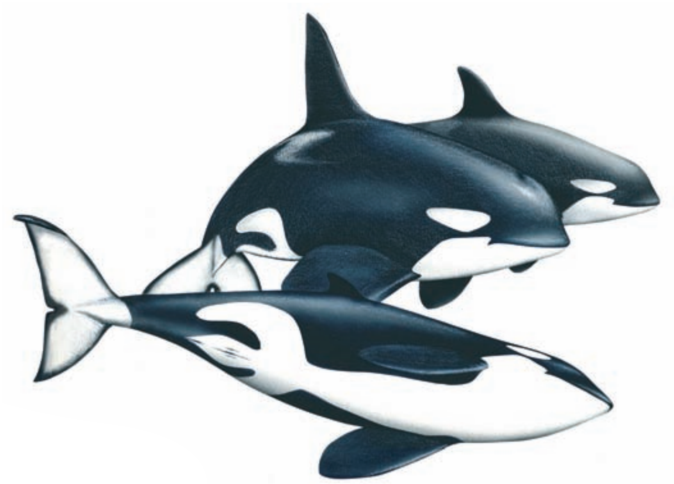
In its report on small cetaceans (IWC, 2000) the IWC Scientific Committee's sub-committee on small cetaceans recommended that comprehensive surveys be conducted to assess abundance, distribution, and habitat quality and that a review be carried out of the distribution and habitat preferences in marine systems and to define oceanographic, bathymetric and biological features associated with high density areas, The sub-committee expressed concern about increases in fishing effort, particularly with gillnets, in some parts of the range of this species. Given the apparently small size of some populations, some by-catches in these fisheries may be unsustainable. The sub-committee recommended that appropriate by-catch mitigation strategies be developed for use with this species (IWC, 2000). See also general recommendations on small cetaceans in Southeast Asia iterated in Perrin et al. (1996).

8. Sources (see page 268)

3.48 Orcinus orca (Linnaeus, 1758)

English: Killer whale
German: Schwertwal
Spanish: Orca
French: Orque

Family Delphinidae



Orcinus orca / Killer whale (© Wurtz-Artescienza)

1. Description

The killer whale is the largest member of the dolphin family. Maximum body lengths are 9 m in males and 7.7 m in females. Males reach 6,600 kg, whereas female maximum weight is 4,700 kg (Ford, 2009). Killer whales are recognized by their distinctive black, white and grey coloration and a white eye patch, or spot, located just above and behind the eye. Just behind the dorsal fin there is a grey saddle patch. The whale's belly, lower jaw and the underside of the tail flukes are white. The rest of the body is black. The wide, tall dorsal fin is curved backwards in females and juveniles and upright and triangular in adult males. The head is rounded, with a barely distinguishable beak. The pectoral flippers are paddle-shaped. In addition to sexual size dimorphism, male appendages, especially the dorsal fin, are disproportionately larger than in females.

According to Black et al. (1997) and Ford (2009) there are at least three recognizable ecotypes of killer whales ("Residents," "Transients," and "Offshores") in the eastern North Pacific that do not associate with members of the other groups. The ecotypes exhibit different home ranges, vocalizations, dietary preferences, foraging patterns, morphological features, and genotypes. Residents prey mostly on fish, Transients prefer marine mammals and Offshores seem to feed on both types of prey but may specialize in sharks.

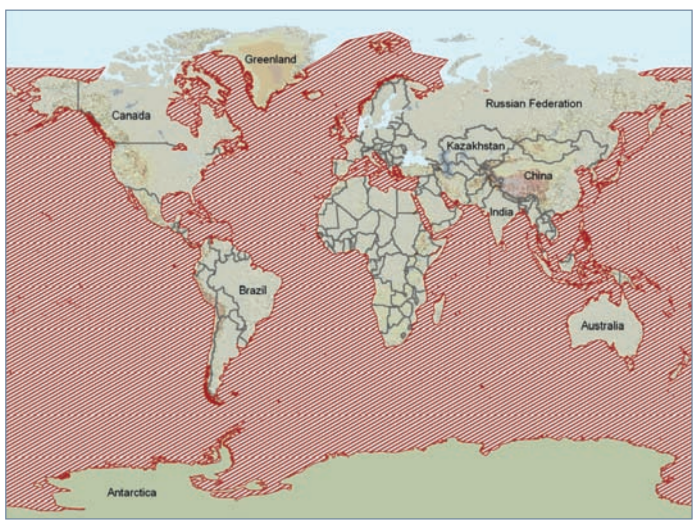
In the Residents, each local "community" of pods is largely endogamous, with mating between pods within the community. The ecotypes differ in both morphology and genetics, as well as in traditions such as migratory behaviour and prey choice. The communities within the resident ecotype can differ in dialects (Rice, 1998 and refs. therein).

Recently, three visually distinct forms of killer whales were described from Antarctic waters and designated as types A, B and C (Pitman and Ensor, 2003). These broadly sympatric but at least seasonally microallopatric forms show consistent differences in prey selection and habitat preferences, morphological divergence and apparent lack of interbreeding, which is also confirmed by genetic studies. However, a relatively low level of sequence divergence indicates that these evolutionary changes occurred relatively rapidly and recently (LeDuc et al. 2008). Pitman et al. (2007) with photogrammetery confirmed that the small ice-dwelling fish-eating form (type C) has a modal length of about 5-5.5 m, much smaller than most offshore whales. However, further studies are needed to ascertain whether these small whales deserve recognition as a separate species or subspecies (Ford, 2009).

Renner and Bell (2008) observed a white adult male killer whale off Adak Island, Aleutians. An open saddle and a rounded dorsal fin tip suggest that this whale belongs to the fish-eating ("resident") ecotype. A circular scar matching a cookie-cutter shark (*Isistius* sp.) bite mark suggested that the animal originated in warmer waters.

2. Distribution

This is probably the most cosmopolitan of all cetaceans and can be seen in literally any marine region. *O. orca* occurs



Distribution of Orcinus orca: this cosmopolitan species is found in all regions of the world (map mod. from Taylor et al. 2008; © IUCN Red List).

throughout all oceans and contiguous seas, from equatorial regions to the polar pack-ice zones, and may even ascend rivers. However, it is most numerous in coastal waters and cooler regions where productivity is high (Jefferson et al. 1993; Dahlheim and Heining, 1999 and refs. therein).

In the Atlantic it ranges north to Hudson Strait, Lancaster Sound, Baffin Bay, Iceland, Svalbard, Zemlya Frantsa Iosifa, and Novaya Zemlya; its range includes the Mediterranean Sea. In the Pacific it ranges north to Ostrov Vrangelya, the Chukchi Sea, and the Beaufort Sea. In the Southern Ocean, the range extends south to the shores of Australia and the Philippines, South Africa, South America and Antarctica, including the Ross Sea at 78°S (Rice, 1998).

Data from the central Pacific are scarce. Killer whales have been reported off Hawaii but do not appear to be abundant in these waters (Barlow, 2003).

3. Population size

Although the available data are far from complete, abundance estimates for the areas that have been sampled provide a minimum worldwide abundance estimate of about 50,000 killer whales (Taylor et al. 2008).There are several recent population estimates for parts of the species range. In the eastern North Pacific, these are, for the different sub-populations:

Resident stocks: In coastal waters of the western Gulf of Alaska and the Aleutian Islands, abundance estimates of resident killer whales are 991 (95% CI = 379-2,585) and 1,587 (95% CI = 608-4,140), respectively (Zerbini et al. 2007).

The eastern North Pacific Northern Resident stock numbered 216 in 1998 (Ford et al. 2000). Sightings surveys conducted in the inshore coastal waters of the Inside Passage, between the British Columbia (BC)-Washington and the BC-Alaska borders, yielded an abundance estimate of 161 (95% CI = 45-574) northern resident killer whales (Williams and Thomas, 2007) in these waters.

The eastern North Pacific Southern Resident stock numbered 86 whales in 2007, 79 in 2001 and 99 in 1995 (Carretta et al. 2009). The population has fluctuated considerably over the past 35 years, due to a variety of reasons (Krahn et al. 2004).

Offshores: Surveys conducted in 2001 (Barlow and Forney 2007) and 2005 (Forney 2007), estimated the total number of killer whales within 300 nm of the coasts of California, Oregon and Washington to be 1,014 (CV= 0.29).

Transients: Off the Japanese coast the most recent estimate is 1,200 individuals north of 35°N and 700 south of 35°N (Dahlheim and Heyning, 1999 and refs. therein).

Estimated transient killer whale abundance for the Gulf of Alaska and the Aleutian Islands, were 200 (95% CI = 81-488) and 251 (95% CI = 97-644) whales, respectively (Zerbini et al. 2007).

The West Coast Transient stock is a trans-boundary stock, including killer whales from British Columbia. In British Columbia and south-eastern Alaska, 219 whales were catalogued (Ford and Ellis 1999). Off the coast of California, 105 'transients' were identified (Black et al. 1997). These are the most recent estimates (Angliss and Outlaw, 2004).

A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 430 (CV=0.72) killer whales (Barlow 2003).

In the northern Gulf of Mexico US oceanic waters (2003 - 2004 data), abundance was 49 (CV=0.77; Mullin 2007).

Sightings in the eastern North Atlantic gave rough estimates of around 3,100 killer whales for the area comprising the Norwegian and Barents Seas and Norwegian coastal waters and some 6,600 whales for Icelandic and Faroese waters (Reyes, 1991 and refs. therein). In Norwegian coastal waters (Dahlheim and Heining, 1999 and refs. therein) questionnaire surveys yielded 483-1,507 killer whales.

Around Antarctica, the most recent estimate is 25,000 killer whales south of 60°S (Branch and Butterworth, 2001). Locally, Poncelet et al. (2002) reported a strong decline of *O. orca* in the coastal waters of Possession Island in the Southern Indian Ocean between 1988 and 2000.

Williams et al. (2009) considered the conservation status of fish-eating killer whales in southern African waters to be 'vulnerable', because the populations are very small and are subject to both short- and long-term impacts from longline fisheries.

4. Biology and Behaviour

Habitat: Sightings range from the surf zone to the open sea, though usually within 800 km of the shoreline. Large concentrations are sometimes found over the continental shelf. Generally, killer whales prefer deep water, but they can also be found in shallow bays, inland seas, and estuaries (but rarely in rivers). They readily enter areas of floe ice in search of prey (Carwardine, 1995). Resident killer whales in Pacific Northwest waters use regions of high relief topography along salmon migration routes, whereas transient whales forage for pinnipeds in shallow protected waters (Dahlheim and Heyning, 1999 and refs. therein). In the southwestern Atlantic Ocean, the majority of sightings per unit of effort occurred between 35° and 37° S, over depths of 200-3000 m. The presence of killer whales there coincides mainly with surface temperature fronts (Passadore et al. 2007).

Reproduction: In the Pacific Northwest, calving occurs in non-summer months, from October to March. Similarly, in the Northeast Atlantic, it occurs from late autumn to mid-winter (Jefferson et al. 1993). Gestation lasts 15 to 18 months and is first observed in females 12-14 years old. Intervals between calves average 5 years, and the reproductive life span is around 25 years long. Mean life expectancy is 50 years and longevity up to 90 years (Ford, 2009).

Schooling and behaviour: Pods of resident killer whales in British Columbia and Washington represent one of the most stable societies known among non-human mammals; individuals stay in their natal pod throughout life. Differences in dialects among sympatric communities appear to help maintain community discreteness. Most pods contain 1 up to 55 whales; resident pods tend to be larger than those of transients (Jefferson et al. 1993). Social organization can be classified into communities, pods, subpods, and matrilineal groups: a community is composed of individuals that share a common range and are associated with one another; a pod is a group of individuals within a community that travel together the majority of time; a subpod is a group of individuals that temporarily fragments from its pod to travel separately; and a matrilineal group consists of individuals within a subpod that travel in very close proximity. Matrilineal groups are the basic unit of social organization, and consist of whales from 2-3 generations. Membership at each group level is typically stable for resident whales, except for births and deaths (Dahlheim and Heining, 1999 and refs. therein).

Social organisation of mammal-eating transients is less well understood. Although the basic socal unit is the matriline, offspring often disperse for extended periods or even permanently, and the transient matrilines are smaller than those of residents. Transient group size is often only one, reflecting the hunting specialisation of these killer whales (Ford, 2009). Baird and Dill (1996) summarize that the typical size of transient killer whale groups is consistent with the maximisation-of-energy-intake hypothesis. Larger groups may form for the occasional hunting of prey other than harbour seals, for which the optimal foraging group size is probably larger than three, and for the protection of calves and other social functions.

Food: Killer whales are generalist predators on a global scale (Ford, 2009). However, local populations can exhibit remarkable specialisations with respect to their food preferences. The best studied example is that of resident, salmon-eating killer whales off the North American west coast, which show seasonal movements synchronised to their main prey, e.g. the fattiest salmon species *Oncorhynchus tshawytscha* (Washington and British Columbia) and *O. kisutch* (off Alaska).

Mammal-eating transient killer whales live in the same area, without undergoing seasonal migrations because their main prey, harbour seals (*Phoca vitulina*), harbour porpoises (*Phocoena phocoena*) and Dall's porpoises (*Phocoenoides dalli*) are present year round. These transient whales have never been observed to eat any species of fish (Ford et al. 1998). In the eastern Aleutian Islands, Alaska, the diet of transient killer whales in spring was primarily gray whales (*Eschrichtius robustus*) and in summer primarily northern fur seals (*Callorhinus ursinus*). Steller sea lions (*Eumetopias jubatus*) did not appear to be a preferred prey or major prey item during spring and summer (Matkin et al. 2007). In the Gulf of Alaska, transient killer whales feed on Steller sea lions, but because takes are lower than previously assumed, this seems to have only a minor effect on the recovery of populations (Maniscalco et al. 2007). Chemical tracer analysis also shows that these transients feed on other prey species as well (Krahn et al. 2007).

A third ecotype, genetically distinct from the other two (Barrett-Lennard, 2000) are the so-called Offshores. They are seldom encountered in the inshore waters of Washington and British Columbia and seem to prey on fish, including halibut and sharks (Ford, 2009). Chemical tracers show that offshores consume prey species that are distinctly different from those of sympatric resident and transient killer whales. These offshores forage as far south as California (Krahn et al. 2007).

In northern Norway, killer whales feed on herring (*Clupea harengus*). They co-operatively herd herring into tight schools close to the surface. During herding and feeding, the killer whales swim around and under a school of herring, periodically lunging at it and stunning the herring by slapping them with the underside of their flukes while completely submerged (Domenici et al. 2000). The whales prefer to search out small patches of herring in the early morning, in shallow waters and near underwater seamounts, which aids in herding their prey. Killer whales are not capable of catching these fish unless they have stunned them first with tail slaps. However, the whales have also learned to follow the fishing fleet and feed on herring that fall from the nets when the catch is being pumped in (Similae, 2005).

Icelandic killer whales have developed another strategy. They can emit a 3-s, 680-Hz call that ends 1 s before the tail slap. The frequency of the call falls within the herring audiogram, but outside that of killer whales. This call seems suited for herding the herring into tighter groups, making it possible to debilitate more fish. However, the herring are not defenceless. The school can produce a flatulent bubble net that could hinder detection by killer whale biosonar (Miller et al. 2006).

In the waters between northern Scotland and Norway, killer whales are frequently observed in the vicinity of the Scottish pelagic fleet targeting mackerel (*Scomber scombrus*) and herring. They approach the vessels during retrieval of the net, and remain there until this is completed. There is no evidence that they ever become entangled in the nets (Luque et al. 2006). They are known to follow fish-processing vessels for many miles, feeding of discarded fish. In the Bering Sea, the same pod of whales was reported to follow a vessel for 31 days for approximately 1,600 km (Dahlheim and Heyning, 1999 and refs. therein).

In the Strait of Gibraltar, killer whales prey on migrating bluefin tuna *Thunnus thynnus*. Their strategy is to chase their prey for up to 30 min at a relatively high sustained speed (3.7 m/s) prior to capture, pushing medium-sized tuna (< 1,5 m long) beyond their aerobic limits until exhaustion. Larger tuna may be inaccessible to killer whales unless they use cooperative hunting techniques or benefit through depredation of fish caught on long lines, drop lines or trap nets (Guinet et al. 2007). Off southern Brazil (Secchi and Vaske, 1998; Rosa and Secchi, 2007) and in may other areas world wide, orcas have learned to prey on fish hooked to longlines. In the Southern Ocean e.g., longline fisheries for Patagonian toothfish (*Dissostichus eleginoides*) suffer catch rate decreases of more than 50% when the whales occurr close to longline vessels (Kock et al. 2006).

Off the coast of Chubut, Argentina, orcas attack sevengill sharks (*Notorhynchus cepedianus*). The same whales were observed to feed on pinnipeds in Peninsula Valdes. Therefore some orca groups in the southwestern Atlantic may regularly feed on both fish and marine mammals (Reyes et al. 2004). In New Zealand waters, killer whales were found to capture and eat thresher (*Alopias vulpinus*) and smooth-hammer-head (*Sphyrna zygaena*) sharks; ten species of elasmobranchs are now recorded as prey for this population (Visser 2005).

In Antarctic type "C" killer whale populations, profiles of individual chemical tracers are consistent with a fish diet (Krahn et al. 2008). While type "B" orcas feed on pinnipeds in loose pack-ice, the larger type "A" killer whales are open water marine mammal hunters specialising on minke whales (*Balaenoptera bonaerensis*) (Pitman and Ensor, 2003).

Mehta et al. (2007) suggested that most killer whale attacks on baleen whales target young animals, probably calves on their first migration from low-latitude breeding and calving areas to high-latitude feeding grounds. Their results imply that adult baleen whales are not an important prey source in high latitudes.

5. Migration

Based on photo-identification studies, year-round and seasonal occurrences are recorded for the waterways of British Columbia and Washington State, where pods are known to range approximately 370 nautical miles (Reyes, 1991). However, numerous individual whales and/or pods have also been documented to move between Puget Sound (Washington)/British Columbia and southeastern Alaska; between southeastern Alaska and Prince William Sound; and between Prince William Sound and Kodiak Island. On an international level, whale movements from Alaska (USA) and British Columbia (Canada) to California (USA), from California to Mexico, and from Mexico to Peru have been documented. In most geographical regions, killer whale movements may be related to movements of their prey. Orcas may travel 125-200 km per day while foraging (Dahlheim and Heyning, 1999 and refs. therein; Guerrero-Ruiz et al. 1998).

In the Beaufort, Chukchi and northern Bering Seas, killer whales move south with the advancing pack ice, performing long-range movements. Similar movements are reported for the western North Atlantic. They approach the Chukotka coasts in June and leave the area in November or even as late as December (Reyes, 1991 and refs. therein).

Killer whales present in off-shore Norwegian waters appear to arrive there from Icelandic waters, following the migration of herring. Similae and Christensen (1992) photoidentified orcas around the Lofoten and Vesteralen Islands, northern Norway during fall-winter (October-February) and summer (June-August) in 1990 and 1991. Based on a capture- recapture estimate, they determined that about 500 killer whales are present in these overwintering areas of the herring. Most of the whales leave the study area in January when herring migrate to the spawning grounds 700 km farther south (Similae et al. 2002). Based on the seasonal distribution, whale groups can be divided into three different types; whales present in fall-winter (25 groups), whales present both in fall and summer (12 groups) and whales present in summer (six groups).

In Northern Patagonia, the seasonal distribution of killer whales is correlated with the distribution of South American sea lions (*Otaria byronia*) and southern elephant seals (*Mirounga leonina*). Most encounters with the whales at Punta Norte occurred in December and March-May, during the sea lions' breeding cycle. Whales depart the area in May when pinnipeds migrate to winter rookeries. One pod, Patagonia Norte B (PNB) was photographed in Golfo San José on 9 January 1986 and in Punta Norte 1 day later, some 60 km distant (Iniguez, 2001).

Evidence of seasonality is also observed in the southern part of the northeastern Atlantic. In the southern hemisphere, killer whales are found in warm waters in winter and migrate into high latitudes in the summer. This migration appears to be related to the migration of prey species, in particular the Antarctic minke whale (Reyes, 1991 and refs. therein). However, Gill and Thiele (1997) reported sighting killer whales in Antarctic sea ice in August, i.e. in late winter, indicating that some individuals may be resident there year-round.

Transient whales appear to cover a more extensive range than residents. A distance traversed of over 2,600 km (California to Alaska) was reported for a transient group of three individuals photographed in Monterey Bay, California, that had previously been identified off Alaska. (Forney and Barlow 1998). However, Californian killer whales may also move to the southern hemisphere. Guerrero et al (2005) reported photo-identifying a male killer whale in Magdalena Bay, Baja California, Mexico in 1988, in La Paz Bay, Mexico in1994 and finally ca. 148 km off Pucusana, Peru in 2001. The minimum distance between these sites is 5,500 km, extending the known maximum range that killer whales are able to travel, and raising questions in relation to population structure and interactions.

6. Threats

Direct catch: Killer whales have been exploited at low levels in several regions world-wide (Jefferson et al. 1993). Norwegian whalers in the eastern North Atlantic took an average of 56 whales per year from 1938 to 1981. The Japanese took an average of 43 whales per year along their coastal waters from 1946 to 1981. The Soviets, whaling primarily in the Antarctic, took an average of 26 animals annually from 1935 to 1979, but took 916 animals in the 1979/80 Antarctic season (Dahlheim and Heyning, 1999 and refs. therein; Reyes, 1991).

After 1976, Iceland was involved in live-captures of killer whales for export. During the period 1976-1988, 59 whales were collected, of which 8 were released, 3 died and 48 (an average 3.7 per year) were exported (Reyes, 1991 and ref. therein). In 1991, the Icelandic Government announced that after expiry of existing permits for live capture, no new ones would be issued (Jefferson et al. 1993). Live-captures of killer whales have also taken place in Japanese waters (Reyes, 1991 and ref. therein). Because individual killer whales play various roles in maintaining social integrity within their population, not all individuals are equal, and historic live-captures are likely to have broken matriline networks into isolated groups (Williams and Lusseau, 2006). Killer whales are still taken in small numbers in coastal fisheries off Japan, Greenand, Indonesia and the Caribbean Islands (Reeves et al. 2003).

Incidental catch: Incidental takes during fishing operations occur but are considered rare (Dahlheim and Heyning, 1999 and refs. therein). Baker et al. (2006) report on the results of molecular monitoring of 'whalemeat' markets in the Republic of (South) Korea based on nine systematic surveys from February 2003 to February 2005, which revealed meat from killer whales. In southern Brazil, killer whales prey on longline-caught tuna (*Thunnus* spp.) and swordfish (*Xiphias gladius*), and cetacean by-cacth is an issue in these fisheries (Rosa and Secchi, 2007).

Killing: Fishermen in many areas see killer whales as competitors, and shooting of whales is known to occur. This problem has been especially serious in Alaska, where conflicts with longline fisheries occur (Jefferson et al. 1993). Although much reduced, some such persecution continues today in Alaska and in the Strait of Gibraltar (Ford, 2009).

Pollution: High levels of PCBs and DDT (250 ppm and 640 ppm, respectively) were reported in the blubber of an adult male transient killer whale in Washington State and 38 ppm PCB and 59 ppm DDE wet weight levels in a resident male (Dahlheim and Heyning, 1999 and refs. therein). Ross et al. (2000) report that total PCB concentrations were surprisingly high in three killer whales communities (2 resident and 1 transient population) frequenting the coastal waters of British Columbia, Canada. Transient killer whales were particularly contaminated. Toxic equivalents in most killer whales surpassed adverse effects levels established in harbour seals, suggesting that the majority of free-ranging killer whales in this region are at risk from toxic effects. The southern resident and transient killer whales of British Columbia were considered among the most contaminated cetaceans in the world (Ross et al. 2000). However, estimated concentrations in both the northern and the more contaminated southern resident populations have declined gradually in recent years. Projections suggest that the northern resident population could largely fall below health effects threshold concentrations by the year 2030 while the endangered southern residents may not do so until at least 2060 (Hickie et al. 2007).

Recent studies from other parts of the world have produced similar results. Killer whales in northern Norway are among the most polluted arctic animals. Average total polychlorinated biphenyl (PCB) and pesticide levels were similar, approximately 25 µg/g lipid, and polybrominated diphenyl ethers (PBDEs) were approximately 0.5 µg/g, exceeding the already very high levels in polar bears. The levels in Norwegian killer whales are more than 20 times higher than those found in beluga whales (*Delphinapterus leucas*; Wolkers et al. 2007).

In eastern Hokkaido, Japan DDTs were the predominant contaminants, with concentrations ranging from 28 to 220 µg/g on a lipid-weight basis, followed by PCBs and other organochlorine pesticides. Japanese killer whales also had high hepatic residue levels of butyltins (from 13 to 770 ng/g wet weight) reflecting their extensive use in antifouling paint (Kajiwara et al. 2006).

Noise pollution: Killer whales use sound for echolocation, social communication, and passive listening. Anthropogenic noise including sonar, acoustic harassment devices, vessel traffic, and construction noise has the potential to interfere with bioacoustics. In the northwestern USA, the endangered Southern Resident killer whales are suffering from noise pollution in their environment (Holt, 2008).

From a sound propagation and impact model, Erbe (2002) deduced that fast boats are audible to killer whales for over 16 km, mask killer whale calls over 14 km, elicit a behavioral response over 200 m, and cause a temporary threshold shift (TTS) in hearing of 5 dB after 30-50 min within 450 m. For boats cruising at slow speeds, the predicted ranges were 1 km for audibility and masking, 50 m for behavioral responses, and 20 m for TTS. Superimposed noise levels of a number of boats circulating around or following the whales were close to the critical level assumed to cause a permanent hearing loss over prolonged exposure. From a study on the effects of acoustic harassment devices, Morton and Symonds (2002) deduced that the deliberate introduction of noise into their environment resulted in whale displacement.

Williams et al. (2002) investigated whether the current guidelines for whalewatchers are sufficient to minimise disturbance to northern resident killer whales in Johnstone Strait, British Columbia, Canada. Local guidelines request that boaters approach whales no closer than 100 m. Additionally, boaters are requested not to speed up when close to whales nor to place their boat in a whale's predicted path: a practice known as "leapfrogging". Williams et al. (2002) found that leapfrogging is a disruptive style of whalewatching and should be discouraged; as the experimental boat increased speed to overtake the whale's path, the source level of engine noise increased by 14-dB. Assuming a standard spherical transmission loss model, the fast-moving boat would need to be 500 m from the whale for the received sound level to be the same as that received from a slow-moving boat at 100 m. Whale-watching guidelines should therefore encourage boaters to slow down around whales and not to resume full speed while whales are within 500 m.

Habitat degradation: Habitat disturbance may be a matter for concern in areas inhabited by killer whales and supporting whale-watching industries (Reyes, 1991). Visser (1999) e.g. reports on propeller scars observed on killer whales and their possible cause of mortality. Vessel traffic may have contributed to southern resident killer whales becoming endangered. Lusseau et al. (2008) observed a reduction in time spent foraging, confirming an effect also previously observed in northern resident killer whales. Each school was within 400 m of a vessel most of the time during daylight hours from May through September. If reduced foraging effort results in reduced prey capture, this would result in decreased energy acquisition and biological fitness (Lusseau et al. 2008).

After the 1989 'Exxon Valdez' oil spill in Alaska, the resident AB Pod and the transient AT1 group suffered losses of 33 and 41%, respectively, in the year following the spill. By 2005, AB Pod had not recovered to pre-spill numbers. Moreover, its rate of increase was significantly less than that of other resident pods that did not decline at the time of the spill. The AT1 Group, which lost 9 members following the spill, continued to decline and is now listed as depleted under the U.S. Marine Mammal Protection Act (Matkin et al. 2008).

Overfishing: Some populations of killer whales could be affected by a reduction of their food supply. For example, coastal Norwegian populations reportedly feed mainly upon herring, a fish heavily exploited in the area (Reyes, 1991 and refs. therein). In Alaska, anthropogenic effects on the ecosystem are thought by some to be responsible for killer whale predation on sea-otters and associated ecological implications (Estes et al. 1998). In British Columbia, Canada, and Washington State, US, salmon stocks have significantly declined as an effect of overfishing, (freshwater) habitat degradation and reduced ocean survival. This is likely to affect fish-eating resident killer whales in that area (Ford, 2009).

Other factors: In the southern Indian Ocean, the strong decline reported by Poncelet et al. (2002) for the coastal waters of Possession Island between 1988 and 2000 may be attributed to several factors: i) a low and decreasing fecundity, possibly impacted by a density dependence (Allee effect); ii) the decline of the main preys (large baleen whales due to past whaling and southern elephant seals (*Mirounga leonina*) from the 1970's to 1990 which remained in low numbers up to at least 1997; iii) the possible mortality induced by recent interactions with the Patagonian toothfish - (*Dissostichus eleginoides*) longline fishery; and iv) the possible dispersion of individuals or groups from coastal waters. A preliminary toxicological study indicates that PCB levels are considerably lower than in British Columbia transients, however the burdens are not negligible (Ross, pers. com.) and the effects of PCBs on health at the observed concentrations are unknown. Poncelet et al. (2002) feared that the killer whales of Possession Island might disappear, losing unique genetic diversity and social culture, like AT1 transients in Alaska.

7. Remarks

Range states (Taylor et al. 2008): Albania; Algeria; American Samoa; Anguilla; Antarctica; Antigua and Barbuda; Argentina; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil; British Indian Ocean Territory; Brunei Darussalam; Cambodia; Cameroon; Canada (Newfoundland); Cape Verde; Cayman Islands; Chile; China; Cocos (Keeling) Islands; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Cuba; Denmark; Djibouti; Dominica; Dominican Republic; Ecuador (Galápagos); El Salvador; Equatorial Guinea; Falkland Islands (Malvinas); Faroe Islands; Fiji; France; French Guiana; French Polynesia; French Southern Territories (the) (Kerguelen); Gabon; Gambia; Ghana; Gibraltar; Greenland; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti;

Heard Island and McDonald Islands; Honduras; Iceland; India; Indonesia; Iran, Islamic Republic of; Ireland; Israel; Italy; Jamaica; Japan; Kenya; Kiribati; Liberia; Madagascar; Malaysia; Maldives; Marshall Islands; Martinique; Mauritania; Mexico; Micronesia, Federated States of; Monaco; Morocco; Mozambique; Myanmar; Namibia; Nauru; Netherlands; Netherlands Antilles; New Caledonia; New Zealand; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Norway; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal; Puerto Rico; Russian Federation; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; South Georgia and the South Sandwich Islands; Spain; Sri Lanka; Suriname; Svalbard and Jan Mayen; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; Tunisia; United Arab Emirates; United Kingdom; USA (including Aleutian Is., Hawaiian Is.); USA Minor Outlying Islands; Uruguay; Vanuatu; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen.

Orcinus orca is listed in Appendix II of CITES and in Appendix II of CMS. The species is categorised as "Data Deficient" by the IUCN. Some regional populations are small or highly specialised and may be threatened by habitat deterioration. This is the case in the critically threatened small Strait of Gibraltar population, which suffers declines in numbers and prey availability; as well as in the southern resident community of Washington and British Columbia, which is listed as Endangered under the US Endangered Species Act and the Canadia Species at Risk Act (Ford, 2009).

8. Sources (see page 269)

3.49 Peponocephala electra (Gray, 1846)

English: Melon-headed whale
German: Breitschnabeldelphin
Spanish: Calderón pequeño
French: Péponocéphale, Dauphin d'Electre

Family Delphinidae

Peponocephala electra / Melon-headed whale (© Wurtz-Artescienza)

1. Description

The melon-headed whale is mostly dark grey, with a faint darker grey cape that narrows at the head. A faint light band extends from the blowhole to the apex of the melon. A distinct dark eye patch, broadening as it extends from the eye to the melon, is often present. The lips are often white, and white or light grey areas are common in the throat region and urogenital region. At sea, the melon-headed whale is difficult to distinguish from the pigmy killer whale (*Feresa attenuata*), but it has a more pointed head and sharply pointed pectoral fins. The largest female was 2.78 m long and the largest male 2,64 m, weighing 228 kg (Perryman, 2009).

2. Distribution

Melon-headed whales have a pantropical distribution. They range north to the Gulf of Mexico, Senegal, Arabian Sea, Bay of Bengal, South China Sea, Taiwan, southern Honshu, Hawaiian Islands, and Baja California Sur; and south to Espiritu Santo in Brazil, Timor Sea, northern New South Wales, and Peru (Rice, 1998).

Specimens from southern Japan, Cornwall in England, Cape Province in South Africa, and Maryland, USA are probably from the extremes of the normal distribution for this species and likely came from populations in adjacent warm currents (Perryman et al. 1994; Rice, 1998).

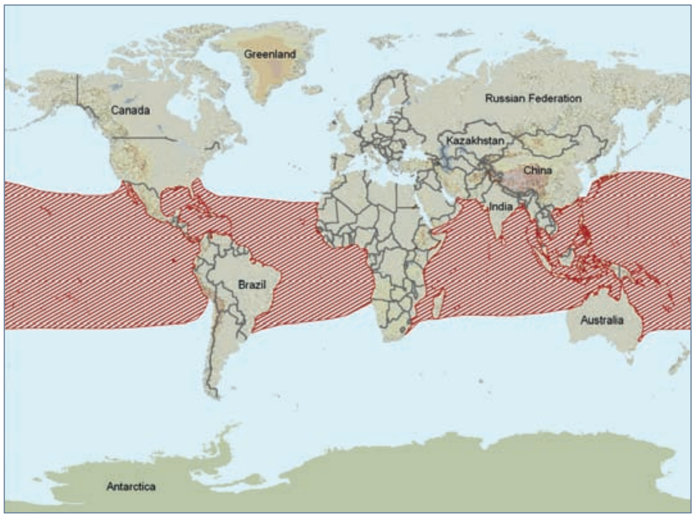
3. Population size

The most recent abundance estimate for melon-headed whales is for the northern Gulf of Mexico. Data from line-transect surveys were pooled from 2003 to 2004, and yielded and estimate of 2,283 (CV=0.76) animals (Mullin 2007). This value is not statistically different from the 1996-2001 estimate of 3,451 (CV=0.55) for the same region (Waring et al. 2008). In the US EEZ around Hawaii, the 2002 estimate is 2,947 animals (CV = 111%; Barlow 2006).

In the Philippine region, Dolar et al. (2006) report 921 (CV=0,83) in the eastern Zulu Sea, as opposed to an earlier estimate of 1,200 (Dolar, 1999). They estimate 1,383 in Tañon Strait between Cebu and Negros Islands (Dolar et al. 2006).

For the eastern tropical Pacific the most recent population estimate is 45,000 (CV = 0.47) individuals (Wade and Gerrodette, 1993). They are frequently seen in waters around the Hawaiian Islands, in the Tuamotus-Marquesas Islands, along the east coast of Australia, and in the oceanic, equatorial Pacific. The lack of reports on this species from many other areas may reflect a preference for offshore habitats where survey effort is generally lowest (Perryman et al. 1994 and refs. therein).

For the Indian Ocean, there are only a few accounts: Kiszka et al. (2007) report observing 5 melon-headed whales off Mayotte, Comoros Arquipelago in 2004-2005 during 284 hours at sea. Anderson (2005) observed cetaceans in Maldivian waters between 1990 and 2002 and found melon-headed whales to be particularly common in the south of the Maldivesbut rare in the centre and north.



Distribution of Peponocephala electra: tropical and subtropical offshore waters around the world (Taylor et al. 2008; © IUCN Red List).

During a dedicated survey of the cetacean population of the Marquesas Islands in French Polynesia, covering 2,255 km in 1998-99, 14 melon-headed whales were identified at sea. During a total effective effort of 6,482 km conducted off the Society Islands (French Polynesia) between 1996-1999, melon-headed whales were also observed, but less frequently (Gannier, 2000, 2002).

4. Biology and Behaviour

Habitat: Most sightings are from the continental shelf seaward and around oceanic islands. They are rarely found in temperate waters (Carwardine, 1995). In the eastern tropical Pacific, the distribution of reported sightings suggests that the oceanic habitat of this species is primarily in the upwelling modified and equatorial waters (Perryman et al. 1994). When they are observed near the coast, it is generally in areas where deep oceanic waters occur nearby (Perryman, 2009).

Behaviour: The animals make low, shallow leaps out of the water when travelling fast, often creating a lot of spray as they surface, which makes it difficult to see any detail. Slow swimmers may lift the head right out of water on surfacing. They are usually wary of boats, but most of these observations stem from areas where tuna boats regularly chase dolphins, so their behaviour may differ elsewhere. They are known to bow-ride for short periods, and breaching has occasionally been recorded. Sometimes they spyhop (Carwardine, 1995; Perryman et al. 1994).

Schooling: Melon-headed whales are highly social and more likely to be seen in large pods than the pygmy killer whale. They occur usually in pods of 100 to 500 (with a known maximum of 2,000 individuals). Animals in a pod are often tightly packed and make frequent course changes (Jefferson et al. 1993).

P. electra may associate with Fraser's dolphins (*Lagenodelphis hosei*) and sometimes other cetaceans such as spinner dolphins (*Stenella longirostris*) and spotted dolphins (*Stenella frontalis*; Carwardine, 1995). In Hawaiian waters a group of 30 melon-headed whales was seen interacting with a group of 15 short-finned pilot whales (*Globicephala macrorhynchus*). The interactions involved behaviours that suggest the encounter was unrelated to feeding symbioses, but it may have involved an inquisitive and/or protective response by the pilot whales (Migura and Meadows, 2002). Off the island of Rota in the Northern Mariana Islands, a group of about 500-700 melon-headed whales was observed at the surface and extensively underwater for several hours. An unidentified number of rough-toothed dolphins (*Steno bredanensis*) were also part of this sighting. Bottom depths ranged from about 77 to 1,100 m over the course of the sighting (Jefferson et al. 2006).

Mass strandings of melon-headed whales have been reported from Moreton Island and Crowdy Heads, Australia; Malekoula Island; Vanuatu; the Seychelles; Aoshima, Japan; Piracanga Beach, Brazil; the Kwajalein Atoll; and Tambor, Costa Rica. It has been noted that in several mass strandings the ratio of females to males was about 2:1. This may reflect behavioural segregation (Perryman et al. 1994 and refs. therein).

Reproduction: Females reach sexual maturity at about 11.5 years and males at 15 years (Perryman, 2009). There is some evidence to indicate a calving peak in July and August, but this is inconclusive (Jefferson et al. 1993). In the southern hemisphere, calving may peak between August and December (Klima, 1994).

Food: Melon-headed whales are known to feed on squid and small fish (Jefferson et al. 1993; Perryman et al. 1994; Clarke and Young, 1998).

5. Migration

No migrations are known (Carwardine, 1995), although the fact that the species follows warm currents may lead it through coastal waters of a variety of countries.

6. Threats

Direct catch: *P. electra* has been taken occasionally in the subsistence fishery for small cetaceans near the island of St. Vincent in the Caribbean and in the Japanese dolphin drive fishery. They continue to be taken in a long-lived and well-established harpoon fishery for sperm whales and various small cetaceans at Lamalera, Indonesia. Small-boat fisherman also occasionally harpoon or net this species near Sri Lanka and in the Philippines (Jefferson et al. 1993; Perryman et al. 1994). Dolar et al. (1994) investigated the fisheries for marine mammals in central and southern Visayas, northern Mindanao and Palawan, Philippines, and reported that hunters at several sites took melon-headed whales for bait or human consumption. They are taken by hand harpoons or, increasingly, by togglehead harpoon shafts shot from modified, rubber-powered spear guns. Around 800 cetaceans of various species were taken annually by hunters at the seven sites, mostly during the inter-monsoon period of February-May. These catches may be ongoing, although their extent is unknown (Perryman, 2009).

Incidental catch: Mortality from incidental captures in the purse-seine fishery for yellowfin tuna in the eastern Pacific will probably continue at a very low level (Perryman et al. 1994; Perryman, 2009). For US Gulf of Mexico waters, there has been no reported fishing-related mortality of melon-headed whales during 1998-2006 (Waring et al. 2008).

Pollution: Concentrations of polychlorinated biphenyls (PCBs), DDTs, and hexachlorbenzole (HCB) in melon-headed whales stranded on Japanese coasts were lower after the year 2000 than in specimens stranded in 1982, whereas polybrominated diphenyl ethers (PBDE) and CHL levels showed a temporal increase during the past 20 years, suggesting that the peak of their usage and contamination occurred only recently (Kajiwara et al. 2008). Specimens stranded on these shores also showed substantial concentrations of mercury and cadmium (Endo et al. 2008).

Noise pollution: In 2004, 150 - 200 melon-headed whales occupied the shallow waters of Hanalei Bay, Kauai, Hawaii for over 28 hours. The usually pelagic animals stayed in the shallow, confined bay and returned to deeper water only with human assistance. This event was coincident with military training exercises in the Hawaiian Islands, suggesting that military sonar might have been the cause (Southall et al. 2006; Taylor et al. 2008).

7. Remarks

Range states (Taylor et al. 2008): American Samoa; Anguilla; Antigua and Barbuda; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil; Brunei Darussalam; Cambodia; Cameroon; Cayman Islands; Cocos (Keeling) Islands; Colombia; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Cuba; Djibouti; Dominica; Dominican Republic; Ecuador; El Salvador; Equatorial Guinea; Fiji; French Guiana; French Polynesia; Gabon; Gambia; Ghana;

Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; India; Indonesia; Iran, Islamic Republic of; Jamaica; Japan; Kenya; Kiribati; Liberia; Madagascar; Malaysia; Maldives; Marshall Islands; Martinique; Mauritania; Mayotte; Mexico; Micronesia, Federated States of; Mozambique; Myanmar; Namibia; Nauru; Netherlands Antilles; New Caledonia; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Puerto Rico; Saint Kitts and Nevis; Saint Lucia; Saint Vincent and the Grenadines; Samoa; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; United States of America; Vanuatu; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen.

Classified as "Least Concern" by the IUCN (Taylor et al. 2008). Not listed by CMS. The species is listed in Appendix II of CITES.

This is a poorly known oceanic species which probably follows oceanographic features such as currents and upwellings near coasts. This behaviour might bring it into coastal waters of a variety of range states in tropical and subtropical waters. Data on abundance, behaviour at sea and by-catch rates are very sparse.

For South American stocks, see further comments and recommendations in Hucke-Gaete (2000) in Appendix 1, and regarding Southeast Asian populations, please see Perrin et al. (1996) in Appendix 2.

8. Sources (see page 271)

3.50 Phocoena dioptrica Lahille, 1912

English: Spectacled porpoise
German: Brillenschweinswal
Spanish: Marsopa de anteojos
French: Marsouin à lunettes

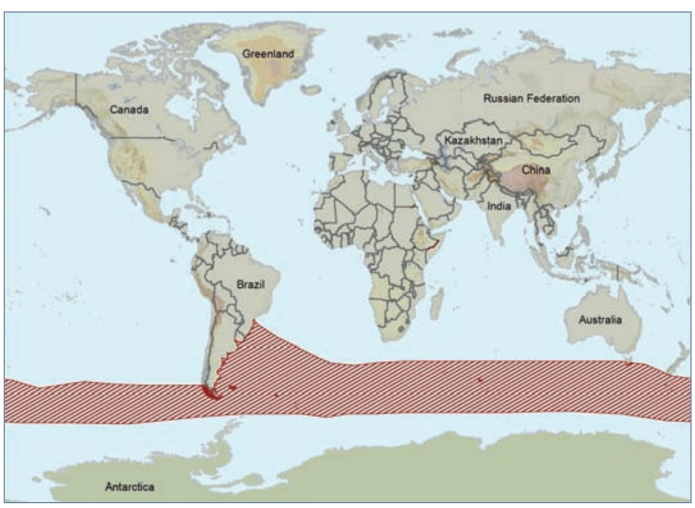
Family Phocoenidae

Phocoena dioptrica / Spectacled porpoise (© Wurtz-Artescienza)

1. Description

Most knowledge on the biology and ecology of the spectacled porpoise was obtained from stranded specimens, with less than fifteen confirmed sightings at sea. Published photographs of live animals in their natural environment are also very rare (Sekiguchi et al. 2006).

The spectacled porpoise is highly distinctive with its unusual pigmentation, small head and facial features and the large male dorsal fin. It is a robust animal with a rounded head and beak. The flippers are small and situated well forward. The dorsal fin is broadly triangular and grows much larger and rounded in males than in females. The flukes are small and have rounded tips. Adults are black dorsally, sharply separated from the white belly. Size ranges to 204 cm in females and 224 cm in males; mass is 85 kg in females and 115 kg in males (Goodall, 2002; 2009). Based on observations at sea and new photographs of live animals, a pale saddle around the dorsal fin is apparent (Sekiguchi et al. 2006).



Distribution of Phocoena dioptrica: coastal waters of southeastern South America and offshore islands around Antarctica (Hammond et al. 2008; © IUCN Red List).

Perrin et al. (2000) described osteological characteristics for specimens from Argentina and other areas of the Southern Hemisphere: tooth counts were16-26 and 17-23 in the upper and lower jaws, respectively. Total number of vertebrae was 66-70. The rostrum may be relatively smaller in the Auckland Islands than in other regions.

2. Distribution

There are records from widely separate locations; some of these may involve strays, or cases of mistaken identity. Records from offshore islands (mostly of dead animals and skulls), hint at a circumpolar distribution and suggest that the range may also include large areas of open sea. It is not known whether these represent isolated populations, or whether they mix with mainland coastal animals by migrating across the open sea (Carwardine, 1995).

According to Goodall (2002, 2009), *P. dioptrica* is circumpolar in cool temperate, sub-Antarctic and low Antarctic waters. It ranges in coastal waters of south-eastern South America, from Santa Catarina in southern Brazil (32°S; Pinedo et al. 2002) south to Tierra del Fuego; Falkland Islands (Islas Malvinas); South Georgia; Iles Kerguélen; Heard Island; Tasmania; Macquarie Island; Auckland Islands; Antipodes Islands (Rice, 1998), South Island, New Zealand (Baker, 1999) and South Australia (Kemper and Hill 2001). The southernmost sighting was at 64°33'S (Goodall, 2009). The suggested circumpolar and offshore distribution of the species was extended further south than previously thought, into Antarctic waters south of the Antarctic Convergence (Brownell and Clapham, 1999; Van Waerebeek et al, 2004; Sekiguchi et al. 2006).

3. Population size

Nothing is known on the abundance of this porpoise (Goodall, 2009; Hammond et al. 2008). It was the most commonly encountered species during preliminary beach surveys undertaken on Tierra del Fuego by R.N.P. Goodall, but once the beaches had been cleared it was exceeded in frequency of occurrence by Commerson's dolphin (Brownell and Clapham, 1999).

4. Biology and Behaviour

Habitat: *P. dioptrica* is mainly an oceanic species sighted in deep offshore waters. However, some have been sighted in coastal habitat, including in channels and even river estuaries (Goodall, 2009; Jefferson et al. 1993). Spectacled porpoises seem to occur only in cold temperate waters and where recorded, water temperatures associated with sightings ranged from 5.5°C to 9.5°C (Brownell and Clapham, 1999). However, this temperature range has recently be extended to 0.9-10.3°C, with most of the sightings (52.0%) in waters of 4.9-6.2 °C (Sekiguchi et al. 2006).

Behaviour: Spectacled porpoises are very inconspicuous when surfacing (Jefferson et al. 1993). They generally show fast swimming behaviour when approached by a vessel, resembling the swimming behaviour of harbour porpoises (Sekiguchi et al. 2006).

Schooling: *P. dioptrica* appears to live mainly alone (most of the strandings and sightings are of solitary animals), but may also live in small groups (Carwardine, 1995; Jefferson et al. 1993). In southern waters, group size was small, averaging 2 animals per group. A total of six cow-calf pairs were observed and all such pairs were accompanied by one or two additional adults, always including a mature male (Sekiguchi et al. 2006).

Reproduction: Births appear to occur in the southern spring to summer (Jefferson et al. 1993). Nothing is known on pregnancy rates, interbirth intervals or duration of lactation in this species (Brownell and Clapham, 1999).

Food: Based upon its dentition, it is likely that, like other phocoenids, *P. dioptrica* feeds upon fish and squid. Records of prey remains are scarce: anchovy (*Engraulis* sp.) and small crustaceans (possibly stomatopods) as well as squid (Brownell and Clapham, 1999; Goodall, 2009).

5. Migration

Nothing is known on the seasonal movements, if any, of this species (Brownell and Clapham, 1999; Goodall, 2009). Most sightings were pelagic, but strandings around Tierra del Fuego suggest at least some neritic activity of the species.

6. Threats

Direct catch: In the past, spectacled porpoises were killed deliberately for food. In Argentina and Chile, spectacled porpoises are taken in gillnets, and they may have been taken deliberately for crab (centolla; *Lithodes santolla*) bait off southern Chile. The effects of these catches on spectacled porpoise populations are not known (Jefferson et al. 1993).

Incidental catch: At least 34 animals were killed incidentally between 1975 and 1990 in coastal gill nets set in Tierra del Fuego, and there was a co-occurrence of strandings and fishing activity in south-eastern Chile, suggesting additional undocumented mortalities from this source. Some mortality of spectacled porpoises was also reported from bottom and mid-water trawls off the coast of Chubut, Argentina (Brownell and Clapham, 1999, and refs. therein). Jefferson and Curry (1994) summarise that the effects of incidental takes on the population are unknown.

Potential threats include also incidental captures in expanding fisheries in the Southern Ocean, especially in areas adjacent to subantarctic islands; disturbance and pollution resulting from coastal and offshore oil and mineral exploration (Argentina); pollution of preferred habitats, leading to accumulation of toxic substances in body tissues (Klinowska 1991; Bannister et al. 1996).

7. Remarks

Range states: Argentina; Australia (Macquarie Is., Tasmania); Brazil; Chile; Falkland Islands (Malvinas); French Southern Territories (the) (Kerguelen); Heard Island and McDonald Islands; New Zealand (Antipodean Is.); South Georgia and the South Sandwich Islands; Uruguay

IUCN Status: "Data Deficient" (Hammond et al. 2008). *P. dioptrica* is included in Appendix II of CMS. The species is listed in Appendix II of CITES.

According to Jefferson and Curry (1994), gillnets represent the single most important threat to porpoises as a group, and this may be an example of a "no technical solution problem". They conclude that better documentation of catches and new approaches to dealing with porpoise/gillnet interaction problems are needed in order to prevent the loss of several species and populations. See further recommendations and conclusions on South American stocks in Hucke-Gaete (2000) in Appendix 1.

8. Sources (see page 271)

3.51 Phocoena phocoena (Linnaeus, 1758)

English: Harbour porpoise
German: Schweinswal
Spanish: Marsopa común
French: Marsouin commun

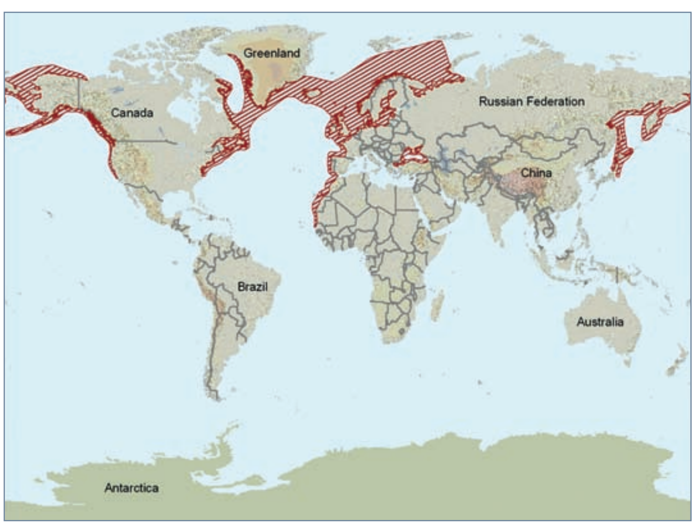
Family Phocoenidae

Phocoena phocoena / Harbour porpoise (© Wurtz-Artescienza)

1. Description

Harbour porpoises have a short, stocky body resulting in a rotund shape, which enables them to limit heat loss in cold northern climes. Adult females reach a mean body length of 160 cm and males only 145 cm. Mean mass is 60 kg and 50 kg, respectively (Bjorge and Tolley, 2009). In some parts of the range, however, animals are much smaller: in the Black Sea mean body length of adult females and males is only 133 and 123 cm, respectively, making these the smallest representatives of the species (Gol'din, 2004).

The dorsal side is dark grey, while the belly is a contrasting light grey to white which sweeps up to the midflanks in a mottled pattern. There is a dark stripe from the mouth to the flippers. The small triangular dorsal fin and the characteristic swimming pattern of several short, rapid surfacings followed by an extended dive of several minutes are characteristic for this species. Whereas early morphological studies suggested a close relationship of the harbour porpoise with *P. sinus* and *P. spinipinnis*, recent genetic information suggests that the closest relative of the harbour porpoise is in fact Dall's porpoise, *Phocoenoides dalli* (Bjorge and Tolley, 2009). There is molecular and morphological evidence of frequent hybridization between free-ranging Dall's and harbour porpoises (Willis et al. 2004).



Distribution of the four subspecies of Phocoena phocoena: cold temperate and subarctic waters of the Northern Hemisphere (Hammond et al. 2008a; © IUCN Red List).

2. Distribution

Harbour porpoises are found in cool temperate and subpolar waters of the Northern Hemisphere (Jefferson et al. 1993). Significant differences in the skulls of P. phocoena from the North Atlantic, the western North Pacific, and the eastern North Pacific have been found and two subspecies are recognised, one in the Atlantic and one in the Pacific. However, western Pacific animals differ sufficiently from those in the eastern Pacific to warrant subspecific separation, although no species-group name has been based on a western Pacific specimen (Rice, 1998 and refs. therein).

P. p. phocoena is distributed in the North Atlantic Ocean and ranges on the western side from Cumberland Sound on the east coast of Baffin Island, south-east along the eastern coast of Labrador to Newfoundland and the Gulf of St. Lawrence, thence south-west to about 34°N on the coast of North Carolina; it is also found in southern Greenland, north to Upernavik on the west coast and Angmagssalik on the east coast. In the eastern Atlantic, its range includes the coasts around Iceland; the Faroes; and the coasts of Europe from Mys Kanin and the White Sea in northern Russia, west and south as far as Cabo de Espichel, Portugal (38°24'N), including parts of the Baltic Sea and the British Isles. An apparently isolated population ranges along the coast of West Africa from Agadir (30°30'N), Morocco, south to Joal-Fadiouth (14°09'N), Senegal (Van Waerebeek et al. 2000); its members appear to attain a greater body length than European individuals. (Rice, 1998 and refs. therein). In the Gulf of Bothnia and the Gulf of Finland, both in the Baltic Sea, the species is no longer observed (Koschinski, 2002). *P. p. phocoena* is vagrant along the arctic coast east to Novaya Zemlya and Mys Bolvanskiy (Rice, 1998). It has also been observed in

Svalbard (Joergensen, 2007). The species is mostly absent from the Mediterranean, except for former, or sporadic, occurrences in the western part (Strait of Gibraltar, Islas Baleares, Barcelona, and Tunisia; Rice, 1998).

Genetic analysis shows that movements of harbour porpoises across the Atlantic appear to occur at a low level (Rosel et al. 1999) and harbour porpoises from West Greenland, the Norwegian West coast, Ireland, the British North Sea, the Danish North Sea and the inland waters of Denmark (IDW) are all genetically distinguishable from each other (Andersen et al. 2001). In a more recent review, Evans et al. (2009) suggest subdivision of the North Atlantic into the following stocks or subpopulations: 1) Gulf of Maine & Bay of Fundy; 2) Gulf of St Lawrence; 3) Newfoundland; 4) West Greenland; 5) Iceland; 6) Faroe Islands; 7) Northwest/Centralwest Norway & Barents Sea; 8) Northeastern North Sea & Skagerrak; 9) Southwestern North Sea & Eastern Channel; 10) Inner Danish Waters; 11) Baltic Sea; 12) Celtic Sea (plus South-west Ireland, Irish Sea & Western Channel); 13) North-west Ireland & West Scotland; 14) Bay of Biscay (West France); 15) IBNA (NW Spain, Portugal & NW Africa).

P. p. relicta is another geographically disjunct population which inhabits the Black Sea, the Sea of Azov, the Bosporus, and the Sea of Marmara (Rice, 1998), with at least four individuals reported in the northern Aegean Sea (Rosel et al. 2003). Analyses of geographic variation in mitochondrial DNA (mtDNA) support the existence of this subspecies (Read, 1999). Viaud-Martinez et al.(2007) found that the morphologically different Black Sea population has been genetically separated from eastern Atlantic populations for thousands of years, warranting its classification as a subspecies.

P. p. subsp. occurs in the Western North Pacific Ocean. It ranges from Olyutorskiy Zaliv south along the east coast of Kamchatka, including Komandorskiye Ostrova and the Near Islands in the western Aleutian Islands, throughout the Ostrova Kuril'skiye, and all around the shores of the Sea of Okhotsk, including Zaliv Shelikhova, Hokkaido, and Honshu as far as Nishiyama on the west coast and Taiji on the east. A distributional gap in the Aleutian Islands between Shemya and Unimak separates this race from the next. *P. p. subsp*. is vagrant north through Bering Strait as far as Ostrov Vrangelya (Rice, 1998).

P. p. vomerina Gill, 1865 is distributed in the Eastern North Pacific Ocean and ranges from the Pribilof Islands, Unimak Island, and the south-eastern shore of Bristol Bay south to San Luis Obispo Bay, California. *P. p. vomerina* is vagrant north to Point Barrow in Alaska, and the mouth of the Mackenzie River in the Northwest Territories of Canada, and south to San Pedro in Southern California. (Rice, 1998).

3. Population size

There are no synoptic surveys covering the entire range within ocean basins, but abundance has been estimated for selected portions of the range. Taken together, these numbers indicate that the global abundance of the harbour porpoise is at least about 700,000 individuals (Hammond et al. 2008a).

Note that all abundance estimates have to be taken with a grain of salt: According to Read (1999) there was an 80% discrepancy between abundance estimates for the Gulf of Maine in 1991 and 1992 (37,500 as opposed to 67,500, respectively). Similarly, aerial surveys conducted in 1995 and 1996 in the German North Sea revealed a mean abundance of 4,288 in 1995 and 7,356 harbour porpoises in 1996 (Siebert et al. 2006). In the south-western Baltic Sea, abundance estimates varied between 457 (CV 0.97, March 2003) and 1,726 (CV=0.39, June 2003; Scheidat et al. 2008).

The factors responsible for this variation may be related to migratory behaviour in response to changes in water temperature or prey availability on a regional scale, but are not fully understood. Methodology also plays a role: Carretta et al. (2001) estimated the abundance of harbour porpoises in northern California at 5,686 from a November 1995 ship survey. However, this abundance estimate was significantly different from an aerial survey estimate obtained 1 to 2 months earlier in the same region, where abundance was estimated at 13,145. A possible explanation was insufficient transect effort during the ship survey, or underestimates of the fraction of porpoise groups missed on the trackline due to large swell.

Pacific Ocean: From North to South: The estimated corrected abundance estimate for the Bering Sea harbor porpoise stock from a 1999 aerial survey is 48,215 (CV = 0.223). No fishery-related harbour porpoise mortalities were observed during the 2002-2006 period (Angliss and Allen 2008a).

For the Gulf of Alaska the estimated corrected abundance estimate from a 1998 aerial survey is 31,046 (CV = 0.214) (Angliss and Allen 2008b). Fishery related mortalities extrapolate to an estimated mortality level of 35.8 animals per year (Manly 2007).

The Southeast Alaska estimated corrected abundance based on a 1997 aerial survey is 11,146 (CV = 0.242). No incidental fishery-related mortalities were reported (Angliss and Allen, 2008c).

Between the British Columbia (BC)-Washington and the BC-Alaska borders, surveys conducted in 2004 and 2005 yield an abundance estimate of 9,120 (95% CI = 4,210-19,760) (Williams and Thomas, 2007).

For the inside waters of Washington and southern British Columbia, aerial surveys conducted during August of 2002 and 2003 led to an estimate of 10,682 (CV=0.38) animals. For coastal Oregon (north of Cape Blanco) and Washington waters the corrected estimate of abundance, based on a 2002 aerial survey from shore to 200 m depth is 37,745 (CV=0.38). The mean estimated mortality for the gillnet fishery in 1999-2003 is 0.6 harbour porpoise per year (Carretta et al. 2009).

The northern California/southern Oregon stock was estimated from pooled 1997-99 aerial survey data including data from both inshore and offshore areas, yielding an abundance estimate of 17,763 (CV=0.39). The Monterey Bay and the Morro Bay stock were estimated from 1999 and 2002 aerial surveys at 1,613 (CV = 0.42)and 1,656 (CV = 0,39) animals, respectively (Carretta and Forney, 2004).

Based on pooled 1995-99 aerial survey data, an updated estimate of abundance for the central California harbour porpoise stock is 7,579 harbour porpoises (CV=0.38; NMFS, K. Forney, unpublished data; Carretta et al. 2009).

Abundance estimates are lacking for the western Pacific Ocean (Hammond et al. 2008a).

Atlantic Ocean: The best current abundance estimate of the Gulf of Maine/Bay of Fundy harbour porpoise stock is 89,054 (CV=0.47), based on 2006 survey results (Waring et al. 2009).

In Greenlandic waters, the harbour porpoise has been observed in the south from Ammassalik on the east coast to Avanersuaq in the northwest. The main distribution lies between Sisimiut and Paamiut in central west Greenland

(Teilmann and Dietz, 1998). However, there are no abundance estimates for this stock (NAMMCO, 2009).

A survey conducted in the eastern North Atlantic in July 2005 (SCANS II), covering continental shelf seas from SW Norway, south to Atlantic Portugal, gave an estimate of 385,600 (CV = 0.20; Hammond et al. 2008a), with regional estimates: North Sea (c. 231,000), Baltic (23,000 in Kattegat/Skagerrak/Belt Seas/Western Baltic Sea), English Channel (40,900), and Celtic Shelf (58,400). From line transect surveys in July 1994 (Hammond et al. 2002), with a somewhat different coverage, population was estimated at 341,000 porpoises (CV=0.14; 95% CI: 260,000-449,000): North Sea (c. 250,000), Baltic region (36,600 in Kattegat/Skagerrak/Belt Seas/Western Baltic Sea), Channel (0), and Celtic Shelf (36,300). Comparing the two surveys, although the overall number estimated for the North Sea, Channel and Celtic Sea was comparable (341,000 in 1994, and 335,000 in 2005), numbers in the northern North Sea and Danish waters had declined from 239,000 to 120,000, whereas in the central and southern North Sea, Channel and Celtic Shelf, they had increased from 102,000 to 215,000. This is thought to represent a southwards range shift rather than actual changes in population size (Winship, 2009), at least for the month of July. This is consistent with recent studies using stranding data and observations from seabird surveys indicating a comeback of the species along the Dutch and Belgian coast (Laczny and Piper, 2006; Haelters and Camphuysen, 2009).

Baltic Sea: In the Skagerrak / Kattegat region between the Baltic and the North Seas, 36,046 (CV = 0,34) were estimated; In the western Baltic Sea Belt region, the count was 5,262 (CV = 0,25; Hammond et al. 2002). Teilmann et al. (2003) used satellite transmitters on animals in Skagerrak/North Sea and in Inner Danish Waters. Throughout the year there was no overlap in the home range of adult porpoises tagged in the two areas, respectively. The authors suggest a population boundary in the northern Kattegat across the Danish island of Læsø. This population structure is confirmed by genetic studies of all age classes during the summer season (Teilmann et al. 2003; 2008).

Harbour porpoises were also once numerous in the Baltic Sea south and east of the Belt region but today the population is estimated in the low thousands. Scheidat et al. (2008) give combined estimates for the German EEZ south in Kiel Bight, Mecklenburg Bight and the German waters of the Baltic proper ranging between 457 (March 2003; CV = 0.97) and 4610 (May 2005; CV = 0.35). The abundance in Kiel Bight was estimated at 588 (CV= 0,48) from 1994 data, with a density of 0.101 ind/km² (Hammond et al. 2002), of which about 50% or 300 would likely be mature (Taylor et al. 2007). Recent density estimates are somewhat higher, with 0.13 ind/km² in July 2004 (Scheidat et al. 2008).

Eastward between Kiel and Mecklenburg Bights the relative abundance of porpoises decreases continuously (Gillespie et al. 2003), from 16.2 acoustic detections/100-km in northern Kiel Bight, 9.2/100 km in southern Kiel Bight, and 2.8/100 km in Mecklenburg Bight to only 0.1/100 km in the Baltic proper. During visual surveys, porpoises were only sighted in Kiel Bight. These results are consistent with Scheidat et al. (2008) who found similar densities: in Kiel Bight: 0.13 ind/km² (95% CI = 0.02 - 0.38) and Mecklenburg Bight: 0.178 ind/km² (95% CI = 0.007 - 0.41) in July 2004, but only 0.008 ind/km² (95% CI = 0-0.03) in the Pomeranian Bight further east. The latter figure corresponds to earlier estimates of 599 individuals for an area around the Island of Bornholm determined in 1995 by L. Hiby and P. Lovell (pers. comm. to Scheidat et al. 2008), corresponding to a density of roughly 0.009 ind/km². A survey of Polish coastal waters conducted in 2001 using the same acoustic equipment, yields 0.05 detections per 100 km line-transect (Gillespie et al. 2003).

Kilian et al. (2003) support these findings using autonomous click detectors (PODs): Around the island of Fehmarn, harbour porpoise click trains were recorded almost every day, whereas along the east coast of the island of Rügen, only few porpoise encounters were collected. Nevertheless, for most areas investigated, porpoises were present regularly. Verfuss et al. (2007) also noted a significant decrease from west to east in the percentage of days with POD porpoise detections. There were more days of porpoise detections in summer than in winter, suggesting that the German Baltic Sea is an important breeding and mating area for these animals. Scheidat et al. (2003) report that on the Oderbank east of Rügen, Baltic harbour porpoise concentrations between May and August 2002 reached 0.086 animals per km aerial transect, as opposed to only 0.014 and 0.024 in nearby Mecklenburg and Kiel Bights, respectively. The reason for this high density in the area of the Oderbank could be foraging behaviour (S. Koschinski, 2010, pers. comm.).

Black Sea: The results of several surveys conducted between 2001 and 2005 in the Black Sea suggest that present total population size is at least several thousands and possibly in the low tens of thousands (Hammond et al. 2008a): 2,922 (95% CI = 1,333 - 6,403) in the Azov Sea (Birkun et al. 2002); 1,215 (95% CI = 492-3,002) in the northern, north-eastern and north-western Black Sea (Birkun et al. 2004), 3,565 (95% CI = 2,071-6,137) in the south-eastern Black sea (Birkun et al. 2006) and 8,240 (95% CI = 1,714 - 39,605) in the central Black Sea (Krivokhizhin et al. 2007).

4. Biology and Behaviour

Habitat: Throughout its range, *P. phocoena* is limited to the waters of the continental shelf by its demersal foraging behaviour and diving capacity (see below). In northern California significantly more porpoises than expected occurred at depths of 20 to 60 m as opposed to depths beyond 60 m (Carretta et al. 2001). Harbour porpoises are seldom found in waters with an annual average temperature above 17°C, preferring cool waters, where aggregations of prey are concentrated (Read, 1999 and refs. therein).

In the Horns Reef area, eastern danish North Sea, small-scale changes in local currents reflecting upwelling driven by the interaction of the semi- diurnal tidal currents with the steep slopes of the bank are the main habitat driver of harbour porpoises. The distribution of harbour porpoises alternates between 2 upwelling cells less than 10 km large, depending on the direction of tidal currents (Skov and Thomsen, 2008). Similarly, at Morte Point in North Devon, UK porpoises are found to aggregate in an area of high tidal flow, where prey items are likely to be abundant (Goodwin, 2008).

Fine-scale distribution in the Bay of Fundy was influenced by tides and prey availability. Whereas over the course of a month individuals ranged across large areas (7,738 to 11,289 km²), they also concentrated their movements in small focal regions (August-September mean = 250 - 300 km²) close to islands, headlands, or restricted channels, where density was significantly larger during flood than ebb tide and associated to prey aggregations along localized fronts (Johnson et al. 2005).

Behaviour: The harbour porpoise is difficult to observe. It shows little of itself at the surface, so a brief glimpse is the most common sighting. On calm days it may be possible to approach a basking animal, but it is generally wary of boats and rarely bow-rides. It can sometimes be detected by the blow which, although rarely seen, makes a sharp, puffing sound rather like a sneeze (Carwardine, 1995). Observations from cliffs above calm fjords or coastal waters yield the best results (Culik et al. 2001).

In Danish waters, maximum dive depth generally does not exceed 50 m, corresponding to the depth of the Belt seas and Kattegat. Maximum dive depth recorded was 132 m from animals moving north into Skagerrak. Dives were frequently recorded in the category 10-15 min, and harbour porpoises dive continuously both day and night, with peak activity during daylight hours (Teilmann et al. 2007). Dives to at least 226 m have been recorded via telemetry in other areas (Westgate et al. 1995).

Schooling: Most harbour porpoise groups are small, consisting of fewer than 8 individuals (pers. obs.). They do, at times, aggregate into large, loose groups of 50 to several hundred animals, mostly for feeding or migration (Jefferson et al. 1993). Harbour porpoises are not generally found in close association with other species of cetaceans and instead are observed to avoid bottlenose dolphins (*Tursiops truncatus*) due to aggressive and lethal interactions (Read, 1999).

Reproduction: Most calves are born from spring through midsummer (Jefferson et al. 1993). The majority of female harbour porpoises in Denmark and the Bay of Fundy become pregnant each year and are simultaneously lactating and pregnant for much of their adult lives. In contrast, female porpoises in California do not appear to reproduce each year (Read, 1999 and refs. therein). In Aberdeenshire, North Sea, Scotland, most porpoise calves and juveniles were recorded between June and September, when 35% of harbour porpoise groups contained immature animals. The proportion of calves amongst porpoise sightings was higher during June than any other month (Weir et al. 2007). Sexual maturity is reached at the age of 3 years and gestation lasts approximately 10.5 months. The life span is on average 8 to 10 years, the oldest documented individual was 23 years old (Bjorge and Tolley, 2009).

Food: Harbour porpoises eat a wide variety of fish and cephalopods, and the main prey items appear to vary on regional and seasonal scales (Jefferson et al. 1993). In the North Atlantic, harbour porpoises feed primarily on clupeoids and gadoids, while in the North Pacific they prey largely on engraulids and scorpaenids. Squids and benthic invertebrates have also been recorded, the latter considered as secondarily introduced (Reyes, 1991 and refs. therein). Individual prey are generally less than 40 cm in length and typically range from 10 to 30 cm in length (Read, 1999).

Many prey items are probably taken on, or very close to, the sea bed. Even though a wide range of species has been recorded in the diet, porpoises in any one area tend to feed primarily on two to four main species [e.g. whiting *Merlangius merlangus* and sandeels (Ammodytidae) in Scottish waters]. The literature on porpoise diets in the northeast Atlantic suggests that there has been a longterm shift from predation on clupeid fish (mainly herring *Clupea harengus*) to predation on sandeels and gadoid fish, possibly related to the decline in herring stocks since the mid-1960s. Evidence from studies on seals suggest that such a shift could have adverse health consequences. Food consumption brings porpoises into contact with two important threats - persistent organic contaminants and fishing nets, both of which have potentially serious impacts (Santos et al. 2003; Santos et al. 2004).

In the Kattegat and Skagerrak stomach contents of juvenile and adult harbour porpoises contained mostly Atlantic herring (*Clupea harengus*) while Atlantic hagfish (*Myxine glutinosa*) was also important for adults (Boerjesson et al. 2003). In another study on animals stranded and by-caught in Denmark, cod (Gadidae), viviparous blenny (Zoarcidae) and whiting (Gadidae) made up most of the stomach contents while in the Netherlands whiting was the main prey, making up around 34 % of the total reconstructed prey weight (Santos et al. 2005).

5. Migration

According to Read (1999) porpoises in each of the Bay of Fundy-Gulf of Maine, Gulf of St. Lawrence, Newfoundland and Labrador, and Greenland populations move into coastal waters during summer. In some areas, harbour porpoises move offshore to avoid advancing ice cover during winter. According to Gaskin et al. (1993) seasonal harbour porpoise migrations, especially in and out of the Sea of Okhotsk, must occur because of extensive ice coverage in winter, but in Japanese waters there are confirmed records of porpoises as far north as the northern tip of Hokkaido Island in January.

In the western North Atlantic, harbour porpoises arrive in the Bay of Fundy area in July, staying there until approximately late September. There is little evidence that the region may be significant either as a mating area or a calving ground. The arrival of females with calves coinciding with the arrival of juvenile herring is more suggestive of a feeding ground (Reyes, 1991 and refs. therein). Trippel et al. (1999) noted in a by-catch study in the lower Bay of Fundy that during years of low herring abundance, low harbour porpoise entanglement rates are observed. This suggests harbour porpoise movements matched the migratory behaviour of one of their preferred prey species. Long-term studies using satellite-linked radio telemetry indicate that porpoises are extremely mobile and are capable of covering large distances in relatively short periods, with mean daily distance travelled varying between 14 - 58 km. Animals move throughout the Bay of Fundy and Gulf of Maine, utilising home ranges that encompass tens of thousands of km^2 and suggesting that they form a single population at risk of entanglement in both Canadian and US fisheries (Read and Westgate, 1997).

Observations gathered from surveys off New Hampshire suggest this may be part of the wintering area for the Bay of Fundy population, which may have a north-south (and inshore-offshore) seasonal migration limited to the continental shelf in the eastern seaboard (Reyes, 1991 and refs. therein). Stranding data from the North Carolina coast confirm that harbour porpoises typically strand during the winter and spring months during migrations (Webster et al. 1995).

For the Baltic Sea, Koschinski (2002) summarised that 1) there might be a tendency of animals from the Kattegat to migrate into the North Sea during winter months; 2) a proportion of animals may stay in the western Baltic during the winter or even in the Baltic proper; 3) there might be a difference in migratory tendency between putative subpopulations; and finally 4) migration patterns might depend on winter severity. Verfuss et al. (2007) identified the Kadet Trench and Fehmarn Belt as important migration corridors.

Satellite telemetry revealed that in a few cases subadult porpoises tagged in the inner Danish waters moved into the Skaggerak/North Sea while only one of the tagged porpoises moved into the Baltic proper for a short visit (Teilmann et al. 2003). Teilmann et al. (2008) satellite-tagged 24 porpoises on the border between Skagerrak and Kattegat on the northern tip of Denmark (Skagen, Jylland) and 39 in Kattegat, Little Belt, Great Belt or Western Baltic (Inner Danish Waters, IDW) from 1997 to 2007. All animals from the northern group stayed in the northern Kattegat or in the Skagerrak and North Sea (including the EEZ of Norway and Sweden). Porpoises tagged in IDW stayed south of this area (including the EEZ of Germany, Sweden and Poland) except for five animals. Three of these stayed the majority of time in IDW and the other two animals moved immediately after tagging into the Skagerrak and North Sea and stayed there for the entire contact period. Based on these data, Teilmann et al. (2008) propose that the Danish waters be divided into four management areas for harbour porpoises 1) southern North Sea, 2) northern North Sea and Skagerrak, 3) Inner Danish Waters and Kattegat and 4) The Baltic Sea proper.

The Black Sea population is isolated, but there are a few records of *P. p. relicta* from the Aegaean Sea, showing that at least some parts of the population may migrate (Rosel et al. 2003).

6. Threats

Direct catch: Directed fisheries have occurred in Puget Sound, the Bay of Fundy, Gulf of St. Lawrence, Labrador, Newfoundland, Greenland, Iceland, Black Sea, and the Baltic Sea. Many of these fisheries are now closed, but hunting of harbour porpoises still occurs in a few areas. Greenland and the Black Sea are the only areas where large direct catches have been reported within the last 20 years (Jefferson et al. 1993). According to Reyes (1991) around 1,000 porpoises were taken annually in West Greenland using rifles and hand-thrown harpoons. Harbour porpoises are mainly caught between April and November, with a peak during June to October (Teilmann and Dietz, 1998). In 2003 the reported catch had increased to 2,320 (NAMMCO 2005); reported takes were 3,100 in 2005 and 2,563 in 2006; without any abundance estimates on population size or potential biological removal levels, these numbers are a matter of concern (NAMMCO 2009). Hunting on a small scale also still occurs in Japan, Canada and the Faroe Islands.

In the Baltic Sea, historical catch levels averaged about 1,000 porpoises per year during most of the nineteenth century, increasing to 2,000 at the end of the century with a subsequent declining trend during the twentieth century until catches increased again in the 1940s. Historical directed catches in the Baltic proper might have been higher than the catches in the Danish Straits (Kinze, 1995).

In the Black Sea, unregulated hunting was the primary threat until 1983, (IWC 1992, 2004). Very large numbers of harbour porpoises, as well as other cetaceans, were taken during the 20th century by all Black Sea countries for a variety of industrial uses. In 1996, the Ministers of Environment of Black Sea countries adopted cetacean conservation and research measures within the framework of the Strategic Action Plan for the Rehabilitation and Protection of the Black Sea (Birkun and Frantzis, 2008).

Incidental catch: Due to their habitat in productive coastal waters, harbour porpoises are captured incidentally in commercial fisheries throughout their range. Porpoises are taken in a variety of gear types including weirs, pound nets, cod traps, purse seine nets and surface gill nets, but the vast majority of this mortality occurs in bottom-set gill nets.

In Newfoundland gillnet fisheries, incidental catches of small cetaceans were estimated to be 862 in 2001, 1,428 in 2002 and 2,228 in 2003, virtually all of which were harbour porpoises. Most by-catches were reported in the nearshore cod fishery, although there were also numerous reports of catches in fisheries for lumpfish, herring and Greenland halibut and in offshore fisheries for monkfish, white hake and Greenland halibut. Most incidental catch events occurred during July-September along the south coast (Benjamins et al. 2007).

In the gillnet fishery of the Estuary and Gulf of St. Lawrence, Canada, a questionnaire survey provided bycatch estimates of 2,215 (95% CI 1,151-3.662) and 2,394 (95% CI 1,440-3,348) porpoises in 2000 and 2001, respectively. Although these numbers are still very high, they indicate a 24-63% reduction in bycatch since the late 1980s (Lesage et al. 2006).

Bycatches in herring weirs in the Bay of Fundy, Canada varied between eight in 1996 to 312 in 2001 (Neimans et al. 2004).

In Icelandic waters, harbour porpoise by-catches numbered 120 in 2006 and 147 in 2007 (NAMMCO, 2009).

The annual bycatch of harbour porpoise in the Danish North Sea bottom-set gillnet fisheries was estimated to have been in the range of 2,867-7,566 between 1987-2001, with a significant reduction in the most recent years due to a decrease in both effort and landings (Vinther and Larsen, 2004).

Along the Dutch and Belgian coastline a distinct increase in the numbers of strandings of porpoises showing lesions indicative of bycatch has occurred in recent years, in parallel to the increasing number of porpoises sighted in the southern North Sea (Haelters and Camphuysen, 2008). By-catch and drowning were noted most frequent in winter and spring and were responsible for 7 - 19 % of deaths similar to the statistics in neighbouring countries (Osinga et al. 2008).

Due to their low abundance, bycatch in the Baltic Sea is thought to be unsustainable, and Baltic porpoises may become extinct in the near future unless actions are taken to prevent future anthropogenic mortality (ASCOBANS 2000).

Kuklik and Skóra (2003) report that in Polish waters, by-catch occurred mostly in so-called salmon "semi-driftnets" and cod bottom-set nets, amounting to 62 by-catch reports between 1990 and 1999. Berggren et al. (2002) estimated potential limits to anthropogenic mortality for harbour porpoises in the Baltic region and concluded that immediate management action is necessary to reduce the magnitude of by-catches to meet the conservation objectives of ASCOBANS, the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas. In German Baltic Sea waters low by-catch numbers are reported (8 individuals reported in 2008, IWC 2009). However, between the years 2000 and 2007, strandings have increased dramatically from 25 to 173. A large proportion of these animals has net marks or cuts indicating a vast majority of unreported cases (Herr et al. 2009; Koschinski and Pfander, 2009).

In northern Portuguese waters (Ferreira et al. 2003) confirmed bycatch was responsible for 34% of all strandings and up to 18% of the deaths were suspected to have been caused by interactions with artisanal fishing gear. This coastal area is used by harbour porpoises as an important feeding and breeding site, thus making bycatch a serious threat to the species. Up to 53% of all harbour porpoise strandings recorded involved animals caught in beach purse-seine nets. Despite limited monitoring effort, by-catches of harbour porpoises have also been documented in artisanal gillnet fisheries in Senegal (Van Waerebeek et al. 2000).

Baker et al. (2006) report on detecting by-caught harbour porpoises through molecular monitoring of 'whalemeat' markets in the Republic of (South) Korea, based on nine systematic surveys from February 2003 to February 2005.

There is some hope that acoustic deterrents may help to reduce by-catch rates in gillnets in certain fisheries, provided foraging harbour porpoises can find prey outside the fishing areas (Culik et al. 2001). Pingers are now mandatory in Danish gillnet-fisheries around wrecks (Finn Larsen, pers. comm.) as well as in the North and Celtic Seas, the German Baltic Sea between Warnemünde and the Polish border and in 2 areas in Swedish Baltic for gillnet vessels over 12 m length (EU Regulation 812/2004). Another solution may lie in using enticing sounds, i.e. of alerting porpoises to nets rather than attempting to deter them. Koschinski et al. (2003) and Eskesen et al. (2003) report that certain sounds trigger investigative behaviour, echolocation activity increasing by 70-130% to investigate the sound source. This may help in alerting them to otherwise "invisible" nets. However, a field study by Kindt-Larsen (2008) concluded that a pinger producing porpoise-alerting-sounds based on porpoise clicks did not reduce bycatch. The author does not exclude, however, the possibility that an alerting pinger which succeeds in stimulating porpoises to a higher click rate may achieve this.

Another possibility for the reduction of by-catch is the use of acoustically reflective nets. High-density iron-oxide gillnets proved to be effective in reducing by-catch while catches of target species (cod) were reduced by as much as 30%. However, both effects were attributed to the mechanical properties of the net material rather than to acoustic reflectivity (Larsen et al. 2007). However, Mooney et al (2004) and Koschinski et al. (2006) found that in an acoustically enhanced Barium-Sulfate net, acoustic target strength was higher at 150 kHz than in a standard nylon net. Koschinski et al. (2006) conclude that harbour porpoises can detect the enhanced net 4.4 m in advance of standard nylon nets. However, because porpoises were found to often swim without echolocating, the authors suggest using a combination of reflective nets and warning sounds.

The most promising means for elimination of by-catch is the closure of important porpoise habitat for certain fisheries and a shift to porpoise friendly gear such as baited pots and jigging reels, in some cases also long-lines.

Overfishing: Large scale fisheries operating in the North Sea take are targeted at species which are important prey items for harbour porpoises. A similar situation occurs with the commercial fisheries for horse mackerel and anchovy in the Black Sea (Reyes, 1991 and refs. therein). Independent of fishery-related data, stable isotope analysis from harbour porpoises tissue collected prior to and after the 1960's in the North Sea indicates that lately they have been feeding at a lower trophic level than during the preceding century (Christensen et al. 2008) and this should also be reflected in the available recent stomach content analyses.

Climate change: One of the prey items of harbour porpoises in the Scottish North Sea, sandeels, are known to be negatively affected by climate change in a number of ways. When porpoise diet from spring 2002 and 2003 was compared to baseline data of 1993-2001, the diet was found to be substantially different, with a significant and substantially smaller proportion of sandeels being consumed in March and May. Whereas 33% of stranded porpoises died of starvation in spring 2002 and 2003, only 5% did so during the baseline period, suggesting that the negative effects of climate change on sandeel availability may have serious negative effects on harbour porpoise populations (MacLeod et al. 2007).

Pollution: A considerable body of literature exists describing the levels of various pollutants in tissues of the harbour porpoise. Contaminant levels often vary geographically and may serve as useful markers in studies of population structure (Read, 1999 and ref. therein, Koschinski, 2002). Pesticides, plasticisers, flame retardants (such as PBDEs BPA and HBCD) and trace metals are of special concern due to their bioaccumulative or endocrine disrupting potential.

In 48% of all samples, concentrations of polychlorinated biphenyls (PCBs) in blubber of female harbour porpoises from the Atlantic coast of Europe were above the threshold at which effects on reproduction could be expected. This rose to 74% for porpoises from the southern North Sea. The average pregnancy rate recorded in porpoises (42%) in the study area was lower than in the western Atlantic. Porpoises that died from disease or parasitic infection had higher concentrations of persistent organic pollutants (POPs) than animals dying from other causes (Pierce et al. 2008). Perfluorooctane sulfonate (PFOS) contamination in samples from the German Baltic Sea and from coastal areas near Denmark are comparable to levels found in Black Sea harbour porpoises and might pose a threat to these populations (Van de Vijver et al. 2007).

Furthermore, as opposed to a series of other local top-predators, harbour porpoises in Danish coastal waters contained the highest hepatic concentrations of butyltin, an antifouling agent in ship paint, with 134-2,283 ng/g ww, indicating a strong degree of bio-magnification in the food chain (Strand and Jacobsen, 2005).

Noise pollution: Harbour porpoises react very sensitively to anthropogenic noise. Consequently, shipping, marine exploration, construction and operation of noisy equipment such as sonar are likely to affect the behaviour and distribution of the species. Intense maritime traffic e.g. was correlated with reduced harbour porpoise density in the North Sea (Herr et al. 2005). Underwater detonations, e.g. from ammunition clearance, mine diver training, ship shock trials, closure of drill holes and other military or civil applications can seriously harm harbour porpoises due to extremely strong pressure changes created by the shock wave (S. Koschinski, 2010, pers. comm.).

The planned construction of offshore wind turbines in the North and Baltic Seas involves the emission of high numbers of intense impulsive sounds when turbine foundations are driven into the ground by impact pile driving, potentially evoking a temporary threshold shift (TTS) in the auditory system of harbour porpoises (Lucke et al. 2008). Cumulative effects of multiple pulses must be considered (Southall et al. 2007). During operation of the offshore turbines, available data indicate that the potential masking effect would be limited to short ranges in the open sea (Koschinski et al. 2003).

7. Remarks

Range states (Hammond et al. 2008a): Belgium; Bulgaria; Canada; Cape Verde; China; Denmark; Estonia; Faroe Islands; Finland; France; Georgia; Germany; Gibraltar; Greenland; Iceland; Ireland; Japan; Latvia; Lithuania; Mauritania; Morocco; Netherlands; Norway; Poland; Portugal; Romania; Russian Federation; Senegal; Spain; Sweden; Tunisia; Turkey; Ukraine; United Kingdom; USA; Western Sahara.

The species is listed in Appendix II of CITES. The Baltic Sea and Black Sea, the western North Atlantic and the North West African populations are listed in Appendix II of CMS.

The IUCN considers the species as "Least Concern" with the exception of the Baltic Sea (Critically endangered) and Black Sea (Endangered) populations (Hammond et al. 2008a). This is justified by all individuals in the Baltic Sea population belonging to one subpopulation, which numbers fewer than 250 mature animals. A continued decline can be inferred based on the current information on bycatches (Hammond et al. 2008b).

In the Black Sea, large directed takes between 1976 and 1983, intensive mortality as by-catch in fisheries, large numbers of casualties attributed to the petrochemical industry, epidemics, and ice entrapments, and a general degradation of the environment have led to a reduction in population size of 70% over the past 30 years (Birkun and Frantzis, 2008).

There have been several reports of decline of harbour porpoise populations in various parts of the range. The low abundance of porpoises observed around Japan may be the result of overhunting or incidental catches in the past (Reyes, 1991 and refs. therein).

Acknowledgement: We are grateful to Sven Koschinski for kindly reviewing this species summary.

8. Sources (see page 272)

3.52 **Phocoena sinus** Norris & McFarland, 1958

English: Vaquita, Gulf of California porpoise
German: Hafenschweinswal
Spanish: Vaquita
French: Marsouin du Golfe de Californie

Family Phocoenidae

Phocoena sinus / Vaquita (© Wurtz-Artescienza)

1. Description

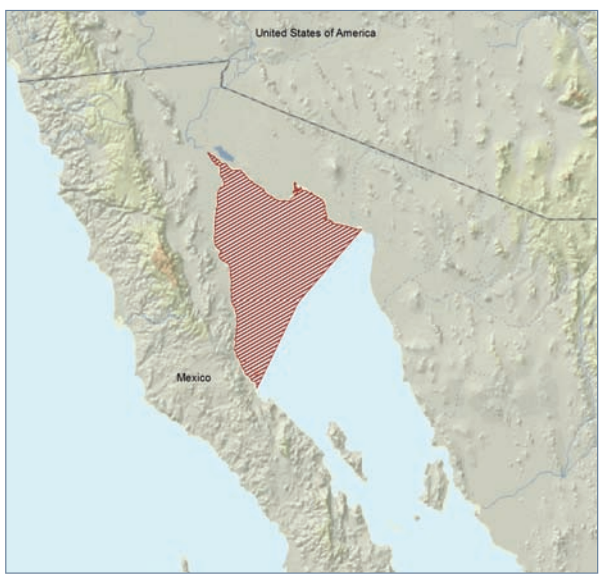
The vaquita is one of the smallest odontocetes (only *P.p. minor* is smaller). Mean length for females is only 140 cm. The flippers are proportionately larger than in other phocoenids and the dorsal fin is taller and more falcate. The pigmentation is a dark grey cape, pale lateral field and white ventral field. There are large black eye rings and lip patches. The skull is smaller and the cranial rostrum is shorter and broader than in other members of the genus. The vaquita is currently the most endangered odontocete species in the world (Rojas-Bracho and Jaramillo-Legorreta, 2009).

2. Distribution

The vaquita is endemic to the head of the Golfo de California (Sea of Cortés), from Puertecitos, Baja California Norte, north and east to Puerto Peñasco, Sonora. Reports from farther south have never been confirmed (Brownell et al. 1986). Vaquitas mainly live north of 30°45'N and west of 114°20'W. Their 'core area' is the most restricted distribution of any marine mammal species and consists of about 2,235 km², centered between Rocas Consag and San Felipe Bay, close to Baja California State coast (Jaramillo-Legorreta et al. 1999; Rojas-Bracho and Jaramillo-Legorreta, 2009).

3. Population size

Jaramillo-Legorreta et al. (1999) conducted a line-transect survey in 1997 and the total population size was estimated to be 567 (95% CI = 177-1073) animals. Note the wide confidence limits: this dated estimate is, until today, the most recent population estimate (Rojas-Bracho and Jaramillo-Legoretta, 2009). The continued increase of fishing effort in the area leads to an estimate of the current population size at 40% of its 1997 level, i.e. in the range of 71 - 430 individuals (Rojas-Bracho and Jaramillo-Legoretta, 2009). A recent estimate of the number of vaquitas remaining is based on the abundance estimate for 1997, the mortality rate in fishing nets in 1993, the estimated level of fishing from 1993 to 2007, the maximum population growth rate for porpoises and a standard population model for population growth. The currently remaining population was estimated at 150 animals (Jaramillo-Legorreta et al, 2007). The IWC in its 2008 meeting confirmed that the current vaquita population size was considered by most, including the Mexican Government, to be no more than 150 animals. This represents an extraordinarily rapid decline of approximately 75% in a decade. If this scale of fishery mortality continues, it will likely result in the effective extinction of the species in a maximum of 5 years and probably sooner (IWC, 2008). The species is not extinct yet and there is still hope: an expedition in 2008 reported 13 sightings (T. Jefferson, 2010, pers. comm. and Jefferson et al. 2009).



Distribution of Phocoena sinus: murky coastal waters in the northern quarter of the Gulf of California. This is the most restricted range of any marine cetacean (Rojas-Bracho et al. 2008; © IUCN Red List)

4. Biology and Behaviour

Habitat: The vaquita lives in a shallow basin, and is rarely seen in water much deeper than 30 m (Vidal, 1995). Other characteristics of its habitat are strong tidal mixing, convection processes and high primary and secondary productivity (Rojas-Bracho and Jaramillo-Legorreta, 2002). Silber (1990) reported 51 sightings in water depths of 13.5-37 m, and most of these sightings were 11-25 km from shore. Water visibility ranged from 0.9 m to 12 m.

Behaviour: The vaquita appears to swim and feed in a leisurely manner, but is elusive and will avoid boats of any kind. It rises to breathe with a slow, forward-rolling movement that barely disturbs the surface of the water, and then disappears quickly, often for a long time (Carwardine, 1995).

Schooling: Like other phocoenids, *P. sinus* occurs singly or in small groups. In 58 sightings, 91% comprised 1-3 individuals, with a mean group size of 1.9 and a range of 1-7 (Silber, 1990). Loose aggregations of vaquitas, i.e. single individuals or small subgroups (from 2-4 , greatest number 8-10) spreading over several hundred square metres were also reported (Vidal et al. 1999 and refs. therein).

Reproduction: Most calving apparently occurs in the spring. Gestation is probably 10-11 months. Maximum observed life span was 21 years (Hohn et al. 1996).

Food: All of the 21 fish species found in vaquita stomachs can be classified as demersal and/or benthic species inhabiting relatively shallow water in the upper Gulf of California. It appears that the vaquita is a rather non-selective feeder on small fish, squid and crustaceans in this zone. (Vidal et al. 1999; Rojas-Bracho and Jaramillo-Legoretta, 2009).

5. Migration

An analysis of all available sightings led Silber and Norris (1991) to suggest that vaquitas occupy the northern Gulf year-round. This has more recently been confirmed with the aid of acoustic surveys (Jaramillo-Legoreta et al. 2005).

6. Threats

Incidental catch: The most important human-induced problem affecting this species is incidental mortality in fishing gear. Vaquitas used to be incidentally captured in gillnet fishing operations (legal, illegal and experimental) for totoaba (*Totoaba macdonaldi*), an endemic and endangered large seabass-like fish. After the ban of the totoaba fishery, vaquitas continue to be captured in gillnets set on sharks, rays, mackerels (*Scomberomorus sierra* and *S. concolor*), chano (*Micropogonias megalops*; a "croaker"), and shrimp (*Penaeus* spp.). Between March 1985 and January 1994, 76 vaquitas were confirmed to have been killed incidentally in totoaba gill nets. All the porpoises taken in shrimp fisheries were referred to as "very small", probably calves or juveniles. Considering the large number (ca. 500) of shrimp boats operating in the upper Gulf of California at the beginning of each typical shrimping season, this fishery poses an additional threat to vaquitas, particularly younger ones (Vidal et al. 1999, and refs. therein).

Vaquita continue to be caught in small-mesh gillnet fisheries throughout much of their range. D'Agrosa et al. (2000) monitored fishing effort and incidental vaquita mortality in the upper Gulf of California from January 1993 to January 1995 to study the magnitude and causes of the incidental take. Of those factors studied, including net mesh size, soak-time, and geographic area, none contributed significantly to the incidental mortality rate of the vaquita, implying that the principal cause of mortality is fishing with gillnets per se. The total estimated incidental mortality caused by the fleet of El Golfo de Santa Clara was 39 vaquitas per year, which is over 17% of the most recent population estimate. Progress towards reducing entanglement has been slow in spite of efforts to phase out gill nets in the vaquita's core range, and the development of schemes involving compensations for fishermen (Rojas-Bracho et al. 2006).

The boundaries of the Upper Gulf of California and Colorado River Delta Biosphere Reserve of 1993 did not correspond well with the distribution of vaquitas. The shallow water north of the town of San Felipe was found to have a higher density of animals than had been indicated by previous surveys (Jaramillo-Legorreta et al. 1999). In December 2005, the Mexican Ministry of Environment therefore declared a Vaquita Refuge that contains within its borders the positions of approximately 80% of verified vaquita sightings. In the same decree, the state governments of Sonora and Baja California were offered $1 million to compensate affected fishermen (Rojas-Bracho et al. 2006). However although this money "ostensibly paid regional fishermen not to fish, they instead went to buy new boats and motors." Very recently, the Mexican government has gone one step further, forbidding any kind of fishing operations inside the Vaquita Refuge (Platt, 2009).

Habitat degradation: The international committee for the recovery of the vaquita (CIRVA) agreed that in the long term, changes in vaquita habitat due to reduction of the Colorado river flow as a result of dam construction and water withdrawal upstream (i.e. in the USA) is a matter of concern and needs to be investigated (Rojas-Bracho and Jaramillo-Legoretta, 2002).

Pollution: Concerns have been expressed about organochlorine pollutants in the food web. However relatively low concentrations of total DDT, alpha-BHC, and PCBs were found in blubber samples analysed in 1985, and values were lower than those reported for various odontocetes and marine birds from most other areas (Vidal et al. 1999, and refs. therein).

7. Remarks

Range states (Rojas-Bracho et al. 2008): Mexico.

Phocoena sinus is listed in CITES Appendix I and II. The World Wide Fund for Nature (WWF) considers the vaquita as one of the most endangered small cetaceans world wide (WWF, 2009). A 2007 study estimated that at least 100 vaquita are necessary to preserve the species' genetic diversity. With presumably only 150 porpoises left today, every vaquita counts (Platt, 2009).

P. sinus is considered "Critically Endangered" by the IUCN (Rojas-Bracho et al. 2008) based on the fact that the population may be declining by as much as 15% per year or more than 80% in three generations. The cause of the mortality has not ceased and may even have increased. Current size of the mature population is estimated at less than 250 mature individuals in a single population. Because the vaquita only occurs in Mexican waters, the framework of CMS does not apply.

As pointed out by Rosel and Reeves (2000), genetic and demographic consequences associated with very small population size can result in extinction even when effective measures are in place to protect the animals and their habitat. This is explained by low genetic variation, genetic drift and inbreeding and lower fitness. Low levels of variation in the

Major Histocompatibility Complex warn about a high susceptibility to novel pathogens and diseases in vaquita (Munguia-Vega et al. 2007).

According to Rojas and Taylor (1999), mortality resulting from fisheries bycatch poses the highest risk and primary conservation efforts should be directed towards immediate elimination of incidental fishery mortality. One of the possibilities could be acoustic deterrents and their compulsory use in gillnet fisheries, provided that protected areas located nearby remain net-free (Culik et al. 2001). However, CIRVA and the IWC did not recommend the use of pingers, as these would require a baseline scientific study and financial support to fishermen. Furthermore, pingers could dislocate the vaquita from its small core area without being expected to reduce by-catch to zero. Therefore, a total ban on fisheries, as pronounced by the Mexican government, was preferred (L Rojas-Bracho, pers. comm. January 2010).

The International Committee for the Recovery of the Vaquita (CIRVA) strongly recommends:

- a reduction of vaquita by-catch to zero, by removing gillnet fisheries in three stages, starting with large mesh sizes,
- enforcement of fishing regulations,
- development and testing of alternative fishing gear,
- expansion of the southern limit of the Upper Gulf of California and Colorado River Delta Biosphere Reserve to include the entire range of the vaquita,
- banning of trawlers from the entire biosphere reserve,
- investigation of the abundance and seasonal movement of vaquitas via acoustic surveys,
- the design and development of public education and awareness programmes,
- investigation and development of strategies to offset economic hardships imposed by such regulations (Rojas-Bracho and Jaramillo-Legoretta, 2002).

D'Agrosa et al. (2000) further recommend:

- a maximum annual allowable mortality limit of vaquitas, and
- mandatory observer coverage of all boats fishing within the Upper Gulf of California and Colorado River Delta Biosphere Reserve.

Recently, the President of Mexico announced a Conservation Programme for Endangered Species, and the vaquita is listed among the top five species. Should this initiative fail, the vaquita would most likely be doomed to extinction in the near future (Rojas-Bracho and Jaramillo-Legoretta, 2009).

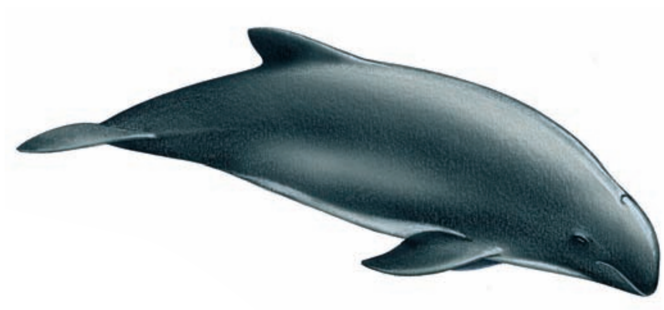
Acknowledgement: We are grateful to Lorenzo Rojas Bracho for kindly reviewing this account.

8. Sources (see page 274)

3.53 Phocoena spinipinnis Burmeister, 1865

English: Burmeister's porpoise
German: Burmeister-Schweinswal
Spanish: Marsopa espinosa
French: Marsouin de Burmeister

Family Phocoenidae



Phocoena spinipinnis / Burmeister porpoise (© Wurtz-Artescienza)

1. Description

The body is robust with a small, blunt head and relatively large flippers. The dorsal fin is set behind the midline, triangular in shape and canted backward in an unusual fashion for a cetacean. The Spanish name for this porpoise "marsopa espinosa" meaning "spiny porpoise" refers to the series of tubercles present on the leading edge of the low dorsal fin. Colouration varies from dark to brownish grey on the back and sides, and a light grey on the ventral region. A dark patch often surrounds the eye. A dark grey stripe runs from the chin to the base of the flipper. A pair of stripes is also present on the abdominal region. Maximum reported length is 200 cm, and maximum weight 105 kg (Reyes, 2009). However of 402 Burmeister's porpoises examined in Peru the largest female measured 183 cm and the largest male 182 cm. The heaviest specimen weighed 79 kg (Reyes and Van Waerebeek, 1995).

Distribution of Phocoena spinipinnis: temperate and subantarctic coastal waters around South America (Hammond et al. 2008; © IUCN Red List).

2. Distribution

P. spinipinnis ranges on the west coast of South America from Paita (05°11'S), Peru, south to Valdivia (39°46'S), Chile; on the east coast of South America from Santa Catarina (28°48'S), Brazil, south to Chubut (42°25'S), Argentina; and in coastal waters around Tierra del Fuego (Rice, 1998).

Whether Burmeister's porpoise has a continuous distribution throughout its range is unclear. There are numerous gaps in the known distribution along both Atlantic and Pacific coasts, but it was thought that many or most of these simply reflect a lack of survey effort in the areas concerned (Brownell and Clapham, 1999). Rosa et al. (2005), however, assessed the genetic differentiation among Burmeister's porpoises from different localities in Peruvian, Chilean, and Argentine waters. Clustering analyses indicate a major population differentiation along the South American Pacific coast, separating Peruvian from both Chilean and Argentine individuals, which has implications for conservation strategies.

3. Population size

There are no quantitative data on abundance (Carwardine,1995; Hammond et al. 2008; Reyes 2009). Burmeister's porpoise is very difficult to detect in any but calm conditions, a fact that may explain the discrepancy between the assumed abundance of this animal in coastal waters on the one hand and the relative rarity of field observations on the other. The animal's respiratory and diving behaviour does not lend itself to easy observation: swimming is highly unobtrusive, surfacing is quiescent, and relatively prolonged dives of 1-3 min are common (Brownell and Clapham, 1999).

4. Biology and Behaviour

Habitat: This is essentially a coastal species, which sometimes frequents rivers and estuaries and, off Tierra del Fuego, is occasionally observed inside the kelp line. Its habitat preferences seem to closely resemble those of the harbour porpoise, which is typically found shoreward of the 60 m isobath, but occasionally they have been recorded offshore in waters up to 1,000 m deep (Brownell and Clapham, 1999 and refs. therein). Although the species prefers close distance to shores of 100 - 1,000 m and water depths of 5 - 25 m, there have been records from more offshore waters, 50 km from the coast of Argentina (Reyes, 2002, 2009).

Burmeister's porpoise is found associated with a broad range of water temperatures. At the southern limit of its distribution near Cape Horn and Tierra del Fuego, water temperatures range from 3°C in June to about 9°C in the summer months. To the north, the species appears to be associated with temperate waters in the two major northward flowing currents of South America, the Humboldt/Perú and Falklands Currents. The highest recorded temperature associated with a Burmeister's sighting was 19.5°C in Golfo San José, Argentina (Brownell and Clapham, 1999 and refs. therein).

Behaviour: A limited number of observations indicate that it is a very shy animal. Some records suggest that small groups scatter when frightened, or approached by a boat, and regroup later. (Carwardine, 1995). There are no reports of porpoising or bow-riding (Reyes, 2009). Behaviour is inconspicuous; they breathe with little surface disturbance (Jefferson et al. 1993).

Schooling: Very little is known about the natural history of this species. Most sightings are of less 2-8 individuals, but aggregations of up to 150 have been reported in waters approx. 30 m deep, presumably associated with foraging behaviour (Van Waerebeek et al. 2002; Reyes, 2009).

Food: Feeding is on demersal and pelagic fish, such as anchovies (*Engraulis* spp.), hake (*Merluccius gayi*), silverside (*Odontesthes regia*), sardine (*Sardinops sagax*), jack mackerel (*Trachurus murphyi*) as well as squid (Reyes and Van Waerebeek, 1995; Reyes, 2002; Garcia-Godos et al. 2007). The stomachs of some Chilean animals also contained small snails, crustaceans and mollusc egg capsules (Brownell and Clapham, 1999 and refs. therein).

Reproduction: There appears to be a protracted summer birth peak; most births in Peru apparently occur in summer to autumn. Gestation lasts 11-12 months (Reyes and Van Waerebeek, 1995; Reyes, 2009).

5. Migration

There is no evidence of seasonality in occurrence either off Peru or Chile and both sightings and by-catches (Peru) are from all seasons (Van Waerebeek et al. 2002). A year-round population of Burmeister's porpoise appears to exist in the Beagle Channel, suggesting site-fidelity; sightings have been reported in every month except August and September. Data on seasonal movements are sparse and come largely from entanglements and incidental sightings. At Golfo San José, Argentina, *P. spinipinnis* is observed almost exclusively in spring and summer. This suggests that seasonal movement (either north-south or inshore-offshore) does occur, although whether this is correlated with water temperature or abundance of prey is unknown. Seasonal porpoise movements inferred from capture rates of the "corvina" fishery off Valdivia, Chile, with animals caught inshore (up to 18.5 km from the coast) in summer, and offshore (18-37 km) in winter, are biased by fishing methods: fishermen move their nets offshore in winter. Although it is unclear whether this by-catch truly reflects movements by the porpoises, it is possible that Burmeister's porpoises migrate offshore to match seasonal movements of potential prey, sardines (Brownell and Clapham, 1999 and refs. therein). Movements of porpoises along the Atlantic coast of South America following sporadic cold-water intrusions associated with the Subtropical Convergence may account for sightings as far north as Uruguay and Brazil (Reyes, 2009).

6. Threats

Direct catch: The most extensive known takes occur in Peruvian waters, where Burmeister's porpoise is caught primarily in net fisheries, and where it has been used extensively for human consumption. Mortality in Peru was estimated as >450 per year and the high mortality is cause for considerable concern (Van Waerebeek and Reyes, 1994; Van Waerebeek et al. 1997). Reyes (2002) states that annual captures in Peru may account for up to 2,000 animals, but current numbers are unknown (Reyes 2009). At least some gillnets are set with the direct intent to capture porpoises (Van Waerebeek et al. 2002). It is widely suspected that Burmeister's porpoises were shot or harpooned for use as crab bait in southern Chile, although this has been reduced due to modified fishery operations (Reyes, 2009). However, because quantitative data are lacking, the current extent of direct catches is unknown.

Incidental catch: By-catch occurs in various areas within the species' range, including Peru, Chile, Argentina, Uruguay and Brazil. Coastal or shark gill net fisheries are responsible for mortality in Burmeister's porpoise in Argentina (>12 per year), Tierra del Fuego, and, to a lesser extent, Uruguay. Takes are poorly documented in all areas (Brownell and Clapham, 1999 and refs. therein).

Between 1991 and 1998, observers stationed at the port of San Juan in southern Peru observed the landings of 214 Burmeister's porpoises. Most of these animals were captured in 1992-1994, when the fishers were mainly using surface-drift gillnets to target a pelagic schooling fish called cojinova (*Seriolella violacea*). Capture rates were much lower in 1995-1998, when fishers were mostly using fixed demersal gillnets and shellfish diving, due apparently to a lack of surface-schooling cojinova in the vicinity (Majluf et al. 2002). This clearly shows how alterations in gear type can reduce cetacean mortality.

More recently, South of Santa Cruz and in Tierra del Fuego, Argentina, the gill net fishery targeted at Patagonian blenny *Eleginops maclovinus* and silverside (Atherinidae) was made responsible for incidental porpoise mortality (Crespo et al. 2007).

Pollution: There has been only one study of pollutants in this species on eight animals caught in gillnets off northern Argentina. Organochlorine levels in all animals were low, a finding which is consistent with the relatively low degree of pollution known from local waters (Brownell and Clapham, 1999 and refs. therein).

7. Remarks

Range states (Hammond et al. 2008): Argentina; Brazil; Chile; Peru; Uruguay

Phocoena spinipinnis is considered as "Data Deficient" by the IUCN (Hammond et al. 2008). The species is included in Appendices II of CMS and CITES.

Jefferson and Curry (1994) summarise that existing information is insufficient to evaluate the effects of gillnets on porpoise populations, but where this is possible, impacts often prove to be severe. Gillnets represent the single most important threat to porpoises as a group. Better documentation of catches and new approaches to dealing with porpoise/gillnet interaction problems are clearly needed in order to enable an assessment of the effects and to suggest mitigation measures in the case of Burmeister's porpoise (see also chapters 3.51 and 3.52). For conclusions and recommendations for small cetaceans off South America: please see Hucke-Gaete (2000).

8. Sources (see page 275)

3.54 Phocoenoides dalli (True, 1885)

English: Dall's porpoise
German: Dall-Hafenschweinswal
Spanish: Marsopa de Dall
French: Marsouin de Dall

Family Phocoenidae

Phocoenoides dalli / Dall's porpoise (© Wurtz-Artescienza)

1. Description

Like the other members of the phocoenid family, Dall's porpoises have a stocky body with a short, wide-based, triangular dorsal fin. The beak is very short and poorly defined. The flippers and flukes are small. The colour pattern is very characteristic, the animals being largely dark grey to black with a large, ventrally continuous white patch which extends up about halfway on each flank. The upper part of the dorsal fin and the trailing edge of the flukes are light grey. Maximum body length is 239 cm and mass 200 kg (Jefferson, 2009).

Dall's porpoises are polymorphic in their pigmentation pattern. In *dalli* type animals, the flank patch extends to about the level of the dorsal fin whereas in *truei* type animals the patch extends to about the level of the flippers. Both colour morphs were variously considered as species or subspecies in the past (e.g. Rice, 1998), and genetic analysis confirms that they form separate populations: Pairwise comparisons indicate a low but significant difference between the Sea of Japan-Okhotsk *dalli*-type population on the one hand and the *truei*-type population and the standard *dalli*-type population in the northwestern North Pacific on the other hand (Escorza-Treviño and Dizon, 2000; Hayano et al. 2003; Amano and Hayano, 2007). Furthermore, there seems to be a demographic distinctiveness between Bering Sea and western North Pacific stocks (McMillan and Bermingham, 1996).

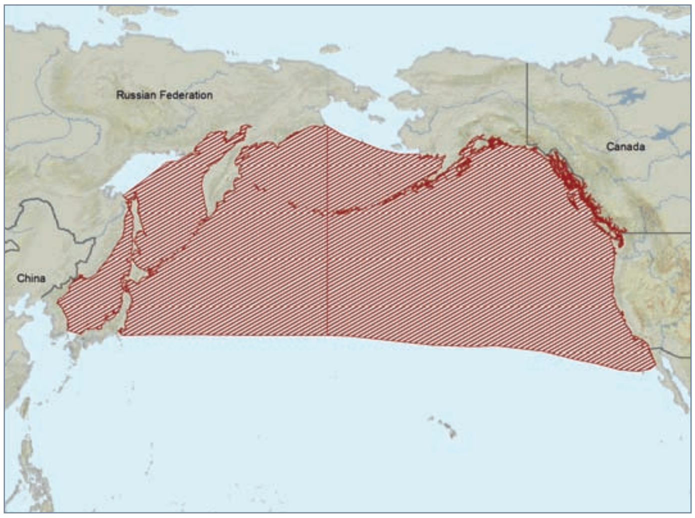
2. Distribution

The distribution of Dall's porpoise is confined to the North Pacific Ocean and adjacent seas. They range in subarctic waters from the Sea of Okhotsk, Bering Sea, and the northern Gulf of Alaska (the Subarctic Boundary at about 63°N across the North Pacific), south to the Sea of Japan, and in the California Current to about 32°N off Baja California Norte. Although mainly an offshore deepwater inhabitant, Dall's porpoise also occurs in narrow channels and fjords where the water is clear and relatively deep, such as in Prince William Sound and around the Alexander Archipelago in Alaska (Jefferson, 2009). There are records of the species as far south as 28°N, off the coast of Baja California (Mexico) although reported only during periods of exceptionally cold waters. At the northern end of the range, sightings are infrequent north of 62°N in the Bering Sea, but there have been occasional sightings in the Chukchi Sea (Reyes, 1991, and refs. therein).

3. Population size

Several stocks have been recognised, based largely on geographic variation in morphology and colour patterns, parasite loads, densities of mother/calf pairs, and genetic differences. Eight stocks (seven dalli-type and one truei-type) are recognised by the International Whaling Commission (Houck and Jefferson, 1999 and refs. therein). Nevertheless, most abundance estimates are geographically justified:

For Alaskan US EEZ waters, Angliss and Outlaw (2005) estimate population size from 1987-1991 data at 83,400 after correcting for vessel attraction behaviour.



Distribution of Phocoenoides dalli in the North Pacific (Hammond et al. 2008; © IUCN Red List).

In the inshore coastal waters of the Inside Passage, between British Columbia (BC)-Washington and the BC-Alaska borders surveys conducted in 2004 and 2005 yield an abundance estimate of 4,910 (CI = 2,700-8,940; Williams and Thomas, 2007).

The most recent estimate of Dall's porpoise abundance in the eastern Pacific US EEZ is the geometric mean of estimates from 2001 (Barlow and Forney 2007) and 2005 (Forney 2007) summer/autumn vessel-based line transect surveys of California, Oregon, and Washington waters, which yields 48,376 (CV = 0.24) animals.

In 2007 new abundance estimates for Dall's porpoises were made available for Japanese waters, based on 2003 survey data. The new population estimates are 173,638 *dalli*-type porpoises and 178,157 *truei* porpoises (IWC, 2008), lower than the estimates of 1991 of 226,000 and 217,000 (IWC, 1998) respectively.

4. Biology and Behaviour

Habitat: Dall's porpoise is found in diverse habitats, including sounds, nearshore waters (near deep water canyons) as well as offshore waters more than 1,000 km from shore. Waters colder than 18°C are preferred, and the peak abundance is in waters colder than 13°C (Reyes, 1991 and refs. therein). It may routinely forage at depths of 500 m or more (Carwardine, 1995). It is not found in the southern extremes of its range during the summer or warm water months (Houck and Jefferson, 1999). Ferrero (1998) confirms, that sea surface temperature was the most important habitat parameter examined.

Behaviour: Almost hyperactive. Darts and zig-zags around at great speed, and may disappear suddenly. Swimming-speeds can reach 55 km/h. This is the only porpoise that will rush to a boat to bow-ride, but soon loses interest in anything that travels slower than 20 km/h. They do not porpoise like other small cetaceans, but produce a "rooster tail" (Carwardine, 1995).

Schooling: Dall's porpoises are found mostly in small groups of 2 to 12, although aggregations of up to several thousand have been reported. Groups appear to be fluid, often forming and breaking up for feeding and playing (Jefferson et al. 1993). They often associate with Pacific white-sided dolphins (*Lagenorhynchus obliquidens*; from 50°N southwards) and pilot whales (*Globicephala macrorhynchus*; from 40°N southwards; Carwardine, 1995). Bowriding behaviour has been observed with gray (*Eschrichtius robustus*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*; Houck and Jefferson, 1999, and refs. therein).

Food: Stomach samples from Dall's porpoises collected in pelagic waters spanning most of their range in the North Pacific and the Bering Sea revealed a diet of myctophid fish in the subarctic North Pacific and on gonatid squids as well as myctophid fish in the Bering Sea, with little prey selectivity. Most of the prey items were mesopelagic species that migrate vertically to shallower waters at night. Stomach content was greater during twilight hours, suggesting the porpoises foraged actively on myctophids at night in shallower waters. According to Ohizumi et al. (2003), the annual consumption by Dall's porpoises was estimated to be 2.0-2.8 million tons, or 4.7-6.5% of the biomass of mesopelagic fish in the subarctic North Pacific. Comparison of stomach contents and trawl samples shows crude consistency (Ohizumi and Watanabe, 2004).

Amano and Kuramochi (1998) suggest from their findings, that Dall's porpoises feed opportunistically, changing prey items and feeding times based on supply. The most common prey items in the Sea of Okhotsk were Japanese pilchard (*Sardinops sagax*) and squid (*Berryteuthis magister*; Walker, 1996). Around Hokkaido in the Sea of Okhotsk and the Sea of Japan, the dominant prey species switched from the late 1980s to the early 1990s as the *Sardinops melanostictus* (Japanese pilchard) populations in both seas declined. In the Sea of Japan, Dall's porpoises switched to *Theragra chalcogramma* (walleye pollock), and in the Sea of Okhotsk, to *Engraulis japonicus* (Japanese anchovy) and *Berryteuthis magister* (magistrate armhook squid; Ohizumi et al. 2000).

Reproduction: Most Dall's porpoise calves are born in spring and summer (Jefferson et al. 1993). Segregation of age and sex classes was determined in the western North Pacific population. Mother-calf pairs are sighted only north of 46°N. Data obtained from the gillnet fishery confirm that pregnant and lactating females dominate in the northern Pacific area and that newborn calves are also present. These observations probably indicate a calving and breeding area for the population north of the USA Exclusive Economic Zone (EEZ). The percentage of mature males in this area is low, and most mature males are found south of the USA EEZ (Reyes, 1991 and refs. therein).

Besides the *truiei* and *dalli* types, there seems to be a frequent hybridization between free-ranging Dall's and harbour porpoises, *Phocoena phocoena*. All crosses examined had Dall's porpoise as the maternal parent, a directionality reflecting the indiscriminate pursuit of female porpoises by male harbour porpoises (Willis et al. 2004).

5. Migration

Although the species as such is present all year round in Prince William Sound, Alaska, a decrease in abundance of Dall's porpoises was observed from fall to winter, indicating a movement of a portion of that population out of the area. These seasonal migrations may also occur in the Gulf of Alaska and the Bering Sea (Reyes, 1991 and refs. therein). According to Forney and Barlow (1998) Dall's porpoises seem to shift their distribution southward during cooler water periods on both interannual and seasonal time scales. In southern California waters, Dall's porpoises were found only in the winter, generally when the water temperature was less than 15°C (Houck and Jefferson, 1999). Carretta et al. (2000) also found that Dall's porpoises were only present off San Clemente Island, California, during the cold-water months of November-April.

Houck and Jefferson (1999), suggest that this species is present year-round in central California, northern California, Puget Sound, Washington, and British Columbia. In these areas, waters remain cool (about 9-15°C) throughout the year. Inshore/offshore movements off southern California and British Columbia have also been postulated.

Although movements in the eastern Pacific also have a north/south component, there appear to be more distinct north/south movements in the western Pacific. These movements may be temperature-related or food-dependent. Truei-type porpoises and mixed schools are generally found in warmer waters, while dalli-types are found in both warmer and colder waters (Houck and Jefferson, 1999 and refs. therein). Porpoises of the truei-type winter off the Pacific coast of Japan, moving in summer towards the north, reaching the southern

Kuril Islands. Migration of truei-type animals into the Okhotsk Sea was recently confirmed, and it has been suggested that this occurs through Kuril Island passages. The presence of a higher percentage of mother-calf pairs in the southern part of that sea suggests that the area represents a breeding ground for the truei-type. Up to 15,000 animals of the dalli-type are reported to migrate through the Tsugaru Strait to the Pacific coast of Japan (Reyes, 1991 and refs. therein).

6. Threats

Direct catch: A fishery for Dall's porpoises operates only in Japanese waters and dates back to the early 20th century. While this fishery was developed primarily during winter months, it has spread to other seasons and areas, resulting in an increase in the annual catch and the inclusion of the dall's-type in the captures. A total of 40,000 were taken in 1988 from a population of about 105,000 porpoises migrating to the fishing grounds. The stock composition of the catches is not known. The population effect of hunting at such high levels was a matter of serious concern (Reyes, 1991 and refs. therein). In later years, the catch was reduced somewhat, but still remained too high, with 11,000 harpooned in 1998 (Houck and Jefferson, 1999 and refs. therein). The latest figure is still in that range with 11,357 captured in 2007, of which 4,070 are of the *dalli* and 7,287 of the *truei* type.

The Japanese hunt of Dall's porpoise has been highlighted by the IWC SC several times as unlikely to be sustainable. However the Japanese government has ignored IWC SC recommendations to reduce quotas, claiming that IWC does not have competence over small cetaceans (WWF, 2009).

Incidental catch: In addition to the direct catch, Dall's porpoises are captured incidentally, mostly in drift net fisheries.

In the Bering Sea and Gulf of Alaska as well as around the Alaska Peninsula and Aleutian Islands salmon drift gillnet fishery results in an estimated annual incidental kill rate in observed fisheries of 33.9 porpoise per year from this stock (Angliss and Outlaw, 2005).

Dall's porpoises are also by-caught in salmon gillnet fisheries in British Columbia, Canada, waters. However, best estimates of bycatch mortality in 2004 and 2005 exceed only the most precautionary limits for porpoise species (Williams et al. 2008).

Estimates of incidental marine mammal, sea turtle, and seabird mortality in the California drift gillnet fishery for broadbill swordfish, *Xiphias gladius*, and common thresher shark, *Alopias vulpinus*, for the 7-year period, 1996 to 2002 amount to 44 Dall's porpoises (Carretta et al. 2004). In the eastern Pacific US EEZ, current mean annual takes for all fisheries for which mortality data are available are 1.4 animals per year (Caretta et al. 2009).

Large numbers of Dall's porpoises die in driftnets within national waters of Japan and Russia, where the UN ban on driftnets does not apply. The estimated bycatch in the Japanese salmon driftnet fishery operating in the Russian EEZ totaled close to 12,000 for the period 1993 to 1999, ranging from 643-3,149 on an annual basis (IWC 2000; 2002). At its 60th annual meeting, the IWC in 2008 reiterated its concern for the stocks of Dall's porpoise off Japan and repeated its previous recommendation that catches should be reduced to sustainable levels, that the bycatch levels be quantified and that a full assessment of each of the affected populations be conducted as soon as possible.

Pollution: Organochlorine compounds (OCs) such as polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane and its metabolites (DDTs), chlordane related compounds, hexachlorocyclohexane isomers (HCHs), hexachlorobenzene (HCB) and tris-chlorophenyl methane (TCPMe) were found in the blubber samples of Dall's porpoises collected from Japanese coastal waters in 1998/1999. Concentrations and compositions of DDTs and HCHs showed significant differences between the truei-type population off the Pacific coast of northern Japan and dalli-type from the Sea of Japan/Okhotsk. OCs levels detected in truei-type porpoises collected in 1998/1999 were lower than those collected in 1984, except TCPMe. On the other hand, except DDTs, the residue levels of other organochlorines in dalli-type porpoises showed no significant decrease since 1984 (Kajiwara et al. 2002). High concentrations of organochlorines (especially DDT) were also reported in Dall's porpoises from southern California (Reyes, 1991 and refs. therein). Since females may transfer organochlorines to their offspring during gestation and especially through lactation, and testosterone levels in males may be reduced by high levels of PCBs and DDE, this may have detrimental effects on production and calf survival (Houck and Jefferson, 1999 and refs. therein; Jarman et al. 1996).

Concentrations and body burdens of 14 trace elements (Hg, Cr, Mn, Co, Cu, Zn, Sr, Ag, Cd, V, Se, Pb, Mo, and Fe) and butyltins (BTs; tributyltin TBT, dibutyltin DBT, and monobutyltin MBT) were determined in various tissues of a porpoise collected off the Sanriku coast of Japan. Selective accumulation was observed for Hg, Mn, Cu, Ag, Mo, Fe, and total BTs (TBT, DBT, and MBT) in the liver, Cd in the kidney, Zn, Sr, V, Pb, and Co in the bone, and Se in the skin (Yang et al. 2006). A mother-fetus pair collected off the Sanriku coast, Japan was contaminated by phenyltin compounds (Yang et al. 2007).

Overfishing: It is unlikely that the fishery for salmon could directly affect the food supply of Dall's porpoises, since salmon is not their regular prey. However, other fisheries operating in the North Pacific take a variety of fish species that could include potential prey species. The development of the squid fishery in the region could eventually represent a potential threat by reducing food availability (Reyes, 1991 and refs. therein).

7. Remarks

Range states (Hammond et al. 2008): Canada; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Mexico; Russian Federation; United States of America.

Phocoenoides dalli is included in CITES Appendix II. The species is considered as "Least Concern" by the IUCN (Hammond et al. 2008). It is included in Appendix II of CMS.

8. Sources (see page 276)

3.55 Physeter macrocephalus Linnaeus, 1758

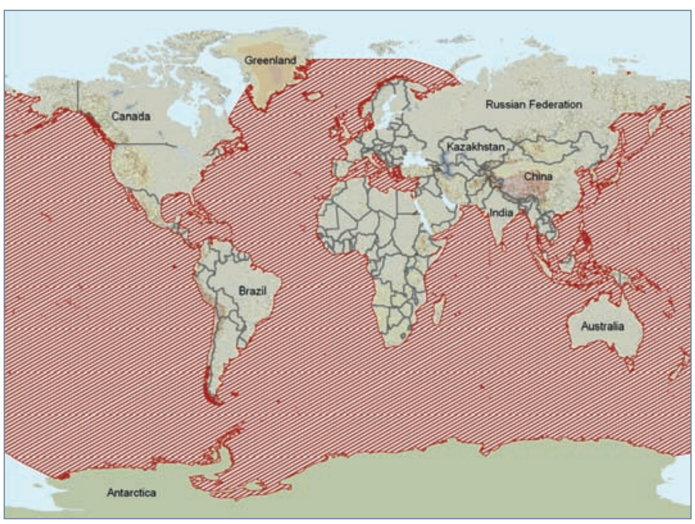
English: Sperm whale
German: Pottwal
Spanish: Cachalote
French: Cachalot

Family Physeteridae

Physeter macrocephalus / Sperm whale (© Wurtz-Artescienza)

1. Description

The sperm whale is the largest of the toothed whales, and there is a strong sexual dimorphism between males and females: adult females reach approx. 11 m in length and a body mass of 15,000 kg, whereas males are much larger with 16 - 18 m body length and 45,000 - 57,000 kg (Whitehead, 2009, Jefferson et al. 2008). The most striking feature of this species is its massive head, which makes up 25 - 30 % of total length. It contains the spermaceti organ and the underlying "junk", both set above the upper jaw and in front of the parabolic-shaped facial region of the skull. These structures are composed of spongy, oil-filled tissue enclosed in a muscular case and bounded at both ends by air sacs. This spermaceti organ is responsible for the striking echo-locating capabilities of sperm whales (Whitehead, 2009).



The sperm whale has a world wide distribution, with females inhabiting the lower latitudes below 40° (except in the north Pacific where they range to 50°N) and males ranging north and south of this boundary to the ice-edge of the Arctic and Antarctic Oceans, respectively (Whitehead, 2009; Taylor et al. 2008; © IUCN Red List).

The single blowhole is set at the front of the head, offset to the left and S-shaped. There is a thick, low dorsal hump instead of a fin, about 2/3 back from the tip of the head, followed by a series of bumps on the dorsal ridge towards the fluke. The flukes are broad and triangular, resembling a ginkgo-leaf, with an almost straight trailing edge showing individually different nicks, notches and cuts, which are used in photo-identification. The body surface is smooth over the head and wrinkled behind and on the sides. The flippers are short, spatulate and wide. The lower jaw is narrow and underslung and carries 18 - 26 pairs of functional teeth, which are absent from the upper jaw. The predominant colour is black to dark brownish-grey with white areas around the mouth and often on the belly. Some animals have white to yellowish calluses on the dorsal hump, and some adult males have white scratches on the head. Albino sperm whales have been observed and one is well-known from the world literature ("Moby Dick", by Herman Melville). The characteristic bushy blow is up to 5 m high and projects to the left of the animal at an angle from the vertical (Jefferson et al. 2008).

2. Distribution

The sperm whale is one of the animals with the widest distribution on the globe. It ranges from the ice-edge of both hemispheres as far south as the equator but concentrates in so-called "grounds" which coincide with areas of high marine productivity. Such areas can measure a few hundred kilometres across and may contain hundreds or even thousands of sperm whales (Rice 1989; Whitehead, 2009).

Both sexes have very distinct distributions when mature. Most females range usually far from land, except for areas near seamounts or oceanic islands, in waters 1000 m deep or deeper. They prefer water temperatures above 15°C and low latitudes within 40°N and 40°S (except for the North Pacific where they range to 50°N). Young males accompany these groups of females until they are 4 - 21 years old and then migrate to higher latitudes. There they may range to the ice-edge, preferring productive waters, e.g. in the vicinity of deep sea canyons such as off Andenes, northern Norway, or Kaikoura, New Zealand, but they may also be found in more shallow waters e.g. off Nova Scotia or New York in water only 300 m deep (Whitehead, 2009).

Recent genetic studies have shown significant subdivision between the Gulf of Mexico, the Mediterranean, and the North Atlantic (Drouot, 2003; Engelhaupt, 2004). Mitochondrial DNA results showed significant differentiation among all populations, while microsatellites showed significant differentiation only for comparisons with the Mediterranean Sea, and at a much lower level than seen for mtDNA (Engelhaupt et al. 2009).

3. Population size

Whitehead (2002) extrapolated from about one quarter of the global habitat that the current population size world-wide is about 360,000 animals (CV = 0.36) or about 29% of the pre-whaling population size. With a maximum rate of increase of around 1% per year (Whitehead 2002), the species is not well adapted to recover from population depletion and the threats exposed below are made responsible for the fact that regional populations of sperm whales are declining or are apparently not recovering from depletion.

There have been several population surveys within the past 20 years:

In the Northwest Pacific a preliminary analysis (Kato and Miyashita, 1998) indicated 102,112 (CV = 0.155) sperm whales, but this was reduced to 29,674 (CV = 0.14) in Kato and Miyashta (2000) using only primary sightings. In the eastern temperate North Pacific a spring 1997 line-transect survey resulted in estimates of 24,000 (CV=0.46) individuals based on visual sightings and 39,200 (CV=0.60) based on acoustic detections and visual group size estimates (Barlow and Taylor 1998). In the EEZ waters off the US west coast from Washington to Califiornia, the most recent of abundance estimate is 2,853 (CV=0.25) animals from ship surveys conducted in 2001 (Barlow and Forney 2007) and 2005 (Forney 2007). In the eastern tropical Pacific, abundance was estimated as 22,700 (95% C.I.=14,800-34,600; Wade and Gerrodette 1993) and in US EEZ around the Hawaii islands, a 2002 shipboard line-transect survey resulted in an abundance estimate of 7,082 (CV=0.30) sperm whales (Barlow 2003), including a correction factor for missed diving animals. No data on current population trends are available from any of these regions (Angliss and Allen, 2008).

In the Northwest Atlantic two 2004 surveys yielded 4,804 (CV =0.38), with an estimate from the northern U.S. Atlantic of 2,607 (CV =0.57) and from the southern U.S. Atlantic of 2,197 (CV =0.47). In the northern Gulf of Mexico oceanic waters, the abundance estimate pooled from 2003 to 2004 is 1,665 (CV=0.20; Mullin 2007). Similar to Pacific estimates, there are insufficient data to determine population trends (Waring et al. 2009). In the Northeast Atlantic the most recent estimates are dated, with 6,013 (CV = 0.32) (Christensen et al. 1992) and 1,772 (CV= 0.18) in the Faroes-Iceland area (Gunnlaugsson and Sigurjónsson, 1990).

Previous and historical population estimates from the Indian Ocean and the southern Hemisphere are deemed unreliable and therefore not presented here (NMFS, 2009).

4. Biology and Behaviour

Habitat: Sperm whales show a strong preference for deep waters (Rice 1989), especially in areas with high sea floor relief. Along the U.S. east coast, the overall distribution is centred along the shelf break and over the continental slope 90-1,800 m deep (CETAP 1982; Waring et al. 2005). Very high densities occur in inner slope waters north of Cape Hatteras, North Carolina seaward of the 1,000 m isobath during summer months (Waring et al. 2005). Sperm whales are also known to move onto the continental shelf in waters less than 100 m deep on the southern Scotian Shelf and south of New England, particularly between late spring and autumn (Whitehead et al. 1992a and b).

In the northern Gulf of Mexico, they occur in greatest density along and seaward of the 1,000 m isobath (Mullin et al. 1991, Mullin and Fulling 2004). They appear to prefer steep rather than shallow depth gradients (Davis et al. 1998). The spatial distribution of sperm whales within the Gulf is strongly correlated with mesoscale physical features such as loop current eddies that locally increase primary production and prey availability (Biggs et al. 2005). Sperm whales may also be found in marine areas thought to be rather unproductive such as the "Charleston grounds" in the Sargasso Sea (Jacquet 1996). However, these are though to be associated with spawning squid (Jacquet and Whitehead 1996).

Behaviour: On average, sperm whales spend more than 72% of their time in foraging dive cycles. While foraging they make repeated long dives, with a modal depth of 985 m in the Atlantic Ocean, 644 m the Gulf of Mexico and 827 m the Ligurian Sea. Dive durations of about 45 min are interrupted by surface intervals lasting about 9 min (Watwood et al. 2006). However, dives can be much deeper or shallower, and dive durations are also quite flexible (Whitehead, 2009). Dives are initiated by a deep breath, followed by a raising of the head, submersion of the animal, and curving of the tail stock above the water surface until the fluke is raised nearly vertically out of the water. Descent to depth as well as return to the surface can be nearly vertical. During the initial phase of the descent the whales remain quiet, presumably navigating visually, but after reaching a depth of between 100 - 220 m they initiate a series of clicks emitted in intervals of 0,5 - 1 s. Watwood et al. (2006) found that sperm whales descend a mean of 392 m from the start of this regular clicking to the first buzz, i.e. accelerated clicks associated with prey detection, which supports the hypothesis that regular clicks function as a long-range biosonar.

During the late afternoon, females and young gather near the surface to rest, in close aggregation. However, at the onset or end of foraging activities, their behaviour may also show breaches, lobtails, manoeuvres, rolls, and touching of conspecifics, while emitting codas, i.e. stereotyped sequences of clicks, or creaks (Whitehead, 2009).

Schooling: Female sperm whales are organized in groups in which adults travel with their sub-adult offspring. Males eventually leave these groups, at age 4 to 21, after which they live in "bachelor schools". The cohesion among males within a bachelor school declines as the animals age (Best 1979) and they generally move to higher latitudes. During their prime breeding period and old age, male sperm whales are essentially solitary (Christal and Whitehead 1997).

Entire schools of sperm whales occasionally strand, but the causes of this phenomenon are uncertain (Rice 1989). Changes in wind patterns which result in colder and presumably nutrient-rich waters being driven closer to the surface (Evans et al. 2005), lunar cycles (possibly as a result of the effects that light levels have on the vertical migration of their prey species (Wright 2005), and solar driven geomagnetic variations (Vanselow and Ricklefs 2005), which over the last 400 years may account for 20% of all observed stranding events around the North Sea (Vanselow et al. 2009), all play a role.

Reproduction: Females become sexually mature at 7-13 years of age. The peak breeding season is generally in the spring: in the northern hemisphere between March/April and June, and in the southern hemisphere between October and December (Best et al. 1984). Gestation lasts between14 - 16 months and females lactate for at least two years. The inter-birth interval is 4-6 years for prime-aged females. Female sperm whales rarely become pregnant after the age of 40 (Best et al. 1984; Whitehead 2003).

Puberty in males usually begins between the ages of 10 and 20, and most individuals do not become fully mature until their late twenties (Best, 1979). Longevity can reach at least 50 years (Whitehead, 2009).

Food: Sperm whales forage in mesopelagic and benthic habitats, primarily targeting cephalopods (Kawakami 1980) but occasionally also fish (Clarke et al. 1993). Histioteuthids, mesopelagic gelatinous squid ranging in mass between 0.1 and 1 kg, are at the top of the list of preferred food items. However, females also feed on larger prey such as giant squid (*Archaeteuthys* sp.) and jumbo squid (*Dosidicus* sp.), and males prey on species such as the Antarctic colossal squid (*Mesonychoteuthis hamiltoni*; Whitehead, 2009).

The yearly turnover of biomass by sperm whales is estimated to be comparable to the total catches of human fisheries, and the impact of sperm whales on deep ocean food webs and nutrient cycling in the ocean is probably significant (Clarke 1976; Kanwisher & Ridgway 1983; Whitehead 2003).

Stomachs of male sperm whales from the Northeast Atlantic stranded in 1997 on the Netherlands coast, in 1998 at Bettyhill (Scotland) and in 1996 at Tory Island (Ireland) consisted almost entirely of cephalopod beaks, with some containing also fish remains. *Gonatus* sp. (probably *Gonatus fabricii*, Oegopsida: Gonatidae) was the main prey. The fish remains were saithe (*Pollachius virens*, Gadiformes: Gadidae), and remains of monkfish (*Lophius* sp., Lophiiformes: Lophiidae). A specimen stranded in Ireland had consumed a wider range of prey, mainly *Histioteuthis bonnellii* (Oegopsida: Histiotetuhidae), but also *Architeuthis* sp. (Oegopsida: Architeuthidae), *Chiroteuthis* sp. (Oegopsida: Chiroteuthidae), *Teuthowenia megalops* (Oegopsida: Cranchiidae) and the octopod *Haliphron atlanticus* (Incirrata: Alloposidae; Santos et al. 2002).

Cephalopod beaks from the stomachs of 10 males stranded in Denmark between 1991 and 2000 revealed *Gonatus fabricii* as the dominant prey species (>98%), the majority (73.5%) individuals with an estimated mantle length between 192 and 257 mm. Other species found were: *Todarodes sagittatus*, *Histioteuthis* sp., *Cyclioteuthis* sp., *Haliphron atlanticus*, and *Bathypolypus* sp. (Simon et al. 2003).

5. Migration

Movements and migratory behaviour of sperm whales has been studied using photo-identification, tags, and satellite tags as well as by following individual groups at sea. When feeding conditions are adequate, sperm whales usually stay in small areas, 10 - 20 km across. During travelling episodes the animals cover about 4 km/hr or about 90 km/day. Female home ranges are approx. 2,000 km across, but males roam more widely (Whitehead, 2009).

Whitehead (2003) found that females and juveniles identified off the Galápagos Islands frequently moved to the waters off the mainland of Ecuador, more than 1,000 km away, to Panama and Perú, about 1,500 - 2,000 km away and rarely to Chile or California, travelling more than 3,000 km. Long-range movements are also reported by tagged females in the South Pacific, where females tagged for periods of over one month travelled on average 650 km (Best, 1979).

Available data suggests periodic migrations of mature males between low latitude breeding and high latitude feeding grounds (Best, 1979). Tagged males in the Southern Ocean showed average displacements of 1,600 km (Best, 1979) or about twice the value recorded for females. In the North Pacific, tagged whales were identified as having traveled1,300 km (Kasuya and Miyashita, 1988). There are more extreme values, such as a male marked off Nova Scotia and killed off Spain, 4,300 km away (Mitchell, 1975), or a male marked south of Mexico and killed off British Columbia, 4,850 km to the North (Kasuya and Miyashita, 1988) and finally a male marked off the north African coast and killed off South Africa, 7,400 km to the South (Ivashin and Rovnin, 1967). In their feeding grounds, males off Kaikoura, New Zealand, or Bleik Canyon, Andenes, Norway, show long term site fidelity, returning over years to the same sites (Whitehead, 2003).

These findings are confirmed by more recent investigations. Genetic comparison of putative sperm whale populations located in the Gulf of Mexico, western North Atlantic, Mediterranean Sea and North Sea indicate a strong fidelity of females to coastal basins on either side of the North Atlantic and suggest the movement of males among these populations for breeding (Engelhaupt et al. 2009). This confirms previous genetic studies based on maternally inherited markers showing inter-oceanic movement to be more prevalent among males than females (Lyrholm et al. 1999) and is consistent with observation of females having smaller geographic ranges.

6. Threats

Direct catch: Local whaling dates back to the 1500s and intense commercial whaling to around 1712. Highly mechanised "modern" whaling was particularly intense around 1950, and at its peak killed around 25,000 sperm whales per year, significantly depleting the global population (Taylor et al. 2008). After the cessation of commercial whaling in 1989, the annual catch decreased to some tens of whales taken each year from small boats in Indonesia (Reeves 2002), although none have been taken in recent years (H. Whitehead, pers. comm. to Taylor et al. 2008), and 10 taken annually by Japan under a special IWC scientific permit (Clapham et al. 2003).

Incidental catch: Incidental capture in fishing gear, such as gillnets and bottom-set longline gear, continues to take a toll on sperm whale populations, although the degree of threat is considered low. They have been found as bycatch in pelagic drift gillnets targeting swordfish and tuna in U.S. east-coast waters (Waring et al. 1997), and in artisanal gillnets targeting sharks and large pelagic fishes off the Pacific coasts of northwestern South America, Central America, and Mexico (Palacios and Gerrodette 1996). The pelagic drift gillnet fishery closed in 1997 and the use of drift gillnets was prohibited in 1999, but sperm whales are still threatened by fishing gear. An estimated average of >0.2 sperm whales are killed or seriously injured annually in the driftnet fishery for thresher sharks and swordfish and unknown fisheries off Oregon and California (Carretta et al. 2009). No estimates of mortality are available for the Mexican driftnet fisheries (NMFS, 2009).

In 2006, there were three observed serious injuries in the Gulf of Alaska sablefish longline fishery, which extrapolates to 10 estimated serious injuries for that fishery for that year (R.P. Angliss, in NMFS, 2009). Entanglements in longline fishing gear have also been observed in South Georgia (Purves et al. 2004) and Chile (Ashford et al. 1996). Sperm whales have been found following deep-water trawlers during hauling operations targeting Greenland halibut, and one case of entanglement in the trawl was reported (Karpouzli and Leaper 2004). Between 1998-2006, no sperm whales were known to be killed due to fishery interactions in the U.S. Atlantic Gulf of Mexico (Waring et al. 2009), indicating that current fishing practices pose a low threat to the recovery of sperm whale populations.

However, unreported by-catch and levels of mortality and injury due to entanglement in lost or discarded gear are still a matter of concern, especially in the Mediterranean (Taylor et al. 2008). Even in the absence of whaling, the Mediterranean population appears to have declined over the past 20 years, with bycatch in driftnets targeted at swordfish a likely principal cause (Reeves and Notarbartolo di Sciara 2006).

Killing: Although the magnitude of these interactions is infrequently documented, there are reports of sperm whales having been killed to keep them away from fishing gear (Gonzalez 2001).

Pollution: Increases in the rate of sperm whale strandings in western Europe since the early 1980s have raised concern that anthropogenic effects, including pollution, may be a contributing factor (Goold et al. 2002). However, the results of tissue analyses of stranded whales for a wide range of contaminants showed no clear link between contamination and stranding (Jacques and Lambertsen 1997). Nevertheless, levels of mercury, cadmium, and certain organochlorines in these whales' tissues were high enough to cause concern about toxicity and other possibly indirect health effects (Bouquegneau et al. 1997; Law et al. 1997). Fossi et al. (2003) stated that high organochlorine concentrations in the Mediterranean could have an effect on reproductive rates of this species. The levels of organochlorine compounds found in females were consistently higher than those in males, which is contrary to the typical findings in other marine mammals. Given that male and female sperm whales are geographically separated during much of the year, it is possible that males feed in less polluted waters or perhaps on less contaminated prey than females (NMFS, 2009).

Noise pollution: Sperm whales may be adversely affected by anthropogenic noise causing permanent or temporary damage to their hearing, masking biologically relevant sounds, or enticing negative changes in behaviour. However, it is difficult to ascertain the level of threat from anthropogenic sound sources with currently available information (NMFS, 2009). During seismic experiments in the northern Gulf of Mexico a whale carrying an acoustic tag moved away from an operating seismic vessel once the seismic pulses were received at roughly 137 dB re 1 µPa (Johnson et al. 2003). As opposed to this, Davis et al. (2000) noted that sighting frequency in the northern Gulf of Mexico did not differ significantly among different acoustic levels. Off Nova Scotia an active seismic program did not elicit any obvious changes in sperm whale distribution or behaviour (McCall 1999). Offshore northern Norway, animals continued to call when exposed to pulses from a distant seismic vessel of up to 146 dB re 1 µPa peak-to-peak (Madsen et al. 2002). And seismic work off Angola (Weir 2008) resulted in no difference in encounter rates of sperm whales or obvious behavioural changes due to air gun activity.

However, in United Kingdom waters sperm whales exhibited some changes in behaviour in the presence of operating seismic vessels (Stone 2003). And in the Gulf of Mexico Jochens et al. (2008) found decreases in foraging activity.

There have been no sperm whale strandings attributed to naval sonar. However, there is some evidence of disruptions of clicking and behaviour from sonars, pingers, and the Acoustic Thermometry of Ocean Climate studies (ATOC, summarised in NMFS, 2009).

Ship strikes: The most recent statistics, in the world-wide large whale ship strike database (Jensen and Silber 2004), indicate that from 1975 to 2002 out of a total record of 292 strikes of all large whales, sperm whales were struck 17 times, 13 of which resulted in death of the whale. Vessel types include Navy vessels, container/cargo ships, whale-watching vessels, cruise ships, ferries, Coast Guard vessels, and tankers. The estimates of serious injury or mortality should be considered minimum values because many ship strikes go either undetected or unreported for various reasons (NMFS, 2009). The most severe injuries are caused by larger vessels (80 m or longer) and vessels travelling at a speed of 14 knots or faster (Laist et al. 2001).

Sperm whales spend long periods (typically up to 10 minutes; Jacquet et al. 1998) "rafting" at the surface between deep dives. Reports of ships colliding with sperm whales are frequent in the Canary Islands, where ship traffic is heavy and the local density of sperm whales relatively high (André et al. 1997). In the Western North Atlantic, a merchant ship reported a strike in Block Canyon off New England in May 2000 (Waring et al. 2007), and from 2001-2003, one stranded sperm whale was reported struck by a naval vessel and another by a merchant vessel near Rhode Island (Waring et al. 2005). More recently in the Pacific, two sperm whales were struck by a ship in 2005, but it is not known if these ship strikes resulted in death or injury (NMFS, 2009). In general, however, it does not appear that ship strikes are a significant threat to sperm whale populations (Whitehead 2003).

Whale watching: In Kaikoura, New Zealand resident whales respond to whale-watching activities with small changes in ventilation and vocalization patterns. These changes may not be of biological importance (Richter et al. 2006). However, transient whales, which receive less whale-watching effort, respond differently, and usually more strongly to whale-watching boats. They spend less time at the surface and adjust their breathing intervals and acoustic behaviour (Gordon et al. 1992).

Marine debris: Instances of stomach obstruction caused by marine debris have been documented in sperm whales, but severity of threat is considered low due to the small number of known cases. In 1989, a necropsy on a stranded sperm whale indicated that its death was caused by a stomach obstruction following accidental ingestion of plastic bags and sheets in the Lavezzi Islands of the Tyrrhenian Sea (Viale et al. 1992). In Iceland a necropsied animal had a lethal obstruction of the gut with plastic marine debris (Lambertsen 1990). The stomach contents of two sperm whales that stranded separately in California (California Marine Mammal Stranding Database 2008, in NMFS, 2009) included extensive amounts of netting from discarded fishing nets; however, the cause of death was not determined.

7. Remarks

Range states (Taylor et al. 2008): Albania; Algeria; Angola; Antarctica; Antigua and Barbuda; Argentina; Australia; Bahamas; Bangladesh; Barbados; Belgium; Belize; Benin; Brazil; Brunei Darussalam; Cameroon; Canada; Cape Verde; Chile; China; Colombia; Comoros; Costa Rica; Croatia; Cyprus; Denmark; Djibouti; Dominica; Dominican Republic; Ecuador; Egypt; El Salvador; Equatorial Guinea; Falkland Islands (Malvinas); Faroe Islands; Fiji; France; Gabon; Gambia; Ghana; Gibraltar; Greece; Greenland; Grenada; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Iceland; India; Indonesia; Iran, Islamic Republic of; Ireland; Israel; Italy; Jamaica; Japan; Kenya; Kiribati; Korea, Democratic People's Republic of; Korea, Republic of; Lebanon; Liberia; Libyan Arab Jamahiriya; Madagascar; Malaysia; Maldives; Malta; Marshall Islands; Mauritania; Mauritius; Mexico; Micronesia, Federated States of; Monaco; Morocco; Mozambique; Namibia; Nauru; Netherlands; Netherlands Antilles; New Zealand; Nicaragua; Nigeria; Niue; Norway; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Portugal; Russian Federation; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Vincent and the Grenadines; Samoa; Sao Tomé and Principe; Senegal; Seychelles; Sierra Leone; Singapore; Slovenia; Solomon Islands; Somalia; South Africa; Spain; Sri Lanka; Suriname; Syrian Arab Republic; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; Tunisia; Turkey; Tuvalu; United Kingdom; USA; Uruguay; Vanuatu; Venezuela; Viet Nam; Yemen.

Sperm whales are classified as Vulnerable by the IUCN. Whitehead (2002) provided a model-based estimate of global trend giving a 6% probability for Endangered, a 54% probability of meeting the Vulnerable category, and a 40% probability of falling into the Near Threatened category.

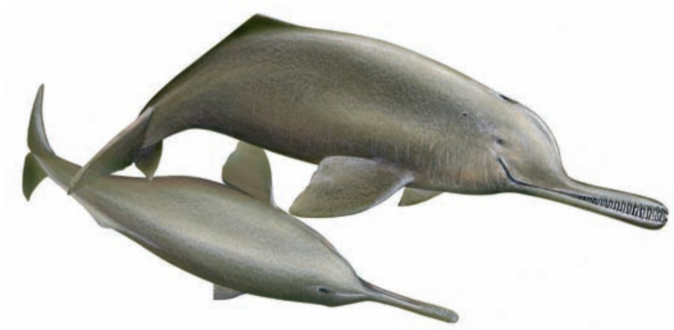
P. macrocephalus is on Appendix I of CITES and Appendices I and II of CMS.

8. Sources (see page 276)

3.56 Platanista gangetica (Roxburgh, 1801)

English: South Asian-, Ganges- (susu), Indus- (bhulan) river dolphin
German: Ganges-Delphin; Indus-Delphin
Spanish: Delfín del río Ganges; Delfín del río Indus
French: Plataniste du Gange; Plataniste de l'Indus

Family Platanistidae



Platanista gangetica / South Asian river dolphin (© Wurtz-Artescienza)

1. Description

The body of the South Asian river dolphin is subtle and robust, attenuating behind the dorsal fin to a narrow tail stock. The colouration is grey all over and becomes blotchy with age. The snout is long and widens at the tip, resembling a forceps. In females, the snout is generally longer and may curve upwards and to one side. The eyes are extremely small, resembling pinhole openings slightly above the mouth. The dorsal fin is a low triangular hump. The broad flippers have a crenellated margin, with visible hand and arm bones. The flukes are also broad. Males are smaller than females, with 210 and 250 cm, respectively (Smith, 2002). Body mass can reach at least 85 kg (Jefferson et al. 2008).

2. Distribution

The Indus and Ganges populations were long regarded as identical until Pilleri and Gihr (1971) divided them into two species, but Kasuya (1972) reduced the two taxa to subspecies of a single species. This is supported by the results of Yang and Zhou (1999), who found that the difference between cytochrome-b sequences of Ganges and Indus river dolphins was very small. According to Rice (1998, and refs. therin) even up until historical times there was probably sporadic faunal exchange between the Indus and Ganges drainages by way of head-stream capture on the low Indo-Gangetic plains, between the Sutlej (Indus) and Yamuna (Ganges) rivers.

Susus and bhulans live exclusively in freshwater. One conservative current view is that there are two disjunct subspecies, but this view is controversial (Jefferson et al. 2008) and further research is needed to establish the true relationship between these two populations:

P. g. minor Owen, 1853: formerly ranged in the Indus River and its tributaries, the Jhelum, Chenab, Ravi, and Sutlej rivers, of Pakistan and India, from tidal limits to the foothills (Rice, 1998). The range is now limited to the mainstream in areas located between barrages (Reeves and Chaudry, 1998). A small population has recently been discovered in a 60 km stretch of the River Beas in Punjab, northern India in 2008 (WWF, 2009).

P. g. gangetica: Formerly distributed throughout the Ganges-Brahmaputra river system of India, Bangladesh, Nepal, and possibly Sikkim and Bhutan, below an elevation of about 250 m. In the Ganges valley it ranges into most of the major affluents, including some of their tributaries: the Son, Yamuna, Sind, Chain-bal, Rainganga, Gumti, Ghaghara, Rapti, Gandak, Baginati, Ghugri, Kosi, Kankai, and Atrai rivers. In the Brahmaputra valley it also ranges into many of the major tributaries: the Tista, Gadadhar, Champamat, Manas, Bhareli, Ranga, Dihang, Dibang, Lohit, Disang, Dikho, and Kapili rivers. Downstream it ranges through most of the larger tributaries between the Hugh and Meghna rivers, as far as the tidal limits at the mouths of the Ganges. Also reported from the Fenny, Karnafuli, and perhaps the Sangu, rivers to the southeast of the mouths of the Ganges (Rice, 1998). Ganges River dolphins live not only in the main channels, but also during the flood

Current main distribution of P. gangetica in the Indus and Chenab Rivers and the Ganges-Brahmaputra river system (Smith and Braulik, 2008; © IUCN Red List).

season, in seasonal tributaries, and the flooded lowlands (Jefferson et al. 1993). The distribution is said to be restricted only by the lack of water and by rocky barriers (Reyes, 1991).

3. Population size

Indus: A survey conducted in 2001 (Choudhary et al. 2006) covered 1.375 km of the Indus River main channel, 136 km of Indus River secondary channels, and 24 km of the Panjnad River, a tributary of the Indus. The resulting abundance estimate was 965 dolphins. Dolphins occurred in five subpopulations separated by irrigation barrages. The three largest subpopulations were estimated between Chashma and Taunsa Barrages (84 dolphins; 0.28/km), Taunsa and Guddu Barrages (259 dolphins; 0.74/km) and Guddu and Sukkur Barrages (602 dolphins; 3.60/km). Reasons suggested for the high encounter rate between Guddu and Sukkur Barrages include high carrying capacity, low levels of anthropogenic threat, effective conservation, and augmentation of the subpopulation by downstream migration of dolphins from upstream (Choudhary et al. 2006). A few scattered individuals may still occur upstream of the Chasma barrage in the Indus (Smith, 2000 and refs. therein).

In 2008, a small population of 10-15 dolphins was discovered in India, in a 60 km stretch of the River Beas (WWF, 2009). This lies in the drainage of the Indus, but upstream of a lake formed by Beas Dam, in the Indian state of Himachal Pradesh. The population is separated from conspecifics of the main population occurring downstream in Pakistan by the Beas Dam and further downstream by yet another barrage (Bill Perrin, pers. comm. 2010).

Low numbers may also occur downstream of the Trimmu, Sidhnai, and Pandjnad barrages in the Chenab, Ravi, and Sutlej rivers, respectively (Smith, 2000 and refs. therein).

Extrapolation of encounter rates to unsurveyed channels and application of a correction factor to account for missed dolphins indicates that the metapopulation may number approximately 1,200 individuals (Choudhary et al. 2006). This compares well to the latest survey conducted in Pakistan by WWF-Pakistan and the Ministry of Environment, estimating the minimum population of Indus River dolphins at 1,341 animals (WWF, 2009).

Current estimates are higher than those from 1996: in the Sindh Dolphin Reserve between the Guddu and Sukkur barrages 458 individuals were counted in 1996, between Taunsa and Guddu barrages 143 individuals; between the Chasma and Taunsa barrages 39 individuals (Smith, 2000, and refs. therein). Reeves (1998, in Smith, 2000) interpreted the counts reported in 1996 to indicate a total of approximately 600-700 individuals for the subspecies as a whole, about half the current estimate.

Ganges: A recent survey conducted by WWF-India and its partners in the entire distribution range in the Ganges and Brahmaputra river system - around 6,000 km - identified fewer than 2,000 individuals in India (WWF, 2009). In mangrove channels of the Sundarbans Delta in Bangladesh, data analysis using two different models resulted in 196 individuals (CV = 12.7%) and 225 individuals (CV = 12.6%), respectively (Smith et al. 2006). In the past there were fewer than 100 dolphins in Nepal, with the group of about 20 in the Karnali River above Chisapani being the largest single concentration (Jones, 1982; Reeves and Brownell, 1989).

In the Brahmaputra River in India between the Assam-Arunachal Pradesh border to the India- Bangladesh border (856 km) a population assessment conducted in 2005 yielded an estimate of 197 animals. Encounter rate was low with 0.23 dolphins per km (Wakid, 2009). This is less than 50% of a former estimate of 400 between South Salmara and Sadiya (Mohan et al. 1997). In the Vikramshila Gangetic Dolphin Sanctuary, a ca. 60 km long segment of the middle Ganges River in Bihar, India, the mean number of dolphins recorded between 2001 and 2003 during upstream surveys was 119.4 (SD 31.8; range 88-174), with an encounter rate of 1.8 dolphins km² (range 1.4-2.8) (Choudhary et al. 2006).

4. Biology and Behaviour

Habitat: *P. gangetica* is exclusively riverine. Relatively high densities of dolphins are found at sites where rivers join or just downstream of shallow stretches, in areas where the current is relatively weak, off the mouths of irrigation canals, and near villages and ferry routes. In the Indus, about 40-45% of the dolphin population is found at junctions of tributaries with the mainstream, at least during the dry season, presumably being attracted to these areas by high prey concentrations (Reeves and Brownell, 1989, and refs. therein).

In the river basins in India, the Ganges river dolphin is present mostly in plains where the rivers run slowly. This seems to be opposite to the habitat observed in Nepal, where the dolphin can be found in relatively clear waters and rapids. In both areas, however, there is a preference for deep waters (Reyes, 1991, and refs. therein). Primary habitats are characterised by an eddy counter-current system in the main river flow caused by a fine sand/silt point bar formed from sediment deposits of a convergent stream branch or tributary. Marginal habitats are characterised by a smaller eddy counter-current system caused by an upstream meander. Dolphins concentrate in locations of high prey availability and reduced flow (Smith 1993).

South Asian river dolphins have been found in water as cold as 8°C and as warm as 33°C (Reeves and Brownell, 1989 and refs. therein). In the Bramaputra River, the highest number of dolphins was found in depths of 4.1-6 m deep (Wakid, 2009). In the Sundarbans mangrove forest of Bangladesh, Ganges River dolphin distribution was conditionally dependent on low salinity, high turbidity, and moderate depth during both low and high freshwater flow. Animals prefer wide sinuous channels with at least two small confluences or one large confluence (Smith et al. 2009).

Schooling: South Asian river dolphins are not usually considered gregarious. In one of the few quantitative studies of group size, it was found that 90% of the groups and 80.4% of the total dolphins observed during the dry season in the Meghna and Jamuna Rivers of Bangladesh were solitary individuals. However, other investigators reported groups of up to 25 individuals near ferryboats in the Indus River, or as many as 25-30 dolphins in a 1-km stretch of river (Reeves and Brownell, 1989, and refs. therein).

Reproduction: Calving apparently can occur at any time of the year, but there may be peaks in December to January and March to May. Newborn calves have been observed mainly in April and May. Calves are weaned within one year of birth (Jefferson et al. 2008). Gestation lasts 10.5 months (Reidenberg and Laitman, 2009).

Food: South Asian river dolphins feed on several species of fish, invertebrates, and possibly turtles and birds. They do much of their feeding at or near the bottom, echolocating and swimming on one side (Reeves and Brownell, 1989; Jefferson et al. 1993). The long beak is possibly an adaptation for extracting prey from crevasses or buried in soft sediment.

5. Migration

The marked seasonal changes in susu distribution and density over much of its range are due, at least in large part, to fluctuations in water levels. During the dry season from October to April, many dolphins leave the tributaries of the Ganges - Brahmaputra systems and congregate in the main channels, only to return to the tributaries the following rainy season. They may become isolated in pools and river branches during the dry season (Reeves and Brownell, 1989).

Observations in Nepal show that susus' move in and out of tributaries of the Gandaki, Koshi, and Karnali systems during high water seasons, probably spending lower-water seasons in deep pools of the tributaries. In the main rivers, a decrease in abundance during the summer would confirm a seasonal pattern of migration (Shrestha, 1989, in Reyes, 1991).

6. Threats

Direct catch: Oil extracted from blubber of the Ganges River dolphin is used as a fish attractant in India and Bangladesh. This oil fishery is associated with the mortality of hundreds of dolphins every year. Whereas the hunting of river dolphins is now banned in Pakistan, poaching presumably still occurs occasionally (IWC, 2000). Although deliberate killing is believed to have declined in most areas, it presumably still occurs in the middle Ganges near Patna, India, in the Kaini-Kushiyara River of Bangladesh, and in the upper reaches of the Brahmaputra River in Assam, India (Mohan et al. 1997). Fish oil was repeatedly suggested as a substitute for susu oil (Mohan and Kunhi, 1996; Bairagi, 1999) and shown to have a better attractant effect on target species (Sinha, 2002). In Assam, they are also killed for their meat (IWC, 2000).

Incidental catch:

Indus: Incidents of accidental killing and observations of dolphin carcasses and products are documented in Reeves et al. (1991) and Reeves and Chaudhry (1998). Little detailed information is available, but the level of take is not thought to be high, even though the Indus river dolphin is vulnerable to gillnets. Permanent losses from the population also occur when animals swim into irrigation channels. Since 1992 there have been reports of one or two dolphins becoming trapped in these channels annually, but then were recorded in the winter of 1999/2000 (IWC, 2000).

Ganges: Accidental killing is a severe problem for Ganges River dolphins throughout most of their range. The primary cause is believed to be entanglement in fishing gear, most often nylon gillnets. Ganges River dolphins may be particularly vulnerable to entanglement in gillnets because their preferred habitat is often in the same location as primary fishing grounds. No rigorous estimates of dolphin mortality have been published but the problem of accidental killing is expected to worsen as the demand for fish and for fishing employment increases (IWC, 2000 and refs. therein; Mansur et al. 2008). Dolphins may also become entangled in long-line fishing gear very similar to the rolling hooks used in the Yangtze River that have been cited as among the primary factors contributing to the probable extinction of the baiji (*Lipotes vexillifer*; Mansur et al. 2008).

Gill net encounter rate in the Ganges River is significantly different in different stretches of the river with maximum encounter rates recorded from Goalpara to Dhubri. Accidental killing through gillnet and poaching of dolphins for oil are the most dangerous threats to their survival. Close monitoring of dolphins and their habitats involving local communities are required for long term conservation of the species in the Brahmaputra River (Choudhary et al. 2006).

Deliberate killing: It has been suggested that some fishermen see Ganges river dolphins as rivals that scare away the fish or tear the fish from the nets. For this reason, the fishermen would scare the dolphins into the nets to kill them. This, however, is unlikely because the high cost in repairing the nets would not be compensated by selling the entire dolphin or its products (Reyes, 1991 and refs. therein).

Pollution:

Indus: Pollution may be affecting the viability of the species, especially considering the decline in the flushing effect of moving water above barrages. Mercury and arsenic concentrations sampled from fish above the Guddu Barrage were high. Massive fish kills have apparently become common from industrial pollution in urban areas and the use of pesticides in the irrigated crops grown along the riverbank (IWC, 2000 and refs. therein).

Ganges: Pollution by fertilisers, pesticides, and industrial and domestic effluents is dramatic in the Ganges River: about 1.15 million metric tons of chemical fertilisers and about 2,600 tons of pesticides were dumped annually to the river system. Industrial effluents are also a source of increasing pollution in Nepal. The effects of pollutants may be considered deleterious to dolphin populations (Reyes, 1991, and refs. therein; Subramaian et al. 1999). Senthilkumar et al. (1999) determined concentrations of polychlorinated biphenyls (PCBs), hexachlorocyclohexane (HCH), chlordane compounds, and hexachlorobenzene (HCB) in river dolphin blubber and prey fishes collected during 1993 through 1996. Comparison of organochlorine concentrations with values reported for samples analysed during 1988 through 1992 suggested that the contamination by these compounds has increased in the river and persists (Kumari et al. 2002).

Kannan et al. (1997) determined concentrations of butyltin compounds in dolphin, fish, invertebrates and sediment collected from the River Ganges. Total level in dolphin tissues was up to 2,000-ng/g wet wt, which was about 5-10 times higher than in their diet. The biomagnification factor for butyltins in river dolphins from food was in the range 0.2-7.5. Butyltin concentrations in Ganges river organisms were higher than those reported for several persistent organochlorine compounds. Discharge of untreated domestic sewage was one of the major sources. River dolphins may be particularly vulnerable to industrial pollution because their habitat in counter-current pools downstream of confluences and sharp meanders often places them in close proximity to point sources in major urban areas (e.g. Allahabad, Varanasi, Patna, Calcutta, and Dhaka). Furthermore, the capacity of rivers to dilute pollutants has been drastically reduced in many areas because of upstream water abstraction (IWC, 2000).

Habitat degradation:

Indus: According to the Scientific Committee of the IWC (2000) the dramatic decline in the range of the species, from the historical distribution of approximately 3,500 km to a range of less than 700 km of river length (Reeves et al. 1991) occurred presumably after the mainstem and major tributaries were segmented by three main barrages completed at Sukkur in 1932, at Kotri in 1955, and at Guddu in 1969. The greatly reduced volume of water, particularly downstream of Sukkur Barrage, caused the dolphins' dry-season range to shrink. Subpopulations on either side of barrages are now isolated and thus are more vulnerable to extirpation by hunting or environmental change (Reeves and Brownell, 1989).

Due to water abstraction, the Indus river becomes virtually dry in several places in the low-water season, especially downstream of the Sukkur Barrage, thereby eliminating suitable habitat in the lower reaches. The greatest threat to the survival of the Indus bhulan is probably the continuing decline in water supply due to the construction of new diversion structures (e.g. Ghazi-Gariala (Barotha) Dam in the upper Indus) and from increasing extraction from aquifers. Increasing human populations and both industrial and agricultural development in the area immediately surrounding this dolphin's range will inevitably lead to even greater habitat loss or damage (IWC, 2000).

Ganges: For Nepal, Smith et al. (1996) and Sinha et al (2000) warn that in the Karnali and Narayani river basins, aquatic species are threatened with local extinction from the effects of habitat degradation, segregation of breeding groups by downstream barrages, incidental catches during fishing operations and declines in prey fish populations.

There has been a dramatic decline in the extent of occurrence of Ganges susus, as well as in the quality of their habitat, especially in the Ganges river basin (IWC, 2000). This decline has been related to the construction, since the late 1950's, of an extensive network of barrages. The species is severely fragmented and additional barrages continue to be built (e.g. Kanpur barrage on the Ganges mainstem). Construction of dams for hydroelectric development and irrigation in the Ganges system has divided dolphin populations into small isolated subpopulations, preventing migrations and reducing food availability. The population above the Kaptai dam in the Karnaphuli River disappeared over a period of 6 or 7 years after the completion of the dam. The diversion of water for irrigation caused high fluctuations in the water flow, reducing suitable habitats for the dolphins.

Similar effects are expected with dolphin populations in the Karnali River in Nepal, in addition to erosion of banks and changes in river beds, as a result of deforestation and mining. Heavy river traffic is increasing drastically in both India and Nepal, and this may result in habitat restriction and changes in feeding behaviour (Reyes, 1991 and refs. therein). The population of the Padma River system was said to be "fast declining" due to the construction of the Farakka Barrage (Reeves and Brownell, 1989). Mohan et al. (1998) observed a land-locked susu population in the Kulsi river, a southern tributary of the Brahmaputra. Its number was reduced from 24 animals in 1992 to 12 in 1995. Large scale sand extraction and operation of fishing gear hazardous to the dolphins were the main causes for the decline.

In addition to fragmenting dolphin populations, dams and barrages degrade downstream habitat and create reservoirs with high sedimentation and altered assemblages of fish and invertebrate species (IWC,2000). Luxuriant growth of macrophytes and excessive siltation have eliminated suitable habitat immediately above the Farakka-Barrage. The insufficiency of water release downstream of the barrage has eliminated dry-season habitat for more than 300 km, or until the Ganges (Padma)-Brahmaputra confluence (Smith et al.1998) and resulted in salt water intruding an additional 160 km into the Sundarbans Delta, further decreasing the amount of suitable habitat for this obligate freshwater species. Consequently, in Bangladesh, Susu's are also threatened from the effects of dams, large embankment schemes, dredging, fisheries bycatch, directed hunting, and water pollution (Smith et al. 1998).

Other sources of habitat degradation include dredging (Smith et al. 1998) and the removal of stones, sand (Mohan et al. 1998), and woody debris (Smith, 1993). These activities threaten the ecological integrity of the riverine environments, especially in small tributaries where suitable habitat is more confined and therefore more vulnerable to local sources of degradation. Suitable habitat is also threatened by water abstraction from surface pumps and tube wells, especially in the Ganges where the mean dry-season water depth has been dramatically reduced in recent years. The long-term implications of the reduction of dry-season flows in the Ganges are catastrophic for the survival of susus. New projects that divert dry-season flow, such as the Kanpur barrage in the upper Ganges, continue to be constructed (IWC, 2000, and refs. therein).

7. Remarks

Range states (Smith and Braulik, 2008): Bangladesh; India; Nepal; Pakistan

P. gangetica is listed in Appendix I of CITES and the subspecies *P. gangetica gangetica* is listed in Appendix II of CMS. The IUCN considers the species as "Endangered" (Smith and Braulik, 2008). This is based on the diversity of ongoing threats, the fragmentation of the populations, the small size of the populations and the ongoing decrease in numbers.

A small subpopulation of the subspecies *P. g. minor* was recently also found in India, but exchange with the main populations in Pakistan is hampered by a series of dams and barrages. The conservation of this isolated population in India should be a matter of priority.

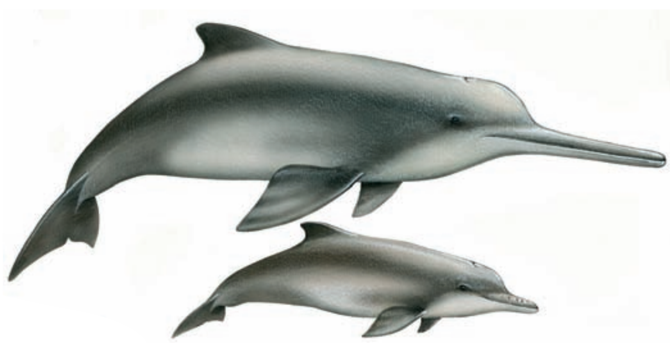
The World Wide Fund for Nature (WWF) considers *P. gangetica* as one of the most endangered small cetaceans world wide (WWF, 2009).

8. Sources (see page 279)

3.57 Pontoporia blainvillei (Gervais and d'Orbigny, 1844)

English: La Plata dolphin
German: La Plata-Delphin
Spanish: Franciscana
French: Dauphin de la Plata

Family Pontoporiidae



Pontoporia blainvillei / La Plata dolphin (© Wurtz-Artescienza)

1. Description

The Franciscana is the only one of the four river dolphin species living in the marine environment and the sole member of its family. It is one of the smallest dolphins and has an extremely long and narrow beak and a bulky head. Its colour is brownish to dark grey above and lighter on the flanks and belly. Females are larger than males, ranging between 137-177 cm as opposed to 121-158 cm in males. Females weigh up to 53 kg and males reach 43 kg (Crespo, 2009).

2. Distribution

The franciscana is restricted to coastal and estuarine central Atlantic waters of South America. The northern limit of the distribution is Itaúnas (18°25'S), Espirito Santo State, Brazil. In the south, the range extends to Golfo San Matías (41°10'S), in northern Patagonia, Argentina (Crespo, 2009).

The sighting of a single individual in Golfo Nuevo, Valdez Peninsula, is considered exceptional and this should not be considered the southern distribution limit for franciscana (Crespo, 2000).

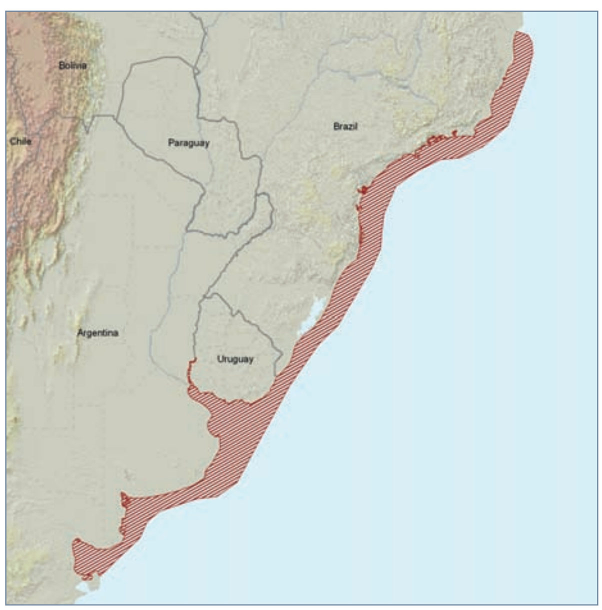
Data on mtDNA, morphometrics, parasitology and population parameters all together provide evidence for splitting the species into four provisional "Franciscana Management Areas": two inhabiting coastal waters of Brazil (FMA I - coastal waters of Espírito Santo and Rio de Janeiro states; FMA II - São Paulo, Paraná and Santa Catarina states); FMA III occurring in Rio Grande do Sul State (southern Brazil) and Uruguay, and FMA IV in coastal Argentine waters (Secchi et al. 2003a). This population fragmentation, together with the relatively low genetic variability, suggests that the franciscana dolphin is a potentially vulnerable species, which may require management efforts to ensure its preservation.

3. Population size

Abundance estimates for the franciscana in its natural environment are difficult to obtain due to the great difficulty in sighting it at sea. Current estimates are presented from north to south of the range:

In Babitonga Bay, on the northern coast of Santa Catarina State, southern Brazil, a total of 561 individuals were observed between 1996 and 2001 (Cremer and Simoes-Lopez, 2005). A subsequent estimate in the same area between 2000 and 2003 gave an estimated population size of only 50 animals. The difference was not explained but is likely due to methodological discrepancies between the two studies rather than population decline. Observed density was 0.32 ind / km². Density estimates evaluated in the sub-areas where franciscanas occurred resulted in a density of 0.46 ind / km² (Cremer and Simoes-Lopez, 2008).

A first abundance estimate for the coastal waters of Rio Grande do Sul State (southern Brazil) and Uruguay stems from 1996 data, resulting in an overall estimate of 42,078 francisca-



Geographic distribution of Pontoporia blainvillei on the east coast of South America (Reeves et al. 2008; © IUCN Red List).

nas (95% CI: 33,047-53,542; Secchi et al. 2001). However, this may be too optimistic: during a corresponding aerial survey 34 franciscanas (in 29 groups) were recorded leading to a mean density estimate of 0.657 individuals/km² for the study area (435 km²) after applying a correction factor for submerged dolphins. This corresponds to an estimated abundance of only 286 franciscanas (95% CI: 225 to 364) in this area, which represents only 0.7 % of the distribution of the proposed population (Secchi et al. 2001).

Extrapolating the 1996 density to the area of the Rio Grande do Sul coast, however, from shoreline up to the 30 m isobath (ca. 24,315 km²), the abundance would be around 15,975 animals (Secchi, 2010a). A subsequent abundance estimate for this region was provided based on a line transect aerial survey carried out in February 2004 (Danilewicz et al. 2009). The surveyed area was much larger than in 1996 and comprised 13,341 km² and at least 20 transect lines. The corrected density was 0.51 franciscanas/km² , which gives an extrapolated abundance of 12,400 for the entire area of 24,315 km². The difference between the 1996 and 2004 estimates was not viewed as a population decline and is attributed to methodological reasons (Secchi, 2010a). However, declining stranding rates in Rio Grande do Sul in the face of substantially increasing fishing effort in the 1990's was attributed to a decline in franciscana abundance (Pinedo and Polacheck, 1999).

The most recent abundance estimate conducted in Argentine waters stems from 2003-2004. A total of 101 Franciscanas were observed in 71 sightings. In northern areas, density was estimated at 0.106 individual/km². Density was lower in southern areas and depths greater than the 30-m isobath (0.05/km²). A correction factor for submerged dolphins was applied to density and then extrapolated to the strip between the coastline and the 30-m isobath. From the number of animals observed and after extrapolation, abundance in the northern area was estimated at 8,279 (4,904-13,960) individuals, while in the southern area it was estimated at 5,896 (1,928-17,999) individuals (Crespo et al. 2009).

The assumed distributional areas significantly influence abundance estimates: while the 30 m and even the 50 m isobath are assumed to be the offshore limit for the distribution of the species (Crespo, 2009), in the North of Rio de Janeiro State, 90% of sightings were obtained within 5 nm from shore, in waters only up to 15 m deep (DiBeneditto and Ramos, 2001). Therefore, the Secchi (2010a) estimate that total abundance could be up to 42,000 franciscanas for the whole Rio Grande do Sul and Uruguay coastal waters, and the Crespo (2009) estimate of 15,000 in Argentina, both considering the 30-m isobath as the offshore limit, may be far too optimistic. The IWC Scientific Committee concluded, after reviewing the methods and limitations of franciscana surveys through 2003-2004, that it was not appropriate to consider them as providing minimum estimates of abundance (IWC 2005).

4. Biology and Behaviour

Habitat: The species shows a pronounced preference for relatively shallow, turbid waters (Pinedo et al. 1989; Secchi and Ott, 2000), a coastal marine ecosystem characterized by continental runoffs with a high discharge of high-nutrient river flows (e.g. Lagoa dos Patos, Rio de la Plata; Crespo, 2009). In the north of Rio de Janeiro State, sightings were recorded in all seasons and 90% of them were obtained up to 5 nm (8 km) from shore, in waters up to 15 m deep (DiBeneditto and Ramos, 2001). Franciscana sightings from shore-based stations and vessels at Bahia Anegada, Argentina, near Rio Colorado were at a mean distance from shore of only 3.2 km (Bordino et al 1999). A positive correlation between the surface water temperature and the presence of franciscana was observed. Tide and depth also influenced behaviour. The animals usually enter the channels during high tide. Other authors state that maximum depth of sightings was of 25 meters measured by nautical charts (Bordino et al. 1999) or even as deep as 50 m in Argentinean waters (Crespo, 2009).

Schooling: Herd size is small, ranging from 2 to 15 individuals (DiBeneditto and Ramos, 2001; Crespo, 2009). In Babitonga Bay, southern Brazil, up to 59.5% of the groups consisted of over four individuals and the average group size was seven (Cremer and Simoes-Lopez, 2005). In other areas, calves were recorded during spring and summer and only one calf was observed per group. In Argentina, the behaviour showed a seasonal pattern with co-operative feeding and travelling activities increasing during winter. Co-operative feeding increased during flood tide, while travelling decreased. The behavioural ecology of the franciscana appears similar to that of other coastal and river dolphins (Bordino et al. 1999 and Bordino, in Crespo, 2000).

Franciscana dolphins may travel in kin groups which might include, besides mothers with their calves or juvenile offspring, the fathers of the youngest group members. All four individuals from the presumed social group shared the same mitochondrial haplotype, suggesting that the social unit might be matrilineally structured (Valsecchi and Zanellatto, 2003).

Reproduction: In the North of Rio de Janeiro State, calving occurs throughout the year, with no seasonal pattern. Females attain sexual maturity at 3 years and 130.0 cm in length and males at 2 years and 115.0 cm (DiBeneditto and Ramos, 2001). In Babitonga Bay, southern Brazil, calves were present in 30.4% of the observations, during all seasons (Cremer and Simoes-Lopez, 2005). Danilewicz (in Crespo, 2000) presents reproduction data from the northern coast of Rio Grande do Sul based on 22 females and 9 males and reports that births in this region occur during October to January with a water temperature over 20°C. He suggests that mating occurs in January and February based on observations of ovaries with traces of recent ovulations. He found lactating females between October and January and that births coincide with the periods of higher abundances of main prey. All the individuals were sexually mature at the age of 3 years. No pregnant females were found nursing at the same time though the sample was small. Crespo (2002) estimates longevity at 15 y for males and 21 y for females.

Food: Analyses of stomach contents indicate that franciscanas consume a wide variety of mainly bottom-dwelling fish species (Brownell, 1989). Sciaenid and engraulid fish comprise the main prey items. Squid and shrimp are also reported. Animals examined in Uruguay had eaten fish species common in coastal waters of the mouth of the La Plata River (Reyes, 1991). In the North of Rio de Janeiro State, Franciscana preferentially feed on the teleosts *Stellifer sp.*, Anchoa *filifera*, *Pellona harroweri* and *Isopisthus parvipinnis*, measuring up to 10 cm of length, and on the cephalopods *Loligo sanpaulensis* and *L. plei* (DiBeneditto and Ramos, 2001). Diet preferences may vary regionally and between years, making franciscana a bioindicator of changes in fish stocks. In Brazilian and Uruguayan waters, a few species accounted for the majority of prey consumed. In Uruguay, the most important species (based on estimated biomass) were *C. striatus* during winter, spring, and summer, and *T. lepturus* during autumn. In Brazil, four sciaenids, *P. brasiliensis*, *C. striatus*, *M. ancylodon*, *M. jurnieri*, and the squid (*L. sanpaulensis*) accounted for 87.7% of the estimated biomass and 89.7% of the total individuals ingested; 76% of these were *C. striatus* (Brownell, 1989 and refs. therein).

5. Migration

Reyes (1991) stated that apart from the documented intrusion into the La Plata River in search of prey, there is no additional information on movements of this species.

In the North of Rio de Janeiro State, sightings were recorded in all seasons and incidental captures were recorded throughout the year (DiBeneditto and Ramos, 2001). Results of parasitological analyses suggest that *P. blainvillei* might be sedentary, at least in spring-early summer, hence showing separate stocks, despite the relative closeness between localities (Aznar et al. 1995).

In Rio Grande do Sul, Southern Brazil, strandings occur year round, with peaks during spring, from September to December. However, this is the main period when the artisanal bottom-tending gillnet fisheries are active. However, in winter, franciscana were found at a significantly greater mean distance from shore than during summer (Pinedo and Polacheck,1999). This may explain why franciscana groups along the Mar del Plata coast and in Bahia Anegada were sighted mostly in spring and summer (Bastida; Bordino and Iniguez, both in Crespo, 2000).

6. Threats

Incidental catch: Combination of information on bycatch from fleet monitoring programs and interviews along the species' range (Secchi, 2010b) resulted in an annual bycatch estimate of about 110 (min: 44; max:176) franciscanas for FMA I; 279 (min: 63; max: 497) for FMA II; 1,245 (min: 562; max: 1,778) for FMA III and; 405 (min: 241; max: 567) for FMA IV (Ott et al. 2002 and Secchi et al. 2003b). Incidental mortality is largely related to fisheries targeting elasmobranchs and sciaenids (Crespo et al. 2007) and similar by-catch estimates are given in Crespo (2009). However, the highest estimates of abundance cannot sustain the lowest estimates of incidental catches (Crespo, 2002; 2009), showing that there is a mismatch. Unfortunately no recent by-catch estimates are available and data generally stem from dated reports, when population size might have been higher and/or fisheries efforts were higher. The estimated total mortality throughout the range could be in the order of 1,200-1,800 per year (Crespo, 2009) and Reeves et al. (2008) estimate that up to 2,900 animals could be incidentally caught in fisheries per year and that even this figure might be underestimated.

However, field data indicate that by-catch rates may be rather variable: in the north of Rio de Janeiro State, the annual catch per unit effort (CPUE) values varied from 0.2-1.8 dolphins per gillnet fishing effort (DiBeneditto and Ramos, 2001). Along the coasts of Uruguay, a decrease in mortality was observed since the 1970's. The highest value for the 1990's was 235 individuals in 1992-93, while during 1998, only 23 individuals were recorded. The suggested reason for the decline of the catch include the drop in fish stocks. At present, this fishery is not profitable. The fisheries using nets with larger mesh, the most harmful for franciscana (32-34 and 20-22 mm) have reduced their effort and nets with smaller mesh (12-14 mm) are being used at present. Uruguayan legislation protecting the marine fauna including franciscana (Law 9481 and Decrees 26 1/78, 586/79 and 565/81) is being enforced (Praderi, in Crespo, 2000).

Similarly relatively low catch values were recorded in the 1990's from Paraná, Brasil (Zanelatto, in Crespo, 2000). Monzón (in Crespo, 2000) comments that since 1991 there was no information on franciscana mortality in the area of Necochea (Buenos Aires Province). She noted a significant decrease in gillnet fishing effort from 50 vessels in the early 1990s to only one at present. Coastal fishing in small communities (for example Santa Teresita), however, results in the highest mortality values of the region.

A promising double blind experiment conducted in an artisanal gillnet fishery in Argentina shows the effectiveness of acoustic deterrents (pingers) at reducing by-catch. As opposed to 45 dolphins being caught in silent nets, only 7 were caught in the active pinger nets. However, sea-lions (*Otaria flavescens*) increasingly damaged the fish in active pinger nets over the course of the experiment suggesting the use of higher pinger frequencies to avoid a "dinner bell" (Bordino et al. 2002).

To conclude, several analyses indicate a high probability that the franciscana population is decreasing. Results indicate that current levels of entanglement mortality cannot be sustained and that protective measures are urgently needed (e.g. Kinas, 2002). About 3.5%-5.6% of the stock may be removed each year by the fishery, i.e. far more than the maximum 2% recommended by the International Whaling Commission. This may not be sustainable. Higher densities in coastal areas make Franciscanas more vulnerable to coastal fishing camps, with increased mortality in recent years (Crespo et al. 2009).

Pollution: According to Brownell (1989) ratios of DDT to DDE in the blubber of franciscana were at least an order of magnitude higher than in small cetaceans from California. This indicates the use of pesticides, which entered the coastal marine ecosystems in southern Brazil and Uruguay. Wide ranges of organochlorine residues were more recently determined in the blubber of franciscana incidentally caught along Brazilian coastal waters (Kajiwara et al. 2004). Concentrations of DDTs and PCBs were the highest, followed by CHLs, TCPMOH, dieldrin, TCPMe, heptachlor epoxide, HCB, and HCHs. Unexpectedly, significant pollution of PCBs, DDTs, TCPMe, and TCPMOH were observed in cetaceans from Brazil, implying the occurrence of local sources comparable to those in the Northern Hemisphere, probably by high industrialization in Brazil (Kajiwara et al. 2004). A large proportion of the distributional range is subject to pollution from several sources, especially agricultural land use and heavy industries between Sao Paolo in Brazil and Bahía Blanca in Argentina (Crespo, 2002).

Habitat degradation: Heavy coastal traffic and pollution from industrial development represent potential threats for the habitat of the franciscana. Recent widespread deforestation and agricultural cultivation occur in many of the basins draining into the Rio de La Plata system, particularly in southeastern Brazil. Fish species of commercial value normally constitute the diet of franciscanas, so an increase in the fishing effort for these fish could reduce available food for the dolphins (Reyes, 1991 and references therein). The coastal zone frequented by the franciscana is also intensively used for boat traffic, tourism, and artisanal and industrial fishing operations (Crespo, 2002; 2009).

7. Remarks

Range states (Reeves et al. 2008): Argentina (Buenos Aires, Chubut, Rio Negro); Brazil (Espírito Santo, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo); Uruguay

The Franciscana is included in Appendices I and II of CMS. The species is listed in Appendix II of CITES. The species is listed as "Vulnerable" by the IUCN (Reeves et al. 2008) based on a suspected 30% and ongoing decline over three generations which is feared to increase due to fishery expansion and lack of mitigating measures. The World Wide Fund for Nature (WWF) considers *Pontoporia blainvillei* as one of the most endangered small cetaceans world wide (WWF, 2009).

Participants in a CMS meeting held in 2000 (Crespo, 2000) considered it essential to prepare an integrated conservation plan which includes work with the pertinent authorities, fishing communities, public awareness, environmental education and legislation review. It was suggested that Argentina, Brazil and Uruguay consider the possibility of developing a *Memoradum of Understanding* for franciscana conservation within the framework of the CMS. Participants agreed to consider franciscana as the most endangered small cetacean in the South-western Atlantic. The endemism of franciscana and its restricted distributional area are important conditions for the species besides the high impact of human activities. Main concerns for franciscana conservation are the higher rates of incidental mortality in artisanal fisheries throughout the area of distribution as well as chlorinated hydrocarbon and heavy-metal spills as a result of the industrial and agricultural activities in the coastal zone.

Open questions related to the franciscana which were identified in 1991 and 2000 and still apply today are: 1) area-dependent rate of incidental mortality in fishing activities and 2) unknown population/stock status and size (Reyes, 1991; Crespo 2000).

Acknowledgement: We are grateful to Eduardo Secchi for kindly reviewing this species summary.

8. Sources (see page 280)

3.58 Pseudorca crassidens (Owen, 1846)

English: False killer whale
German: Kleiner Schwertwal, Unechter Schwertwal
Spanish: Orca falsa
French: Faux-orque

Family Delphinidae

Pseudorca crassidens / False killer whale (© Wurtz-Artescienza)

1. Description

Despite its world-wide distribution throughout the tropics and subtropics, the false killer whale (*P. crassidens*) is one of the lesser-known large odontocetes. These are large members of the delphinid family, adult males reaching 6 m, while adult females reach 5 m in length. The skull is similar to that of *Orcinus orca*, but the two species don't seem to be closely related. The colour is largely black or dark grey, with a white blaze on the ventral side between the flippers. The head is rounded, without a beak, the body shape elongate, the dorsal fin falcate and positioned in the middle of the back. In males, the melon protrudes farther forward than in females (Baird, 2009). Body mass may reach up to 2,000 kg in males (Jefferson et al. 2008).

Currently, there are no recognized subspecies (Rice, 1998) although Kitchener et al. (1990) found substantial differences in cranial characters between false killer whales from Australia, Scotland and South Africa. While genetic comparison of specimens from the eastern North Pacific Ocean, the western North Pacific, Indian, and Atlantic oceans indicates low genetic variability, there seems to be a demographically isolated population with long-term fidelity around the main Hawaiian Islands (Chivers et al. 2007; Baird et al. 2008).

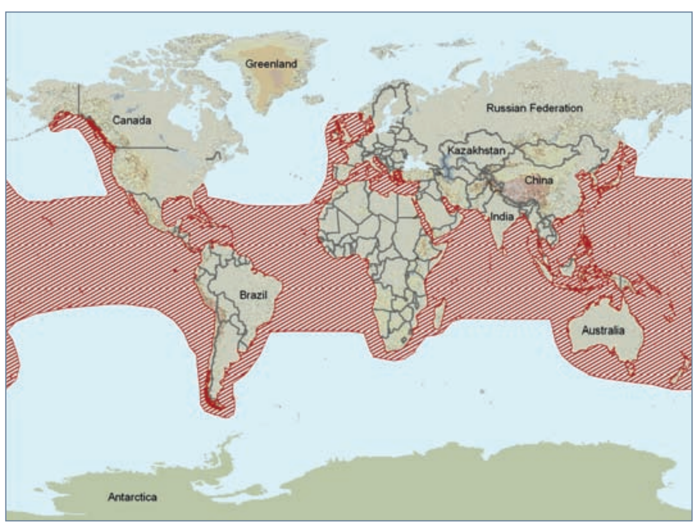
2. Distribution

Most of the distributional records and many of the data available for the species are the result of strandings (Odell and McClune, 1999). *P. crassidens* generally does not range beyond 50° latitude in either hemisphere (Jefferson et al. 1993) and is found world-wide in tropical and warm-temperate waters. It ranges north to Maryland, Scotland, Japan, Hawaii, and Alaska and south to Patagonia in Argentina, Cape Province, South Australia, Tasmania, South Island of New Zealand, Chatham Islands, and southern Chile (Taylor et al. 2008). Although there are numerous records of animals seen in cool temperate waters, these appear to be outside the normal range. Wanderers have been recorded as far afield as Norway and Alaska (Carwardine, 1995).

3. Population size

Although widely distributed, the species is not really abundant anywhere. There is no estimate of global abundance or of global or regional population trends (Baird, 2009; Taylor et al. 2008). In the past, *P. crassidens* appears to have been relatively common off the Japanese coast, and population estimates of 16,000 have been reported for the coastal waters of China and Japan (Odell and McClune, 1999 and refs. therein). Abundance in the eastern tropical Pacific has been estimated at 39,800 (CV=64%; Wade and Gerrodette 1993).

The most recent data are for the USA EEZ: In the northern Gulf of Mexico the pooled abundance estimate for 2003-2004 of 777 (CV=0.56; Mullin 2007) and for 1996-2001 of 1,038 (CV=0.71) are not significantly different (P>0.05; Waring et al. 2008). A recent study conducted during 2000-2004 produced an estimate of 123 (CV=0.72) false killer whales for the Hawaii insular stock (Baird et al. 2005). The Hawaii pelagic



Distribution of Pseudorca crassidens: tropical, subtropical and warm temperate waters, mainly offshore (Taylor et al. 2008; © IUCN Red List).

stock (within the EEZ outside of 75 nm of the Main Hawaiian Islands) is estimated at 484 (CV = 0.93) false killer whales. And in the US EEZ of the Palmyra Atoll, a recent line transect survey produced an estimate of 1,329 (CV = 0.65) individuals (Barlow and Rankin 2007).

Finally, there are several recent observations from other areas. Johnston et al. (2008) recently observed 5 false killer whales in the western tropical Pacific off American Samoa. Gannier (2002) observed one false killer whale near the Marquesas Islands in French Polynesia. Kiszka et al. (2007) observed 2 false killer whales around Mayotte in the northern Mozambique Channel and Weir (2007) recently observed the species off northern Angola.

4. Biology and Behaviour

Habitat: *P. crassidens* is mainly seen in deep, offshore waters (and some semi-enclosed seas such as the Red Sea and the Mediterranean) and sometimes in deep coastal waters. It seems to prefer warmer temperatures (Carwardine, 1995). Off Hawaii, individuals were only infrequently encountered, and while found in depths from 38 to 4,331 m, sighting rates were greatest in depths >3,000 m (Baird et al. 2008). With the exception of sightings from the eastern tropical Pacific, data on distribution are lacking for most oceanic areas (Odell and McClune, 1999, and refs. therein).

Behaviour: The false killer whale readily approaches boats and is an exceptionally active and playful animal, especially for its large size (Carwardine, 1995).

Schooling: Sightings of groups of 10-20 individuals are common and group sizes as high as 300 have been reported, presumably forming when food is abundant. Herd size in recent mass strandings ranged from 28 to over 1,000 animals, and a mean herd size of 55 has been reported from Japanese waters. Mass-stranded herds have about equal numbers of males and females of various sizes. False killer whales may associate with other species, e.g. bottlenose dolphins and other small cetaceans, possibly indicating shared or overlapping feeding grounds (Odell and McClune, 1999). Long-term bonds between individuals have been documented in Hawaiian waters (Baird et al. 2008).

Reproduction: Both sexes seem to mature between 8 and 14 years of age and maximum age seems to be 57 years in males and 62 in females (Baird, 2009). No seasonality in breeding is known for the false killer whale (Jefferson et al. 1993).

Food: Although false killer whales eat primarily fish and cephalopods, they also have been known to attack small cetaceans and, on one occasion, even a humpback whale (Jefferson et al. 1993). Depending on location, stomach contents included salmon (*Oncorhynchus sp.*), squid (*Berryteuthis magister* or *Gonatopsis borealis*), sciaenid and carangid fish, bonito (*Sarda sp.*), mahi mahi or dolphin-fish (*Coryphaena hippurus*), yellowfin tuna (*Thunnus albacares*), yellowtail (*Pseudosciana* spp.), perch (*Lateolabrax japonicus*), mackerel, herring and smelt (Odell and Miller McClune, 1999, and refs. therein).

Koen-Alonso et al. (1999) examined the stomachs of false killer whales from both coasts of the Strait of Magellan, Chile. The most important prey were the oceanic and neritic-oceanic squids *Martialia hyadesi* and *Illex argentinus*, followed by the neritic fish *Macruronus magellanicus*. The prey species were mostly subantarctic, including two antarctic species, abundant over the Patagonian shelf and adjacent oceanic waters around Tierra del Fuego. There are reports that *Pseudorca* fed on and chased other dolphins in the eastern tropical Pacific during chase and backdown operations of tuna purse seine fishing, a habit that has also been attributed to the pygmy killer whale (*Feresa attenuata*; Odell and McClune, 1999, and refs. therein). In an individual stranded on Gran Canaria the stomach contained cephalopod beaks from six species, the most important by number being *Thysanoteuthis rhombus*, *Argonauta sp.* and ommastrephids. Most of the cephalopod species represented inhabit the epipelagic zone (Hernandez-Garcia, 2002).

False killer whales maintained in captivity consume up to 4.3% of their body mass per day, which amounts to between 5000 and 6000 kg annually (body mass up to 450 kg; Kastelein et al. 2000).

5. Migration

Migration is not well documented, although it has been suggested that closely related globicephalid whales including *Globicephala*, *Pseudorca* and *Grampus* species in the western North Pacific move from warmer, southern waters in winter to cooler, northern waters in summer. Apparent seasonal movements in the western North Pacific may be related to prey distribution. False killer whales have been seen travelling in line formation, and one large herd of about 300 individuals was distributed over an area several km long and about one km wide. Reported travelling speeds are 3-6 knots and as high as 10 knots (Odell and McClune, 1999, and refs. therein).

The population around Hawaii seems to show strong site fidelity: although individual movements of up to 283 km were documented, with a large proportion of individuals moving among islands, individuals were resighted up to 20.1 yr after first being documented, showing long-term fidelity to the islands. Resighting rates were high, with an average of 76.8% of distinctive individuals within groups documented on more than one occasion (Baird et al. 2008).

6. Threats

Direct catch: *Pseudorca* were occasionally taken in Japan for food and at St. Vincent Island in the Caribbean for meat and cooking oil (Jefferson et al. 1993; Odell and McClune, 1999).

In a molecular monitoring of 'whalemeat' markets in the Republic of South Korea, false killer whale meat was detected. Significant inconsistencies were found in the expected frequencies of products from most species, including a large over-representation of false killer whales (Baker et al. 2006).

Incidental catch: Incidental take of small numbers of false killer whales in gill nets has occurred off northern Australia, the Andaman Islands, the southern coasts of Brazil and in tuna purse seines in the eastern tropical Pacific. Dolphin entrapment in tuna purse seine nets may be providing artificial feeding opportunities for *Pseudorca* on other marine mammals (Odell and McClune, 1999; Alves et al. 2002).

Yang et al. (1999) reported on by-catch rates in Chinese coastal fisheries (trawl, gill and stow net) which may number in the hundreds per year for *P. crassidens* alone. Between 1994 and 2006, 24 false killer whales were observed hooked or entangled in Hawaii-based longline fisheries, with approximately 4-34% of all effort observed. Fifteen additional unidentified cetaceans, which may have been false killer whales based on the observer's descriptions, were also taken (hooked or entangled) in this fishery (Forney and Kobayashi 2007). The rate of mortality and serious injury to false killer whales within the Palmyra Atoll EEZ in the Hawaii-based longline fishery is estimated at 1.2 animals per year (Caretta et al. 2008).

There was 1 reported fisheries-related stranding of a false killer whale in the Gulf of Mexico during 1999-2006 (Waring et al. 2008).

Killing: The largest documented fisheries interaction was in the waters around Iki Island, Japan, where over 900 false killer whales were killed in drive fisheries from 1965 to 1980 in an attempt to reduce interactions with the yellowtail (*Pseudosciaena* spp.) fishery (Jefferson et al. 1993; Odell and McClune, 1999).

Pollution: High levels of pesticides (DDE) and heavy metals (mercury) were detected in stranded specimens, and one individual had the remains of a plastic jug in its stomach (Odell and McClune, 1999 and refs. therein). Concentrations of butyltin (BT) and phenyltin (PT) compounds of specimens stranded on the coasts of Thailand were higher than in other odontocetes: False killer whales feed on squid and large pelagic fish containing higher concentrations of organotin (OT) compounds and may thus be particularly concentrating these compounds (Harino et al. 2007).

Noise pollution: Nachtigall et al. (2008) showed that false killer whales have very acute hearing capabilities including an active 'automatic gain control' mechanism. This entails a high susceptibility to marine noise pollution.

7. Remarks

Range states (Taylor et al. 2008): American Samoa; Anguilla; Antigua and Barbuda; Argentina; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil; British Indian Ocean Territory; Brunei Darussalam; Cambodia; Cameroon; Canada; Cape Verde; Cayman Islands; Chile; China; Cocos (Keeling) Islands; Colombia; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Croatia; Cuba; Denmark; Djibouti; Dominica; Dominican Republic; Ecuador; Egypt; El Salvador; Equatorial Guinea; Fiji; France; French Guiana; French Polynesia; Gabon; Gambia; Germany; Ghana; Gibraltar; Greece; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Ireland; Israel; Italy; Jamaica; Japan; Jordan; Kenya; Kiribati; Kuwait; Liberia; Madagascar; Malaysia; Maldives; Malta; Marshall Islands; Martinique; Mauritania; Mexico; Micronesia, Federated States of; Morocco; Mozambique; Myanmar; Namibia; Netherlands; Netherlands Antilles; New Caledonia; New Zealand; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Norway; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal; Puerto Rico; Qatar; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Sao Tomé and Principe; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Spain; Sri Lanka; Suriname; Syrian Arab Republic; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tokelau; Tonga; Trinidad and Tobago; Turkmenistan; Turks and Caicos Islands; United Arab Emirates; United Kingdom; USA; Uruguay; Vanuatu; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen.

P. crassidens is classified as "Data Deficient" by the IUCN (Taylor et al. 2008). The species is not listed by CMS. Listed in Appendix II of CITES .

See more recommendations for South American populations in the Hucke-Gaete (2000) report in Appendix 1; and for southeast Asian populations see Appendix 2 (Perrin et al. 1996).

8. Sources (see page 281)

3.59 Sotalia fluviatilis (Gervais and Deville, 1853)

English: Tucuxi
German: Amazonas-Sotalia
Spanish: Delfín del Amazonas
French: Sotalie fluviale

Family Delphinidae

Sotalia fluviatilis / Tucuxi (© Wurtz-Artescienza)

1. Description

The appearance of the tucuxi resembles that of a smaller bottlenose dolphin. The tucuxi is light grey to bluish-grey on the back and pinkish to light grey on the belly, with a distinct boundary between the mouth gape and the flipper's leading edge. On the sides, there is a lighter area between the flippers and the dorsal fin. The dorsal fin is triangular and may be slightly hooked at the tip. The beak is moderately slender and long. Body size reaches 152 cm and the tucuxi is thus much smaller than its close relative, the Guiana dolphin. It reaches a body mass of 55 kg (Flores and da Silva 2009).

2. Distribution

Dolphins of the genus *Sotalia* are found along the Caribbean and Atlantic coasts of Central and South America and in the Amazon River and most of its tributaries. Until recently, the taxonomy of these dolphins was unresolved. Although five species were described in the late 1800s, only one species was recognized prior to 2007 (*Sotalia fluviatilis)* with two ecotypes or subspecies, the coastal subspecies (*Sotalia fluviatilis guianensis*) and the riverine subspecies (*Sotalia fluviatilis fluviatilis*) (Rice, 1998 and refs. therein; Culik, 2004).

Distribution of Sotalia fluviatilis: rivers of north-eastern South America (Reeves et al. 2008; © IUCN Red List).

Recent morphometric analyses, as well as mitochondrial DNA analysis, suggested recognition of each subspecies as a separate species (e.g. Furtado, 1999). Caballero et al. (2007) and Cunha et al (2005) reviewed the history of the classification of this genus. Caballero et al. (2007) presented new genetic evidence from ten nuclear and three mitochondrial genes as well as evidence from previous studies supporting the elevation of each subspecies to the species level under the Genealogical Lineage Concordance Species Concept and the criterion of irreversible divergence. For the riverine species, the authors accepted the previously proposed nomenclature: 'tucuxi' dolphin, *Sotalia fluviatilis* (Gervais,1853).

S. fluviatilis, the tucuxi occurs in the main tributaries of the Amazon/Solimoes River basin with records in all three types of water that occur in this region. The tucuxi does not occur in the Beni/Mamoré river basin in Bolivia nor in the upper Rio Negro. In the Orinoco, the species presence is controversial, a stretch of rapids and water falls blocking movements (Flores and da Silva 2009).

3. Population size

The species appears to be relatively abundant throughout its range (Flores and da Silva 2009). Numerous estimates exist of relative abundance in small areas, such as minimum number sighted, encounter rate, and estimates of minimum density (IWC, 2000):

In the Amazon drainage area, an average density of approximately 1.1 dolphins per km of river was estimated between Manaus and Tefé in the Solimoes river. In the Iquitos area, Kasuya and Kajihara (1974, in da Silva and Best, 1994) recorded 62 *Sotalia* during 36 hr of observations. Further upstream, *Sotalia* were frequently encountered in the Samiria river and its tributary the Santa Helena river. They are also common in Colombia in the Loretoyacu River, and the Tarapoto River at the El Correo Lake system and in the lower reaches of the Orinoco River (da Silva and Best, 1994 and refs. therein). Mean density along the margins of main rivers in the central Amazon, Brasil (1,320 km of survey strip) was 3,2 individuals per km². More that 54 % of the individuals occurred within 50 m of the edge of rivers and channels (Martin et al. 2004).

Vidal et al. (1997) conducted a boat survey in 1993 to estimate the abundance of the tucuxi along ca. 120 km of the Amazon River bordering Colombia, Peru, and Brazil. They estimated that there are 409 *Sotalia* in the study area. *Sotalia* density was highest in lakes (8.6 per km²), followed by areas along main banks (2.8 per km²) and around islands (2.0 per km²). These are among the highest densities measured to date for any cetacean.

In Peru's Pacaya-Samiria National Reserve. encounter rates were within the range of encounter rates for these dolphins elsewhere in South America. Riverine dolphin populations appear to be relatively healthy. Studies indicate that population numbers in the Samiria System have been stable over the last 10 years (McGuire, 2002).

4. Biology and Behaviour

Habitat: Tucuxis inhabit all types of water ("whitewater", "clearwater", and "blackwater" rivers) of the Amazon region, so physical factors such as visibility and pH appear not to affect their distribution directly. They are found in the main channels of rivers as well as in larger lakes where access is not limited by a narrow or shallow channel. They generally do not enter the flooded forest. Rapids and fast-moving turbulent water are also avoided. *Sotalia* show a distinct preference for junctions of rivers and channels (da Silva and Best, 1994 and references therein). Martin et al. (2004) confirmed that in western Brazil highest densities occurred near the margin, and were lowest in the center of rivers. Tucuxi prefer areas with diminished current and where two channels join, the most preferred habitat type being where a sediment-rich white water channel meets one carrying acidic black water; the resultant mixing produces particularly productive, and obviously attractive, conditions for dolphins.

McGuire and Henningsen (2007) used photo-identification to examine range, rate of movement, and site fidelity of *S. fluviatilis* in Peru's Pacaya-Samiria Reserve from 1991 to 2000. Maximum range for *Sotalia* was 130 km, with a greatest rate of movement of 56 km/d. Encounter rates were highest in confluences, intermediate in lakes, and lowest in rivers. In general, encounter rates in rivers and lakes did not differ among seasons. During low water, tucuxi persisted longer in the confluences throughout the sampling day, and occurred in higher densities than in any other season; the reverse pattern was observed during high water (McGuire, 2002).

Schooling: According to da Silva and Best (1994) the tucuxi and Guiana dolphin have a similar social structure. The riverine form occurs in groups of one to six individuals in 55 % of all observations. Groups of more than nine animals are seen on rare occasions. Group composition is unknown. Two groups that were captured consisted of a female with a male calf, and the third of a pregnant female with an immature female (da Silva and Best, 1994). Vidal et al. (1997) reported overall mean group size of 3.9 individuals in the upper Amazon river. In rivers and lakes of Peru's Pacaya-Samiria Reserve, tucuxis were seen most often as singles or pairs. Significant seasonal differences in group size were not detected (McGuire, 2002).

Reproduction: In Brazil, calving in the riverine form apparently occurs primarily during the low water period, September to November (Jefferson et al. 1993). Gestation is estimated at 11 months (Flores and da Silva, 2009).

Food: In the Amazon region, tucuxis prey upon at least 28 species of fish belonging to 11 families. The characoid family Curimatidae was represented in 52 %, Sciaenidae in 39 % and siluriforms in 54 % of the stomachs analysed (n = 29). In the dry season fish become concentrated in the main water bodies and thus are more vulnerable to predation. During the flood period many of these fish enter the floodplain to feed, but *Sotalia* usually do not enter this habitat (da Silva and Best, 1994). Da Silva and Best (1996) found that competition between man and dolphin for commercial fish is still minimal in the Central Amazon. Dietary analysis has shown that only 43 % of 53 identified prey-species are of commercial value and that the dolphins generally prey on size-classes of fish below those of commercial interest.

5. Migration

General patterns: The principal limiting factor in the Amazon is the presence of rapids and small channels, where manoeuvrability would be restricted. The large seasonal fluctuation in water levels (10 m) influences the distribution of tucuxis: they enter lake systems during periods of high water but will leave these as the waters recede, thus avoiding entrapment in lakes that are too small or shallow. Animals may occur during the whole year in the same area. Two tagged individuals in the Amazon were found within 5 km of the tagging site up to 1 year later (da Silva and Best, 1994 and references therein; Jefferson et al. 1993). It is therefore possible that tucuxis have a limited home range, but the area of such a range is unknown (Reyes, 1991).

Two types of travelling were observed: slow directional movement and faster swimming, including porpoising, usually in a single direction (Jefferson et al. 1993). The tucuxi is present in rivers of the Amazon region that cross territories of such countries as Brazil, Colombia, Ecuador and Peru. It definitely crosses international boundaries in areas such as Leticia, similar to Amazon river dolphins (Reyes, 1991, and refs. therein).

Diurnal rhythms: An apparent diurnal behaviour rhythm has been observed in the Amazon, where more *Sotalia* were seen between 09:00 and 10:00 h than at any other time (da Silva, unpublished data). There was a marked movement into lakes from rivers in the early morning before about 09:00 h, and again in the late afternoon from about 16:00 to 18:00 h.

6. Threats

Major threats for the tucuxi are related to human fishing activity, and include entanglement in fishing gear and possibly poisoning to reduce net damage and predation on fish. Potential threats include boat strikes, oil spills, water and noise pollution, and overfishing of prey (McGuire 2002).

Direct catches: There are no records of past or recent commercial fisheries for *Sotalia* spp. (IWC, 2000). Tucuxis have been protected by the superstitions of fishermen from Colombia to southern Brazil as well as in the Amazon. (Jefferson, 1993; da Silva and Best, 1994 and refs. therein). Interviews with fishermen in the boats, in the fishmarket and in the shops supposedly selling dolphin products were conducted in an attempt to quantify the overall incidental kill attributed to commercial fisheries operations. The results showed that in the Central Amazon, dolphin catches are incidental and only a very small number of these carcasses are used for commercial purposes (da Silva and Best, 1996).

Incidental catches: Modern fishing practices and the greatly increased intensity of fishing are the greatest direct threats to the species. The tucuxi is easily captured in monofilament gill nets as well as in shrimp and fish traps and seine nets. Analysis of the type of fishing gear associated with the mortality of 34 animals from the central Amazon revealed that 74% were caught in gill nets and 15% in seine nets. They apparently do not steal fish from nets as do *Inia* in the Amazon, but as they consume 14 of the 30 species of fish most exploited by man in the Amazon, incidental captures during fishing are frequent (da Silva and Best, 1994 and refs. therein; da Silva and Best, 1996). Martin et al. (2004) showed that tucuxis selectively occur in areas known to be favoured for gill net deployment by local fishermen, which may explain why entanglement is apparently a common cause of mortality.

Habitat degradation: Another potential threat to riverine *Sotalia* is the damming of rivers for hydroelectric projects, with future plans for up to 200 such dams in series along many of the main Amazon tributaries. At the very least, such dams would interrupt gene flow between *Sotalia* populations, creating isolated groups between dams. Furthermore, most of the migratory fish on which *Sotalia* feed would become extinct in the reservoirs, and the potential suitability of nonmigratory fish for the diet of *Sotalia* is unknown (da Silva and Best, 1994, Jefferson et al. 1993).

Pollution: Pollution from industrial and agricultural activities may be considered a threat both directly, through the destruction of habitat, or indirectly, through contamination of the food chain. The continued use of insecticides containing substances banned elsewhere is common in South America. Mercury is used in the refining of fluvial gold and then, like the pesticides, probably enters the aquatic food chain of the rivers (da Silva and Best, 1994 and ref. therein).

7. Remarks

Range states (mod from Reeves et al. 2008): Brazil; Colombia; Ecuador; Peru; Venezuela

According to Monteiro et al. (2000) the small number of individuals in conjunction with long gestation and nursing periods suggests that an increased mortality due to dolphin-fisheries interactions could severely impact local populations. The IWC sub-committee on small cetaceans (IWC, 2000) recognised that incidental catches of tucuxi are widespread.

Sotalia fluviatilis is listed in Appendix I of CITES and in Appendix II of CMS. The species is listed as "Data Deficient" by the IUCN.

The tucuxi is abundant and widely distributed in the central Amazon, but there are no estimates of total population size. It is vulnerable to the same threats that apply to Inia, including fisheries entanglement, habitat deterioration and fragmentation of populations by dam construction. The large numbers of animals taken as incidental catches in the Amazon estuary are a cause for concern, though it is not yet clear which form of *Sotalia* these represent (IWC, 2000, and refs. therein).

The IWC sub-committee on small cetaceans (2000) recommends:

- that research should be directed towards detecting trends in abundance by making repeatable and statistically rigorous estimates of density in a range of regions and habitats,
- that information be collected to allow evaluation of the relative levels of incidental mortality of the tucuxi associated with different fishing methods,
- that research be directed to determine which form of tucuxi occurs in areas such as the Orinoco and Amazon estuaries.

National legislation specifically protects the tucuxi in Brazil, Peru, and Colombia. The species is indirectly protected in Ecuador, Venezuela, Guyana, and French Guiana (Reyes, 1991, and refs. therein).

8. Sources (see page 282)

3.60 Sotalia guianensis (Van Bénéden 1864)

English: Guiana dolphin; Costero
Spanish: Costero
German: Küsten-Sotalia
French: Sotalie côtière

Family Delphinidae

Sotalia guianensis / Guiana dolphin; Costero (© Wurtz-Artescienza)

1. Description

The appearance of the Guiana dolphin resembles that of a smaller bottlenose dolphin. It is light grey to bluish-grey on the back and pinkish to light grey on the belly, with a distinct boundary between the mouth gape and the flipper's leading edge. On the sides, there is a lighter area between the flippers and the dorsal fin. The dorsal fin is triangular and may be slightly hooked at the tip. The beak is moderately slender and long. The Guiana dolphin is significantly larger than the tucuxi. Body size reaches 210-220 cm and body mass 80 kg (Flores and da Silva, 2009).

2. Distribution

Dolphins of the genus Sotalia are found along the Caribbean and Atlantic coasts of Central and South America and in the Amazon River and most of its tributaries. Until recently, the taxonomy of these dolphins was unresolved. Although five species were described in the late 1800s, only one species was recognized prior to 2007 (*Sotalia fluviatilis*) with two ecotypes or subspecies, the coastal subspecies (*Sotalia fluviatilis guianensis*) and the riverine subspecies (*Sotalia fluviatilis fluviatilis*) (Rice, 1998 and refs. therein; Culik, 2004).

Recent morphometric analyses, as well as mitochondrial DNA analysis, suggested recognition of each subspecies as a separate species (e.g. Furtado, 1999). Caballero et al. (2007) and Cunha et al (2005) reviewed the history of the classification of this genus. Caballero et al. (2007) presented new genetic evidence from ten nuclear and three mitochondrial genes as well as evidence from previous studies supporting the elevation of each subspecies to the species level under the Genealogical Lineage Concordance Species Concept and the criterion of irreversible divergence. The authors proposed the common name 'costero' for the coastal species, *Sotalia guianensis* (Van Beneden 1864). More recently, "Guiana dolphin" has been introduced as a synonym for "costero" (Flores and da Silva, 2009).

S. guianensis (P.-J. van Bénéden, 1864) is found in inshore coastal waters, estuaries, and the lower reaches of rivers along the western Atlantic from Nicaragua (14°35'S) south to Floreanópolis, Santa Catarina, Brazil (27°35'S; Flores and daSilva, 2009). This subspecies includes *Sotalia brasiliensis* E. Van Bénéden, 1875 (Rice, 1998 and references therein). In a recent paper Carr and Bonde (2000) extended the known range to the northwest in northeastern Nicaragua, north of the mouth of the Layasiksa River, west side of Waunta Lagoon (13°40'N) where one individual was positively identified.

3. Population size

The species appears to be relatively abundant throughout its range. Numerous estimates exist of relative abundance in small areas, such as minimum number sighted, encounter rate, and estimates of minimum density (IWC, 2000). The following summary moves from north to south. Edwards and Schnell

Distribution of Sotalia guianensis: coasts of north-eastern South America and eastern Central America (Reeves et al. 2008; © IUCN Red List).

(2001) found that in the Cayos Miskito Reserve, Nicaragua, 49 costeros inhabited the portions of the Reserve studied. Mean overall density was 0.6 individuals/km², with slightly lower densities in lagoons (0.5 ind/km²). Bossenecker (1978, in da Silva and Best, 1994) estimated 100-400 dolphins near the mouth of the Magdalena River in Colombia, and noted that they were abundant in the Gulf of Cispata, near San Antero (Colombia). In Suriname, they were described as "rather common" in the mouths of the larger rivers, and in Guyana they were reported as "frequent" in the lower reaches and mouth of the Essequibo river.

Sotalia were reported to be common in the Baia de Guanabara (Rio de Janeiro), by Geise (1991, in da Silva and Best, 1994) who estimated the population at 418 individuals in about 109 groups. Geise (1989, in da Silva and Best, 1994) estimated the total number of individuals for the area around Cananéia Island to be 2,829. In Sepetiba Bay, Southeast Brazil, a population density of 2.79 dolphins/km² and a population of 1,269 individuals (CI=739-2,196) were recently estimated. Density and abundance were similar for the entrance and interior of the Bay (Flach et al. 2008).

4. Biology and Behaviour

Habitat: Costeros show a preference for shallow protected estuarine waters or bays. In the Baia de Guanabara (Rio de Janeiro), they prefer the deeper channels (25 m depth) and avoid areas with less than about 6 m of water. Where the rivers that feed such areas are large enough, dolphins may penetrate up to 130 km or more upriver; however the species identity of these dolphins is still uncertain. The major restriction to the south seems to be low sea-surface temperature (Reyes, 1991 and refs. therein) of the Malvinas current. They may range as far as 70 km offshore, e.g. in the Abrolhos Archipelago (Flores and daSilva, 2009).

Sightings of costero groups in the Cayos Miskito Reserve, Nicaragua indicates that some areas are preferred. In coastal areas *Sotalia* were sighted most often within 100 m of shore and the animals were seldom observed in more than 5 m of water (Edwards and Schnell, 2001).

Schooling: According to da Silva and Best (1994) Guiana dolphins occur in groups of as many as 30 individuals, with a mode of 2 per group in the Baia de Guanabara and Cananéia. Group size varies in these two areas according to the time of day and type of activity. Borobia (1984) and Geise (1984, 1989, all in da Silva and Best, 1994) reported that calves are usually observed in small groups of three (one calf and two adults) or four (two calves and two adults). Azevedo et al. (2005) investigated group characteristics in Guanabara Bay, south-eastern Brazil. Group size ranged between 1 - 40 individuals and groups of 2 -10 were most common. There was no variation in group size between seasons, but nursery groups were twice as large than non-calf groups. Flores and daSilva (2009) reported that Guiana dolphins do not associate with bottlenose dolphins in Brazilian waters.

Edwards and Schnell (2001) found a mean group size of 3 in the Cayos Miskito Reserve, Nicaragua.

Reproduction: Males reach sexual maturity at 7 years and at body lengths estimated at 170-175 cm. Females mature at 5-8 years of age and at body lengths of 164-169 cm. The reproductive cycle is estimated at 2 years, with no marked seasonality in ovulation or timing of birth. Gestation is about 12 months, fetal growth rate was 9 cm/month, and length at birth is estimated at 92 cm. Females older than 25 years have senescent ovaries (Rosas and Monteiro-Filho, 2002).

Food: *S. guianensis* from southeast Brazil feed on a diet of pelagic clupeids (*Trichurus lepturus* and *Pellona barroweri*), demersal sciaenids (*Cynoscio* spp., *Porichthys porosissimus*, *Micropogonias furnieri*) and neritic cephalopods (*Loligo* spp. and *Lolliguncula brevis*). In Santa Catarina these dolphins are known to feed on the anchovies which are abundant in this area (da Silva and Best, 1994). Back-calculation of prey lengths indicated that fish ranged from 1.2 to106.9 cm and cephalopods from 3.4 to 22.2 cm in mantle length (Di Beneditto and Arruda Remos, 2004). Demersal fishes usually associated with estuarine sandy bottoms were the main prey items. Sciaenid fishes that produce relatively loud sounds by swimbladder muscular contraction were observed as common prey items. The dolphins also prey on shrimps (*Penaeus schmitii* and *P. paulensis*; Penaeidae; De oliveira Santos et al. 2002).

5. Migration

General patterns: Costeros may penetrate up to 130 km or more upriver. They probably also have a defined home range, although the area covered may be large because of the distances between one estuary or protected bay and another (Reyes, 1991). Geise (1989) and Andrade et al. (1987, both in da Silva and Best, 1994) observed individuals identified by natural marks in the same area for over 1 year. Home ranges are probably among the smallest for small cetaceans, with 15 km² in southern Brazil and up to 265 km² in another location.

Movement patterns vary among cold and warm seasons in the temperate regions, whereas in warmer waters no seasonal movements are known (Flores and daSilva 2009). Furthermore, Guiana dolphins show strong site fidelity. In Guanabara Bay, southeastern Brazil, which is surrounded by a metropolitan complex and is the most degraded area of the species' distribution, individuals were seen for 4.5 consecutive years, with a range of 1 to 8 years, and calves remained in the area beyond sexual maturity (Azevedo et al. 2004).

Diurnal rhythms: An apparent diurnal behaviour rhythm has been observed with Guiana dolphins entering the Bahía de Guanabara between 06:00 and 08:00 h and leaving between 13:00h and 18:00 h. They were rarely seen entering and leaving the bay on the same day (12 % of the observations). A similar behaviour was reported for *S. guianensis* in the Cananéia region (da Silva and Best, 1994 and references therein; Geise et al. 1999).

At Enseada do Mucuripe in Fortaleza, Brazil, the distribution of sightings and displacement routes of *Sotalia* suggests preferential uses of the sites Praia Mansa and Praia de Iracema at different times, with movement patterns between resting and feeding areas. Highest and lowest frequencies of sightings at Praia de Iracema occurred respectively in the first and fourth quarters of the day. The higest frequencies happened at low tide (Oliveira et al. 1995).

6. Threats

Direct catches: There are no records of past or recent commercial fisheries for *Sotalia* (IWC, 2000). On the coast of Brazil they may occasionally be killed for use as bait for sharks or shrimp traps or for human consumption, although the extent of this practice is unknown.

Incidental catches: Modern fishing practices and the greatly increased intensity of fishing in both the marine and freshwater habitats are the greatest direct threats to the species. Guiana dolphins are easily captured in monofilament gill nets as well as in shrimp and fish traps and seine nets. Beltran (1998, in IWC, 2000) recorded 938 animals taken in drift nets from the port of Arapiranga during the summer of 1996 and a further 125 taken during the winter. These data were collected by interviewing fishermen in port after trips, and collecting carcasses. The IWC sub-committee on small cetaceans expressed its concern about the magnitude of these catches. More recently, Monteiro-Neto et al. (2004) estimated that approximately 90 Guiana dolphins are killed every year in the passive gill net fisheries along the Brazilian coast. In the metropolitan area of Fortaleza, the capital of Ceara State, 32 bycaught animals were recorded. The use of pingers in fishing nets may assist in the mitigation of entanglements.

Habitat degradation: Another potential threat to *Sotalia* spp., in both riverine and coastal environments, is the damming of rivers for hydroelectric projects, with future plans for up to 200 such dams in series along many of the main Amazon tributaries. Where such dams are built on rivers that empty directly into the sea, the altered flux of freshwater may affect both the primary and secondary productivity in the estuaries and reduce the feeding potential of these areas for Guiana dolphins (da Silva and Best, 1994, Jefferson et al. 1993).

Pollution: Pollution from industrial and agricultural activities may be considered a threat both directly, through the destruction of habitat, or indirectly, through contamination of the food chain. Large harbours like the Baia de Guanabara (Rio de Janiero) and Santos (São Paulo) are extremely polluted with effluent, including heavy metals, posing a serious potential threat. The continued use of insecticides containing substances banned elsewhere is common in South America (da Silva and Best, 1994 and ref. therein). However, Guiana dolphins from the Cananeia Estuary, an important biological area on the southeast coast of Brazil, had lower organochlorine concentrations in their blubber than small cetaceans from developed areas elsewhere in the world, although the estuary is known to have been impacted by both chlorinated pesticides and polychlorinated biphenyls (PCBs; Yogui et al. 2003).

Mercury is used in the refining of fluvial gold and then, like the pesticides, probably enters the aquatic food chain of the rivers and coasts. Mercury and selenium were found in the livers of two costeros from Suriname (da Silva and Best, 1994 and ref. therein). The detection of Cd, Hg and Pb in tissue samples of *S. guianensis* off the coast of Ceara, Brazil, indicated that heavy metals are locally available in the water and bioaccumulation may be occurring through the food web. Contamination levels were not considered critical, but they could be related to Ceara's growing industrial development. The associated risks of pollution outfalls may pose a threat to marine organisms in a near future, especially for top predators such as the Guiana dolphin (Monteiro-Neto et al. 2003).

Exploration for oil in the offshore regions of Brazil, Venezuela and Colombia may not pose a direct threat to *S. guianensis*. Nevertheless, the apparent dependence of this dolphin on estuaries entails that an oil spill near such an area could contaminate the food chain and affect local populations (da Silva and Best, 1994 and ref. therein).

7. Remarks

Range states (Reeves et al. 2008): Brazil, Colombia, Ecuador, French Guiana, Guyana, Nicaragua, Panama, Peru, Suriname and Venezuela.

Sotalia sp. is listed in Appendix II of CITES and *S. guinanensis* is listed in Appendix II of CMS. The species is listed as "Data Deficient" by the IUCN.

On the Atlantic coast of South America, large rivers are geographical limits for countries along the coast. Because of the estuarine preference of costeros in the area, it is likely that the dolphins move between some of these countries (Reyes, 1991, and refs. therein). According to Monteiro et al. (2000) the small number of individuals in conjunction with long gestation and nursing periods, suggest that an increased mortality due to dolphin-fisheries interactions could severely impact local populations. The IWC sub-committee (IWC, 2000) recognised that incidental catches of *S. guianensis* are widespread. Little information exists regarding population size, and in many areas, such as the lower Orinoco, it is not clear which species is present (IWC, 2000, and refs. therein).

The IWC sub-committee on small cetaceans (2000) recommended:

- that research should be directed towards detecting trends in abundance by making repeatable and statistically rigorous estimates of density in a range of regions and habitats,
- that information be collected to allow evaluation of the relative levels of incidental mortality associated with different fishing methods,
- that research be directed to determine which species of *Sotalia* occurs in areas such as the Orinoco and Amazon estuaries.

8. Sources (see page 282)

3.61 Sousa chinensis (Osbeck, 1765)

English: Indo-Pacific-humpback dolphin, Chinese white dolphin
German: Chinesischer Weißer Delphin
Spanish: Delfín blanco de China
French: Dauphin blanc de Chine

Family Delphinidae

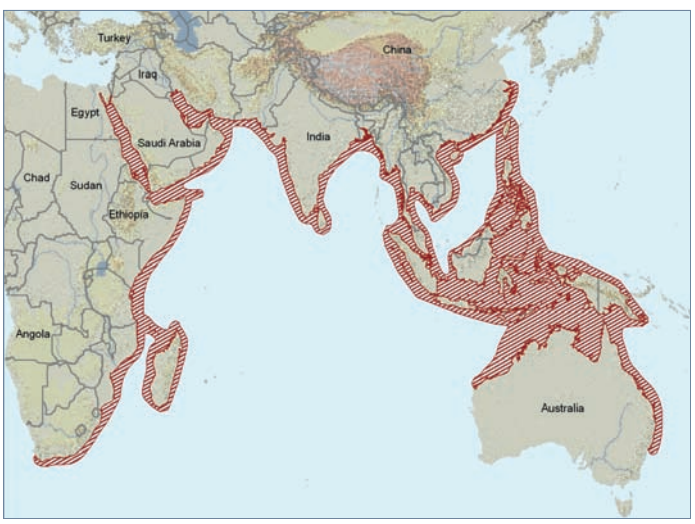
Sousa chinensis / Indo-Pacific-humpback dolphin (© Wurtz-Artescienza)

1. Description

Humpback dolphins are medium sized and robust. Their melon is slightly depressed and slopes gradually to an indistinct junction with the long, narrow beak. The broad flippers are rounded at the tip and the flukes are broad and full, with a deep median caudal notch. The form of the dorsal fin varies geographically. Body length reaches 2.5 - 2.8 m in different parts of the range. In South Africa, males may reach 2.7 m and 260 kg as opposed to the smaller females which only attain 2.4 m and 170 kg. Colour also varies greatly with age and location, in both the timing and extent in the loss of the grey background colour to white (pink when flushed; Ross, 2002).

For the first edition of this review, I followed Rice (1998) who separated the genus *Sousa* into three species: *S. chinensis* (eastern Indo-Pacific), *S. plumbea* (western Indo-Pacific) and *S. teuszii* (eastern Atlantic). However, a recent morphological study based on 222 dolphin skulls showed that only the distinctness of *S. teuszii* is clearcut (Jefferson and VanWaerebeek, 2004). Subsequent genetic analyses confirm that all Indo-Pacific populations form a robust, monophyletic clade (Frere et al. 2008), settling the dispute with respect to *S. chinensis* and *S. plumbea*, which seem to be a single species for which the name *S. chinensis* has priority (Ross, 2002).

Surprisingly, however, humpback dolphins from South Africa and China form a strongly-supported clade with the Atlantic *S. teuszii*, to the exclusion of animals from Australia. This results strongly suggest that Australian humpback dolphins are not *S. chinensis* but may represent a distinct species in their own right (Frere et al. 2008).



Distribution of Sousa chinensis: shallow coastal waters of the Indo-Pacific Ocean (Reeves et al. 2008; © IUCN Red List).

2. Distribution

The Chinese white dolphin is discontinuously distributed in coastal waters of the Indian and Pacific Oceans. Known areas of occurrence from west to east are False Bay (18°30'E) in Cape Province, north along the coast of eastern Africa, including Madagascar, to the Red Sea as far north as Gulf of Suez, the Arabian Sea, and the Persian Gulf, thence east along the coasts of southern Asia at least as far as Vishakhapatam on the western Bay of Bengal. It is vagrant in the Ganges River 250 km from the sea and has also strayed into the Mediterranean Sea via the man-made Suez Canal (Rice, 1998). It occurs from the Bay of Bengal east to the coast of southern China, including Taiwan, from the Gulf of Tonkin to Jiangsu, entering the lower reaches of the Zhu Jiang (=Canton River), the Jiulong Jiang (=Amoy River), and the Mim Jiang (=Foochow River), and ascending 1,200 km up the Chang Jiang (=Yangtse River) as far as Wuhanthe Gulf of Thailand; the Strait of Malacca; the northwestern coast of Borneo from Sematan in Sarawak to Sandakan in Sabah (Rice, 1998). Following Rice (1998), this species account includes *S. borneensis* (Lydekker, 1901) and *S. lentiginosa* (Gray, 1866).

Finally, the distribution also includes the northwestern coast of Western Australia between North West Cape and Larrey Point; and the coast of eastern Australia from Cairns in Queensland to Wollonggong in New South Wales (Rice, 1998), but this may be another species or subspecies (see above).

3. Population size

Recent information on population size is limited and comes from a few restricted locations. These reports present a picture of low if not declining population numbers everywhere. The sparse data available for selected areas indicate that humpback dolphins occur in discrete, geographically localized populations and are susceptible to anthropogenic threats. The following summary spans the distributional area from West to East:

Eastern Africa: The minimum population size at Algoa Bay on the south Eastern Cape coast of South Africa was about 466 dolphins (Karczmarski et al. 1999).

Off the KwaZulu-Natal coast (South Africa) there is a total of perhaps 200 animals (Jefferson and Karczmarski, 2001), which was confirmed by Keith et al. (2002) who reported a minimum of 181 individuals at Richards Bay.

In the Bazaruto Archipelago in Mozambique between the mainland and the Bazaruto islands, a 1992 survey counted 60 animals.

A mark-recapture analysis conducted between 1995 and 1997 in Maputo Bay suggested a population size of approximately 105 dolphins, but the precision of the estimate is low (30.5-150.9; Guissamulo and Cockroft, 2004).

Around Mayotte in the northern Mozambique Channel, Kiszka et al (2007) observed 44 humpback dolphins.

Approximately 65 humpback dolphins were observed in five groups (mean group size of 13) off Anakao, Madagascar, during boat-based surveys conducted in 1999. These surveys and other sources of information indicate that humpback dolphins may largely be restricted to the west coast (Razafindrakoto et a. 2004).

Off the south coast of Zanzibar, mark-recapture methods were used to estimate a population size of 71 (95% CI 48-94) humpback dolphins in a 26 km² study area in 2001 (Stensland 2004).

Persian Gulf: Estimates of cetacean abundance in the UAE differed significantly between 1986 and 1999 and indicate a population decline of 71%. In the region between Oman and Kuwait, the Indo-Pacific humpback dolphin used to be the second most commonly observed cetacean at sea (27%; Preen, 2004).

In the immediate vicinity of Kuwait's Boubyan Island, a combined total of 524 individuals were estimated in 2004-2005 (Bishop and Alsaffar, 2008).

Indian Ocean: A rough population estimate for the Indus delta was 500 animals (Ross et al. 1994 and refs. therein). In nearshore waters of Bangladesh, 6 humpback dolphins were observed in a 2004 survey (Smith et al. 2008). Off the Mergui (Myeik) Archipelago of southern Myanmar 3 individuals were identified at sea (Smith and Tun, 2008).

Chinese waters: There is only limited knowledge about distribution in the coastal waters of southern China, including Fujian, Taiwan and Guangxi provinces, where 5 important populations of *S. chinensis* can be identified, but populations appear to be in decline (Zhang and Tang, 2008).

In Hong Kong waters sightings occurred in all of the waters surrounding Lantau Island but were most common in the North Lantau area. Estimates in 1995-97 ranged from 88 dolphins in spring to 155 dolphins in autumn, with a year-round average of 109. Mark-recapture estimates of abundance suggest that between 208 and 246 different animals used the Hong Kong area (Jefferson and Leatherwood, 1997). Jefferson and Karczmarski (2001, and refs. therein) report for Hong Kong waters and the adjacent Pearl River Estuary a combined estimate of >1,028 animals.

A 2005 preliminary estimate of the size of the Leizhou population is about 237 individuals, second only to the Pearl River estuary population, suggesting that Leizhou Bay has the potential to serve as a "humpback dolphin sanctuary" in Chinese waters (Zhou et al. 2007).

Liu and Huang (2000) recorded 392 individuals in Xiamen waters, with a negative population trend.

Off central western Taiwan there are few and sporadic records. Several groups of Indo-Pacific humpback dolphins were sighted in 2002 and overall 28 individuals observed (Wang et al. 2004)

Australia: Estimates for Moreton Bay in 1984-1986, and 1985-1987, respectively, were163 animals (95% confidence intervals 108-251), and 119 animals (95% confidence intervals 81-166); preliminary results for Cleveland Bay, in the Central Section of the Great Barrier Reef, suggest a population of less than 200 animals (Ross, 2006; Parra et al. 2004).

4. Biology and Behaviour

Habitat: *S. chinensis* is rarely found more than a few kilometres from shore, preferring coasts with mangrove swamps, lagoons, and estuaries and areas with reefs, sandbanks, and mudbanks. Animals sometimes enter rivers, though rarely more than a few kilometres upstream and usually within the tidal range (Carwardine, 1995). They prefer water less than 25 m deep and, on more open coasts, are typically found in the surf zone (Ross, 2002).

In Algoa Bay, South Africa, no apparent preference for clear or turbid water was observed, water depth probably being the main factor limiting their inshore distribution; the 25-m isobath seems to represent the critical depth. Within this confined, inshore distribution, dolphin activities concentrate in the vicinity of rocky reefs - their primary feeding grounds and "key habitat" (Karczmarksi et al. 2000). These habitat preferences were confirmed by aerial surveys of the Great Barrier Reef region, which showed that humpbacked dolphins occur mostly in waters close to the coast, although they also occur in offshore waters that are relatively sheltered, and close to reefs or islands (Corkeron et al. 1997).

Behaviour: The species is usually quite difficult to approach and tends to avoid boats by diving and reappearing some distance away in a different direction. They rarely permit a close approach before diving, splitting up into small groups or single animals (Carwardine,1995; Ross et al.1994).

Schooling: Humpback dolphins form small schools throughout their distribution, ranging from one to about 25 dolphins off South Africa and the northern Indian Ocean (Ross et al. 1994 and references therein). In Maputo Bay, Mozambique, estimated group size was 14.9 individuals and was the largest reported for the eastern Africa region. There was no change with month, season, daylight, or tidal state (Guissamulo and Cockroft, 2004). Off Kuwait, however, group size in 159 sightings was low; 40% of sightings were comprised of a single individual and 26% consisted of pairs. Pods of 10 or more members were observed on only 13 occasions (Bishop and Alsaffar, 2008).

Off southern China, schools usually contain three to five animals. In Moreton Bay, Queensland, mean group size was 2.4 animals (range 1-9, n =9). *S. chinensis* associates with bottlenose dolphins and, to a lesser extent, with finless porpoises and spinner dolphins (Ross et al. 1994).

Reproduction: Some calves may be born throughout the year, but spring or summer calving peaks are the norm. Gestation lasts 10-12 months, and age at sexual maturity is 10 years in females and 12-13 years in males (Jefferson and Karczmarski, 2001). Some females may cycle outside of the apparent summer breeding season, perhaps indicating a secondary winter season. Circumstantial evidence suggests a minimum of a 3-year calving interval. Maternal care lasts at least 3-4 years, but female-calf separation is seemingly not related to the female's next pregnancy (Karczmarski, 1999).

Food: According to Ross (2002), food consists mainly of fish and cephalopods, dolphins temporarily beaching to retrieve bonefish washed onto exposed sandbanks. Fish species comprise sardines, mackerel, mullet and other near-shore fishes. Off southern Africa humpback dolphins seem to feed on or close to reefs along rocky coastal areas in preference to areas with sandy bottoms (Reyes, 1991 and refs. therein; Ross et al. 1994 and refs. therein).

All 503 prey items in the stomachs of 17 dolphins captured in shark nets off Natal, South Africa, were fish. Numerically, the major prey species were *Thryssa vitrirostris* (46.4%), *Trickiurus lepturus* (9.2%), *Pomadasys olivaceum* (8.6%), *Otolithes ruber* (7.2%), and *Diplodus sargus* (3.6%). The remaining 24% comprised a further 28 prey species. Nearly 61% of all fish were littoral or estuarine species, and a further 25% were demersal species primarily associated with reefs (Ross et al. 1994 and references therein).

Humpback dolphins in China feed on several species of demersal and estuarine fishes, with little evidence of predation on cephalopods or crustaceans (Jefferson and Hung, 2004). Stomachs of two dolphins netted off the northern Queensland coast contained fish remains, and in one case, some crustacean fragments. In Moreton Bay, southeastern Australia, humpback dolphins feed with bottlenose dolphins on trawl discards (Ross et al. 1994 and refs. therein).

5. Migration

Indo-Pacific *Sousa* are not known to be migratory (Ross 2002), although numbers of animals increase seasonally in South Africa. Some seasonal inshore-offshore and longshore movements are recorded for West African *Sousa* and these most likely cross international boundaries. In Richards Bay, South Africa, photo-identification suggests that some humpback dolphins display long-distance movement patterns (up to 150 km), while other individuals display long-term residency within the area (Keith et al. 2002).

A high level of seasonal immigration of humpback dolphins into, and emigration from, the Algoa Bay region in summer has been reported (Karczmarski 1999, 2000). There is evidence for summer influxes of humpback dolphins into eastern Maputo Bay, and there are considerable numbers of apparently transient individuals. A substantial proportion of humpback dolphins (13.5%) display high site fidelity to eastern Maputo Bay and could be long-term residents (Guissamulo and Cockroft, 2004). Migration of the species along the coast is related to the movements of the fishes on which they feed. In other areas, movements are poorly understood (Reyes, 1991 and refs. therein).

The Pearl River, southern China, influences the hydrography of the region, notably with regard to turbidity, salinity, pH, tides, currents and temperature of the waters of Hong Kong and Lingding Bay. Consequently the dramatic increase in its freshwater output during the summer also changes fish distribution, which in turn influences the abundance distribution of Hong Kong's Pacific humpback cetaceans (Parsons 2002a). Dolphins in Hong Kong and the Pearl River Estuary have individual ranges averaging 99.5 km², which is only a small portion of the population's range (Jefferson and Hung, 2004). Seasonal changes in their abundance were significantly correlated with water temperature (positively) and salinity (negatively) (Parsons 1998b).

Humpback dolphins appear to be present throughout the year off southern China and northern Queensland (Ross et al. 1994). However, stranding rates differ between various seasons (with peaks during the summer monsoon), which seems to indicate variable dolphin densities and possibly seasonally differing habitats (Parsons, 1998a).

6. Threats

Direct catch: Small numbers have been taken for food and oil in the Red Sea, Arabian Sea and Persian Gulf, and meat is consumed on the southwest coast of India (Calicut). This may still be practiced today (Reyes, 1991 and refs. therein; Jefferson et al. 1993). They are also among the dolphin species intentionally targeted for their meat in south-western Madagascar. From interview surveys, 22 humpback dolphins had been recorded as directly hunted (Razafindrakoto et a. 2004). Ross (2006) reported that live capture may occur in Queensland, and North South Wales, Australia, with permits granted for up to 12 per year at present.

By-catches: The inshore distribution of these dolphins makes them very susceptible to many human activities in the coastal zone, particularly those relating to fishing. Fishing nets, including seine nets and especially gill nets set for sharks and other large fish, pose the greatest threat to humpback dolphins throughout much of their distribution. Entanglements in gillnets are reported from Zanzibar, Djibouti, the Arabian Gulf, the Indus delta, the south-west coast of India (Ross et al. 1994 and references therein; Lal Mohan,1988), Pakistan, Sri Lanka, Iraq, Kuwait (Reyes, 1991, and refs. therein), Madagascar (Razafindrakoto et a. 2004), Bangladesh (Smith et al. 2008), Myanmar (Smith and Tun, 2008) and China (Chen et al. 2005) Fisheries interactions in China are made responsible for the decline of the population (Wang and Han, 2007).

On Unguja island of Zanzibar, the level of reported incidental catches in artisanal gillnet fisheries in 1999 was 5 Indo-Pacific humpback dolphins, extrapolated to approx. 10 in the whole fleet (Amir et al. 2002). As a follow-up to that survey, from January 2000 to August 2003, incidental catches of dolphins in drift- and bottom set gillnets collected from 12 fish landing sites were recorded. In total, 11 Indo-Pacific humpback dolphins were caught.

Most of the bycatches (71%) were in nets set off the north coast of Unguja Island. This estimate may be high enough as to have a significant negative impact on local populations (Amir et al. 2005).

Dolphins are also caught in shark nets set to protect bathing beaches along the Natal coast, South Africa. At least 67 humpback dolphins were caught in the Natal nets between 1980 and 1989, or about 7-8 animals per year (Ross, 2002). Anti-shark nets are a source of ongoing incidental mortality in South Africa (Reyes, 1991 and refs. therein; Atkins et al. 2004).

Dolphins are also caught in shark nets set to protect bathing beaches along the coast off Queensland and New

South Wales (Reyes, 1991; Parra et al. 2004). Accurate catch data for humpback dolphins in the Australian nets are unavailable, though six of 10 dolphins examined by Heinsohn et al. (1980, in Ross et al. 1994) were taken from shark nets. Some specimens were taken in an offshore driftnet fishery operating off northern Australia (Reyes, 1991, and references therein).

Mass strandings: Between 23 August and 30 October 1986, over 500 dead dolphins were found on the western shores of the Persian Gulf, primarily those of Saudi Arabia and Qatar. At least 140 of these were humpback dolphins (Ross et al. 1994). The cause of this mortality, which included three other odontocete species, dugongs, sea turtles and fish, was not established conclusively.

Habitat degradation: Increased use of sensitive habitats also poses a threat to humpback populations. Pilleri and Pilleri (1979, in Ross et al. 1994) pointed to the reduction in prime habitat for these dolphins in the Indus delta through construction of harbor facilities, drainage and destruction of mangroves, pollution and boat traffic which disturbs their habitat. Dolphins are no longer present in the lower reaches of rivers because of the construction of dams, silting of river mouths and increasing pollution (Reyes, 1991 and refs. therein).

The disposal of contaminated mud arising from Hong Kong's dredging and reclamation projects poses a risk to the Indo-Pacific humpback dolphin via reduced abundance of prey species (Clarke et al. 2000). Acoustic disturbance results from industrial activity underwater, such as pile-driving during land-reclamation as in the construction of Hong Kong Kai Tak airport. Würsig et al. (2000) reported on the successful development of an air bubble curtain to reduce underwater noise of percussive piling.

Hong Kong is one of the busiest ports in the world with approximately half a million oceanic and river-going vessels per year and thirty high-speed and hydrofoil ferries daily passing through the area of greatest humpback dolphin abundance (Parsons, 1997a). Boat traffic seems to interfere with acoustic communication between the animals (Parijs et al. 2001). Between 1993 and 1998 four Pacific humpback dolphin strandings were diagnosed to have been caused by boat strikes (Parsons and Jefferson, 2000). This represents 14% of all humpback dolphin strandings during this period (Parsons and Jefferson, 2000; Parsons, 2004).

Pollution: Off the South African coast, organochlorine levels are the highest found in any marine mammal. These levels may affect the reproductive efficiency of males and be lethal to neonates of females pregnant for the first time (Reyes, 1991 and refs. therein).

Hong Kong's population of Indo-Pacific hump-backed dolphins inhabits an area where a high volume of sewage waste discharge and the close proximity of contaminated mud pits mean a considerable potential for trace metal contamination (Parsons 1998c). Lu and Fang (2008) reported on a stranded animal which had ingested parts of a gillnet. Mercury concentrations in dolphin tissues were an order of magnitude higher than in prey items and could be considered potentially health threatening (max: 906 µg/kg dry wt.; Clarke et al. 2000). The concentrations of organochlorines were significantly higher than those found in various seals collected from other parts of the world. Correlations between the concentrations of tris-chlorophenyl compounds with other persistent organochlorines such as HCHs, CHLs, DDTs and PCBs were significant, suggesting their bio-accumulation (Minh et al. 1999).

Concentrations of the flame-retardant hexabromocyclododecane (HBCDs) in animals collected from the South China Sea (31-380ng/g lipid) were higher by one order of magnitude than in finless porpoises (4.7-55ng/g lipid), which was attributed to habitat differences (Isobe et al. 2007). The concentrations of yet another flame retardant, polybrominated diphenyl ethers (PBDEs), ranged from a low value of 6.0 ng/g lipid wt. in spinner dolphins (*Stenella longirostris*) from India to a high value of 6000 ng/g lipid wt. in Indo-Pacific humpback dolphins from Hong Kong (Kajiwara et al. 2006). The pesticides PCB and DDT also showed high concentrations in animals collected from Hong Kong waters, and the ratio of DDT to its breakdown products (and addidtional information) suggests that there may be a recent or nearby source of DDT discharging into the dolphins' ecosystem (Ramu et al. 2005; Jefferson et al. 2006).

Hong Kong discharges over 2,000 million litres of sewage into its coastal waters every day. Bacteria can gain egress into the mammalian body by a variety of routes, and Parsons (1997b) estimated that a Hong Kong humpback dolphin's minimum daily intake of sewage bacteria through ingesting contaminated seawater alone could be up to 70,500 faecal coliforms/day. By comparison a one-off ingestion rate of 200-300 coliforms is considered to be unacceptable for humans (Parsons, 2002b).

According to Parsons (2002b) it is also extremely likely that many areas populated by humpback dolphins are highly contaminated with butyltin (BT). For example, humpback dolphins inhabit the waters of several coastal ports in Asia that host a large volume of shipping and, therefore, potential butyltin pollution, e.g., Shanghai, Bombay, Singapore and Hong Kong. However, next to nothing is known about levels or effects of BT contamination on these cetaceans, and analysis of BT contamination in the tissues of humpback dolphins in areas of high shipping traffic should be a priority

Noise pollution: Würsig and Greene (2002) reported on heavy noise pollution in Hong Kong harbour, potentially masking echolocating sounds and acoustic communication in humpback dolphins. The noise is related to heavy vessel traffic.

Tourism: Karczmarski et al. (1997, 1998) found that the behaviour of Indian humpback dolphins in Algoa Bay, South Africa was not affected by the presence of bathers or surfboats. However, powerboats did cause changes in behaviour, and when these vessels were present, avoidance reactions were observed by the dolphins in 95.3% of occasions (Karczmarski et al. 1998). The response to boat traffic were long dives, changes in direction and swimming away perpendicular to the route of the boat (Karczmarski et al. 1997).

In Kizimkazi (Zanzibar) marine mammals were previously used as bait for sharks. However, in the mid 1990's the local fishermen realised that their touristic value far exceeded their value as shark bait. As many as 2,000 tourists visit the dolphin site at Kizimkaki per month. Dolphin-tourism is currently becoming a popular economic activity. Successful management of the dolphin-tourist trade will ensure continued visitors to the villages where dolphins are present and thus add income to these villages while contributing to management and conservation (Ali and Jiddavi, 1999).

7. Remarks

Range states (Reeves et al. 2008): Australia; Bahrain; Bangladesh; Brunei Darussalam; Cambodia; China; Comoros; Djibouti; Ecuador; Egypt; Ethiopia; Hong Kong; India; Indonesia;

Iran, Islamic Republic of; Iraq; Israel; Kenya; Kuwait; Macao; Madagascar; Malaysia; Mozambique; Myanmar; Oman; Pakistan; Papua New Guinea; Philippines; Qatar; Saudi Arabia; Singapore; Somalia; South Africa; Sri Lanka; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; United Arab Emirates; Viet Nam; Yemen.

Sousa chinensis is listed in Appendix II of CMS. *Sousa* sp. is listed in Appendix I of CITES. The IUCN considers *S. chinensis* as "Near Threatened". This is based on the fact that although the population may consist of more than 10,000 individuals, it is under substantial threat by fisheries activities and habitat degradation. It is possible that the reductions in population size have been large and pervasive enough to cause a net reduction for the entire species of at least 30 % over a period of 3 generations. The species may however be re-classified as "Vulnerable" in the near future, if population size was estimated to lie below 10,000 individuals, with a discontinuous distributional range (Reeves et al. 2008).

More research on biology, taxonomy, stock identity and movements is needed. Assessment of ecological impact should be requested of development projects through the range. Compilation of Information on direct takes and incidental mortality should be encouraged.

See also general recommendations on Southeast Asian stocks in Perrin et al. (1996) in Appendix 2. Recommendations for further research are given by Jefferson (2000).

8. Sources (see page 283)

3.62 Sousa teuszii (Kükenthal, 1892)

English: Atlantic humpback dolphin, Cameroon dolphin
German: Kamerun-Flussdelphin
Spanish: Delfín jorobado del Atlántico
French: Dauphin du Cameroun

Family Delphinidae

Sousa teuszii /Atlantic humpback dolphin (© Wurtz-Artescienza)

1. Description

Humpback dolphins are medium sized and robust. Their melon is slightly depressed and slopes gradually to an indistinct junction with the long, narrow beak. The broad flippers are rounded at the tip and the flukes are broad and full, with a deep median caudal notch. The dorsal fin emerges from a hump or ridge of connective tissue on the back. Body length reaches 2.8 m and body mass 284 kg. Colour is somewhat variable with slate gray on the back and light gray-whitish below. Some animals have dark spots on the tail stock and near the base of the fin (Jefferson et al. 2008).

Recent morphological as well as genetic research confirms that *S. teuszii* is in fact a separate species of the genus *Sousa* (Jeffersson and Van Waerebeek, 2004; Frere et al. 2008).

2. Distribution

Sousa teuszii ranges on the coast of West Africa from Dakhla Bay (23°54'N) in Western Sahara south to Tombua (15°47'S), southern Angola. A total of six contemporary management stocks are provisionally discerned: Dakhla Bay (Western Sahara), Banc d'Arguin (Mauritania), Saloum-Niumi (Senegal), Canal do Gêba-Bijagos (Guinea-Bissau), South Guinea and Angola. Two stocks are historical (now extirpated): Cameroon and Gabon Estuary (Van Waerebeek et al. 2004).

The species remains unrecorded in Ghana and neighbouring nations despite apparently suitable coastal habitat (Van Waerebeek et al. 2009).

3. Population size

S. teuszii seems to be particularly common in southern Senegal and northwestern Mauritania (Carwardine,1995). However, there are no rigourous population estimates for any of the regions where the species might exist (Van Waerebeek et al. 2004). From north to south, the Dakhla Bay and the Banc d'Arguin stocks appear to be very small (Van Waerebeek et al. 2004). Rough population estimates for the Saloum delta, Senegal were 100 animals (Ross et al. 1994, Reyes, 1991 and refs. therein). The high number of opportunistic sightings suggests that the still relatively undisturbed waters of Guinea-Bissau, enclosing extensive mangrove forest habitat, may support one of the largest known populations of *S. teuszii*: the Canal do Gêba-Bijagos stock. The status of the South Guinea, Cameroon and Gaboon Estuaries management stocks is unknown, although the latter two are likely extinct. The Angola stock is presumably very small (Van Waerebeek et al. 2004), but its existence was recently re-confirmed (Weir, 2007).

4. Biology and Behaviour

Habitat: This species prefers coastal and estuarine waters less than 20 m deep and occurs in the surf zone on more open

Distribution of Sousa teuszii: coastal waters of tropical West Africa (Reeves et al. 2008; © IUCN Red List).

coasts. There are no reports of its presence in offshore waters. The preferred habitat is near sandbanks and mangrove areas, in turbid waters with temperatures ranging between 17°C and 28°C (Maigret, 1982, in Ross et al. 1994). It has been recorded up to 33 miles up the Saloum River and is known to enter the Niger and Bandiala Rivers, and possibly others, though it rarely travels far upstream and usually remains within the tidal range (Carwardine, 1995).

Schooling: Humpback dolphins form small schools throughout their distribution, ranging from one to about 25 dolphins off West Africa (Ross et al. 1994 and refs. therein).

Reproduction: Breeding has been reported in March and April, but the season may be more protracted (Jefferson et al. 1993).

Food: Schooling fish e.g. mullet (Jefferson et al. 1993). Stomachs contained pomadasyid, clupeid and mugilid fish (Ross et al. 1994 and references therein). There is no evidence for herbivory as suggested by Kükenthal (1892; Jefferson et al. 1993).

Busnel (1973; in Ross, 1994) described a remarkable example of a symbiotic relationship between fishermen and groups of bottlenose dolphins on the Mauritanian coast around Cap Timiris, north of Nouakchott. The fishermen wait for migrating shoals of mullet to appear close to shore, and then apparently summon the dolphins by slapping sticks on the water surface. The dolphins effectively contain the mullet on their seaward edge while feeding, enabling the fishermen to deploy their nets around the fish more easily. Humpback dolphins also take part in the cooperative harvest, though perhaps fortuitously, since the method probably requires a larger number of dolphins than the usual humpback school size.

5. Migration

There are signs of a probable north-south migration, and there is a potential exchange of individuals between known population or subpopulation distribution centres (from north to south): Dakhla Bay (Western Sahara), Banc d'Arguin (Mauritania), Langue de Barbarie (Senegal), Sine Saloum delta (Senegal), NW bank of the Gambia River outer estuary (The Gambia) and Guinea-Bissau archipelago (Van Waerebeek et al. 2000).

Regular cross-border movements between the Saloum Delta (Senegal) and Niumi National Park (The Gambia) technically qualifies *S. teuszii* as a "migratory species" under the Conservation of Migratory Species (CMS) Convention (Van Waerebeek et al. 2004). They have been recorded in the Saloum Estuary from January to April, with very few observations in subsequent months. However, catch data show that the species was taken north of the estuary from June to August (Reyes, 1991 and ref. therein, confirmed by Ross, 2002). Daily movements observed off Senegal show that humpback dolphins move onshore with the rising tide to feed in the mangrove channels of the Saloum Delta, returning towards the sea with the ebb tide (Maigret, 1981 in Ross et al. 1994).

Maigret (1982, in Reyes, 1991) recorded sightings of this species in the Banc d' Arguin (Mauritania) between May and January, with a peak in August and September.

6. Threats

Direct catch: A few Atlantic humpback dolphins have reportedly been taken along the range. No recent information is available, but direct catches still may occur (Reyes, 1991; Van Waerebeek et al. 2000).

Incidental catch: There are reports of incidental catches in beach seines and shark nets in Senegal. Past and present levels of these captures remain unknown (Reyes, 1991 and refs. therein). The most recent interaction in Senegal was recorded in November 1996, when three animals were found together, each with a piece of netting tied around the tailstock, on a beach of Sangomar Island in the Saloum delta, probably an abandoned take. In Guinea-Bissau, a 190-cm male was by-caught in a fishing trap at Canhabaque Island, Bijagós in March 1989 (van Waerebeek et al. 2000 and refs. therein).

Habitat degradation: In Senegal there has been a permanent reduction of mangrove areas for extension of rice culture and exploitation of forest, especially in the Fathala area. Excessive fishing of prey species may reduce food availability and increase the risk of incidental catch. Pollution may also be a source of habitat destruction, since the species inhabits areas with high population growth subject to agricultural and industrial development (Reyes, 1991 and refs. therein). The possible fracturing of the species' habitat range, resulting in reproductively isolated groups, due to coastal development should be monitored (van Waerebeek et al. 2000).

7. Remarks

Range states (Reeves et al. 2008): Angola; Cameroon; Congo; Côte d'Ivoire; Gabon; Gambia; Guinea; Guinea-Bissau; Liberia; Mauritania; Nigeria; Senegal; Western Sahara.

Sousa teuszii is listed in Appendix I&II of CMS. The World Wide Fund for Nature (WWF) considers *S. teuszii* as one of the most endangered small cetaceans world-wide (WWF, 2009).

Sousa sp. is listed in Appendix I of CITES. The species is categorized as "Vulnerable" by the IUCN (Reeves et al. 2008). This is based on the fact that the current population size is below 10,000 with local populations smaller than 1,000 animals. There is an inferred or suspected continuing decline in population size with ongoing threats (see above).

There is a need to obtain baseline abundance data and establish seasonal patterns of distribution for *S. teuszii* in northwestern Africa, as well as to investigate the level of genetic interchange among different dolphin communities. At least two boat surveys, one each in the rainy and dry season, would need to be conducted in the estuarine and larger creek systems, and the coastal shelf waters of southern Senegal and The Gambia. Similar surveys of inshore and coastal waters are needed in Dakhla Bay and other parts of the Western Saharan and Moroccan coasts known or suspected to have humpback dolphins (Reeves et al 2003).

8. Sources (see page 285)

3.63 Stenella attenuata (Gray, 1846)

English: Pantropical spotted dolphin
German: Schlankdelphin, Fleckendelphin
Spanish: Delfín manchado
French: Dauphin tacheté

Family Delphinidae

Stenella attenuata / Pantropical spotted dolphin (© Wurtz-Artescienza)

1. Description

Pantropical spotted dolphins can be identified by their long beak sharply demarcated from the melon, slender body, strongly recurved fin and spotted body. The ventral spots fuse and fade to a medium grey, and the dorsal light spots intensify, sometimes to the point of making the animal appear nearly white above. The tip of the beak is white. Details of coloration and spot intensity vary regionally. The newborn calf is unspotted. Adults range from 166 to 257 cm and weigh up to 119 kg. Males are on average slightly larger than females. As opposed to *S. frontalis*, with which it may easily be confounded, *S. attenuata* lacks a light spinal blaze and dark ventral spots and has a dorsoventral division of the peduncle (Perrin, 2009).

2. Distribution

Stenella attenuata is distributed in tropical and warm-temperate waters around the world, from roughly 40 °N to 40°S (Jefferson et al. 1993). It ranges north to Massachusetts, the islands of Cape Verde, the northern Red Sea, Persian Gulf, Arabian Sea, Bay of Bengal, South China Sea, East China Sea, Pacific coast of northern Honshu, the Hawaiian Islands, and Baja California Sur. Vagrant to Santa Cruz County in California, and Cold Bay on the Alaska Peninsula (Rice, 1998). It ranges south to Argentina, Cape Province in South Africa, Timor Sea, New South Wales, and about southern Peru (Hammond et al. 2008).

This species varies geographically in cranial and postcranial measurements, in body size and coloration, but in most of its range, a division into subspecies has not been attempted because too few specimens are available (Rice, 1998). Of the two regocnised subspecies:

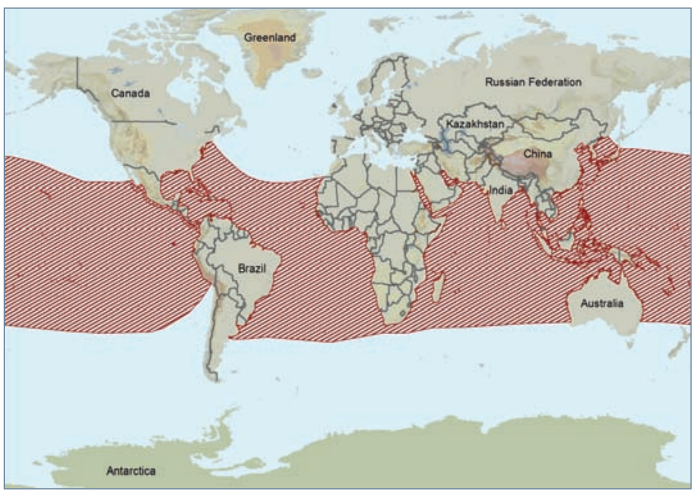
S. a. attenuata is pantropical, found in all oceans between about 40°N and 40°S, although it is much more abundant in the lower-latitude portions of its range. The range extends to some enclosed seas, such as the Red Sea and Persian Gulf, but does not include the Mediterranean Sea (Perrin 2001, 2009).

S. a. graffmani - The coastal spotted dolphin is found only in a narrow band (<200 km wide) along the coast of Latin America, from southern Mexico to Peru (Perrin 2001; Escorza-Treviño et al. 2005). Recent genetic data suggest there may be several populations contained within this subspecies (Escorza-Treviño et al. 2005).

Silva et al. (2005) describe two aberrant individuals of the genus *Stenella* from Fernando de Noronha Archipelago, tropical West Atlantic. One specimen was presumably an inter-specific hybrid between *S. longirostris* and *S. attenuata*, and the second possibly a hybrid between *S. longirostris* and *S. clymene*.

3. Population size

S. attenuata is among the most abundant dolphins in the eastern tropical Pacific (Jefferson et al. 1993). It ranks second in abundance in the deeper waters of the Gulf of Mexico, the eastern tropical Pacific and Sulu Sea, and sixth in the tropical Indian Ocean (Perrin 2009). Perrin and Hohn (1994 and refs. therein) estimated that in 1979 the population amounted to 1.7 million animals in total, a value which matches well with current estimates.



Distribution of Stenella attenuata (Hammond et al. 2008; © IUCN Red List): tropical and warm-temperate waters of the Atlantic, Pacific and Indian Oceans.

The most recent population estimates come from USA EEZ waters. In the western North Atlantic, data from two 2004 surveys yielded a joint estimate of 4,439 (CV=49%) individuals (Waring et al. 2009). In oceanic waters of the USA Gulf of Mexico, the estimate pooled from 2003 to 2004 was 34,067 (CV=0.18; Mullin 2007). This is significantly different from the 1996-2001 estimate of 91,321 (CV=0.16). However, the 2003-2004 estimate is similar to that for 1991-1994 of 31,320 (CV=0.20; Waring et al. 2009).

The 1999 estimates of absolute abundance in the eastern Pacific (Gerrodette, 1999) were 592,000 for the "north-eastern" stock, 710,000 for the "west/south" stock, and 73,000 for the "coastal" stock (*S. a. graffmani*). Corresponding values for 2003 are 737,000 for the "north-eastern" stock (CV = 14.7), 628,000 (CV = 30.9) for the western/southern offshore stock and 149,400 (CV = 26.6) for the "coastal" stock (Gerrodette et al. 2005). In Hawaiian waters, there are an estimated 8,978 (CV=48%; Barlow 2006).

In the southern part of the Sulu Sea and north-eastern Malaysian waters, Dolar et al. (1997) estimated abundance at 3,500 individuals. Dolar et al (2006) estimated about 14,930 (CV=41%) for the eastern Sulu Sea and 640 (CV=27%) for the Tañon Strait between the islands of Negros and Cebu.

Other reports are rather qualitative: *S. attenuata* was one of the most numerous species recorded off Costa Rica in the Caribbean (MayCollado et al. 2005), off the island of St Helena (McLeod and Bennett, 2007) and off Angola (Weir, 2007) in the tropical south-eastern Atlantic, off Mayotte in the Indian Ocean (Kiszka et al. 2007), and off the Marquesas Islands in French Polynesia (South Pacific; Gannier, 2002).

4. Biology and Behaviour

Habitat: In the Atlantic, *S. attenuata* is primarily a dolphin of the high seas and oceanic islands, but in the eastern Pacific a large-bodied race occurs along the coast from Mexico to Peru; it may feed on larger prey than does the oceanic form and may be an ecological counterpart of the large form of the endemic *S. frontalis* in Atlantic coastal waters (Perrin and Hohn, 1994 and refs. therein).

The pantropical spotted dolphin of the eastern Pacific inhabits the tropical, equatorial and southern subtropical water masses. The waters in which it occurs with greatest frequency are those underlain by a sharp thermocline at depths of less than 50 m and with surface temperatures over 25°C and salinities less than 34 parts per thousand. These conditions prevail year round in the region north of the Equator called the "Inner Tropical" waters of the eastern Pacific. Occurrence in this core habitat is correlated with apparent multi-species foraging and feeding behaviour. The species also occurs in closely similar waters south of the Equator that expand and contract greatly with season and year to year (Perrin and Hohn, 1994 and refs. therein).

Schooling: A "school" (all of the animals seen at one time, or captured in one purse-seine set) may consist of from just a few dolphins to several thousand. Observations of schools captured in purse seines show that they are often formed of distinct subgroups containing cow-calf pairs, adult males, or juveniles (Perrin and Hohn, 1994 and refs. therein).

Spotted dolphins in the oceanic eastern tropical Pacific aggregate with yellowfin tuna, *Thunnus albacares*. Other participants in the aggregations include spinner dolphins (*S. longirostris*), skipjack tuna (*Katsuwonus pelamis*), oceanic birds of several families, and less commonly other small cetaceans, sharks and billfish. The reason for these associations is not known but may have to do with foraging efficiency, protection from predators, orientation in the pelagic void, or some other factor or circumstance not yet understood. Tuna fishermen take advantage of the dolphin-tuna association in finding and catching tuna (Perrin and Hohn, 1994 and refs. therein).

Similarly, in the western tropical Indian Ocean (WTIO), Balance and Pitman (1998) recorded 26 mixed-species cetacean schools, 43 schools with which seabirds associated, and 17 schools associated with tuna. Notable among these were mixed aggregations of *S. attenuata*, *S. longirostris*, yellowfin tuna, and seabirds. In Hawaiian waters spinner dolphins were typically present in greater numbers than spotted dolphins with ratios as high as 75:1. Interspecific behaviours observed include aggression, copulation, and travelling (Psarakos et al. 2003).

Reproduction: Females reach sexual maturity at 9-11 years and males at 12-15 years. Gestation lasts approx. 11.5 months (Perrin, 2009). Spotted dolphins begin to take solid food at approximately 6 months of age, or 115 cm, but continue to suckle until they are nearly 2 years old. Calves tend to feed more frequently on squid as they get older, which suggests there is a shift in diet during weaning. The average age and total body length at weaning is estimated to be 0.8 yr and 122 cm. The oldest suckling calf was almost 2 yr old (Archer and Robertson, 2004).

Food: The prey of the pantropical spotted dolphin is made up primarily of small epipelagic fish, squid and crustaceans, with some take of mesopelagic animals (Perrin and Hohn, 1994 and refs. therein). In the eastern tropical Pacific, significant differences in prey composition by season and geographic region indicate that they are flexible in their diet and may be opportunistic feeders.

Identified prey include 56 species of fish and 36 species of cephalopods (Roberston and Chivers, 1997). The most frequently found fish were lanternfish (family Myctophidae) at 40%, and the most frequently found cephalopods were trying squids (family Ommastrephidae) at 65 %. The dominance of these primarily mesopelagic prey species and a significantly higher stomach fullness index for stomachs collected during the morning hours suggest that pantropical spotted dolphins feed at night when many mesopelagic species migrate toward the surface: Near the islands of Maui and Lana'i, Hawai'I, dives at night were deeper (average 57.0 m, maximum depth 213 m) than during the day (average 12.8 m, maximum depth 122 m), and swim velocity also increased after dark.

Together with the series of deep dives recorded immediately after sunset this suggests that pantropical spotted dolphins feed primarily at night on organisms associated with the deep-scattering layer as it rises up to the surface after dark (Baird et al. 2001).

Off eastern Taiwan, mesopelagic prey species also dominate the stomach contents. Sixty-four species of fish made up 67.5% and 21 species of cephalopods made up 32.5% by number. Myctophid lanternfishes and enoploteuthid squid accounted for 78.3% of all prey consumed. The enoploteuthid squid *Enoploteuthis chunii* was the primary prey and represented 25.8% by number of the total prey, with an overall occurrence of 66.7% (Wang et al. 2003).

5. Migration

In the pelagic eastern tropical Pacific (ETP), Reilly (1990) studied large-scale patterns of dolphin distribution and oceanography from research-vessel surveys. The species was sighted in abundance west of 120°W along 10°N coincident with seasonal shoaling of a thermocline ridge. Highest-density areas for the different species were clearly separated spatially, and the thermocline depths surface temperatures of sighting localities were statistically different between spotted/spinner dolphin schools and common dolphin schools.

Tagging experiments in the ETP show that movements of pantropical spotted dolphins may generally be onshore in fall and winter and offshore in late spring and summer. The minimum distance travelled by the tagged animals ranged from 7 to 582 nautical miles (Reyes, 1991, and refs. therein). Offshore spotted dolphins may be found as close to the coast as 16 nautical miles, where they overlap with the coastal form (Reyes, 1991, and refs. therein). A recent radio-tracking study shows that the animals associate with areas of relatively high biological productivity. The movement data suggest that close to shore the dolphins move along the continental slope, while some dolphins travel farther offshore along thermocline 'ridges' (Scott and Chivers, 2009).

Seasonal migrations have been observed for the population in the coastal waters of Japan. Here, spotted dolphins move north in summer and probably concentrate at the northern boundary of the Kuroshiro current. In winter they move south, reaching a migration peak in late October and early November (Reyes, 1991, and ref. therein).

6. Threats

Direct catches: Only Japan takes large numbers of spotted dolphins for human consumption in drive and harpoon fisheries. The catch in 1982 was 3,799, and annual catches between 1995 and 2004 averaged 129 (Kasuya, 2007). The drive fishery for spotted dolphins began in 1959 and is thought to have caused a slight decline in the minimum age attainment of sexual maturity in females. Pantropical spotted dolphins are also taken in hand-harpoon fisheries in the Philippines, Laccadive Islands and Indonesia and Sri Lankan gillnet and harpoon fisheries (e.g. Dolar et al. 1994). A drive fishery at Malaita in the Solomon Islands took several hundred or thousands of spotted dolphins annually in the 1960s and still operates. Small numbers are taken in numerous small subsistence fisheries for dolphins and whales around the world, e.g. at St Vincent in the Lesser Antilles (Perrin and Hohn, 1994 and refs. therein).

Incidental catches: The tuna fishery in the eastern tropical Pacific targets the pantropical spotted dolphin to catch yellowfin and skipjack tuna that often swim below the herds. This ecological association of tuna and dolphins is not clearly understood (Gerrodette, 2002). Wade (1995) estimated that 4.9 million dolphins were killed by the purse-seine fishery over the fourteen-year period 1959-72, an average of 347,082 per year. Nearly all of the fisheries kill of pantropical spotted dolphins was of the northeastern stock, totalling 3.0 million (211,612 per year). In the early 1990's, the kill declined to around 15,000 due to improved rescue techniques (Perrin and Hohn, 1994 and refs. therein).

Although tuna and dolphins are still herded and captured together in the net, the crew attempt to release the dolphins by a procedure called "backdown," while utilising various dolphin safety gear. Though a great majority of the dolphins are released unharmed, some die during the fishing operation. The Tuna-Dolphin Program of the Inter-American Tropical Tuna Commission (IATTC) is charged with monitoring this incidental mortality, studying its causes, and encouraging fishermen to adopt fishing techniques which minimise it. Analyses of observer data show that many factors cause dolphin mortality, such as fishing areas; dolphin species and herd sizes; environmental factors; gear malfunctions; and crew motivation, skill, and decision-making. A combination of major and minor technological developments, training in their use, better decision-making skills, and constant pressure to improve performance led to a significant progress: since 1986, dolphin mortality has been reduced by 97% (Bratten and Hall, 1997). Recently, a series of factors such as the presence of hazardous net conditions (net canopies and net collapses), the duration of the backdown procedure (the primary method of releasing dolphins from the net), the size and species composition of the encircled dolphin herd and the amount of tuna encircled, were all found to require improvements in order to consistently reduce dolphin mortality per set (Lennert-Cody et al. 2004).

Gosliner (1999) reported that as the US brought dolphin mortality by its fishermen under control in the 1980's, the numbers of dolphins being killed again skyrocketed as a shrinking US fleet was replaced by those from Mexico, Venezuela, and other nations. Through the use of trade sanctions, and ultimately international co-operation, dolphin mortality was reduced to levels believed to be biologically insignificant by 1997 (0 dolphins in US fishery, ca. 3,000 in non-US fisheries). Since the Inter-American Tropical Tuna Commission (IATTC) implemented per-vessel mortality limits on the international fleet, the combined annual mortality for all spotted dolphins in the ETP has decreased greatly, e.g. to 373 in 2005 (IATTC 2006).

The estimates for offshore spotted dolphin mortalities in 2007 are 187 animals of the northeastern, 116 of the west-southern and 6 of the coastal stocks a total of 309 animals (IATTC, 2009).

Nevertheless, the use of dolphins to locate and catch tuna will remain controversial as long as any of these cetaceans are killed or injured in the process (Gosliner, 1999). Gerrodette (2002) stated that by 1999, there was no clear indication of a recovery for northeastern offshore spotted dolphins, and the same assessment was repeated in 2005. Possible reasons include underreporting of dolphin bycatch, effects of chase and encirclement on dolphin survival and reproduction, long-term changes in the ecosystem, and effects of other species on spotted dolphin population dynamics (Gerrodette and Forcada, 2005).

The intense fishing pressure on tuna supports these hypotheses: Schools of 1,000 or more dolphins are estimated to be set on approximately once a week each on average, but such schools are estimated to represent just under one tenth of the animals in the northeastern offshore stock. Schools set on most often by tuna purse-seiners, containing from about 250 to 500 dolphins, are estimated to be set on between two and eight times each per year and are estimated to include approximately one third of the stock. An estimated one half of the stock occurs in schools smaller than 250 animals; schools of this size are estimated to be set on less than twice per year each (Perkins and Edwards, 1999).

Aerial photographs taken between 1987 and 2003 show that the proportion of adults with calves decreased steadily from 1987 to 2003. Annual number of purse-seine sets on dolphins is a predictor of both proportion with calves and length at disassociation. Because northeastern pantropical spotted dolphins are the main species targeted by the fishery, the link between fishing activity and both measures of reproductive output indicates that the fishery still has population-level effects beyond reported direct kill (Cramer et al. 2008; Wade et al. 2007; Archer et al. 2004).

In other regions fisheries-related mortality is far less important:

in the Hawaii-based longline fishery annual mortality and serious injury for during 1994-2005 included one pantropical spotted dolphin (Forney and Kobayashi, 2007).

In gillnet fisheries off Zanzibar (Unguja Island), from January 2000 to August 2003, 6 (4%) pantropical spotted dolphins were recorded in 12 landing sites (Amir et al. 2005).

There has been no reported fishing-related mortality during 1998-2006 in the US Gulf of Mexico EEZ. Total annual estimated average fishery-related mortality or serious injury to the western North Atlantic US EEZ stock during 2001-2005 was 6 (CV=1) undifferentiated spotted dolphins. (Waring et al. 2009).

Yang et al. (1999) reported incidental mortality from Chinese fisheries, and Dolar et al. (1997) found that 4 of the 7 fishing villages surveyed in the Philippines reported directed and/or incidental spotted dolphin takes.

Culling: Dolphins and small whales of several species, including *S. attenuata*, interfere in hook-and-line fisheries for squid and yellowtail in the Iki Island region of Japan. Bounties have been paid to fishermen for dolphins killed since 1957. During the period 1976-1982 a total of 538 spotted dolphins were killed. The effect of these takes on the population is not known (Perrin and Hohn, 1994 and refs. therein).

Pollution: André (1988, in Perrin and Hohn, 1994) and André et al. (1990a, 1990b) reported levels, somatic distribution, and age-related changes in levels of Hg, Cd, Cr, Cu, Mn, Ni, Se, Zn, sDDT and PCBs in pantropical spotted dolphins from the eastern Pacific. Calmet et at. (1992, in Perrin and Hohn, 1994) reported levels of radioactive isotopes of Pb, Cs and K in the same specimens. Cockcroft et at. (1991, in Perrin and Hohn, 1994) reported levels of seven organochlorine chemicals in four specimens from Natal. In the waters of the Coiba archipelago, Panama, blubber levels of HCB (hexachlorobenzene), tPCB (polychlorinated biphenyls) and tDDT (dichlorodiphenyl-trichloroethane) were 0.064, 2.30 and 6.4 mg / kg respectively. These levels are low and are not considered to represent a threat to the *S. attenuata* population (Borrell et a. 2004). In Taiwanese waters of the Taiwan Strait, muscle samples from specimens collected in 1994-95 showed the highest mean concentration (mg/kg wet wt.) of both total mercury (3.64 mg/kg wet wt) and organic-Hg (2.79 mg/kg; Chen et al. 2002).

7. Remarks

Range states (Hammond et al. 2008): American Samoa; Anguilla; Antigua and Barbuda; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil; Brunei Darussalam; Cambodia; Cameroon; Cape Verde; Cayman Islands; China; Cocos (Keeling) Islands; Colombia; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Cuba; Djibouti; Dominica; Dominican Republic; Ecuador; El Salvador; Equatorial Guinea; Fiji; French Guiana; French Polynesia; Gabon; Gambia; Ghana; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Jamaica; Japan; Kenya; Kiribati; Liberia; Madagascar; Malaysia; Maldives; Marshall Islands; Martinique; Mexico; Micronesia, Federated States of; Morocco; Mozambique; Myanmar; Namibia; Nauru; Netherlands Antilles; New Caledonia; New Zealand; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Puerto Rico; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Sudan; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; USA; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen.

The eastern tropical Pacific and south-eastern Asian populations of *S. attenuata* are listed in Appendix II of CMS. The species is listed as "Least Concern" by the IUCN Hammond et al. 2008). The species is listed in Appendix II of CITES.

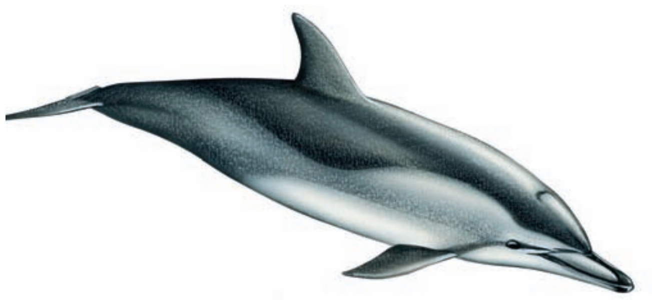
The species also occurs in southern South America, so please see Hucke-Gaete (2000) for further recommendations in Appendix 1. General recommendations on Southeast Asian stocks can be found in Perrin et al. (1996) in Appendix 2.

8. Sources (see page 285)

3.64 **Stenella clymene** (Gray, 1850)

English: Clymene dolphin
German: Clymene-Delphin
Spanish: Delfín Clymene
French: Dauphin de Clymène

Family Delphinidae



Stenella clymene / Clymene dolphin (© Wurtz-Artescienza)

1. Description

The Clymene dolphin is small but rather stocky and has a moderately long beak. The dorsal fin is tall and nearly triangular to slightly falcate, and flippers and flukes resemble those of other members of the genera *Delphinus* or *Stenella*. The coloration is tripartite: the belly is white, the flanks are light grey and the cape is dark grey. There is a dark grey line running down the length of the top of the beak, but the most distinctive feature is a black "moustache" marking of variable extent at the top of the beak. With this exception, most of this species' external characters are very similar to those of the spinner dolphin. Body size reaches 170-190 cm in females and 176-197 cm in males, and maximum body mass recorded was 80 kg (Jefferson, 2009).

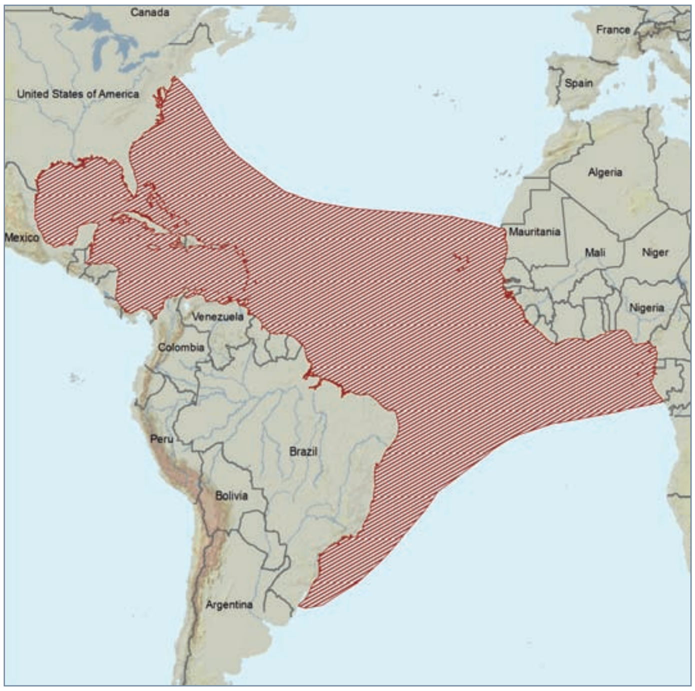
2. Distribution

The Clymene dolphin is found in tropical and warm temperate waters of both the North and South Atlantic Oceans. The northernmost records are from New Jersey (39°17'N) in the western Atlantic and from Mauritania (16° 13'W) in the eastern Atlantic. The southernmost record on the west is from southern Brazil (29°58'S), in the central Atlantic at 3°40'S off Ascension Island (Fertl et al. 2003), and in the east near northern Angola (7°S, Weir, 2006). It can be expected to occur along the eastern seaboard of the United States, throughout the Gulf of Mexico and Caribbean, along the north-eastern coast of South America, throughout the equatorial Atlantic and along the entire tropical coast of West Africa (Perrin and Mead, 1994).

3. Population size

The scarcity of records of this species indicates that the Clymene dolphin may not be very abundant, at least in coastal waters. Considering the difficulty of distinguishing it from similarly marked species at sea, however, it may not be as rare as it would seem to be (Perrin and Mead, 1994). The best recent abundance estimate for the western North Atlantic is 6,086 animals (CV = 0.93; Mullin and Fulling 2003). No Clymene dolphins have been observed in subsequent surveys (Waring et al. 2007). The best available abundance estimate for the northern Gulf of Mexico in oceanic waters, pooled from 2003 to 2004, was 6,575 (CV=0.36; Mullin 2007).

Based on capture records, *S. clymene* appears to be the most common cetacean in Ghana's coastal waters, but no individual stocks have been distinguished on the coasts of West Africa (Van Waerebeek et al. 2000 and refs. therein). However, new West African specimens of *S. clymene* are evidence that the present unequal distribution of this species in the western and eastern parts of the tropical North Atlantic could be an artefact of poor sampling in African waters (Robineau et al. 1994).



Distribution of Stenella clymene (Hammond et al. 2008; © IUCN Red List): the species prefers the tropical, subtropical and occasionally the warm temperate waters of the Atlantic Ocean.

4. Biology and Behaviour

Habitat: Clymene dolphins were found in waters with bottom depths ranging from 44 to 4500 m (mean = 1870 m). A single sighting reported at a location with a bottom depth of 44 m is considered to be atypical, as this species has an otherwise exclusively oceanic distribution (Perrin and Mead, 1994, and refs. therein; Fertl et al. 2003).

Schooling: Group sizes range from at least one individual in a mixed-species school of spinner dolphins *S. longirostris* to a group of an estimated 1,000 animals (mean = 71). Stranding group size range from 1 to 46 individuals, with single individuals being most common. There is information available for seven mass strandings, all of which occurred in the south-eastern USA (Fertl et al. 2003)

Watkins and Moore (1982, in Perrin and Mead, 1994) observed groups of 1-10 animals around St Vincent in the Caribbean. The Clymene dolphins were swimming in close association with schools of spinner dolphins but remained clustered together and did not approach the vessel as closely as the spinners did. Three groups of Clymene dolphins seen off the US coast consisted of three, eight and 15 animals. Perrin and Mead (1994) also reported that schools of this species may be segregated by sex and age; three mass strandings in Florida were of two females with calves, three adult males, and six adult males. Of 47 specimens from a mass stranding in Louisiana in 1985, 43 were males (164-197cm), two were females (155 and 168cm, probably immature) and two were of unknown sex.

A school off West Africa consisted of approximately 50 dolphins. Schools of this species have also been seen in the company of common dolphins (*Delphinus delphis*) off West Africa (Perrin and Mead, 1994, and refs. therein).

Food: Clymene dolphins may be night feeders on small fish and squids. The stomach of one stranded specimen contained one pair of small squid beaks (unidentified) and over 800 very small otoliths of fishes of the families Myctophidae, Argentinidae and Bregmacerotidae. Most of the species represented are mesopelagic but known to reach the surface at night during the course of vertical migrations. One myctophid (*Lampanyctus* sp.) usually does not occur in surface waters even at night (Perrin and Mead, 1994, and refs. therein). As opposed to this, Fertl et al. (1997) report on Clymene dolphins feeding during the daytime in a co-ordinated manner on schooling fish in the Gulf of Mexico in waters 1,243 m deep.

5. Migration

Unknown.

6. Threats

Direct catches: Clymene dolphins were taken by harpoon in small numbers in a subsistence fishery at St Vincent in the Lesser Antilles (Perrin and Mead, 1994 and refs. therein). Off the coast of West Africa, this species is possibly one of several taken in large numbers in tuna purse seines in the Gulf of Guinea (Van Waerebeek et al. 2000).

Incidental catch: They were captured incidentally in gillnets in Venezuelan waters and utilised for longline shark bait and for human consumption (Perrin and Mead, 1994 and refs. therein). They may be one of the species taken in tuna purse seines in the eastern tropical Atlantic (Jefferson et al. 1993) and have been recorded from by-catches in Brazilian fisheries (Zerbini and Kotas, 1998). Annual estimated fishery-related mortality and serious injury to the US western Atlantic and the northern Gulf of Mexico stocks during 2001-2005 were zero, as there were no reports of deaths or serious injury to Clymene dolphins (Waring et al. 2007).

Pollution: Contaminant levels have not been recorded (Jefferson and Curry, 2003).

7. Remarks

Range states (Hammond et al. 2008): Antigua and Barbuda; Bahamas; Barbados; Belize; Brazil; Cameroon; Cape Verde; Cayman Islands; Côte d'Ivoire; Dominica; Gabon; Ghana; Guinea; Honduras; Jamaica; Mauritania; Mexico; Netherlands Antilles; Puerto Rico; Saint Helena; Saint Vincent and the Grenadines; Senegal; Sierra Leone; USA; Venezuela.

The Clymene dolphin is listed as "Data Deficient" by the IUCN. The West African population is listed in Appendix II of CMS. The species is listed in Appendix II of CITES.

The species is poorly known with respect to biology, life history, distribution and migratory habits. Further research on all aspects of its biology is needed. Sightings at sea suggest a wide home-range, and individuals or groups thus may cross many international boundaries, especially in the Caribbean. Therefore, full inclusion in Appendix II of CMS should be considered.

See further recommendations in Hucke-Gaete (2000) in Appendix 2.

8. Sources (see page 287)

3.65 Stenella coeruleoalba (Meyen, 1833)

English: Striped dolphin, blue-white dolphin
German: Blau-Weißer Delphin
Spanish: Delfín listado
French: Dauphin bleu et blanc, dauphin rayé

Family Delphinidae

Stenella coeruleoalba / Striped dolphin (© Wurtz-Artescienza)

1. Description

The species name "coeruleoalba" refers to the pattern of blue/dark-gray and white stripes and blazes along the lateral and dorsal sides of the body. The dorsal cape is muted blue or blueish-grey, usually invaded by a white to light grey spinal blaze. The sides are darker than the belly. Striped dolphins have a long beak, well demarcated from the melon and falcate dorsal fin. In the field, they are most likely confused with common dolphins (*Delphinus delphis*) and other similar-sized species but can be distinguished by their robust body and coloration. The largest recorded specimen was 2.56 m long and the maximum weight recorded was 156 kg. Mean body length in the western Pacific is 2.4 m for males and 2.2 m for females (Archer, 2009).

Striped dolphins show only moderate geographical variation in skeletal morphometrics and little if any geographical variation in pigmentation pattern. However, several authors found slight but significant differences in body size between local populations in the eastern North Atlantic, the northwestern Mediterranean, and the southwestern Mediterranean (Rice, 1998). MtDNA and microsattelite differentiation suggests that NE-Atlantic striped dolphins form a separate population from the Mediterranean population (Garcia-Martinez et al. 1999; Bourret et al. 2007).

2. Distribution

The striped dolphin is distributed world-wide in tropical and temperate waters. It ranges north in the Atlantic to Newfoundland, northern Scotland, and Denmark; in the Mediterranean Sea; and in the Pacific to the Sea of Japan, Hokkaido, about 40°N across the western and central Pacific, and British Columbia (Canada). The southern limit of its range is in Argentina, Cape Province of South Africa, Southern Australia, New Zealand, and Peru (Archer and Perrin, 1999; Hammond et al. 2008).

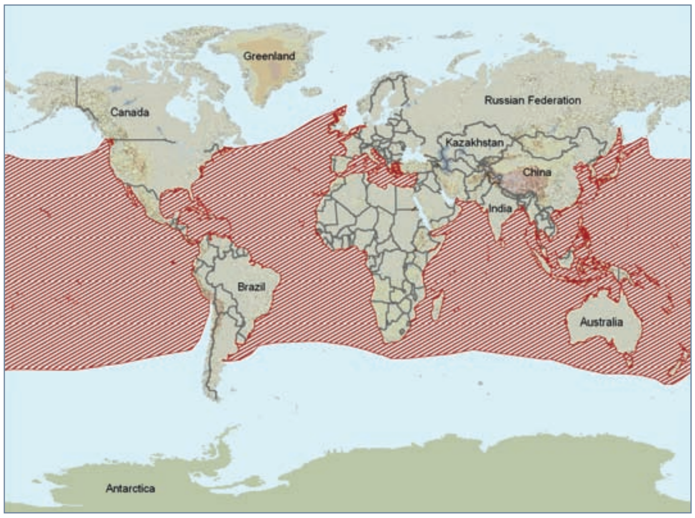
Although Perrin et al (1994) stated that it is not a common inhabitant of cold boreal waters as previously claimed, there are coldwater records, e.g. from Greenland and the Faroe Islands, and Syvertsen et al. (1999) and Isaksen and Syvertsen (2002) reported sightings/strandings from the Norwegian and Swedish coasts. Vagrants have even been recorded as far north as from Komandorskiye Ostrova (Rice, 1998).

3. Population size

Würsig et al. (1998) assessed cetacean responses to survey ships and aircraft and found that *S. coeruleoalba* avoided ships in 33 % of sightings. This indicates that density estimates for this species may tend to be biased downwards.

In the western Atlantic Ocean, the most recent estimate of abundance for striped dolphins in oceanic waters of the Northern Gulf of Mexico (US EEZ) pooled from 2003 to 2004, is 3,325 animals (CV=0.48; Mullin 2007). This value is not statistically different from the 1996-2001 estimate of 6,505 (Waring et al. 2009).

In the eastern Atlantic Ocean, the Bay of Biscay population size was estimated at 74,000 animals in 1993 (Goujon, 1996)



Distribution of S. coeruleoalba (Hammond et al. 2008; © IUCN Red List): warm temperate, subtropical, and tropical waters around the world.

and more recently at 56,500 (95 % CI 29 100-90 400) in 2002 (Certain et al. 2008).

In the central Mediterranean, striped dolphins were the most abundant species (43.5 %) observed during surveys (Perrin et al. 1994, Reyes, 1991 and refs. therein). In the waters of the central Spanish Mediterranean coast, 2001 - 2003 estimates yield a mean abundance of 15,778 dolphins (95% CI = 10,940-22,756). This density is comparable to that obtained in the International Ligurian Sea Cetacean Sanctuary (Gomez et al. 2006). In the southern Tyrrhenian Sea around the Aeolian archipelago the 2003 estimate was 4,030 individuals (CV=0.30; Fortuna et al. 2007).

In the Pacific Ocean, the preliminary 2003 estimate of abundance for the 2001-2005 striped dolphins is 1,470,854 (CV=0.15) animals (Gerrodette et al. 2005). Geometric mean abundance estimate for California, Oregon and Washington waters based on the 2001 and 2005 ship surveys is 17,925 (CV=0.37) striped dolphins (Forney 2007).

A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 10,385 (CV=0.48) striped dolphins (Barlow 2003). This is currently the best available abundance estimate for this stock.

In the western North Pacific, most recent estimates are dated (Hammond et al. 2008) and stem from the 1980's: 570,000 (CV = 0,19) striped dolphins occurred there (Miyashita, 1993). Two areas of concentration were identified, comprising about 52,682 animals (CV = 95%) between 20° and 30°N and around 497,725 (CV = 18%) animals between 30° and 40°N. Relatively few striped dolphins (about 19,631; CV = 70%) were present in the nearshore waters off Japan. However, there is clear evidence that there has been a decline since the 1950's as a result of stock depletion by over-hunting (Kasuya 1999). They are uncommon in the Sea of Japan, East China Sea and Ryukyuan waters (Reyes, 1991).

There is very little data from other areas of distributional range: Ballance and Pitman (1998) found that *S. coeruleoalba* was the second-most abundant species sighted in the western tropical Indian Ocean (14% of all cetaceans, compared to 33% for the eastern tropical Pacific and 10% for the Gulf of Mexico). Striped dolphins are also reported from the coast of Angola (Weir, 2007).

4. Biology and Behaviour

Habitat: Striped dolphins are pelagic animals. In the Pacific waters off Japan, they are found in three geographical aggregations in the summer, between 20 °N and 42 °N. Occurrence is seasonal in the northern part of the range (Kasuya, 1999). In the eastern Pacific, they prefer areas with large seasonal changes in surface temperature and thermocline depth and with seasonal upwelling (Reyes, 1991).

In western North Atlantic waters, striped dolphins seem to be confined to the Gulf Stream or the waters off the continental slope (Davis et al. 1998). Along the Mid-Atlantic Ridge from Iceland to the Azores they inhabit warmer (12-22 °C) and more-saline (34.8-36.7 psu) waters in the south (Doksaeter et al. 2008). In the eastern North Atlantic, as well as off South Africa they are found in deep water (> 1,000 m) past the continental slope (Perrin et al. 1994 and refs. therein). In the Strait of Gibraltar and in the Mediterranean they prefer waters of 600 m or more depth (Hashmi, 1990; Reyes, 1991; Bourreau and Gannier, 2003).

Schooling: Schools are of varying size and composition. Of 45 schools examined from off the coast of Japan, most (86%) contained fewer than 500 individuals. The mean school size was 101 animals. Schools moving south with the retreating front of the Kuroshio Current are larger than those moving north earlier in the year. Schools in the eastern North Atlantic more commonly have 10-30 individuals and rarely reach the hundreds. In the western Pacific, three major types of schools are recognised: juvenile, adult and mixed, the latter being divided into breeding and non-breeding schools. Juvenile schools may migrate closer to the coast than adult and mixed schools. Calves remain in adult schools until 1 or 2 years after weaning and then leave to join juvenile schools (Perrin et al. 1994 and refs. therein).

Food: Feeding depth may extend to below 200 m and down to 700 m (Archer, 2009); 75-80 % of the prey in Japanese and South African specimens had organs of luminescence. Individual fish in the stomachs of the animals captured off Japan ranged in length from 60 to 300 mm (Perrin et al. 1994 and refs. therein; Santos et al. 2001a, 2001b). Myctophid fish predominate in specimens from Japan and South Africa whereas in dolphins stranded on the Mediterranean coasts of France, Spain, and Italy, cephalopods dominate in the stomach contents. Blanco et al. (1995) found that the cephalopods *Albraliopsis pfefferi*, *Onychoteuthis banksii*, *Todarodes sagittatus* and *Brachioteuthis riisei* were dominant in stomach samples from the western Mediterranean. In the eastern Mediterranean Sea off the Turkish coast, the cephalopod *Abralia veranyi* was the most common prey (51.2 % of all the beaks found in this species), followed by *Onychoteuthis banksii* and *Heteroteuthis dispar*. The stomachs also contained remains of fish and shrimp (Özturk et al. 2007).

In the oceanic waters of the Northeast Atlantic, the diet was found to be primarily composed of fish (39 % by mass) and cephalopods (56 %) and less of crustaceans (5 %). The most significant fish family identified was the lanternfish (24 %). The oceanic squid *Teuthowenia megalops* and *Histioteuthis* spp. were the most significant. The pelagic shrimp *Sergastes arcticus* and *Pasiphaea multidentata* were the most prevalent crustaceans. Prey sizes ranging from 30 to 170 mm accounted for 80 % of the prey items, while 80 % of the reconstituted biomass consisted of prey measuring between 60 and 270 mm. Prey composition and size-range differed slightly with sex and age or body size of the dolphins. The state of digestion of food remains suggest that predation took place at dusk or during the early hours of the night (Ringelstein et al. 2006). In the Bay of Biscay, striped dolphins are able to shift from vertically migrating meso-pelagic prey to neritic or coastal prey types (Spitz et al. 2006). The diet of striped dolphins also varies according to food availability both in terms of quantity and composition, reflecting changes in the relative abundance of fish species (Spiz et al. 2003).

5. Migration

While in some regions (e.g. portions of the US east coast) striped dolphins are encountered in all seasons, they elsewhere appear to be associated with the fronts of warm oceanic currents that move seasonally and produce sporadic warm-water intrusions and meanders. In Japanese waters, the species is associated with the northern boundary of the warm Kuroshio Current, which extends up to 46°N in the summer and retreats to 33°N in the winter. It appears earlier in the season than *S. attenuata*, consistent with the hypothesis that the latter is the more tropical (Perrin et al. 1994 and refs. therein). Striped dolphins approach the coast in September and October and move southward along the coast, apparently dispersing into the East China Sea for the winter. In April they return along roughly the same route, but farther offshore. Eventually they leave the coast to summer in the pelagic North Pacific. Segregation by age is observed (Reyes, 1991).

Seasonal movements may also occur in the Mediterranean. The dolphins move towards the northern part of the basin as sea surface temperatures in the southern part increase. Between the French mainland and Corsica, data obtained 2001-2004 show that relative abundance peaks in May and September, while a consistent minimum is obtained from December to April (Laran and Drouot-Dulau, 2007). Sighting data also suggest seasonal movements of this species in the eastern tropical Pacific (Perrin et al. 1994; Reyes, 1991 and refs. therein).

In the Ligurian Sea of the French Riviera, there are also diurnal offshore-inshore movements. Night acoustic results show the presence and intense feeding activity of striped dolphins close to the shelf break. Day distribution shows a marked preference for the open sea (Gannier, 1999).

6. Threats

Direct catch: The largest direct catches have been taken in Japanese waters, in drive and hand-harpoon fisheries at several locations. The catches were voluntarily reduced beginning in 1981 and have since varied between 358 (in 1987) and 4,883 (1981), averaging 2,830 during the period 1981-89. Between 1989 and1993, the average annual catch was 1,028.

Kasuya (1999) reported that Japanese multispecies dolphin fisheries received an annual quota of 725. Ten years later, striped dolphins continue to be caught in Japan. In the Wakayama prefecture, 86 were landed by hand-harpoon and 384 by driving fisheries in 2007. The quota for 2007/2008 was set at 685 dolphins (Iwasaki, 2008). Fragmented information on morphology, life history, pollutant levels and genetics suggests that the striped dolphins taken by Japanese fisheries are from more than one population, with varying proportions among fisheries and perhaps over time (Kasuya, 1999).

Striped dolphins are also taken in the drive fishery at Malaita in the Solomon Islands and in the harpoon fishery for small cetaceans at St Vincent. Other such small indigenous fisheries may exist elsewhere. Small numbers were taken by French and Spanish fishermen for human consumption in the Mediterranean (Perrin et al. 1994 and refs. therein; Jefferson et al. 1993).

In the Northeast Atlantic, striped and common dolphins were harpooned to supply food for consumption on board or to scare them away from tuna trolling lines. It is difficult to ascertain the number of dolphins taken in this way, but it has been estimated in the thousands (Reyes, 1991).

Incidental catch: Incidental catches are known to occur in gillnets in the north-eastern Indian Ocean, in tuna purse seines in the eastern tropical Pacific, in fisheries in the northeastern Atlantic, in drift nets, purse seines and other gear in the Mediterranean, in various gear off the coast of Japan, and in drift gillnets in the North Pacific, and probably occur in similar fisheries in tropical and warm-temperate waters around the world. Although rare on these coasts, striped dolphins have also been caught in shark nets in Natal and South Africa (Perrin et al. 1994 and refs. therein).

Recently, the Inter-American Tropical Tuna Commission estimated that 6 striped dolphins were caught as by-catch in the 2007 purse-seine tuna fishery (IATTC, 2009). There has been no reported fishing-related mortality during 1998-2006 in the US waters of the Northern Gulf of Mexico or off the northeast U.S. coast (Warring et al. 2009). Similarly, no striped dolphins were observed killed in the most recent five-year period in eastern Pacific US waters (Carretta et al. 2009).

Elsewhere, the news are less good. Despite a UN moratorium on the use of drift-nets in the high seas and a ban in the Mediterranean by all European Union countries, some fisheries continue to operate illegally. In 2002 and 2003 line-transect surveys conducted in the southern Tyrrhenian Sea around the Aeolian archipelago estimated the striped dolphin by-catch as 36 by-caught animals over a period of only 12 days. These results are a cause for concern (Fortuna et al. 2007). According to international official sources, Morocco harbors the bulk of this fleet in the Mediterranean. Between 2002 and 2003 the driftnet fleet targeting swordfish (*Xiphias gladius*) based in Al Hoceima (Alboran Sea) consisted of at least 177 units with estimated average net lengths ranging from 6.5 to 7.1 km. This fleet causes estimated by-catch mortality of 3,110-4,184 common and striped dolphins per year, and annual take rates exceed 10% of their population sizes in the Alboran Sea (Tudela et al. 2005).

Antoine et al. (2001) estimated that by-catches in the tuna drift-net fishery in the Northeast Atlantic were to 90% composed of *Delphinus delphis* and *S. coeruleoalba*. Mean catch rate by trip in the years 1992-1993 were 4.7 striped dolphins per km of net and per day. Such rates are similar to those estimated in other driftnet fisheries. Goujon (1996) estimated the annual additional mortality linked to the driftnets in the Bay of Biscay albacore tuna fishery to 1.8% for the striped dolphin (this estimate must be increased by 30% in order to take into account the whole European albacore tuna driftnet fishery). The extrapolated decadal scale data from Irish and other driftnet fleets operating in this area suggest that during the period 1990-2000, a minimum of 12,635 (10,009-15,261) striped dolphins were killed as by-catch (Rogan and Mackey, 2007). Unfortunately, acoustic deterrents developed for harbour porpoise (*Phocoena phocoena*) show no effect on striped dolphins (Kastelein et al. 2006).

In the Southwest Atlantic, off Brazil, by-catch of *S. coeroleoalba* was also noted (Zerbini and Kotas, 1998).

Overfishing: The European anchovy is the most heavily exploited pelagic resource in the Mediterranean, where some other stocks of pelagic fish are already over-exploited. Since striped dolphins are reported to eat anchovies and sardines in the area, this could eventually become either a source of conflict with the commercial fisheries or a potential threat for dolphin populations (Reyes, 1991). The 1990-1992 epizootic devastated the whole Mediterranean population; over one thousand corpses were examined in the western Mediterranean alone, but the toll was probably much higher. The causative agent of the die-off was a morbillivirus, but the effect of some pollutants and decreased food availability were suggested as triggering factors. Depletion of fish and cephalopod resources is widespread in the Mediterranean and, given that the diet of striped dolphins includes commercial species, this undoubtedly has a potential for limiting population numbers (Aguilar, 2000).

Pollution: Contaminants have been studied more intensively in this species than in any other cetacean. A long series of papers has reported the levels, accumulation rates, distribution, relationships and transfer dynamics of organochlorine compounds and heavy metals in striped dolphins taken in the Japanese drive fishery or washed ashore as by-catch in the Mediterranean.

In Japanese samples, increasing trends of PBDEs and HBCDs were observed, suggesting a growing pollution in Japan and surrounding countries in recent years (Isobe et al. 2009).

In European waters, decreasing lead concentrations in tissues reflect the decrease in the production of alkyl lead and the increasing use of unleaded gasoline (Caurant el al., 2006). Similarly, concentrations of PCBs, DDT and its metabolites have slowly decreased, although the decline in PCB has been steeper than that of DDT, suggesting that the offshore marine environment has not been exposed to significant releases of these contaminants in recent years (Aguilar and Borell, 2005; Wafo et al. 2005). However, the detected levels reflect the ubiquity and environmental persistence of these compounds.

Other studies revealed high levels of mercury in striped dolphins from the Ligurian, Adriatic, and Thyrrenian Seas (Cardellicchio, 2000). Monaci et al. (1998) found that mercury levels were higher in tissues from animals stranded on the Italian coasts and in skin biopsies obtained in the Tyrrhenian and Ligurian Seas than in the respective Spanish samples. This is probably related to Hg pollution from the natural weathering of cinnabar ores in central Italy. Geographical differences in trace-element accumulation patterns may also reflect the existence of two different populations of *S. coeruleoalba* in the western Mediterranean.

According to Aguilar (2000) tissue levels of organochlorine compounds, some heavy metals and selenium are high in Mediterranean samples and exceed threshold levels above which detrimental effects commonly appear in mammals. However, apart from the indication that these levels may have acted as triggering factors in the 1990-1992 epizootic by depressing the immune system of diseased individuals and potential lesions in the ovaries, no information on pollutant-related effects is available.

Noise pollution: Observations undertaken during seismic surveys employing airguns in UK and adjacent waters show a clear effect on several dolphin species. Small odontocetes showed the strongest lateral spatial avoidance (extending at least as far as the limit of visual observation) in response to active airguns (Stone and Tasker, 2006). In 2005, there was a series of stranding events throughout Taiwan, involving several species including striped dolphins, which was linked to navy exercises using sonar (Wang and Yang, 2006).

7. Remarks

Range states (Hammond et al. 2008): Algeria; American Samoa; Anguilla; Antigua and Barbuda; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil; British Indian Ocean Territory; Brunei Darussalam; Cambodia; Cameroon; Canada; Cape Verde; Cayman Islands; China; Cocos (Keeling) Islands; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Cuba; Cyprus; Denmark; Djibouti; Dominica; Dominican Republic; Ecuador; El Salvador; Equatorial Guinea; Ethiopia; Fiji; France; French Guiana; French Polynesia; Gabon; Gambia; Germany; Gibraltar; Greece; Greenland; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Ireland; Israel; Italy; Jamaica; Japan; Kenya; Kiribati; Kuwait; Liberia; Madagascar; Malaysia; Maldives; Marshall Islands; Martinique; Mauritania; Mexico; Micronesia, Federated States of; Monaco; Morocco; Mozambique; Myanmar; Namibia; Netherlands; Netherlands Antilles; New Caledonia; New Zealand; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal; Puerto Rico; Qatar; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Sao Tomé and Principe; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Spain; Sri Lanka; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; Turks and Caicos Islands; United Arab Emirates; United Kingdom; USA; Uruguay; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen.

S. coeruleoalba is categorised as "Least Concern" by the IUCN (Hammond et al. 2008). The species is listed in Appendix II of CITES. The eastern tropical Pacific population and the Mediterranean populations are included in Appendix II of CMS. However, observations off the coast off Japan also indicate migratory behaviour in these waters. Range states concerned in these waters are Japan, North and South Korea, the Peoples Republic of China and Taiwan (see Perrin et al. 1996 in Appendix 2). Therefore, it is recommended that the West Pacific Stock also be included in Appendix II of CMS.

To date, striped dolphins have faced relatively few threats compared with other small cetacean species, although very little is known about the species in some areas. However, some discrete populations are affected either by both direct and indirect catches or by habitat encroachment. In particular the direct catches off the Pacific coast of Japan are a matter of concern, as was expressed by the International Whaling Commission. The levels of contamination in the Mediterranean Sea, coupled with the increasing incidental catches in the driftnet fishery and reduced prey availability represent the major threats for this and other cetacean species in the area.

8. Sources (see page 287)

3.66 Stenella frontalis (G. Cuvier, 1829)

English: Atlantic spotted dolphin
German: Zügeldelphin
Spanish: Delfín pintado
French: Dauphin tacheté de l'Atlantique

Family Delphinidae

Stenella frontalis / Atlantic spotted dolphin (© Wurtz-Artescienza)

1. Description

Atlantic spotted dolphins have a moderately long, stocky beak, with a distinctive crease between the base of the beak and the melon. The dorsal fin is tall and falcate and the flippers are curved backwards. Juveniles are unspotted and look similar to bottlenose dolphins, with their dark cape, spinal blaze, light gray sides and white belly. As the animals age, spots on both ventral and dorsal surfaces develop and some individuals become so heavily spotted that the underlying colour pattern becomes obscured. However, adults in some offshore and temperate populations may remain unspotted (Jefferson et al. 2008). *S. frontalis* can be distinguished from *S. attenuata*, which also occurs in the tropical Atlantic, by its spinal blaze which sweeps up into the dorsal cape. In addition, the peduncle does not exhibit the dorsoventral division into darker upper and lighter lower halves observed in *S. attenuata*. Adult size ranges from 166 cm to 229 cm, and mass reaches 143 kg (Perrin, 2009).

There is a marked regional variation in the size and shape of the skull and in adult body size (Perrin et al. 1987, in Rice, 1998). The largest individuals inhabit the coastal waters of the southeastern United States; these are the animals that long went under the name *S. plagiodon* (Cope, 1866; Rice, 1998). Genetic differentiation of Atlantic spotted dolphins in the western North Atlantic, including the Gulf of Mexico was recently tested by Adams and Rosel (2006) who presented evidence for 3 populations coupled to known biogeographic transition zones at Cape Hatteras, North Carolina and Cape Canaveral, Florida, USA. This also supports previously documented morphotypes of Atlantic spotted dolphins in coastal and offshore waters.

2. Distribution

Stenella frontalis ranges in the tropical and warm-temperate Atlantic, north to the Gulf of Mexico, Cape Cod, the Azores, and the Canary Islands, and south to Rio Grande do Sul in Brazil, Saint Helena, and Gabon. A synonym is *Stenella froenata* (F. Cuvier, 1829; Rice, 1998). The species is well documented from Equatorial Guinea and Côte d'Ivoire, with recent sightings at sea off Senegal (Van Waerebeek et al. 2000 and refs. therein) and Angola (Weir, 2008) . The range extends to about 50°N to 25°S (Hammond et al. 2008; Jefferson et al. 2008).

3. Population size

In the US (EEZ) waters of the North Atlantic Ocean, south of Maryland, the Atlantic spotted dolphin was the most abundant species in 1998 (14,438; CV = 0.63; Mullin and Fulling, 1998). Subsequent abundance estimates are significantly higher: the best recent abundance estimate from two 2004 western U.S. Atlantic surveys are: Maryland to the Bay of Fundy 3,578 animals (CV = 0.48) and Florida to Maryland 47,400 animals

Distribution of Stenella frontalis (Hammond et al. 2008; © IUCN Red List): warm, temperate, subtropical and tropical waters in the North and South Atlantic.

(CV = 0.45; Waring et al. 2008).The best available abundance estimate for the northern Gulf of Mexico is the combined estimate of abundance for both the outer continental shelf (fall surveys, 2000-2001) and oceanic waters (spring and summer surveys, 2003-2004), which yields 37,611 (CV=0.28; Waring et al. 2008).

There are no data on abundance available from West Africa (van Waerebeek et al. 2000) or for other populations in the mid and east Atlantic ocean (Hammond et al. 2008; Perrin, 2009).

4. Biology and Behaviour

Habitat: Atlantic spotted dolphins are encountered primarily in continental shelf (<200 m) and continental slope waters (200-2000 m; Mullin and Fulling, 1998). The large, heavily spotted form along the south-eastern and Gulf coasts of the United States inhabits the continental shelf, usually being found inside or near the 100-fathom curve (within 250-350 km of the coast) but sometimes coming into very shallow water adjacent to the beach seasonally, perhaps in pursuit of migratory forage fish (Perrin et al. 1994 and refs. therein; Jefferson and Schiro, 1997). In the eastern Gulf of Mexico between Tampa Bay and Charlotte Harbor, Florida, *S. frontalis* was the most common shelf species at depths of 20-180 m. Although its habitat has elsewhere been described as broadly extending over the shelf, these data suggest that in the eastern Gulf of Mexico the species prefers midshelf habitat (Davis et al. 1996; Griffin and Griffin, 2003).

The smaller and less-spotted forms that inhabit more pelagic offshore waters and waters around oceanic islands are less well known in their habitat requirements. In the Bahamas, Atlantic spotted dolphins spend much time in shallow water (6-12 m) over sand flats (Perrin et al. 1994 and refs. therein; Jefferson and Schiro, 1997). Off the Azores Archipelago, they were found around each group of islands, where they were also more abundant in offshore (9 to 28 km) as opposed to coastal areas (to 9 km from shore; Silva et al. 2003).

Schooling: Small to moderate groups, generally of fewer than 50 individuals, are characteristic for this species. Coastal groups usually consist of 5 to 15 animals (Jefferson et al. 1993). However, on both coasts of northern Florida, moving groups may consist of up to 100 individuals and may attract other, smaller groups that join the large group briefly. Segregated schools of subadults and adults, or of adults with calves have also been observed (Perrin et al. 1994 and refs. therein). In a report from the Canary Islands, maximum group size of *S. frontalis* is given as 650 animals (mean 40) in 321 sightings between 1994-2001 (Ritter, 2003). Herzing and Johnson (1997) observed interactions between free-ranging Atlantic spotted dolphins and bottlenose dolphins (*Tursiops truncatus*) in Bahamian waters. Mixed-sex, mixed-species adult groups (including pregnant females) were seen foraging together and travelling together (Herzing et al. 2003).

In the Gulf of Mexico, Atlantic spotted dolphins feed in a co-ordinated manner and herd schools of clupeid fish into dense balls against the sea surface. While such feeding activity has been well-described for other delphinid species nearshore, co-ordinated feeding offshore is rarely reported (Fertl and Würsig 1995).

In the central Azores, the presence of large concentrations of bait fish in the area each summer gives rise to mixed-species feeding aggregations, usually at dawn and dusk (Clua and Grosvalet, 2001). The encircling of prey initiated by common dolphins (*Delphinus delphis*), often mixed with spotted dolphins, results in the formation of a compact 'ball' of several thousand prey fish close to the surface. Other dolphins, in particular bottlenose dolphins, also eat the prey fish, whose high concentration makes them easy to capture. Large tunas (*Thunnus thynnus*, *Thunnus albacares*) some-times participate in the phenomenon. Seabirds (mainly Cory's shearwaters, *Calonectris diomedea borealis*) are always present throughout the few minutes during which the entire collective food hunt takes place. Clua and Grosvalet (2001) showed that it is the tunas that generate and benefit from the aggregation with dolphins, rather than the contrary.

Food: A wide variety of fish and squid are taken (Jefferson et al. 1993): The stomach of a specimen captured off northern Florida contained a large number of small cephalopod beaks, and *S. frontalis* have been observed to feed on small clupeoid and carangid fishes and large squid and to follow trawlers to eat discarded fish. Observers in the north-eastern Gulf of Mexico have reported that small squid have been regurgitated during captures of spotted dolphins (Perrin et al. 1994). Dives to 40-60 m and lasting up to 7 min have been recorded, but most time is spent at less than 10 m depth (Davis et al. 1996).

Reproduction: Age at sexual maturity is estimated at 8-15 years in females (Herzing, 1997). The average calving interval is about 3 years, nursing lasting for up to 5 years (Perrin, 2009). In the Bahamas, genotypes of females and offspring revealed that more than two males were required to explain the progeny arrays, indicating promiscuous mating among females. Males mate within their social cluster or with females from the next-closest cluster (Green, 2008). In southeastern Brazil the oldest specimen was 23 years old, and the asymptotic length of 224.4 cm predicted by the growth curve occurred at about 20 years (Sicilliano et al. 2007).

5. Migration

Davis et al. (1996) reported on the diving behaviour and daily movements of a rehabilitated Atlantic spotted dolphin that was tracked in the northwestern Gulf of Mexico for 24 d using satellite telemetry. During that time, the animal travelled a total of 1,711 km at a mean travelling speed of 0.8 m/s. The mean minimum distance travelled daily was 72 km. Although this single animal can hardly be considered representative of the species, it illustrates the habitat use and movements within the marine habitat. International borders (e.g. between Texas and Mexico) are not limiting for wild populations.

Over the west-Florida continental shelf, monthly surveys conducted between 1998 and 2001 between the coast and the 180 m depth contour showed significant seasonal variation in Atlantic spotted dolphin densities. Lowest abundances were recorded during the warm season (June-October) and highest densities during the cool season (November-May). Densities significantly decreased during 2000 and 2001, suggesting a species response to short-term environmental variation (Griffin and Griffin, 2004).

Mignucci et al. (1999) assessed cetacean strandings (including Atlantic spotted dolphins) in Puerto Rico and the United States and British Virgin Islands. Between 1990 and 1995, the average number of cases per year increased from 2.1 to 8.2. There was a seasonal pattern of strandings, with a high number occurring in the winter and spring. The monthly temporal distribution showed an overall bimodal pattern, with the highest number of cases reported for February, May and September.

6. Threats

Direct catches: Atlantic spotted dolphins were taken in a direct fishery for small cetaceans in the Caribbean. Direct takes may also occur off the Azores and off West Africa (Jefferson et al. 1993; Perrin et al. 1994).

Incidental catches: The total annual fishery-related mortality or serious injury to the US west Atlantic stock during 2001-2005 was estimated at 6 (CV=1) spotted dolphins (*S. frontalis* and *S. attenuata* combined). There was no reported fishing-related mortality of spotted dolphins in US Gulf of Mexico waters during 1998-2006 (Waring et al. 2008).

In Campeche Sound, Mexico, Atlantic spotted dolphins stay behind shrimping vessels and eat the discarded bycatch (mainly at night). Because dolphins respect trawl net position, the probability of incidental catch appears to be low (Delgado, 1997).

For Puerto Rico and the Virgin Islands, the most common human-related causes observed in strandings are entanglement and accidental captures, followed by animals being shot or speared (Mignucci et al. 1999). Atlantic spotted dolphins are also captured incidentally in gill nets in Brazil and Venezuela (e.g. Zerbini and Kotas, 2001). In Venezuela, the dolphin carcasses are utilised for shark bait and for human consumption (Perrin et al. 1994).

Some are probably taken incidentally in tuna purse seines off the West African coast. While there are no reliable estimates of the number of animals taken in this fishery (Jefferson et al. 1993; Carwardine, 1995), it may be considerable. Nieri et al. (1999) reported that in 1995, a large number of Atlantic spotted dolphins washed ashore on the sandy beaches north of Nouakchott, the capital of Mauritania, presumably due to fishery interaction.

Pollution: In specimens found stranded along the coastal waters of Florida, USA, during 1989 to 1994, PCBs were the most predominant contaminants followed by DDTs, chlordanes, tris(4-chlorophenyl)methane (TCPMe), tris(4-chlorophenyl) methanol (TCPMOH), hexachlorobenzene, and hexachlorocyclohexane isomers. Concentrations of TCPMe and TCPMOH were greater than those in the blubber of marine mammals of various other regions, suggesting the presence of sources for these chemicals along the Atlantic coast of Florida (Watanabe et al. 2000). In specimens from Brazilian coastal waters, concentrations of DDTs and PCBs were the highest, followed by CHLs, TCPMOH, dieldrin, TCPMe, heptachlor epoxide, HCB, and HCHs. Unexpectedly, the significant pollution of PCBs, DDTs, TCPMe, and TCPMOH implies the occurrence of local sources in the Southern Hemisphere comparable to those in the Northern Hemisphere, probably by high industrialization in Brazil (Kajiwara et al. 2004).

Red tide blooms: Between August 1999 and May 2000, 152 bottlenose dolphins died coincident with red tide (*K. brevis*) blooms and fish kills in the Florida Panhandle (Waring et al. 2008).

Noise pollution: Off Angola a dual-source airgun array used in oil field prospection resulted in overt response by Atlantic spotted dolphins; they were observed at a significantly greater distance from the airgun array during full-array operations than during guns-off. However, there was no evidence for prolonged or large-scale displacement from the region during the 10-month survey duration (Weir, 2008).

7. Remarks

Range states (Hammond et al. 2008): Antigua and Barbuda; Bahamas; Barbados; Brazil; Cameroon; Cape Verde; Cayman Islands; Colombia; Côte d'Ivoire; Cuba; Dominica; Gabon; Ghana; Guinea; Guinea-Bissau; Haiti; Honduras; Jamaica; Mauritania; Mexico; Morocco; Netherlands Antilles; Nicaragua; Panama; Portugal (Azores); Puerto Rico; Saint Helena; Saint Vincent and the Grenadines; Senegal; Spain (Canary Is.); United States; Venezuela; Western Sahara.

The species is listed in Appendix II of CITES. Classified as "Data Deficient" by the IUCN. Not listed by CMS.

Atlantic spotted dolphins seem to prefer inshore waters on both sides of the tropical Atlantic and may venture even further. Satellite telemetry showed that the species is capable of moving considerable distances, and stranding data show seasonal peaks. These data show that movements and home range size are likely to stretch across international boundaries. Inclusion in Appendix II of CMS is therefore strongly suggested.

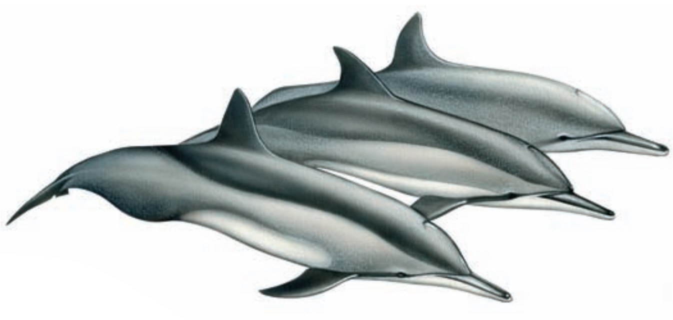
Atlantic spotted dolphins also occur in South America, so please see Hucke-Gaete (2000) in Appendix 1 for further recommendations. Range states in the Caribbean should be encouraged to investigate into and reduce accidental by-catch.

8. Sources (see page 289)

3.67 Stenella longirostris (Gray, 1828)

English: Spinner dolphin, Long-beaked dolphin
German: Ostpazifischer Delphin
Spanish: Estenela giradora, Delfín tormillón
French: Dauphin à long bec

Family Delphinidae



Stenella longirostris / Spinner dolphin (© Wurtz-Artescienza)

1. Description

Spinner dolphins can be detected from large distances as they spin high in the air and then land with a loud splash. The body is slender and the beak is extremely long and thin. Colouration consists of a dark grey cape, light grey lateral field and white ventral field. A dark band runs from the eye to the flipper, bordered above by a thin light line. The rostrum is tipped with black or grey. The dorsal fin is basically triangular, slightly falcate to erect or canted forward. The flippers are thin and recurved. Adults range from 129-235 cm and reach a body mass of 23-80 kg (Perrin, 1998; 2009).

2. Distribution

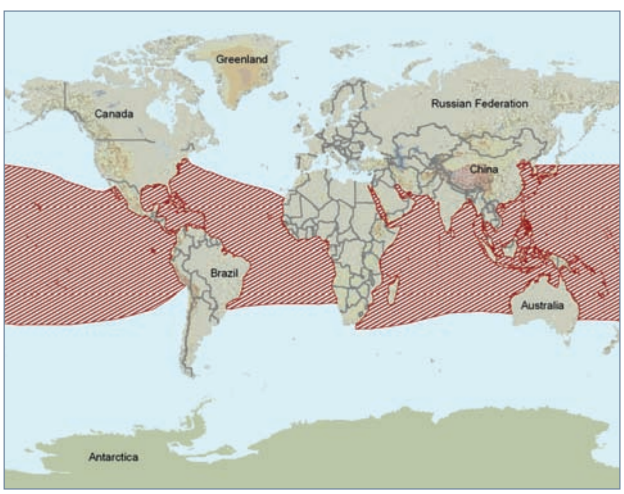
Spinner dolphins are pantropical, occurring in all tropical and subtropical waters around the world between roughly 40°N and 40°S (Jefferson et al. 2008). The geographical variation in body configuration and colour pattern is more pronounced in spinner dolphins than in any other species of cetacean.

Perrin (1990) and Perrin et al. (1999) recognized this variation by naming four subspecies:

S. l. longirostris: The nominate subspecies (all spinner dolphins aside from the other described subspecies) occurs mainly around oceanic islands in the tropical Atlantic, Indian, western and central Pacific east to about 145°W. It ranges north to New Jersey, Senegal, the Red Sea, Gulf of Oman, Arabian Sea, Sri Lanka, the Andaman Sea, Gulf of Thailand, southern Honshu, and the Hawaiian Islands (Rice, 1998). Smith et al. (1997a and 1997b) sighted individuals off Myanmar and Vietnam. It ranges south to Paraná in Brazil, Saint Helena, Cape Province, Timor Sea, Queensland, and Tonga Islands and is vagrant to New Zealand (Rice, 1998).

It is found in relatively small and discrete communities around many islands throughout the Pacific. In island communities of the Society Archipelago, French Polynesia, gene flow among neighbouring communities is restricted, although some individual movement was documented (Oremus et al. 2007). Similarly around Hawaii, dolphins at almost every island were found to be significantly genetically differentiated from dolphins at every other island for one or more tests of population subdivision (Andrews et al. 2006). And finally, genetic data shows differences between American Samoa and the Hawaiian Islands (Johnston et al. 2008).

The southernmost record is from New Zealand, more than 2,000 km south of what is thought to be the normal range but still well north of subantarctic waters. The distribution of *S. l. longirostris* in the Atlantic is very poorly known, especially in South American and African waters (Perrin and Gilpatrick, 1994 and refs. therein). Van Waerebeek et al. (2000) note a lack of recent sightings, strandings or by-catches off West Africa, whereas Ali and Jiddawi (1999) report sightings on the coast of Zanzibar in the Western Indian Ocean. Interspecific hybrids between *S. longirostris* and *S. attenuata* and between *S. longirostris* and *S. clymene* are reported from the Fernando de Noronha Archipelago, tropical West Atlantic (Silva et al. 2005).



Distribution of Stenella longirostris. Four different subspecies occur in tropical and subtropical waters in the Atantic, the Indian and Pacific Oceans (Hammond et al. 2008; © IUCN Red List).

Perrin (1990) proposed the name "Gray's spinner dolphin" for this race; the "Hawaiian spinner porpoise" is included here. The "whitebelly spinner porpoise" and the "southern spinner dolphin" are intergrades or hybrids between this race and *S. l. orientalis* (Rice, 1998 and refs. therein).

S. l. orientalis Perrin, 1990: Ranges in pelagic waters of the tropical Pacific east of about 145°W, from 24°N off Baja California south to 10°S off Peru, but exclusive of the range of the following race. This is the "eastern spinner dolphin" of Perrin (1990).

S. l. centroamericana (Perrin, 1990): Found in coastal waters over the continental shelf of the tropical Pacific from the Gulf of Tehuantepec in southern Mexico southeast to Costa Rica. This is the "Central American spinner dolphin" of Perrin (1990). However, Perryman and Westlake (1998) examined lengths of spinner dolphins taken from vertical aerial photographs in the eastern tropical Pacific and found three unique morphotypes. Two of these forms correspond, at least in average length and distribution, to the existing eastern and Central American subspecies. The third form is intermediate in length between the two recognised subspecies and is found along the edge of the continental shelf north of Cabo Corrientes, Mexico. They provisionally called this form the "Tres Marias spinner dolphin."

S. l. roseiventris (Wagner, 1846): is distributed in shallow innner waters of Southeast Asia, including the Gulf of Thailand, Timor and Arafura Seas, and similar waters off Indonesia, Malaysia and Northern Australia. It is replaced in deeper and outer waters by the larger pelagic subspecies *S. l. longirostris* (Perrin et al. 1999).

Based on morphological data, van Waerebeek et al. (1999) concluded that Oman spinner dolphins should be treated as a discrete population, morphologically distinct from all known spinner dolphin subspecies. Confirmed coastal range states off the Arabian Peninsula include the United Arab Emirates, the Sultanate of Oman, Yemen, Somalia, Djibouti, Saudi Arabia, Sudan and Egypt. It is likely that additional regional subspecies will be split off from the nominate subspecies in the future.

3. Population size

There are several abundance estimates for this circumglobal species, most of which are quantitative.

The largest population is reported from the eastern tropical Pacific (ETP). The 2003 estimate of the eastern spinner dolphin (*S. l. orientalis*) was 613,000 (CV=21.9) and for the whitebelly spinner dolphin (an intergrade between *S. l. longirostris* and *S. l. orientalis*) 442,000 (CV=44.6; Gerrodette el al., 2005). This is higher than the 2000 estimates of about 428,000 eastern spinner dolphins (CV = 0.218). For the whole period from 1979 to 2000, annual estimates of abundance ranged from 271,000 to 734,000 (Gerrodette and Forcada, 2005).

Balance and Pitman (1998) conducted a cetacean survey in the pelagic western tropical Indian Ocean (WTIO) and reported that the cetacean community there was similar to that of the ETP and the Gulf of Mexico (GM). In the central and western Pacific, spinner dolphins are often the most abundant species. A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an estimate of 3,351 (CV=0.74) animals (Barlow 2006). In the nearshore waters of Manu'a Islands, Rose Atoll and Swains Island, American Samoa, spinner dolphins (n=34 groups, 46 animals), were the most abundant cetacean species in summer 2006 (Johnston et al. 2008). In Philippine waters it is also the most abundant species, with a population estimate of 31,512 (CV=26.63%) in the eastern Sulu Sea and 3,489 (CV=26.47%) in the Tañon Strait (Dolar et al. 2006). In the waters around the Marquesas Islands in French Polynesia, spinner dolphins were the second most abundant species (Gannier, 2002).

Off the Mergui (Myeik) Archipelago of southern Myanmar, spinner dolphins were the third most frequent species (Smith and Tun, 2008). In the northern Mozambique Channel around the island of Mayotte, spinner dolphins were also very numerous: 118 animals were observed (Kiszka et al. 2007).

In the northern Gulf of Mexico (US EEZ), the current estimate of abundance for spinner dolphins in oceanic waters averaged over 2003 to 2004, is 1,989 (CV=0.48; Mullin 2007). This estimate is significantly different ($P<0.05$) from that for 1996-2001 of 11,971 (CV=0.71), while the 1991-1994 estimate of 6,316 (CV=0.43) is intermediate. These differences are difficult to interpret without a Gulf-of-Mexico-wide understanding of spinner dolphin abundance (Waring et al. 2009).

4. Biology and Behaviour

Habitat: In most tropical waters, nearly all records of spinner dolphins are associated with inshore waters, islands or banks. Around Hawaii, spinner dolphins depend on the availability of sheltered shallow bays for use as resting areas during the day. In coastal waters of the Society Islands (French Polynesia), they are observed year-round during daytime in sheltered bays or within lagoons. Dolphins stay within the bay from early morning until the early afternoon, when they move slowly offshore. On average, they stay 400 m from shore, although they approach as close as 100 to 150 m. Dolphin presence and residence time seems to be negatively affected by surface water turbidity (river flow) and lagoon current strength. Seasonally, there are slight differences in presence with 81% of dolphin days in from May to November and only 67% between December and April (Cannier and Petiau, 2006). The dwarf form of the spinner dolphin in Thai waters apparently inhabits a shallow coral reef habitat (Perrin and Gilpatrick, 1994 and refs. therein).

In the eastern tropical Pacific, however, spinner dolphins, like pantropical spotted dolphins, occur in very large numbers on the high seas many hundreds of km from the nearest land. The spotted dolphin school may serve as a surrogate "protected bay" for the spinner dolphins to shelter them from predators during their daily quiescent period, thus allowing them to exist and make a living far from land. The habitat there, called by oceanographers "tropical surface water", is typified by unusual conditions of shallow mixed layer, shoal and sharp thermocline, and relatively small annual variation in surface temperature (Reyes, 1991, Perrin and Gilpatrick, 1994 and refs. therein).

Davis et al. (1998) characterised the physical habitat of cetaceans found along the continental slope in the north-central and western Gulf of Mexico. *S. longirostris* was found over intermediate bottom depths, its distribution overlapping with that of purely pelagic and purely coastal species.

Schooling: The spinner dolphin society is composed partly of familial units and more broadly of learned associations beyond the family group. Mother-calf bonds are persistent, as in other dolphins. Around Hawaii, social groupings are very fluid, with individuals moving freely among several sets of companions over periods of minutes, hours, days or weeks. Large schools form, break down and re-form with different permutations of subgroups in the course of diurnal inshore-offshore and long-shore movements related to nocturnal feeding. It is not known whether or not these broader associations are with members of dispersed kin groups.

There is some segregation by age and sex among schools of spinner dolphins in the far-offshore eastern Pacific. It has been suggested that such segregation may be temporary and more pronounced during migration in dolphins. There appears to be no consistent "leader" in a spinner dolphin school. Directional movement appears to be a group process, with direction imparted often from behind, to the sides or below in the school. In a time of stress, the school becomes what has been termed a "sensory integration system" (SIS) and direction may come from anywhere in the school. In the eastern tropical Pacific spinner dolphins are often found in close association with pantropical spotted dolphins, yellowfin tuna and birds of several species; the association varies in percentage occurrence with time of day (Perrin and Gilpatrick, 1994, and refs. therein). In mixed-species associations off Hawaii, spinner dolphins are typically present in greater numbers than spotted dolphins with ratios as high as 75:1. Interspecific behaviours observed include aggression, copulation, and travelling (Psarakos et al. 2003).

Around the Society Islands (French Polynesia), school sizes range from 15 - 30 to 100 - 140 individuals (Cannier and Petiau, 2006). At Midway Island, spinner dolphins live in stable bisexually bonded societies of long-term associates, with strong geographic fidelity, no obvious fission-fusion, and limited contacts with other populations. Their large cohesive groups change little over time and are behaviorally/socially discrete from other spinner dolphin groups. With deepwater food resources in close proximity and other atolls relatively far away for day-to-day access, it may be energetically more beneficial in remote atolls to remain "at home" than to travel to other atolls, explaining the observed school stability (Karczmarski et al. 2005).

Behaviour: The spinner dolphin performs spectacular leaps from the water while rotating around its longitudinal axis up to seven times. Although twisting of the body while airborne has been proposed as the mechanism to effect the spin, angular momentum to induce the spin is generated underwater, prior to the leap. One hypothesis of the function of the spinning behavior is that the high rotation rates and orientation of the dolphin's body during re-entry into the water could produce enough force to dislodge unwanted remoras (Fish et al. 2006).

Off Oahu, Hawaii, spinner dolphins at night actively aggregate their prey through cooperative foraging using their preys' avoidance behaviour to create distinct, high-density patches in the prey. Dolphins swim around the edge of a 28-40 m diameter circle at least 5 times, concentrating prey within this area before pairs of dolphins on opposite sides of the circle swap positions, swimming through the high density prey 'donut' they have formed (Benoit-Bird and Au, 2003).

Food: Spinner dolphins feed primarily on small (generally less than 20 cm) mesopelagic fish, squids and sergestid shrimps, diving to at least 200-300 m (Dolar et al. 2003). In Hawaii, many prey organisms become available to spinner dolphins when the deep scattering layer moves toward the surface at night. Spinner dolphins in the Gulf of Thailand may have an entirely different trophic ecology, feeding on benthic and coral reef organisms (Perrin and Gilpatrick, 1994, and refs. therein). At Fernando de Noronha Archipelago in the southwestern Atlantic, twelve fish species in seven families are known to feed on dolphin offal. The black durgon (*Melichthys niger*) is the most ubiquitous waste-eater, recognizing the postures a dolphin adopts prior to defecating or vomiting and converging on an individual shortly before it actually voids. Offal is then quickly fed upon (Sazima et al. 2003).

Reproduction: Gestation lasts about 10 months, and nursing duration is 1-2 years. Females reach sexual maturity at 4-7 years and may calve every 3 years. Males are sexually mature at 7-10 years (Perrin, 2009). The oldest eastern spinner dolphin by-caught in the ETP tuna fishery was estimated to be 24.5 years old and the oldest whitebelly spinner dolphin was 26 (Larese and Chivers, 2008). Smaller testis size in the eastern spinner than in the whitebelly spinner suggests that the breeding system in the former may tend more toward polygyny (Perrin and Mesnick, 2003).

5. Migration

Norris et al. (1994) concluded that spinner dolphin distribution and abundance is related to certain local oceanographic phenomena. For example, divergence zones at current margins and current ridges both concentrate food organisms and are heavily frequented by dolphins of various species, including spinners. Whereas one scientific view suggests that populations remain geographically stable over rough bottom topography, another view suggests that at least some populations may move widely without reference to the bottom. Where a warm current swings away from the tropics along an ocean margin - for example where the Kuroshiro current moves northward along the eastern shore of Japan - oceanic dolphin populations, including the spinner dolphin, migrate in such water masses and move considerable distances.

Perrin and Gilpatrick (1994, and refs. therein) noted that in different regions such as Hawaii and Fernando de Noronha Island (northern Brazil) spinner dolphins usually spend the daytime hours resting in shallow bays near deep water. They move offshore at dusk to feed. During feeding, they may move some distance along the shore, so the same animals may not be present in the same bay on two consecutive days. Not all animals go into the rest coves every day; some move slowly along the shore between successive nights. Maximum net movement observed was 113 km over 1,220 days. In general , site-fidelity in Hawaiian animals is strong. At least one and up to three animals were re-sighted northwest of Oahu 20 years after the first reported sighting (Marten and Psarakos, 1999). Capture-recapture analyses at Moorea (Society Archipelago, French Polynesia) based on long-term observations of marked individuals and molecular data also indicated a local and relatively closed community (of about 150 dolphins). This is also confirmed by resightings of individuals across 15 years (Oremus et al. 2007).

In the eastern tropical Pacific, however, tagged spinner dolphins moved minimum distances of 12 to 275 nautical miles (within 16 h and 365 days, respectively). The number of tag returns (seven of 340) was insufficient to allow detection of a migratory pattern, if one exists. Minimum distances moved were less than for pantropical spotted dolphins at liberty for similar periods of time; the spinner dolphin may be less migratory (Perrin and Gilpatrick, 1994, and refs. therein).

6. Threats

Directed fisheries: Small numbers of spinner dolphins are taken in localised harpoon fisheries in many places around the world, e.g. the Lesser Antilles, the Philippines, and Indonesia. They were formerly taken in small numbers in drive fisheries in Japan. 117 by-caught spinner dolphins were landed in India in 1986-87, presumably for human consumption. Dolphins taken incidentally in Venezuela are utilised for shark bait and human consumption (Dolar et al. 1994; Perrin and Gilpatrick, 1994 and refs. therein).

Ilangakoon (1997) reported on the interaction between small cetaceans and the fisheries industry in Sri Lanka. He found *S. longirostris* to be the most abundantly caught species at all investigated sites. The post-monsoonal period from the end of August to November was the season when peak catches were recorded. Deliberate harpooning was found to account for a sizeable proportion of the small cetacean catch, and the practice seems to be spreading to new areas.

By-catches: There has been no reported fishing-related mortality of spinner dolphins during 1998-2006 in the Northern Gulf of Mexico US EEZ (Waring et al. 2009). In the Hawaii-based longline fishery during 1994-2005, annual fishing effort was roughly constant at about 12,000 sets through 2001 and then increased to over 18,000 sets through 2005. During 24,542 observed sets, 67 cetaceans were observed hooked or entangled, of which only 2 were spinner dolphins (Forney and Kobayashi, 2007).

Since the Inter-American Tropical Tuna Commission (IATTC) implemented per-vessel mortality limits on the international fleet, the mortality for the eastern and whitebelly forms combined decreased, from 30,500 in 1986 to 288 in 2007 (IATTC, 2009). Although current mortality is greatly reduced, the eastern form appears to be recovering very slowly. Possible reasons include underreporting of dolphin bycatch, effects of chase and encirclement on dolphin survival and reproduction, long-term changes in the ecosystem, and effects of other species on population dynamics (Gerrodette and Forcada, 2005).

Reproductive data from the eastern tropical Pacific shows that proportion with calves is related to number of dolphins in the school and/or proportion of the school made up of the focal species. Annual number of purse-seine sets on dolphins was a predictor of both proportion with calves and length at disassociation. Because the spinner dolphin is one of the two main species targeted by the fishery, the link between fishing activity and both measures of reproductive output indicates that the fishery has population-level effects beyond reported direct kill and may be responsible for the failure of dolphin populations to recover at rates expected after the reduction of high bycatch levels (Cramer et al. 2008).

Dolphin mortality seems to increase with the number of dolphins encircled, because of increased risk of entanglement and longer duration of the backdown procedure, including the risk of entrapment in net-canopies. Therefore, large herds are particularly threatened by the tuna fishery (Lennert-Cody et al. 2004). Gerrodette (2002) also mentioned cryptic effects of repeated chase and encirclement on survival an/or reproduction (internal injuries, stress, hyperthermia and separation of nursing calves from their mothers during the fishing process).

A total of 96 dolphins were reported to have been incidentally caught in gillnet fisheries off Zanzibar (Unguja Island) between 1995 and 1999, including 29 spinner dolphins (Amir et al. 2003). Reports on incidental catches monitored at 12 landing sites between 2000 and 2003 numbered 44 (31% of all by-caught cetaceans) spinner dolphins. Most of the bycatches (71%) were in nets set off the north coast of Unguja Island (Amir et al. 2005). Significant catches of spinner dolphins also occur in the Caribbean, Australia, Japan, the Philippines, and Sri Lanka; in the last area up to 15,000 are killed each year in gill-nets and by hand-harpooning. There are likely to be fisheries interactions off West Africa (Jefferson et al. 1993; Perrin and Gilpatrick, 1994; Carwardine, 1995). A trawl shrimp fishery in the Gulf of Thailand takes a yet unknown number of *S. l. roseiventris* (Reyes, 1991). Zerbini and Kotas (1998) reported on by-catches in Brazilian drift-net fisheries and Cockroft (1990) on animals entangled in shark nets off Natal.

Pollution: Relatively high levels of mercury and contamination with DDT, Dieldrin and PCBs have been reported for the species (e.g. Tanabe et al. 1993). The high level of Hg has been attributed to natural sources, but in the case of DDT and PCBs the agricultural and industrial development in Central America may be the cause (Velayutham et al. 1994; Velayutham and Venkataramanujam 1995; Perrin and Gilpatrick, 1994 and refs. therein; Reyes, 1991). Blubber samples of animals from the Bay of Bengal (southeast coast of India) contained considerable levels of organochlorines with DDT in the range of 3330-23 330 ng/g; HCHs in the range of 95-765 ng/g; and PCBs in the range of 210-1220 ng/g (wet weight basis; Karuppiah et al. 2005).

Specimens stranded along the coasts of the lower Gulf of California, Mexico contained mercury (Hg) and methylmercury (MeHg) in their tissues, albeit at low levels (Ruelas et al. 2003). Lately, polybrominated diphenyl ethers (PBDEs), one of the flame retardants widely used in plastics, textiles, electronic appliances, and electrical household appliances were detected in the blubber of cetaceans found stranded along the coasts of Japan, Hong Kong, the Philippines and India during the period from 1990 to 2001. However, concentrations of PBDEs in spinner dolphins were low, with 6.0 ng/g lipid wt (Kajiwara et al. 2006).

Tourism: Tourist development may affect the near-shore habitat of some spinner dolphin populations, for example, at Fernando de Noronha Island, Brazil (Reyes, 1991). Although increasing levels of human activity has a limited but measurable effect on the movement patterns of Hawaiian spinner dolphin groups at Kealakekua Bay (Delfour, 2007; Timmel et al. 2008), Ali and Jiddawi (1999) reported that in Zanzibar tourism was beneficial for the species: their touristic value far exceeds that of using them as bait for sharks. As many as 2,000 tourists visit the dolphin site at Kizimkazi per month.

7. Remarks

Range states (Hammond et al. 2008): American Samoa; Anguilla; Antigua and Barbuda; Aruba; Australia (Queensland); Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil (Paraná); British Indian Ocean Territory; Brunei Darussalam; Cambodia; Cameroon; Cape Verde; Cayman Islands; China; Cocos (Keeling) Islands; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Cuba; Djibouti; Dominica; Dominican Republic; Ecuador (Galápagos); Egypt; El Salvador; Equatorial Guinea; Fiji; French Guiana; French Polynesia; Gabon; Gambia; Ghana; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India (Andaman Is., Nicobar Is.); Indonesia; Iran, Islamic Republic of; Jamaica; Japan (Honshu);

Kenya; Kiribati; Liberia; Madagascar; Malaysia; Maldives; Marshall Islands; Martinique; Mauritania; Mexico; Micronesia, Federated States of; Morocco; Mozambique; Myanmar; Namibia; Nauru; Netherlands Antilles; New Caledonia; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Puerto Rico; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Sao Tomé and Principe; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa (KwaZulu-Natal); Sri Lanka; Sudan; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; United Arab Emirates; USA (Hawaiian Is., New Jersey); United States Minor Outlying Islands; Uruguay; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen (Socotra).

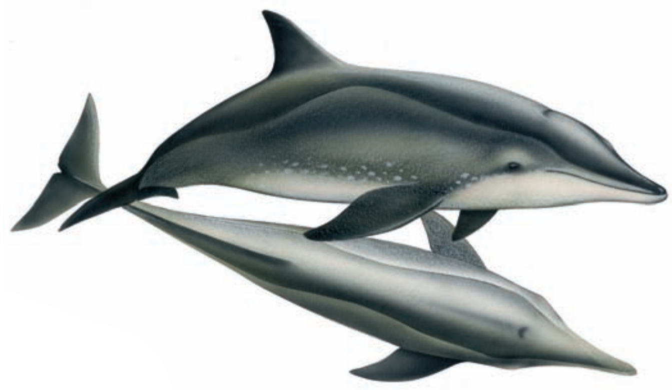
The species is listed in Appendix II of CITES. The IUCN lists the species as "Data Deficient" (Hammond et al. 2008). The eastern tropical Pacific populations and south-eastern Asian populations of *S. longirostris* are listed in Appendix II of CMS.

8. Sources (see page 290)

3.68 Steno bredanensis (G. Cuvier in Lesson, 1828)

English: Rough-toothed dolphin
German: Rauhzahndelphin
Spanish: Delfín de dientes rugosas
French: Dauphin sténo

Family Delphinidae



Steno bredanensis / Rough-toothed dolphin (© Wurtz-Artescienza)

1. Description

S. bredanensis derives its common name from the vertical ridges in the teeth, which give them a roughened appearance. This is the only long-beaked dolphin with a smoothly sloping melon that gently blends into the upper beak. The body is not very slender and the anterior portion may be stocky. The large flippers are set farther back on the body than in most other delphinds. The dorsal fin is tall and only slightly recurved. Some large males may have a hump posterior to the anus resembling a keel. Rough-toothed dolphins are countershaded with white bellies and black to dark grey backs. The sides are medium grey and separated from the a cape on the back. Size reaches 255 cm in females and 280 cm in males, and body mass may reach 155 kg (Jefferson, 2009).

2. Distribution

S. bredanensis is distributed in tropical and warm temperate waters around the world. It ranges north to the Gulf of Mexico, Virginia, Brittany on the French coast, Mediterranean Sea, Gulf of Aden, Arabian Sea, Bay of Bengal, East China Sea, Northern Japan, Hawaiian Islands, and California (Hammond et al. 2008). Its southern range extends to Rio Grande do Sul in Brazil, about 32°S in the eastern Atlantic, Natal, Timor Sea, Coral Sea, New Zealand, and Botija (24°30'S) in northern Chile (Rice, 1998). Monteiro et al. (2000) and Ott and Danilewicz (1996) confirm a few sightings and by-catches of *S. bredanensis* off Brazil.

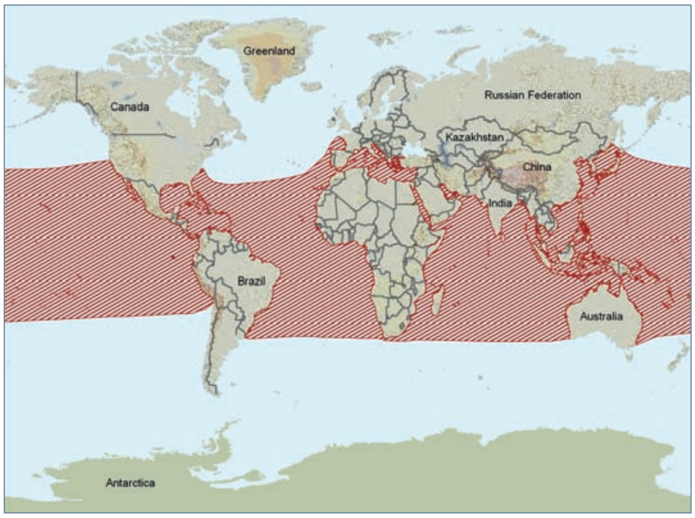
Recently, the species has been observed in the US Exclusive Economic Zone (EEZ) waters of American Samoa (Johnston et al. 2008), off the Marquesas and Windward Islands Islands in French Polynesia as well as around Tahiti and Moorea. (Gannier 2002; Gannier and West, 2005), off the Island of St Helena in the tropical south-eastern Atlantic (Macleod and Bennet 2007), and off northern Angola (Weir 2007).

Ocasionally vagrant north to Oregon and Washington in the eastern Pacific (Ferrero et al. 1994; Rice, 1998), but see abundance below; visitor to the Mediterranean Sea (Hammond et al. 2008).

3. Population Size

There are few recent abundance estimates. *S. bredanensis* is one of the most common delphinids of the U.S. Exclusive Economic Zone (EEZ) around the Hawaiian Islands where its abundance was estimated at 8,709 (CV = 0.45) from a 2002 survey (Barlow, 2006). The best available abundance estimate for the species in the northern Gulf of Mexico is the combined estimate for both the outer continental shelf and oceanic waters obtained in 2003-2004 which is 2,653 (CV = 0.42) (Waring et al. 2008). More to the north, however, abundance is unknown, as the species was no longer seen during surveys conducted off the eastern U.S. and Canadian Atlantic coast after 1999 (Waring et al. 2008).

Previous estimates indicate that 146,000 (CV = 0,32) rough-toothed dolphins inhabit the eastern tropical Pacific (Wade and Gerrodette, 1993). During a number of survey cruises conducted in the region over a period of approximately 20 years,



Distribution of Steno bredanensis: deep tropical, subtropical and warm temperate waters around the word (Hammond et al. 2008; © IUCN Red List).

176 of 4,006 schools of small cetaceans seen were of rough-toothed dolphins; the species was encountered less often than *Stenella attenuata*, *S. longirostris*, *S. coeruleoalba*, *Delphinus delphis*, *Globicephala macrorhynchus*, *Grampus griseus*, and *Tursiops truncatus* but more often than *Peponocephala electra*, *Orcinus orca*, *Pseudorca crassidens*, *Feresa attenuata*, *Kogia* spp. and beaked whales. However, this ranking could be affected by relative sightability as well as by abundance (Miyazaki and Perrin, 1994 and refs. therein).

4. Biology and Behaviour

Habitat: Most often *S. bredanensis* is found in deep water far offshore, usually beyond the continental shelf (Maigret, 1995). Off the Canary Island of La Gomera, *S. bredanensis* was found in waters of 506 m mean depth, but mean distance from shore was only 4.4 km (Ritter, 2002). In the Pacific, around the main Hawaiian Islands, sighting rates were highest in waters of >1,500 m and associated with upwelling (Baird et al. 2008). Near the Windward Islands of French Polynesia, rough-toothed dolphins were usually sighted 1.8 to 5.5 km from the barrier reef, in water depths between 1,000 and 2,000 m (Gannier and West, 2005). Ritter (2002) reported that the year-round abundance off La Gomera, Canary Islands, indicates that this species might endure temperatures well below 25°C.

Behaviour: *S. bredanensis* is a fast swimmer, sometimes porpoising with low, arc-shaped leaps. It may swim rapidly just under the surface, with its dorsal fin and a small part of the back clearly visible. Sometimes it bow-rides, especially in front of fast-moving vessels, though not as readily as many other tropical dolphins. *Steno* may associate with bottlenose dolphins and pilot whales and, less frequently, with spinner dolphins and spotted dolphins. They also may occur with shoals of yellowfin tuna, *Thunnus albacares* (Carwardine, 1995; Miyazaki and Perrin, 1994).

Off La Gomera, Canary Islands, behavioural data collected for 26 sightings showed that the reaction of the animals to the observation vessel varied from no response to interaction. Predominant types of boat-related behaviours were approaching (46%), bowriding (21%), and scouting (20%; Ritter, 2002). This is confirmed by observations off the coast of Utila, Honduras, where dolphins sometimes expressed interest in the research vessel and other boats by approaching and on separate occasions examining a hydrophone and slow moving propeller visually and by echolocation (Kuczaj and Yeater, 2007).

Schooling: Schools of up to 50 animals have been reported in the eastern tropical Pacific and central Atlantic (Ritter, 2002), but smaller groups of 10-20 seem more usual (e.g. Gannier and West, 2005). Five schools in Japanese waters contained from 23 to 53 animals. However, these small schools may be parts of larger, dispersed aggregations; one such aggregation of "schools" observed from the air off Hawaii contained an estimated 300 dolphins, and another seen in the Mediterranean contained approximately 160 animals in eight groups of about 20 each (Miyazaki and Perrin, 1994 and references therein). Near Utila, Honduras, behavioural observations suggest synchronous behaviours and 'tight' groupings during travelling, tactile contact being an important aspect of social interactions, and cooperative behaviour during play (Kuczaj and Yeater, 2007). In the eastern tropical Pacific, they tend to associate with other cetaceans (especially pilot whales and Fraser's dolphins; Miyazaki and Perrin, 1994).

Reproduction: Males reach sexual maturity at about 14 years and females at about 10 years. Animals may reach 32-36 or more years of age (Miyazaki and Perrin, 1994).

Food: The diet in the wild includes fish and squid. Cephalopods reported from stomach contents include *Teuthowenia* sp. and *Tremoctopus violaceus*. The alga *Sargassum filipendula* was found in the stomachs of several stranded animals; the significance of this is unknown. The stomachs of animals stranded in Hawaii contained the atherinid *Pranesus insularum*, the scomberesocid *Cololabis adocetus*, the belonid *Tylosurus crocodilus*, all nearshore species, and squid. Other, larger fish may be taken in deeper water. Co-operative food gathering has been reported (Miyazaki and Perrin, 1994 and refs. therein; Pitman and Stinchcomb, 2002) reported on four separate observations of rough-toothed dolphins apparently preying on adult-sized (>1 m) mahimahi (*Coryphaena hippurus*) in the eastern Pacific. Maximum reported dive depth was 70 m, but they may dive deeper. Maximum dive duration was 15 min (Jefferson, 2009).

5. Migration

This species is difficult to observe at sea; schools are extremely difficult to follow, staying submerged for as long as 15 min (Miyazaki and Perrin, 1994). Around Hawaii, frequent within- and between-year resightings indicate a small local population with high site fidelity. Resighting rates were lower off Kaua'i-Ni'ihau, indicating a larger population size, but with some site fidelity. Two individuals were documented moving from Kaua'i to Hawai'i, a distance of 480 km, the largest travelling distance reported for the species (Baird et al. 2008).

6. Threats

Mass strandings: Miyazaki and Perrin (1994 and references therein) posited that mass stranding may reduce population size. A school of 17 stranded in Hawaii in 1976. Further mass strandings have been summarised by Maigret (1995). The reasons for such mass strandings are to date poorly understood. A possible cause is disorientation, caused by parasites affecting the inner ear, by damage due to military sonar or geological prospection, or by variability in the earth's magnetic field, coupled with altruistic behaviour (herd members not abandoning one another).

In the late 1990's, IMMRAC (the Israeli Marine Mammal Research and Assistance Center) examined 7 strandings of rough-toothed dolphins along the entire Mediterranean Israeli coastline. The species is considered rare in the Mediterranean, and this regional clustering seems rather unusual. It is interesting to notice that all the standings occurred between the months of February and April: presumably during a seasonal migration (Aviad Scheinin, pers. comm.).

Directed fisheries: Small numbers were taken in drive fisheries at Okinawa in the Ryukyus and in the home islands of Japan, the Solomon Islands and Papua New Guinea. Some may still be taken by harpoon in Japan, Taiwan, at St Vincent in the Lesser Antilles and in West Africa. However, only 23 rough-toothed dolphins were captured off Japan (Okinawa) during the period 1976-81 (Miyazaki and Perrin, 1994 and refs. therein; Hammond et al. 2008).

By-catches: A few rough-toothed dolphins are killed incidentally in tuna purse seines in the eastern tropical Pacific: 21 were estimated killed during the period 1971-75, and 36 died in a single net haul in 1982. Small numbers are also taken as by-catch in gillnet and driftnet fisheries in Sri Lanka, Brazil, the Central North Pacific, Taiwan and probably elsewhere around the world in tropical and warm-temperate waters (Miyazaki and Perrin, 1994 and references therein; Hammond et al. 2008).

Monteiro et al. (2000) reported on fishery-related mortality along the coast of Ceara state, Northeast Brazil, commenting on the possible conservation implications for the local populations. From January 1992 to December 1998, a total of 13 strandings occurred along the coast, mostly during the austral spring (October-December). Most animals were recovered in areas where finfish fisheries and stranding survey efforts were highest.

There has been no reported fishing-related mortality or serious injury of rough-toothed dolphins during 1992-2006 in the Northern Gulf of Mexico (Waring et al. 2008).

Pollution: Polychlorinated biphenyls(PCBs) are persistent, long distant movable and highly bioaccumulative contaminants in the marine environment. Levels of PCBs and Dichlor-diphenyl-dichlor-ethen (DDE) in the blubber of two specimens collected in the western Pacific were lower by two orders of magnitude than those recorded in *S. coeruleoalba* and other delphinids (Miyazaki and Perrin, 1994 and refs. therein). However, a subsequent study showed that the levels of PCBs in marine mammals would reach peak levels between 2000 and 2030. Compared with toxicity equivalents in other dolphinids from around the world, the toxicity equivalent of PCBs in rough-toothed dolphin from Dapeng Bay, Gguangdong, China, was at relatively high levels (Huang et al. 2007). Similarly, Marsili and Focardi (1997) reported on chlorinated hydrocarbon concentrations in specimens from the Mediterranean Sea. Concentration of toxaphene and polybrominated diphenyl ethers from rough-toothed dolphins stranded on the coast of Massachussetts were 1.4 µg/g and 0.5 µg/g wet mass, approximately one order of magnitude lower than in *L. acutus* (Tuerk et al. 2005).

7. Remarks

Range states (Hammond et al. 2008): Algeria; American Samoa; Anguilla; Antigua and Barbuda; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil; British Indian Ocean Territory; Brunei Darussalam; Cambodia; Cameroon; Cape Verde; Cayman Islands; Chile; China; Cocos (Keeling) Islands; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Cuba; Djibouti; Dominica; Dominican Republic; Ecuador; El Salvador; Equatorial Guinea; Ethiopia; Fiji; France (Corse); French Guiana; French Polynesia; Gabon; Gambia; Ghana; Gibraltar; Greece (Kriti); Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Israel; Italy (Sardegna, Sicilia); Jamaica; Japan; Kenya; Kiribati; Kuwait; Liberia; Libyan Arab Jamahiriya; Madagascar; Malaysia; Maldives; Marshall Islands; Martinique; Mauritania; Mexico; Micronesia, Federated States of; Morocco; Mozambique; Myanmar; Namibia; Nauru; Netherlands Antilles; New Caledonia; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal; Puerto Rico; Qatar; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Sao Tomé and Principe; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Spain (Baleares, Canary Is.); Sri Lanka; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; Turks and Caicos Islands; United Arab Emirates; USA; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen.

IUCN Status: "Least Concern" (Hammond et al. 2008). Not listed by CMS but listed in Appendix II of CITES.

See also recommendations on South American stocks in Hucke-Gaete (2000) in Appendix 1 and recommendations on Southeast Asian stocks in Perrin et al. (1996) in Appendix 2.

8. Sources (see page 291)

3.69 Tasmacetus shepherdi Oliver, 1937

English: Shepherd's beaked whale; Tasman beaked whale
German: Shepherdwal
Spanish: Ballena picuda de Shepherd
French: Tasmacète de Shepherd

Family Ziphiidae

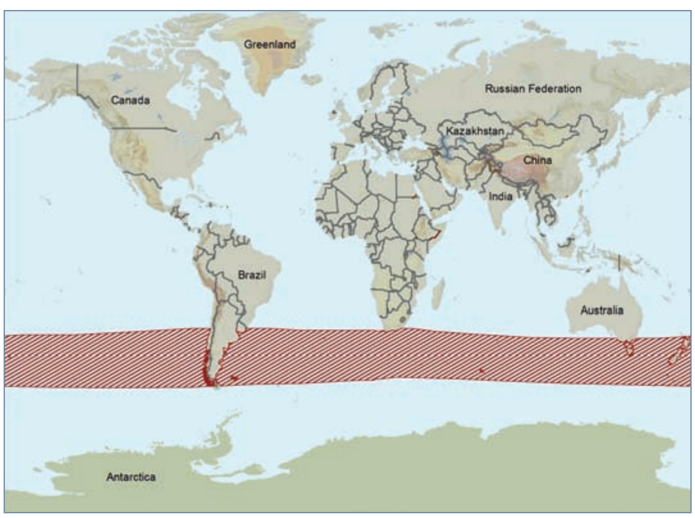
Tasmacetus shepherdi / Shepherd's beaked whale (© Wurtz-Artescienza)

1. Description

Tasmacetus shepherdi is thought to be a rare animal, known from only 29 strandings and 6 sightings in the Southern Hemisphere (Mead, 2009). However, limited survey effort in deep offshore waters may partly explain its apparent scarcity. Adults are between 6 and 7 m long and have a full set of functional teeth, as opposed to all other beaked whale species. Colouring is distinctive for ziphiids (Jefferson et al 2008) dark grey dorsally with a white ventral field extending towards the back on both anterior and posterior sides of the flippers (Mead, 2002) and on the side of the face just below gape and eye (Jefferson et al. 2008).

2. Distribution

Tasman's beaked whale is probably circumglobal in temperate waters of the Southern Hemisphere (Rice, 1998; Mead, 2009). It is associated with cooler waters from 33°S to 53°50'S.



Distribution of Tasmacetus shepherdi: cold temperate waters of the Southern Hemisphere, predominantly New Zealand (mod. from Mead, 2009, Taylor et al. 2008; © IUCN Red List).

Mead (2009) lists a total of six published sightings from New Zealand, the Seychelles (Islands), the South Sandwich Islands, Tristan da Cunha and Tasmania.

3. Population size

Nothing is known about the relative abundance of this species or its population composition. It is suspected, based on the lack of identified sightings, that all ziphiids except *Berardius* and *Hyperoodon*, have relatively small populations. This could also be due to their naturally cryptic habits (Mead, 1989). However, it is possible that the species may be somewhat more widespread than the records suggest, since it was not likely to be accurately identified at sea until its recent re-description (Pitman et al. 2006).

4. Biology and Behaviour

Habitat: Mead (2009) suggests that similarly to the other beaked whales, Shepherd's beaked whale presumably feeds offshore in deep waters.

Schooling: Pitman et al. (2006) report of aerial photographs (Tristan da Cunha Islands, Gough island, South Atlantic Ocean) of various groups ranging from 4 - 5 Shepherd's whales.

Food: Mead and Payne (1975) examined a stranded adult female in Argentina and found traces of bottom fish, squid and a small crab. Pitman et al. (2006) reports that a stranded animal from Tristan da Cunha had only cephalopod remains in its stomach: "single buccal masses from *Todarodes filippovae* and *Teuthowenia pellucida*, single beaks from *Ancistrocheirus lesueuri* and *Histioteuthis*, and one unidentified cephalopod beak; all the eye lenses present were from cephalopods, not fish".

5. Migration

Six of the strandings have occurred in the southern summer (November-March) and one has occurred in the winter (August). This is too small a sample on which to base conclusions on seasonal distribution (Mead, 1989).

6. Threats

There are no records of human exploitation (Jefferson et al. 1993, Mead, 2009). Marine pollution, however, might pose a problem, as one stranded calf was found to have plastic debris in its stomach (Mead, 2009).

7. Remarks

Range states (Taylor et al. 2008): Argentina; Australia; Chile (Juan Fernández Is.); New Zealand (Stewart and Chatham Is., North Is., South Is.); Saint Helena (Tristan da Cunha); South Africa.

Tasman's beaked whale is listed by the IUCN as "Data Deficient" and not listed by CMS. Listed on Appendix II of CITES.

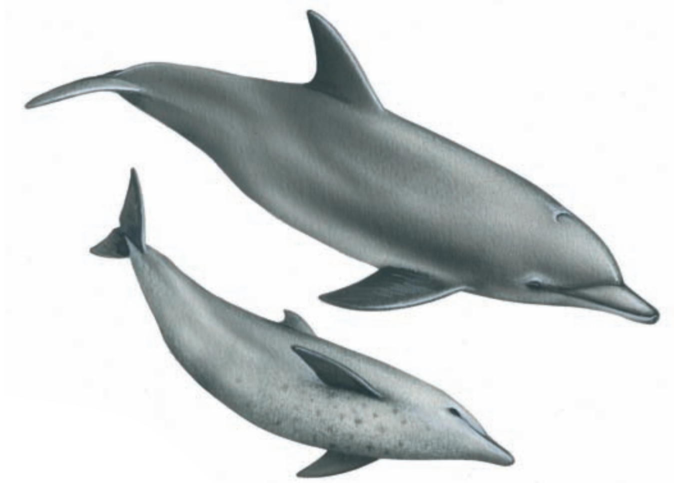
T. shepherdi also occurs in southern South America, there fore the recommendations iterated by the scientific committee of CMS for small cetaceans in that area (Hucke-Gaete, 2000 in Appendix 1) also apply.

8. Sources (see page 292)

3.70 Tursiops aduncus (Ehrenberg, 1833)

English: Indo-Pacific bottlenose dolphin, Indian Ocean bottlenose dolphin
German: Großer Tümmler des Indischen Ozeans
Spanish: Delfín mular del Oceano Indico
French: Grand dauphin de l'Océan Indien

Family Delphinidae

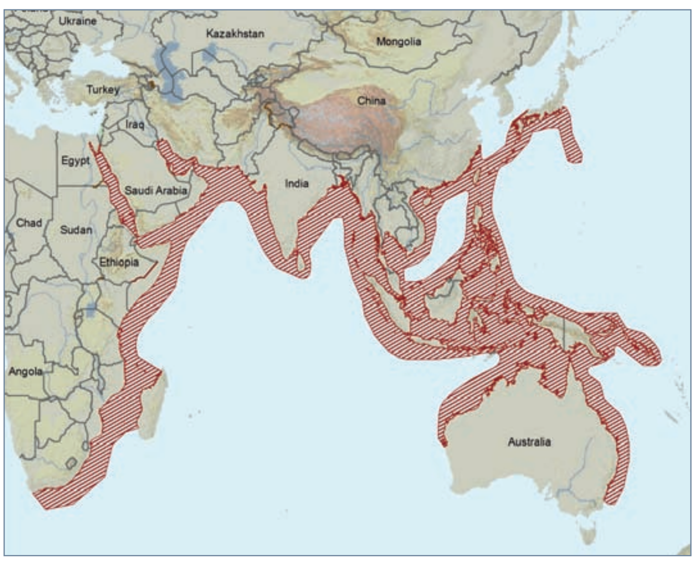


Tursiops aduncus / Indo-Pacific bottlenose dolphin (© Wurtz-Artescienza)

1. Description

T. aduncus resembles *T. truncatus*, having a relatively robust body, moderately long beak, and a falcate dorsal fin (Jefferson et al. 2008). However, the species tends to be smaller than *T. truncatus*, has a proportionately longer rostrum and, most distinctivly, develops ventral spotting at about the time of sexual maturity (Wells and Scott, 2002). Maximum size is geographically variable, with length and weight for males of 238 cm and 160 kg respectively off Zanzibar, East Africa (Amir et al. 2007) and maximum reported values of 2,7 m and 230 kg, respectively (Jefferson et al. 2008).

The taxonomic status of *Tursiops aduncus* was uncertain until 1999, when Wang et al. (1999) confirmed that in Chinese waters two genetically distinct morphotypes of bottlenose dolphins, which he referred to *T. truncatus* and *T. aduncus*, existed in sympatry.



Distribution of Tursiops aduncus in coastal tropical to warm temperate waters of the Indian and western Pacific Oceans (Hammond et al. 2008; Wang and Yang, 2009; © IUCN Red List).

Genetic evidence suggests that *T. aduncus* is more closely related to pelagic *Stenella* and *Delphinus* species, and in particular to *S. frontalis*, than to *T. truncatus* (Wells and Scott, 2002). However, this seems to be inconsistent with osteological characters (Wang and Yang, 2009), and further studies using multiple independent characters will be required to resolve these issues.

2. Distribution

Information on the distribution of *T. aduncus* is patchy, but the species seems to be widespread along the entire eastern coast of Africa, through the Red Sea and Persian Gulf, eastwards as far as Taiwan and south-eastward to the coastal waters of Australia (Curry and Smith,1997; Möller and Beheregaray, 2001; Wells and Scott, 2002). However, the level of continuity in the distributional range is unknown (Wang and Yang, 2009).

3. Population size

In some regions where these dolphins have been studied, the populations have been found to be small compared to nearby open-ocean populations of common bottlenose dolphins (*T. truncatus*) and other species.

Off the south coast of Zanzibar, East Africa, Stensland (2004) estimated population size at 161 (95% CI 144-177). High frequency of re-sightings indicated that the species was resident in the area.

For the Arabian Gulf (Preen, 2004) report population size to reach 1,200. In the region between Kuwait and Oman, the Indian Ocean bottlenose dolphin is the most common cetacean (71% of groups and individuals). However, the estimates of cetacean abundance in the United Arab Emirates differed significantly between 1986 and 1999 and indicated a population decline of 71%. At least two die-offs of marine mammals occurred between these surveys.

Known large concentrations are in regions with large shallow-water areas. There are 2,700 in Shark Bay on the western coast of Australia (Preen et al. 1997) and 700-1,000 around North Stradbroke Island on the eastern coast of Australia

(Chilvers and Corkeron, 2003). Cribb (2006) counted 191 individuals in the Adelaide Dolphin Sanctuary, Gulf St Vincent, South Australia. Lukoschek and Chilvers (2008) used different methods to estimate abundances of bottlenose dolphins in central eastern Moreton Bay in 2000 and found 407 (± 113.5) animals in that area with a line-transect study. As opposed to this, they determined 818 (± 152) animals for 1998 with a photo-identification study. The reasons for the difference seem to lie in the different methodologies employed.

In the coastal waters of Amakusa-Shimoshima Island, western Kyushu, Japan, Shirakihara et al. (2002) estimated population size in 1995-1997 at 218 individuals (CV = 5.41 %). In Kagoshima Bay there were 50 individuals in 1999, 40 individuals in 2000, and 50 individuals in 2001. The slight change in the number of identified dolphins indicated the possibility of their residency inside the bay (Nanbu et al. 2006).

Given the restricted areas of potentially suitable habitat, populations of *T. aduncus* in the South Pacific islands are likely small, i.e. in the hundreds (Reeves and Brownell, 2009).

4. Biology and Behaviour

Habitat: Boat based and photo-identification surveys conducted in the Adelaide Dolphin Sanctuary, Gulf St Vincent, South Australia, yielded a large mean dolphin group size over the bare sand habitat for all behavioural activities observed (Cribb, 2006). However, in other regions, *T. aduncus* prefers areas with rocky and coral reefs, or sea grass. They can be found over waters 200 m deep but are encountered most frequently in waters shallower than 100 m. They seem to prefer water temperatures of 20-30°C, with a minimum of 12°C (Wang and Yang, 2009).

Schooling: Lukoschek and Chilvers (2008) estimated group size of bottlenose dolphins in central eastern Moreton Bay using line-transect surveys in 2000, obtaining a mean of 2.85 animals per group. Mark-recapture surveys in 1998 yielded 5.78 animals per group. Differences in methodologies employed seem to be responsible for the discrepancies observed. Connor et al. (2006) reported that synchronous surfacing in male bottlenose dolphins is associated with alliance membership and that synchrony between members of cooperating alliances is more common during social behaviour with female consorts. Males within the alliance form temporary trios and occasionally pairs in order to consort with individual females (e.g. mounting, displays, chasing; Connor et al. 2001).

In Kagoshima Bay (Japan), Indo-Pacific bottlenose dolphins were observed near the shore of the innermost area of the bay. The mean school size was 30 individuals (Nanbu et al. 2006). In the coastal waters of Amakusa-Shimoshima Island, western Kyushu, Japan, the group commonly consisted of more than 100 individuals. The large group size was thought to be a requirement for feeding on schooling fishes (Shirakihara et al. 2002).

Mixed-species groups of Indo-Pacific bottlenose and humpback dolphins frequently occur off the south coast of Zanzibar. Defense against predators coupled with social advantages may offer an explanation for the formation of these groups. However, mixed-species groups may have different functions depending on the individuals that participate (Stensland, 2004). Mixed-species groups include *T. truncatus*, *Pseudorca crassidens*, *Delphinus* sp., *Sousa chinensis*, and *Stenella longirostris* (Wang and Yang, 2009).

Reproduction: In the Port River estuary, Adelaide, South Australia, Steiner and Bossley (2008) found the calving season to last from December to March, which coincides with the maximum surface water temperature of the estuary. Inter-birth intervals was 3.8 years when the previous calf was weaned and 1.7 years when the previous calf died. Average crude birth rate was 0.064, which is similar to that found for other bottlenose dolphin populations. Average gestation time is 12 months (Wang and Yang, 2009). Around Zanzibar (Unguja) Island (Amir et al. 2007) calves were born at a length of around 104.5 cm and weight of 15.5 kg. Males became sexually mature at about 13 years, which is late for dolphins, at a length about 202 cm and weight of 112 kg. They may live more than 36 years, based on counts of Growth Layer Groups (GLGs) in teeth.

Food: There is great geographical variety in the species' diet. The primary prey species seem to be benthic and reef-dwelling fish and cephalopods, less than 30 cm in length, of continental shelf waters (Wang and Yang, 2009). Off the coast of Zanzibar, Indo-Pacific bottlenose dolphins forage on a relatively large number of prey species. However, only a few small- and medium-sized neritic fish and cephalopods contribute substantially to the diet. While stomach contents comprised 50 species of bony fish and three species of squid, only 5 species of fish, *Uroconger lepturus*, *Synaphobranchus kaupii*, *Apogon apogonides*, *Lethrinus crocineus*, *Lutjanus fulvus*, and 3 species of squid, *Sepioteuthis lessoniana*, *Sepia latimanus* and *Loligo duvauceli*, were the most important prey. *Uroconger lepturus* proved to be the most important prey species of mature dolphins, whereas *Apogon apogonides* was the preferred prey of immature dolphins.

The ecology and behavior of the preferred fish prey species indicate that the dolphins in that area forage over reefs or soft bottom substrata and near the shore (Amir et al. 2005a). Around oceanic islands, epi- and mesopelagic fish and cephalopods as well as benthic crustaceans dominate the diet (Wang and Yang, 2009).

5. Migration

Dolphins of different regions appear to exhibit strong year-round residency and natal philopatry in both sexes, with males being more dispersive than females. Although generally considered a coastal species, movements across deep oceanic waters have been reported (Wang and Yang, 2009).

Fury and Harrison (2008) investigated habitat utilisation in two Australian subtropical estuaries and found that 60 % and 37 % of identified dolphins were residents, 26 % and 21 % occasional visitors and 14 % and 42 % transients in the Clarence and Richmond Rivers, respectively.

In the coastal waters of Amakusa-Shimoshima Island, western Kyushu, Japan, individuals identified in one season were frequently resighted, with percentages of mostly over 60 % during subsequent seasons. Most of the dolphins off Amakusa were year-round residents, although the total extent of their habitat was unknown (Shirakihara et al. 2002).

6. Threats

Indo-Pacific bottlenose dolphins in coastal areas are exposed to reduced prey availability caused by environmental degradation and overfishing as well as habitat degradation due to marine construction and demolition. The cumulative impact of these threats and those listed below is likely to result in longitudinal population declines (Hammond et al. 2008). E.g. in the Port River estuary, Adelaide, South Australia, Steiner and Bossley (2008) reported high calf mortality rates caused by direct impacts by entanglements, boat strikes, deliberate attacks, or exposure to toxic pollution: First-year calf mortality (30%) and mortality rate for calves prior to weaning (46%) were higher than mortality rates described for other locations.

Direct catch: In many regions of the world, e.g. Philippines, Taiwan and East Africa, the species is taken directly for human consumption or as bait for fishing operations. Through past drive hunting, hundreds may have been captured per season in the Penghu Islands, although only 20 were captured in 1993, possibly an indication of local depletion (Wang and Yang, 2009).

Incidental catch: Shark nets placed along the coast of KwaZulu-Natal, South Africa, to protect bathers from shark attacks result in an incidental by-catch of dolphins at twice the level suggested by the IWC as the maximum sustainable capture rate for a cetacean population (Natoli et al. 2008).

Incidental catches are reported from drift- and bottom set gillnet fisheries off Zanzibar (Unguja Island). Amir et al. (2002) expressed concern over exceedingly high by-catch rates for *T. aduncus* at this location; between 1995 and 1999, 43 Indo-Pacific bottlenose dolphins were reported taken, 50 % of these in 1999. However, the numbers were extrapolated to about twice that value. In a later study (Amir et al. 2005b), conducted between 2000 and 2003, 68 Indo-Pacific bottlenose dolphins were recorded. Most of the bycatches (71 %) were in nets set off the north coast of Unguja Island. These figures suggests that the incidental capture of dolphins in Zanzibar's artisanal gillnet fisheries is an ongoing problem and is high enough to have a significant negative impact on local populations.

A large number of possibly over 2,000 per year was incidentally taken in northern Australian waters by a Taiwanese drift gillnet fishery in the 1980s, which after establishment of strict regulations moved into neighbouring waters off Indonesia (Wang and Yang, 2009).

Live capture: The government of the Solomon Islands issued a permit for export of up to 100 live dolphins per year in 2008, most likely to be only *T. aduncus*. If an international standard rule allowing 1 % or 2 % of a population to be removed annually were applied in this instance, the local *T. aduncus* population would have to be at least 5,000 or 10,000 to sustain the permitted level of exports. However, an ongoing photo-identification study around Guadalcanal Island has catalogued only something more than 100 individuals (Reeves and Brownell, 2009).

Pollution: Lavery et al. (2008) report on trace metal concentrations in stranded or by-caught *T. truncatus* in South Australia from 1988 to 2004. This species had higher mean tissue burdens of liver Pb (0.45 g/kg), Cd (6.45 mg/kg), Hg (475.78 mg/kg), Se (178.85 mg/kg) and Zn (93.88 mg/kg) and bone Pb (2.78 mg/kg), as opposed to *D. delphis* and *T. truncatus*, probably reflecting their coastal habitat and benthic prey. Lavery et al. (2009) found that two dolphins had high metal burdens, high metallothionein concentrations, renal damage, and evidence of bone malformations, indicating possible severe and prolonged metal toxicity.

Tourism: Stensland and Berggren (2007) found behavioural changes in Indo-Pacific bottlenose dolphins in response to boat-based tourism off the south coast of Zanzibar. While movement patterns of dolphin groups were not affected by the presence of 1 to 2 tourist boats without swimmers, groups displayed a significantly larger proportion of erratic (non-directional) movements as tourist activities increased and when swimmers were present. Females travelled more frequently, with potential negative effects on the time available to nurse their calves. Intense non-regulated dolphin tourism may lead to a shift in habitat use by nursing females, and the apparent changes in dolphin behaviour due to the increased levels of tourism may ultimately reduce fitness at both individual and population levels.

Natural threats: Both scar frequencies and attack rate suggest that dolphins in Shark Bay, Western Australia face a greater risk of predation than bottlenose dolphins in other locations. Bite scars from sharks were found on 74.2% (95 of 128) of non-calves; most of these were inflicted by tiger sharks (*Galeocerdo cuvier*). Large sharks (>3 m) are responsible for a disproportionate number of attacks. However, bites from small carcharhinid sharks on 6.2% of dolphins suggest that some of these small sharks may be dolphin ectoparasites (Heithaus, 2001).

7. Remarks

Range states (Hammond et al. 2008): Australia; Bangladesh; Brunei Darussalam; Cambodia; China; Djibouti; Egypt; Eritrea; Guam; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Japan; Kenya; Madagascar; Malaysia; Mozambique; Myanmar; Northern Mariana Islands; Oman; Pakistan; Papua New Guinea; Philippines; Saudi Arabia; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; United Arab Emirates; Viet Nam; Yemen.

T. aduncus is categorized as "Data Deficient" by the IUCN (Hammond et al. 2008). However, the variety and intensity of threats the species is exposed to may well lead to a reconsideration of this status. There are serious concerns about the depletion of local populations, particularly as the species shows strong residency and limited population sizes in many regions (Wang and Yang, 2009).

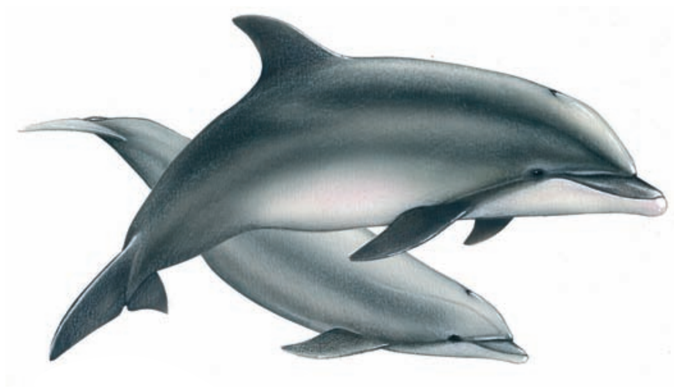
Populations in the Arafua/Timor Sea are listed in Appendix II of CMS. For general remarks on south-east Asian species, see also Perrin et al. (1996). The species is listed in Appendix II of CITES.

8. Sources (see page 292)

3.71 Tursiops truncatus (Montagu, 1821)

English: Common bottlenose dolphin
German: Großer Tümmler
Spanish: Delfín mular
French: Grand dauphin

Family Delphinidae



Tursiops truncatus / Common bottlenose dolphin (© Wurtz-Artescienza)

1. Description

The common bottlenose dolphin is presumably the most familiar of the small cetaceans because of its coastal occurrence around the world, its prevalence in dolphinaria and zoos and its frequent appearance in the media (Jefferson et al. 2008). This species is recognized by its medium-sized, robust body, with a sharp demarcation between the melon and the short rostrum, and the moderately curved dorsal fin. Pigmentation is light grey to black dorsally, with a light belly. Adult length ranges from 2-3.8 m and body mass from 220-500 kg, varying geographically. Body size seems to vary inversely with water temperature in many parts of the world (Bloch and Mikkelsen, 2000; Wells and Scott, 2009).

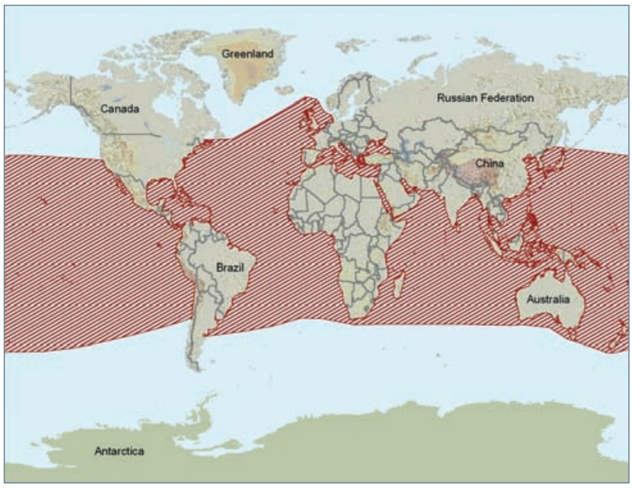
Geographical variation in bottlenose dolphins is only vaguely comprehended, and in most parts of the world subspecific designations are best avoided. The name *T. t. truncatus* (type locality: Great Britain) may be applied to the offshore populations on both sides of the North Atlantic, and some authors have used it for similar animals that live in the temperate waters of the western North Pacific, South Africa, Walters Shoal, southern Australia, and New Zealand (Rice, 1998 and refs. therein).

Often, there are size differences between neighbouring populations: The dolphins that live in the Black Sea (named *T. t. ponticus* Barabash-Nikiforov, 1940) are smaller than those in the North Atlantic and possess a uniquely shaped skull, while those in the Mediterranean are intermediate in size. The Black Sea population was found to be genetically distinct from these two populations, with relatively low levels of mtDNA diversity (Viaud-Martinez et al. 2008).

In some parts of the world, sharply differentiated inshore and offshore populations live in close proximity. Results of mtDNA analyses do not indicate genetic isolation among offshore populations from different ocean basins, but do show that there are differing coastal or inshore populations which are genetically isolated from offshore populations (Rice, 1998 and refs. therein). Thus bottlenose dolphins occurring in the pelagic waters of the North Atlantic, including the Azores and Madeira archipelagos, were shown to belong to a large oceanic population, which must be regarded as a single conservation unit (Querouil et al. 2007).

In the eastern South Pacific, there is also genetic evidence for a single, wide-ranging Peru-Chile offshore stock, whereas a separate cluster is formed by the Peruvian inshore ecotype and a single resident inshore community (pod-R) in central-north Chile differing from both (Sanino et al. 2005).

Oceanic bottlenose dolphins seem to maintain high levels of gene flow, unlike coastal populations. E.g. in the Gulf of Mexico, a significant genetic population structure was found among four resident, inshore bottlenose dolphin stocks (Sarasota Bay, FL, Tampa Bay, FL, Charlotte Harbor, FL and Matagorda Bay, TX) and one coastal stock (1-12 km offshore). This is surprising given the short geographical distance between many of these areas and the lack of obvious geographic barriers to prevent gene flow (Sellas et al. 2005).



Tursiops truncatus is distributed worldwide in cold temperate to tropical seas (map mod. from Hammond et al. 2008; © IUCN Red List).

Finally, genetic work (Le Duc et al. 1999; Wells and Scott, 2009), osteological comparisons (Wang et al. 2000; Wang and Yang 2009) and morphological analyses by Hale et al. (2000) support the view that the widespread common bottlenose dolphin (*T. truncatus*) is reproductively isolated from the Indo-Pacific bottlenose dolphin (*T. aduncus*).

2. Distribution

Bottlenose dolphins are found primarily in coastal and inshore regions of tropical and temperate waters of the world, and population density seems to be higher near-shore. There are also pelagic populations, such as those in the eastern tropical Pacific and around the Faroe Islands. The bottlenose dolphins occurring around the Faroe Islands (62°N 7°W) seem to be the most northerly of the North Atlantic offshore populations (Bloch and Mikkelsen, 2000).

In the Atlantic, *T. truncatus* occurs north to Massachusetts, the southern coast of Iceland, northern Norway (Lofoten Islands), the Mediterranean and Black seas. In the Pacific it ranges north to the Okhotsk Sea, the Skuril Islands and Central California. In the Southern Hemisphere *T. truncatus* occurs south to Tierra del Fuego, South Africa, Australia and New Zealand (Wells and Scott, 2009). The species is rare in the Baltic Sea, and there is some question as to its occurrence in the Barents Sea (Wells and Scott, 1999 and refs. therein).

3. Population size

Summing available estimates, a minimum world-wide estimate is 600,000 (Wells and Scott, 2009; Hammond et al. 2008). There are recent abundance estimates for several parts of the species' range, but the there is generally insufficient data to estimate population trends:

Atlantic:

From central Florida to Canada, the abundance estimate of the western North Atlantic offshore stock from aerial and vessel surveys conducted between 2002 and 2004 provides complete coverage of the offshore habitat during summer months. The combined abundance estimate from these surveys is 81,588 (CV = 0.17; Waring et al. 2009).

From Florida to New Jersey, the primary habitat of the western North Atlantic coastal morphotype during summer months is in waters less than 20 m deep, including estuarine and inshore waters. Re-analysis of stranding data (McLellan et al. 2003) and extensive analysis of genetic, photo-identification, satellite telemetry, and stable isotope studies demonstrate a complex mosaic, with seven prospective stocks of coastal morphotype bottlenose dolphins inhabiting nearshore coastal waters along the Atlantic coast. Best estimates are from summer aerial surveys conducted in 2002 and/or 2004: Northern Migratory Stock: 7,489 (CV = 0,36), Southern Migratory Stock: 10,341 (CV = 0,33), Southern North Carolina stock: 4,818 (CV = 0,50), South Carolina stock: 1,952 (CV = 0,28), Georgia stock: 5,996 (CV = 0,37), Northern Florida stock: 3,064 (CV = 0,24) and Southern Florida stock: 6,317 (CV = 0,26; Waring et al. 2009).

Estimates of the northern Gulf of Mexico coastal stocks date from 1991-1994 surveys with 9,912 (CV = 0,12) in the eastern, 4,191 (CV = 0,21) in the northern and 3,499 (CV = 0,21) in the western parts of the northern Gulf of Mexico (Waring et al. 2009). For the northern Gulf of Mexico continental shelf and slope stock, the best abundance estimate is based on data pooled from 2000 through 2001 for continental shelf vessel surveys and is 17,777 (CV= 0.32) (Waring et al. 2009). The northern Gulf of Mexico Oceanic (outer continental shelf) stock estimate is pooled from 2003 to 2004 data and is 3,708 (CV = 0.42; Mullin 2007).

From the North Atlantic Sightings Surveys in 1987 and 1987 (NASS-87 and NASS-89) a very cautious estimate of the bottlenose dolphins around the Faroe Islands comes to about 1,000 animals (Sigurjónsson et al. 1989; Sigurjónsson and Gunnlaugsson, 1990; Bloch and Mikkelsen, 2000).

A wide-scale survey in 2005 of western European continental shelf waters including the western Baltic, North Sea and Atlantic margin as far as southern Spain estimated that there were 12,600 bottlenose dolphins in this area (CV = 27%; Hammond et al. 2006).

Pacific:

Estimates for the eastern tropical Pacific stem from data gathered in the early 1990's, yielding 243,500 (CV = 29 %; Wade and Gerrodette, 1993), and the same can be said for Japanese surveys in the Northwestern Pacific west of 180°E where 168,000 (CV = 26 %) were found, including 36,791 (CV = 25 %) in Japanese coastal waters (Miyashita 1993). More recently, the California/Oregon/Washington offshore stocks were estimated on the basis of ship surveys conducted between 2001-2005 at 3,257 (CV= 0.43) offshore bottlenose dolphins (Barlow 2003, Forney 2007). The California coastal stock abundance, estimated from photographic mark-recapture surveys in 2004 and 2005 and including an additional 35% of animals (lacking identifiable dorsal fin marks) was ca. 450-500 animals (Carretta et al. 2009).

Mediterranean:

In north-western Mediterranean waters, including a putative subpopulation in the Balearic Islands, total abundance was estimated as 7,654 (CV = 0.47). Abundance in inshore waters of the Balearic Islands varied from 727 (CV = 0.47) dolphins in spring 2002 to 1,333 (CV = 0.44) dolphins in autumn 2002, with an average estimate of 1,030 (CV = 0.35; Forcada et al. 2004). In the central Spanish Mediterranean, aerial surveys conducted between 2001 yielded a mean abundance of 1,333 dolphins (95% CI = 739-2,407; Gomez de Segura et al. 2006). Off southern Spain, surveys conducted in the Alboran Sea between 2000 to 2003 yielded an estimate of 584 dolphins (95% CI = 278-744; Cañadas and Hammond, 2006).

In eastern Ionian Sea coastal waters boat surveys conducted between 1993 and 2003 yielded 235 bottlenose dolphin sightings. Individual photo-identification showed a relatively stable presence, some individuals showing high levels of site fidelity and others using the area only occasionally (Bearzi et al. 2005). In the 400-km² Amvrakikos Gulf, western Greece, boat surveys conducted between 2002 and 2005 yielded a total population estimate of 148 individuals (95% CI=132-180). Mean dolphin density in the Gulf was 0.37 animals km² (Bearzi et al. 2008).

The total population size in the **Black Sea** is unknown. However, there are recent abundance estimates for parts of the range suggesting that population size is at least several thousand (Birkun, 2008).

Finally, there are only a few estimates from other parts of the world. Approximately 900 bottlenose dolphins inhabit the 400 km stretch of coastal waters off Natal, south-east of southern Africa (Wells and Scott, 1999 and refs. therein; Reyes, 1991 and refs. therein). In the eastern Sulu Sea, Dolar et al. (2006) estimated the population size at 2,630.

4. Biology and Behaviour

Habitat: As a result of increased pelagic survey efforts, researchers have come to recognise *T. truncatus* as a truly cosmopolitan species. Although it tends to be primarily coastal, it can also be found in pelagic waters (Wells and Scott, 1999). Bottlenose dolphins exploit a wide variety of habitats. The inshore form frequents river mouths, bays, lagoons and other shallow coastal regions (depths between 0.5 - 20 m). Occasionally they may travel far up into rivers. In Santa Monica Bay, California, e.g. they occur year-round and are found 80% of the time in waters within 0.5 km of shore (Bearzi, 2005).

The offshore form is apparently less restricted in range and movement, and can be found in many productive areas, particularly in the tropics. Some offshore populations are residents around oceanic islands. A coastal habitat seems to be preferred in the Black Sea, with limited movements into offshore waters (Reyes, 1991 and refs. therein). Limits to the species' range appear to be temperature related, either directly, or indirectly through distribution of prey.

Off the coasts of North America, they tend to inhabit waters with surface temperatures ranging from about 10°C to 32°C (Wells and Scott, 1999 and refs. therein). In the Gulf of Mexico off the coast of Louisiana, their distribution is correlated with depth, distance to shore, bottom oxygen, distance to the edge of a hypoxic zone and density of sciaenid fishes, particularly Atlantic croaker, *Micropogonias undulatus* (Good et al. 2006), and in Sarasota Bay, Florida, seagrass areas are particularly important to foraging dolphins (Weiss, 2006).

In Moray Firth, NE Scotland, there are clear relationships between feeding events and submarine habitat characteristics; during June and July certain forms of feeding occur primarily over steep sea bed gradients and in deeper waters (Hastie et al. 2004). Along the Dorset coast of England, chlorophyll a and fish distribution (brill, cuttlefish, plaice, Pollack, red and grey mullet, sole, sprat and spurdog) were the main factors influencing distribution and could explain 13.5% and 88% of the frequency of dolphin sightings, respectively (Sykes et al. 2003).

Food: The differences between inshore and offshore *Tursiops* are also reflected in their feeding habits. The inshore form feeds primarily on a variety of fish and invertebrates from both the littoral and sub-littoral zones, whereas mesopelagic fish and oceanic squids are commonly reported as the diet of animals of the offshore form (Reyes, 1991 and refs. therein). Diet varies with local prey availability including benthic-reef and sandy-bottom prey and their associated predators, pelagic schooling fish and cephalopods, and deeper-water fish (Wells and Scott, 1999 and refs. therein).

In North Carolina, USA, sciaenid fishes were the most common prey, with Atlantic croaker (*Micropogonias undulatus*) dominating the diet of dolphins that stranded inside estuaries, whereas weakfish (*Cynoscion regalis*) was most important for dolphins in the ocean. Inshore squid (*Loligo* sp.) was eaten commonly by dolphins in the ocean, but not in the estuaries (Gannon and Waples 2004). The overwhelming majority of prey were soniferous species, which are detected through passive listening. Gannon et al. (2005) showed that by listening passively, dolphins obtain useful information on identity, number, size and location of soniferous prey. Once prey is detected, dolphins then use echolocation for tracking during pursuit and capture.

In South Carolina, stomach contents included fish (89 % of stomachs) and cephalopods (sole dietary component in 11 % of stomachs). Dolphins preferred smaller-sized benthic and demersal fish species of the family Sciaenidae, with star drum (*Stellifer lanceolatus*) the most abundant species. Brief squid (*Lolliguncula brevis*) was the most frequently observed cephalopod (Pate, 2008).

Off the coast of Normandy, France, the diet was dominated by gadoid fish (*Trisopterus* sp.), gobies and mackerel (*Scomber scombrus*; de Pierrepont et al. 2005).

Off Galicia, north-western Spain, the most important prey species between 1990 and 2005 were blue whiting (*Micromesistius poutassou*) and hake (*Merluccius merluccius*), both of high commercial importance. Although bottlenose dolphins are often seen close inshore, their diet suggests that they feed at the shelf edge. The amount of hake in the diet remained stable against a background of falling local abundance, while the amount of blue whiting declined despite an increase in spawning stock size (Santos et al. 2007).

Off Peru, both coastal and offshore dolphins consumed Pacific sardines, anchovetas, and hake, but demersal species such as sciaenids and toadfish were found only in coastal dolphins. By contrast, the offshore animals were the only ones with mesopelagic fish and squid in their stomachs (Wells and Scott, 1999 and refs. therein).

In Mauritania and Brazil, dolphins regularly drive schools of mullet towards fishermen wading with nets in shallow water, and in other regions they have been observed feeding behind shrimp trawlers and in the vicinity of small purse seiners, collecting discarded fish from these operations after the nets are retrieved, and stealing fish from a variety of fishing gear (Wells and Scott, 1999 and refs. therein). E.g. in Florida, bottlenose dolphins prey on king mackerel (*Scomberomorus cavalla*) taken by the troll fishery. Dolphins took 6% of king mackerel caught by charter fishermen and 20% of fish caught by commercial fishermen, causing substantial losses. A modification to the outrigger planer was suggested to deter bottlenose dolphins from engaging in depredation without causing a reduction in catch (Zollett and Read, 2005).

Behaviour: Although individual feeding is perhaps most prevalent, co-operative herding of schools of prey fish has been reported from a number of regions. During the hunt, dolphins are very agile and were observed to rapidly manoeuvre during chases of fish in open water or around patches of rooted vegetation. Video analysis of chase sequences indicates that mean rate of turn was 561.6 degrees /sec with a maximum rate measured at 1,372.0 degrees /sec (or 3.8 turns per sec). High turning rates with small turning radii were primarily the result of maneuvers in which the dolphin rolled 90 degrees and rapidly flexed its body ventrally (Maresh et al. 2004). In the deep waters surrounding the Bermuda Pedestal, satellite-tracked dolphins travel a mean distance of 28.3 km/day. Dive behaviour correlates with the reported nightly vertical migrations of mesopelagic prey. At night, dive depths are greater than 450 m and last longer than 5 min. whereas during daytime dives are restricted to 50 m of the surface, lasting less than 1 min (Klatsky et al. 2007).

The plasticity of bottlenose dolphin behaviour is shown, e.g. in the San Luis Pass area near Galveston, Texas, where there are two populations of bottlenose dolphins using adjacent habitats in different ways. Resident dolphins forage predominantly in the bays and pass and display group foraging behaviour. In contrast, Gulf dolphins are only observed foraging in coastal waters, and do so individually. These behavioural differences may reflect strategies based on habitat variation but may also be indicative of distinct social structures. There is also a seasonal component to behaviour and group size, with larger mixed groups and more social behaviour occurring in summer (Henderson and Würsig, 2007).

Schooling: Group size is commonly around 2-15 animals, but large herds of several hundred to a thousand are regularly seen offshore (Bloch, 1998; Wells and Scott, 2009). In order to maintain group cohesion, bottlenose dolphins developed individually distinctive signature whistles to transmit identity information, which was found to be independent of the caller's voice or location (Janik et al. 2006).

Bottlenose dolphins are commonly associated with other cetaceans, such as pilot whales, white-sided, spotted, rough-toothed and Risso's dolphins, and humpback whales. Hybrids with other species are known from both captivity and in the wild (Jefferson et al. 1993; Bloch, 1998; Wells and Scott, 1999). However, interspecific interactions may be aggressive, and in Baia Norte, southern Brazil, e.g. attacts of bottlenose dolphins on estuarine dolphins (*Sotalia guianensis*) were observed (Wedekin et al. 2004) Aggressive and lethal interactions with harbour porpoises (*Phocoena phocoena*) were frequently reported (e.g. Read, 1999).

Reproduction: Longevity in females is more than 57 years and in males up to 48 years (Wells and Scott, 1999). Females reach sexual maturity at 5 - 13 years and males at 9-14 years. Spring and summer or spring and autumn calving peaks are known for most populations, and gestation lasts about 12 months (Jefferson et al. 1993; Wells and Scott, 2009).

5. Migration

According to Wells and Scott (1999; 2009), coastal dolphins exhibit a full spectrum of movements, including 1) seasonal migrations, 2) year-round home ranges, 3) periodic residency, and 4) a combination of occasional long range movements and repeated local residency. Long-term residency may take the form of a relatively permanent home range or repeated occurrence in a given area over many years. For example, the residents of several dolphin communities along Florida's west coast have maintained relatively stable home ranges during more than 28 years of observations. In other areas, residency is long-term but more variable. Dolphins seen frequently during 1974-1976 in Golfo San Jose, Argentina, showed a subsequent decline in frequency of occurrence, but were still occasionally identified in the area 8-12 years later.

Along the central west coast of Florida, communities of resident dolphins appear to inhabit a mosaic of overlapping home ranges. Most of the activities of the residents are concentrated within the home ranges, but occasional movement between ranges occurs also. The same applies to bottlenose dolphins off San Luis Pass, Texas (Maze and Würsig, 1999). Within the home range, habitat use varies with season, with shallow estuarine waters frequented during the summer and coastal waters and passes between barrier islands used during the winter (Wells and Scott, 1999 and refs. therein). However, behaviour may also vary among animals within the same area: Simões-Lopez and Fabian (1999) found that in Laguna, southern Brazil 88.5 % of the individuals were resident and the rest were non-resident.

In Southern California, a high proportion of dolphins photographed off Santa Barbara, Orange County, and Ensenada, Mexico, were also photographed off San Diego. The majority of these dolphins exhibited back-and-forth movements between study areas, with no evidence of site fidelity to any particular region. Minimum range estimates were between 50 and 470 km. Minimum travel-speed estimates were 11-47 km/d, and all dolphin schools sighted during the study were within 1 km of the shore (Defran et al. 1999). Long-distance movements have also been reported in conjunction with an El Niño warm water event, expanding the species' range more than 500 km northward (Wells and Scott, 1999 and refs. therein). Following the El Niño, some dolphins remained in northern waters, while others returned to their previous range to the south. Würsig (1978, in Wells and Scott, 1999) reported a 600-km round-trip for several identifiable dolphins in Argentina. Tanaka (1987) reported that a satellite-tracked dolphin off Japan apparently travelled 604 km in 18 days along the Kuroshio Current.

Dolphins living at the high latitude or cold water extremes of the species' range may migrate seasonally. It has been suggested that some dolphins may use seasonal home ranges joined by a travelling range: a 4-month cycle of occurrence of dolphins was observed in Golfo San Jose, Argentina (Wells and Scott, 1999 and refs. therein). In Moray Firth, northeastern Scotland, bottlenose dolphins were seen in all months of the year, but numbers were low in winter and spring and peaked in summer and autumn. Individuals exhibited rapid movements across the population's range, and one individual was sighted at locations 190 km apart within a 5-day period (Wilson et al. 1997). Similarly in the Faroes, bottlenose dolphins are observed all year round but with peaks in March and July-October (Bloch, 1998). In the coastal waters of Cornwall, UK, dolphins demonstrated a seasonal residency pattern, spending the winter in southern Cornwall and moving farther north-eastward during spring and summer. The dolphins occupied a linear coastal range of 650 km. Within this range they repeatedly made long-distance journeys covering up to 1,076 km and lasting up to 20 days (Wood, 1998).

Wells et al. (1999) tracked two rehabilitated adult male bottlenose dolphins with satellite- linked transmitters in 1997. "Rudy" was equipped in the Gulf of Mexico off central west Florida. He moved around Florida and northward to Cape Hatteras, NC, covering 2,050 km in 43 d. "Gulliver" was released off Cape Canaveral, FL. He moved 4,200 km in 47d to a location north-east of the Virgin Islands. Gulliver swam through 5,000-m-deep waters 300 km offshore of the northern Caribbean islands, against the North Equatorial Current.

Long-distance migrations are presumably regularly undertaken by offshore bottlenose dolphins, whose diet is comprised of highly migratory species of fish and squids. E.g. in the Azores, North Atlantic bottlenose dolphins carry out extensive movements and have large home ranges in response to the lower density and patchy distribution of prey compared to other areas. The extensive ranging behaviour and the lack of territoriality provide an opportunity for interbreeding between different island groups, thus preventing genetic differentiation within the population (Silva et al. 2008).

6. Threats

Direct catch: Directed fisheries taking bottlenose dolphins have previously occurred around the Black Sea as well as in Mexico, Guatemala, Costa Rica, the West Indies, Venezuela, Sri

Lanka, and off southern Africa, India and Peru. Drive fisheries for bottlenose and other dolphins were also reported from the Republic of China (Taiwan), but the numbers are not known. The species was taken in a drive fishery in the Faroe Islands which dates back to 1803, annual takes numbering from 1-308, often in mixed schools with long finned pilot whales (*Globicephala melas*; Reyes, 1991 and refs. therein; Bloch, 1998). However, there are no reports on catches in recent years (NAMMCO, 2008).

In Peru, coastal fisheries still take *Tursiops* and other cetaceans for human consumption, using gill nets, purse seines, and harpoons. A similar fishery occurs in Sri Lanka (Wells and Scott, 1999 and refs. therein; Wells and Scott, 2009). Although direct killing has noticeably decreased since dolphin hunting was banned by law in 1996, around a thousand dolphins and other small whales are still falling victim annually to fishermen to supply bait meat for the shark fishery there. The most significant take probably occurs off Japan, where bottle-nose dolphins are killed for human consumption, bait and because of perceived competition with fisheries (Wells and Scott, 2009). Reported catches in 2007 are 300 in the drive fisheries and 101 in the hand-harpoon fishery (Iwasaki, 2008).

Live captures: More than 530 *Tursiops* have been taken from US waters since the passage of the Marine Mammal Protection Act of 1972 (MMPA), particularly from the southeastern USA. Present federal regulations limit the annual allowable take to less than 2 % of the minimum estimated population in designated management areas, but no bottlenose dolphins have been collected in US waters since 1989. Some live-capture removals continue in other countries, including Cuba where at least 238 were captured between 1986-2004 (Van Waerebeek et al. 2006), the Solomon Islands, Japan, and Russia (Wells and Scott 1999; 2009).

Incidental catch: Fisheries around the world account for incidental takes of bottlenose dolphins, in gillnets, driftnets, purse seines, trawls, long-lines, and on hook-and-line gear used in commercial and recreational fisheries, but the present level of takes remains unknown (Hammond et al. 2008).

Along the east coast of the United States, by-catches of bottlenose dolphins in gillnet fisheries exceed removal levels set under the US Marine Mammal Protection Act (Cox et al. 2004). The use of acoustic deterrents, so-called "pingers" to deter dolphins from nets, however, did not show clear results and was not recommended. In North Caroliona interactions between dolphins and gill nets are common, and many of these interactions are food-based. Surprisingly, however, dolphins engaging in depredation do not appear to become entangled; instead it seems more likely entanglement occurs as a result of dolphins failing to change course around the net (Read et al. 2003). A new type of net material made with barium sulphate was found to be acoustically more reflective than the standard nylon net and should increase dolphin detection range sufficiently to reduce entanglement (Mooney et al. 2004).

The best protective measure, however, seems to be a decrease in fishing effort. A marked decrease in fishing effort for spiny dogfish in North Carolina corresponded with a marked decrease in winter stranding rates of bottlenose dolphins with entanglement lesions (Byrd et al. 2008). In South Carolina, analysis of historical strandings showed that approximately 24 % of the 42 entanglement cases from 1992-2003 resulted from the blue crab fishery. The average number of entanglements per year exceeded 1% of PBR across a five-year period (1999-2003; Burdett and McFee, 2004). Longlines seem to be far less dangerous: in the Hawaii-based longline fishery targeting primarily tunas and swordfish, only 1 bottlenose dolphin was caught in 159,572 sets during 1994-2005 (Forney and Kobayashi, 2007).

A high proportion of the common dolphins that strand on the south coast of England in winter months bear evidence of fishery interactions. Many animals were recorded from trawl tows targeted at bass. Preliminary mitigation trials using pingers, however, were not effective, and current work is focussed on using exclusion grids to allow dolphins to escape from the sleeve of the trawl, as the number of stranded by-caught dolphins has raised concerns for their conservation status (Northridge, 2003).

Around the Balearic Islands, the artisanal gillnet fishery is experiencing a growing problem with bottlenose dolphins depredating bottom-set nets. The resulting catch loss engenders hostility from fishers, and interactions between dolphins and nets can result in bycatch mortality. A large-scale experimental trial using pingers to deter dolphins from the nets suggests that some pinger types are effective in reducing net interactions (Brotons et al. 2008). Whereas cetacean interactions with fishing gear are reported regularly and most frequently involve incidental capture, another cause of mortality is the ingestion of gill-net parts and subsequent larynx strangulation documented e.g. in 10% of dolphins stranded along the Croatian coast of the Adriatic Sea (Gomeric et al. 2009).

The use of shark nets to protect bathing beaches in South Africa and Australia has caused mortality as well. Dolphins were found with full stomachs, indicating recent feeding in the vicinity of the nets, and there was a correlation of mortality rates with the direction of the prevailing current. Attempts to prevent the animals from entangling by incorporating active and passive devices in the net were not successful. The relatively high incidental catches of coastal dolphins off South Africa has prompted concerns that the take is not sustainable (Wells and Scott, 1999 and refs. therein).

Incidental catches in Chinese fisheries reach several hundred per year (Yang et al. 1999), and a large incidental take of *Tursiops* has apparently occurred in the Taiwanese gill net fishery off Australia, with an annual mortality perhaps exceeding 2,000 animals, although these may be of the other species, *Tursiops aduncus*. Molecular monitoring of 'whale-meat' markets in the Republic of (South) Korea revealed that at least some *T. truncatus* by-catch is sold and used in human consumption (Baker et al. 2006).

Overfishing: Peddemors (1999) summarises for the coast of Africa south of 17°S that more research emphasis should in future be placed on possible detrimental interactions due to overfishing of delphinid prey stocks. Increased commercial fishing pressure will inevitably increase interactions between the fishery and the affected delphinids. One of the inshore species considered to be vulnerable is the bottlenose dolphin in KwaZulu-Natal and Namibia.

Killing: *Tursiops* have been intentionally killed by fishermen in Japan and Hawaii, and presumably such practices are found elsewhere in their range (Reyes, 1991). The Japanese drive fishery off Iki Island and the Kii Peninsula took several hundred *Tursiops truncatus* annually to reduce the perceived competition with the commercial fishery for yellowtail, *Seriola* sp. (Wells and Scott, 1999 and refs. therein).

Pollution: Its worldwide distribution and great adaptability to diverse habitats make this species a good indicator of the quality of inshore marine ecosystems. Concentrations of many contaminants in common dolphin tissues are magnified through bio-accumulation and often are the highest recorded in any mammal.

In the blubber of South African specimens, concentrations of polychlorinated biphenyls and dieldrin in tissues of males reached levels that theoretically could impair testosterone production and thus reduce reproductive ability. First-born calves received 80% of their mother's body burden of contaminant residues, possibly leading to increased neonatal mortality (Wells and Scott, 1999, and refs. therein), as even relatively low levels of PCBs and DDT can result in a decline in immune system function (Lahvis et al. 1995). This was confirmed by subsequent results. In primiparous females from Sarasota Bay, Florida, PCB concentrations in blubber and plasma and the rates of first-born calf mortality were both high. Subsequent calves of similar age had lower concentrations than first-born calves (Wells et al. 2005).

Persistent organic pollutants in coastal ecosystems have half-lives of decades or more, and their signatures can be used to confirm site-specificity of local populations. In Biscayne Bay (Miami, FL), male dolphins in the northern, metropolitan area had PCB concentrations that were 5 times higher than in their congeners from the southern, more rural area (43 mg/g vs. 8.6 mg/g wet mass), demonstrating local and persistent differences in habitat use. PCB concentrations in northern bay dolphins are high compared to other estuarine dolphin populations and may place these animals at risk of reproductive failure and decreased immune function (Litz et al. 2007). Similarly, along the coast of Georgia, southeastern USA, blubber PCB concentrations from free-ranging animals from the Turtle/Brunswick River estuary were ten times higher (77µg/g lipid) and showed different Aroclor 1268 signatures compared with strandings samples from Savannah area estuaries 90 km to the north, confirming that inshore *T. truncatus* populations exhibit long-term fidelity to specific estuaries (Pulster and Maruya, 2008) and highlighting the necessity to control local pollution sources.

Contamination of bottlenose dolphins is a world-wide problem, and blubber samples from the Bay of Bengal (southeast coast of India) contained considerable concentrations of the organochlorine pesticides hexachlorocyclohexane (HCHs), dichlorodiphenyl trichloroethane (DDTs), and polychlorinated biphenyls (PCBs; Karuppiah et a. 2005). Dolphins stranded on the coasts of the Mediterranean sea between 2000 and 2003 showed very high concentrations of PCBs and DDT in all tissues and organs analysed. Their values were still comparable to those obtained during the 1990's in the Mediterranean environment (Wafo et al. 2005).

In the Charleston Harbor estuary, South Carolina, USA, the levels of another bioaccumulative chemical, polybrominated diphenyl ethers (PBDE) in dolphins represent some of the highest measured in marine mammals (5,860 ng/g lipid) and warrant further investigation of potential deleterious effects (Fair et al. 2007).

Almost all bottlenose dolphins found stranded along the western Italian and Greek coasts in the mid-1990's contained the anti-fouling component tributyltin (TBT) and its degradation products, monobutyltin (MBT) and dibutyltin (DBT), in the liver and kidney. BTs were found to be transferred from mother to fetus (Focardi et al. 2000). In waters around Japan butyltin concentrations in coastal *T. truncatus* were higher than in offshore populations, indicating land-based sources (Le et al. 1999), e.g. shipyards where contaminated paint is stripped during repair.

Specimens stranded along the Corsican coast, Mediterranean, France, in the mid-1990's showed high levels of mercury accumulation in the liver, with concentrations as high as 4,250 µg Hg/g dw suggesting a life-long uptake of this heavy metal (Frodello et al. 2000).

Finally, there are also biological sources of toxic substances. In Sarasota Bay, Florida, USA, brevetoxins produced by blooms of the harmful alga *Karenia brevis* were measured at high levels in bottlenose dolphin carcasses after large-scale mortality, and levels in animals stranded during non-bloom conditions were also detectable (Fire et al. 2007). Since masss-occurrence of these algae is linked to high concentrations of fertilizers in terrestrial runoff, this toxic substance can also be indirectly attributed to anthropogenic activities (NOAA, 2009).

Noise pollution: Anthropogenic sounds in the ocean are increasing from such influences as shipping, drilling, sonars, and scientific exploration, and several marine mammal strandings have been linked to anthropogenic noise-induced events. Odontocetes rely on utilizing sound in the ocean and are particularly affected by man-made noise. In April 2006, an exceptional mass stranding event occurred in the northern part of Zanzibar involving more than 600 dolphins. The dolphins were alive at the stranding spot and the locals ate the meat without any problems, which excludes red tides as a mortality cause. Amir and Jiddawi (2007) speculated that a seismic event which at the time was taking place in the southern part of Tanzania for gas exploration, a sea quake or sonar activities could have caused the stranding.

Mooney et al. (2006) showed that temporary threshold shifts in the bottlenose dolphin can be induced by long exposure times or high sound pressure levels. Whereas bottlenose dolphins may have a protective mechanism that reduces harmful physiological noise damage at shorter duration exposures, the inverse might be true for long duration exposures at lower levels. In Teignmouth Bay, UK, stationary boats elicited no response, but speedboats and jet skis were associated with aversive behaviours, even when boats were not directly approaching the dolphins (Goodwin and Cotton, 2004). In Aberdeen harbour, Scotland, dolphins were usually concentrated around the harbour entrance. Their responses to boats varied considerably according to boat size, activity and speed, but there was evidence of habituation to boat traffic (Sini et al. 2005). A more subtle effect of noise is the acoustic detection range of female dolphins and their dependent calves. Quintana-Rizo et al. (2006) found it to be limited by ambient noise as opposed to being limited by hearing sensitivity. In shallow-water seagrass areas, low-frequency (7-13 kHz) whistles with a source level of 165 dB can be normally heard by dolphins at a distance of 487 m, which is larger than usual mother-calf separation distances.

Tourism: Excessive and unregulated visiting of wild dolphins habituated to humans has raised concern in several areas, in particular in Europe (Reyes, 1991 and refs. therein). Off Sarasota, Florida, animal behavioral observations conducted during boat approaches detected longer interbreath intervals compared to control periods (no boats within 100 m). Dolphins decreased interanimal distance, changed heading, and increased swimming speed significantly more often in response to an approaching vessel than during control periods (Nowacek et al. 2001). These findings provide additional support for the need to consider disturbance in management plans for cetacean conservation (P. Yazdi, pers. comm. 2003).

In South Carolina, USA, and New Zealand multiple boats were found to have a greater influence on dolphin behaviour and movement than the presence of a single boat (Constantine et al. 2004; Mattson et al. 2005). Dolphin-watching boats, motorboats, shrimp boats, and jet skis affected group size and behaviour of dolphin groups, with jet-skis having the most pronounced effects. Boat-related effects on bottlenose dolphin behaviour are considered "harassment" under the USA Marine Mammal Protection Act (1972) and should be scrutinized (Mattson et al. 2005). This is also a problem in Australia, where excessive interaction with tourists has led to reduced survivorship of juveniles at Shark Bay (W. Perrin, La Jolla, CA, USA, 2010, pers. comm.).

However, in Zanzibar waters, Western Indian Ocean, local fishermen realised that the touristic value of dolphins far exceeds that of using them as bait for shark. As many as 2,000 tourists visit the dolphin site at Kizimkazi per month and dolphin-tourism has become a popular economic activity. It is hoped that successful management of the dolphin-tourist trade will ensure continued visitors to coastal villages and thus add to local income while contributing to management and conservation (Ali and Jiddawi, 1999).

7. Remarks

Range states (Hammond et al. 2008): Albania; American Samoa; Anguilla; Antigua and Barbuda; Argentina; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belgium; Belize; Benin; Bermuda; Brazil; Brunei Darussalam; Bulgaria; Cambodia; Cameroon; Canada; Cape Verde; Cayman Islands; Chile; China; Cocos (Keeling) Islands; Colombia; Comoros; Cook Islands; Costa Rica; Côte d'Ivoire; Croatia; Cuba; Cyprus; Denmark; Djibouti; Dominica; Dominican Republic; Ecuador; El Salvador; Falkland Islands (Malvinas); Fiji; France; French Guiana; French Polynesia; Gabon; Gambia; Georgia; Germany; Ghana; Gibraltar; Greece; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Ireland; Italy; Jamaica; Japan; Kenya; Kiribati; Liberia; Madagascar; Malaysia; Maldives; Malta; Marshall Islands; Mauritania; Mexico; Micronesia, Federated States of; Montenegro; Morocco; Mozambique; Myanmar; Namibia; Nauru; Netherlands; Netherlands Antilles; New Caledonia; New Zealand; Nicaragua; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal; Puerto Rico; Romania; Russian Federation; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Senegal; Singapore; Slovenia; Solomon Islands; Somalia; South Africa; Spain; Sri Lanka; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; Turkey; Ukraine; United Arab Emirates; United Kingdom; USA; Uruguay; Vanuatu; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen

The common bottlenose dolphin is listed in Appendix II of CITES.

The North Sea, Baltic Sea, Mediterranean and Black sea populations are listed in Appendix II of CMS.

The IUCN lists the species as "Least Concern" with the exception of the Black sea bottlenose dolphin *T. t. ponticus*, which is listed as "Endangered". Its current population size is around several thousand animals, but the population was significantly reduced by large directed takes, incidental mortality in fisheries, live-catches and a mass mortality of unknown cause in 1990, and it is currently suffering from a degradation of the Black Sea environment (Birkun, 2008).

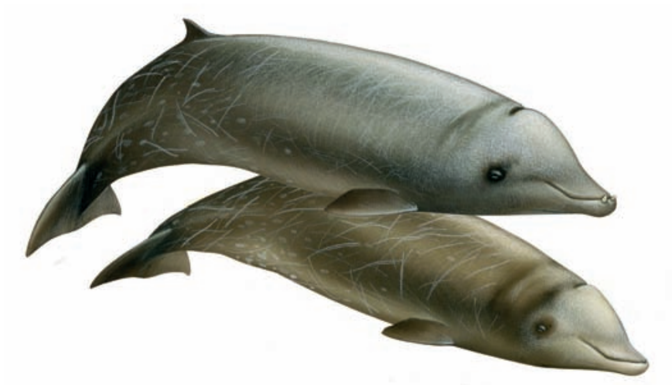
In the Mediterranean Sea, important ongoing threats include incidental mortality in fishing gear and the reduced availability of key prey caused by overfishing and environmental degradation throughout the region. Additional potential or likely threats include the toxic effects of xenobiotic chemicals, epizootic outbreaks, direct disturbance from boating and shipping, noise, and the consequences of climate change. Dolphin abundance is thought to have declined considerably in the region and management measures are needed to prevent further decline. Compliance with existing legislation and treaties, which outline appropriate measures, is urgently required (Bearzi et al. 2009).

8. Sources (see page 293)

3.72 Ziphius cavirostris G. Cuvier, 1823

English: Cuvier's beaked whale, Goosebeak whale
German: Cuvier-Schnabelwal
Spanish: Zifio de Cuvier, ballena picuda de Cuvier
French: Ziphius, baleine à bec de Cuvier

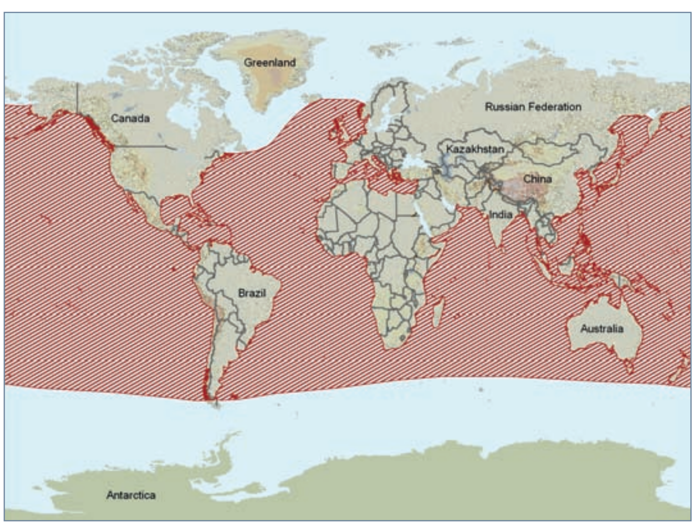
Family Ziphiidae



Ziphius cavirostris / Cuvier´s beaked whale (© Wurtz-Artescienza)

1. Description

The general body shape of *Z. cavirostris* is similar to that of other beaked whales: rather robust, cigar-shaped, small falcate dorsal fin, relatively small flippers. The flippers can be tucked into a slight depression along the body wall. The flukes are proportionately large, as in other ziphiids. The head is rather blunt in profile with a small, poorly defined rostrum that grades into the gently sloping melon. Pigmentation is dark slate grey over most of the body, with a distinctively white head in males and a slight lightening of the skin in females. Light oval patches attributed to cookie-cutter sharks (*Isistius* sp.) and linear marks due to intraspecific fighting between males (which have two apical teeth) are common. The largest adult male was 7 m long (Heyning, 2002).



Distribution of Ziphius cavirostris: world-wide distribution in tropical, subtropical, and temperate waters (mod. from Taylor et al. 2008; © IUCN Red List).

2. Distribution

Cuvier's beaked whale is the most cosmopolitan of the beaked whales and is found in all oceans except in the high polar waters (Heyning and Mead, 2009). Rice (1998) includes all temperate and tropical waters around the world, north to Massachusetts, the Shetland Islands, the Mediterranean, Honshu, the Aleutian Islands, and the northern Gulf of Alaska; south to Tierra del Fuego, Cape Province in South Africa, Tasmania, South Island of New Zealand, and the Chatham Islands.

These whales are generally inconspicuous and uncommonly seen at sea. They are known mainly from strandings (see Heyning, 1989, for a detailed list) and are found stranded more often than most other beaked whales. In certain areas, such as the eastern tropical Pacific they seem to be fairly common (Jefferson et al. 1993; Heyning, 1989), however, geographical variation has not been analysed (Rice, 1998). For a detailed account on the Pacific islands Region see Miller (2007).

3. Population size

Abundance has been estimated by various authors and for several study areas in the Pacific Ocean, compiled by Barlow et al. (2006). In the eastern tropical Pacific, over 90,000 *Ziphius* were estimated from ship surveys conducted between 1986-1990. Other dive-corrected estimates of Cuvier's beaked whale abundance include 1,884 off the U.S. west coast (years 1996-2002) and 15,242 in Hawaiian waters in 2002. In the Atlantic Ocean, US-NE coast values are 25 (1978-82 surveys), US-SE coast 348 (1998 survey), Gulf of Mexico 95 (1996-2001 survey). Waring et al. (2001) provide a stock assessment for all beaked whales in the western North Atlantic including *Z. cavirostris* and *Mesoplodon* spp. and come up with a minimum figure of 2,400 animals.

Dalebout et al. (2005) estimated rates of female migration among ocean basins to be low (generally less than or equal to 2 individuals per generation). Their results demonstrate a high degree of isolation and low maternal gene flow among oceanic, and in some cases, regional populations of Cuvier's beaked whales.

Taylor et al. (2008) conclude that Cuvier's beaked whales are among the most common and abundant of all the beaked whales, and worldwide abundance is likely to be well over 100,000. There is no information on trends in the global abundance of this species.

4. Biology and Behaviour

Habitat: *Z. cavirostris* is known around many oceanic islands, and is relatively common in enclosed seas such as the Mediterranean and Sea of Japan. It is rarely found close to mainland shores, except in submarine canyons or in areas where the continental shelf is narrow and coastal waters are deep (Carwardine, 1995) and is mostly a pelagic species which appears to be confined by the 10°C isotherm (lower limit) and the 1,000-m bathymetric contour (Heyning, 1989 and refs. therein; Houston, 1991; Robineau and di Natale,1995).

Moulins et al. (2007) analysed sightings in the Pelagos Sanctuary (north-western Mediterranean Sea) in order to define the favoured habitat of Cuvier's beaked whales. Forty-eight percent of beaked whales were seen where the depth was between 756 and 1,389 m but the encounter rate was higher between depths of 1,389 and 2,021 m.

Behaviour: Cuvier's beaked whales normally avoid boats but are occasionally inquisitive and approachable, especially around Hawaii. Breaching has been observed, though it is probably rare (Carwardine, 1995).

Z. cavirostris hunt by echolocation in deep water between 222 and 1,885 m, with average foraging dives and dive times reaching 1,070 m and 58 min, respectively, higher values than reported for any other air-breathing species. A series of shallower dives, containing no indications of foraging, followed most deep foraging dives. The average interval between deep foraging dives was 63 min. This may be required for beaked whales to recover from an oxygen debt accrued in the deep foraging dives, which last about twice the estimated aerobic dive limit (Tyack et al. 2006). Baird et al. (2006) somewhat expand these values and found Cuvier's beaked whales in median depth of 2,079 m reaching maximal dive depths of 1,450 m in dives regularly lasting 48-68 min.

Schooling: Cuvier's beaked whales are found mostly in small groups of 2 to 7, but are not uncommonly seen alone (Jefferson et al. 1993). Mc Sweeny et al. (2007) confirm that group sizes are small and most groups have only a single adult male present. In the NW Mediterranean, mean herd size observed was 2.3 (range = 1-11; Moulins et al. 2007).

Food: Cuvier's beaked whales, like all beaked whales, feed mostly on deep sea squid, but also take fish and some crustaceans (Jefferson et al. 1993). MacLeod et al. (2003) compiled stomach content data and report: 46 species of cephalopods from 15 families, and two species of crustaceans. Eighty-seven per cent of individuals contained the remains of cephalopods, while 13 % contained crustacean remains and 8 % contained the remains of fish. Blanco and Raga (2000) investigated the stomach contents of two Cuvier's beaked whales stranded on the western Mediterranean coast. Food consisted exclusively of hard cephalopod remains, which agrees with their offshore and deep diving behaviour. Nishiwaki and Oguro (1972) found that stomach contents of *Z. cavirostris* caught off Japan varied consistently with a predominance of squid from animals taken in waters slightly under 1,000 m in depth, with fish being the most abundant prey item found in animals taken in deeper waters. *Z. cavirostris* could thus be somewhat opportunistic in its feeding habits. Most of the prey items found were either open ocean, mesopelagic, or deep-water benthic organisms, reflecting that *Z. cavirostris* is an offshore, deep-diving species (Heyning, 1989).

Cuvier's beaked whales in the Canary Islands mainly feed of oceanic cephalopods, the most numerous being *Taonius pavo*, *Histioteuthis* sp., *Mastigoteuthis schmidti* and *Octopoteuthis sicula*. Many of the cephalopod species found in the diet appear to undertake diel vertical migrations, being found in shallower waters during the night and moving to deeper waters during the day. Clearly, *Z. cavirostris* in these waters specialises on cephalopods (Santos et al. 2007).

5. Migration

Robineau and di Natale (1995) summarise that there are seasonal differences in strandings recorded from the French coast with peaks in winter and spring, whereas strandings in the Mediterranean seem to peak in winter. MacLeod et al. (2004) found that strandings of Cuvier's beaked whales occurred almost exclusively on the Atlantic coasts of the UK and in Ireland. There were significantly more Cuvier's beaked whale strandings than expected in January and February and in June and July. A specimen which stranded in northern Scotland in February contained similar prey as two whales stranded in northwestern Spain at the same time of year, suggesting this animal could have been feeding in more southern waters prior to stranding.

In the north-eastern Pacific from Alaska to Baja California, Mitchell (1968) summarised the stranding record to date and found no obvious pattern of seasonality to the strandings. Mc Sweeny et al. (2007) used a 21-yr photographic data set from the west coast of Hawaii and found that resightings of individuals spanned 15 years, suggesting long-term site fidelity to the area. Long-term resightings were documented primarily from adult females.

6. Threats

Direct catches: In the past, there have been a few small cetacean fisheries that have taken *Z. cavirostris*. In the Japanese *Berardius bairdii* fishery, *Z. cavirostris* were taken on an opportunistic basis with catches varying from 3 to 35 animals yearly. Although the *B. bairdii* fishery still continues, there have been no takes of *Z. cavirostris* in recent years (Heyning, 1989).

Incidental catches: Mignucci et al. (1999) conducted an assessment of cetacean strandings in waters off Puerto Rico, the United States and the British Virgin Islands to identify the factors associated with reported mortality events between 1867 and 1995. Cuvier's beaked whales were the second most commonly stranded species, with an increase in the number of strandings averaging 63.1 % per year over 20 years. Between 1990 and 1995, the average number of cases per year increased from 2.1 to 8.2. The seasonal pattern of strandings was not found to be uniform, with a high number of strandings occurring in the winter and spring. The most common human-related cause categories observed were entanglement and accidental captures, followed by animals being shot or speared. However, estimates for the western North Atlantic are very low, with one animal reported between 1994 and 1998 (Waring et al. 2001).

Occasional bycatches are reported from many areas, e.g. in artisanal gillnet fisheries in Colombia (Mora-Pinto et al. 1995), Peru (Van Waerebeek et al.1988), St Vincent, Barbados (Caldwell et al. 1971), Ghana (Van Waerebeek et al. 2009) and in the Italian swordfish fishery (Notarbartolo di Sciara, 1990). Baker et al. (2006) report on Cuvier's beaked whales detected by molecular monitoring of 'whalemeat' markets in the Republic of (South) Korea, assumed to be incidental fisheries mortalities.

Pollution: Analysis of tissues from a male from New Zealand found no traces of lead or organophosphates, but the following levels of potential toxins were noted: DDE, 1.2-mg/kg; DDT, 1.2-mg/kg; DDD, 0.25-mg/kg; and mercury, 1.9-mg/kg (Fordyce et al. 1979, in Heyning, 1989).

Colin McLeod (2002, pers. comm.) reviewed stomach contents in beaked whales and found that at least 50% of Cuvier's beaked whales stranding on European coasts contained some plastic debris, while this was much rarer in northern bottlenose whales and *Mesoplodon* species. One possible explanation is that floating plastic sheets and bags either at the surface or at depth will act as fish attractors, providing shelter from predatory fish. Beaked whales being suction feeders may then ingest the bag/plastic sheeting while 'hoovering' up actual prey which are hanging around close to the floating debris. For these suction feeders there would be little chance to "select" prey based on taste or feel as it would be in the mouth and swallowed before it is noticed.

Acoustic pollution: Frantzis (1998) found that a mass-stranding of 12 Cuvier's beaked whales in the Ionian Sea (Mediterranean) coincided closely in time and location with military tests of an acoustic system for submarine detection being carried out by the North Atlantic Treaty Organisation (NATO). The connection between military tests and strandings is supported by the stranding of at least 12 specimens during a naval exercise off The Bahamas in March 2000 (Waring et al. 2001). Another seven *Z. cavirostris* died in September 2002 during a naval exercise conducted around Gran Canaria, Spain (Vidal Martin, pers. comm.). High intensity Low Frequency Active Sonar (LFAS) was used by US and NATO vessels in these areas, respectively, which led to stranding of other species as well, including *M. densirostris*. Finally, Arbelo et al. (2008) report on an event in 2004 involving two stranded Cuvier beaked whales on the coast of Almería, Southeast Spain in this series of strandings caused by naval exercises.

According to K. Balcomb (NMFS, pers. comm.), NATO and the US Naval Under-sea Warfare Center have calculated the resonance frequency of airspaces in Cuvier's beaked whales to be about 290 Hz at 500 meters depth, which is almost precisely the middle frequency of the sonar systems that were tested. Whale mortality during tests could therefore be due to resonance phenomena in the whales' cranial airspaces that are tearing apart delicate tissues around the brains and ears.

Degollada et al. (2003) performed necropsies on carcasses in Gran Canaria 24 to 72-h postmortem following standard procedures. The most remarkable features were inner ear hemorrhages and edema starting in the VIIIth cranial nerve and extending into the spiral ganglion and the cochlear channels, as well as inner ear structural damages. These findings are consistent with lesions observed in other organs, in particular the brain, confirming an acoustically induced trauma as the cause of death.

Cox et al. (2006) suggest a plausible pathologic mechanism for the effect of sonar exposure, which is related to the disruption of natural dive behaviour forced on these deep divers. Extended surface times to avoid acoustic exposure at depth and omission of the requisite shallow re-compression bounce dives would induce excessive levels of nitrogen supersaturation in tissues, driving gas bubble and emboli formation similar to decompression sickness in humans and leading to lethal tissue damage. Cox et al. (2006) also point out that visual monitoring methods prior to naval exercises are ineffective for detecting these animals. This might be achieved by additional sensing technologies, such as passive acoustics as well as active sonar and radar, currently under development.

Seismic surveys have also been linked to stranding events. In 2002 two Cuvier's beaked whales stranded on Isla San Jose, in the Gulf of California, at a time when the US National Science Foundation was conducting seismic surveys from R/V Maurice Ewing. It is possible that seismic surveys are also the causative factor for cetacean strandings in other areas, such as the Galápagos Islands (Parsons et al. 2007).

7. Remarks

Known and inferred **range states** (Taylor, 2008): Albania; American Samoa; Anguilla; Antigua and Barbuda; Argentina; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil; Brunei Darussalam; Cambodia; Cameroon; Canada; Cape Verde; Cayman Islands; Chile; China; Cocos (Keeling) Islands; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Croatia; Cuba; Côte d'Ivoire; Denmark; Djibouti; Dominica; Dominican Republic; Ecuador; El Salvador; Equatorial Guinea; Falkland Islands (Malvinas); Faroe Islands; Fiji; France; French Guiana; French Polynesia; Gabon; Gambia; Germany; Ghana; Gibraltar; Greece; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; India; Indonesia; Iran, Islamic Republic of; Ireland; Italy; Jamaica; Japan; Kenya; Kiribati; Korea, Republic of; Kuwait; Liberia; Madagascar; Malaysia; Maldives; Marshall Islands; Martinique; Mauritania; Mexico; Micronesia, Federated States of; Monaco; Morocco; Mozambique; Myanmar; Namibia; Nauru; Netherlands; Netherlands Antilles; New Caledonia; New Zealand; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Norway; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal; Puerto Rico; Russian Federation; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Senegal; Seychelles; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Spain; Sri Lanka; Sudan; Suriname; Sweden; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; United Kingdom; USA; Uruguay; Vanuatu; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen

Listed by the IUCN as "Least concern" (Taylor et al. 2008) and listed in Appendix II of CITES. Not listed by CMS.

Very little is known about this species. However, mass strandings after military sonar tests are a matter of concern and should be further investigated. Due to a lack of abundance data, the effects of by-catches in fisheries cannot be evaluated.

Z. cavirostris also occurs in southern South America, therefore the recommendations iterated by the scientific committee of CMS for small cetaceans in that area (Hucke-Gaete, 2000; Appendix 1) also apply. For recommendations concerning south-east Asian stocks, see Perrin et al. (1996) in and Appendix 2.

8. Sources (see page 296)

4 SOURCES

4 Sources

3.1. Berardius arnuxii

Baker AN (1999) Whales and Dolphins of New Zealand and Australia: an identification guide. Wellington, Victoria University Press. 133 pp.

Balcomb KC (1989) Baird's Beaked Whales - *Berardius bairdii* Stejneger, 1883; Arnoux Beaked Whale - *Berardius arnuxii* Duvernoy, 1851. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 261-288.

Barlow J, Ferguson MC, Perrin WF, Balance L, Gerrodette T, Joyce G, MacLeod CD, Mullin K, Palka DL, Waring G (2006) Abundance and densities of beaked and bottlenose whales (family Ziphiidae). J Cetacean Res Manage 7: 263-270

Blume M, Schmiing M, Stahl J (2007) Monitoring of whales. In "The Expedition ANT-XXIII/4 of the Research Vessel Polarstern in 2006 ((K Gohl ed.). Rep Polar Mar Res, 557: 100 -103.

Blume M, Schmiing M, Stahl J (2007) Monitoring of whales. In "The Expedition ANT-XXIII/4 of the Research Vessel Polarstern in 2006 ((K Gohl ed.). Rep Polar Mar Res, 557: 100 -103.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Hobson RP, Martin AR (1996) Behaviour and dive times of Arnoux's beaked whales, *Berardius arnuxii*, at narrow leads in fast ice. Can J Zool 74(2): 388-393.

Hucke-Gaete R (2000) Review of the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, German, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Kasuya T (2002) Giant beaked whales. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, 519-522.

Kasuya T (2009) Giant beaked whales *Berardius bardii* and *B. arnuxii*. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, 498-500.

Martuscelli P, Olmos F, Silva RSE, Mazzarella IP, Pino FV (1996) Cetaceans of São Paulo, southeastern Brazil. Mammalia 60(1): 125-140.

Martuscelli P, Milanelo M, Olmos F (1995) First record of Arnoux's beaked whale (*Berardius arnuxi*) and Southern right-whale dolphin (*Lissodelphis peronii*) from Brazil. Mammalia 59(2): 274-275.

Paterson RA, Parker AE (1994) Aerial observations of large ziphid whales, possibly *Berardius arnuxii*, off the southern coast of New South Wales. Mem Queensl Mus 37: 301-306.

Ponganis PJ, Kooyman GL, Castellini MA (1995) Multiple sightings of Arnoux's beaked whales along the Victoria Land Coast. Mar Mamm Sci 11: 247-250.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Rogers TL, Brown SM (1999) Acoustic observations of Arnoux's beaked whale (*Berardius arnuxii*) off Kemp Land, Antarctica. Mar Mamm Sci 15: 192-198.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Berardius arnuxii*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>.

Van Waerebeek K, Leaper R, Baker AN, Papastavrou V, Thiele D (2004) Odontocetes of the Southern Ocean Sanctuary. Paper SC/56/SOS1 presented to the IWC Scientific Committee, Sorrento, Italy. 35 pp.

3.2. Berardius bairdii

Balcomb KC (1989) Baird's Beaked Whales - *Berardius bairdii* Stejneger, 1883; Arnoux Beaked Whale - *Berardius arnuxii* Duvernoy, 1851. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 261-288.

Barlow J, Ferguson MC, Perrin WF, Balance L, Gerrodette T, Joyce G, MacLeod CD, Mullin K, Palka DL, Waring G (2006) Abundance and densities of beaked and bottlenose whales (family Ziphiidae). J Cetacean Res Manage 7: 263-270.

Brownell Jr RL, Yamada T, Mead JG, van Helden AL (2004) Mass Strandings of Cuvier's Beaked Whales in Japan: US Naval Acoustic Link? IWC Scientific Committee Document SC/56/E37, 56th IWC Annual Meeting, 29 June-10 July 2004, Sorrento, Italy.

Dalebout ML, Baker CS, Mead JG, Cockroft VG, Yamada TK (2004) A comprehensive and validated molecular taxonomy of beaked whales, family Ziphiidae. J Hered 95: 459-473.

Haraguchi K, Hisamichi Y, Endo T (2006) Bioaccumulation of Naturally Occurring Mixed Halogenated Dimethylbipyrroles in Whale and Dolphin Products on the Japanese Market. Arch Environ Contam Toxicol 51: 135-141.

IWC (1992) Report of the sub-committee of small cetaceans. Rep Int whal Comm 42: 108-119.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Kasuya T, Miyashita T (1997) Distribution of Baird's beaked whales off Japan. Rep Int Whal Comm 47: 963-968.

Kasuya T (1986) Distribution and behavior of Baird's beaked whales off the Pacific coast of Japan. Sci Rep Whales Res Inst, Tokyo 37: 61-83.

Kasuya T (2002) Giant beaked whales. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 519-522.

Kasuya T (2009) Giant beaked whales. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 498-500.

Kishiro T (2007) Geographical variations in the external body proportions of Baird's beaked whales (*Berardius bairdii*) off Japan. J Cetacean Res Manag 9: 89-93.

Minamikawa S, Iwasaki T, Kishiro T (2007) Diving behaviour of a Baird's beaked whale, *Berardius bairdii*, in the slope water region of the western North Pacific: first dive records using a data logger. Fish Oceanogr 16: 573-577.

Ohizumi H, Isoda T, Kishiro T, Kato H (2003) Feeding habits of Baird's Beaked Whale *Berardius bairdii*, in the Western North Pacific and Sea of Okhotsk off Japan. Fish Sci 69: 11-20.

Reeves RR, Mitchell E (1994) Status of Baird's beaked whale, *Berardius bairdii*. Can Field Nat 107: 509-523.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, Ed.), Lawrence, KS. USA.

Subramanian A, Tanabe S, Tatsukawa R (1988) Estimating some biological parameters of Baird's beaked whales using PCBs and DDE as tracers. Mar Pollut Bull 284-287.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Berardius bairdii*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>.

Urban Ramirez J, Jaramillo Legoreta AM (1992) Second stranding of *Berardius bairdii* at La Paz Bay, B.C.S. Rev Invest Cient Univ Auton Baja Calif Sur Ser Cienc Mar 1992 vol 3, no 1, 3:85-92.

Walker WA, Mead JG, Brownell RL Jr (2002) Diets of baird's beaked whales, *Berardius bairdii*, in the southern Sea of Okhotsk and off the Pacific coast of Honshu, Japan. Mar Mamm Sci 18: 902-919.

3.3. Cephalorhynchus commersonii

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Clarke M, Goodall N (1994) Cephalopods in the diets of three odontocete cetacean species, stranded at Tierra del Fuego, *Globicephala melaena* (Traill, 1809), *Hyperoodon planifrons* Flower, 1882 and *Cephalorhynchus commersonii* (Lacepede, 1804). Ant Sci 6(2): 149-154.

Coscarella MA, Dans SL, Crespo EA, Pedraza SN (2003) Potential impact of unregulated dolphin watching activities in Patagonia. J Cetacean Res Manag 5: 77-84.

Crespo EA, Pedraza SN, Dans SL, Alonso MK, Reyes LM, Garcia N, Coscarella M, Schiavini ACM (1995) Direct and indirect effects of the high seas fisheries on the marine mammal populations in the northern and central Patagonian coast. Nafo Sci Counc Res Doc 1995 no 95/88, 25 pp.

Crespo EA, Dans SL, Koen Alonso M, Pedraza SN (2007) Interactions between marine mammals and fisheries. The Argentine Sea and its fisheries resources. Vol. 5. The marine ecosystem. pp. 151-169.

Dawson SM (2009) *Cephylorhynchus* dolphins. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 191-196.

de Bruyn PJN, Hofmeyr GJG, de Villiers MS (2006) First record of a vagrant Commerson's dolphin, *Cephalorhynchus commersonii,* at the southern African continental shelf. Afr Zool 41: 131-133.

Goodall RNP (1994) Commerson's dolphin – *Cephalorhynchus commersonii* (Lacépède, 1804). In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 241-268.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Iniguez MA, Tossenberger VP (2007) Commerson's Dolphins (*Cephalorhynchus commersonii*) off Ria Deseado, Patagonia, Argentina. Aquat Mamm 33: 276-285.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA, Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Leatherwood S, Kastelein RA, Hammond PS (1988) Estimate of numbers of Commerson's dolphins in a portion of the northeastern Strait of Magellan, January-February 1984. Biology of the Genus *Cephalorhynchus*. (Brownell, R L, Jr; Donovan, G P, eds.) 93-102. Rep Int Whal Comm (SI 9).

Lescrauwaet A-C, Gibbons J, Guzman L, Schiavini A (2000) Abundance estimation of Commerson's dolphin in the eastern area of the Strait of Magallan-Chile. Rev Chil Hist Nat 73: 473-478.

Mora NJ, Pedraza SN,Coscarella MA, Crespo, E (2001) Resultados preliminares de la evaluación de la técnica de foto-identificación en tonina overa (*Cephalorhynchus commersonii*). IX Congreso Latonoamericano sobre Ciencias del Mar. Isla San Andrés, Colombia Septiembre 16 – 20, 2001.

Pedraza SN, Schiavini ACM, Crespo EA, Dans SL, Coscarella MA (in review). Abundance of Commerson´s dolphins (*Cephalorhynchus commersonii*) in the coasts of Patagonia (Argentina). Journal of Cetacean Research and Management.

Pinedo MC, Barreto AS, Lammardo MP, Andrade ALV, Geracitano L (2002) Northernmost records of the spectacled porpoise, Layard's beaked whale, Commerson's dolphin, and Peale's dolphin in the southwestern Atlantic Ocean. Aquat Mamm 28: 32-37.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Reeves RR, Crespo EA, Dans SL, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Pedraza S, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Cephalorhynchus commersonii*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ 4, Lawrence, KS. USA.

Robineau D (1989) The cetacean species of the Kerguelen Islands. Mammalia 53: 265-278.

Robineau D, Goodall RNP, Pichler F, Baker CS (2007) Description of a new subspecies of Commerson's dolphin, *Cephalorhynchus commersonii* (Lacepede, 1804), inhabiting the coastal waters of the Kerguelen Islands. Mammalia. 71: 172-180.

Venegas CC (1996) Estimation of population density by aerial line transects of Commerson's dolphin *Cephalorhynchus commersonii* in the Strait of Magellan, Chile. An Inst Patagonia Ser Cien Nat 24: 41-48.

3.4. Cephalorhynchus eutropia

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Dawson SM (2009) *Cephylorhynchus* dolphins. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 191-196.

Goodall RNP (1994) Chilean dolphin – *Cephalorhynchus eutropia* (Gray, 1846). In: Handbook of marine mammals (Ridgway SH, Harrison SR eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 269-288.

Heinrich S (2006) Ecology of Chilean dolphins and Peales dolphins at Isla Chiloé, Southern Chile. Ph D Thesis, U. St. Andrews, UK.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Perez-Alvarez MJ, Alvarez E, Aguayo-Lobo A, Olavarria C (2007) Occurrence and distribution of Chilean dolphin

(*Cephalorhynchus eutropia*) in coastal waters of central Chile. N Z J Mar Freshw Res 41: 405-409.

Reeves RR, Crespo EA, Dans SL, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Pedraza S, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Cephalorhynchus eutropia*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Ribeiro S, Viddi FA, Freitas TRO (2005) Behavioural responses of Chilean dolphins (*Cephalorhynchus eutropia*) to boats in Yaldad Bay, Southern Chile. Aquat Mamm 31: 234-242.

Ribeiro S, Viddi FA, Cordeiro JL, Freitas TRO (2007) Fine-scale habitat selection of Chilean dolphins (*Cephalorhynchus eutropia*): Interactions with aquaculture activities in southern Chiloe Island, Chile. J Mar Biol Assoc UK 87: 119-128.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ 4, Lawrence, KS. USA.

3.5. Cephalorhynchus heavisidii

Best PB, Abernethy RB (1994) Heaviside's dolphin - *Cephalorhynchus heavisidii* (Gray, 1828). In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 289-310.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Dawson SM (2009) *Cephylorhynchus* dolphins. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 191-196.

Elwen S, Meyer MA, Best PB, Kotze PGH, Thornton M, Swanson S (2006) Range and movements of female heaviside's dolphins (*Cephalorhychus heavisidii*), as determined by satellite-linked telemetry. J Mammal 87: 866-877.

Elwen SH, Reeb D, Thornton M, Best PB (2009) A population estimate of Heaviside's dolphins, *Cephalorhynchus heavisidii*, at the southern end of their range. Mar Mamm Sci 25: 107-124.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Peddemors VM (1999) Delphinids of southern Africa: A review of their distribution, status and life history. J Cetacean Res Manage 1: 157-165.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Reeves RR, Crespo EA, Dans SL, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Pedraza S, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Cephalorhynchus heavisidii*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy Spec Publ 4, Lawrence, KS. USA.

Rice FH, Saayman GS (1984) Movements and behaviour of Heaviside's dolphins (*Cephalorhynchus heavisidii*) off the western coasts of southern Africa. Invest Cetacea 16: 49-63.

3.6. Cephalorhynchus hectori

Baker AN, Smith ANH, Pichler FB (2002) Geographical variation in Hector's dolphin: recognition of new subspecies of *Cephalorhynchus hectori*. J Royal Soc NZ 32: 713-727.

Bejder L, Dawson S (2001) Abundance, residency, and habitat utilisation of Hector's dolphins (*Cephalorhynchus hectori*) in Porpoise Bay, New Zealand. N Z J Mar Freshwat Res 35: 277-287.

Bejder L, Dawson S, Harraway JA (1999) Responses by Hector's dolphins to boats and swimmers in Porpoise Bay, New Zealand. Mar Mamm Sci 15 (3): 738-750.

Braeger S, Dawson SM, Slooten E, Smith S, Stone GS, Yoshinaga A (2002) Site fidelity and along-shore range in Hector's dolphin, an endangered marine dolphin from New Zealand. Biol Conserv 108: 281-287.

Braeger S, Harraway JA, Manly BFJ (2003) Habitat selection in a coastal dolphin species (*Cephalorhynchus hectori*). Mar Biol 143: 233-244.

Braeger S, Schneider K (1998) Near-shore distribution and abundance of dolphins along the west coast of the South Island, New Zealand. N Z J Mar Freshwat Res 32: 105-112.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Constantine R (1999) Effects of tourism on marine mammals in New Zealand. Sci Conserv 106, 60 pp.

Dawson S, Pichler F, Russell K, Baker CS (2001) The North Island Hector's dolphin is vulnerable to extinction. Mar Mamm Sci 17: 366-371.

Dawson S, Slooten E (1988) Hector's dolphin, *Cephalorhynchus hectori*: distribution and abundance. Rep Int Whaling Comm Spec Issue 9:315-324.

Dawson S, Slooten E, DuFresne S, Wade P, Clement D (2004) Small-boat surveys for coastal dolphins: line-transect surveys for Hector's dolphins (*Cephalorhynchus hectori*). Fish Bull 102: 441-451.

Dawson SM (2009) *Cephylorhynchus* dolphins. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 191-196.

Department of Conservation New Zealand (2010) Marine reserves & other protected areas. http://www.doc.govt.nz/conservation/marine-and-coastal/marine-protected-areas/marine-mammal-sanctuaries/banks-peninsula/

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

KCC (2002) Hector's dolphin. Kiwi Conservation Club. http://www.kcc.org.nz/animals/hectorsdolphin.htm

McEldeny H, McCullough D, Schrader J, Illingworth J (2007) Pilot study to test the effectiveness of electronic monitoring in Canterbury fisheries. New Zealand Dep Conserv Res Develop Series 259-265.

Minstry of Fisheries New Zealand (2010) Hector's and Maui's dolphin draft threat management plan. http://www.fish.govt.nz/en-nz/Consultations/Archive/2008/Hectors+dolphins/Threat+Management+Plan.htm

Pichler FB, Baker CS (2000) Loss of genetic diversity in the endemic Hector's dolphin due to fisheries-related mortality. Proceedings of the Royal Society of London, Series B: Biol Sci 267: 97-102.

Pichler, F (2002) Genetic assessment of population boundaries and gene exchange in Hector's dolphin. Department of Conservation Science Internal Series 44. 37 p.

Pichler FB, Dawson SM, Slooten E, Baker CS (1998) Geographic isolation of Hector's dolphin populations described by mitochondrial DNA sequences. Cons Biol 12(3): 676-682.

Reeves RR, Crespo EA, Dans Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Pedraza S, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Cephalorhynchus hectori*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Slooten E (2007) Conservation management in the face of uncertainty: effectiveness of four options for managing Hector's dolphin bycatch. Endangered Species Res 3:169-179.

Slooten E, Dawson SM (1994) Hector's dolphin - *Cephalorhynchus hectori* (van Beneden, 1881). In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 311-334.

Slooten E, Dawson S, Rayment W (2002) Quantifying abundance of Hector's dolphins between Farewell Spit and Milford Sound. DOC Sci Internal Ser NZ Dept Conserv 33-40, 18pp.

Slooten E, Dawson SM, Rayment WJ (2004) Aerial surveys for coastal dolphins: abundance of Hector's dolphins off the South Island west coast, New Zealand. Mar Mamm Sci 20: 477-490.

Slooten E, Dawson S, Rayment W, Childerhouse S (2006a) A new abundance estimate for Maui's dolphin: What does it mean for managing this critically endangered species? Biol Conserv 128: 576-581.

Slooten E, Rayment W, Dawson S (2006b) Offshore distribution of Hector's dolphins at Banks Peninsula, New Zealand: is the Banks Peninsula Marine Mammal sanctuary large enough? N Z J Mar Freshwat Res 40: 333-343.

Stone GS, Brown J, Yoshinaga A (1995) Diurnal movement patterns of Hector's dolphin as observed from clifftops. Mar Mamm Sci 11: 395-402.

Stone G, Hutt A, Brown J, Yoshinaga A, Joy L, Burleigh R (1998) Respiration and movement of Hector's dolphin from suction-cup VHF radio tag telemetry data. Mar Technol Soc J 32: 89-93.

Stone G, Kraus S, Hutt A, Martin S, Yoshinaga A, Joy L (1997) Reducing by-catch: Can acoustic pingers keep Hector's dolphins out of fishing nets? Mar Tech-nol Soc J 31: 3-7.

WWF (2009) Small cetaceans, the forgotten whales. (Elliott W, Sohl H, Bugener V). Whaling Report. Indd 34.

3.7. Delphinapterus leucas

Alvarez-Flores CM, Heide-Joergensen MP (2004) A risk assessment of the sustainability of the harvest of beluga (*Delphinapterus leucas* (Pallas 1776)) in West Greenland. ICES J Mar Sci 61: 274-286.

Andersen G, Foereid S, Skaare JU, Jenssen BM, Lydersen C, Kovacs KM (2006) Levels of toxaphene congeners in white whales (*Delphinapterus leucas*) from Svalbard, Norway. Sci Total Environ. 357: 128-137.

Angliss RP, Allen BM (2008a) Beluga whale: Cook Inlet stock. Alaska Marine Mammal Stock Assessments, 2008 NOAA-TM-AFSC-193.

Angliss RP, Allen BM (2008b) Beluga whale: Bristol Bay stock. Alaska Marine Mammal Stock Assessments, 2008 NOAA-TM-AFSC-193.

Angliss RP, Allen BM (2008C) Beluga whale: Eastern Chukchi Sea Stock. Alaska Marine Mammal Stock Assessments, 2008 NOAA-TM-AFSC-193.

Angliss RP, Allen BM (2008D) Beluga whale: Beaufort Sea Stock. Alaska Marine Mammal Stock Assessments, 2008 NOAA-TM-AFSC-193.

Angliss RP, Outlaw RB (2005) Beluga Whale: Eastern Bering Sea stock. Alaska marine mammal stock assessments 2005. NOAA Technical Memorandum NMFS-AFSC-161.

Aubin DJST (1989) Thyroid function and epidermal growth in beluga whales, *Delphinapterus leucas*. University of Guelph (Canada). Diss Abst Int Pt B Sci and Eng. 50 (1).

Barber DG, Saczuk E, Richard PR (2001) Examination of Beluga-Habitat Relationships through the Use of Telemetry and a Geographic Information System. Arctic 54: 305-316.

Bjoerge A, Brownell RL, Perrin WF, Donovan GP eds. (1991) *Delphinapterus leucas*. In: Significant direct and incidental catches of small cetaceans. A report by the Scientific committee of the Int Whal Comm pp. 12-24.

Boltunov AN, Belikov SE (2002) Belugas (*Delphinapterus leucas*) of the Barents, Kara and Laptev seas. NAMMCO Scientific Publications 4:149-168.

Brown Gladden JG, Ferguson MM, Clayton JW (1997) Matriarchal genetic population structure of North American beluga whales *Delphinapterus leucas* (Cetacea: Monodontidae). Molec Ecol 6: 1033-1046

Caron LMJ, Sergeant DE (1988) Yearly variation in the frequency of passage of beluga whales (*Delphinapterus leucas*) at the mouth of the Saguenay River, Quebec, over the past decade. Can Nat 115 (2): 111-116.

Cosens SE, Dueck LP (1993) Icebreaker noise in Lancaster Sound, N.W.T., Canada: Implications for marine mammal behavior. Mar Mamm Sci 9 (3): 285-300.

COSEWIC (2004) Committee on the Status of Endangered Wildlife in Canada. Assessment and update status report on the beluga whale *Delphinapterus leucas* in Canada. Ottawa, Canada. http://www.cosewic.gc.ca/

Dalcourt MF, Beland P, Pelletier E, Vigneault Y (1992) Characteristics of the benthic communities and a study of contaminants in the areas frequented by the beluga whale in the St. Lawrence Estuary. Rapp Tech Can Sci Halieut Aquat 1845, 93 pp.

DFO (2002) Underwater World - The Beluga. Canadian Department of Fisheries and Oceans, Communications Directorate. Ottawa, ON.

Everett JT, Bolton HS (1996) Lessons in Climate Change Projections and Adaptation: From One Living Marine Resource to Another. SC/M96/CC11, submitted to the IWC Workshop on Climate Change and Cetaceans, 1996.

Finley KJ, Miller GW, Davis RA, Greene CR (1990) Reactions of belugas, *Delphinapterus leucas*, and narwhals, *Monodon monoceros*, to ice-breaking ships in the Canadian High Arctic. In "Advances in research on the beluga whale, *Delphinapterus leucas*" (Smith TG, St. Aubin DJ, Geraci JR, eds) Can Bull Fish Aquat Sci 224: 97-117.

Frost KJ, Lowry LF, Carroll G (1993) Beluga whale and spotted seal use of a coastal lagoon system in the northeastern Chukchi Sea. Arctic 46 (1): 8-16.

Gewalt W (1994) *Delphinapterus leucas* - Weißwal oder Beluga. In: Handbuch der Säugetiere Europas. Meeressäuger. Teil IA: Wale und Delphine 1 (Robineau D, Duguy R and Klima M, eds.) Aula-Verlag, Wiesbaden. pp. 185-208.

Gladden JGB, Ferguson MM, Friesen MK, Clayton JW (1999) Population structure of North American beluga whales (*Delphinapterus leucas)* based on nuclear DNA microsatellite variation and contrasted with the population structure revealed by mitochondrial DNA variation. Mol Ecol 8: 347-363.

Goetz KT, Rugh DJ, Read AJ, Hobbs RC (2007) Habitat use in a marine ecosystem: beluga whales *Delphinapterus leucas* in Cook Inlet, Alaska. Mar. Ecol. Prog Ser 330: 247-256.

Hammill MO, Lesage V, Gosselin JF, Bourdages H, De March BGE, Kingsley MCS (2004) Evidence of a decline in northern Quebec (Nunavik) belugas. Arctic 57: 183-195.

Hammill MO, Lesage V, Gosselin J-F (2005) Abundance of Eastern Hudson Bay belugas. Canadian Science Advisory Secretariat Research Document 2005/010.

Heide Jørgensen MP (1994) The scientific background for the management of monodontids in West Greenland. Whales, Seals fish and man. Proceedings of the international symposium on the biology of marine mammals in the north east

Atlantic held in Tromsø, Norway. Blix A S, Walloe L, Woltang O (eds.) Elsevier science, Amsterdam, Netherlands.

Heide-Jørgensen MP (2005) The Beluga whale. North Atlantic Marine Mammal Commission Report. Tromsø, Norway. 11 pp.

Heide-Jørgensen MP, Acquarone M. (2002) Size and trends of bowhead whales, beluga and narwhal stocks wintering off West Greenland. NAMMCO Scientific Publications 4: 191-210.

Heide-Jørgensen MP, Reeves RR (1996) Evidence of a decline in beluga, *Delphinapterus leucas*, abundance off West Greenland. ICES J Mar Sci 53 (1): 61-72.

Heide-Jørgensen MP, Richard P, Dietz R, Laidre KL, Orr J, Schmidt HC (2003) An estimate of the fraction of belugas (*Delphinapterus leucas*) in the Canadian high Arctic that winter in West Greenland. Polar Biol 26: 318-326.

Hobbs RC, Laidre KL, Vos DJ, Mahoney BA, Eagleton M (2005) Movements and Area Use of Belugas, *Delphinapterus leucas*, in a Subarctic Alaskan Estuary. Arctic 58: 331-340.

Huntington HP (1999) Traditional Knowledge of the Ecology of Beluga Whales (*Delphinapterus leucas*) in the Eastern Chukchi and Northern Bering Seas, Alaska. Arctic 52 (1): 49-61.

Innes S, Heide-Jørgensen MP, Laake JL, Laidre KL, Cleator HJ, Richard P, Stewart REA (2002) Surveys of belugas and narwhals in the Canadian High Arctic in 1996. NAMMCO Scientific Publications 4: 169-190.

IWC (1997) International Whaling commission. Report of the IWC Workshop on Climate Change and Cetaceans. Rep Int Whal Comm47: 293-318.

IWC (2000) International Whaling commission. Report of the Scientific Committee from its Annual Meeting 3-15 May 1999 in Grenada. J Ceta Res Manage 2 (Suppl.).

Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Reeves RR, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Delphinapterus leucas*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP / FAO, Rome, 320 pp.

Kingsley MCS, Gosselin S, Sleno GA (2001) Movements and dive behaviour of belugas in Northern Quebec. Arctic 54: 262-275.

Kovacs KM, Lydersen C (eds) (2006) Birds and Mammals of Svalbard. Polarhåndbok No. 13, Norwegian Polar Institute, Tromsø, Norway, Grafisk Nord AS, Finnsnes, Norway.

Lebeuf M, Noel M, Trottier S, Measures L (2007) Temporal trends (1987-2002) of persistent, bioaccumulative and toxic (PBT) chemicals in beluga whales (*Delphinapterus leucas*) from the St. Lawrence Estuary, Canada. Sci Total Environ 383: 216-231.

Lesage V, Kingsley MCS (1998) Updated status of the St. Lawrence River population of the beluga, *Delphinapterus leucas*. Can Field Nat 112 (1): 98-114.

Lockhart WL, Stern GA, Wagemann R, Hunt RV, Metner DA, DeLaronde J, Dunn B, Stewart REA, Hyatt CK, Harwood L, Mount K (2005) Concentrations of mercury in tissues of beluga whales (*Delphinapterus leucas*) from several communities in the Canadian Arctic from 1981 to 2002. Sci. Total Environ. 351-352: 391-412.

Loseto LL, Ferguson SH, Stern GA (2008) Size and Biomagnification: How Habitat Selection Explains Beluga Mercury Levels. Environ Sci Technol 42: 3982-3988.

Loseto LL, Richard P, Stern GA, Orr J, Ferguson SH (2006) Segregation of Beaufort Sea beluga whales during the open-water season. Can J Zool 84: 1743-1751.

Loseto LL, Stern GA, Connelly TL, Deibel D, Gemmill B, Prokopowicz A, Fortier L, Ferguson SH (2009) Summer diet of beluga whales inferred by fatty acid analysis of the eastern Beaufort Sea food web. J Exp Mar Biol Ecol 374: 12-18.

Lowry LF, Frost KJ, Zerbini A, De Master D, Reeves RR (2008) Trend in aerial counts of beluga or white whales (*Delphinapterus leucas*) in Bristol Bay, Alaska, 1993-2005. J Cetac Res Manage 10: 201-207

Lowry L, O'Corry-Crowe G, Goodman D (2006) *Delphinapterus leucas* (Cook Inlet population). 2006 IUCN Red List of Threatened Species. IUCN, Gland, Switzerland.

Lydersen C, Martin AR, Kovacs KM, Gjertz I (2001) Summer and autumn movements of white whales *Delphinapterus leucas* in Svalbard, Norway. Mar Ecol Prog Ser 219: 265-274.

MacLeod C (2009) Global climate change, range changes and potential implications for the conservation of marine cetaceans: a review and synthesis. ESR 7: 125-136.

March BGE de, Maiers LD, Friesen MK (2002) An overview of genetic relationships of Canadian and adjacent stocks of beluga whales (*Delphinapterus leucas*) with emphasis on Baffin Bay and Canadian eastern Arctic stocks. NAMMCO Scientific Publications 4: 17-38.

Martin AR, Smith TG, Cox OP (1998) Dive form and function in belugas *Delphinapterus leucas* of the eastern Canadia high Arctic. Polar Bio 20: 218-228.

Martineau D, De Guise S, Fournier M, Shugart L, Girard C, Lagace A, Béland P (1994) Pathology and toxicology of beluga whales from the St. Lawrence Estuary, Quebec, Canada. Past, present and future. Sci Tot Env 154: 201-115.

McKinney MA, De Guise S, Martineau D, Beland P, Lebeuf M, Letcher RJ (2006) Organohalogen contaminants and metabolites in beluga whale (*Delphinapterus leucas*) liver from two Canadian populations. Environ Toxicol Chem 25: 1246-1257.

Mymrin NI, Huntington HP (1999) Traditional Knowledge of the Ecology of Beluga Whales (*Delphinapterus leucas*) in the Northern Bering Sea, Chukotka, Russia. Arctic 52 (1): 62-70.

O' Corry-Crowe GM (2009) Beluga Whale - *Delphinapterus leucas*. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, 108-112.

O' Corry-Crowe GM, Suydam RS, Rosenberg A, Frost KJ, Dizon AE (1997) Phylogeography, population structure and dispersal patterns of the beluga whale *Delphinapterus leucas* in the western Nearctic revealed by mitochondrial DNA. Mol Ecol 6 (10): 955-970.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/ CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Richard PR, Martin AR, Orr JR (2001a) Summer and Autumn Movements of Belugas of the Eastern Beaufort Sea Stock. Arctic 54: 223-236.

Richard PR, Heide-Jørgensen MP, Orr JR, Dietz R, Smith TG (2001b) Summer and Autumn Movements and Habitat Use by Belugas in the Canadian High Arctic and Adjacent Areas. Arctic 54: 207-222.

Rugh DJ, Mahoney BA, Smith BK (2004) Aerial Surveys of Beluga Whales in Cook Inlet, Alaska, Between June 2001 and June 2002. NOAA Technical Memorandum NMFS AFSC. no. 145, 20 pp.

Shelden KEW, Rugh DJ, Mahoney BA, Dahlheim ME (2003) Killer whale predation on belugas in Cook Inlet, Alaska:

Implications for a depleted population. Mar. Mamm. Sci 19: 529-544.

Stewart REA, Campana SE, Jones CM, Stewart BE (2006) Bomb radiocarbon dating calibrates beluga (*Delphinapterus leucas*) age estimates. Can J Zool 84: 1840-1852.

Suydam RS, Lowry LF, Frost KJ, O' Corry-Crowe GM, Pikok D JR (2001) Satellite Tracking of Eastern Chukchi Sea Beluga Whales into the Arctic Ocean. Arctic 54: 237-243.

Tynan CT, DeMaster DP (1997) Observations and predictions of Arctic climatic change: Potential effects on marine mammals. Arctic 50: 308-322.

Wolkers H, Lydersen C, Kovacs KM, Burkow I, Bavel B (2006) Accumulation, Metabolism, and Food-Chain Transfer of Chlorinated and Brominated Contaminants in Subadult White Whales (*Delphinapterus leucas*) and Narwhals (*Monodon monoceros*) From Svalbard, Norway. Arch. Environ. Contam Toxicol 50: 69-78.

3.8. Delphinus capensis

Barlow J, Forney KA (2007) Abundance and population density of cetaceans in the California Current ecosystem. Fish Bull, US 105: 509-526.

Bernal R, Olavarria C, Moraga R (2003) Occurrence and long-term residency of two long-beaked common dolphins, *Delphinus capensis* (Gray 1828), in adjacent small bays on the Chilean central coast. Aquat Mamm 29: 396-399.

Carretta JV, Price T, Petersen D, Read R (2004) Estimates of marine mammal, sea turtle, and seabird mortality in the California drift gillnet fishery for swordfish and thresher shark, 1996-2002. Mar Fish Rev 66: 21-30.

De Oliveira-Santos MC, Rosso S, Dos Santos RA, Lucato SHB (2002) Insights on small cetacean feeding habits in southeastern Brazil. Aquat Mamm 28: 38-45.

Gerrodette T, Palacios DM (1996) Estimates of cetacean abundance in EEZ waters of the eastern tropical Pacific. SWFSC Admin. Rep. LJ-96-10, 28 pp.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS , Wilson B (2008) *Delphinus capensis*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>

Heyning JE, Perrin WF (1994) Evidence for two species of common dolphins (genus *Delphinus*) from the eastern North Pacific. Los Angeles County Mus. Nat. Hist. Contr. Sci. 442: 1-35.

Hucke-Gaete R, ED. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Van Waerebeek K (2002) The taxonomic status of the nominal dolphin species *Delphinus tropicalis* van Bree , 1971. Mar. Mamm. Sci. 18: 787-818.

Jefferson TA, Webber MA , Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Kajiwara N, Matsuoka S, Iwata H, Tanabe S, Rosas FCW, Fillmann G, Readman JW(2004) Contamination by persistent organochlorines in cetaceans incidentally caught along Brazilian coastal waters. Arch. Environ. Contam. Toxicol. 46: 124-134.

Kingston SE, Rosel PE (2004) Genetic differentiation among recently diverged delphinid taxa determined using AFLP markers. J Hered 95: 1-10.

Li S (1997) Studies on sea mammals and its distribution from Fujian coastal waters. J Oceanogr Taiwan Strait; Taiwan Haixia 16: 479-485.

Ohizumi H, Yoshioka M, Mori K, Miyazaki N (1998) Stomach contents of common dolphins (*Delphinus delphis*) in the pelagic western North Pacific Mar Mamm Sci. 14: 835-844.

Perrin WF (2009) Common dolphins. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 255-259.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand. 101 pp.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec. Pub. 4, Lawrence, KS. USA.

Sanino GP, Van Waerebeek K, Yanez J (2003) Revision de la distribucion del género *Delphinus* y registros documentados de *Delphinus delphis* en Chile. Bol Mus Nac Hist Nat (Chile) 52: 97-102.

Smith HR, Worthy GAJ (2006) Stratification and intra- and inter-specific differences in fatty acid composition of common dolphin (*Delphinus* sp.) blubber: Implications for dietary analysis. Comp Biochem Physiol B143: 486-499.

van Bree PJH (1971) *Delphinus tropicalis*, a new name for *Delphinus longirostris* Cuvier 1829. Mammalia 35: 345-346.

van Bree PJH, Gallagher MD (1978) On the taxonomic status *of Delphinus tropicalis* van Bree, 1971 (Notes on Cetacea, Delphinoidea IX). Beaufortia 28: 1-8.

Van Bressem M-F, Van Waerebeek K, Montes D, Kennedy S, Reyes JC, Garcia-Godos IA, Onton-Silva K, Alfaro-Shigueto Joanna (2006) Diseases, lesions and malformations in the long-beaked common dolphin *Delphinus capensis* from the Southeast Pacific. Dis Aquat Org 68: 149-165.

3.9. Delphinus delphis

Aguayo A , Bernal R, Olavarria C, Vallejos (1998) Cetacean observations carried out between Valparaiso and Easter Island, Chile, in the winters of 1993, 1994 and 1995. Rev. Biol. Mar. Ocean. 33: 101-123.

Antoine L, Goujon M, Massart G (2001) Dolphin bycatch in tuna driftnet in North East Atlantic. Copenhagen Denmark Ices, 8 pp.

Azzellino, A; Gaspari, S; Airoldi, S; Nani, B (2008) Habitat use and preferences of cetaceans along the continental slope and the adjacent pelagic waters in the western Ligurian Sea. Deep Sea Res (I. Oceanogr, Res, Pap,) 55: 296-323.

Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Anim Conserv 9: 474-482.

Bearzi G (2003) Assessment short-beaked common dolphin (*Delphinus delphis*) (Mediterranean subpopulation). In Reeves R., Notarbartolo di Sciara G. (compilers and editors). 2006. The status and distribution of cetaceans in the Black Sea and Mediterranean Sea. IUCN Centre for Mediterranean Cooperation, Malaga, Spain. 137 pp.

Bearzi G, Holcer D, Sciara, G (2004) The role of historical dolphin takes and habitat degradation in shaping the present status of northern Adriatic cetaceans. Mar Freshwat Ecosyst 14: 363-379.

Bearzi G, Politi E, Agazzi S, Bruno S, Costa M, Bonizzoni S (2005) Occurrence and present status of coastal dolphins (*Delphinus delphis* and *Tursiops truncatus*) in the eastern Ionian Sea. Mar Freshwat Ecosyst 15: 243-257.

Berrow SD, Rogan E (1998) Incidental capture of cetaceans in Irish waters. Ir Nat J 26: 22-31.

Bilgmann K, Moeller LM, Harcourt RG, Gales R, Beheregaray LB (2008) Common dolphins subject to fisheries impacts in Southern Australia are genetically differentiated: implications for conservation. Anim Conserv 11: 518-528.

Birkun A (2006) Short-beaked common dolphin (*Delphinus delphis ponticus*) Black Sea subspecies. IUCN/ACCOBAMS Workshop on the Red List Assessment of Cetaceans in the ACCOBAMS Area.

Bourreau S, Gannier A (2003) Distribution of *Delphinus delphis* in the Mediterranean Sea: competition with striped dolphin or fisheries? Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Braeger S, Schneider K (1998) Near-shore distribution and abundance of dolphins along the West Coast of the South Island, New Zealand. N Z J Mar Freshw Res 32: 105-112.

Bratten D, Hall M (1997) Working with fishers to reduce bycatch: The tuna-dolphin problem in the eastern Pacific Ocean. Fisheries Bycatch: Consequences and Management, pp. 97-100.

Cañadas A, Hammond PS (2008) Abundance and habitat preferences of the short-beaked common dolphin *Delphinus delphis* in the southwestern Mediterranean: Implications for Conservation. Endang Species Res 4: 309-331.

Carretta JV, Price T, Petersen D, Read R (2004) Estimates of marine mammal, sea turtle, and seabird mortality in the California drift gillnet fishery for swordfish and thresher shark, 1996-2002. Mar Fish Rev 66: 21-30

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Chivers SJ, Robertson KM, Henshaw MD (1997) Composition of the incidental kill of cetaceans in two California gillnet fisheries: 1990-1995. Int Whal Comm 47: 909-915.

Collet A (1994) *Delphinus delphis* - Gewöhnlicher oder gemeiner Delphin. In: Handbuch der Säugetiere Europas. (Niethammer J, Krapp F, Eds.) Band 6: Meeressäuger. Teil 1A: Wale und Delphine 1. Aula-Verlag, Wiesbaden, pp. 281-305.

Couperus AS (1997) Interactions between Dutch midwater-trawl and Atlantic white-sided dolphins (*Lagenorhynchus acutus*) southwest of Ireland. J Northwest Atl Fish Sci 41 (3): 209-218.

Crespo EA, Koen Alonso M, Dans SL, Garcia NA, Pedraza SN, Coscarella M, Gonzalez R (2000) Incidental catches of dolphins in mid-water trawls for Argentine anchovy (*Engraulis anchoita*) off the Argentine Shelf. J Cetacean Res Manage 2: 11-16.

Danil K, Chivers SJ (2007) Growth and reproduction of female short-beaked common dolphins, *Delphinus delphis*, in the eastern tropical Pacific. Can J Zool 85: 108-121.

De Boer MN, Leaper R, Keith S, Simmonds MP (2008) Winter abundance estimates for the common dolphin (*Delphinus delphis*) in the western approaches of the English Channel and the effect of responsive movement. J Mar Animals Their Ecol 1: 15-21.

Delgado Estrella A, Ortega Ortiz J G, Sanchez Rios A (1994) Stranding of marine mammals during spring and autumn, and its relation with human activity in the northern part of Gulf of California. Anal Inst Biol Univ Nac Auton Mexico Ser Zool 65 (2): 287- 295.

Evans WE (1994) Common dolphin, white-bellied porpoise - *Delphinus delphis* Linnaeus, 1758. In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 191-224.

Evans PGH (1998) Biology of cetaceans in the North-East Atlantic (in relation to seismic energy). In: Proceedings of the Seismic and Marine Mammals Workshop, London 23-25 June 1998, (M. L. Tasker & C. Weir, eds.) Sea Mammal Research Unit, U. of St. Andrews, Scotland. http://smub.st-and.ac.uk/seismic/pdfs/

Ferreira M, Sequeria M, Vingada J, Eira C (2003) Cetacean bycatches in coastal fisheries off northern Portugal. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Ferrero R C, Walker W A (1995) Growth and reproduction of the common dolphin, *Delphinus delphis* Linnaeus, in the offshore waters of the North Pacific Ocean. US Fish Bull 93: 483-494.

Gannier A (1998) North-western Mediterranean Sea cetacean populations: new results about their distribution, the population structure and the relative abundance of the different species. Mesogee 56: 3-19.

Gerrodette T, Watters G, Perryman W, Balance L (2008) Estimates of 2006 dolphin abundance in the eastern tropical Pacific, with revised estimates from 1986-2003.. NOAA-TM-NMFS-SWFSC-422.

Goffman O, Spanier E, Kerem D, Tsur I (1995) Distribution and death of dolphins along the Mediterranean coast of Israel. Israel J Zool 41 (1): 88.

Goncalves JM, Barreiros JP, Azevedo JMN, Norberto R (1996) Cetaceans stranded in the Azores during 1992-96. Arquipelago Cienc Biol Mar; Life Mar Sci 14A: 57-65.

Goold JC (1996) Acoustic assessment of populations of common dolphin *Delphinus delphis* in conjunction with seismic surveying. J Mar Biol Assoc U K 76: 811-820.

Goold JC (1998) Acoustic assessment of populations of common dolphin off the west Wales coast with perspectives from satellite infrared imagery. J Mar Biol Assoc UK 78: 1353-1364.

Goujon M (1996) Driftnet incidental catch and population dynamics of dolphins off the Bay of Biscay. Publ Lab Halieut Ec Natl Super Agron Rennes 15, 239 pp.

Gowans S, Whitehead H (1995) Distribution and habitat partitioning by small odontocetes in the Gully, a submarine canyon on the Scotian Shelf. Can J Zool 73: 1599-1608.

Hammond PS, Berggren P, Benke H, Borchers DL, Collet A, Heide-Joergensen MP, Heimlich S, Hiby AR, Leopold MF, Oeien N (2002) Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. J Appl Ecol 39: 361-376.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008). *Delphinus delphis*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>

Holsbeek L, Siebert U, Joiris CR (1998) Heavy metals in dolphins stranded on the French Atlantic coast. Sci Tot Env 217: 241-249.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Fertl D, Bolanos-Jimenez J, Zerbini AN (2009) Distribution of common dolphins (*Delphinus* spp.) in the western Atlantic Ocean: a critical re-examination. Mar Biol 156: 109-1124.

Jefferson TA, Van Waerebeek K (2002) The taxonomic status of the nominal dolphin species *Delphinus tropicalis* van Bree, 1971. Mar Mamm Sci 18: 787-818.

Kastelein RA, Macdonald GJ, Wiepkema PR (2000) A note on food consumption and growth of common dolphins (*Delphinus delphis*). J Cetacean Res Manage 2:69-74.

Kuiken T, Simpson VR, Allchin CR, Bennett PM, Codd GA (1994) Mass mortality of common dolphins (*Delphinus delphis*) in south west England due to incidental capture in fishing gear. Vet Rec 134: 81-89.

Long M , Reid R J , Kemper C M (1997) Cadmium accumulation and toxicity in the bottlenose dolphin *Tursiops truncatus*, the common dolphin *Delphinus delphis*, and some dolphin prey species in South Australia. Aust Mam 20: 25-33.

Lucas ZN, Hooker SK (2000) Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. Can Field Nat 114: 45-61.

Meynier L, Pusineri C, Spitz J, Santos MB, Pierce GJ, Ridoux V (2008) Intraspecific dietary variation in the short-beaked common dolphin *Delphinus delphis* in the Bay of Biscay: importance of fat fish. Mar Ecol Prog Ser 354: 277-287

Moessner S, Ballschmiter K (1997) Marine mammals as global pollution indicators for organochlorines. Chemosphere 34 (5-7): 1285-1296.

Morato, T, Varkey DA, Damaso C, Machete M, Santos M, Prieto R, Santos RS, Pitcher TJ (2008) Evidence of a seamount effect on aggregating visitors. Mar Ecol Prog Ser 357: 23-32

Mundo Azul (2009) Historia de la matanza de delfines en el Perú. http://www.mundoazul.org/delfines_contra_caza.htm

Neumann DR (2001) Seasonal movements of short-beaked common dolphins (*Delphinus delphis*) in the north-western Bay of Plenty, New Zealand: influence of sea surface temperature and El Niño/La Niña. N Z J Mar Freshwat Res 35: 371-374.

Neumann DR, Orams MB (2003) Feeding behaviours of short-beaked common dolphins, *Delphinus delphis*, in New Zealand. Aquat Mamm 29: 137-149.

Neumann DR, Orams MB (2006) Impacts of ecotourism on short-beaked common dolphins (*Delphinus delphis*) in Mercury Bay, New Zealand. Aquat Mamm 32: 1-9.

Ohizumi H, Watanabe H (2004) Stomach contents of toothed whales in relation to prey distribution in the North Pacific. PICES 13th Annual Meeting Book of Abstracts. p. 51.

Parsons ECM, Clark J, Ross A, Simmonds MP (2007) The conservation of British cetaceans: A review of the threats and protection afforded to whales, dolphins and porpoises in UK Waters. WDCS report.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Perrin WF (2009) Common dolphins. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 255-259.

Pierce GJ, Santos MB, Murphy S, Learmonth JA, Zuur AF, Rogan E, Bustamante P, Caurant F, Lahaye V, Ridoux V, Zegers BN, Mets A, Addink M, Smeenk C, Jauniaux T, Law RJ, Dabin W, Lopez A, Alonso Farre JM, Gonzalez AF, Guerra A, Garcia-Hartmann M, Reid RJ, Moffat CF, Lockyer C, Boon JP (2008) Bioaccumulation of persistent organic pollutants in female common dolphins (*Delphinus delphis*) and harbour porpoises (*Phocoena phocoena*) from western European seas: Geographical trends, causal factors and effects on reproduction and mortality. Environ Pollut 153 : 401-415.

Pierrepont JF de, Dubois B, Desormonts S, Santos MB, Robin JP (2003) Diet of English Channel cetaceans stranded on the coast of Normandy. ICES Council Meeting Documents Copenhagen. no. 2003.

Pusineri C, Magnin V, Meynier L, Spitz J, Hassani S, Ridoux V (2007) Food and feeding ecology of the common dolphin (*Delphinus delphis*) in the oceanic northeast Atlantic and comparison with its diet in neritic areas. Mar Mamm Sci: 23: 30-47.

Reeves RR, Smith BD, Crespo EA, Notarbartolo di Sciara G (compilers) (2003) Dolphins, Whales and Porpoises: 2002-2010 Conservation Action Plan for the World's Cetaceans. IUCN/SSC Cetacean Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. ix + 139pp.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Rogan E, Mackey M (2007) Megafauna bycatch in drift nets for albacore tuna (*Thunnus alalunga*) in the NE Atlantic. Fish Res: 86: 6-14.

Ross G (2006) Review of the conservation status of Australia's smaller whales and dolphins. Australian Government.

Scott MD, Cattanach KL (1998) Diel patterns in aggregations of pelagic dolphins and tunas in the eastern pacific. Mar Mamm Sci 14: 401-428.

Silva MA (1999) Diet of common dolphins, *Delphinus delphis*, off the Portuguese continental coast. J Mar Biol Assoc U K 79: 531-540.

Silva MA, Sequieira M (2003) Patterns in the mortality of common dolphins (*Delphinus delphis*) on the Portuguese coast, using stranding records, 1975-1998. Aquat Mamm 29: 88-98.

Silvani L, Gazo M, Aguilar A (1999) Spanish driftnet fishing and incidental catches in the western Mediterranean. Biol Cons 90: 79-85.

Sokolov V E , Yaskin V A, Yukhov V L (1997) Distribution and numbers of the Black Sea dolphins surveyed from ships. Zool Zh 76: 364-370.

Stanev T (1996) Distribution and number of dolphins in the Bulgarian sector of the Black Sea. Izv Inst Ribni Resur Varna; Proc Inst Fish Varna 24: 177-182.

Stone CJ, Tasker ML (2005) The effects of seismic airguns on cetaceans in UK waters. J Cetacean Res Manage 8: 255-263

Syvertsen PO, Van der Kooij J, Isaksen K (1999) The occurrence of striped dolphin *Stenella coeruleoalba* and common dolphin *Delphinus delphis* in Norwegian coastal waters. Fauna Oslo 52 (2): 104-117.

Tregenza NJC, Collet A (1998) Common dolphin *Delphinus delphis* bycatch in pelagic trawl and other fisheries in the Northeast Atlantic. Int Whal Comm 48: 453-462.

Tregenza N, Turk S, Nicholson T, Ball D (2003) Rising stranding rates of small cetaceans in the southwest of England. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Tudela S, Kai AK, Maynou F, El Andalossi M, Guglielmi, P (2005) Driftnet fishing and biodiversity conservation: the case study of the large-scale Moroccan driftnet fleet operating in the Alboran Sea (SW Mediterranean). Biol Conserv 121: 65-78

Viale D (1994) Cetaceans as indicators of a progressive degradation of Mediterranean water quality. Int J Environ Stud, Sect A 45: 183-198.

Waring GT, Nottestad L, Olsen E, Skov H, Vikingsson, G (2008) Distribution and density estimates of cetaceans along the mid-Atlantic Ridge during summer 2004. J Cetacean Res Manag 10: 137-146.

Waring GT, Josephson E, Fairfield CP, Maze-Foley K, editors. (2007) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2006. NOAA Tech Memo NMFS NE 201; 378 p.

Young DD, Cockroft VG (1994) Diet of common dolphins (*Delphinus delphis*) off the south-east coast of southern Africa: Opportunism or specialization? J Zool (London) 234: 41-53.

3.10. Feresa attenuata

Barlow J (2006) Cetacean abundance in Hawaiian waters estimated from a summer/ fall survey in 2002. Mar Mamm Sci 22: 446-464.
Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.
Castro C (2004) Encounter with a school of pygmy killer whales (*Feresa attenuata*) in Ecuador, Southeast Tropical Pacific. Aquat Mamm 30: 441-444.
Dolar M L L, Suarez P, Ponganis P J, Kooyman G L (1999) Myoglobin in pelagic small cetaceans. J Exp Biol 202: 227-236.
Donahue MA, Perryman WL (2009) Pygmy Killer Whale - *Feresa attenuata*. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 938-939.
Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.
Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.
Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.
Madsen PT, Kerr I, Payne R (2004) Source parameter estimates of echolocation clicks from wild pygmy killer whales (*Feresa attenuata*) (L). J Acoust Soc Amer 116: 1909-1912.
Mazzuca L, Atkinson S, Keating B, Nitta E (1999) Cetacean mass strandings in the Hawaiian Archipelago, 1957-1998. Aquat Mamm 25: 105-114.
Mignucci-Giannoni AA, Toyos-Gonzalez GM, Perez-Padilla J, Rodriguez-Lopez MA, Overing J. (2000) Mass stranding of pygmy killer whales (*Feresa attenuata*) in the British Virgin Islands. J Mar Biol Assoc U-K 80: 759-760.
Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.
Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ. 4, Lawrence, KS. USA.
Ross GJB, Leatherwood S (1994) Pygmy killer whale - *Feresa attenuata*. In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 387-404.
Rudolph P, Smeenk C (2009) Indo-West Pacific marine mammals. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 608-616.
Santos RA, Haimovici M (1998) Cephalopods in the diet of marine mammals stranded or incidentally caught along southeast and southern Brazil (21° to 34°S). Copenhagen Denmark Ices, 15 pp.
Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008). Feresa attenuata. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>.
Wade P, Gerrodette T (1993) Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep Int Whal Comm 43: 477-493.
Wang JY, Yang S-C (2006) Unusual cetacean stranding events of Taiwan in 2004 and 2005. J Cetacean Res Manage 8: 283-292.
Waring GT, Josephson E, Fairfield CP, Maze-Foley K, ed. (2007) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2006. NOAA Tech Memo NMFS NE 201; 378 p.
Williams AD, Williams R, Brereton T (2002) The sighting of pygmy killer whales (*Feresa attenuata*) in the southern Bay of Biscay and their association with cetacean calves. J Mar Biol Assoc UK 82: 509-511.
Zerbini AN, De Ooliveira Santos MC (1997) First record of the pygmy killer whale *Feresa attenuata* (Gray, 1874) for the Brazilian coast. Aquat Mamm 23:105-109.

3.11. Globicephala macrorhynchus

Baird RW, Mcsweeney DJ, Heithaus MR, Marshall G (2003) Sub-surface and night-time behaviour of short-finned pilot whales in Hawaii: Information from suction-cup attached time-depth recorders and video camera (Crittercam) systems. Annual Meeting of the European Cetacean Society, Tenerife, Spain.
Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Anim Conserv 9: 474-482.
Barlow J (2006) Cetacean abundance in Hawaiian waters estimated from a summer/ fall survey in 2002. Mar Mamm Sci 22: 446-464.
Bernard HJ, Reilly B (1999) Pilot whales - *Globicephala* Lesson, 1828. In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises. pp. 245 - 280.
Bustamante P, Garrigue C, Breau L, Caurant F, Dabin W, Greaves J, Dodemont R (2003) Trace elements in two odontocete species (*Kogia breviceps* and *Globicephala macrorhynchus*) stranded in New Caledonia (South Pacific). Environ Pollut 124: 263-271.
Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.
Dolar ML (1999) Abundance, distribution and feeding ecology of small cetaceans in the Eastern Sulu Sea and Tañon Strait, Philippines. PhD thesis, U Cal San Diego, USA.
Davis RW, Fargion GS, May N, Leming TD, Baumgartner M (1998) Physical habitat of cetaceans along the continental slope in the north-central and western Gulf of Mexico. Mar Mamm Sci 14: 490-507.
Dolar MLL, Leatherwood SJ, Wood CJ, Alava MNR, Hill CL (1994) Directed fisheries for cetaceans in the Philippines. Rep Int Whal Comm 44: 439-449.
Forney KA, Kobayashi DR (2007) Updated estimates of mortality and injury of cetaceans in the Hawaii-based longline fishery, 1994-2005. NOAA Tech Memo NMFS SWFSC. 412, 35 pp.
Fullard JK, Early G, Heide-Jorgensen PM, Bloch D, Rosing-Asvid A, Amos W (2000) Population structure of long-finned pilot whales in the North Atlantic: a correlation with sea surface temperature? Mol Ecol 9: 949-958.
Glen R (2003) Beavioural reponses of the short-finned pilot whale, *Globicephala macrorhynchus*, in relation to the number of surrounding whale-watching vessels. Annual Meeting of the European Cetacean Society, Tenerife, Spain.
Gerrodette T, Forcada J (2002) estimates of abundance of western/spotted whitebelly spinner, striped and common dolphins, and pilot, sperm and Bryde's whales in the eastern tropical Pacific Ocean. Southwest Fishery Center, La Jolla, California.
Hacker SE (1992) Stomach contents of four short-finned pilot whales (*Globicephala macrorhynchus*) from the Southern California Bight. Mar Mamm Sci 8: 76-81.
Hernandez Garcia V, Martin V (1994) Stomach contents of two short-finned pilot whalees (*Globicephala macrorhynchus* Gray, 1846) (Cetacea, Delphinidae) off the Canary Islands: A preliminary note. Copenhagen Denmark Ices.

Hindell M (2008) To breathe or not to breathe: optimal strategies for finding prey in a dark, three-dimensional environment. J Anim Ecol 77: 847-849.

Hohn AA, Rotstein DS, Harms CA, Southall BL (2006) Report on marine mammal unusual mortality event UMESE0501Sp: Multispecies mass stranding of pilot whales (*Globicephala macrorhynchus*), minke whale (*Balaenoptera acutorostrata*), and dwarf sperm whales (*Kogia sima*) in North Carolina on 15-16 January 2005. NOAA Technical Memorandum NMFS-SEFSC-537, 222 p.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Mazzuca L, Atkinson S , Keating B, Nitta E (1999) Cetacean mass strandings in the Hawaiian Archipelago, 1957-1998. Aquat Mamm 25: 105-114.

Mignucci Giannoni AA, Pinto Rodriguez B, Velasco Escudero M (1999) Cetacean strandings in Puerto Rico and the Virgin Islands. J Cetacean Res Manag 1: 191-198.

Mintzer VJ, Gannon DP, Barros NB, Read AJ (2008) Stomach contents of mass-stranded short-finned pilot whales (*Globicephala macrorhynchus*) from North Carolina. Mar Mamm Sci 24: 290-302.

Olson P (2009) Pilot whales *Globicephala melas* and *G. macrorhynchus*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 847-852.

Olson PA, Reilly SB (2002) Pilot whales - *Globicephala melas* and *G. macrorhynchus*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 898-903.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ 4, Lawrence, KS. USA.

Shane S H (1995) Behavior patterns of pilot whales and Risso's dolphins off Santa Catalina Island, California. Aquat Mamm 21: 195-197.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008). *Globicephala macrorhynchus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>.

Waring GT, Josephson E, Fairfield CP, Maze-Foley K, eds. (2007) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2006. NOAA Tech Memo NMFS NE 201; 378 p.

Weir CR (2008) Short-finned pilot whales (*Globicephala macrorhynchus*) respond to an airgun Ramp-up procedure off Gabon. Aquat Mamm 34: 349-354.

3.12. Globicephala melas

Abend AG, Smith TD (1997) Differences in stable isotope ratios of carbon and nitrogen between long-finned pilot whales (*Globicephala melas*) and their primary prey in the Western North Atlantic. Ices J Mar Sci 54: 500-503.

Aguayo A, Bernal R, Olavarria C, Vallejos (1998) Cetacean observations carried out between Valparaiso and Easter Island, Chile, in the winters of 1993, 1994 and 1995. Rev Biol Mar Ocean 33: 101-123.

Baird RW, Borsani JF, Hanson MB, Tyack PL (2002) Diving and night-time behavior of long-finned pilot whales in the Ligurian Sea. Mar Ecol Prog Ser 237: 301-305.

Baraff LS, Asmutis SRA (1998) Long-term association of an individual long-finned pilot whale and Atlantic white-sided dolphins. Mar Mamm Sci 14: 155-161.

Beatson EL, O'Shea S (2009) Stomach contents of long-finned pilot whales, *Globicephala melas*, mass-stranded on Farewell Spit, Golden Bay in 2005 and 2008. N Z J Zool 36: 47-58.

Bernard HJ, Reilly B (1999) Pilot whales - *Globicephala* Lesson, 1828. In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises. pp. 245-280.

Bloch D (1998) A review of marine mammals observed, caught or stranded over the last two centuries in Faroese Waters. Shetland Sea Mamm Rep 1997: 15-37.

Bloch D, Desportes G, Mouritsen R, Skaaning S, Stefansson E (1993c) An introduction to studies on the ecology and status of the long-finned pilot whale (*Globicephala melas*) off the Faroe Islands, 1986-1988. Rep Int Whal Comm (14): 1-32.

Bloch D, Heide-Joergensen MP, Stefansson E, Mikkelsen B, Ofstad LH, Dietz R, Andersen LW (2003) Short-term movements of pilot whales around the Faroe Islands. Wildl Biol 9: 47-58.

Bloch D, Lastein L (1993) Morphometric segregation of long-finned pilot whales in eastern and western North Atlantic. Ophelia 38: 55-68.

Bloch D, Lastein L (1995) Modelling the school structure of pilot whales in the Faroe Islands, 1832-1994. In: Blix, AS, Walløe, L and Ulltang, U, (eds). Whales, seals, fish and man: 499-508. Elsevier. Amsterdam- Lausanne-New York-Oxford-Shannon-Tokyo.

Bloch D, Zachariassen M, Zachariassen P (1993a) Some external characters of the long-finned pilot whale off the Faroe Islands and a comparison with the short-finned pilot whale. Rep Int Whal Comm (14): 117-136.

Bloch D, Lockyer C, Zachariassen M (1993b) Age and growth parameters of the long-finned pilot whale off the Faroe Islands. Rep Int Whal Comm (14): 163-208.

Borrell A, Aguilar A (1993) DDT and PCB pollution in blubber and muscle of long-finned pilot whales from the Faroe Islands. Rep Int Whal Comm (14): 351-358.

Buckland ST, Bloch D, Cattanach KL, Gunnlaugsson T, Hoydal K, Lens S, Sigurjónsson J (1993) Distribution and abundance of long-finned pilot whales in the North Atlantic, estimated from NASS-1987 and NASS-89 data. Rep Int Whal Comm (14): 33-50.

Butterworth D (ed.) (1996) Report of the Study Group on Long-Finned Pilot Whales. Report of Meeting, Cambridge, UK, 22-26 April 1996. Int Counc Exp Sea 1-37. ICES C.M.1996/A:6.

Cañadas A, Sagarminaga R (2000) The northeastern Alboran Sea, an important breeding and feeding ground for the long-finned pilot whale (*Globicephala melas*) in the Mediterranean Sea. Mar Mamm Sci 16: 513-529.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Caurant F, Amiard-Triquet C (1995) Cadmium contamination in pilot whales *Globicephala melas*: source and potential hazard to the species. Mar Poll Bull 30: 207-210.

Caurant F, Amiard-Triquet C, Amiard JC (1993) Factors influencing the accumulation of metals in pilot whales

(*Globicephala melas*) off the Faroe Islands. Rep Int Whal Comm (14): 369-390.

Desportes G, Andersen LW, Aspholm PE, Bloch D, Mouritsen R (1994) A note about a male-only pilot whale school observed in the Faroe Islands. Fróðskaparrit 40: 31-37.

Desportes G, Mouritsen R (1993) Preliminary results on the diet of long-finned pilot whales off the Faroe Islands. Rep int Whal Comm (special issue 14): 305-324.

Desportes G, Saboureau M, Lacroix A (1993) Reproductive maturity and seasonality of male long-finned pilot whales, off the Faroe Islands. Rep int Whal Comm (14): 233-262.

Faengstroem B, Athanasiadou M, Athanassiadis I, Bignert A, Grandjean P, Weihe P, Bergman K (2005) Polybrominated diphenyl ethers and traditional organochlorine pollutants in fulmars (*Fulmarus glacialis*) from the Faroe Islands. Chemosphere 60: 836-843

Frodello J P, Romeo M, Viale D (2000) Distribution of mercury in the organs and tissues of five toothed-whale species of the Mediterranean. Environmental Pollution 108 (3): 447-452.

Fullard K J, Early G, Heide Jorgensen M P, Bloch D, Rosing (2000) Population structure of long-finned pilot whales in the North Atlantic: A correlation with sea surface temperature? Molecular Ecology 9 (7): 949-958.

Heide-Jørgensen MP, Bloch D, Stefansson E, Mikkelsen B, Ofstad LH,and Dietz R (2002) Diving behaviour of long-finned pilot whales *Globicephala melas* around the Faroe Islands. Wildlife Biology 8,4: 307-313.

Goodall RNP, Macnie SV (1998) Sightings of pilot whales off South America South of 30°S: A review of data to 1988. Report of the International Whaling Commission 48: 565-579.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jankowski M (2006) Long-finned pilot whale movement and social structure: Residency, population mixing and identification of social units. Masters Abs Int. 45: 124.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Leeney RH, Amies R, Broderick AC, Witt MJ, Loveridge J, Doyle J, Godley BJ (2008) Spatio-temporal analysis of cetacean strandings and bycatch in a UK fisheries hotspot. Biodiversity & Conservation 17: 2323-2338.

Lopez A, Pierce GJ, Santos MB, Gracia J, Guerra A (2003) Fishery by-catches of marine mammals in Galician waters: results from on-board observations and an interview survey of fishermen. Biol Conserv 111: 25-40.

Martin AR (1994) *Globicephala melas* - Langflossen-Grindwal. In: Handbuch der Säugetiere Europas (Niethammer J, Krapp F, Eds) Band 6: Meeressäuger. Teil 1A Wale und Delphine 1. Aula-Verlag, Wiesbaden, Germany, pp. 407-421.

Martin AR, Rothery P (1993) Reproductive parameters of female long-finned pilot whales (*Globicephala melas*) around the Faroe Islands. European Research on Cetaceans. Proc. 7th Ann. Conf. European Cetacean Society, Inverness, Scotland 18-21 February, 1993: 95.

Mate B (1989) Satellite-monitored radio tracking as a method for studying cetacean movements and behaviour (SC/40/O 42). Rep Int Whaling Comm 40: 389-391.

Mintzer VJ, Gannon DP, Barros NB, Read AJ (2008) Stomach contents of mass-stranded short-finned pilot whales (*Globicephala macrorhynchus*) from North Carolina. Mar Mamm Sci 24: 290-302.

NAMMCO (1997) North Atlantic Marine Mammal Commission Annual Report 1996: Report of the Scientific Committee working group on abundance estimates: 173-202.

NAMMCO (2006) North Atlantic Marine Mammal Commission Annual Report 2006, Vol II. Scientific Committee National Progress reports.

Nielsen JB, Nielsen F, Joergensen P-J, Grandjean P (2000) Toxic metals and selenium in blood from pilot whales (*Globicephala melas*) and sperm whales (*Physeter catodon*). Mar Poll Bull 40: 348-351.

Olson PA (2009) Pilot whales - *Globicephala melas* and *G. macrorhynchus*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 847-852.

Ottensmeyer CA, Whitehead H (2003) Behavioural evidence for social units in long-finned pilot whales. Can J Zool 81: 1327-1338.

Parsons ECM, Dolman SJ, Wright AJ, Rose NA, Burns WCG (2008) Navy sonar and cetaceans: Just how much does the gun need to smoke before we act? Mar Poll Bull 56: 1248-1257.

Rendell LE, Gordon JCD (1999) Vocal response of long-finned pilot whales (*Globicephala melas*) to military sonar in the Ligurian Sea. Marine Mammal Science 15:198-204.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP / CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, Ed.), Lawrence, KS. USA.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Globicephala melas*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>.

Waring GT, Josephson E, Fairfield CP, Maze-Foley K, eds. (2007) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2006. NOAA Tech Memo NMFS NE 201; 378 p.

Weinrich M, Panigada S, Guinet C (2005) Report of the Joint ACCOBAMS/Pelagos Workshop on Large Whale Ship Strikes in the Mediterranean Sea. Joint ACCOBAMS/ PELAGOS workshops on fin whale and collisions Monaco, 12-15 November 2005.

Weisbrod AV, Shea D, Moore MJ, Stegeman JJ (2000) Bioaccumulation patterns of polychlorinated biphenyls and chlorinated pesticides in Northwest Atlantic pilot whales. Environmental Toxicology and Chemistry 19 (3): 667 - 677

Werth A (2000) A kinematic study of suction feeding and associated behavior in the long-finned pilot whale, *Globicephala melas* (Traill). Marine Mammal Science 16 (2): 299 - 314.

Zachariassen P (1993) Pilot whale catches in the Faroe Islands, 1709-1992. Rep int Whal Comm (14): 69-88.

Zerbini AN, Kotas JE (1998) A note on cetacean bycatch in pelagic driftnetting off southern Brazil. Rep Int Whal Comm 48: 519-524.

3.13. Grampus griseus

Azzellino A, Gaspari S, Airoldi S, Nani B (2008) Habitat use and preferences of cetaceans along the continental slope and the adjacent pelagic waters in the western Ligurian Sea. Deep-Sea Research Part I Oceanographic Research Papers 55: 296-323.

Baird RW (2002) Risso's dolphin. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 1037-1039.

Baird RW (2009) Risso's dolphin. In: Encyclopedia of marine mammals (2nd. Ed.; Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 975-976.

Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Anim Cons 9: 474-482.

Barlow J (2006) Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Mar Mamm Sci 22: 446-464.

Barlow, J and K A Forney (2007) Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105: 509-526.

Baumgartner M F (1997) The distribution of Risso's dolphin (*Grampus griseus*) with respect to the physiography of the northern Gulf of Mexico. Mar Mamm Sci 13: 614-638.

Baumgartner MF, Mullin KD, May LN, Leming TD (2001) Cetacean habitats in the northern Gulf of Mexico. Fish Bull 99: 219-239.

Blanco C, Raduan A, Fernandez M, Raga JA (2003) Diet of Risso's dolphin in the western Mediterranean. Annual Conf. of the European Cetacean Society, Tenerife, Spain.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Chen M-H, Shih, C-C, Chou CL, Chou L-S (2002) Mercury, organic-mercury and selenium in small cetaceans in Taiwanese waters. Mar Poll Bull 45: 237-245.

Chou CC, Chen YN, Li CS (2004) Congener-specific polychlorinated biphenyls in cetaceans from Taiwan waters. Arch Env Contam & Toxic 47: 551-560.

Davis RW, Fargion GS, May N, Leming TD, Baumgartner M, Evans WE, Hansen LJ, Mullin K (1998) Physical habitat of cetaceans along the continental slope in the north-central and western Gulf of Mexico. Mar Mamm Sci 14: 490-507.

Dolar ML (1999) Abundance, distribution and feeding ecology of small cetaceans in the Eastern Sulu Sea and Tañon Strait, Philippines. PhD thesis, U Cal San Diego, USA.

Endo T, Haraguchi K, Hotta Y, Hisamichi Y, Lavery S, Dalebout ML, Baker CS (2005) Total mercury, methyl mercury, and selenium levels in the red meat of small cetaceans sold for human consumption in Japan. Env Sci & Tech 39: 5703-5708.

Evans PGH (1998) Biology of cetaceans in the North-East Atlantic (in relation to seismic energy). In: Proceedings of the Seismic and Marine Mammals Workshop, London 23-25 June 1998, (M L Tasker & C Weir, eds.) Sea Mammal Research Unit, U of St. Andrews, Scotland. http://smub.stand.ac.uk/seismic/pdfs/

Forney KA, Barlow J (1998) Seasonal patterns in the abundance and distribution of California cetaceans, 1991-1992. Mar Mamm Sci 14: 460-489.

Forney, K A (2007) Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-406. 27 p.

Frantzis A, Herzing D (2002) Mixed-species associations of striped dolphins (*Stenella coeruleoalba*), short-beaked common dolphins (*Delphinus delphis*), and Risso's dolphins (*Grampus griseus*) in the Gulf of Corinth (Greece, Mediterranean Sea). Aquat Mamm 28: 188-197.

Frodello J P, Romeo M, Viale D (2000) Distribution of mercury in the organs and tissues of five toothed-whale species of the Mediterranean. Env Poll 108: 447-452.

Gannier A (1998) North-western Mediterranean sea cetacean populations: news results about their distribution, the population structure and the relative abundance of the different species. Mesogee 56: 3-19.

Garrison L (2007) Interactions between marine mammals and pelagic longline fishing gear in the US Atlantic Ocean between 1992 and 2004. Fish Bull (Seattle) 105: 408-417.

Gomez de Segura A, Crespo EA, Pedraza SN, Hammond PS, Raga JA (2006) Abundance of small cetaceans in waters of the central Spanish Mediterranean. Mar Biol 150: 149-160.

Gomez De Segura A, Hammond PS, Raga J A (2008) Influence of environmental factors on small cetacean distribution in the Spanish Mediterranean. J Mar Biol Assoc UK 88: 1185-1192.

Hartman KL, Visser F, Hendriks AJE (2008) Social structure of Risso's dolphins (*Grampus griseus*) at the Azores: a stratified community based on highly associated social units. Can J Zool 86: 294-306.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP / FAO, Rome, 320 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Kruse S, Caldwell DK, Caldwell MC (1999) Risso's dolphin - *Grampus griseus* (G. Cuvier, 1812) In: Handbook of Marine Mammals (Ridgway SH, Harrison SR Eds.) Vol. 6: The second book of dolphins and porpoises. pp. 183-212.

Moulins A, Rosso M, Ballardini M, Wuertz M (2008) Partitioning of the Pelagos Sanctuary (north-western Mediterranean Sea) into hotspots and coldspots of cetacean distributions. J Mar Biol Assoc UK 88: 1273-1281.

Mullin KD, Fulling GL (2004) Abundance of cetaceans in the oceanic northern Gulf of Mexico. Mar Mammal Sci 20(4): 787-807.

Oeztuerk B, Salman A, Oeztuerk AA, Tonay A (2007) Cephalopod remains in the diet of striped dolphins (*Stenella coeruleoalba*) and Risso's dolphins (*Grampus griseus*) in the eastern Mediterranean Sea. Vie et Milieu 57: 57-63.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Philips JD, Nachtigall PE, Au WWL, Pawloski JL, Roitblat HL (2003) Echolocation in the Risso's dolphin, *Grampus griseus*. J Acoust Soc Am 113: 605-616.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ 4, Lawrence, KS. USA.

Santos MB, Pierce GJ, Lopez A, Barreiro A, Guerra A (2001) Diets of small cetaceans stranded in NW Spain 1994-95. Copenhagen Denmark Ices, 6 pp.

Shoham-Frider E, Amiel S, Roditi-Elasar M, Kress N (2002) Risso's dolphin (*Grampus griseus*) stranding on the coast of Israel (eastern Mediterranean). Autopsy results and trace metal concentrations. Sci Tot Env 295: 157-166.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Grampus griseus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>

Wade PR, Gerrodette T (1993) Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep Int Whal Comm 43: 477-493.

Wang JY, Yang SC (2006) Unusual cetacean stranding events of Taiwan in 2004 and 2005. J Cetacean Res Manage 8: 283-92.
Waring GT, Josephson E, Fairfield CP, Maze-Foley K, eds. (2007) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2006. NOAA Tech Memo NMFS NE 201; 378 p.
Weir CR, Pollock C, Cronin C, Taylor S (2001) Cetaceans of the Atlantic Frontier, North and West of Scotland. Cont Shelf Res 21: 1047-1071.

3.14. Hyperoodon ampullatus

Barlow J, Ferguson MC, Perrin WF, Balance L, Gerrodette T, Joyce G, Macleod CD, Mullin K, Palka DL, Waring G (2006) Abundance and densities of beaked and bottlenose whales (family Ziphiidae). J Cetacean Res Manage 7: 263-270
Bloch D, Desportes G, Zachariassen M, Christensen I (1996) The Northern Bottlenose Whale in the Faroe Islands, 1584-1993. J Zool London 239: 123-140.
Boschma H (1950) Maxillary teeth in specimens of *Hyperoodon rostratus* (Müller) and *Mesoplodon grayi* von Haast stranded on the Dutch coasts. Kon. Nederlandse Akad. Wetensch. 8(6): 775-786.
Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.
Clarke MR, Kristensen TK (1980) Cephalopod beaks from the stomachs of two northern bottlenosed whales (*Hyperoodon ampullatus*). J Mar Biol Assoc U K 60: 151-156.
Dalebout, Merel L; Ruzzante, Daniel E; Whitehead, Hal; Oeien, Nils I (2006) Nuclear and mitochondrial markers reveal distinctiveness of a small population of bottlenose whales (*Hyperoodon ampullatus*) in the western North Atlantic. Mol Ecol 15: 3115-3129.
De Smet WMA (1974) Inventaris van de walvisachtigen (Cetacea) van de Vlaamse kust en de Schelde. Bull. K. Belg. Inst. Nat. Wet. 50(1): 1-156.
Duguy R (1990) (Cetacea stranded on the coasts of France during the last ten years). Copenhagen Denmark Ices 1990 5 pp.
Gowans S (2002) Bottlenose whales - *Hyperoodon ampullatus* and *H planifrons*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 128-129.
Gowans S (2009) Bottlenose whales *Hyperoodon ampullatus* and *H. planifrons*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 129-131.
Gowans S, Whitehead H, Arch JK, Hooker SK (2000) Population size and residency patterns of northern bottlenose whales (*Hyperoodon ampullatus*) using the Gully, Nova Scotia. J Cetacean Res 2: 201-210.
Gowans S, Whitehead H, Hooker SK (2001) Social organization in northern bottlenose whales, *Hyperoodon ampullatus*: not driven by deep-water foraging? Anim Behav 62: 369-377.
Gunnlaugsson T, Sigurjónsson J (1990) NASS-87: Estimation of whale abundance based on observations made onboard Icelandic and Faroese survey vessels. Rep int Whal Comm 40: 571-80.
Hooker SK, Baird RW (1999) Deep-diving behaviour of the northern bottlenose whale, *Hyperoodon ampullatus* (Cetacea: Ziphiidae). Proc Royal Soc London, Ser B: Biol Sci 266: 671-676.
Hooker SK, Iverson SJ, Ostrom P, Smith SC (2001) Diet of northern bottlenose whales inferred from fatty-acid and stable-isotope analyses of biopsy samples. Can J Zool 79: 1442-1454.
Hooker SK, Metcalfe TL, Metcalfe CD, Angell CM, Wilson JY, Moore MJ, Whitehead H (2008) Changes in persistent contaminant concentration and CYP1A1 protein expression in biopsy samples from northern bottlenose whales, *Hyperoodon ampullatus*, following the onset of nearby oil and gas Development. Environ Pollut 152: 205-216.
Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.
Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.
Kastelein RA, Gerrits NM (1991) Swimming, diving, and respiration patterns of a Northern bottle nose whale (*Hyperoodon ampullatus*, Forster, 1770). Aquat Mamm 17: 20-30.
Kinze CC, Tougaard S, Baagoe HJ (1998) Danish whale records (strandings and incidental catches) for the period 1992-1997. Flora og Fauna 104 (3-4): 41-53.
Lick R, Piatkowski U (1998) Stomach contents of a northern bottlenose whale (*Hyperoodon ampullatus*) stranded at Hiddensee, Baltic Sea. J Mar Bio Assoc UK 78 (2): 643-650.
Lucas ZN, Hooker SK (2000) Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. Can Field Nat 114 (1): 45-61
Macleod CD, Reid JB (2003) Distributions, migrations and bottlenecks: implications for anthropogenetic impacts on beaked whales on the Atlantic frontier. Annual Meeting of the European Cetacean Society, Tenerife, Spain.
MacLeod CD, Pierce GJ, Santos MB (2004) Geographic and temporal variations in strandings of beaked whales (Ziphiidae) on the coasts of the UK and the Republic of Ireland from 1800-2002. J Cetacean Res Manag 6: 79-86.
Mcquinn IH, Carrier D (2005) Far-field measurements of seismic airgun array pulses in the Nova Scotia Gully Marine Protected Area. Can Tech Rep Fish Aquat Sci no. 2615, 24 pp.
Mead JG (1989) Bottlenose whales - *Hyperoodon ampullatus* (Forster, 177) and *Hyperoodon planifrons* Flower, 1882. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 321-348.
NAMMCO (1995) North Atlantic Marine Mammal Commission Annual Report 1995: Report of the joint meeting of the Scientific Committee, Working Group on Northern Bottlenose and Killer Whales and Management Procedures: 89-99.
NEFSC (2007) Northern Bottlenose Whale (*Hyperoodon ampullatus*): Western North Atlantic Stock. NOAA http://www.nefsc.noaa.gov/publications/
Parsons ECM, Clark J, RossA, Simmonds MP (2007) The Conservation of British Cetaceans: A review of the threats and protection afforded to whales, dolphins and porpoises in UK Waters. Whale and Dolphin Conservation Society, 122 pp.
Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.
Reeves RR, Mitchell E, Whitehead H (1993) Status of the Northern Bottlenose Whale, *Hyperoodon ampullatus*. Can Field Nat 107: 490-508.
Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.
Santos MB, Pierce GJ, Smeenk C, Addink MJ, Kinze CC, Tougaard S, Herman, J (2001) Stomach contents of northern bottlenose whales *Hyperoodon ampullatus* stranded in the North Sea. J Mar Biol Assoc UK 81: 143-150.
Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Hyperoodon ampullatus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>

Van Gompel J (1991) Observations and stranding of Cetacea on the Belgian coast, 1975-1989. Lutra 34: 27-36.

Whitehead H, Faucher A, Gowans S, Mccarrey S (1997) Status of the northern bottlenose whale, *Hyperoodon ampullatus*, in the Gully, Nova Scotia. Can Field Nat 111: 287-292.

Whitehead H, Wimmer T (2005) Heterogeneity and the mark-recapture assessment of the Scotian Shelf population of northern bottlenose whales (*Hyperoodon ampullatus*). Can J Fish Aquat Sci 62: 2573-2585.

3.15. Hyperoodon planifrons

Bastida, R and Rodríguez, D (2003) Mamíferos Marinos de Patagonia y Antartida. Vazquez Mazzini Editores, Buenos Aires. 206 pp.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Cockroft VG, Peddemors VM, Ryan PG, Lutjeharms JRE (1990) Cetacean sightings in the Agulhas retroflection, Agulhas rings and subtropical convergence. South African Journal Of Antarctic Research 20(2): 64-67.

Gowans S (2009) Bottlenose whales *Hyperoodon ampullatus* and *H. planifrons*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 129-131.

Hucke-Gaete R (2000) Review of the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, German, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP / FAO, Rome, 320 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Kasamatsu F, Joyce GG (1995) Current status of Odontocetes in the Antarctic. Antarctic Science 7(4): 365-379.

Kasamatsu F, Hembree D, Joyce G, Tsunoda L, Rowlett R, Nakano T (1988) Distribution of cetaceans sightings in the Antarctic: results obtained from the IWC/IDCR minke whale assessment cruises, 1978/79 to 1983/84. Rep Int Whal Comm 38: 449-485.

MacLeod CD, Santos MB, Pierce GJ (2003) Review of data on diets of beaked whales: evidence of niche separation and geographic segregation. J Mar Biol Ass UK 83: 651-665.

Mead JG (1989) Bottlenose whales - *Hyperoodon ampullatus* (Forster, 177) and *Hyperoodon planifrons* Flower, 1882. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Pres, London, pp. 321-348.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand.101 pp.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, Ed.), Lawrence, KS. USA.

Ross GJB (2006) Review of the Conservation Status of Australia's Smaller Whales and Dolphins. Australian Government, 124 pp.

Sekiguchi K, Klages N, Findlay K, Best PB (1993) Feeding habits and possible movements of southern bottlenose whales (*Hyperoodon planifrons*). Proc Nipr Symp Polar Biol 6:84-97.

Slip DJ, Moore GJ, Green K (1995) Stomach contents of a southern bottlenose whale, *Hyperoodon planifrons*, stranded at Heard Island. Mar Mamm Sci 11: 575-580.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Hyperoodon planifrons*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>

Van Waerebeek K, Findlay K, Friedrichsen G, Best PB (2005) Bold colouration pattern in southern bottlenose whales, a preliminary assessment of external variation. IWC Scientific Committee Document SC/57/SM12.

Van Waerebeek K, Leaper R, Baker AN, Papastavrou V, Thiele D (2004) Odontocetes of the Southern Ocean Sanctuary. IWC Scientific Committee Document SC/56/SOS1, July 2004, Sorrento, Italy. 25 pp.

3.16. Indopacetus pacificus

Anderson RC, Clark R, Madsen PT, Johnson C, Kiszka J, Breysse O (2006) Observations of Longman's Beaked Whale (*Indopacetus pacificus*) in the Western Indian Ocean. Aq Mamm 32: 223-231.

Barlow J, Ferguson MC, Perrin WF, Balance L, Gerrodette T, Joyce G, Macleod CD, Mullin K, Palka DL, Waring G (2006) Abundance and densities of beaked and bottlenose whales (family Ziphiidae). J Cetacean Res Manage 7: 263-270.

Dalebout ML, Ross GJB, Baker CS, Anderson RC, Best PB, Cockcroft VG, Hinsz HL, Peddemors V, Pitman RL (2003) Appearance, distribution and genetic distinctiveness of Longman's beaked whale, *Indopacetus pacificus*. Mar Mamm Sci 19: 421-461.

Dayaratne, P, & Joseph, L (1993). A study on dolphin catches in Sri Lanka (Report of the Bay of Bengal Programme Madras, BOBP/REP/56). 43 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Leatherwood S, Reeves RR, Perrin WF, Evans WE (1988). Whales, dolphins and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification. New York: Dover Publications. 245 pp.

Parsons ECM, Dolman SJ, Wright AJ, Rose NA, Burns WCG (2008) Navy sonar and cetaceans: Just how much does the gun need to smoke before we act? Marine Pollution Bulletin 56: 1248-1257.

Pitman RL (2009) Indo-Pacific beaked whale - *Indopacetus pacificus*. In: Encyclopedia of Marine Mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 600-602.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Indopacetus pacificus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>.

Yang WC, Chou LS, Jepson PD, Brownell RL Jr, Cowan D, Chang PH, Chiou HI, Yao CJ, Yamada TK, Chiu JT, Wang PJ, Fernández A (2008) Unusual cetacean mortality event in Taiwan, possibly linked to naval activities. Vet Rec 162:184-6.

3.17. Inia geoffrensis

Aliaga-Rossel E (2002) Distribution and abundance of the river dolphin (*Inia geoffrensis*) in the Tijamuchi River, Beni, Bolivia. Aquat Mamm 28: 312-323.

Aliaga-Rossel E, McGuire TL, Hamilton H (2006) Distribution and encounter rates of the river dolphin (*Inia geoffrensis boliviensis*) in the central Bolivian Amazon. J Cetacean Res Manag 8: 87-92.

Banguera-Hinestroza E, Cardenas H, Ruiz-Garcia M, Marmontel M, Gaita N, Vazquez R, Garcia- Vallejo R (2002) Molecular Identification of Evolutionarily Signifcant

Units in the Amazon River Dolphin Inia sp. (Cetacea: Iniidae). Am Gen Assoc 93: 312-322.

Best RC, Da Silva VMF (1989) Amazon River Dolphin, Boto - *Inia geoffrensis*. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 1-24.

Da Silva V (1994) Aspects of the biology of the Amazonian dolphins Genus *Inia* and *Sotalia fluviatilis*. PhD Dissertation, Univ. of Cambridge, Cambridge, 327 pp.

Da Silva V (2002) Amazon River Dolphin - *Inia geoffrensis*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 18-20.

Da Silva V (2009) Amazon River Dolphin - *Inia geoffrensis*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 26-28.

Da Silva V, Martin AR (2000) The status of the boto or Amazon River dolphin *Inia geoffrensis* (de Blainville, 1817): a review of available information. Paper submitted at the meeting of the IWC Scientific Committee, 2000. IWC, Cambridge, UK.

Da Silva VMF, Best RC (1996) Freshwater dolphin/fisheries interaction in the Central Amazon (Brazil). Amazoniana 14: 165-175.

IWC Scientific Committee (2000) Report of the Scientific Sub-Committee on Small Cetaceans, 2000. IWC, Cambridge, UK.

IWC Scientific Committee (2008) Annual Report of the International Whaling Commission. J Cetacean Res Manage 10

Magnusson WR, Best RC, da Silva VMF (1980) Numbers and Behaviour of Amazonian Dolphins, *Inia geoffrensis* and *Sotalia fluviatilis fluviatilis*, in the Rio Solimoes, Brasil. Aquat Mamm 8: 27-32.

Martin AR, da Silva VMF (2004a) Number, seasonal movements, and residency characteristics of river dolphins in an Amazonian floodplain lake system. Can J Zool 82: 1307-1315.

Martin AR, da Silva VMF (2004b) River dolphins and flooded forest: seasonal habitat use and sexual segregation of botos (*Inia geoffrensis*) in an extreme cetacean environment. J Zool 263: 295-305

Martin AR, Silva VMFda, Salmon DL (2004) Riverine Habitat Preferences of Botos (*Inia geoffrensis*) and Tucuxis (*Sotalia fluviatilis*) in the Central Amazon. Mar Mamm Sci 20: 189-200

McGuire TL (2002) Distribution and abundance of river dolphins in the Peruvian Amazon. Diss Abst Int Pt A - Hum & Soc Sci 63:1403.

McGuire TL, Aliaga-Rossel ER (2007) Seasonality of Reproduction in Amazon River Dolphins (*Inia geoffrensis*) in Three Major River Basins of South America. Biotropica 39: 129-135

McGuire TL, Henningsen T (2007) Movement Patterns and Site Fidelity of River Dolphins (*Inia geoffrensis* and *Sotalia fluviatilis*) in the Peruvian Amazon as Determined by Photo-Identification. Aquat Mamm 33: 359-367.

Pilleri G (1969) On the behaviour of the Amazon dolphin, *Inia geoffrensis* in Beni (Bolivia). Rev Suisse Zool 757-791.

Pilleri G, Gihr M (1977) Observations on the Bolivian (*Inia boliviensis* d'Orbigny, 1834) and the Amazonian bufeo (*Inia geoffrensis* de Blainville, 1817), with a description of a new subspecies (*Inia geoffrensis* humboldtiana). Invest Cetacea 8: 11-76.

Reeves RR, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Inia geoffrensis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Rosas FCW, Lehti KK (1996) Nutritional and mercury content of milk of the Amazon River dolphin, *Inia geoffrensis*. Comp Biochem Physiol 115A: 117-119.

Vidal O (1993) Aquatic mammal conservation in Latin America: Problems and perspectives. Conserv Biol 7: 788-795.

Vidal O, Barlow J, Hurtado LA, Torre J, Cendon P, Ojeda Z (1997) Distribution and abundance of the Amazon River dolphin (*Inia geoffrensis*) and the tucuxi (*Sotalia fluviatilis*) in the upper Amazon River. Mar Mamm Sci 13: 427-445.

3.18. Kogia breviceps & 3.19. Kogia sima

Abollo E, Lopez A, Gestal C, Benavente P, Pascual S (1998) Macroparasites in cetaceans stranded on the northwestern Spanish Atlantic coast. Dis Aquat Organisms 32: 227-231.

Baird R W, Nelson D, Lien J, Nagorsen DW (1996) The status of the Pygmy Sperm Whale, *Kogia breviceps*, in Canada. Can Field Nat 110: 525-53.2

Baird RW (2005) Sightings of Dwarf (*Kogia sima*) and Pygmy (*K. breviceps*) Sperm Whales from the Main Hawaiian Islands. Pac Sci 59: 461-466

Barlow J (2006) Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Mar Mamm Sci 22: 446-464.

Bastida R, Rodríguez D (2003) Mamíferos Marinos de Patagonia y Antártida. 1ra. Ed. Buenos Aires. Vázquez Maziini Editores, 208 pp.

Baumgartner MF, Mullin KD, May LN, Leming TD (2001) Cetacean habitats in the northern Gulf of Mexico. Fish Bull 99: 219-239.

Beatson E (2007) The diet of pygmy sperm whales, *Kogia breviceps*, stranded in New Zealand: implications for conservation. Rev. Fish Biol. Fish 17: 295-303.

Bustamante P, Garrigue C, Breau L, Caurant F, Dabin W, Greaves J, Dodemont R (2003) Trace elements in two odontocete species (*Kogia breviceps* and *Globicephala macrorhynchus*) stranded in New Caledonia (South Pacific). Environ Pollut 124 : 263-271.

Caldwell DK Caldwell MC (1989) Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838); Dwarf sperm whale *Kogia simus* Owen, 1866. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 235-260.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Chivers SJ, Leduc RG, Robertson KM, Barros NB, Dizon AE (2005) Genetic Variation of Kogia spp. with Preliminary Evidence for Two Species of *Kogia sima*. Mar. Mamm. Sci.]. Vol. 21, no. 4, pp. 619-634.

Debrot AO, Barros NB (1992) Notes on a Gervais' beaked whale, *Mesoplodon europaeus*, and a dwarf sperm whale, *Kogia simus*, stranded in Curacao, Netherlands Antilles. Mar Mamm Sci 8: 172-178.

Delgado Estrella A, Villa RB, Vazquez MLE (1998) First records of dwarf sperm whale (*Kogia breviceps*) pygmy sperm whale (*K. simus*) and pygmy killer whale (*Feresa attenuata*) in Veracruz, Mexico. An Inst Biol Univ Nac Auton Mex Zool 69: 129-134.

Dolar ML (1999) Abundance, distribution and feeding ecology of small cetaceans in the Eastern Sulu Sea and Tañon Strait, Philippines. PhD thesis, U Cal San Diego, USA.

Duffield DA, Barros NB, Espinoza EO, Ploen S, Gulland FMD, Heyning JE (2003) Identifying pygmy and dwarf sperm whales (genus *Kogia*) using electrospray ionization mass spectrometry of myoglobin and hemoglobin. Mar Mamm Sci 19: 395-399.

Duguy R (1990) Cetacea stranded on the coasts of France during the last ten years. Copenhagen Denmark Ices, 5 pp.

Duguy R (1991) Annual report of Cetacea and Pinnipedia recorded from the coasts of France. Copenhagen Denmark Ices, 2 pp.

Duguy R (1994) *Kogia breviceps* (de Blainville, 1838) - Zwergpottwal. In: Niethammer J, Krapp F (eds.) Handbuch der Säugetiere Europas. Band 6: Meeressäuger. Teil 1B: Wale unbd Delphine 2. Aula-Verlag, Wiesbaden, Germany, pp. 598-614.

Eldredge LG (1991) Annotated checklist of the marine mammals of Micronesia. Micronesica 24: 217-230.

Felix F, Haase B, Samaniego J (1995) First record of pygmy killer whale *Feresa attenuata* (Cetacea: Delphinidae) and dwarf sperm whale *Kogia simus* (Cetacea: Physeteridae) on the ecuadorean continental coast. Estud Oceanol 14: 77-85.

Ferguson MC, Barlow J (2001) Spatial distribution and density of cetaceans in the eastern tropical Pacific Ocean based on summer/fall research vessel surveys in 1986-96. Report No. LJ-01-04, Southwest Fisheries Science Center, La Jolla, CA.

Goncalves JM, Barreiros JP, Azevedo JMN, Norberto R (1996) Cetaceans stranded in the Azores during 1992-96. Arquipelago Cienc Biol Mar; Life Mar Sci 14A: 57-65.

Handley COJr (1966) A Synopsis of the Genus *Kogia* (pygmy sperm whale). In: Norris, K.R., ed. Whales, Dolphins and Porpoises. pp 62-69. Berkeley and Los Angeles: University of California Press.

Hucke-Gaete R (2000) Review of the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, German, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Kemper CM, Ling JK (1991) Whale strandings in south Australia (1881-1989) Trans Royal Soc S Austr 115: 37-52.

Lucas ZN, Hooker SK (2000) Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. Can Field Nat 114: 45-61.

Marcovecchio JE, Gerpe MS, Bastida RO, Rodriguez DH, Moron SG (1994) Environmental contamination and marine mammals in coastal waters from Argentina: An overview. Sci Total Environ 154: 141-151.

Martin JW, Heyning JE (1999) First record of *Isocyamus kogiae* Sedlak-Weinstein, 1992 (Crustacea, Amphipoda, Cyamidae) from the eastern Pacific, with comments on morphological characters, a key to the genera of the Cyamidae, and a checklist of Cyamids and their hosts. Bull S Cal Acad Sci 98: 26-38.

Mazzuca L, Atkinson S, Keating B, Nitta E (1999) Cetacean mass strandings in the Hawaiian Archipelago, 1957-1998. Aquat Mamm 25: 105-114.

McAlpine DF (2002) Pygmy and dwarf sperm whales. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 1007-1009.

McAlpine DF (2009) Pygmy and dwarf sperm whales. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 936-938.

Mullin KD, Hoggard W, Roden CL, Lohoefener RR, Rogers CM, Taggart B (1994) Cetaceans on the upper continental slope in the north-central Gulf of Mexico. Fish Bull 92: 773-786.

Parsons ECM, Dolman SJ, Wright AJ, Rose NA, Burns WCG (2008) Navy sonar and cetaceans: Just how much does the gun need to smoke before we act? Mar Poll Bull 56: 1248-1257.

Perez C, Lopez A, Sequeira M, Silva M, Herrera R, Goncalves J, Valdes P, Mons L, Freitag L, Lens S, Cendrero O (2001) Stranding and by-catch of cetaceans in the Northeastern Atlantic during 1996. Copenhagen Denmark Ices, 4 pp.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand.101 pp.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, Ed.), Lawrence, KS. USA.

Sanino GP, YaÑez J (1997) Study of *Kogia breviceps* in Chilean coastal waters. Museo Nacional de Historia Natural Boletin Santiago 46: 81- 93

Santos RA, Haimovici M (1998) Cephalopods in the diet of marine mammals stranded or incidentally caught along Southeast and Southern Brazil (21° to 34° S). Copenhagen Denmark Ices 15 pp.

Scott MB, Hohn AA, Westgate AJ, Nicolas JR, Whitaker BR, Campbell WB (2001) A note on the release and tracking of a rehabilitated pygmy sperm whale *Kogia breviceps*. J Cetacean Res Nanage 3 : 87-94.

Scott MD, Cordaro JG (1987) Behavioral observations of the dwarf sperm whale, *Kogia simus*. Mar Mamm Sci 3: 353-354.

Sedlak-Weinstein E (1992) A new species of *Isocyamus* (Amphipoda: Cyamidae) from *Kogia breviceps* (De Blainville, 1838) in Australian waters. Syst Parasit 23: 1-6.

Smith BD, Jefferson TA, Leatherwood S, Ho Dao Tan, Van Thuoc Chu, Hai Quang Le (1997) Investigations of marine mammals in Vietnam. Asian Mar Biol 14: 145-172.

Stamper MA, Whitaker BR, Schofield TD (2006) Case study. Morbidity in a pigmy sperm whale, *Kogia breviceps*, due to ocean-borne plastic. Mar Mamm Sci 22: 719-722.

Sylvestre JP (1988) Note on three dwarf sperm whales *Kogia simus* (Owen, 1866) and comments on Kogiids of Japanese Coasts. Aquat Mamm 14: 120-122.

Tarpley RJ, Marwitz S (1993) Plastic debris ingestion by cetaceans along the Texas coast: Two case reports. Aquat Mamm 19: 93-98.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008a) *Kogia breviceps*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008b) *Kogia sima*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>.

Wang, Ming-Chih; Walker, WA; Shao, Kwang-Tsao; Chou, Lien-Siang (2002) Comparative analysis of the diets of pygmy sperm whales and dwarf sperm whales in Taiwanese waters. Acta Zool Taiwan 13: 53-62.

Waring GT, Josephson E, Fairfield CP, Maze-Foley K, editors (2007) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2006. NOAA Tech Memo NMFS NE 201; 378 p.

Watanabe M, Kannan K, Takahashi A, Loganathan BG, Odell DK, Tanabe S, Giesy JP (2000) Polychlorinated biphenyls, organochlorine pesticides, tris(4-chlorophenyl)methane, and tris(4-chlorophenyl)methanol in livers of small cetaceans stranded along Florida coastal waters, USA. Env Tox Chem 19: 1566-1574.

Willis PM, Baird RW (1998) Status of the dwarf sperm whale, *Kogia simus*, with special reference to Canada. Can Field Nat 112: 114-125.

Zerbini AN, Kotas JE (1998) A note on cetacean bycatch in pelagic driftnetting off southern Brazil. Rep Int Whal Comm 48: 519-524.

3.20. Lagenodelphis hosei

Amano M, Miyasaki N, Yanagisawa F (1996) Life history of Fraser's dolphin, *Lagenodelphis hosei*, based on a school captured off the Pacific coast of Japan. Mar Mamm Sci 12: 199-214.

Barlow J (2006) Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Mar Mamm Sci 22: 446-464

Bolaños J, Villarroel-Marín A (2003) Three new records of cetacean species for Venezuelan waters. Carib J Sci 39: 230-232.

Bones M, Neill B, Reid B (1998) Fraser's dolphin (*Lagenodelphis hosei*) stranded in South Uist: first record in U.K. waters. J Zool 246: 443-486.

Carretta JV, Forney KA, Lowry MS, Barlow J, Baker J, Johnston D, Hanson B, Muto MM, Lynch D, Carswell L (2008) U.S. Pacific Marine mammal Stock Assessments: 2008. NOAA-TM-NMFS-SWFSC-434

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Cockroft VG (1990) Dolphin catches in the Natal (South Africa) shark nets, 1980 to 1988. S Af J Wildl Res 20: 44-51.

Dolar ML (2009) Fraser's Dolphin - *Lagenodelphis hosei*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 469-471.

Dolar MLL, Leatherwood SJ, Wood CJ, Alava MNR, Hill CL, Aragones LV (1994) Directed fisheries for cetaceans in the Philippines. Rep Int Whaling Comm 44: 439- 449.

Dolar MLL, Suarez P, Ponganis PJ, Kooyman GL (1999) Myoglobin in pelagic small cetaceans. J Exp Biol 202: 227-236.

Dolar MLL, Perrin WF, Taylor BL, Kooyman GL (2006) Abundance and distributional ecology of cetaceans in the central Philippines. J Cet Res Manage 8: 93-111.

Dolar MLL, Perrin WF, Yaptinchay ASP, Jaaman SABH, Santos MD, Alava MN, Suliansa MSB (1997) Preliminary investigation of marine mammal distribution, abundance, and interactions with humans in the southern Mulu sea. Asian Mar Biol 14: 61-81.

Dolar MLL, Walker, WA, Kooyman GL, Perrin WF (2003) Comparative feeding ecology of spinner dolphins (*Stenella longirostris*) and Fraser's dolphins (*Lagenodelphis hosei*) in the Sulu Sea. Mar Mamm Sci 19: 1-19.

Gerrodette T, Wade PR (1991) Monitoring trends in dolphin abundance in the eastern Tropical Pacific: Analysis of 1989 data. (IWC SC/42/SM-42). Rep Int Whal Comm 41: 511-515.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Lagenodelphis hosei*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Mignucci Giannoni AA, Montoya Ospina RA, Perez Zayas JJ, Rodriguez Lopez MA, Williams EHJ (1999) New records of Fraser's dolphin (*Lagenodelphis hosei*) for the Caribbean. Aquat Mamm 25: 15-19.

Minh TB, Nakata H, Watanabe M, Tanabe S, Miyazaki N, Jefferson TA, Prudente M, Subramanian A (2000) Isomer-specific accumulation and toxic assessment of polychlorinated biphenyls, including coplanar congeners, in Cetaceans from the North Pacific and Asian coastal waters. Arch Environ Contam Toxicol 39: 398-410.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Perrin WF, Leatherwood S, Collet A (1994) Fraser's dolphin - *Lagenodelphis hosei* Fraser. In: Handbook of marine mammals (Ridgway SH, Harrison SR eds.) Vol. 5: The first book of dolphins. Academic Pres, London, pp. 225-240.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ 4, Lawrence, KS. USA.

Santos RA, Haimovici M (1998) Cephalopods in the diet of marine mammals stranded or incidentally caught along Southeast and Southern Brazil (21° to 34°S). Copenhagen Denmark Ices, 15 pp.

Van Waerebeek K, Ndiaye E, Djiba A, Diallo M, Murphy P, Jallow A, Camara A, Ndiaye P, Tous P (2000) A survey of the conservation status of cetaceans in Senegal, the Gambia and Guinea-Bissau. UNEP / CMS Secretariat, Bonn, Germany, 80 pp.

Wade PR, Gerrodette T (1993) Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep Int Whal Comm 43: 477-493.

Watkins W A, Daher M A, Fristrup K, Notarbartolo Di Sciara G (1994) Fishing and Acoustic Behavior of Fraser's Dolphin (*Lagenodelphis hosei*) near Dominica, Southeast Caribbean. Carib J Sci 30: 76-82.

Waring GT, Josephson E, Fairfield CP, Maze-Foley K, eds. (2007) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2006. NOAA Tech Memo NMFS NE 201; 378 p.

Weir CR, Debrah J, Ofori-Danson PK, Pierpoint C, Van Waerebeek K (2008) Records of Fraser's dolphin *Lagenodelphis hosei* Fraser 1956 from the Gulf of Guinea and Angola. Afr J Mar Sci 30: 241-246.

3.21. Lagenorhynchus acutus

Anderwald, P. (2002) Niche Differentiation of Cetaceans in the Northeast Atlantic. MSc thesis, University of Zurich. 119 pp.

Burt ML, Borchers DL, Samarra F (2006) Aerial survey abundance estimates for minke whale and dolphins. In: SCANS II Final report. Hammond PS (ed.). University of St Andrews, St Andrews, UK.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Cipriano F (2002) Atlantic white-sided dolphin *Lagenorhynchus acutus*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 49-51.

Cipriano F (2009) Atlantic white-sided dolphin *Lagenorhynchus acutus*. In: Encyclopedia of marine mammals, 2nd. Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 56-58.

Compton R, Banks A, Goodwin L, Hooker SK (2007) Pilot cetacean survey of the sub-arctic North Atlantic utilizing a cruise- ship platform. J Mar Biol Assoc UK 87: 321-325.

Couperus AS (1997) Interactions between Dutch midwater-trawl and Atlantic white-sided dolphins (*Lagenorhynchus acutus*) southwest of Ireland. J Northwest Atl Fish Sci 22: 209-218.

Craddock JE, Polloni PT, Hayward B, Wenzel F (2009) Food habits of Atlantic white-sided dolphins (*Lagenorhynchus acutus*) off the coast of New England. Fish Bull 107: 384-394.

Das K, Lepoint G, Debacker V, Bouquegneau JM (2001) Marine mammals from the North Sea: Approach of their feeding ecology through stable isotope and cadmium measurements. J Rech Oceanogr 26: 146.

Doksaeter L, Olsen E, Nottestad L, Ferno A (2008) Distribution and feeding ecology of dolphins along the Mid-Atlantic Ridge between Iceland and the Azores. Deep Sea Res (II Top Stud Oceanogr) 55: 243-253.

Evans PGH (2009) Status and distribution of white-beaked and Atlantic white-sided dolphins in the Eastern North Atlantic. In: ASCOBANS/HELCOM small cetacean population structure workshop. Evans PGH, Teilmann J (Eds.) ASCOBANS, Bonn, Germany.

Gaskin DE (1992) Status of the Atlantic white-sided dolphin, *Lagenorhynchus acutus*, in Canada. Can Field Nat 106: 64-72.

Hammond PS, Berggren P, Benke H, Borchers DL, Collet A, Heide-Joergensen MP, Heimlich S, Hiby AR, Leopold MF, Oeien N (2002) Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. J Appl Ecol 39: 361-376.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Lagenorhynchus acutus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA, Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Kaschner K (2004) Modelling and mapping resource overlap between marine mammals and fisheries on a global scale. PhD Thesis, U British Columbia, Vancouver BC, Canada.

Kinze CC, Addink M, Smeenk C, Hartmann MG, Richards HW, Sonntag RP, Benke H (1997) The white-beaked dolphin (*Lagenorhynchus albirostris*) and the white-sided dolphin (*Lagenorhynchus acutus*) in the North and Baltic Seas: Review of available information. Rep Int Whal Comm 47: 675-682.

Kingsley MCS, Reeves RR (1998) Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. Can J Zool 76: 1529-1550.

Kucklick JR, Becker PR, Peck AM, Pugh RS, Porter BJ, Ellisor MB, Moors A (2008) Hexabromocyclododecane in white-sided dolphins: temporal trend and stereoisomer distribution in tissues. Environ Sci Technol 42: 2650-2655.

Lens S (2001) Interactions between marine mammals and deep water trawlers in the NAFO regulator area. Copenhagen Denmark Ices, 8 pp.

Mate BR, Stafford KM, Nawojchik R, Dunn JL (1994) Movements and dive behavior of a satellite-monitored Atlantic white-sided dolphin (*Lagenorhynchus acutus*) in the Gulf of Maine. Mar Mamm Sci 10: 116-121.

Macleod K (2004) Abundance of Atlantic white-sided dolphin (*Lagerorhynchus acutus*) during summer off northwest Scotland. J Cetacean Res Manage 6: 33-40.

Mikkelsen AMH, Lund A (1994) Intraspecific variation in the dolphins *Lagenorhynchus albirostris* and *L. acutus* (Mammalia: Cetacea) in metrical and non-metrical skull characters, with remarks on occurrence. J Zool (London) 234: 289-299.

Morizur Y, Berrow S D, Tregenza NJC, Couperus A S, Pouvreau S (1999) Incidental catches of marine-mammals in pelagic trawl fisheries of the northeast Atlantic. Fish Res Amsterdam 41: 297-307.

NAMMCO North Atlantic Marine Mammal Commission (2006) Annual Report. Vols. I & 2. North Atlantic Marine Mammal Commission, Tromsø, Norway.

Palka DL, Hammond PS (2001) Accounting for responsive movement in line transect estimates of Abundance. Can J Fish Aquat Sci 58: 777-787.

Reeves RR, Smeenk C, Brownell L, Kinze CC (1999) Atlantic white-sided dolphin - *Lagenorhynchus acutus* (Gray, 1828) In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 31-56.

Selzer LA, Payne PM (1988) The distribution of white-sided (*Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. Mar Mamm Sci 4: 141-153.

Waring GT, Nøttestad L, Olsen E, Skov H, Vikingsson G (2008) Distribution and density estimates of cetaceans along the mid-Atlantic ridge during summer 2004. J Cetacean Res Manage 10:137-46.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, editors (2009) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Weinrich MT, Belt CR, Morin D (2001) Behavior and ecology of the Atlantic white-sided dolphin (*Lagenorhynchus acutus*) in coastal New England waters. Mar Mamm Sci 17: 231-248.

Weir CR, Pollock C, Cronin C, Taylor S (2001) Cetaceans of the Atlantic Frontier, North and West of Scotland. Cont Shelf Res 21: 1047-1071.

3.22. Lagenorhynchus albirostris

Alling AK, Whitehead HP (1987) A preliminary study of the status of white-beaked dolphins, *Lagenorhynchus albirostris*, and other small cetaceans off the coast of Labrador. Can Field Nat 101: 131-135.

Banguera-Hinestroza E, Bjørge A, Reid RJ, Jepson P, Hoelzel AR (2009) The influence of glacial epochs and habitat dependence on the diversity and phylogeography of a coastal dolphin species: *Lagenorhynchus albirostris*. Cons genetics 11: 1823-1836.

Canning SJ, Evans PG, Santos MB, Reid RJ, Pierce GJ (2005) Distribution of and habitat use of white-beaked dolphins (*Lagenorhynchus albirostris*) along the Aberdeenshire (UK) coastline, with new information on diet. Theme Session on Marine Mammals: Monitoring Techniques, Abundance Estimation, and Interactions with Fisheries (R). ICES Council Meeting Documents. Copenhagen. no. 2005.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

De Haan D-d, Dremiere PY, Woodward B, Kastellein R, Amundin M, Hansen K (1998) Prevention of by-catch of small cetaceans in pelagic trawls by technical means. Third European Marine Science and Technology (Mast) Conference, Lisbon, 23 27 May 1998: Project Synopses Vol 5: Fisheries and Aquaculture, pp. 262-266.

Evans PGH, Teilmann J (2009) ASCOBANS/HELCOM Small Cetacean Population Structure Workshop. ASCOBANS; Bonn, Germany, 141 pp.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Lagenorhynchus albirostris*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hammond PS, Berggren P, Benke H, Borchers DL, Collet A, Heide-Joergensen MP, Heimlich S, Hiby AR, Leopold MF, Oeien N (2002) Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. J Appl Ecol 39: 361-376.

Hammond PS, Macleod K (2006) SCANS II - Report on Progress. Document Paper prepared for ASCOBANS 5th Meeting of the Parties, Netherlands, September, 2006. MOP5/Doc. 26.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

JNCC: Joint Nature Conservation Committee (2007) Second Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2001 to December 2006. Peterborough: JNCC. Available from: www.jncc.gov.uk/article17

Kingsley MCS, Reeves RR (1998) Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. Can J Zool 76: 1529-1550.

Kinze CC (2002) White-beaked dolphin *Lagenorhynchus albirostris*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 1032-1034.

Kinze CC (2009) White-beaked dolphin *Lagenorhynchus albirostris*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Second Edition. Academic Press, Amsterdam, pp. 1255-1258.

Kinze CC, Addink M, Smeenk C, Hartmann MG, Richards HW, Sonntag RP, Benke H (1997) The white-beaked dolphin (*Lagenorhynchus albirostris*) and the white-sided dolphin (*Lagenorhynchus acutus*) in the North and Baltic Seas: Review of available information. Rep Int Whal Comm 47: 675-682.

Lien J, Nelson D, Hai DJ (2001) Status of the white-beaked dolphin, *Lagenorhynchus albirostris*, in Canada. Can Field Nat 115: 118-126.

Mikkelsen AMH, Lund A (1994) Intraspecific variation in the dolphins *Lagenorhynchus albirostris* and *L. acutus* (Mammalia: Cetacea) in metrical and non-metrical skull characters, with remarks on occurrence. J Zool (London) 234: 289-299.

Nachtigall PE, Mooney TA, Taylor KA, Miller LA, Rasmussen MH, Akamatsu T, Teilmann J, Linnenschmidt M, Vikingsson, GA (2008) Shipboard measurements of the hearing of the white-beaked dolphin *Lagenorhynchus albirostris*. J Exp Biol 211: 642-647.

Northridge S, Tasker M, Webb A, Camphuysen K, Leopold M (1997) White-beaked *Lagenorhynchus albirostris* and Atlantic white-sided dolphin *L. acutus* distributions in northwest European and US North Atlantic waters. Rep Inter Whal Comm 47: 797-805.

Reeves RR, Smeenk C, Kinze CC, Brownell RL, Lien J (1999) White-beaked dolphin - *Lagenorhynchus albirostris* (Gray, 1846) In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 1-30.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication 4, Lawrence, KS. USA.

Siebert U, Joiris C, Holsbeek L, Benke H, Failing K, Frese K, Petzinger E (1999) Potential relation between mercury concentrations and necropsy findings in cetaceans from German waters of the North and Baltic Seas. Mar Poll Bull 38: 285-295.

Stone CJ, Tasker ML (2006) The effects of seismic airguns on cetaceans in UK waters. J Cetacean Res Manage 8: 255-263.

Weir CR, Stockin KA, Pierce GJ (2007) Spatial and temporal trends in the distribution of harbour porpoises, white- beaked dolphins and minke whales off Aberdeenshire (UK), North-Western North Sea. J Mar Biol Assoc UK 87: 327-338.

3.23. Lagenorhynchus australis

Brownell RL, Crespo EA, Donahue MA (1999) Peale's dolphin - *Lagenorhynchus australis* (Peale, 1848) In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 105-120.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

De Haro JC, Iniguez MA (1997) Ecology and behavior of the Peale's dolphin, *Lagenorhynchus australis* (Peale, 1848), at Cabo Virgenes (52 degree 30'S, 68 degree 28'W), in Patagonia, Argentina. Rep Int Whal Comm 47: 723-727.

Goodall RNP (2002) Peale's Dolphin - *Lagenorhynchus australis*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 890-894.

Goodall RNP (2009) Peale's Dolphin - *Lagenorhynchus australis*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Second Edition. Academic Press, Amsterdam, pp. 844-847.

Goodall RNP, de Haro JC, Fraga F, Iniguez MA, Norris KS (1997a) Sightings and behaviour of Peale's dolphins, *Lagenorhynchus australis*, with notes on dusky dolphins, *L. obscurus*, off southernmost South America. Rep Int Whal Comm 47: 757-775.

Goodall RNP, Norris KS, Schevill WE, Fraga F, Praderi R, Iniguez MA J, de Haro JC (1997b) Review and update on the biology of Peale's dolphin, *Lagenorhynchus australis*. Rep Int Whal Comm 47: 777-796.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Lagenorhynchus australis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hucke-Gaete R (ed.) (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Lescrauwaet A-K (1997) Notes on the behaviour and ecology of the Peale's dolphin, *Lagenorhynchus australis*, in the Strait of Magellan, Chile. Rep Int Whal Comm 47: 747-755.

Pinedo MC, Barreto AS, Lammardo MP, Andrade ALV, Geracitano L (2002) Northernmost records of the spectacled porpoise, Layard's beaked whale, Commerson's dolphin, and Peale's dolphin in the southwestern Atlantic Ocean. Aquat Mamm 28: 32-37.

Reyes JC (1991) The conservation of small cetaceans: a review. Unep/CMS Secretariat, Bonn, 115 pp.

Schiavini ACM, Goodall RNP, Lescrauwaet A-K, Alonso MK (1997) Food habits of the Peale's dolphin, *Lagenorhynchus australis*; Review and new information. Rep Int Whal Comm 47: 827-834.

Viddi FA, Lescrauwaet A-K (2005) Insights on habitat selection and behavioural patterns of Peale's dolphins (*Lagenorhynchus australis*) in the Strait of Magellan, Southern Chile. Aquat Mamm 31: 176-183.

3.24. Lagenorhynchus cruciger

Brownell RL, Donahue MA (1999) Hourglass dolphin - *Lagenorhynchus cruciger* (Quoy and Gaimard, 1824) In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 121-136.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Goodall RNP (1997) Review of sightings of the hourglass dolphin, *Lagenorhynchus cruciger*, in the South American Sector of the Antarctic and sub-Antarctic. Rep Int Whal Comm 47: 1001-1014.

Goodall RNP (2009) Hourglass Dolphin - *Lagenorhynchus cruciger*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 573-576.

Goodall RNP, Baker AN, Best PB, Meyer M, Miyazaki N (1997) On the biology of the hourglass dolphin, *Lagenorhynchus cruciger* (Quoy and Gaimard, 1824). Rep Int Whal Comm 47: 985-999.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Lagenorhynchus cruciger*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hucke-Gaete R (ed.) (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Kasamatsu F, Joyce GG (1995) Current status of odontocetes in the Antarctic. Antarctic Sci 7: 365-379.

Reid K, Brierley AS, Nevitt GA (2000) An initial examination of relationships between the distribution of whales and Antarctic krill *Euphausia superba* at South Georgia. J Cetacean Res Manage 2: 143-149.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ 4, Lawrence, KS. USA.

White RW, Reid JB, Black AD; Gillon KW (1999) Seabird and marine Mammal dispersion in the waters around the Falkland Islands 1998-1999. Joint Nature Conservation Committee, UK.

3.25. Lagenorhynchus obliquidens

Aurioles GD, Gallo RJP, Munoz LE, Egido VJ (1989) The white-sided dolphin *Lagenorhynchus obliquidens* Gill, 1865 (Cetacea: Delphinidae): A seasonal resident at the southwestern Gulf of California, Mexico. An Inst Biol Univ Nac Auton Mex Zool 60: 459-472.

Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Anim Conserv 9: 474-482.

Barlow J, Forney KA (2007) Abundance and population density of cetaceans in the California Current ecosystem. Fish Bull, US 105: 509-526.

Black NA (2009) Pacific white-sided dolphin *Lagenorhynchus obliquidens*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Second Edition. Academic Press, Amsterdam, pp. 817-819.

Brownell RL, Walker WA, Forney KA (1999) Pacific white-sided dolphin - *Lagenorhynchus obliquidens* (Gray, 1828) In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 57-84.

Buckland ST, Cattanach KL, Hobbs RC (1993) Abundance estimates of Pacific white-sided dolphin, northern right whale dolphin, Dall's porpoise and northern fur seal in the North Pacific, 1987-1990. Int N Pac Fish Comm Bull 53 (3): 387-407.

Carretta JV, Lowry MS, Stinchcomb CE, Lynn MS, Cosgrove R (2000) Distribution and abundance of marine mammals at San Clemente Island and surrounding waters: results from aerial and ground surveys in 1998 and 1999. Admin Rep Southwest Fish Sci Cent no. 2, 44 pp.

Carretta JV, Forney KA, Lowry MS, Barlow J, Baker J, Johnston D, Hanson B, Muto MM, Lynch D, Carswell L (2008) US Pacific marine mammal stock assessments 2008. NOAA Techn Mem NMFS SWFSC 434, 340 pp.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Dahlheim ME, Towell RG (1994) Occurrence and distribution of Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) in southeastern Alaska, with notes on an attack by killer whales (*Orcinus orca*). Mar Mamm Sci 10: 458-464.

Ferreo RC (1998) Life history and multivariate analyses of habitat selection patterns among small cetaceans in the central North Pacific Ocean. Diss Abs Int B: Sci Eng 59, no 3.

Ferrero RC, Hobbs RC, Van Blaricom GR (2002) Indications of habitat use patterns among small cetaceans in the Central North Pacific based on fisheries observer data. J Cet Res Man 4: 311-321.

Forney KA (1994) Recent information on the status of odontocetes in Californian waters. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-202. 87 pp.

Forney KA, Barlow J, Carretta JV (1995) The abundance of cetaceans in California waters: Part II. Aerial surveys in winter and spring of 1991 and 1992. Fish Bull US 93: 15-26.

Forney KA, Barlow J (1998) Seasonal patterns in the abundance and distribution of California Cetaceans, 1991-1992. Mar Mamm Sci 14: 460-489.

Forney KA (2007) Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Tech Mem NMFS-SWFSC-406. 27p.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Lagenorhynchus obliquidens*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hayano A, Yoshioka M, Tanaka M, Amano M (2004) Population differentiation in the Pacific white-sided dolphin *Lagenorhynchus obliquidens* inferred from mitochondrial DNA and microsatellite analyses. Zool Sci 21: 989-999.

Heise K (1997a) Diet and feeding behaviour of Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) as revealed through the collection of prey fragments and stomach content analyses. Int Whal Comm 47: 807-815.

Heise K (1997b) Life history and population parameters of Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) as revealed through the collection of prey fragments and stomach content analyses. Int Whal Comm 47: 817-825.

Hobbs RC, Jones LL (1993) Impacts of high seas driftnet fisheries on marine mammal populations in the North Pacific. Int North Pacific Fish Comm Bulletin 53: 409-434.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Lux CA, Costa AS, Dizon AE (1997) Mitochondrial DNA population structure of the Pacific white-sided dolphin. Int Whal Comm 47: 645-652.

Miyashita T (1993) Distribution and abundance of some dolphins taken in the North Pacific driftnet fisheries. Int North Pacific Fish Comm Bull 53: 435-449.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication 4, Lawrence, KS. USA.

Tsutsui S, Tanaka M, Miyazaki N, Furuya T (2001) Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) with anomalous colour patterns in Volcano Bay, Hokkaido, Japan. Aquat Mamm 27: 172-182.

Tynan CT, Ainley DG, Barth JA, Cowles TJ, Pierce SD, Spear LB (2005) Cetacean distributions relative to ocean processes in the northern California Current System. Deep Sea Res. (II Top. Stud. Oceanogr.) 52: 145-167.

Van Waerebeek K (2002) Pacific White-Sided Dolphin and Dusky Dolphin - *Lagenorhynchus obliquidens* and *L. obscurus*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 859-861.

Williams R, Hall A, Winship A (2008) Potential limits to anthropogenic mortality of small cetaceans in coastal waters of British Columbia. Can J Fish Aquat Sci 65: 1867-1878.

Williams R, Thomas L (2007) Distribution and abundance of marine mammals in the coastal waters of British Columbia, Canada. J Cet Res Man 9: 15-28.

3.26. Lagenorhynchus obscurus

Aguayo A, Bernal R, Olavarria C, Vallejos V, Hucke R (1998) Cetacean observations carried out between Valparaiso and Easter Island, Chile, in the winters of 1993, 1994 and 1995. Rev Biol Mar Ocean 33: 101-123.

Alonso MK, Crespo EA, Garcia NA, Pedraza SN, Coscarella MA (1998): Diet of dusky dolphins, *Lagenorhynchus obscurus*, in waters off Patagonia, Argentina. Fish Bull 96: 366-374.

Baker AN (1990) Whales & Dolphins of New Zealand & Australia. Victoria University Press, Wellington.

Braeger S, Schneider K (1998) Near-shore distribution and abundance of dolphins along the west coast of the South Island, New Zealand. N Z J Mar Freshwat Res 32: 105-112.

Brownell RL, Cipriano F (1999) Dusky dolphin - *Lagenorhynchus obscurus* (Gray, 1828) In: Handbook of Marine Mammals (Ridgway SH, Harrison SR Eds.) Vol. 6: The second book of dolphins and porpoises. Pp. 85-104.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Cassens I, Van Waerebeek K, Best PB, Tzika A, Van Helden AL, Crespo EA, Milinkovitch MC (2005) Evidence for male dispersal along the coasts but no migration in pelagic waters in dusky dolphins (*Lagenorhynchus obscurus*). Mol Ecol 14: 107-121.

Cassens I, Van Waerebeek K, Best PB, Crespo EA, Reyes J, Milinkovitch MC (2003) The phylogeography of dusky dolphins (*Lagenorhynchus obscurus*): a critical examination of network methods and rooting procedures. Mol Ecol 12: 1781-1792.

Coscarella MA, Dans SL, Crespo EA, Pedraza SN (2003) Potential impact of unregulated dolphin watching activities in Patagonia. J Cet Res Man 5: 77-84.

Crespo EA, Pedraza SN, Coscarella M, Garcia NA, Dans SL, Iniguez M, Reyes LM, Alonso MK, Schiavini ACM, Gonzalez R (1997) Distribution and school size of dusky dolphins, *Lagenorhynchus obscurus* (Gray, 1828), in the southwestern South Atlantic Ocean. Rep Int Whal Comm 47: 693-697.

Crespo EA, Dans SL, Koen Alonso M, Pedraza SN (2007) Interacciones entre mamíferos marinos y pesquerias.The Argentine Sea and its fisheries resources. Vol. 5. The marine ecosystem. pp. 151-169.

Dans SL, Crespo EA, Garcia NA, Reyes LM, Pedraza SN, Alonso MK (1997) Incidental mortality of patagonian dusky dolphins in mid-water trawling: Retrospective effects from the early 1980s. Rep Int Whal Comm 47: 699-703.

Dans SL, Koen Alonso M, Pedraza SN, Crespo EA (2003) Incidental catch of dolphins in trawling fisheries off Patagonia, Argentina: Can populations persist? Ecol Appl 13: 754-762.

Gill PC, Graham J, Ross B, Dawbin WH, Wapstra H (2000) Confirmed sightings of dusky dolphins (*Lagenorhynchus obscurus*) in southern Australian waters. Mar Mamm Sci 16: 452-459.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Lagenorhynchus obscurus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Harlin-Cognato AD, Markowitz T, Wuersig B, Honeycutt RL (2007) Multi-locus phylogeography of the dusky dolphin (*Lagenorhynchus obscurus*): passive dispersal via the west-wind drift or response to prey species and climate change? BMC Evol. Biol 7: 131.

Harlin AD, Markowitz T, Baker CS, Wuersig B, Honeycutt RL (2003) Genetic structure, diversity, and historical demography of New Zealand's dusky dolphin (*Lagenorhynchus obscurus*). J Mammal 84: 702-717.

Hucke-Gaete R (ed.) (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA, Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Markowitz TM (2004) Social organization of the New Zealand dusky dolphin. Diss Abst Int Pt B - Sci & Eng 65: 2200.

Markowitz TM, Harlin AD, Würsig B, McFadden CJ (2004) Dusky dolphin foraging habitat: overlap with aquaculture in New Zealand. Aquat Conserv Mar Freshwat Ecosyst 14: 133-149.

McKinnon J (1994) Feeding habits of the dusky dolphin, *Lagenorhynchus obscurus*, in the coastal waters of central Peru. Fish Bull 92: 569-578.

Read AJ, Van Waerebeek K, Reyes JC, McKinnon JS, Lehman LC (1988) The exploitation of small cetaceans in coastal Peru. Biol Conserv 46: 53-70.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication 4, Lawrence, KS. USA.

Ross GJB (2006) Review of the conservation status of Australia's smaller whales and dolphins. Australian Government. 124 pp.

Sanchez R, Arias Schreiber M, Onton K (1998) Sightings of cetacean in Peruvian sea and its relation with the main pelagic resources. Cruise RV Humboldt 9803-05 from Tumbes to Tacna. Inf Inst Mar Peru 135: 163-179.

Schiavini A, Pedraza SN, Crespo EA, Gonzalez R, Dans SL (1999) Abundance of dusky dolphins (*Lagenorhynchus obscurus*) off north and central Patagonia, Argentina, in spring and a comparison with incidental catch in fisheries. Mar Mam Sci 15: 828-840.

Van Waerebeek K (2002) Pacific White-Sided Dolphin and Dusky Dolphin - *Lagenorhynchus obliquidens* and *L. obscurus*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, 859-861.

Van Waerebeek K, Würsig B (2009) Dusky dolphin - *Lagenorhynchus obscurus*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Second Edition. Academic Press, Amsterdam, pp. 335-338.

Van Waerebeek K, Reyes JC, Alfaro J (1993) Helminth parasites and phoronts of dusky dolphins *Lagenorhynchus obscurus* (Gray, 1828) from Peru. Aquat Mamm 19:159-169.

Van Waerebeek K, Van Bressem M-F, Felix F, Alfaro Shigueto J, Garcia Godos A, Chavez Lisambart L, Onton K, Montes D, Bello R (1997) Mortality of dolphins and porpoises in coastal fisheries off Peru and Southern Ecuador in 1994. Biol Cons 81: 43-49.

Van Waerebeek K, Read A (1994) Reproduction of the dusky dolphins *Lagenorhynchus obscurus*, from coastal Peru. J Mamm 75: 1054-1062.

Vaughn RL, Shelton DE, Timm LL, Watson LA, Wuersig B (2007) Dusky dolphin (*Lagenorhynchus obscurus*) feeding tactics and multi-species associations. N Z J Mar Freshw Res 41: 391-400.

Weir JS, Duprey NMT, Würsig B (2008) Dusky dolphin (*Lagenorhynchus obscurus*) subgroup distribution: are shallow waters a refuge for nursery groups? Can J Zool 86: 1225-1234.

Würsig B (1982) Radio tracking dusky porpoises in the South Atlantic. Mammals in the seas, volume 4, small cetaceans, seals, sirenians and otters. Selected papers of the scientific consultation on the conservation and management of marine mammals and their environment. FAO Adv Comm Experts Mar Resour Res, Rome Italy, pp. 145-160.

Würsig B, Bastida R (1986) Long-range movement and individual associations of two dusky dolphins (*Lagenorhynchus obscurus*) off Argentina. J Mamm 67: 773-774.

Würsig B, Cipriano F, Slooten E, Constantine R, Barr K, Yin S (1997) Dusky dolphins (*Lagenorhynchus obscurus*) off New Zealand: Status of present knowledge. Rep Int Whal Comm 47: 715-722.

Würsig B, Würsig M (1980) Behaviour and ecology of the dusky dolphin, *Lagenorhynchus obscurus*, in the south Atlantic. Fish Bull 77: 871-890.

Würsig B, Würsig M, Cipriano F (1989) Dolphins in different worlds. Oceanus 32: 71-75.

Würsig B, Duprey N, Weir J (2007) Dusky dolphins (*Lagenorhynchus obscurus*) in New Zealand waters: Present knowledge and research goals. N Z Dep Conserv Res Dev Ser 270, 28 pp.

Yazdi, P (2002) A possible hybrid between a dusky dolphin (*Lagenorhynchus obscurus*) and the southern right whale dolphin (*Lissodelphis peronii*). Aquat Mamm 28: 211-217.

3.27. Lipotes vexillifer

Dudgeon D (1995) River regulation in southern China: Ecological implications, conservation and environmental management. Reg Riv Res Man 11(1): 35-54.

Hua Y, Gao S, Zhang J (1994) Population size of baiji and the analysis of the population decreasing. In Working Paper on Baiji Population and Habitat Viability Assessment Workshop Report, Zhou K, Ellis S, Leatherwood S, Bruford M, Seal US (eds), 41-45.

Huan Y, Chen P (1992) Investigation for impacts of changes of the lower reach of Gezhou Dam between Yichang and Chenglingji on the baiji, *Lipotes vexillifer vexillifer* after its key water control project founded. J Fish China Shuichan Xuebao. 16(4): 322-329.

Peixun (1989) Baiji - *Lipotes vexilifer*. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Pres, London, pp. 25-44.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP / CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, Ed.), Lawrence, KS. USA.

Rosel PE, Reeves RR (2000) Genetic and demographic considerations for the conservation of Asian river cetaceans. In: Reeves, RR (ed); Smith, BD (ed); Kasuya, T (ed). Biology and conservation of freshwater cetaceans in Asia. 23: 144-152.

Smith BD, Zhou K, Wang D, Reeves RR, Barlow J, Taylor BL, Pitman R (2008a) *Lipotes vexillifer*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Turvey ST, Pitman RL, Taylor BL, Barlow J, Akamatsu T, Barrett LA, Zhao X, Reeves RR, Stewart BS, Wang K, Wei Z, Zhang X, Pusser LT, Richlen M, Brandon JR, Wang D (2007) First human-caused extinction of a cetacean species? Biol Lett 3: 537-540.

Yang J, Xiao W, Kuang X-A, Wei Z, Liu R-J (2000) Studies on the distribution, population size and the active regularity of *Lipotes vexillifer* and *Neophocaena phocaenoides* in Dongting Lake and Boyang Lake. Resour Environ Yangtze Basin 9: 443-450.

Zhang, X, Jiang G, Jiang X, Li Y (2001) Impacts on baiji and finless porpoise by some projects of preventing and controlling flood in the Yangtze River, with conservation strategies. Resour Environ Yangtze Basin 10: 242-246.

Zhang X, Wang A, Liu R, Wei Z, Hua Y, Wang Y, Chen Z, Wang L (2003) TheYangtze River dolphin or baiji (*Lipotes vexillifer*): population status and conservation issues in the Yangtze River, China. Aqu Con Mar Freshw Ecosyst 13: 51-64.

Zhou K (2002) Baiji - *Lipotes vexilifer*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, 58 - 61.

Zhou K, Sun J, Gao A, Wuersig B. (1998) Baiji (*Lipotes vexillifer*) in the lower Yangtze River: Movements, numbers, threats and conservation needs. Aqu Mamm 24:123-132.

3.28. Lissodelphis borealis

Barlow J (1995) The abundance of cetaceans in California waters: Part I. Ship surveys in summer and fall of 1991. Fish Bull, US 93: 1-14.

Barlow J, Forney KA (2007) Abundance and population density of cetaceans in the California Current ecosystem. Fish Bull, US 105:509-526

Buckland ST, Cattanach KL, Hobbs RC (1993) Abundance estimates of Pacific white-sided dolphin, northern right whale dolphin, Dall's porpoise and northern fur seal in the North Pacific, 1987-1990. Biology, distribution and stock assessment of species caught in the high seas driftnet fisheries in the North Pacific Ocean; 1 Driftnet fisheries of the North Pacific Ocean; 2 Oceanography biology ecology all species; 3 Catch and fishery impact all sp, pp. 387-407.

Carretta JV, Lowry MS, Stinchcomb CE, Lynn MS, Cosgrove R (2000) Distribution and abundance of marine mammals at San Clemente Island and surrounding waters: results from aerial and ground surveys in 1998 and 1999. Admin Rep Southwest Fish Sci Cent 2, 44 pp.

Carretta JV, Price T, Petersen D, Read R (2004) Estimates of marine mammal, sea turtle, and seabird mortality in the California drift gillnet fishery for swordfish and thresher shark, 1996-2002. Mar Fish Rev 66: 21-30

Carretta JV, Forney KA, Lowry MS, Barlow J, Baker J, Johnston D, Hanson B, Muto MM, Lynch D, Carswell L (2008) US Pacific marine mammal stock assessments 2008. NOAA Techn Mem NMFS SWFSC 434, 340 pp.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Chou L S, Bright AM, Yeh SY (1995) Stomach contents of dolphins (*Delphinus delphis* and *Lissodelphis borealis*) from North Pacific Ocean. Zool Stud 34: 206-210.

Dizon AE, Leduc CA, Leduc RG (1994) Intraspecific structure of the northern right whale dolphin (*Lissodelphis borealis*): The power of an analysis of molecular variation for differentiating genetic stocks. Rep CalCofi 35: 61-67.

Ferrero RC (1998) Life history and multivariate analyses of habitat selection patterns among small cetaceans in the central North Pacific Ocean. Dissertation Abstracts International Part B: Sci Eng 59, no. 3.

Ferrero RC, Hobbs RC, Van Blaricom GR (2002) Indications of habitat use patterns among small cetaceans in the Central North Pacific based on fisheries observer data. J Cet Res Man 4: 311-321

Ferrero RC, Walker WA (1993) Growth and reproduction of the northern right whale dolphin *Lissodelphis borealis*, in the offshore waters of the North Pacific Ocean. Can J Zool 71: 2335-2344

Forney KA (2007) Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Tech Mem NMFS-SWFSC-406. 27p.

Forney KA, Barlow J, Carretta JV (1995) The abundance of cetaceans in California waters: Part II. Aerial surveys in winter and spring of 1991 and 1992. Fish Bull, US 93: 15-26.

Forney KA, Barlow J (1998) Seasonal patterns in the abundance and distribution of California Cetaceans, 1991-1992. Mar Mamm Sci 14: 460-489.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Lissodelphis borealis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hiramatsu K (1993) Estimation of population abundance of northern right whale dolphins in the North Pacific using the bycatch data from the Japanese squid driftnet fishery. Biology, distribution and stock assessment of species caught in the high seas driftnet fisheries in the North Pacific Ocean; 1 Driftnet fisheries of the North Pacific Ocean; 2 Oceanography biology ecology all species; 3 Catch and fishery impact all sp, pp. 381-386.

Iwasaki T, Kasuya T (1997) Life history and catch bias of Pacific white-sided (*Lagenorhynchus obliquidens*) and northern right whale dolphins (*Lissodelphis borealis*) incidentally taken by the Japanese high seas squid driftnet fishery. Rep Int Whal Comm 47: 683-692.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Newcomer MW, Leatherwood S, van Waerebeek K (1994) Right wale dolphins - *Lissodelphis borealis* (Peale, 1848) and *Lissodelphis peronii* (Lacépède, 1804). In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 335-362.

Jefferson TA, Webber MA, Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Lipsky JD (2009) Right whale dolphins - *Lissodelphis borealis* and *L. peronii*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 958-962.

Mangel M (1993) Effects of high-seas driftnet fisheries on the northern right whale dolphin *Lissodelphis borealis*. Ecol App 3: 221-229.

Minh TB, Nakata H, Watanabe M, Tanabe S, Miyazaki N, Jefferson TA, Prudente M, Subramanian A (2000) Isomer-Specific Accumulation and Toxic Assessment of Polychlorinated Biphenyls, Including Coplanar Congeners, in Cetaceans from the North Pacific and Asian Coastal Waters. Arch environ Contam Toxicol 39: 398-410.

Ohizumi H, Kato H (2004) Food of toothed whales in the northern North Pacific: Geographic and temporal variation. PICES 13th Annual Meeting Book of Abstracts. p. 261.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication 4, Lawrence, KS. USA.

3.29. Lissodelphis peronii

Aguayo A, Bernal R, Olavarria C, Vallejos V, Hucke R (1998) Cetacean observations carried out between Valparaiso and Easter Island, Chile, in the winters of 1993, 1994 and 1995. Rev Biol Mar Ocean 33: 101-123.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Clarke, RH (2000) First record of the southern right whale dolphin, *Lissodelphis peronii* (Lacepede, 1804) (Odonoceti: Delphinidae), from waters off South Australia. Trans R Soc S Aust 124: 177-178.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Lissodelphis peronii*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hucke-Gaete R (ed.) (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Newcomer MW, Leatherwood S, van Waerebeek K (1994) Right wale dolphins - *Lissodelphis borealis* (Peale, 1848) and *Lissodelphis peronii* (Lacépède, 1804). In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 335-362.

Lipsky JD (2009) Right whale dolphins - *Lissodelphis borealis* and *L. peronii*. In: Encyclopedia of marine mammals, 2nd Ed.(Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 958-962.

Markowitz TM (2004) Social organization of the New Zealand dusky dolphin. Diss Abst Int Pt B Sci & Eng 65: 2200

Peddemors VM (1999) Delphinids of southern Africa: A review of their distribution, status and life history. J Cetacean Res Manag 1: 157-165.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ 4, Lawrence, KS. USA.

Rose B, Payne AIL (1991) Occurrence and behavior of the southern right whale dolphin *Lissodelphis peronii* off Namibia. Mar Mamm Sci 7: 25-34.

Ross GJB (2006) Review of the conservation status of Australia's smaller whales and dolphins. Australian Government. 124 pp.

Van Waerebeek K, Canto J, Gonzalez J, Oporto J, Brito JL (1991) Southern right whale dolphins, *Lissodelphis peronii* off the Pacific coast of South America. Z Säugetier 56: 284-295.

Visser IN, Fertl D, Pusser LT (2004) Melanistic southern right-whale dolphins (*Lissodelphis peronii*) off Kaikoura, New Zealand, with records of other anomalously all-black cetaceans. N Z J Mar Freshwat Res 38: 833-836.

Yazdi, P (2002) A possible hybrid between the dusky dolphin (*Lagenorhynchus obscurus*) and the southern right whale dolphin (*Lissodelphis peronii*). Aquat Mamm 28: 211-217.

3.30 - 3.43. Genus Mesoplodon - Beaked whales: Sources cited in species account

Aguayo A, Bernal R, Olavarria C, Vallejos (1998) Cetacean observations carried out between Valparaiso and Easter Island, Chile, in the winters of 1993, 1994 and 1995. Rev Biol Mar Ocean. 33: 101-123.

Anderson R C, Shaan A, Waheed Z (1999) Records of cetacean 'strandings' from the Maldives. J S Asian Nat His 4: 187-202.

Baird RW, Webster DL, McSweeney DJ, Ligon AD, Schorr GS, Barlow J (2006) Diving behaviour of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales in Hawaii. Can J Zool 84: 1120-1128.

Baird RW, Webster DL, Schorr GS, McSweeney DJ, Barlow J (2008) Diel variation in beaked whale diving behavior. Mar Mamm Sci 24: 630-642.

Baker AN, Van Helden AL (1999) New records of beaked whales, genus Mesoplodon, from New Zealand (Cetacea: Ziphiidae). J Royal Soc N Z 29: 235-244.

Baker AN (2001) Status, relationships, and distribution of *Mesoplodon bowdoini* Andrews, 1908 (Cetacea: Ziphiidae). Mar Mamm Sci 17: 473-493.

Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets Anim Conserv 9: 474-482

Baker CS, Funahashi N, Steel D (2008) Market surveys of whale meat in Japan, 2007 - 2008, with reference to the number of fin whales for sale. Int Whaling Comm SC/60/BC2

Barlow J, Ferguson MC, Perrin WF, Balance L, Gerrodette T, Joyace G, Macleod CD, Mullin K, Palka DL, Waring G (2006) Abundance and densities of beaked and bottlenose whales (family Ziphiidae). J Cetacean Res Manage 7: 263-270

Carlstroem J, Denkinger J, Feddersen P, Oeien N (1997) Record of a new northern range of Sowerby's beaked whale (*Mesoplodon bidens*). Polar Biol 17: 459-461.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Casinos A, Filella S (1995) *Mesoplodon densirostris* - Blainville-Zweizahnwal. In: Handbuch der Säugetiere Europas. Meeressäuger. Teil IB: Wale und Delphine 2 (Robineau D, Duguy R and Klima M, eds.) Aula-Verlag, Wiesbaden. pp. 575-582.

Cook MLH, Varela RA, Goldstein JD, McCulloch SD, Bossart GD, Finneran JJ, Houser D, Mann DA (2006) Beaked whale auditory evoked potential hearing measurements. J Comp Physiol A 192: 489-495

Cox TM, Ragen TJ, Read AJ, Vos E and others (2006) Understanding the impacts of anthropogenic sound on beaked whales. J Cetacean Res Manag 7:177-187

Dalebout ML, Van Helden A, Van Waerebeek K, Baker CS (1998) Molecular genetic identification of southern hemisphere beaked whales (Cetacea: Ziphiidae). Mol Ecol 7: 687-694.

Dalebout ML, Mead JG, Van Waerebeek K, Reyes JC, Baker CS (2000) Molecular genetic discovery of a new beaked whale (Ziphiidae). IWC Scientific Committee Document SC/52/SM11.

Dalebout ML, Mead JG, Baker CS, Baker AN, Van Helden AL (2002) A new species of beaked whale *Mesoplodon perrini* sp. n. (Cetacea: Ziphiidae) discovered through phylogenetic analyses of mitochondrial DNA sequences. Mar Mamm Sci 18: 1-32.

Dalebout ML Russell KG, Little MJ, Ensor, P (2004) Observations of live Gray's beaked whales (*Mesoplodon grayi*) in Mahurangi Harbour, North Island, New Zealand, with a summary of at-sea sightings. J R Soc NZ 34: 347-356.

De Buffrénil V (1995a) *Mesoplodon mirus* - True-Zweizahnwal. In: Handbuch der Säugetiere Europas. Meeressäuger. Teil IB: Wale und Delphine 2 (Robineau D, Duguy R and Klima M, eds.) Aula-Verlag, Wiesbaden. pp. 561-574.

De Buffrénil V (1995b) *Mesoplodon bidens* - Sowerby-Zweizahnwal. In: Handbuch der Säugetiere Europas. Meeressäuger. Teil IB: Wale und Delphine 2 (Robineau D, Duguy R and Klima M, eds.) Aula-Verlag, Wiesbaden. pp. 545-560.

Dolar MLL, Leatherwood SJ, Wood CJ, Alava MNR, Hill CL (1994) Directed Fisheries for Cetaceans in the Philippines. Rep Int Whal Comm 44: 439-449.

Ferguson MC, Barlow J (2001) Spatial distribution and density of cetaceans in the eastern Pacific Ocean based on summer/fall research vessel surveys in 1986-96. SW Fish Sci Cent Admin Rep LJ-01-04: 61 pp.

Forney KA, Kobayashi DR (2007) Updated Estimates of Mortality and Injury of Cetaceans in the Hawaii-Based Longline Fishery, 1994-2005. NOAA Technical Memorandum NMFS SWFSC. no. 412, 35 pp

Gannon DP, Craddock JE, Read AJ (1998) Food habits of beaked whales (*Mesoplodon bidens* and *Ziphius cavirostris*) from the northeastern U.S. In: Abstracts of the World Marine Mammal Science Conference. Monaco, 20-24th January 1998, pp 49.

Honma Y, Ushiki T, Takeda M, Naito E, Dewa K, Yamanouchi H (1999) Identification by histological and microsatellite analyses of a stranded beaked whale as that struck previously by a jetfoil operating in the Sea of Japan. Fish Sci 65: 547-552

Hooker SK, Baird RW (1999) Observations of Sowerby's beaked whales, Mesoplodon bidens, in the Gully, Nova Scotia. Can Field Nat 113: 273-277.

Houston J (1990a) Status of True's beaked whale, *Mesoplodon mirus*, in Canada. Can Field Nat 104: 135-137.

Houston J (1990b) Status of Hubbs' beaked whale, *Mesoplodon carlhubbsi*, in Canada. Can Field Nat 104: 121-124.

Houston J (1990c) Status of Blainville's beaked whale, *Mesoplodon densirostris*, in Canada. Can Field Nat 104: 117-120.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Sources

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Kinze CC, Tougaard S, Baagoe HJ (1998) Danish whale records (strandings and incidental catches) for the period 1992-1997. Flora og Fauna 104 (3-4) 41-53.

Lien J, Barry F, Breecke K, Zuschlag U (1990) Multiple strandings of Sowerby's beaked whales, *Mesoplodon bidens*, in Newfoundland (Canada). Can Field Nat 104: 414-420.

Lien J, Barry F (1990) Status of Sowerby's beaked whale, *Mesoplodon bidens*, in Canada. Can Field Nat 104: 125-130.

Liu H, Gan JL, Jia XP (2009) Distribution characteristic and risk assessment of PCBs in blubber of *Mesoplodon ginkgodens* from Honghai Bay, Guangdong China. J Fish Sci China 16: 381-387

Loughlin TR, Perez MA (1985) *Mesoplodon stejnegeri*. Mammalian Species 250. The American Society of Mammalogists: 1-6.

Lucas ZN, Hooker S (2000) Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. Can Field Nat 114: 45-61.

Martin V, Carrillo M, Andre M, Hernandez Garcia V (2001). Records of cetaceans stranded on the Canary Islands coast from 1992 to 1994. Copenhagen Denmark ICES. 5 pp.

Martin V, Servidio A, García S (2003) Mass strandings of beaked whales in the Canary islands. In: Active sonar and cetaceans (Evans PGH, Miller L, Eds). Workshop at the 17th Conf of the European Cetacean Society, Gran Canary, Spain. pp. 33-36.

Mcalpine DF, Rae M (1999) First confirmed reports of beaked whales, cf. *Mesoplodon bidens* and *M. densirostris* (Ziphiidae), from New Brunswick. Can Field Nat 113: 293-295.

Macleod CD (2000) Review of the distribution of *Mesoplodon* species (order Cetacea, family Ziphiidae) in the North Atlantic. Mamm Rev 30: 1-8.

Macleod CD, Santos MB, Pierce GJ (2003) Review of data on diets of beaked whales: Evidence of niche separation and geographic segregation. J Mar Biol Ass UK 83: 651-665.

MacLeod CD, Herman JS (2004) Development of tusks and associated structures in *Mesoplodon bidens* (Cetaceae, Mammalia). Mammalia 68(2-3): 175-184.

MacLeod CD, Perrin WF, Pitman R, Barlow J, Balance L, D'Amico A, Gerrodette T, Joyce G, Mullin KD, Palka DL, Waring GT (2006a) Known and inferred distributions of beaked whale species (Cetacea: Ziphiidae). J Cetacean Res Manage 7: 271-286

MacLeod CD, Santos MB, López A, Pierce GJ (2006b) Relative prey size consumption in toothed whales: implications for prey selection and level of specialisation. Mar Ecol Prog Ser 326: 295-307

MacLeod CD, Zuur AF (2005) Habitat utilization by Blainville's beaked whales off Great Abaco, northern Bahamas, in relation to seabed topography. Mar Biol 147: 1-11

McSweeney DJ, Baird RW, Mahaffy SD (2007) Site Fidelity, Associations, and Movements of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) Beaked Whales off the Island of Hawai'i. Mar Mamm Sci 23: 666-687.

Mead JG (1989) Beaked whales of the genus Mesoplodon. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 349-430.

Mead JG Walker WA Houck WJ (1982) Biological observations on *Mesoplodon carlubbsi* (Cetacea: Ziphiidae), Smith Contr Zool 344, 25 pp.

Moore, JC (1963) Recognizing certain species of beaked whales of the Pacific Ocean. The American Midland Naturalist 70(2): 396-428.

Moore MJ, Rubinstein B, Norman SA, Lipscomb T (2004) A note on the most northerly record of Gervais' beaked whale from the western North Atlantic Ocean. J Cetacean Res Manage 6: 279-281.

Moretti D, Morrissey R, DiMarzio N, Ward J (2006) Verified passive acoustic detection of beaked whales (*Mesoplodon densirostris*) using distributed bottom-mounted hydrophones in the tongue of the ocean, Bahamas. J Acoust Soc Am 119: 3374.

Nishiwaki M, Kamiya T (1958) A beaked whale Mesoplodon stranded at Oiso beach, Japan. Sci. Rep. Whales Res. Inst., Tokyo 13: 53-83.

Norman SA, Mead, JG (2001) *Mesoplodon europaeus*. Mammalian Species 688: 1-5.

Ostrom PH, Lien J, Macko SA (1993) Evaluation of the diet of Sowerby's beaked whale, *Mesoplodon bidens*, based on isotopic comparisons among northwestern Atlantic cetaceans. Can J Zoo 71: 858-861.

Palacios DM (1996) On the specimen of the ginkgo-toothed beaked whale, *Mesoplodon ginkgodens*, from the Galapagos Islands. Mar Mamm Sci 12: 444-446.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Pinedo MC, Lammardo MP, Barreto AS (2001) Review of *Ziphius cavirostris*, *Mesoplodon grayi* and *Lagenodelphis hosei* (Cetacea: Ziphiidae and Delphinidae) in Brazilian waters, with new records from southern Brazil. Atlantica 23: 67-76.

Pinedo MC, Barreto AS, Lammardo MP, Andrade ALV, Geracitano L (2002) Northernmost records of the spectacled porpoise, Layard's beaked whale, Commerson's dolphin, and Peale's dolphin in the southwestern Atlantic Ocean. Aquat Mamm 28: 32-37.

Pitman RL, Aguayo-L A, Urban-R J (1987) Observations of an unidentified beaked whale (*Mesoplodon* sp.) in the eastern tropical Pacific. Mar Mamm Sci 3: 345-352.

Pitman RL, Lynn MS (2001) Biological observations of an unidentified mesoplodont whale in the eastern tropical Pacific and probable identity: *Mesoplodon peruvianus*. Mar Mamm Sci 17: 648-657.

Pitman RL (2002) Mesoplodont whales. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, 738-742.

Pitman RL (2009) Mesoplodont whales. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, 721-726.

Reidenberg JS, Laitman JT (2009) Cetacean prenatal development. In: "Encyclopedia of marine mammals, 2nd Ed." Perrin WF, Würsig B, Thewissen JGM (Eds.) Elsevier, Amsterdam, 1316 pp.

Reiner F (1980) First record of a Antillean beaked whale, *Mesoplodon europaeus* Gervais 1855, from República popular da Guiné Bissau. Memorias do Museu do mar. Ser.Zool. 1(8):1-8.

Reiner F, Goncalves JM, Santos RS (1993) Two new records of Ziphiidae (Cetacea) for the Azores with an updated checklist of cetacean species. Arq Cien Nat 11: 113-118.

Reyes JC, Mead JG, Van Waerebeek K (1991) A new species of beaked whale *Mesoplodon peruvianus* sp.n. (Cetacea: Ziphiidae) from Peru. Marine Mammal Science 7(1): 1-24.

Reyes JC, Van Waerebeek K, Cárdenas JC, Yañez JL (1995) *Mesoplodon bahamondi* sp.n. (Cetacea, Ziphiidae), a new living beaked whale from the Juan Fernández Archipelago, Chile. Boletin Museo Nacional de Historia Natural de Chile 45: 31-44.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Ritter F, Brederlau B (1999) Behavioural observations of dense beaked whales (*Mesoplodon densirostris*) off La Gomera, Canary Islands (1995-1997). Aquat Mamm 25: 55-61.

Robineau D (1995) *Mesoplodon europaeus* - Gervais-Zweizahnwal. In: Handbuch der Säugetiere Europas. Meeressäuger. Teil IB: Wale und Delphine 2 (Robineau D, Duguy R and Klima M, eds.) Aula-Verlag, Wiesbaden. pp. 583-594.

Robineau D, Vély M (1993) Stranding of a specimen of Gervais' beaked whale (*Mesoplodon europaeus*) on the coast of West Africa (Mauritania). Mar Mamm Sci 9(4): 438-440.

Sanino GP, Yáñez JL, Van Waerebeek K (2007) A first confirmed specimen record in Chile, and sightings attributed to the lesser beaked whale *Mesoplodon peruvianus* Reyes, Mead and Van Waerebeek, 1991. Bol Mus Nac Hist Nat, Chile 56: 89-96.

Santos MB, Pierce GJ, Wijnsma G, Ross HM, Reid, RJ (2001) Diets of small cetaceans stranded in Scotland 1993-1995. Copenhagen Denmark Ices 8 pp.

Santos MB, Martin V, Arbelo M, Fernandez A, Pierce GJ (2007) Insights Into the Diet of Beaked Whales from the Atypical Mass Stranding in the Canary Islands in September 2002. J Mar Biol Assoc UK 87: 243-251.

Scott MD, Hohn A , Westgate AJ, Nicolas JR, Whitaker BR, Campbell WB (2001) A note on the release and tracking of a rehabilitated pygmy sperm whale (*Kogia breviceps*). J Cet Res Man 3: 87-94.

Secchi ER, Zarzur S (1999) Plastic debris ingested by a Blainville's beaked whale, *Mesoplodon densirostris*, washed ashore in Brazil. Aquat Mamm 25: 21-24.

Sekiguchi K, Klages NTW, Best PB (1996) The diet of strap-toothed whales (*Mesoplodon layardii*). J Zool (London) 239(3): 453-463.

Smeenk C (1995) Cetacea stranded on the Dutch coast in 1990, 1991 and 1992. Lutra 38: 90-104.

Soto JMR, Vega SS (1997) First record of Gray's beaked whale, *Mesoplodon grayi* Haast, 1876 (Cetacea, Ziphiidae) from Brazil, with reference to osteology and a review of the ziphiids citations in Brazilian waters. Biociencias 5: 69-89.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2009) *Mesoplodon* spec. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1

Tove M (1995) Live sighting of Mesoplodon cf. *M. mirus*, true's beaked whale. Mar Mamm Sci 11: 80-85.

Tyack PL, Johnson M, Soto NA, Sturlese A, Madsen PT (2006) Extreme diving of beaked whales. J Exp Biol 209: 4238-4253.

True, FW (1913) Description of *Mesoplodon mirum*, a beaked whale recently discovered on the coast of North Carolina. Proc. US National Museum 45: 651-657.

Urbán-Ramírez J, Aurioles-Gamboa D (1991) First record of the pygmy beaked whale *Mesoplodon peruvianus* in the North Pacific. Mar Mam sci 8: 420-425.

Van Helden AL, Baker AN, Dalebout ML, Reyes JC, Van Waerebeek K, Baker CS (2002) Resurrection of *Mesoplodon traversii* (Gray, 1874), senior synonym of *M. bahamondi* Reyes, Van Waerebeek, Cárdenas and Yañez, 1995 (Cetacea: Ziphiidae). Mar Mamm Sci 18: 609-621.

Van Waerebeek K, Leaper R, Baker AN, Papastavrou V, Thiele D (2004) Odontocetes of the Southern Ocean Sanctuary. IWC Scientific Committee Document SC/56/SOS1, Sorrento, Italy, June 2004. 35 pp.

Walker WA, Hanson MB (1999) Biological observations on Stejneger's beaked whale, *Mesoplodon stejnegeri*, from strandings on Adak Island, Alaska. Mar Mamm Sci 15: 1314-1329.

Wang JY, Yang SC (2006) Unusual cetacean stranding events of Taiwan in 2004 and 2005. J Cetacean Res Manag 8: 283-292.

Wang PL, Tong SH, Yuan HM (2006) Stranding of Blainville's Beaked Whale (*Mesoplodon densirostris*) Along the Coast of Huian, Fujian Province, China. Fish. Sci./Shuichan Kexue 25: 524-527.

Waring GT, Quintal JM, Schwartz SL (eds.) (2001) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2001. NOAA Technical Memorandum NMFS-NE-168.

3.44. Monodon monoceros

Born EW (1994) *Monodon monoceros* Linnaeus, 1758 - Narwhal. In: Handbuch der Säugetiere Europas. Meeressäuger. Teil IA: Wale und Delphine 1 (Robineau D, Duguy R and Klima M, eds.) Aula-Verlag, Wiesbaden, pp. 209-240.

Born, EW, Heide-Jørgensen, MP, Larsen, F and Martin, AR (1994) Abundance and stock composition of narwhals (*Monodon monoceros*) in Inglefield Bredning (NW Greenland). Meddelelser om Gronland Bioscience 39: 51-68.

Dietz R, Heide-Jørgensen MP, Richard PR, Acquarone M (2001) Summer and fall movements of Narwhals (*Monodon monoceros*) from northeastern Baffin Island towards northern Davis Strait. Arctic 54: 244-261.

Dietz R, Riget F, Hobson KA, Heide-Joergensen MP, Moeller P, Cleemann M, De Boer J, Glasius M (2004) Regional and inter annual patterns of heavy metals, organochlorines and stable isotopes in narwhals (*Monodon monoceros*) from West Greenland. Sci Total Environ 331: 83-105.

DFO (2008) Total allowable harvest recommendations for Nunavut narwhal and beluga populations. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/035.

Garde E, Heide-Joergensen MP, Hansen SH, Nachman G, Forchhammer MC (2007) Age-Specific Growth And Remarkable Longevity In Narwhals (*Monodon monoceros*) From West Greenland As Estimated By Aspartic Acid Racemization. J Mammal 88: 49-58.

Gjertz I (1991) The narwhal, *Monodon monoceros*, in the Norwegian High Arctic. Mar Mamm Sci 7: 402-408.

Hay KA (1985) The life history of the narwhal (*Monodon monoceros L.*) in the eastern Canadian Arctic. Diss Abst Int Pt B Sci and Eng 45 (10).

Hay KA, Mansfield AW (1989) Narwhal - *Monodon monoceros* Linnaeus, 1758. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 145-176.

Heide-Joergensen MP (2002) Narwhal - *Monodon monoceros*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 783-787.

Heide-Joergensen MP (2004) Aerial Digital Photographic Surveys of Narwhals, *Monodon monoceros*, in Northwest Greenland. Mar Mamm Sci 20: 246-261.

Heide-Joergensen MP (2009) Narwhal - *Monodon monoceros*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 754-758.

Heide Jorgensen MP, Dietz R, Laidre KL, Richard P (2002) Autumn movements, home ranges, and winter density of narwhals (*Monodon monoceros*) tagged in Tremblay Sound, Baffin Island. Polar Biol 25: 331-341.

Heide-Joergensen MP, Dietz R, Laidre KL, Richard P, Orr J, Schmidt HC (2003) The migratory behaviour of narwhals (*Monodon monoceros*). Can J Zool 81: 1298-1305.

Heide-Joergensen MP, Dietz R, Laidre KL, Nicklen P, Garde E, Richard P, Orr J (2008) Resighting of a Narwhal (*Monodon monoceros*) Instrumented with a Satellite Transmitter. Arctic 61: 395-398.

Innes S, Heide-Joergensen MP, Laake JL, Laidre KL, Cleator HJ, Richard P, Stewart REA (2002) Surveys of belugas and narwhals in the Canadian High Arctic in 1996. Belugas in the North Atlantic and the Russian Arctic. pp. 169-190. NAMMCO Sci Pub 4.

IWC (2000) Report of the Scientific Committee from its Annual Meeting 3-15 May 1999 in Grenada. J Cetacean Res Manage 2 (Suppl).

Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Reeves RR, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Monodon monoceros*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Koski WR, Davis RA (1994) Distribution and numbers of narwhals (*Monodon monoceros*) in Baffin Bay and Davis Strait. Meddelelser om Gronland Bioscience 39: 15-40.

Laidre KL, Heide-Joergensen MP (2005) Winter Feeding Intensity of Narwhals (*Monodon monoceros*). Mar Mamm Sci 21: 45-57.

Laidre KL, Heide-Joergensen MP, Dietz R, Hobbs RC, Joergensen OA (2003) Deep-diving by narwhals *Monodon monoceros*: Differences in foraging behavior between wintering areas? Mar Ecol Prog Ser 261: 269-281.

Laidre KL, Heide-Joergensen MP, Logdson ML, Hobbs RC, Heagerty P, Dietz R, Joergensen OA, Treble MA (2004) Seasonal narwhal habitat associations in the high Arctic. Mar Biol 145: 821-831.

NAMMCO Annual Report (2006) - Volume I North Atlantic Marine Mammal Commission, Tromsø, Norway, 277 pp.

Palsboll PJ, Heide-Joergensen MP, Dietz R (1997) Population structure and seasonal movements of narwhals, *Monodon monoceros*, determined from mTDNA analysis. Heredity: 284-292.

Reeves RR (1992) Recent developments in the commerce in narwhal ivory from the Canadian Arctic. Arct Alp Res 24: 179-187.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Roberge MM, Dunn JB (1990) Assessment of the subsistence harvest and biology of narwhal (*Monodon monoceros L.*) from Admiralty Inlet, Baffin Island, N.W.T., 1983 and 1986-89. Can Tech Rep Fish Aquat Sci 1747, 38 pp.

Wagemann R, Kozlowska H (2005) Mercury distribution in the skin of beluga (*Delphinapterus leucas*) and narwhal (*Monodon monoceros*) from the Canadian Arctic and mercury burdens and excretion by moulting. Sci Total Environ 351-352: 333-343.

Wolkers H, Lydersen C, Kovacs KM, Burkow I, Bavel B (2006) Accumulation, Metabolism, and Food-Chain Transfer of Chlorinated and Brominated Contaminants in Subadult White Whales (*Delphinapterus leucas*) and Narwhals (*Monodon monoceros*) From Svalbard, Norway. Arch Environ Contam Toxicol 50: 69-78.

3.45. Neophocaena phocaenoides

Akamatsu T, Ding W, Kexiong W, Zhuo W, Zhao Q, Naito Y (2002) Diving behaviour of freshwater finless porpoises (*Neophocaena phocaenoides*) in an oxbow of the Yangtze River, China. ICES J Mar Sci 59: 438-443.

Akamatsu T, Wang D, Wang K, Naito Y (2005) Biosonar behavior of free-ranging porpoises. Proc R Soc Lond, Ser B: Biol Sci 272: 797-801.

Akamatsu T, Wang D, Wang K, Songhai L (2006) Acoustic Monitoring of Echolocating Porpoises. IEEE Oceans Asia-Pacific Conference. Proceedings. pp. 1-4.

Akamatsu T, Nakazawa I, Tsuchiyama T, Kimura N (2008) Evidence of nighttime movement of finless porpoises through Kanmon Strait monitored using a stationary acoustic recording device. Fish Sci 74: 970-975.

Amano M (2009) Finless porpoise - *Neophocaena phocaenoides*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) 2nd ed. Academic Press, Amsterdam, pp. 437-439.

Amano M, Nakahara F, Hayano A, Shirakihara K (2003) Abundance estimate of finless porpoises off the Pacific coast of eastern Japan based on aerial surveys. Mamm Study 28: 103-110.

Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Anim Conserv 9: 474-482.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Dong WW, Xu Y, Wang D, Hao YJ (2006) Mercury concentrations in Yangtze finless porpoises (*Neophocaena phocaenoides asiaeorientalis*) from Eastern Dongting lake, China. Fresenius Environ Bull 15: 441-447.

IWC (2000) Annex K: Report of the sub-committee on small cetaceans. Rep Int Whal Comm, Cambridge, UK.

Jefferson TA, Hung SK (2007) An updated, annotated checklist of the marine mammals of Hong Kong. Mammalia 71: 105-114.

Jefferson TA, Hung SK, Law L, Torey M, Tregenza N (2002) Distribution and abundance of finless porpoises in Hong Kong and adjacent waters of China. Raffles Bulletin of Zoology 10: 43-55.

Jefferson TA, Hung SK (2004) *Neophocaena phocaenoides*. Mammalian Species 746: 1-12.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Kastelein RA, Au WWL, de Haan D (2000) Detection distances of bottom-set gillnets by harbour porpoises (*Phocoena phocoena*) and bottlenose dolphins (*Tursiops truncatus*). Mar Environm Res 49: 359-375

Kasuya T (1999) Finless porpoise - *Neophocaena phocoenoides* (G. Cuvier, 1829). In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 411-442.

Koschinski S, Culik BM, Trippel EA, Ginzkey L (2006) Behavioral reactions of free-ranging harbor porpoises *Phocoena phocoena* encountering standard nylon and BaSO4 mesh gillnets and warning sound. Mar Ecol Prog Ser 313: 285-294

Le L-T-H, Takahashi S, Saeki K, Nakatani N, Tanabe S, Miyazaki N, Fujise Y (1999) High percentage of butyltin residues in total tin in the livers of cetaceans from Japanese coastal waters. Env Sci Tech 33: 1781-1786.

Minh T-B, Watanabe M, Nakata H, Tanabe S, Jefferson TA (1999) Contamination by Persistent Organochlorines in Small Cetaceans from Hong Kong Coastal Waters. Mar Poll Bull 39: 383-392.

Park KJ, Zhang CI, Kim ZG, Choi SG, An YR (2006) Abundance of finless porpoise (*Neophocaena phocaenoides*) and their role in the eastern Yellow Sea ecosystem. PICES XV. Book of Abstracts. p. 128.

Parsons ECM (1998a) The behaviour of Hong Kong's resident cetaceans: The Indo-Pacific hump-backed dolphin and the finless porpoise. Aquat Mamm 24: 91-110.

Parsons ECM (1998b) Strandings of small cetaceans in Hong Kong territorial waters. J Mar Biol Assoc Uk 78: 1039-1042.

Parsons ECM (1999) Trace element concentrations in the tissues of cetaceans from Hong Kong's territorial waters. Env Cons 26: 30-40.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Preen A (2004) Distribution, abundance and conservation status of dugongs and dolphins in the southern and western Arabian Gulf. Biol Conserv 118: 205-218.

Ramu K, Kajiwara N, Lam PKS, Jefferson TA, Zhou K, Tanabe S (2006) Temporal variation and biomagnification of organohalogen compounds in finless porpoises (*Neophocaena phocaenoides*) from the South China Sea. Environ Pollut 144: 516-523.

Ramu K, Kajiwara N, Tanabe S, Lam PKS, Jefferson TA (2005) Polybrominated diphenyl ethers (PBDEs) and organo-chlorines in small cetaceans from Hong Kong waters: Levels, profiles and distribution. Mar Pollut Bull 51: 669-676.

Reeves RR, Collins T, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Neophocaena phocaenoides*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Shirakihara K, Shirakihara M (2002) Survey of Ariake/Tachibana Bay, Omura Bay and Inland Sea. Survey of Marine Animals: finless porpoises, pp. 27-52. Biodiversity Centre, Fujiyoshida., Fujiyoshida.

Shirakihara K, Shirakihara M, Yamamoto Y (2007) Distribution and abundance of finless porpoise in the Inland Sea of Japan. Mar Biol 150: 1025-1032.

Shirakihara M, Seki K, Takemura A, Shirakihara K, Yoshida H, Yamazaki T (2008) Food Habits of Finless Porpoises *Neophocaena phocaenoides* in Western Kyushu, Japan. J Mammal 89: 1248-1256

Singh HS (2003) Sea mammals in marine protected area in the Gulf of Kachchh, Gujarat State, India. Indian J Mar Sci 32: 258-262.

Smith BD, Ahmed B, Mowgli RM, Strindberg S (2008) Species occurrence and distributional ecology of nearshore cetaceans in the Bay of Bengal, Bangladesh, with abundance estimates for Irrawaddy dolphins *Orcaella brevirostris* and finless porpoises *Neophocaena phocaenoides*. J Cetacean Res Manag 10: 45-58.

Smith BD, Tun MT (2008) A note on the species occurrence, distributional ecology and fisheries interactions of cetaceans in the Mergui (Myeik) Archipelago, Myanmar. J Cetacean Res Manag 10: 37-44.

Van Waerebeek K, Baker AN, Félix F, Gedamke J, Iñiguez M, Sanino GP, Secchi E, Sutaria D, van Helden A, Wang Y (2007) Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment. The Latin American Journal of Aquatic Mammals 6(1): 43-69.

Wei Z, Zhang X, Wang K, Zhao Q, Kuang X, Wang X, Wang D (2003) Habitat use and preliminary evaluation of the habitat status of the Yangtze finless porpoise (*Neophocaena phocaenoides asiaeorientalis*) in the Balijiang section of the Yangtze River, China. Acta Zool Sin 49: 163-170.

Yang G, Zhou K, Xu X, Leatherwood S (1999) A survey on the incidental catches of small cetaceans in coastal waters of China. Yingyong Shengtai Xuebao 10: 713-716.

Yang F, Zhang Q, Xu Y, Jiang G, Wang Y, Wang D (2008b) Preliminary Hazard Assessment of Polychlorinated Biphenyls, Polybrominated Diphenyl Ethers, and Polychlorinated Dibenzo-P-Dioxins and Dibenzofurans to Yangtze Finless Porpoise in Dongting Lake, China. Environ Toxicol Chem 27: 991-996.

Yang G, Guo L, Bruford MW, Wei F, Zhou K (2008a) Mitochondrial phylogeography and population history of finless porpoises in Sino-Japanese waters. Biol J Linn Soc 95: 193-204.

Yoshida H (2002) Population structure of finless porpoises (*Neophocaena phocaenoides*) in coastal waters of Japan. Raffles Bulletin of Zoology 10: 35-42.

Zhang X, Liu R, Zhao Q, Zhang G, Wei Z, Wang X, Yang J (1993) The population of finless porpoise in the middle and lower reaches of Yangtze River. Acta Theriologica Sinica 13: 260-270.

Zhang X, Jiang G, Jiang X, Li Y (2001) Impacts on baiji and finless porpoise by some projects of preventing and controlling flood in the Yangtze River, with conservation strategies. Resour EnvironYangtze Basin 10: 242-246.

Zhao X, Barlow J, Taylor BL, Pitman RL, Wang K, Wei Z, Stewart BS, Turvey ST, Akamatsu T, Reeves RR, Wang D (2008) Abundance and conservation status of the Yangtze finless porpoise in the Yangtze River, China. Biol Conserv 141: 3006-3018.

3.46. Orcaella brevirostris

Arnold PW (2002) Irrawaddy dolphin - *Orcaella brevirostris*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 652-654.

Baird IG, Beasley IL (2005) Irrawaddy dolphin *Orcaella brevirostris* in the Cambodian Mekong River: an initial survey. Oryx 39: 301-310

Baird IG, Mounsouphom B (1994) Irrawaddy dolphins (*Orcaella brevirostris*) in southern Lao PDR and northeastern Cambodia. Nat Hist Bull Siam Soc 42: 159-175.

Baird IG, Mounsouphom B (1997) Distribution mortality, diet and conservation of Irrawaddy dolphins (*Orcaella brevirostris* Gray) in Lao, PDR. Asian Mar Biol 14: 41-48.

Beasley I, Roberston KM, Arnold P (2005) Description of a new dolphin, the Australian snubfin dolphin *Orcaella heinsohni* sp. n. (Cetacea, Delphinidae). Mar Mamm Sci 21: 365-400.

Gonzales B-J, Matillano M-V (2008) Irrawaddy dolphin conservation in the fisheries of Malampaya inner sound, Palawan, Philippines. Mem Fac Fish Kagoshima Univ. Special Issue, pp. 16-25.

IWC (2000) Annex K: Report of the sub-committee on small cetaceans. Rep Int Whal Comm, Cambridge, UK.

Jefferson TA, Karczmarski L, Kreb D, Laidre K, O'Corry-Crowe G, Reeves RR, Rojas-Bracho L, Secchi E, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Orcaella brevirostris* (Mahakam River subpopulation). In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Kannan K, Ramu K, Kajiwara N, Sinha RK, Tanabe S (2005) Organochlorine pesticides, polychlorinated biphenyls, and polybrominated diphenyl ethers in Irrawaddy dolphins from India. Arch Environ Contam Toxicol 49: 415-420

Kreb D, Budiono (2005) Conservation management of small core areas: key to survival of a Critically Endangered population of Irrawaddy river dolphins *Orcaella brevirostris* in Indonesia. Oryx 39: 178-188

Kreb D, Rahadi KD (2004) Living under an aquatic freeway: Effects of boats on Irrawaddy dolphins (*Orcaella brevirostris*) in a coastal and riverine environment in Indonesia. Aquat Mamm 30: 363-375

Marsh H, Lloze R, Heinsohn GE, Kasuya T (1989) Irrawaddy dolphin - *Orcaella brevirostris* (Gray, 1866) In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 4: River dolphins and the larger toothed whales. Academic Press, London, pp. 101-118.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Poulsen A, Poeu O, Viravong S, Suntornratana U, Tung NT (2002) Deep pools as dry season fish habitats in the Mekong River basin. MRC Tech Pap 4, 24 pp.

Reeves RR, Dalebout ML, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Orcaella Brevirostris*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Rosel PE, Reeves RR (2000) Genetic and demographic considerations for the conservation of Asian river cetaceans. Biology and conservation of freshwater cetaceans in Asia. Vol. 23, pp. 144-152. [Occas. Pap. IUCN Species Survival Comm.].

Sarkar SK (2007) Dolphins in Chilika Lake - Endangered due to tourist activities J Indian Ocean Stud 15: 283-291

Smith BD (2004) *Orcaella brevirostris* (Ayeyarwady River subpopulation). In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Smith BD (2009) Irrawaddy Dolphin *Orcaella brevirostris*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 638-642.

Smith BD, Ahmed B, Mowgli RM, Strindberg S (2008) Species occurrence and distributional ecology of nearshore cetaceans in the Bay of Bengal, Bangladesh, with abundance estimates for Irrawaddy dolphins *Orcaella brevirostris* and finless porpoises *Neophocaena phocaenoides*. J Cetacean Res Manag 10: 45-58.

Smith BD, Beasley I (2004) *Orcaella brevirostris* (Malampaya Sound subpopulation). In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>

Smith BD, Beasley I, Buccat M, Calderon V, Evina R, De Valle JL, Cadigal A, Tura E, Visitacion Z (2004) Status, ecology and conservation of Irrawaddy dolphins (*Orcaella brevirostris*) in Malampaya Sound, Palawan, Philippines. J Cet Res Man 6: 41-52.

Smith BD, Braulik G, Strindberg S, Ahmed B, Mansur R (2006) Abundance of Irrawaddy dolphins (*Orcaella brevirostris*) and Ganges river dolphins (*Platanista gangetica gangetica*) estimated using concurrent counts from independent teams in waterways of the Sundarbans mangrove forest in Bangladesh. Mar Mamm Sci 22: 1-21.

Smith BD, Braulik G, Strindberg S, Diyan R, Mansura AB (2009b) Habitat selection of freshwater-dependent cetaceans and the potential effects of declining freshwater flows and sea-level rise in waterways of the Sundarbans mangrove forest, Bangladesh. Aquat Conserv: Mar Freshw Ecosyst 19: 209-225.

Smith BD, Jefferson TA, Leatherwood S, Ho Dao Tan, Van Thuoc Chu, Hai Quang Le (1997b) Investigations of marine mammals in Vietnam. Asian Mar Biol 14: 145-172.

Smith BD, Thant UH, Lwin JM, Shaw CD (1997a) Investigation of cetaceans in the Ayeyarwady river and northern Coastal waters in Myanmar. Asian Mar Biol 14: 173-194.

Smith BD, Tun MT (2008) A note on the species occurrence, distributional ecology and fisheries interactions of cetaceans in the Mergui (Myeik) Archipelago, Myanmar. J Cetacean Res Manag 10: 37-44.

Smith BD, Tun MT, Chit AM, Win H, Moe T (2009a) Catch composition and conservation management of a human-dolphin cooperative cast-net fishery in the Ayeyarwady River, Myanmar. Biol Conserv 142: 1042-1049.

Stacey PJ, Hvenegaard GT (2002) Habitat use and behaviour of Irrawaddy dolphins (*Orcaella brevirostris*) in the Mekong River of Laos. Aquat Mamm 28: 1-13

Stacey PJ, Leatherwood S (1997) The Irrawaddy dolphin, *Orcaella brevirostris*: A summary of current knowledge and recommendations for conservation action. Asian Mar Biol 14: 195-214.

Tun T (2008) Sound signals ssed in castnet fishing with the help of Irrawaddy dolphins. Bioacoustics 17: 224-226.

WWF (2009) Small cetaceans, the forgotten whales. (Elliott W, Sohl H, Bugener V). Whaling Report. Indd 34.

3.47. Orcaella heinsohni

Beasley I, Roberston KM, Arnold P (2005) Description of a new dolphin, the Australian snubfin dolphin *Orcaella heinsohni* sp. n. (Cetacea, Delphinidae). Mar Mamm Sci 21: 365-400.

Corkeron PJ, Morissette NM, Porter LJ, Marsh H (1997) Distribution and status of hump-backed dolphins, *Sousa chinensis*, in Australian waters. Asian Marine Biology 14, 49-59.

Freeland WJ, Bayliss P (1989) The Irrawaddy River dolphin (*Orcaella brevirostris*) in coastal waters of the Northern Territory, Australia: Distribution, abundance and seasonal changes. Mammalia 53: 49-58.

Hale P (1997) Conservation of inshore dolphins in Australia. Asian Mar Biol 14: 83-91.

IWC (2000) Annex K: Report of the sub-committee on small cetaceans. Rep Int Whal Comm, Cambridge, UK.

Parra, GJ (2005) Behavioural ecology of Irrawaddy, *Orcaella brevirostris* (Owen in Gray, 1866), and Indo-Pacific humpback dolphins, Sousa chinensis (Osbeck, 1765), in northeast Queensland, Australia: a comparative study. Ph.D. Thesis, James Cook University, Townsville.

Parra GJ, Azuma C, Preen AR, Corkeron PJ, Marsh H (2002) Distribution of Irrawaddy dolphins, *Orcaella brevirostris*, in Australian waters. Raffles Bulletin of Zoology Supplement 10, 141-154.

Parra GJ, Schick R, Corkeron PJ (2006a) Spatial distribution and environmental correlates of Autralian snubfin and Indo-Pacific humpback dolphins. Ecography 29: 396-406

Parra GJ, Corkeron PJ, Marsh H (2006b) Population sizes, site fildelity and residence patterns of Australian snubfin and Indo-Pacific humpback dolphins: Implications for conservation. Biol Conserv 129: 167-180.

Parra GJ, Jedensjö M (2009) Feeding habits of Australian Snubfin (*Orcaella heinsohni*) and Indo-Pacific humpback dolphins (*Sousa chinensis*). Project Report to the Great Barrier Reef Marine Park Authority, Townsville and Reef & Rainforest Research Centre Limited, Cairns 22 pp.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Reeves RR, Dalebout ML, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Orcaella heinsohni*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Robertson KM, Arnold PW (2009) Australian snubfin dolphin *Orcaella heinsohni*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 62-64.

3.48. Orcinus orca

Angliss RP, Outlaw RB (2004) Killer whale (*Orcinus orca*) west coast transient stock. NOAA-TM-AFSC-161

Baird RW, Dill LM (1996) Ecological and social determinants of group size in transient killer whales. Behav Ecol 7: 408-416.

Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Anim Conserv 9: 474-482.

Barlow J (2003) Cetacean abundance in Hawaiian waters during summer/fall 2002. Admin. Rep. LJ-03-13. Southwest Fisheries Science Center, U.S. National Marine Fisheries Service

Barlow J, Forney KA (2007) Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105: 509-526.

Barrett-Lennard LG (2000) Population structure and mating patterns of killer whales (*Orcinus orca*) as revealed by DNA analysis. Ph.D. dissertation, University of British Columbia.

Black NA, Schulman Janiger A, Ternullo RL, Guerrero Ruiz (1997) Killer whales of California and western Mexico: A catalog of photo-identified individuals. Report for the National Marine Fisheries Service, South Fisheries Science Center/ NOAA, 184 pp.

Branch TA, Butterworth DS (2001) Estimates of abundance south of 60°S for cetacean species sighted frequently on the 1978/79 to 1997/98 IWC/IDCR-SOWER sighting surveys. J Cetacean Res Manage 3: 251-270.

Carretta JV, Forney KA, Lowry MS, Barlow J, Baker J, Johnston D, Hanson, Muto MM, Lynch D, Carswell L (2009) U.S. Pacific marine mammal stock assessments: 2008. NOAA-TM-NMFS-SWFSC-434

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Dahlheim ME, Heyning JE (1999) Killer whale - *Orcinus orca* (Linnaeus, 1758). In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 281-322.

Domenici P, Batty RS, Similae T, Ogam E (2000) Killer whales (*Orcinus orca*) feeding on schooling herring (*Clupea harengus*) using underwater tail-slaps: kinematic analyses of field observations. J Exp Biol 203: 283-294.

Erbe, C (2002) Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. Mar Mamm Sci 18: 394-418.

Estes JA, Tinker MT, Williams TM, Doak DF (1998) Killer whale predation on sea otters linking oceanic and nearshore ecosystems. Science 282: 473-476.

Ford JKB (2009) Killer whale - *Orcinus orca*. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 650-657

Ford JKB, Ellis GM, Barrett Lennard LG, Morton AB (1998) Dietary specialization in two sympatric populations of killer whales (*Orcinus orca*) in coastal British Columbia and adjacent waters. Can J Zool 76: 1456-1471.

Ford JKB, Ellis GM (1999) Transients: Mammal-hunting killer whales of British Columbia, Washington, and southeastern Alaska. Univ. British Columbia Press. Vancouver, Toronto, Canada.

Ford JKB, Ellis GM, Balcomb KC (2000) Killer whales. University of British Columbia Press, Vancouver, Toronto, Canada; University of Washington Press, Seattle. 104 pp.

Forney KA, Barlow J (1998) Seasonal patterns in the abundance and distribution of California cetaceans, 1991-1992. Mar Mamm Sci 14: 460-489.

Forney KA (2007) Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Tech Memo NMFS-SWFSC-406. 27p.

Gill PC, Thiele D (1997) A winter sighting of killer whales (*Orcinus orca*) in Antarctic sea ice. Polar Biol 17: 401-404.

Guerrero Ruiz M, Gendron D, Urban RJ (1998) Distribution, movements and communities of killer whales (*Orcinus orca*) in the Gulf of California, Mexico. Rep Int Whal Comm 48: 537-543.

Guerrero-Ruiz M, Garcia-Godos I, Urban RJ (2005) Photographic match of a killer whale (*Orcinus orca*) between Peruvian and Mexican waters. Aquat Mamm 31: 438-441.

Guinet C, Domenici P, De Stephanis R, Barrett-Lennard L, Ford JKB, Verborgh, P (2007) Killer whale predation on bluefin tuna: exploring the hypothesis of the endurance-exhaustion technique. Mar Ecol Prog Ser 347:111-119.

Hickie BE, Ross PS, Macdonald RW, Ford JKB (2007) Killer whales (*Orcinus orca*) face protracted health risks associated with lifetime exposure to PCBs. Environ. Sci Technol 41: 6613-6619.

Holt, MM (2008) Sound exposure of southern resident killer whales (*Orcinus orca*): A review of current knowledge and data gaps. NOAA Tech Memo NMFS NWFSC. no. 89, 77 pp.

Iniguez MA (2002) Seasonal distribution of killer whales (*Orcinus orca*) in northern Patagonia, Argentina. Aquat Mamm 27: 154-161.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Kajiwara N, Kunisue T, Kamikawa S, Ochi Y, Yano S, Tanabe S (2006) Organohalogen and organotin compounds in killer whales mass-stranded in the Shiretoko Peninsula, Hokkaido, Japan. Mar Pollut Bull 52: 1066-1076.

Kock, K-H, Purves MG, Duhamel G (2006) Interactions between cetaceans and fisheries in the Southern Ocean. Polar Biol 29: 379-388

Krahn MM, Pitman RL, Burrows DG, Herman DP, Pearce RW (2008) Use of chemical tracers to assess diet and persistent organic pollutants in Antarctic Type C killer whales. Mar Mamm Sci 24: 643-663.

Krahn MM, Ford MJ, Perrin WF, Wade PR, Angliss RP (2004) Status review of Southern Resident Killer Whales (*Orcinus orca*) under the Endangered Species Act, 2004. NOAA Tech Memo NMFS NWFSC. no. 62, 100 pp

Krahn MM, Herman DP, Matkin CO, Durban JW, Barrett-Lennard L, Burrows DG, Dahlheim ME, Black N, LeDuc RG, Wade PR (2007) Use of chemical tracers in assessing the diet and foraging regions of eastern North Pacific killer whales. Mar Environ Res 63 : 91-114.

LeDuc RG, Robertson KM, Pitman RL (2008) Mitochondrial sequence divergence among Antarctic killer whale ecotypes is consistent with multiple species. Biol Lett 4: 426-429.

Luque PL, Davis CG, Reid DG, Wang J, Pierce GJ (2006) Opportunistic sightings of killer whales from Scottish pelagic trawlers fishing for mackerel and herring off North Scotland (UK) between 2000 and 2006. Aquat Living Resour 19: 403-410.

Lusseau D, Bain DE, Williams R, Smith JC (2008) Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*. Endang Species Res 6: 211-221.

Maniscalco JM, Matkin CO, Maldini D, Calkins DG, Atkinson S (2007) Assessing killer whale predation on Steller sea lions from field observations in Kenai fjords, Alaska. Mar Mamm Sci 23: 306-321.

Matkin CO, Barrett-Lennard LG, Yurk H, Ellifrit D, Trites AW (2007) Ecotypic variation and predatory behavior among killer whales (*Orcinus orca*) off the eastern Aleutian Islands, Alaska. Fish. Bull. 105: 74-87.

Matkin CO, Saulitis EL, Ellis GM, Olesiuk P, Rice SD (2008) Ongoing population-level impacts on killer whales *Orcinus orca* following the 'Exxon Valdez' oil spill in Prince William Sound, Alaska. Mar Ecol Prog Ser 356: 269-281.

Mehta AV, Allen JM, Constantine R, Garrigue C, Jann B, Jenner C, Marx MK, Matkin CO, Mattila DK, Minton G, Mizroch SA, Olavarria C, Robbins J, Russell KG, Seton RE, Steiger GH, Vikingsson GA, Wade PR, Witteveen BH, Clapham PJ (2007) Baleen whales are not important as prey for killer whales *Orcinus orca* in high-latitude regions. Mar Ecol Prog Ser 348: 297-307.

Miller LA, Simon M, Ugarte F, Wahlberg M (2006) Exploitation of sound during predator-prey interactions: killer whales and herring. J Acoust Soc Am 119:. 3372.

Morton AB, Symonds HK (2002) Displacement of *Orcinus orca* (L.) by high amplitude sound in British Columbia, Canada. ICES J Mar Sci 59: 71-80.

Mullin KD (2007) Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. NMFS, Southeast Fisheries Science Center, 26 pp.

Passadore C, Szephegyi M, Domingo A, Mora O (2007) The longline fleet as a source of information on the distribution of the killer whale (*Orcinus orca*) in the southwest Atlantic Ocean (2002-2006). Collect. Vol. Sci. Pap. ICCAT/Recl. Doc. Sci. CICTA/Colecc. Doc. Cient. CICAA. 60: 2118-2139

Pitman RL, Ensor P (2003) Three forms of killer whales in Antarctic waters. J Cetacean Res Manage 5: 131-139.

Pitman RL, Perryman WL, LeRoi D, Eilers E (2007) A dwarf form of killer whale in Antarctica. J Mammal 88: 43-48.

Poncelet E, Guinet C, Mangin S, Barbraud L (2002) Life history and decline of killer whales in the Crozet Archipelago, Southern Indian Ocean. Fourth International Orca Symposium and Workshops, September23-28 2002, CEBC-CNRS, France

Reeves RR, Smith BD, Crespo EA, Notarbartolo di Sciara G (2003) Dolphins, whales and porpoises: 2002-2010 Conservation Action Plan for the world's cetaceans. IUCN/SSC Cetacean Specialist Group, Gland, Switzerland and Cambridge, UK.

Renner M, Bell K (2008) A white killer whale in the central Aleutians Arctic 61: 102-104.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Reyes LM, Garcia-Borboroglu P (2004) Killer whale (*Orcinus orca*) predation on sharks in Patagonia, Argentina: a first report. Aquat. Mamm. 30: 376-379.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Pub 4, Lawrence, KS. USA.

Rosa LD, Secchi ER (2007) Killer Whale (*Orcinus orca*) Interactions with the tuna and swordfish longline fishery off southern and south-eastern Brazil: a comparison with shark interactions. J Mar Biol Assoc UK 87: 135-140

Ross PS, Ellis GM, Ikonomou MG, Barrett Lennard LG, Addison R (2000) High PCB concentrations in free-ranging pacific killer whales, *Orcinus orca*: effects of age, sex and dietary preference. Mar Poll Bull 40: 504-515.

Secchi ER, Vaske TJ (1998) Killer whale (*Orcinus orca*) sightings and depredation on tuna and swordfish longline catches in southern Brazil. Aquat Mamm 24: 117-122.

Similae T (2005) Interactions between herring fishery and killer whales in northern Norway. ICES Council Meeting Documents. Copenhagen 2005.

Similae T, Christensen I (1992) Seasonal distribution and abundance of killer whales around Lofoten and Vesteralen Islands, northern Norway. Copenhagen Denmark ICES 1992, 11 pp.

Similae T, Holst JC, Øien, N, Hanson MB (2002) Satellite tracking study of movements and diving behaviour of killer whales in the Norwegian Sea. Fourth International Orca Symposium and Workshops, September 23-28 2002, CEBC-CNRS, France.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Orcinus orca*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Visser IN (1999) Propeller scars on and known home range of two orcas (*Orcinus orca*) in New Zealand waters. N Z J Mar Freshw Res 33: 635-642.

Visser IN (2005) First observations of feeding on thresher (*Alopias vulpinus*) and hammerhead (*Sphyrna zygaena*) sharks by killer whales (*Orcinus orca*) specialising on elasmobranch prey. Aquat. Mamm. 31: 83-88

Williams AJ, Petersen SL, Goren M, Watkins BP (2009) Sightings of killer whales *Orcinus orca* from longline vessels in South African waters, and consideration of the regional conservation status. Afr J Mar Sci 31: 81-86.

Williams R, Bain DE, Ford JKB, Trites AW (2002) Behavioural responses of male killer whales to a 'leap-frogging' vessel. J Cetacean Res Manage 4: 305-310

Williams R, Lusseau D (2006) A killer whale social network is vulnerable to targeted removals. Biol Lett 2: 497-500.

Williams R, Thomas L (2007) Distribution and abundance of marine mammals in the coastal waters of British Columbia, Canada. J Cetacean Res Manag 9: 15-28.

Wolkers H, Corkeron PJ, Van Parijs SM, Similae T, Van Bavel B (2007) Accumulation and transfer of contaminants in killer whales (*Orcinus orca*) from Norway: indications for contaminant metabolism. Environ Toxicol Chem 26: 1582-1590.

Zerbini AN, Waite JM, Durban JW, LeDuc R, Dahlheim ME, Wade PR (2007) Estimating abundance of killer whales in the nearshore waters of the Gulf of Alaska and Aleutian Islands using line-transect sampling. Mar Biol 150: 1033-1045.

3.49. Peponocephala electra

Anderson RC (2005) Observations of cetaceans in the Maldives, 1990-2002. J Cetacean Res Manage 7: 119-135.

Barlow J (2006) Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Mar Mamm Sci 22: 446-464.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Clarke M, Young R (1998) Description and analysis of cephalopod beaks from stomachs of six species of odontocete cetaceans stranded on Hawaiian shores. J Mar Biol Assoc UK 78: 623-641.

Dolar ML (1999) Abundance, distribution and feeding ecology of small cetaceans in the Eastern Sulu Sea and Tañon Strait, Philippines. PhD thesis, U Cal San Diego, USA.

Dolar MLL, Leatherwood SJ, Wood CJ, Alava MNR, Hill CL (1994) Directed fisheries for cetaceans in the Philippines. Rep Int Whal Comm 44: 439-449.

Dolar MLL, Perrin WF, Taylor BL, Kooyman GL, Alava MNR (2006) Abundance and distributional ecology of cetaceans in the central Philippines. J Cetacean Res Manage 8:93-111.

Endo T, Hisamichi Y, Kimura O, Haraguchi K, Baker CS (2008) Contamination levels of mercury and cadmium in melon-headed whales (*Peponocephala electra*) from a mass stranding on the Japanese coast. Sci Total Environ 401: 73-80.

Gannier A (2000) Distribution of cetaceans off the Society Islands (French Polynesia) as obtained from dedicated surveys. Aquat Mamm 26: 111-126.

Gannier A (2002) Cetaceans of the Marquesas Islands (French Polynesia): distribution and relative abundance as obtained from a small boat dedicated survey. Aquat Mamm 28: 198-210.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Fertl D, Michael M, Fagin TD (2006) An unusual encounter with a mixed school of melon-headed whales (*Peponocephala electra*) and rough-toothed dolphins (*Steno bredanensis*) at Rota, Northern Mariana Islands. Micronesica 38: 239-244.

Kajiwara N, Kamikawa S, Amano M, Hayano A, Yamada TK, Miyazaki N, Tanabe S (2008) Polybrominated diphenyl ethers (PBDEs) and organochlorines in melon-headed whales, *Peponocephala electra*, mass stranded along the Japanese coasts: Maternal transfer and temporal trend. Environ Pollut 156: 106-114.

Kiszka J, Ersts PJ, Ridoux V (2007) Cetacean diversity around the Mozambique Channel Island of Mayotte (Comoros archipelago). J Cetacean Res Manage 9: 105-109.

Klima M (1994) *Peponocephala electra* - Melonenkopf oder Breitschnabeldelphin. In: Handbuch der Säugetiere Europas (Niethammer J, Krapp F, eds.) Band 6 Meeressäuger. Teil 1A: Wale und Delphine 1. Aula-Verlag, Wiesbaden, Germany, pp. 482-488.

Migura KA, Meadows DW (2002) Short-finned pilot whales (*Globicephala macrorhynchus*) interact with melon-headed whales (*Peponocephala electra*) in Hawaii. Aquat Mamm 28: 294-297.

Mullin KD (2007) Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. 26 pp. Available from: NMFS, Southeast Fisheries Science Center, P.O. Drawer 1207, Pascagoula, MS 39568.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Perryman WL (2009) Melon-headed whale - *Peponocephala electra*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, 719-721.

Perryman WL, Au DWK, Leatherwood S, Jefferson TA (1994) Melon-headed whale - *Peponocephala electra*. In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 363-386.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication 4, Lawrence, KS. USA.

Southall BL, Braun R, Gulland FM, Heard AD, Baird RW (2006) Hawaiian Melon-headed Whale (*Peponocephala electra*) mass stranding Event of July 3-4, 2004. NOAA Tech Memo NMFS OPR. no. 31, 78 pp.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Peponocephala electra*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>

Wade PR, Gerrodette T (1993) Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep Int Whal Comm 43: 477-493.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, editors (2008) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2008. NOAA Tech Memo NMFS NE 210; 440 p.

3.50. Phocoena dioptrica

Baker, AN (1999) Whales and dolphins of New Zealand and Australia: an Identification Guide. Victoria University Press, Wellington. 133 pp.

Bannister JL, Kemper CM, Warneke RM (1996) The Action Plan for Australian Cetaceans. Australian Nature Conservation Agency: Canberra vii 242 pp.

Brownell RL, Clapham PJ (1999) Spectacled porpoise - *Phocoena dioptrica* Lahille, 1912. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp.379-392.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Goodall RNP (2002) Spectacled porpoise - *Phocoena dioptrica*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 1158-1161.

Goodall RNP (2009) Spectacled porpoise - *Phocoena dioptrica*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 1087-1091.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Phocoena dioptrica*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Curry BE (1994) A global review of porpoise (Cetacea: Phocoenidae) mortality in gillnets. Biol Conserv 67: 167-183.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Kemper C, Hill M (2001) First records of the spectacled porpoise *Phocoena dioptrica* in continental australian waters. Mar Mamm Sci 17: 161-170.

Klinowska M (1991). Dolphins, Porpoises and Whales of the World: The IUCN Red Data Book. IUCN, Gland and Cambridge vii 429 pp.

Perrin WF, Goodall RNP, Cozzuol MA (2000) Osteological variation in the spectacled porpoise (*Phocoena dioptrica*). J Cetacean Res Manag 2: 211-215

Pinedo MC, Barreto AS, Lammardo MP, Andrade ALV, Geracitano L (2002) Northernmost records of the spectacled porpoise, Layard's beaked whale, Commerson's dolphin, and Peale's dolphin in the southwestern Atlantic Ocean. Aquat Mamm 28: 32-37

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Sekiguchi I, Olavarria C, Morse L, Olson P, Ensor P, Matsuoka K, Pitman R, Findlay K, Gorter U (2006) The spectacled porpoise (*Phocoena dioptrica*) in Antarctic waters. J Cet Res Man 8: 265-271.

Van Waerebeek K, Leaper R, Baker AN, Papastavrou V, Thiele D (2004) Odontocetes of the Southern Ocean Sanctuary. IWC Scientific Committee Document SC/56/SOS1. 25pp.

3.51. Phocoena phocoena

Andersen LW, Ruzzante DE, Walton M, Berggren P, Bjoerge A, Lockyer C (2001) Conservation genetics of harbour porpoises, *Phocoena phocoena*, in eastern and central North Atlantic. Conserv Genet 2: 309-324.

Angliss and Allen (2008a) Harbor porpoise (*Phocoena phocoena*): Bering Sea Stock. NOAA-TM-AFSC-193.

Angliss and Allen (2008b) Harbor porpoise (*Phocoena phocoena*): Gulf of Alaska Stock. NOAA-TM-AFSC-193.

Angliss and Allen (2008c) Harbor porpoise (*Phocoena phocoena*): Southeast Alaska Stock. NOAA-TM-AFSC-193.

ASCOBANS (2000) Report of the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) Baltic Discussion Group (ABDG), January 2001, Charlottenlund, Denmark.

Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Anim Conserv 9: 474-482.

Benjamins S, Lawson J, Stenson G (2007) Recent harbour porpoise bycatch in gillnet fisheries in Newfoundland and Labrador, Canada. J Cetacean Res Manag 9: 189-199.

Berggren P, Wade PR, Carlstroem J, Read AJ (2002) Potential limits to anthropogenic mortality for harbour porpoises in the Baltic region. Biol Cons 103: 313-322.

Birkun JrAA, Frantzis A (2008) *Phocoena phocoena* ssp. *relicta*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Birkun JrA, Glazov D, Krivokhizhin S, Mukhametov L (2002) Distribution and abundance of cetaceans in the Sea of Azov and Kerch Strait: Results of aerial survey (July 2001). P.73. 16th Annual Conference of the European Cetacean Society: 86 pp. (Liege, 7-11 April 2002).

Birkun JrA, Krivokhizhin S, Komakhidze A, Mukhametov L, Shpak O, Goradze I, Komakhidze G, Kryukova A (2006) Wintering concentrations of Black Sea cetaceans off the Crimean and Caucasian coasts. 20th Annual Conference of the European Cetacean Society. (Gdynia, 2-7 April 2006)

Birkun JrAA, Krivokhizhin SV, Glazov DM, Shpak OV, Zanin AV, Mukhametov LM (2004) Abundance estimates of cetaceans in coastal waters of the northern Black Sea: Results of boat surveys in August-October 2003. Marine Mammals of the Holarctic: Collection of Scientific Papers after the 3rd International Conference: Pp. 64-68. (Koktebel, Ukraine, 11-17 October 2004).

Bjorge A, Tolley KA (2009) Harbour porpoise - *Phocoena phocoena*. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 530-533.

Boerjesson P, Berggren P, Ganning B (2003) Diet of harbor porpoises in the Kattegat and Skagerrak seas: Accounting for individual variation and sample size. Mar Mamm Sci 19: 38-58.

Carretta JV, Forney KA (2004) Preliminary estimates of harbor porpoise abundance in California from 1999 and 2002 aerial surveys. SWFSC Administrative Report LJ-04-01, 13pp.

Carretta JV, Forney KA, Lowry MS, Barlow J, Baker J, Johnston D, Hanson, Muto MM, Lynch D, Carswell L (2009) U.S. Pacific Marine Mammal Stock Assessments: 2008. NOAA-TM-NMFS-SWFSC-434.

Carretta JV, Taylor BL, Chivers SJ (2001) Abundance and depth distribution of harbor porpoise (*Phocoena phocoena*) in northern California determined from a 1995 ship survey. Fish Bull 99: 29-39.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Christensen JT, Richardson K (2008) Stable isotope evidence of long-term changes in the North Sea food web structure. Mar Ecol Prog Ser 368: 1-8.

Culik BM, Koschinski S, Tregenza N, Ellis G (2001) Reactions of harbour porpoises (*Phocoena phocoena*) and herring (*Clupea harengus*) to acoustic alarms. Mar Ecol Prog Ser 211: 255-260.

Eskesen I, Amundin M, Desportes G, Rosager L, Larsen F, Hansen JR, Jepsen T, Bulholzer L (2003) Enticing sounds: a possibility for alerting porpoises instead of deterring them? Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Evans P, Andersen L, Bjørge A, Fontaine M, Galatius A, Kinze CC, Lockyer C, De Luna C, Pierce G, Sveegaard S, Teilmann J, Tiedemann R, Walton M (2009) Harbour Porpoise *Phocoena phocoena*. In: Report of the ASCOBANS / HELCOM small cetacean population structure workshop (Eds. Evand PGH, Teimann J). ASCOBANS Bonn, Germany.

Ferreira M, Sequeira M, Vingada J, Eira C (2003) Cetacean bycatches in coastal fisheries off northern Portugal. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Gaskin D E, Yamamoto S, Kawamura A (1993) Harbor porpoise, *Phocoena phocoena* (L.), in the coastal waters of northern Japan. U-S Fish Bull 91: 440-454.

Gillespie D, Brown S, Lewis T, Matthews J, Mclanaghan R, Moscrop A (2003) Relative abundance of harbour porpoises (*Phocoena phocoena*) in the Baltic from acoustic and visual surveys. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Gol'din PE (2004) Growth and body size of the harbour porpoise, *Phocoena phocoena* (Cetacea, Phocoenidae), in the Sea of Azov and the Black Sea. Vestn. Zool. 38: 59-73.

Goodwin L (2008) Diurnal and Tidal Variations in Habitat Use of the Harbour Porpoise (*Phocoena phocoena*) in Southwest Britain. Aquat Mamm 34: 44-53.

Haelters, J and Camphuysen, C, (2008) The harbour porpoise in the southern North Sea: abundance, threats and research- and management proposals. International Fund for Animal Welfare, EU Office, Brussels. 56pp.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008a) *Phocoena phocoena*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008b) *Phocoena phocoena* (Baltic Sea subpopulation). In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2.

Hammond PS, Berggren P, Benke H, Borchers DL, Collet A, Heide-Jorgensen MP, Heimlich S, Hiby AR, Leopold MF Oien N (2002) Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. J Appl Ecol 39: 361-376.

Herr H, Gilles A, Scheidat M, Siebert U (2005) Distribution of harbour porpoise (*Phocoena phocoena*) in the German North Sea in relation to density of sea traffic. ASCOBANS information document. AC12/Doc. 8. ASCOBANS. Bonn. 6 pp.

Herr H, Siebert U, Benke H (2009) Stranding numbers and bycatch implications of harbour porpoises along the German Baltic Sea coast. 16th ASCOBANS Advisory Committee Meeting, Brugge, Belgium, 20-24 April 2009. Document AC16/Doc.62 (P). ASCOBANS. Bonn, Germany. 3 pp.

IWC (1992) Report of the Sub-Committee on Small Cetaceans. Report Of The International Whaling Commission 42: 178-234.

IWC (2004) Annex L. Report of the Sub-committee on Small Cetaceans. Journal of Cetacean Research and Management 6(Suppl.): 315-334.

IWC (2009) Germany, Progress report on cetacean research. IWC/SC61/ProgRep Germany, 14pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Joergensen M (2007) First Photographed Observation of the Harbour Porpoise (*Phocoena phocoena*) in Svalbard. Polar Rec. 43: 73-74.

Johnston DW, Westgate AJ, Read AJ (2005) Effects of fine-scale oceanographic features on the distribution and movements of harbour porpoises *Phocoena phocoena*in the Bay of Fundy. Mar Ecol Prog Ser 295: 279-293.

Kilian A, Verfuss U, Ludwig S, Siebert U, Benke H (2003) Investigating the habitat use of harbour por-poises in German waters unsing porpoise detectors (PODS). Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Kindt-Larsen L (2008) Can alerting sounds reduce bycatch of harbour porpoise? Master Thesis in biology, U. of Copenhagen, DTU Aqua, 81 pp.

Kinze CC (1995) Danish whale records 1575-1991 (Mammalia, Cetacea). Review of whale specimens stranded, directly or incidentally caught along the Danish coasts. Steenstrupia 21: 155-196.

Koschinski S (2002) Current knowledge on harbour porpoises *Phocoena phocoena* in the Baltic Sea. Ophelia 55: 167-197.

Koschinski S, Culik BM, Henriksen OD, Tregenza N, Ellis G, Jansen C, Kathe G (2003) Behavioural reactions of free-ranging porpoises and seals to the noise of a simulated 2 MW windpower generator. Mar Ecol Prog Ser 265: 263-273.

Koschinski S, Culik BM, Trippel EA, Ginzkey L (2006) Behavioral reactions of free-ranging harbor porpoises *Phocoena phocoena* encountering standard nylon and BaSO4 mesh gillnets and warning sound. Mar Ecol Prog Ser 313: 285-294

Koschinski S, Pfander A (2009) By-catch of harbour porpoises (*Phocoena phocoena*) in the Baltic coastal waters of Angeln and Schwansen (Schleswig-Holstein, Germany). 16th ASCOBANS Advisory Committee Meeting, Brugge, Belgium, 20-24 April 2009. Document AC16/Doc.60 (P). ASCOBANS. Bonn, Germany. 5 pp.

Krivokhizhin S, Birkun JrA, Shpak O, Mukhametov L (2007) "Offshore" harbour porpoises in the central Black Sea. 20th Annual Conference of the European Cetacean Society. Gdynia, 2-7 April 2006.

Kuklik I, Skóra KE (2003) Harbour porpoise bycatch in Poland. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Laczny M, Piper W (2006) A recovery of harbour porpoises (*Phocoena phocoena*) in the southern North Sea? A case study off Eastern Frisia, Germany. Helgol Mar Res 60: 189-195.

Larsen F, Eigaard OR, Tougaard J (2007) Reduction of harbour porpoise (*Phocoena phocoena*) bycatch by iron-oxide gillnets. Fish. Res. 85: 270-278.

Lesage V, Keays J, Turgeon S, Hurtubise S (2006) Bycatch of harbour porpoises (*Phocoena phocoena*) in gillnet fisheries of the Estuary and Gulf of St Lawrence, Canada, 2000-02. J Cetacean Res Manag 8: 67-78.

Lucke K, Lepper PA, Blanchet M-A, Siebert U (2008) Testing the acoustic tolerance of harbour porpoise hearing for impulsive sounds. Bioacoustics 17: 329-330.

MacLeod CD, Santos MB, Reid RJ, Scott BE, Pierce GJ (2007) Linking sandeel consumption and the likelihood of starvation in harbour porpoises in the Scottish North Sea: could climate change mean more starving porpoises? Biol Lett 3: 185-188.

Manly BFJ (2007) Incidental Take and Interactions of Marine Mammals and Birds in the Kodiak Island Salmon Set Gillnet Fishery, 2002 and 2005. Final report to NMFS Alaska Region. 221 pp.

Mooney TA, Nachtigall PE, Au WWL (2004) Target Strength of a Nylon Monofilament and an Acoustically Enhanced Gillnet: Predictions of Biosonar Detection Ranges. Aquat Mamm 30: 220-226.

NAMMCO (2005) Annual Report 2005. North Atlantic Marine Mammal Commission, Tromsø, Norway.

NAMMCO (2009) Annual Report 2007 - 2008. North Atlantic Marine Mammal Commission, Tromsø, Norway, 399 pp.

Neimans AS, Koopman HN, Westgate AJ, Murison LD, Read AJ (2004) Entrapment of harbour porpoises (*Phocoena phocoena*) in herring weirs in the Bay of Fundy, Canada. J Cetacean Res Manag 6: 7-17.

Osinga N, 't Hart P, Morick D (2008) By-catch and drowning in harbour porpoises (*Phocoena phocoena*) stranded on the northern Dutch coast Eur J Wildl Res 54: 667-674.

Pierce GJ, Santos MB, Murphy S, Learmonth JA, Zuur AF, Rogan E, Bustamante P, Caurant F, Lahaye V, Ridoux V, Zegers BN, Mets A, Addink M, Smeenk C, Jauniaux T, Law RJ, Dabin W, Lopez A, Alonso Farre JM, Gonzalez AF, Guerra A, Garcia-Hartmann M, Reid RJ, Moffat CF, Lockyer C, Boon JP (2008) Bioaccumulation of persistent organic pollutants in female common dolphins (*Delphinus delphis*) and harbour porpoises (*Phocoena phocoena*) from western European seas: Geographical trends, causal factors and effects on reproduction and mortality. Environ Pollut 153: 401-415.

Read AJ (1999) Harbour porpoise - *Phocoena phocoena* (Linnaeus, 1758). In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 323-356.

Read AJ, Westgate AJ (1997) Monitoring the movements of harbour porpoises (*Phocoena phocoena*) with satellite telemetry. Mar Biol 130: 315-322.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Rosel PE, Frantzis A, Lockyer C, Komnenou A (2003) Source of Aegean Sea harbour porpoises. Mar Ecol Prog Ser 247: 257-261.

Rosel PE, Tiedemann R, Walton M (1999) Genetic evidence for limited trans-Atlantic movements of the harbor porpoise *Phocoena phocoena*. Mar Biol 133: 583-591.

Santos MB, Pierce GJ, Gibson RN, Atkinson RJA (2003) The diet of harbour porpoise (*Phocoena phocoena*) in the northeast Atlantic. Oceanogr. Mar. Biol. Annu Rev 41: 355-390.

Santos MB, Pierce GJ, Ieno EN, Addink M, Smeenk C, Kinze CC (2005) Harbour porpoise (*Phocoena phocoena*) feeding ecology in the eastern North Sea. Theme Session on Marine Mammals: Monitoring Techniques, Abundance Estimation, and Interactions with Fisheries (R). ICES Council Meeting documents [ICES Council Meeting Documents. Copenhagen]. no. 2005.

Santos MB, Pierce GJ, Learmonth JA, Reid RJ, Ross HM, Patterson IAP, Reid DG, Beare D (2004) Variability in the diet of harbor porpoises (*Phocoena phocoena*) in Scottish waters 1992-2003. Mar Mamm Sci 20: 1-27.

Scheidat M, Kock K.-H., Siebert U (2003) summer distribution of harbour porpoise (*Phocoena phocoena*) in the German North and Baltic Sea. Working paper presented at the 2003 ASCOBANS meeting.

Scheidat M, Gilles A, Kock K.-H., Siebert U (2008) Harbour porpoise *Phocoena phocoena* abundance in the southwestern Baltic Sea. Endang Species Res 5: 215-233.

Siebert U, Gilles A, Lucke K, Ludwig M, Benke H, Kock K-H, Scheidat M (2006) A decade of harbour porpoise occurrence in German waters: analyses of aerial surveys, incidental sightings and strandings. J Sea Res 56: 65-80.

Skov H, Thomsen F (2008) Resolving fine-scale spatio-temporal dynamics in the harbour porpoise *Phocoena phocoena*. Mar Ecol Prog Ser 373: 173-186.

Southall BL, Bowles AE, Ellison WT, Finneran JJ, Gentry RL, Greene CRJr, Kastak D, Ketten DR, Miller JH, Nachtigall PE, Richardson WJ, Thomas JA, Tyack PL (2008) Marine mammal noise exposure criteria: Initial scientific recommendations. Aquat. Mamm. 33 (4): 1-521.

Strand J, Jacobsen JA (2005) Accumulation and trophic transfer of organotins in a marine food web from the Danish coastal waters. Sci Total Environ 350: 72-85.

Taylor BL, Chivers SJ, Larese J, Perrin W (2007) Generation Length and Percent Mature Estimates for IUCN Assessments of Cetaceans. Administrative report LJ-07-01.

Teilmann J, Dietz R (1998) Status of the harbour porpoise in Greenland. Polar Biol 19: 211-220.

Teilmann J, Dietz R, Larsen F, Desportes G, Geertsen B (2003) Seasonal migrations and population structure of harbour porpoises (*Phocoena phocoena*) in the North Sea and inner Danish waters based on satellite telemetry. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Teilmann J, Sveegaard S, Dietz R, Petersen IK, Berggren P, Desportes G (2008) High density areas for harbour porpoises in Danish waters. NERI Technical Report. 657. National Environmental Research Institute, University of Aarhus. Aarhus, Denmark. 84 pp.

Teilmann J, Larsen F, Desportes G (2007) Time allocation and diving behaviour of harbour porpoises (*Phocoena phocoena*) in Danish and adjacent waters. J. Cetacean Res Manag 9: 201-210.

Trippel EA, Strong MB, Terhune JM, Conway JD (1999) Mitigation of harbour porpoise (*Phocoena phocoena*) by-catch in the gillnet fishery in the lower Bay of Fundy. Can J Fish Aquat Sci 56: 113-123.

Van de Vijver KI, Holsbeek L, Das K, Blust R, Joiris C, De Coen Wim (2007) Occurrence of Perfluorooctane Sulfonate and Other Perfluorinated Alkylated Substances in Harbor Porpoises from the Black Sea. Environ Sci Technol 41: 315-320.

Van Waerebeek K, Ndiaye E, Djiba A, Diallo M, Murphy P, Jallow A, Camara A, Ndiaye P and Tous P (2000) A survey of the conservation status of cetaceans in Senegal, The Gambia and Guinea-Bissau. WAFCET-1 Report. CMS/UNEP Secretariat, Bonn, Germany. 80 pp.

Verfuss UK, Honnef CG, Meding A, Daehne M, Mundry R, Benke H (2007) Geographical and Seasonal Variation of Harbour Porpoise (*Phocoena phocoena*) Presence in the German Baltic Sea Revealed By Passive Acoustic Monitoring. J Mar Biol Assoc UK 87: 165-176.

Viaud-Martinez KA, Vergara MM, Gol'din PE, Ridoux V, Oeztuerk AA, Oeztuerk B, Rosel PE, Frantzis A, Komnenou A, Bohonak AJ (2007) Morphological and genetic differentiation of the Black Sea harbour porpoise *Phocoena phocoena*. Mar. Ecol. Prog. Ser.]. Vol. 338: 281-294.

Vinther M, Larsen F (2004) Updated estimates of harbour porpoise (*Phocoena phocoena*) bycatch in the Danish North Sea bottom-set gillnet fishery. J Cetacean Res Manag 6: 19-24.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, Eds. (2009) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Webster WD, Goley PD, Pustis J, Gouveia JF (1995) Seasonality in Cetacean strandings along the coast of North Carolina. Brimleyana 23: 41-51.

Weir CR, Stockin KA, Pierce GJ (2007) Spatial and Temporal Trends in the Distribution of Harbour Porpoises, White- Beaked Dolphins and Minke Whales Off Aberdeenshire (Uk), North-Western North Sea. J Mar Biol Assoc UK 87: 327-338.

Westgate AJ, Read AJ, Berggren P, Koopman HN, Gaskin DE (1995) Diving behaviour of harbour porpoises, *Phocoena phocoena*. Can J Fish Aquat Sci 52: 1064-1073

Williams R, Thomas L (2007) Distribution and abundance of marine mammals in the coastal waters of British Columbia, Canada. J Cetacean Res Manag 9: 15-28.

Willis PM, Crespi BJ, Dill LM, Baird RW, Hanson MB (2004) Natural hybridization between Dall's porpoises (*Phocoenoides dalli*) and harbour porpoises (*Phocoena phocoena*) Can J Zool 82: 828-834.

Winship AJ (2009) Estimating the impact of bycatch and calculating bycatch limits to achieve conservation objectives as applied to harbour porpoise in the North Sea. PhD Thesis, University of St Andrews. 262 pp.

3.52. Phocoena sinus

Brownell RL Jr. (1986) Distribution of the vaquita, *Phocoena sinus*, in Mexican waters. Mar Mamm Sci 2 : 299-305.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Culik BM, Koschinski S, Tregenza N, Ellis G (2001) Reactions of harbour porpoises (*Phocoena phocoena*) and herring (*Clupea harengus*) to acoustic alarms. Mar Ecol Prog Ser 211: 255-260.

D'Agrosa C, Lennert-Cody EC, Vidal O (2000) Vaquita Bycatch in Mexico's Artisanal Gillnet Fisheries: Driving a Small Population to Extinction. Cons Biol 14: 1110-1119.

Hohn AA, Read AJ, Fernandez S, Vidal O, Findley LT (1996) Life history of the vaquita (*Phocoena sinus*) J Zool Lond 239: 235-251.

IWC (2008) International Whaling Commission: Scientific Committee Report. Santiago, Chile, 1 - 13 June 2008. 80 pp.

Jaramillo Legorreta AM, Rojas Bracho L, Gerrodette T (1999) A new abundance estimate for vaquitas: First step for recovery. Mar Mamm Sci 15: 957-973.

Jaramillo Legorreta AM, Rojas Bracho L, Urban J (2005) A review of acoustic surveys and conservation actions for the vaquita. IWC Scientific Committee meeting document SC/57/ SM 10.

Jaramillo-Legorreta A, Rojas-Bracho L, Brownell Jr RL, Read AJ, Reeves RR, Ralls K, Taylor BL (2007) Saving the Vaquita: Immediate Action, Not More Data. Conservation Biology 21:1653-5.

Jefferson TA, Olson PA, Kieckhefer TR, Rojas-Bracho L (2009) Photo-identification of the vaquita (*Phocoena sinus*): the worlds most endangered cetacean. LAJAM 7: 53-56.

Munguia-Vega A, Esquer-Garrigos Y, Rojas-Bracho L, Vazquez-Juarez R, Castro-Prieto A, Flores-Ramirez S (2007) Genetic drift vs. natural selection in a long-term small isolated population: major histocompatibility complex class II variation in the Gulf of California endemic porpoise (*Phocoena sinus*). Mol Ecol 16: 4051-4065.

Platt J (2009) Last chance to save the vaquita porpoise from extinction? Scientific American Nov 6.

Rojas-Bracho L, Jaramillo Legorreta AM (2002) Vaquita - *Phocoena sinus*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 1277-1280.

Rojas-Bracho L, Jaramillo Legorreta AM (2009) Vaquita - *Phocoena sinus*. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 1196-1200.

Rojas-Bracho L, Reeves RR, Jaramillo-Legorreta A (2006) Conservation of the vaquita *Phocoena sinus*. Mamm Rev 36:179-216.

Rojas-Bracho L, Reeves RR, Jaramillo-Legorreta A, Taylor BL (2008) *Phocoena sinus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Rojas-Bracho L, Taylor BL (1999) Risk factors affecting the vaquita (*Phocoena sinus*). Mar Mamm Sci 15:974-989.

Rosel PE, Reeves RR (2000) Genetic and demographic considerations for the conservation of Asian river cetaceans. Biology and conservation of freshwater cetaceans in Asia. Vol. 23, pp. 144-152. [Occas. Pap. IUCN Species Survival Comm.].

Silber GK (1990) Occurrence and distribution of the vaquita *Phocoena sinus* in the northern Gulf of California (Mexico). Fish Bull 88: 339-346.

Silber GK, Norris KS (1991) Geographic and seasonal distribution of the vaquita,*Phocoena sinus*. An Inst Biol, Univ Nac Auton Mex, Ser Zool 62: 263-268.

Vidal O (1995) Population biology and incidental mortality of the Vaquita, *Phocoena sinus*. Report of the International Whaling Commission 16: 247-272.

Vidal O, Brownell RL, Findley LT (1999) Vaquita - *Phocoena sinus* Norris and McFarland, 1958. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 357-378.

WWF (2009) Small cetaceans, the forgotten whales. (Elliott W, Sohl H, Bugener V). Whaling Report Indd 34.

3.53. Phocoena spinipinnis

Brownell RL, Clapham PJ (1999) Burmeister's porpoise - *Phocoena spinipinnis* Burmeister, 1865. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 393-410.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Crespo EA, Dans SL, Koen Alonso M, Pedraza SN (2007) Interactions between marine mammals and fisheries. In: "The Argentine Sea and its fisheries resources. Vol. 5. The marine Ecosystem" pp. 151-169.

García-Godos I, Van Waerebeek K, Reyes JC, Alfaro-Shigueto J, Arias-Schreiber M (2007) Prey occurrence in the stomach contents of four small cetacean species in Peru. The Latin American Journal of Aquatic Mammals 6(2).

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Phocoena spinipinnis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Curry BE (1994) A global review of porpoise (Cetacea: Phocoenidae) mortality in gillnets. Biol Conserv 67: 167-183.

Majluf P, Babcock EA, Riveros JC, Schreiber MA, Alderete W (2002) Catch and Bycatch of Sea Birds and Marine Mammals in the Small-Scale Fishery of Punta San Juan, Peru. Conserv Biol 16: 1333-1343.

Reyes JC, Van Waerebeek K (1995) Aspects of the Biology of Burmeister's porpoise from Peru. Reports of the International Whaling Commission (Special Issue 16): 349-364.

Reyes JC (2002) Burmeister's porpoise. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 177-179.

Reyes JC (2009) Burmeister's porpoise - *Phocoena spinipinnis*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 163-167.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Rosa S, Milinkovitch M, Van Waerebeek K, Berck J, Oporto J, Alfaro-Sigueto J, Van Bressem M, Goodall N, Cassens I (2005) Population structure of nuclear and mitochondrial DNA variation among South American Burmeister's porpoises (*Phocoena spinipinnis*). Cons Genet 6: 431-443.

Van Waerebeek, K and Reyes, JC (1994) Post-ban small cetacean takes off Peru: a review. Reports of the International Whaling Commission (Special Issue 15): 503-520.

Van Waerebeek K, Van Bressem M F, Felix F, Alfaro Shigueto J, Garcia Godos A, Chavez Lisambart L, Onton K, Montes D, Bello R (1997) Mortality of dolphins and porpoises in coastal fisheries off Peru and southern Ecuador in 1994. Biol Cons 81: 43-49.

Van Waerebeek K, Santillán L, Reyes JC (2002) An unusually large aggregation of Burmeister's porpoise *Phocoena spnipinnis* off Peru, with a review of sightings from the eastern South Pacific. Noticiario Mensual 350: 12-17.

3.54. Phocoenoides dalli

Amano M, Hayano A (2007) Intermingling of dalli type dall's porpoises into a wintering truei-Type population off Japan: Implications from color patterns. Mar Mamm Sci 23: 1-14.

Amano M, Kuramochi T (1998) Diurnal feeding by Dall's porpoise, *Phocoenoides dalli*. Mar Mamm Sci 14: 130-135.

Angliss RP, Outlaw RB (2005) Alaska marine mammal stock assessments. NOAA Technical Memorandum NMFS-AFSC.

Barlow J, Forney KA (2007) Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105:509-526.

Carretta JV, Forney KA, Lowry MS, Barlow J, Baker J, Johnston D, Hanson B, Muto MM, Lynch D, Carswell L (2009) U.S. Pacific Marine Mammal Stock Assessments: 2008. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-434. 340p.

Carretta JV, Lowry MS, Stinchcomb CE, Lynn MS, Cosgrove R (2000) Distribution and abundance of marine mammals at San Clemente Island and surrounding waters: results from aerial and ground surveys in 1998 and 1999. Admin Rep Southwest Fish Sci Cent 2, 44 pp.

Carretta JV, Price T, Petersen D, Read R (2004) Estimates of Marine Mammal, Sea Turtle, and Seabird Mortality in the California Drift Gillnet Fishery for Swordfish and Thresher Shark, 1996-2002. Mar Fish Rev 66: 21-30.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Escorza-Treviño S, Dizon AE (2000) Phylogeography, intraspecific structure and sex-biased dispersal of Dall's porpoise, *Phocoenoides dalli* revealed by mitochondrial and microsatellite DNA analysis. Mol Ecol 9: 1049-1060.

Ferrero RC (1998) Life History and Multivariate Analyses of Habitat Selection Patterns Among Small Cetaceans in the Central North Pacific Ocean. Dissertation Abstracts International Part B: Science and Engineering 59 (3).

Forney KA (2007) Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-406. 27 p.

Forney KA, Barlow J (1998) Seasonal patterns in the abundance and distribution of California cetaceans, 1991-1992. Mar Mamm Sci 14: 460-489.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Phocoenoides dalli*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hayano A, Amano M, Miyazaki N (2003) Phylogeography and population structure of the Dall's porpoise, *Phocoenoides dalli*, in Japanese waters revealed by mitochondrial DNA. Genes & Genetic Systems 78: 81-91.

Houck WJ, Jefferson TA (1999) Dall's porpoise - *Phocoenoides dalli* (True, 1885). In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises. pp. 443-472.

IWC (1998) International Whaling Commission: Report of the scientific committee. Rep Int Whaling Comm 48: 53-302.

IWC (2000) International Whaling Commission: Report of the sub-committee on the revised management procedure. J Cetacean Res Manage 2 (Supplement), 79-124.

IWC (2002) International Whaling Commission: Report of the Standing Sub-Committee on Small Cetaceans. J Cetacean Res Manage 4: 325-338.

IWC (2008) International Whaling Commission: Report of the scientific committee. Rep Int Whaling Comm 60/Rep 1: p. 60.

Jarman WM, Norstrom RJ, Muir DCG, Rosenberg B, Simon M, Baird RW (1996) Levels of organochlorine compounds, including PCDDS and PCDFS, in the blubber of cetaceans from the west coast of North America. Mar Pollut Bull 32: 426-436.

Jefferson TA (2009) Dall's porpoise - *Phocoenoides dalli*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 296-298.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Kajiwara N, Watanabe M, Tanabe S, Nakamatsu K, Amano M, Miyazaki N (2002) Specific accumulation and temporal trends of organochlorine contaminants in Dall's porpoises (*Phocoenoides dalli*) from Japanese coastal waters. Mar Pollut Bull 44: 1089-1099.

Mcmillan WO, Bermingham E (1996) The phylogeographic pattern of mitochondrial DNA variation in the Dall's porpoise *Phocoenoides dalli*. Mol Ecol 5: 47-61.

Ohizumi H, Kuramochi T, Amona M, Miyazaki N (2000) Prey switching of Dall's porpoise *Phocoenoides dalli* with population decline of Japanese pilchard *Sardinops melanostictus* around Hokkaido, Japan. Mar Ecol Prog Ser 200: 265-275.

Ohizumi H, Watanabe H (2004) Stomach contents of toothed whales in relation to prey distribution in the North Pacific. PICES 13th Annual Meeting Book of Abstracts. p. 51.

Ohizumi H, Kuramochi T, Kubodera T, Yoshioka M, Miyazaki N (2003) Feeding habits of Dall's porpoises (*Phocoenoides dalli*) in the subarctic North Pacific and the Bering Sea basin and the impact of predation on mesopelagic micronekton. Deep Sea Res (I Oceanogr. Res. Pap.) 50: 593-610.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA

Walker WA (1996) Summer feeding habits of Dall's porpoise, *Phocoenoides dalli*, in the southern Sea of Okhotsk. Mar Mamm Sci 12: 167-181.

Williams R, Hall A, Winship A (2008) Potential limits to anthropogenic mortality of small cetaceans in coastal waters of British Columbia. Can J Fish Aquat Sci 65: 1867-1878.

Williams R, Thomas L (2007) Distribution and abundance of marine mammals in the coastal waters of British Columbia, Canada. J Cetacean Res Manag 9: 15-28.

Willis PM, Crespi BJ, Dill LM, Baird RW, Hanson MB (2004) Natural hybridization between Dall's porpoises (*Phocoenoides dalli*) and harbour porpoises (*Phocoena phocoena*). Can J Zool 82: 828-834.

WWF (2009) Small cetaceans, the forgotten whales. (Elliott W, Sohl H, Bugener V). Whaling Report Indd 34.

Yang J, Harino H, Miyazaki N (2007) Transplacental transfer of phenyltins from a pregnant Dall's porpoise (*Phocoenoides dalli*) to her fetus. Chemosphere 67: 244-249.

Yang J, Miyazaki N, Kunito T, Tanabe S (2006) Trace elements and butyltins in a Dall's porpoise (*Phocoenoides dalli*) from the Sanriku coast of Japan. Chemosphere 63: 449-457.

3.55. Physeter macrocephalus

André M, Terada M, Watanabe Y (1997) Sperm whale (*Physeter macrocephalus*) behavioural response after the playback of artificial sounds. Rep Int Whal Comm 47:499-504.

Angliss RP, Allen BM (2008) Sperm whale (*Physeter macrocephalus*): North Pacific Stock NOAA-TM-AFSC-193.

Ashford JR, Rubilar PS, Martin AR (1996) Interactions between cetaceans and longline fishery operations around South Georgia. Mar Mamm Sci 12:452-457.

Barlow J (2003) Cetacean abundance in Hawaiian waters during summer/fall 2002. Admin Rep LJ-03-13. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA.

Barlow J, Forney KA (2007) Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105:509-526.

Barlow J, Taylor BL (1998) Preliminary abundance of sperm whales in the northeastern temperate Pacific estimated from a combined visual and acoustic survey. Paper SC/50/CAWS20 presented to the International Whaling Commission, June 1998 (unpublished).

Best PB (1979) Social organization in sperm whales, *Physeter macrocephalus*. pp. 227-289 in H.E. Winn and B.L. Olla (eds.), Behaviour of marine animals, Vol. 3. Plenum, New York.

Best PB, Canham PAS, MacLeod N (1984) Patterns of reproduction in sperm whales, *Physeter macrocepahlus*. Rep. Int. Whal. Comm Spec Iss 6:51-79.

Biggs PB, Jochens AE, Howard NK, Di Marco SF, Mullin KD, Leben RF, Muller-Karger FE, Hu C (2005) Eddy forced variations in on- and off-Margin summertime circulation along the 1000-m isobath of the northern Gulf of Mexico, 2000-2003, and links with sperm whale distributions around the middle slope. Circulation in the Gulf of Mexico: Observations and Models. Geophys Mon Ser 161: 71-85.

Bouquegneau JM, Debacker V, Govert S, Nellissen JP (1997) Toxicological investigations on four sperm whales stranded on the Belgian coast: inorganic contaminants. Bul Inst Roy Sci Nat Belgique, Biologie 67-Suppl.: 75-78.

Carretta JV, Forney KA, Lowry MS, Barlow J, Baker J, Johnston D, Hanson, Muto MM, Lynch D, Carswell L (2009) U.S. Pacific Marine Mammal Stock Assessments: 2008. NOAA-TM-NMFS-SWFSC-434.

CETAP (1982) A characterization of marine mammals and turtles in the mid- and North-Atlantic areas of the US Outer Continental Shelf, Final Report. Bureau of Land Management, Washington, DC. (Ref. AA551-CT8-48).

Christal J, Whitehead H (1997) Aggregations of mature male sperm whales on the Galapagos Islands breeding ground. Mar Mamm Sci 13:59-69.

Christensen I, Haug T, Øien N (1992) Seasonal distribution, exploitation and present abundance of stocks of large baleen whales (Mysticeti) and sperm whales (*Physeter macrocephalus*) in Norwegian and adjacent waters. ICES J Mar Sci 49:341-355.

Clapham PJ, Berggren P, Childerhouse S, Friday NA, Kasuya T, Kell L, Kock K-H, Manzanilla-Naim S, Notarbartolo di Sciara G, Perrin WF, Read AJ, Reeves RR, Rogan E, Rojas-Bracho L, Smith TD, Stachowitsch M, Taylor BL, Thiele D, Wade PR, Brownell JrRL (2003) Whaling as science. Bioscience 53: 210-211.

Clarke MR (1976) Observation on sperm whale diving. J Mar Biol Assoc UK 56: 809-810.

Clarke MR, Martins HR, Pascoe P (1993) The diet of sperm whales (*Physeter macrocephalus* Linnaeus 1758) off the Azores. Phil Trans R Soc Lond B 339: 67-82.

Davis RW, Evans WE, Würsig B (2000) Cetaceans, sea turtles and seabirds in the Northern Gulf of Mexico: distribution, abundance and habitat associations. OCS Study MMS 2000-03, US Dept of the Interior, Geological Survey, Biological Resources Division and Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA.

Davis RW, Fargion GS, May N, Leming TD, Baumgartner, Evans WE, Hansen LJ, Mullin AK (1998) Physical habitat of cetaceans along the continental slope in the northcentral and western Gulf of Mexico. Mar Mamm Sci 14:490-507.

Drouot V (2003) Ecology of sperm whales (*Physeter macrocephalus*) in the Mediterranean Sea. PhD Thesis, University of Wales, Bangor.

Engelhaupt DT (2004) Phylogeography, kinship and molecular ecology of sperm whales (*Physeter macrocephalus*). PhD Thesis, University of Durham.

Engelhaupt D, Hoelzel AR, Nicholson C, Fratzis A, Mesnick S, Gero S, Whitehead H, Rendell L, Miller P, De Stefanis R, Canadas A, Airoldi S, Mignucci-Giannoni AA (2009) Female philopatry in coastal basins and male dispersion across the North Atlantic in a highly mobile marine species, the sperm whale (*Physeter macrocephalus*). Molecular Ecology 18: 4193-4205.

Evans K, Thresher R, Warneke RM, Bradshaw CJA, Pook M, Thiele D, Hindell MA (2005) Periodic variability in cetacean strandings: links to large-scale climate events. Biol Lett 1: 147-150.

Forney KA (2007) Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-406. 27p.

Fossi MC, Marsili L, Giovanni N, Natoli A, Politi E, Panigada S (2003) The use of a non-lethal tool for evaluating toxicological hazard of organochlorine contaminants in Mediterranean cetaceans: New data 10 years after the first paper published in MPB. Mar Pollut Bull 46, 972-982.

Gonzalez E (2001) Interactions of the *Dissostichus eleginoides* fishery with *Physeter macrocephalus* in the central-south waters of Chile. Abstract in Proceedings of the XXI Marine Sciences Meeting. Vina del Mar, Chile.

Goold JC, Whitehead H, Reid RJ (2002) North Atlantic sperm whale, *Physeter macrocephalus*, strandings on the coastlines of the British Isles and Eastern Canada. Can Field Nat 116: 371-388.

Gordon J, Leaper R, Hartley FG, Chappell O (1992) Effects of whale-watching vessels on the surface and underwater acoustic behaviour of sperm whales off Kaikoura, New Zealand. Science & Research Series No. 52, Department of Conservation, Wellington, N.Z. 64 pp.

Gunnlaugsson T, Sigurjónsson J (1990) NASS-87: Estimation of whale abundance based on observations made onboard Icelandic and Faroese survey vessels. Rep Int Whaling Comm 40: 571-580.

Ivashin MV, Rovnin AA (1967) Some results of the Soviet whale marking in the waters of the North Pacific. Norsk Hvalf-Tid 56:123-135.

Jacques TG, Lambertsen RH (eds.) (1997) Sperm whale deaths in the North Sea: science and management. Bull Ins Roy Sci Nat Belgique, Biologie 67-Suppl.: 133pp.

Jaquet N (1996) How spatial and temporal scales influence understanding of sperm whale distribution: a review. Mamm Rev 26:51-65.

Jaquet N, Dawson S, Slooten E (1998) Diving behaviour of male sperm whales: foraging implications. International Whaling Commission, Scientific Committee Doc. SC/50/CAWS 38, 20 pp.

Jaquet N, Whitehead H (1996) Scale-dependent correlation of sperm whale distribution with environmental features and productivity in the South Pacific. Mar Ecol Prog Ser 135:1-9.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Jensen AS, Silber GK (2004) Large whale ship strike database. NOAA Tech Memo NMFSOPR-39 pp.

Jochens A, Biggs D, Benoit-Bird K, Engelhaupt D, Gordon J, Hu C, Jaquet N, Johnson M, Leben R, Mate B, Miller P, Ortega-Ortiz J, Thode A, Tyack P, Würsig B (2008) Sperm whale seismic study in the Gulf of Mexico: Synthesis report. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2008-006. 341 pp.

Johnson M, Tyack P, Miller P, Nowacek D (2003) DTAG: A synchronous sound and orientation recording tag for wild marine mammals. Environmental Consequences of Underwater Sound (ECOUS) Symposium. 12-16 May 2003. San Antonio, Texas.

Kanwisher JW, Ridgway SH (1983) The physiological ecology of whales and porpoises. Sci Am 248: l10-120.

Karpouzli E, Leaper R (2004) Opportunistic observations between sperm whales and deep-water trawlers based on sightings from fisheries observers in the northwest Atlantic. Aquat Cons: Mar & Freshw Ecos 14: 95-103.

Kasuya T, Miyashita T (1988) Distribution of sperm whale stocks in the North Pacific. Sci Rep Whales Res Inst 39: 31-75.

Kato H, Miyashita T (1998) Current status of North Pacific sperm whales and its preliminary abundance estimates. Unpubl. report submitted to Int. Whal Comm (SC/50/CAWS/52). 6 pp.

Kato H, Miyashita T (2000) Current status of the North Pacific sperm whale and its preliminary abundance estimates. Paper SC/50/CAWS2 presented to the Scientific Committee of the Int. Whal Comm

Kawakami T (1980) A review of sperm whale food. Sci Rep Whales Res Inst Tokyo 32: 199-218.

Laist DW, Knowlton AR, Mead JG, Collet AS, Podesta M (2001) Collisions between ships and whales. Mar Mamm Sci 17: 35-75.

Lambertsen RH (1990) Disease biomarkers in large whales of the North Atlantic and other oceans. Pp. 395-417 in J.F. McCarthy and L.R. Shugart (eds.), Biomarkers of environmental contamination. Lewis Publishers, CRC Press, Boca Raton, FL.

Law RJ, Morris RJ, Allchin CR, Jones BR (1997) Metals and chlorobiphenyls in tissues of sperm whales (*Physeter macrocephalus*) and other cetacean species exploiting similar diets. Bull Instit Roy Sci Nat Belgique, Biologie 67-Suppl.: 79-89.

Lyrholm T, Leimar O, Johanneson B, Gyllensten U (1999) Sex biased dispersal in sperm whales: contrasting mitochondrial and nuclear genetic structure of global populations. Proc Roy Soc Lond B 266: 347-354.

Madsen PT, Payne R, Kristiansen NU, Wahlberg M, Kerr I, Møhl B (2002) Sperm whale sound production studied with ultrasound time/depth-recording tags. J Exp Biol 205: 1899-1906.

McCall HMP (1999) Sperm whales, *Physeter macrocephalus*, in the Gully, Nova Scotia: population, distribution, and response to seismic surveying. BSc Hons Thesis, Dalhousie University, Halifax, Nova Scotia.

Mitchell E (1975) Preliminary report on Nova Scotia fishery for sperm whales (*Physeter catodon*). Rep Int Whal Comm 25: 226-235.

Mullin K, Hoggard W, Roden C, Lohoefener R, Rogers C, Taggart B (1991) Cetaceans on the upper continental slope in the north-central Gulf of Mexico. OCS Study/MMS 910027. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, Louisiana. 108 pp.

Mullin KD (2007) Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. 26 pp. NMFS, Southeast Fisheries Science Center, Pascagoula, USA.

Mullin KD, Fulling GL (2004) Abundance of cetaceans in the oceanic northern Gulf of Mexico, 1996-2001. Mar Mam Sci 20: 787-807.

Mullin KD, Fulling GL (2004) Abundance of cetaceans in the oceanic northern Gulf of Mexico, 1996-2001. Mar Mam Sci 20: 787-807.

NMFS (2009) Sperm Whale (*Physeter macrocephalus*. 5-Year Review: Summary and Evaluation. National Marine Fisheries Service Office of Protected Resources, Silver Spring, MD, 44. pp.

Palacios DM, Gerrodette T (1996) Potential impact of artisanal gillnet fisheries on small cetacean populations in the eastern tropical Pacific. NOAA Admin Rep LJ-96-11.

Purves MG, Agnew DJ, Balguerias E, Moreno CA, Watkins B (2004) Killer whale (*Orcinus orca*) and sperm whale (*Physeter macrocephalus*) interactions with longline vessels inChe Patagonia toothfish fishery at South Georgia, South Atlantic. CCAMLR Science 11 (111-126).

Reeves RR (2002) The origins and character of 'aboriginal subsistence' whaling: a global review. Mam Rev 32: 71-106.

Reeves RR, Notarbartolo Di Sciara G (2006) The status and distribution of cetaceans in the Black Sea and Mediterranean Sea. IUCN Centre for Mediterranean Cooperation, Malaga, Spain.

Rice DW (1989) Sperm whale *Physeter macrocephalus* Linnaeus, 1758. in Ridgway SH, Harrison R (eds.), Handbook of marine mammals, vol. 4. Academic Press, London. Pp. 177-233.

Richter C, Dawson S, Slooten E (2006) Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. Mar Mam Sci 22: 46-63.

Santos MB, Pierce GJ, García Hartmann M, Smeenk C, Addink MJ, Kuiken T, Reid RJ, Patterson AP, Lordan C, Rogan E, Mente E (2002) Additional notes on stomach contents of sperm whales *Physeter macrocephalus* stranded in the north-east Atlantic. J Mar Biol Assoc UK 82: 501-507.

Simon MJ, Kristensen TK, Tendal OS, Kinze CC, Tougaard S (2003) Gonatus fabricii (Mollusca, Theuthida) as an important food source for sperm whales (*Physeter macrocephalus*) in the Northeast Atlantic. Sarsia 88: 244-246.

Stone CJ (2003) The effect of seismic activity on marine mammals in UK waters, 1998-2000. Report No. 323 of the Joint Nature Conservation Committee, Aberdeen, Scotland.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Physeter macrocephalus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Vanselow KH, Ricklefs K (2005) Are solar activity and sperm whale *Physeter macrocephalus* strandings around the North Sea related? J Sea Res 53: 319-327.

Vanselow KH, Ricklefs K, Colijn F (2009) Solar driven geomagnetic anomalies and sperm whale (*Physeter macrocephalus*) strandings around the North Sea: an analysis of long term datasets. The Open Mar Biol J 3: 89-94.

Viale D, Verneau N, Tison Y (1992) Stomach obstruction in a sperm whale beached on the Lavezzi islands: Macropollution in the Mediterranean. J Rech Oceanogr 16: 100-102.

Wade PR, Gerrodette T (1993) Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep Int Whal Comm 43: 477-493.

Waring GT, Josephson E, Fairfield CP, Maze-Foley K (2005) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2005. NOAA Tech Memo NMFS-NE-194: 318pp.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K (eds.) (2007) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2007. NOAA Tech Memo MFS NE 205; 415 p.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, eds (2009) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Waring GT, Palka DL, Mullin KD, Main JHW, Hansen LJ, Bisack KD (1997) U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 1996. NOAA Tech Memo NMFS-NE-114: 250 pp.

Watwood SL, Miller P, Johnson M, Madsen PT, Tyack PL (2006) Deep-diving foraging behaviour of sperm whales (*Physeter macrocephalus*). J An Eco 75: 814-825.

Weir CR (2008) Overt responses of humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), and Atlantic spotted dolphins (*Stenella frontalis*) to seismic exploration off Angola. Aquat Mamm 34: 71-83.

Whitehead H (2002) Estimates of the current global population size and historical trajectory for sperm whales. Mar Ecol Prog Ser 242: 295-304.

Whitehead H (2003) Sperm whales: social evolution in the ocean. University of Chicago Press, Chicago, IL.

Whitehead H (2009) Sperm whale *Physeter macrocephalus*. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, 1091-1097.

Whitehead H, Brennan S, Grover D (1992a) Distribution and behaviour of male sperm whales on the Scotian Shelf, Canada. Can J Zool 70: 912-918.

Whitehead H, Waters S, Lyrholm T (1992b) Population structure of female and immature sperm whales (*Physeter macrocephalus*) off the Galapagos Islands. Can J Fish Aquat Sci 49: 78-84.

Wright A (2005) Lunar cycles and sperm whales (*Physeter macrocephalus*) strandings on the North Atlantic coastlines of the British isles and eastern Canada. Mar Mam Sci 21: 145-149.

3.56. Platanista gangetica

Bairagi SP (1999) Oil bait fishery of catfishes in Brahmaputra River affecting river dolphin populations in Assam, India. J Bombay Nat Hist Soc 96: 424-426.

Choudhary SK, Smith BD, Dey S, Dey S, Prakash S (2006) Conservation and biomonitoring in the Vikramshila Gangetic Dolphin Sanctuary, Bihar, India. Oryx 40: 189-197.

IWC Scientific Committee (2000) Report of the Scientific Sub-Committee on Small Cetaceans, 2000. IWC, Cambridge, UK.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA, Pitman RL (2008) Marine Mammals of the World. Elsevier, Amsterdam, 573 pp.

Jones S (1982) The present status of the Gangetic susu, *Platanista gangetica* (Roxburgh), with comments on the Indus susu, *P. minor* Owen. Mammals in the Seas 4. Small cetaceans, seals, sirenians and otters. FAO Adv Comm Experts. Mar Resour Res, Rome Italy, pp. 97-115.

Kannan K, Senthilkumar K, Sinha RK (1997) Sources and accumulation of butyltin compounds in Ganges River dolphin, *Platanista gangetica*. Appl Organomet Chem 11: 223-230.

Kasuya, T. 1972. Some informations on the growth of the Ganges dolphin with a comment on the Indus dolphin. Scientific Reports of the Whales Research Institute 24: 87-108.

Kumari A, Sinha RK, Gopal K, Lata S (2002) Concentration of organochlorines in Ganges River dolphins from Patna, Bihar. J Environ Biol 23: 279-281.

Mansur EF, Smith BD, Mowgli RM, Diyan, MAA (2008) Two Incidents of Fishing Gear Entanglement of Ganges River Dolphins (*Platanista gangetica gangetica*) in Waterways of the Sundarbans Mangrove Forest, Bangladesh. Aquat Mamm 34: 362-366.

Mohan RSL, Kunhi KVM (1996) Fish oils as alternative to river dolphin, *Platanista gangetica* (Lebeck) oil for fishing catfish *Clupisoma garua* in the River Ganges, India. J Bombay Nat Hist Soc 93: 86-89.

Mohan RSL, Dey SC, Bairagi SP, Roy S (1997) On a survey of Ganges River dolphin *Platanista gangetica* of Brahmaputra River, Assam. J Bombay Nat Hist Soc 94: 483-495.

Mohan RSL, Dey SC, Bairagi SP (1998) On a resident population of the Ganges River dolphin *Platanista gangetica* in the Kulsi River (Assam) a tributary of Brahmaputra. J Bombay Nat Hist Soc 95: 1-7.

Pillerri, G. and Gihr, M. 1971. Differences observed in the skulls of *Platanista indi* and *gangetica*. Investigations on Cetacea 3: 13-21.

Reeves RR, Brownell RL (1989) Susu - *Platanista gangetica* (Roxburgh, 1801) and *Platanista minor* Owen, 1853. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 69-100.

Reeves RR, Chaudhry AA, Khalid U (1991) Competing for water on the Indus Plain: Is there a future for Pakistan's river dolphins? Env Conserv 18: 341-350.

Reeves RR, Chaudhry AA (1998) Status of the Indus River dolphin *Platanista minor*. Oryx 32: 35-44.

Reidenberg JS, Laitman JT (2009) Cetacean prenatal development. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 220-230.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special publication 4 (Wartzok D, ed.), Lawrence, KS. USA.

Senthilkumar K, Kannan K, Sinha RK, Tanabe S, Giesy JP (1999) Bioaccumulation profiles of polychlorinated biphenyl congeners and organochlorine pesticides in Ganges River dolphins. Env Tox Chem 18: 1511-1520.

Sinha RK (2002) An alternative to dolphin oil as a fish attractant in the Ganges River system: conservation of the Ganges River dolphin. Biol Conserv 107: 253-257.

Sinha RK, Smith, BD, Sharma G, Prasad K, Choudhury BC, Sapkota K, Sharma RK, Behera SK (2000) Ganges river dolphin, or susu (*Platanista gangetica*). In Biology and conservation of freshwater cetaceans in Asia (Reeves RR, Smith BD, Kasuya T, eds). IUCN Species Survival Commission, Occasional Paper 23: 54-61.

Smith BD (1993) 1990 status and conservation of the Ganges River dolphin *Platanista gangetica* in the Karnali River, Nepal. Biol Cons 66: 159-169.

Smith BD (2000) Review of river dolphins, genus Platanista, in the south Asian subcontinent. IWC Scientific Committee document, 2000. IWC, Cambridge, UK.

Smith BD (2002) Susu and Bhulan - *Platanista gangetica gangetica* and *P. g. minor*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 1208-1213.

Smith BD, Bhandari B, Sapkota K (1996) Aquatic biodiversity in the Karnali and Narayani river basins, Nepal. Kathmandu Nepal IUCN Nepal, 59 pp.

Smith BD, Braulik GT (2008) *Platanista gangetica*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Smith BD, Braulik G, Strindberg S, Ahmed B, Mansur R (2006) Abundance of Irrawaddy dolphins (*Orcaella brevirostris*) and Ganges river dolphins (*Platanista gangetica gangetica*) estimated using concurrent counts made by independent teams in waterways of the sundarbans mangrove forest in Bangladesh. Mar Mamm Sci 22: 527-547

Smith BD, Braulik G, Strindberg S, Diyan RM, Ahmed B (2009) Habitat selection of freshwater-dependent cetaceans and the potential effects of declining freshwater flows and sea-level rise in waterways of the Sundarbans mangrove forest, Bangladesh. Aquat Conserv: Mar Freshw Ecosyst 19: 209-225.

Smith BD, Haque AKMA, Hossain MS, Khan A (1998) River dolphins in Bangladesh: Conservation and the effects of water development. Env Manag 22: 323-335.

Subramaian AN, Mohan RSL, Karunagaran VM, Rajendran RB (1999) Concentrations of HCHs and DDTs in the tissues of river dolphins, *Platanista gangetica*, from the River Ganges, India. Chem Ecol 16:143-150.

Wakid A (2009) Status and distribution of the endangered Gangetic dolphin (*Platanista gangetica gangetica*) in the Brahmaputra River within India in 2005. Current Science 97: 1143-1151

WWF (2009) Small cetaceans, the forgotten whales. (Elliott W, Sohl H, Bugener V). Whaling Report. Indd

Yang G, Zhou K (1999) A study on the molecular phylogeny of river dolphins. Acta Theriologica Sinica 19: 1-9.

3.57. Pontoporia blainvillei

Aznar FJ, Raga JA, Corcuera J, Monzon F (1995) Helminths as biological tags for franciscana (*Pontoporia blainvillei*) (Cetacea, Pontoporiidae) in Argentinian and Uruguayan waters. Mammalia 59: 427-435.

Bordino P, Thompson G, Iniguez M (1999) Ecology and behaviour of the franciscana (*Pontoporia blainvillei*) in Bahia Anegada, Argentina. J Cet Res Manag 1: 213-222.

Bordino P, Kraus S, Albareda D, Fazio A, Palmiero A, Mendez M, Botta S (2002) Reducing incidental mortality of Franciscana dolphin *Pontoporia blainvillei* with acoustic warning devices attached to fishing nets. Mar Mam Sci 18: 833-842.

Brownell RL (1989) Franciscana - *Pontoporia blainvillei* (Gervais and d'Orbigny, 1844). In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 45-68.

Cremer MJ, Simoes-Lopes PC (2005) The occurrence of *Pontoporia blainvillei* (Gervais & d'Orbigny) (Cetacea, Pontoporiidae) in an estuarine area in southern Brazil. Rev Bras Zool 22: 717-723.

Cremer MJ, Simoes-Lopes PC (2008) Distribution, abundance and density estimates of franciscanas, *Pontoporia blainvillei* (Cetacea: Pontoporiidae), in Babitonga bay, southern Brazil. Rev Bras Zool 25: 397-402.

Crespo EA (2000) Overview and recommendations. In: Report of the third workshop for coordinated research and conservation of the franciscana dolphin (*Pontoporia blainvillei*) in the southwestern Atlantic. UNEP/CMS Secretariat, Bonn, Germany. pp. 1-11.

Crespo EA (2002) Franciscana - *Pontoporia blainvillei*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 482-487.

Crespo EA (2009) Franciscana - *Pontoporia blainvillei*. In: Encyclopedia of marine mammals, 2nd. Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 466-469.

Crespo EA, Dans SL, Koen Alonso M, Pedraza SN (2007) Interactions between marine mammals and fisheries. The Argentine Sea and its fisheries resources. Vol. 5. The marine ecosystem. pp. 151-169.

Crespo EA, Pedraza SN, Grandi MF, Dans SL, Garaffo EV (2009) Abundance and distribution of endangered Franciscana dolphins in Argentine waters and conservation implications. Mar Mamm Sci 26: 17-35.

Danilewicz D, Secchi ER, Ott PH, Moreno IB, Bassoi M, Borges-Martins M (2009) Habitat use patterns of franciscana dolphins (*Pontoporia blainvillei*) off southern Brazil in relation to water depth. J Mar Bio Assoc UK 89: 943-949.

Di Beneditto APM, Ramos RMA (2001) Biology and conservation of the franciscana (*Pontoporia blainvillei*) in the North of Rio de Janeiro State, Brazil. J Cet Res Man 3: 185-192.

IWC (2005) International Whaling Commission: Annex L. Report of the Sub-Committee on Small Cetaceans. J Cet Res Man 7: 307-326.

Kajiwara N, Matsuoka S, Iwata H, Tanabe S, Rosas FCW, Fillman G, Readman JW (2004) Contamination by Persistent Organochlorines in Cetaceans Incidentally Caught Along Brazilian Coastal Waters. Arch Environ Contam Toxicol 46: 124-134.

Kinas PG (2002) The impact of incidental kills by gill nets on the Franciscana dolphin (*Pontoporia blainvillei*) in southern Brazil. Bull Mar Sci 70: 409-421.

Ott PH, Secchi ER, Moreno IB, Danilewicz D, Crespo EA, Bordino P, Ramos R, Di Beneditto AP, Bertozzi C, Bastida R, Zanelatto R, Perez JE, Kinas PG (2002) Report of the Working Group on Fishery Interactions. Pages 55-64 in Secchi, E.R. (ed.). Special Issue on the Biology and Conservation of Franciscana. Lat Am J Aqu Mamm, (special issue 1): 1-192.

Pinedo MC, Polacheck T (1999) Trends in franciscana (*Pontoporia blainvillei*) stranding rates in Rio Grande do Sul, southern Brazil (1979-1998). J Cet Res Manag 1: 179-189.

Pinedo MC, Praderi R, Brownell R Jr (1989) Review of the biology and status of the franciscana *Pontoporia blainvillei*. In 'Biology and Conservation of the River Dolphins'. (Eds W.F.Perrin, R.L.Brownell, Z. Kaiya and L. Jiankang.) pp. 46-51. (Occasional Papers. IUCN SSC 3: Gland.).

Reeves RR, Dalebout ML, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G., Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zerbini AN, Zhou K (2008) *Pontoporia blainvillei*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Secchi ER (2010a) Life History and Ecology of Franciscana, *Pontoporia blainvillei* (Cetacea, Pontoporiidae; in revision). In: Ruiz-Garcia M, Shostell JM (Eds.) Biology, evolution and conservation of river dolphins within South America and Asia. Wildlife Protection, destruction and extinction series. Nova Publishers, New York.

Secchi ER (2010b) Review on the Threats and Conservation Status of Franciscana, *Pontoporia blainvillei* (Cetacea, Pontoporiidae) (in revision). In: Ruiz-Garcia M, Shostell JM (Eds.) Biology, evolution and conservation of river dolphins within South America and Asia. Wildlife Protection, destruction and extinction series. Nova Publishers, New York.

Secchi ER, Ott PH (2000) A profundidade como um fator determinante da distribuição de toninhas, *Pontoporia blainvillei*, conforme indicado pelos índices de CPUE. In 'Report of the Third Workshop for Coordinated Research and Conservation of the Franciscana Dolphin (*Pontoporia blainvillei*) in the Southwestern Atlantic'. (Eds UNEP/CMS.) p. 55-57. (UNEP/CMS: Bonn.)

Secchi ER, Ott PH, Crespo EA, Kinas PG, Pedraza SN, Bordino P (2001) A first estimate of franciscana (*Pontoporia blainvillei*) abundance off southern Brazil. J Cet Res Man 3: 95-100.

Secchi ER, Danilewicz D, Ott PH (2003a) Applying the phylogeographic concept to identify franciscana dolphin stocks: implications to meet management objectives. J Cet Res Man 5: 61-68.

Secchi, ER, Ott, PH and Danilewicz, DS (2003b). Effects of fishing by-catch and conservation status of the franciscana dolphin, *Pontoporia blainvillei*. Pages 174-191 in Gales, N., Hindell, M. and Kirkwood, R. (Eds) Marine Mammals: Fisheries, Tourism and Management Issues. CSIRO Publishing. Collingwood. Australia.

Valsecchi E, Zanellatto RC (2003) Molecular analysis of the social and population structure of the franciscana (*Pontoporia blainvillei*): conservation implications. J Cet Res Man 5: 69-75.

WWF (2009) Small cetaceans, the forgotten whales. (Elliott W, Sohl H, Bugener V). Whaling Report. Indd 34.

3.58. Pseudorca crassidens

Alonso MK, Pedraza SN, Schiavini ACM, Goodall RNP, Crespo EA (1999) Stomach contents of false killer whales (*Pseudorca crassidens*) stranded on the coasts of the Strait of Magellan, Tierra del Fuego. Mar Mamm Sci 15: 712-724

Alves MDO, Meirelles ACOde, Barros HMDdo R, Silva CPN, Campos AA (2002) First report of the occurrence of false killer whale, *Pseudorca crassidens* (Cetacea: Delphinidae), at Ceara State, Brazil. Arq Cienc Mar 35 :107-112

Barid RW (2009) False Killer Whale - *Pseudorca crassidens*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 405-406.

Baird RW, Gorgone AM , Webster DL, McSweeney DJ, Durban JW, Ligon AD, Salden DR, Deakos M (2005). False killer whales around the Main Hawaiian Islands: An assessment of inter-island movements and population size using individual photo-identification. Contract Report JJ133F04SE0120 prepared for the Pacific Islands Fisheries Science Center, National Marine Fisheries Service, 2570 Dole Street, Honolulu, Hawaii, 96822. 24 pp.

Baird RW, Gorgone AM, McSweeney DJ, Webster DL, Salden DR, Deakos MH, Ligon AD, Schorr GS, Barlow J, Mahaffy SD (2008) False killer whales (*Pseudorca crassidens*) around the main Hawaiian Islands: Long-term site fidelity, inter-island movements, and association patterns. Mar Mamm Sci 24: 591-612

Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Anim Conserv 9: 474-482

Barlow J, Rankin S (2007) False killer whale abundance and density: Preliminary estimates for the PICEAS study area south of Hawaii and new estimates for the US EEZ around Hawaii. Admin Rep LJ-07-02. Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive. La Jolla, CA 92037

Carretta JV, Forney KA, Lowry MS, Barlow J, Baker J, Johnston D, Hanson B, Muto MM, Lynch D, Carswell L (2008) US Pacific marine mammal stock assessments 2008. NOAA Techn Mem NMFS SWFSC 434, 340 pp.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Chivers SJ, Baird RW, McSweeney DJ, Webster DL, Hedrick NM, Salinas JC (2007) Genetic variation and evidence for population structure in eastern North Pacific false killer whales (*Pseudorca crassidens*). Can J Zool 85: 783-794.

Forney KA, Kobayashi DR (2007) Updated Estimates of Mortality and Injury of Cetaceans in the Hawaii-Based Longline Fishery, 1994-2005. NOAA Technical Memorandum NMFS SWFSC. no. 412, 35 pp.

Gannier A (2002) Cetaceans of the Marquesas Islands (French Polynesia): distribution and relative abundance as obtained from a small boat dedicated survey. Aquat Mamm 28: 198-210.

Harino H, Ohji M, Wattayakorn G, Adulyanukosol K, Arai T, Miyazaki N (2007) Accumulation of Organotin Compounds in Tissues and Organs of Stranded Whales Along the Coasts of Thailand. Arch Environ Contam Toxicol 53: 119-125.

Hernandez-Garcia V (2002) Contents of the digestive tract of a false killer whale (*Pseudorca crassidens*) stranded in Gran Canaria (Canary Islands, Central East Atlantic). Bull Mar Sci 71: 367-369.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Johnston DW, Robbins J, Chapla ME, Mattila DK, Andrews KR (2008) Diversity, habitat associations and stock structure of odontocete cetaceans in the waters of American Samoa, 2003-06. J Cetacean Res Manag 10: 59-66.

Kastelein RA, Mosterd J, Schooneman NM, Wiepkema PR (2000) Food consumption, growth, body dimensions, and respiration rates of captive false killer whales (*Pseudorca crassidens*). Aquat Mamm 26: 33-44.

Kitchener DJ, Ross GJB, Caputi N (1990) Variation in skull and external morphology in the false killer whale, *Pseudorca crassidens*, from Australia, Scotland (UK) and South Africa. Mammalia 54: 119-136.

Kiszka J, Ersts PJ, Ridoux V (2007) Cetacean diversity around the Mozambique Channel Island of Mayotte (Comoros archipelago). J Cetacean Res Manag 9: 105-109.

Koen Alonso M, Pedraza SN, Schiavini ACM, Goodall RNP (1999) Stomach contents of false killer whales (*Pseudorca crassidens*) stranded on the coasts of the Strait of Magellan, Tierra del Fuego. Mar Mamm Sci 15: 712-724.

Mullin KD (2007) Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. 26 pp.

NMFS, Southeast Fisheries Science Center, P.O. Drawer 1207, Pascagoula, MS 39568.

Nachtigall PE, Supin AY (2008) A false killer whale adjusts its hearing when it echolocates. J Exp Biol 211: 1714-1718

Odell DK, Mcclune KM (1999) *Pseudorca crassidens* (Owen, 1846) In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 213-244.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Pseudorca crassidens*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>

Wade PR, Gerodette T (1993) Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep Int Whal comm. 43: 477-493

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, editors (2008) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Weir CR (2007) Occurrence and distribution of cetaceans off northern Angola, 2004/05. J Cetacean Res Manag 9: 225-239.

Yang G, Zhou K, Xu X, Leatherwood S (1999) A survey on the incidental catches of small cetaceans in coastal waters of China. Yingyong Shengtai Xuebao 10: 713-716.

3.59. Sotalia fluviatilis

Caballero S, Trujillo F, Vianna JA, Barrios-Garrido H, Montiel MG, Beltran-Pedreros S, Marmontel M, Santos MC, Rossi-Santos M, Santos FR, Baker CS (2007) Taxonomic status of the genus Sotalia: species level ranking for 'tucuxi' (*Sotalia fluviatilis*) and 'costero' (*Sotalia guianensis*) dolphins. Mar Mamm Sci 23: 358-386.

Culik BM (2004) Review of small cetaceans: distribution, behaviour, migration and threats. UNEP/CMS Secretariat. Marine Mammal Action plan/ Regional Seas Reports and Studies no. 177. 343 pp.

Cunha HA, Silva VMF, Lailson-Brito J, Santos MCO, Flores PAC, Martin AR, Azevedo AF, Fragoso ABL, Zanelatto RC, Sole-Cava AM (2005) Riverine and marine ecotypes of *Sotalia* dolphins are different species. Mar Biol 148: 449-457.

Da Silva VMF, Best RC (1994) Tucuxi - *Sotalia fluviatilis* (Gervais 1853) In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 43-70.

Da Silva VMF, Best RC (1996) Freshwater dolphin/fisheries interaction in the Central Amazon (Brazil). Amazoniana 14: 165-175.

Flores PAC, Dasilva VMF (2009) Tucuxi and Guiana Dolphin - *Sotalia fluviatilis* and *S. guianensis*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 1188-1192.

Furtado NM (1999) Molecular systematics and population genetics of marine vertebrates from Brazil. Dissertation Abstracts International Part B: Science and Engineering 60: 463:463.

IWC (2000) Annex K: Report of the sub-committee on small cetaceans. IWC, Cambridge, 2000.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Martin AR, Silva VMFda, Salmon DL (2004) Riverine habitat preferences of botos (*Inia geoffrensis*) and tucuxis (*Sotalia fluviatilis*) in the Central Amazon. Mar Mamm Sci 20: 189-200

McGuire TL (2002) Distribution and abundance of river dolphins in the Peruvian Amazon. Diss Abst Int Pt A - Hum & Soc Sci 63: 1403.

McGuire TL, Henningsen T (2007) Movement patterns and site fidelity of river dolphins (*Inia geoffrensis* and *Sotalia fluviatilis*) in the Peruvian Amazon as determined by photo-identification. Aquat Mamm 33: 359-367

Monteiro NC, Alves JTT, Avila FJC, Campos AA, Costa AF, Silva CPN, Furtado NMAA (2000) Impact of fisheries on the tucuxi (*Sotalia fluviatilis*) and rough-toothed dolphin (*Steno bredanensis*) populations off Ceara state, northeastern Brazil. Aquat Mamm 26: 49-56.

Reeves RR, Crespo EA, Dans, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Pedraza S, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008). *Sotalia fluviatilis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ 4, Lawrence, KS. USA.

Vidal O, Barlow J, Hurtado L A, Torre J, Cendon P, Ojeda Z (1997) Distribution and abundance of the Amazon river dolphin (*Inia geoffrensis*) and the Tucuxi (*Sotalia fluviatilis*) in the Upper Amazon river. Mar Mamm Sci 13: 427-445.

3.60. Sotalia guianensis

Azevedo AF, Lailson-Brito JJr, Cunha HA, van Sluys M A (2004) A note on site fidelity of marine tucuxis (*Sotalia fluviatilis*) in Guanabara Bay, southeastern Brazil

Azevedo AF, Viana SC, Oliveira AM, Van Sluys M (2005) Group characteristics of marine tucuxis (*Sotalia fluviatilis*) (Cetacea: Delphinidae) in Guanbara Bay, south-eastern Brazil. J Mar Biol Assoc UK 85: 209-212

Caballero S, Trujillo F, Vianna JA, Barrios-Garrido H, Montiel MG, Beltran-Pedreros S, Marmontel M, Santos MC, Rossi-Santos M, Santos FR, Baker CS (2007) Taxonomic status of the genus Sotalia: species level ranking for 'tucuxi' (*Sotalia fluviatilis*) and 'costero' (*Sotalia guianensis*) dolphins. Mar Mamm Sci 23: 358-386.

Carr T, Bonde RK (2000) Tucuxi (*Sotalia fluviatilis*) occurs in Nicaragua, 800 km north of its previously known range. Mar Mamm Sci 16: 447-452.

Culik BM (2004) Review of small cetaceans: distribution, behaviour, migration and threats. UNEP/CMS Secretariat. Marine Mammal Action plan/ regional Seas Reports and Studies no. 177. 343 pp.

Cunha HA, Silva VMF, Lailson-Brito J, Santos MCO, Flores PAC, Martin AR, Azevedo AF, Fragoso ABL, Zanelatto RC, Sole-Cava AM (2005) Riverine and marine ecotypes of *Sotalia* dolphins are different species. Mar Biol 148: 449-457.

Da Silva VMF, Best RC (1994) Tucuxi - *Sotalia fluviatilis* (Gervais 1853) In: Handbook of marine mammals (Ridgway

SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 43-70.

De Oliveira Santos MC, Rosso S, Dos Santos RA, Lucato SHB, Bassoi M (2002) Insights on small cetacean feeding habits in southeastern Brazil. Aquat Mamm 28: 38-45.

Di Beneditto APM, Arruda Remos RM (2004) Biology of the marine tucuxi dolphin (*Sotalia fluviatilis*) in south-eastern Brazil. J Mar Biol Assoc UK 84:1245-1250.

Edwards HH, Schnell GD (2001). Status and ecology of *Sotalia fluviatilis* in the Cayos Miskito Reserve, Nicaragua. Mar Mamm Sci 17: 445-472.

Flach L, Flach PA, Chiarello AG (2008) Density, abundance and distribution of the Guiana dolphin (*Sotalia guianensis* van Benéden, 1864) in Sepitiba Bay, southeast Brazil. J Cetacean Res Manage 10:31-36.

Flores PAC, Da Silva VMF (2009) Tucuxi and guiana Dolphin - *Sotalia fluviatilis* and *S. guianensis*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 1188-1192.

Furtado NM (1999) Molecular systematics and population genetics of marine vertebrates from Brazil. Dissertation Abstracts International Part B: Science and Engineering 60: 463:463.

GeiseL , Gomes N, Cerqueira R (1999) Behavior, habitat use and population size of *Sotalia fluviatilis* (Gervais, 1853) (Cetacea, Delphinidae) in the Cananeia estuary region, Sao Paulo, Brazil. Rev Brasil Biol 59: 183-194.

IWC (2000) Annex K: Report of the sub-committee on small cetaceans. IWC, Cambridge, 2000. J Cet Res Man 6: 265-268

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Monteiro NC, Alves JTT, Avila FJC, Campos AA, Costa AF, Silva CPN, Furtado NMAA (2000) Impact of fisheries on the tucuxi (*Sotalia fluviatilis*) and rough-toothed dolphin (*Steno bredanensis*) populations off Ceara state, northeastern Brazil. Aquat Mamm 26: 49-56.

Monteiro-Neto C, Avila FJC, Alves TT Jr, Araujo DS, Campos AA, Martins AMA, Parente CL, Furtado-Neto MAA, Lien J (2004) Behavioral responses of *Sotalia fluviatilis* (Cetacea, Delphinidae) to acoustic pingers, Fortaleza, Brazil. Mar Mamm Sci 20: 145-151.

Monteiro-Neto C, Itavo RV, Moraes LEU (2003) Concentrations of heavy metals in *Sotalia fluviatilis* (Cetacea: Delphinidae) off the coast of Ceara, northeast Brazil. Environ Pollut 123: 319-324.

Oliveira JA, Avila FJC, Alves Junior TT, Furtado Neto MAA, Monteiro Neto C (1995) Monitoring of the gray dolphin, *Sotalia fluviatilis* (Cetacea: Delphinidae), off Fortaleza, Ceara State, Brazil. Arq Cienc Mar 29: 28-35.

Reeves RR, Crespo EA, Dans, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Pedraza S, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Sotalia fluviatilis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ 4, Lawrence, KS. USA.

Rosas FCW, Monteiro-Filho ELA (2003) Reproduction of the estuarine dolphin (*Sotalia guianensis*) on the coast of Parana, Southern Brazil. J Mammal 83: 507-515.

Yogui GT, Santos MCU, Montone RC (2003) Chlorinated pesticides and polychlorinated biphenyls in marine tucuxi dolphins (*Sotalia fluviatilis*) from the Cananeia Estuary, southeastern Brazil. Sci Total Environ 312: 67-78.

3.61. Sousa chinensis

Ali O, Jiddawi NS (1999) Dolphin tourism and community participation in Zanzibar: The case of Kizimkazi Village. Conference on Advances on Marine Sciences in Tanzania Zanzibar Tanzania Ims 1999, pp. 48-48.

Amir OA, Berggren P, Jiddawi P (2002) The incidental catch of dolphins in gillnet fisheries in Zanzibar, Tanzania. West Indian Ocean J Mar Sci 1: 155-162.

Amir OA, Jiddawi NS, Berggren P (2005) The occurrence and distribution of dolphins in Zanzibar, Tanzania, with comments on the differences between two species of *Tursiops*. West Indian Ocean J Mar Sci 4: 85-93.

Atkins S, Pillay N, Peddemors VM (2004) Spatial distribution of Indo-Pacific humpback dolphins (*Sousa chinensis*) at Richards Bay, South Africa: Environmental influences and behavioural patterns. Aquat Mamm 30: 84-93.

Bishop JM, Alsaffar AH (2008) Quantitative observations on marine mammals and reptiles of Kuwait's Boubyan Island. Zool Middle East 43: 3-12.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Chen Y, Chen J, Chen H, Wu Y (2005) Pathological anatomy and identification of death causes for four Chinese white dolphins in Pearl River Estuary. Mar Fish Res 26: 31-35.

Clarke SC, Jackson AP, Neff J (2000) Development of a risk assessment methodology for evaluating potential impacts associated with contaminated mud disposal in the marine environment. Chemosphere 41: 69-76.

Corkeron PJ , Morissette NM, Porter L, Marsh H (1997) Distribution and status of hump-backed dolphins, *Sousa chinensis,* in Australian waters. Asian Mar Biol 14: 49-59.

Frere CH, Hale PT, Porter L, Cockcroft VG, Dalebout ML (2008) Phylogenetic analysis of mtDNA sequences suggests revision of humpback dolphin (*Sousa* spp.) taxonomy is needed. Mar Freshw Res 59: 259-268.

Guissamulo A, Cockcroft VG (2004) Ecology and population estimates of Indo-Pacific humpback dolphins (*Sousa chinensis*) in Maputo Bay, Mozambique. Aquat Mamm 30: 94-102

Isobe T, Ramu K, Kajiwara N, Takahashi S, Lam PKS, Jefferson TA, Zhou K, Tanabe S (2007) Isomer specific determination of hexabromocyclododecanes (HBCDs) in small cetaceans from the South China Sea - Levels and temporal variation. Mar Pollut Bull 54: 1139-1145.

Jefferson TA (2000) Population biology of the Indo-Pacific hump-backed dolphin in Hong Kong waters. Wildl Monogr 64 (4).

Jefferson TA, Hung SK (2004) A review of the status of the Indo-Pacific humpback dolphin (*Sousa chinensis*) in Chinese waters. Aquat Mamm 30: 149-158.

Jefferson TA, Karczmarski (2001) *Sousa chinensis*. Mamm Spec 655: 1-9.

Jefferson TA, Leatherwood S (1997) Distribution and abundance of Indo-Pacific hump-backed dolphins (*Sousa chinensis* Osbeck, 1765) in Hong Kong waters. Asian Mar Biol 14: 93-110.

Sources

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Van Waerebeek K (2004) Geographic variation in skull morphology of humpback dolphins (*Sousa* spp.). Aquat Mamm 30: 3-17.

Jefferson TA, Hung SK, Lam PKS (2006) Strandings, mortality and morbidity of Indo-Pacific humpback dolphins in Hong Kong, with emphasis on the role of organochlorine contaminants. J Cetacean Res Manag 8: 181-193.

Kajiwara N, Kamikawa S, Ramu K, Ueno D, Yamada TK, Subramanian A, Lam PKS, Jefferson TA, Prudente M, Chung KH, Tanabe S (2006) Geographical distribution of polybrominated diphenyl ethers (PBDEs) and organochlorines in small cetaceans from Asian waters. Chemosphere 64: 287-295.

Karczmarski L (1999) Group dynamics of humpback dolphins (*Sousa chinensis*) in the Algoa Bay region, South Africa. J Zool London 249: 283-293.

Karczmarski L (2000) Conservation and management of humpback dolphins: the South African perspective. Oryx 34: 207-216.

Karczmarski L, Cockroft VG, Mclachlan A, Winter PED (1998) Recommendations for the conservation and management of humpback dolphins *Sousa chinensis* in the Algoa Bay region, South Africa. Koedoe 41: 121-129.

Karczmarski L, Cockroft VG, Mclachlan A (2000) Habitat use and preferences of Indo-Pacific humpback dolphins *Sousa chinensis* in Algoa Bay, South Africa. Mar Mamm Sci 16: 65-79.

Karczmarski L, Thornton M, Cockroft VG (1997) Description of selected behaviours of humpback dolphins *Sousa chinensis*. Aquat Mamm 23: 127-133.

Karczmarski L, Winter PED, Cockroft VG, Mclachlan A (1999) Population analyses of Indo-Pacific humpback dolphins *Sousa chinensis* in Algoa Bay, Eastern Cape, South Africa. Mar Mamm Sci 15: 1115-1123.

Keith M, Peddemors VM, Bester MN, Ferguson JWH (2002) Population characteristics of Indo-Pacific humpback dolphins at Richards Bay, South Africa: implications for incidental capture in shark nets. S Afr J Wildl Res 32: 153-162.

Kiszka J, Ersts PJ, Ridoux V (2007) Cetacean diversity around the Mozambique Channel Island of Mayotte (Comoros Archipelago). J Cetacean Res Manag 9: 105-109.

Lal Mohan RS (1988). Observations on the by-catch of dolphins *Stenella longirostris*, *Tursiops aduncus*, *Sousa chinensis* and *Delphinus delphis tropicalis* in the gill nets off Calicut coast, India. In: Proceedings of the Symposium on Endangered Marine Mammals and Marine Parks, 12-16 January, 1985, Cochin, India (EG Silas, ed.), pp. 78-83. Marine Biological Association of India, Cochin.

Liu W, Huang Z (2000) Distribution and abundance of Chinese white dolphins (*Sousa chinensis*) in Xiamen. Acta Oceanol Sin./ Haiyang Xuebao 22: 95-101.

Lu H, Fang Z-Q (2008) Chinese white dolphin in the water near Dajin Island of Chuanshan Island sea area. J South Chin Norm Univ (Nat. Sci. Ed.) 1:125-129

Minh T-B, Watanabe M, Nakata H, Tanabe S, Jefferson TA (1999) Contamination by persistent organochlorines in small cetaceans from Hong Kong coastal waters. Mar Poll Bull 39: 383-392.

Parijs SMVan, Corkeron PJ (2001) Boat traffic affects the acoustic behaviour of Pacific humpback dolphins, *Sousa chinensis*. J Mar Biol Assoc UK 81: 533-538.

Parra GJ, Corkeron PJ, Marsh H (2004) The Indo-Pacific humpback dolphin, *Sousa chinensis* (Osbeck, 1765), in Australian waters: A summary of current knowledge. Aquat Mamm 30: 197-206.

Parsons ECM (1997a) Hong Kong's cetaceans: the biology, ecology and behaviour of *Sousa chinensis* and *Neophocaena phocaenoides*. PhD thesis. The University of Hong Kong.

Parsons ECM (1997b) Sewage pollution in Hong Kong: Implications for the health and conservation of local cetaceans. Friends of the Earth, Hong Kong.

Parsons ECM (1998a) Strandings of small cetaceans in Hong Kong territorial waters. J Mar Biol Assoc U-K 78: 1039-1042.

Parsons ECM (1998b) Trace metal pollution in Hong Kong: Implications for the health of Hong Kong's Indo-Pacific humpbacked dolphins (*Sousa chinensis*). Sci Tot Env 214: 175-184.

Parsons ECM (1998c) The behaviour of Hong Kong's resident cetaceans: The Indo-Pacific hump-backed dolphin and the finless porpoise. Aquat Mamm 24: 91-110.

Parsons ECM (2002a) The behaviour and ecology of the Indian humpback dolphin (*Sousa chinensis*) and the Pacific humpback dolphin (*Sousa chinensis chinensis*). IWC Publication SC54/SM4.

Parsons ECM (2002b) The impacts of pollution on humpback dolphins. IWC Publication SC54/SM5.

Parsons ECM (2004) The behavior and ecology of the Indo-Pacific humpback dolphin (*Sousa chinensis*). Aquat Mamm 30: 38-55.

Parsons ECM, Jefferson TA (2000) Post-mortem investigations on stranded dolphins and porpoises from Hong Kong waters. J Wildl Dis 36: 342-356.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Preen A (2004) Distribution, abundance and conservation status of dugongs and dolphins in the southern and western Arabian Gulf. Biol Conserv 118: 205-218

Ramu K, Kajiwara N, Tanabe S, Lam PKS, Jefferson TA (2005) Polybrominated diphenyl ethers (PBDEs) and organochlorines in small cetaceans from Hong Kong waters: Levels, profiles and distribution. Mar Pollut Bull 51: 8-12

Razafindrakoto Y, Andrianarivelo N, Rosenbaum HC (2004) Sightings, catches, and other records of Indo-Pacific humpback dolphins in the coastal waters of Madagascar. Aquat Mamm 30: 103-110

Reeves RR, Dalebout ML, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Sousa chinensis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Ross GJB (2002) Humpback dolphins - *Sousa chinensis*, *S. plumbea*, and *S. teuszii*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 585-589.

Ross GJB (2006) Review of the conservation status of Australia's smaller whales and dolphins. Australian Government, 124 pp.

Ross GJB, Heinsohn GE, Cockroft VG (1994) Humpback dolphins - *Sousa chinensis* (Osbeck, 1765), *Sousa plumbea* (G. Cuvier, 1829) and *Sousa teuszii* (Kükenthal, 1892). In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 23-42.

Smith BD, Tun MT (2008) A note on the species occurrence, distributional ecology and fisheries interactions of cetaceans in the Mergui (Myeik) Archipelago, Myanmar. J Cetacean Res Manag 10: 37-44

Smith BD, Ahmed B, Mowgli RM, Strindberg S (2008) Species occurrence and distributional ecology of nearshore cetaceans in the Bay of Bengal, Bangladesh, with abundance estimates for Irrawaddy dolphins Orcaella brevirostris and finless porpoises Neophocaena phocaenoides. J Cetacean Res Manag 10: 45-58

Stensland E (2004) Behavioural ecology of Indo-Pacific bottlenose and humpback dolphins. PhD Thesis, Stockholm Universtiy, Stockholm (Sweden). 118 pp

Wang JY, Hung SK, Yang S-C (2004) Records of Indo-Pacific humpback dolphins, *Sousa chinensis* (Osbeck, 1765), from the waters of western Taiwan. Aquat Mamm 30: 189-196

Wang PL, Han JB (2007) Present status of distribution and protection of Chinese white dolphins (*Sousa chinensis*) population in Chinese waters. Mar Environ Sci 26: 484-487

Würsig B, Greene CR JR, Jefferson TA (2000) Development of an air bubble curtain to reduce underwater noise of percussive piling. Mar Env Res 49: 79-93.

Wuersig B, Greene CR Jr (2002) Underwater sounds near a fuel receiving facility in western Hong Kong: relevance to dolphins. Mar Environ Res 54 :129-145

Zhang L, Tang S (2008) Distribution of Chinese white dolphin in the coast waters of China. J Oceanogr Taiwan Strait 27: 79-86

Zhou K, Xu X, Tian C (2007) Distribution and abundance of Indo-Pacific humpback dolphins in Leizhou Bay, China. N Z J Zool 34: 35-42.

3.62. Sousa teuszii

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Frere CH, Hale PT, Porter L, Cockcroft VG, Dalebout ML (2008) Phylogenetic analysis of mtDNA sequences suggests revision of humpback dolphin (*Sousa* spp.) taxonomy is needed. Mar Freshw Res 59: 259-268.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Van Waerebeek K (2004) Geographic variation in skull morphology of humpback dolphins (*Sousa* spp.). Aquat Mamm 30: 3-17

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Reeves RR, Smith BD, Crespo EA, Notarbartolo di Sciara G (compilers) (2003) Dolphins, whales and porpoises: 2002-2010 Conservation Action Plan for the world's cetaceans. IUCN/SSC Cetacean Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. ix + 139pp.

Reeves RR, Dalebout ML, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) *Sousa teuszii*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Ross GJB (2002) Humpback dolphins - *Sousa chinensis*, *S. plumbea*, and *S. teuszii*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 585-589.

Ross GJB, Heinsohn GE, Cockroft VG (1994) Humpback dolphins - *Sousa chinensis* (Osbeck, 1765), *Sousa plumbea* (G. Cuvier, 1829) and *Sousa teuszii* (Kükenthal, 1892). In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 23-42.

Van Waerebeek K, Ndiaye E, Djiba A, Diallo M, Murphy P, Jallow A, Camara A, Ndiaye P, Tous P (2000) A survey of the conservation status of cetaceans in Senegal, the Gambia and Guinea-Bissau. UNEP/CMS Secretariat, Bonn, Germany,. 80 pp. PDF-copy of full report: (www.wcmc.org.uk/cms/reports/WAFCET/ WAFCET2/pdf/Wafcet2_Report.pdf)

Van Waerebeek K, Barnett L, Camara A, Cham A, Diallo M, Djiba A, Jallow A, Ndiaye E, , Samba Ould Bilal AO, Bamy IL (2004) Distribution, status, and biology of the Atlantic humpback dolphin, *Sousa teuszii* (Kükenthal, 1892). Aquat Mamm 30: 56-83.

Van Waerebeek K, Ofori-Danson PK, Debrah J (2009) The cetaceans of Ghana, a validated faunal checklist. West Afr J Appl Ecol 15: 61-89

Weir C (2007) Occurrence and distribution of cetaceans off northern Angola, 2004/05. J Cetacean Res Manag 9: 225-239

WWF (2009) Small cetaceans, the forgotten whales. (Elliott W, Sohl H, Bugener V). Whaling Report.Indd 34.

3.63. Stenella attenuata

Amir OA, Jiddawi NS, Berggren P (2005) The occurrence and distribution of dolphins in Zanzibar, Tanzania, with comments on the differences between two species of *Tursiops*. West Indian Ocean J Mar Sci 4: 85-93.

Andre JM, Amiard JC, Amiard-Triquet C, Boudou A, Ribeyre F (1990a) Cadmium contamination of tissues and organs of delphinid species (*Stenella attenuata*): Influence of biological and ecological factors. Ecotox Env Safety 20: 290-306.

Andre JM, Ribeyre F, Boudou A (1990b) Mercury contamination levels and distribution in tissues and organs of delphinids (*Stenella attenuata*) from the eastern tropical Pacific, in relation to biological and ecological factors. Mar Environ Res 30: 43-72.

Archer F, Gerrodette T, Chivers S, Jackson A (2004) Annual estimates of the unobserved incidental kill of pantropical spotted dolphin (*Stenella attenuata attenuata*) calves in the tuna purse-seine fishery of the eastern tropical Pacific. Fish Bull 102: 233-244.

Archer FI, Robertson KM (2004) Age and length at weaning and development of diet of pantropical spotted dolphins, *Stenella attenuata*, from the eastern tropical Pacific. Mar Mamm Sci 20: 232-245.

Baird RW, Ligon AD, Hooker SK, Gorgone AM (2001) Subsurface and nighttime behaviour of pantropical spotted dolphins in Hawai'i. Can J Zool 79: 988-996.

Ballance LT, Pitman RL (1998) Cetaceans of the western tropical Indian Ocean: Distribution, relative abundance, and comparisons with cetacean communities of two other tropical ecosystems. Mar Mamm Sci 14: 429-459.

Barlow J (2006) Cetacean abundance in Hawaii waters estimated from a summer/ fall survey in 2002. Mar Mamm Sci 22: 446-464

Borrell A, Cantos G, Pastor T, Aguilar A (2004) Levels of organochlorine compounds in spotted dolphins from the Coiba archipelago, Panama. Chemosphere 54: 669-677.

Bratten D, Hall M (1997) Working with fishers to reduce bycatch: The tuna-dolphin problem in the eastern Pacific Ocean. Fisheries Bycatch: Consequences and Management, pp. 97-100.

Chen M-H, Shih C-C, Chou CL, Chou L-S (2002) Mercury, organic-mercury and selenium in small cetaceans in Taiwanese waters. Mar Pollut Bull 45: 237-245.

Cramer KL, Perryman WL, Gerrodette T (2008) Declines in reproductive output in two dolphin populations depleted by the yellowfin tuna purse-seine fishery. Mar Ecol Prog Ser 369: 273-285.

Dolar MLL, Leatherwood SJ, Wood CJ, Alava MNR, Hill CL, Aragones LV (1994) Directed fisheries for cetaceans in the Philippines. Rep Int Whal Comm 44: 439-449.

Dolar ML, Perrin WF, Yaptinchay AASP, Jaaman SABH, Santos MD, Alava MN, Suliansa MSB (1997) Preliminary investigation of marine mammal distribution, abundance, and interactions with humans in the southern Sulu sea. Asian Mar Biol 14: 61-81.

Dolar MLL, Perrin WF, Taylor BL, Kooyman GL, Alava MNR (2006) Abundance and distributional ecology of cetaceans in the central Philippines. J Cetacean Res Manage 8: 93-111.

Escorza-Trevino S, Archer FI, Rosales M, Lang A, Dizon AE (2005) Genetic differentiation and intraspecific structure of eastern tropical Pacific spotted dolphins, *Stenella attenuata*, revealed by DNA analyses. Conserv Genet 6 : 587-600.

Forney KA, Kobayashi DR (2007) Updated estimates of mortality and injury of cetaceans in the Hawaii-based longline fishery, 1994-2005. NOAA Tech Mem NMFS SWFSC.412, 35 pp.

Gannier A (2002) Cetaceans of the Marquesas Islands (French Polynesia): distribution and relative abundance as obtained from a small boat dedicated survey. Aquat Mamm 28: 198-210.

Gerrodette T (1999) Preliminary estimates of 1999 abundance of four dolphin stocks in the eastern tropical Pacific. Southwest Fisheries Science Center Administrative Report LJ-00-12 (www.swfsc.nmfs.noaa.gov).

Gerrodette T (2002) Tuna-dolphin issue. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 1269-1273.

Gerrodette T, Forcada J (2005) Non-recovery of two spotted and spinner dolphin populations in the eastern tropical Pacific Ocean. Mar Ecol Prog Ser 291: 1-21.

Gerrodette T, Watter G, Forcada J (2005) Preliminary estimates of 2003 dolphin abundance in the eastern tropical Pacific. NMFS, Admin Rep LJ-05-05. 28 p.

Gosliner ML (1999) The tuna-dolphin controversy. In: Conservation an management of marine mammals (Twiss JR, Reeves RR, eds.) Smithsonian Institution Press, pp. 120-155.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Stenella attenuata*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hucke-Gaete R (2000) Review of the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

IATTC (2006) Annual report of the Inter-American Tropical Tuna Commission-2005. La Jolla, California. http://www.iattc.org/AnnualReportsENG.htm

IATTC (2009) Annual report of the Inter-American Tropical Tuna Commission-2007. La Jolla, California. http://www.iattc.org/AnnualReportsENG.htm

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Kasuya T (2007) Japanese whaling and other cetacean fisheries. Environ Sci Poll Res 14: 39-48

Kiszka J, Ersts PJ, Ridoux V (2007) Cetacean diversity around the Mozambique Channel Island of Mayotte (Comoros archipelago). J Cetacean Res Manage 9:105-109.

Lennert-Cody CE, Minami M, Hall MA (2004) Incidental mortality of dolphins in the eastern Pacific Ocean purse-seine fishery: correlates and their spatial association. J Cetacean Res Manage 6: 151-163.

MacLeod CD, Bennett E (2007) Pantropical spotted dolphins (*Stenella attenuata*) and other cetaceans around St Helena in the tropical southeastern Atlantic. J Mar Biol Assoc UK 87: 339-344.

May Collado L, Gerrodette T, Calambokidis J, Rasmussen K, Sereg I (2005) Patterns of cetacean sighting distribution in the Pacific Exclusive Economic Zone of Costa Rica based on data collected from 1979-2001. Rev Biol Trop 53: 249-263.

Mullin KD (2007) Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. 26 pp.Available from: NMFS, Southeast Fisheries Science Center, P.O. Drawer 1207, Pascagoula, MS 39568.

Perkins PC, Edwards EF (1999) Capture rate as a function of school size in pantropical spotted dolphins, *Stenella attenuata*, in the eastern tropical Pacific. Fish Bull US 97: 542-554.

Perrin WF (2001) *Stenella attenuata*. Mamm Species 633: 1-8.

Perrin WF (2009) Pantropical spotted dolphin - *Stenella attenuata*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 819-821.

Perrin WF, Hohn AA (1994) Pantropical spotted dolphin - *Stenella attenuata*. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 71-98.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Psarakos S, Herzing DL, Marten K (2003) Mixed-species associations between pantropical spotted dolphins (*Stenella attenuata*) and Hawaiian spinner dolphins (*Stenella longirostris*) off Oahu, Hawaii. Aquat Mamm 29: 390-395.

Reilly SB (1990) Seasonal changes in distribution and habitat differences among dolphins in the eastern tropical Pacific. Mar Ecol Prog Ser 66: 1-12.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Publ 4, Lawrence, KS. USA.

Robertson KM, Chivers SJ (1997) Prey occurrence in pantropical spotted dolphins, *Stenella attenuata*, from the eastern tropical Pacific. Fish Bull US 95: 334-348.

Scott MD, Chivers SJ (2009) Movements and diving behavior of pelagic spotted dolphins. Mar Mamm Sci 25: 137-160

Silva JMJr, Silva FJL, Sazima I (2005) Two presumed interspecific hybrids in the genus *Stenella* (Delphinidae) in the tropical West Atlantic. Aquat Mamm 31: 468-472.

Wade PR (1995) Revised estimates of incidental kill of dolphins (Delphinidae) by the purse-seine tuna fishery in the eastern tropical Pacific, 1959-1972. Fish Bull US 93: 345-354.

Wade PR, Watters GM, Gerrodette T, Reilly SB (2007) Depletion of spotted and spinner dolphins in the eastern tropical Pacific: modeling hypotheses for their lack of recovery. Mar Ecol Prog Ser 343: 1-14.

Wang M-C, Walker WA, Shao K-T, Chou L-S (2003) Feeding habits of the pantropical spotted dolphin, *Stenella attenuata*, off the eastern coast of Taiwan. Zool Stud 42: 368-378.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, editors. (2009) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Weir CR (2007) Occurrence and distribution of cetaceans off northern Angola, 2004/05. J Cetacean Res Manage 9: 225-239.

Yang G, Zhou K, Xu X, Leatherwood S (1999) A survey on the incidental catches of small cetaceans in coastal waters of China. Yingyong Shengtai Xuebao10:713-716.

3.64. Stenella clymene

Fertl D, Schiro AJ, Peake D (1997) Coordinated feeding by Clymene dolphins (*Stenella clymene*) in the Gulf of Mexico. Aquat Mamm 111-112.

Fertl D, Jefferson TA, Moreno IB, Zerbini AN, Mullin KD (2003) Distribution of the Clymene dolphin *Stenella clymene*. Mammal Rev 33: 253-271.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA (2009) Clymene dolphin - *Stenella clymene*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 241-243.

Jefferson TA, Curry BE (2003) *Stenella clymene*. Mamm Spec. 726: 1-5

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Stenella clymene*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Mullin KD (2007) Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. 26 pp. Available from: NMFS, Southeast Fisheries Science Center, P.O. Drawer 1207, Pascagoula, MS 39568

Mullin KD, Fulling GL (2003) Abundance of cetaceans in the southern U.S. North Atlantic Ocean during summer 1998. Fish Bull 101: 603-613

Perrin WF, Mead JG (1994) Clymene dolphin - *Stenella clymene*. In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 161-172.

Robineau D, Vely M, Maigret J (1994) *Stenella clymene* (Cetacea, Delphinidae) from the coast of West Africa. J Mamm 75: 766-767.

Van Waerebeek K, Ndiaye E, Djiba A, Diallo M, Murphy P, Jallow A, Camara A, Ndiaye P, Tous P (2000) A survey of the conservation status of cetaceans in Senegal, the Gambia and Guinea-Bissau. UNEP/CMS Secretariat, Bonn, Germany, 80 pp.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, eds. (2007) U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 2007. NOAA Tech Memo NMFS NE 205; 415 p.

Weir CR (2006) Occurrence and distribution of cetaceans off northern Angola, 2004/05. J Cet Res Man 9: 225-239

Zerbini AN, Kotas JE (1998) A note on cetacean bycatch in pelagic driftnetting off southern Brazil. Rep Int Whal Comm 48: 519-524.

3.65. Stenella coeruleoalba

Aguilar A (2000) Population biology, conservation threats and status of Mediterranean striped dolphins (*Stenella coeruleoalba*). J Cetacean Res Manage 2: 17-26.

Aguilar A, Borrell A (2005) DDT and PCB reduction in the western Mediterranean from 1987 to 2002, as shown by levels in striped dolphins (*Stenella coeruleoalba*). Mar Environ Res 59: 391-404.

Archer FI (2009) Striped dolphins - *Stenella coeruleoalba*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 1127-1129.

Antoine L, Goujon M, Massart G (2001) Dolphin bycatch in tuna driftnet in North East Atlantic. Copenhagen Denmark Ices, 8 pp.

Archer FI, Perrin WF (1999) *Stenella coeruleoalba*. Mammal Spec 603: 1-9.

Ballance LT, Pitman RL (1998) Cetaceans of the western tropical Indian Ocean: Distribution, relative abundance, and comparisons with cetacean communities of two other tropical ecosystems. Mar Mamm Sci 14: 429-459.

Barlow J (2003) Cetacean abundance in Hawaiian waters during summer/fall 2002. Admin. Rep. LJ-03-13. Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037.

Blanco C, Aznar J, Raga JA (1995) Cephalopods in the diet of the striped dolphin *Stenella coeruleoalba* from the western Mediterranean during an epizootic in 1990. J Zool London 237: 151-158.

Bourreau S, Gannier RA (2003) Distribution of *Delphinus delphis* in the Mediterranean Sea: competition with striped dolphin or fisheries? Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Bourret VJR, Mathias RJM, Crouau-Roy MB (2007) genetic variation and population structure of western Mediterranean and North Atlantic *Stenella coeruleoalba* populations inferred from microsatellite data. J Mar Biol Assoc UK 87: 265-269.

Cardellicchio N, Giandomenico S, Ragone P, Dileo A (2000) Tissue distribution of metals in striped dolphins (*Stenella coeruleoalba*) from the Apulian coasts, Southern Italy. Mar Env Res 49: 55-66.

Carretta JV, Forney KA, Lowry MS, Barlow J, Baker J, Johnston D, Hanson B, Muto MM, Lynch D, Carswell L (2009) U.S. Pacific Marine Mammal Stock Assessments: 2008. U.S. Department of Commerce, NOAA Tech Mem NMFS-SWFSC-434. 340 p.

Caurant F, Aubail A, Lahaye V, Van Canneyt O, Rogan E, Lopez A, Addink M, Churlaud C, Robert M, Bustamante P (2006) Lead contamination of small cetaceans in European waters - The use of stable isotopes for identifying the sources of lead exposure. Mar Environ Res 62: 131-148.

Certain G, Ridoux V, van Canneyt O, Bretagnolle V (2008) Delphinid spatial distribution and abundance estimates over the shelf of the Bay of Biscay. [ICES J Mar Sci 65: 656-666.

Davis RW, Fargion GS, May N, Leming TD, Baumgartner M, Evans WE, Hansen LJ, Mullin K (1998) Physical habitat of cetaceans along the continental slope in the north-central and western Gulf of Mexico. Mar Mamm Sci 14: 490-507.

Doksaeter L, Olsen E, Nottestad L, Ferno A (2008) Distribution and feeding ecology of dolphins along the Mid-Atlantic Ridge between Iceland and the Azores. Deep Sea Res. (II Top. Stud. Oceanogr.) 55, no. 1-2: 243-253

Forney KA (2007) Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Tech Mem NMFS-SWFSC-406. 27p.

Fortuna CM, Canese S, Giusti M, Revelli E, Consoli P, Florio G, Greco S, Romeo T, Andaloro F, Fossi MC, Lauriano G (2007) An insight into the status of the striped dolphins, *Stenella coeruleoalba*, of the southern Tyrrhenian Sea. J Mar Biol Assoc UK 87: 1321-1326.

Gannier A (1999) Diel variations of the striped dolphin distribution off the French Riviera (northwestern Mediterranean Sea). Aquat Mamm 3: 123-134.

Gerrodette T, Watter G, Forcada J (2005) Preliminary estimates of 2003 dolphin abundance in the eastern tropical Pacific. NMFS, SWFSC Admin Rep LJ-05-05. 28 p.

Garcia Martinez J, Moya A, Raga JA, Latorre A (1999) Genetic differentiation in the striped dolphin *Stenella coeruleoalba* from European waters according to mitochondrial DNA (mtDNA) restriction analysis. Mol Ecol 8: 1069-1073.

Gómez de Segura A, Crespo EA, Pedraza SN, Hammond PS, Raga JA (2006) Abundance and distribution of striped dolphin, *Stenella coeruleoalba*, in Spanish eastern waters. Mar Biol 150: 149-160.

Goujon M (1996) Driftnet incidental catch and population dynamics of dolphins off the Bay of Biscay. Publ Lab Halieut Ec Natl Super Agron, Ecole Nationale Superieure Agronomique De Rennes, Rennes France, no 15, 239 pp.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Stenella coeruleoalba*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hashmi DDK (1990) Habitat selection of cetaceans in the Strait of Gibraltar. European Research on Cetaceans. 4. Proc. of the Fourth Annual Conference of the European Cetacean Society, Palma De Mallorca, Spain, 24 March 1990. (Evans PGH, Aguilar A, Smeenk C, eds.), p. 40.

IATTC (2009) Annual report of the Inter-American Tropical Tuna Commission-2007. La Jolla, California. http://www.iattc.org/AnnualReportsENG.htm

Isaksen K, Syvertsen PO (2002) Striped dolphins, *Stenella coeruleoalba*, in Norwegian and adjacent waters. Mammalia 66: 33-41.

Isobe T, Ochi Y, Ramu K, Yamamoto T, Tajima Y, Yamada TK, Amano M, Miyazaki N, Takahashi S, Tanabe S (2009) Organohalogen contaminants in striped dolphins (*Stenella coeruleoalba*) from Japan: Present contamination status, body distribution and temporal trends (1978-2003). Mar Pollut Bull 58: 396-401

Iwasaki T (2008) Japan. Progress report on small cetacean research. April 2007 to March 2008, with statistical data for the calendar year 2007. IWC, Japan Prog rel. SM/2008. 9 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Kastelein RA, Jennings N, Verboom WC, De Haan D, Schooneman NM (2006) Differences in the response of a striped dolphin (*Stenella coeruleoalba*) and a harbour porpoise (*Phocoena phocoena*) to an acoustic alarm. Mar Environ Res 61: 363-378.

Kasuya T (1999) Review of the biology and exploitation of striped dolphins in Japan. J Cetacean Res Manage 1: 81-100.

Laran S, Drouot-Dulau V (2007) Seasonal variation of striped dolphins, fin- and sperm whales' abundance in the Ligurian Sea (Mediterranean Sea). J Mar Biol Assoc UK 87: 345-352

Miyashita T (1993) Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Rep Int Whal Comm 43, 417-437.

Monaci F, Borrel A, Leonzio C, Marsilli L, Calzada N (1998) Trace elements in striped dolphins (*Stenella coeruleoalba*) from the western Mediterranean. Env Poll 99: 61-68.

Mullin KD (2007) Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. 26 pp. NMFS, Southeast Fisheries Science Center, P.O. Drawer 1207, Pascagoula, MS 39568.

Özturk B, Salman A, Özturk AA, Tonay A (2007) Cephalopod remains in the diet of striped dolphins (*Stenella coeruleoalba*) and risso's dolphins (*Grampus griseus*) in the Eastern Mediterranean Sea. Vie Milieu 57: 57-63.

Perrin WF, Wilson CE, Archer FI II (1994) Striped dolphin - *Stenella coeruleoalba* (Meyen, 1833). In: Handbook of marine mammals (Ridgway SH, Harrison SR. eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 129-160.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Pub 4, Lawrence, KS. USA.

Ringelstein J, Pusineri C, Hassani S, Meynier L, Nicolas R, Ridoux V (2006) Food and feeding ecology of the striped dolphin *Stenella coeruleoalba*, in the oceanic waters of the NE Atlantic. J Mar Biol Assoc UK 86: 909-918.

Rogan E, Mackey M (2007) Megafauna bycatch in drift nets for albacore tuna (*Thunnus alalunga*) in the NE Atlantic. Fish Res 86: 6-14.

Santos MB, Pierce GJ, Lopez A, Barreiro A, Guerra A (2001a) Diets of small cetaceans stranded NW Spain 1994-95. Copenhagen Denmark Ices, 6 pp.

Santos MB, Pierce GJ, Wijnsma G, Ross HM, Reid RJ (2001b) Diets of small cetaceans stranded in Scotland 1993-1995. Copenhagen Denmark Ices, 8 pp.

Spitz J, Poulard J-C, Richard E, Meynier L, Pusineri C, Ridoux V (2003) May changes in the diet of striped dolphins (*Stenella coeruleoalba*) from the Bay of Biscay reflect trends from gourndfish surveys? Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Spitz J, Richard E, Meynier L, Pusineri C, Ridoux V (2006) Dietary plasticity of the oceanic striped dolphin, *Stenella coeruleoalba*, in the neritic waters of the Bay of Biscay. J Sea Res 55: 309-320.

Stone CJ, Tasker ML (2006) The effects of seismic airguns on cetaceans in UK waters. J Cetacean Res Manage 8: 255-263

Syvertsen PO, vd Kooij J, Isaksen K (1999) The occurrence of striped dolphin *Stenella coeruleoalba* and common dolphin *Delphinus delphis* in Norwegian coastal waters. Fauna Oslo 52: 104-117.

Tudela S, Kai AK, Maynou F, El Andalossi M, Guglielmi P (2005) Driftnet fishing and biodiversity conservation: the case study of the large-scale Moroccan driftnet fleet operating in the Alboran Sea (SW Mediterranean). Biol Conserv 121: 65-78.

Wang JY, Yang SC (2006) Unusual cetacean stranding events of Taiwan in 2004 and 2005. J Cetacean Res Manage 8: 283-292.

Wafo E, Sarrazin L, Diana C, Dhermain F, Schembri T, Lagadec V, Pecchia M, Rebouillon P (2005) Accumulation and distribution of organochlorines (PCBs and DDTs) in various organs of *Stenella coeruleoalba* and a *Tursiops truncatus* from Mediterranean littoral environment (France). Sci Total Environ 348: 115-127.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, editors (2009) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Weir CR (2007) Occurrence and distribution of cetaceans off northern Angola, 2004/05. J Cetacean Res Manage 9: 225-239.

Würsig B, Lynn SK, Jefferson TA, Mullin KD (1998) Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquat Mamm 24: 41-50.

Zerbini AN, Kotas JE (1998) A note on cetacean bycatch in pelagic driftnetting off southern Brazil. Rep Int Whal Comm 48: 519-524.

3.66. Stenella frontalis

Adams LD, Rosel PE (2006) Population differentiation of the Atlantic spotted dolphin (*Stenella frontalis*) in the western North Atlantic, including the Gulf of Mexico. Mar Biol 148: 671-681.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Clua E, Grosvalet F (2001) Mixed-species feeding aggregation of dolphins, large tunas and seabirds in the Azores. Aquat Living Resour 14: 11-18.

Davis RW, Worthy GAJ, Wuersig B, Lynn SK, Townsend FI (1996) Diving behavior and at-sea movements of an Atlantic spotted dolphin in the Gulf of Mexico. Mar Mamm Sci 12: 569-581.

Delgado EA (1997) Interaction of bottlenose dolphins, *Tursiops truncatus* and spotted dolphin, *Stenella frontalis* with shrimp fishery in the Campeche Sound, Mexico. An Inst Biol U Nac Aut Mexico Ser Zool 68: 317-338.

Fertl D, Wuersig B (1995) Coordinated feeding by Atlantic spotted dolphins (*Stenella frontalis*) in the Gulf of Mexico. Aquat Mamm 21 (1): 3-5.

Green ML (2008) Assessment of genetic population structure, promiscuity, and paternity in free-ranging Atlantic spotted dolphins, *Stenella frontalis*, in the Bahamas. Dissertation Abstracts International 69, no. 03, suppl. B, 127

Griffin RB, Griffin NJ (2003) Distribution, habitat partitioning, and abundance of Atlantic spotted dolphins, bottlenose dolphins, and loggerhead sea turtles on the eastern Gulf of Mexico continental shelf. Gulf Mex Sci 21: 23-34

Griffin RB, Griffin NJ (2004) Temporal variation in Atlantic spotted dolphin (*Stenella frontalis*) and bottlenose dolphin (*Tursiops truncatus*) densities on the West Florida continental shelf. Aquat Mamm 30: 380-390.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Stenella frontalis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Herzing DL (1997) The life history of free-ranging Atlantic spotted dolphins (*Stenella frontalis*): Age classes, color phases, and female reproduction. Mar Mamm Sci 13 (4): 576-595.

Herzing DL, Johnson CM (1997) Interspecific interactions between Atlantic spotted dolphins (*Stenella frontalis*) and bottlenose dolphins (*Tursiops truncatus*) in the Bahamas, 1985-1995. Aquat Mamm 23: 85-99.

Herzing DL, Moewe K, Brunnick BJ (2003) Interspecies interactions between Atlantic spotted dolphins, *Stenella frontalis* and bottlenose dolphins, *Tursiops truncatus*, on Great Bahama Bank, Bahamas. Aquat Mamm 29: 335-341.

Hucke-Gaete R (2000) Review of the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Schiro AJ (1997) Distribution of cetaceans in the offshore Gulf of Mexico. Mamm Rev 27: 27-50.

Jefferson TA, Webber MA, Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Kajiwara N, Matsuoka S, Iwata H, Tanabe S, Rosas FCW, Fillmann G, Readman JW (2004) Contamination by persistent organochlorines in cetaceans incidentally caught along Brazilian coastal waters. Arch Environ Contam Toxicol 46: 124-134.

Mignucci GAA, Pinto RB, Velasco EM, Montoya ORA, Jimenez MNM, Rodriguez LMA, Williams EH, Odell DK (1999) Cetacean strandings in Puerto Rico and the Virgin Islands. J Cet Res Manag 1: 191-198.

Mullin KD, Fulling GL (1998) Abundance of cetaceans in the southern U.S. North Atlantic Ocean during summer 1998. Fish Bull 101 : 603-613.

Nieri M, Garu E, Lamarche B, Aguilar A (1999) Mass mortality of Atlantic spotted dolphins (*Stenella frontalis*) caused by a fishing interaction in Mauritania. Mar Mamm Sci 15: 847-854.

Perrin WF (2009) Atlantic spotted dolphin - *Stenella frontalis*. In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 54-56.

Perrin WF, Caldwell DK, Caldwell MC (1994) Atlantic spotted dolphin - *Stenella frontalis* (Gray, 1828). In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 173-190.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Ritter F (2003) Interactions of cetaceans with whale watching boats-implications for the management of whale watching tourism. M.E.E.R. e.V., Berlin, Germany, 91 pp. (www.M-E-E-R.org)

Siciliano S, Ramos RMA, Di Beneditto APM, Santos MCO, Fragoso AB, Brito JLJr, Azevedo AF, Vicente AFC, Zampirolli E, Alvarenga FS, Barbosa L, Lima NRW (2007) Age and growth of some delphinids in south-Eastern Brazil. J Mar Biol Assoc UK 87: 293-303.

Silva MA, Prieto R, Magalhaes S, Cabecinhas R, Cruz A, Goncalves JM, Santos RS (2003) Occurrence and distribution of cetaceans in the waters around the Azores (Portugal), Summer and Autumn 1999-2000. Aquat Mamm 29: 77-83.

Van Waerebeek K, Ndiaye E, Djiba A, Diallo M, Murphy P, Jallow A, Camara A, Ndiaye P, Tous P (2000) A survey of the conservation status of cetaceans in Senegal, the Gambia and Guinea-Bissau. UNEP/CMS Secretariat, Bonn, Germany, 80 pp.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, eds. (2009) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Watanabe M, Kannan K, Takahashi A, Loganathan BG, Odell DK, Tanabe S, Giesy JP (2000) Polychlorinated biphenyls, organochlorine pesticides, tris(4-chlorophenyl) methane, and tris(4-chlorophenyl)methanol in livers of small cetaceans stranded along Florida coastal waters, USA. Env Tox Chem 19: 1566-1574

Weir CR (2008) Overt responses of humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), and Atlantic spotted dolphins (*Stenella frontalis*) to seismic exploration off Angola. Aquat Mamm 34: 71-83

Zerbini AN, Kotas JE (2001) A note on cetacean bycatch in pelagic driftnetting off southern Brazil. Rep Int Whal Comm 48:-519-524.

3.67. Stenella longirostris

Ali O, Jiddawi NS (1999) Dolphin tourism and community participation in Zanzibar: The case of Kizimkazi Village. Conference on Advances on Marine Sciences in Tanzania Zanzibar Tanzania Ims 1999, p. 48.

Amir OA, Berggren P, Jiddawi P (2003) The incidental catch of dolphins in gillnet fisheries in Zanzibar, Tanzania. West Indian Ocean J Mar Sci 1: 155-162.

Amir OA, Jiddawi NS, Berggren P (2005) The occurrence and distribution of dolphins in Zanzibar, Tanzania, with comments on the differences between two species of *Tursiops*. W Ind Ocean J Mar Sci 4: 85-93.

Andrews KR, Karczmarski L, Au WWL, Rickards SH, Vanderlip CA, Toonen RJ (2006) Patterns of genetic diversity of the Hawaiian spinner dolphin (*Stenella longirostris*). Atoll Res Bull 543: 65-73.

Ballance LT, Pitman RL (1998) Cetaceans of the western tropical Indian Ocean: Distribution, relative abundance, and comparisons with cetacean communities of two other tropical ecosystems. Mar Mamm Sci 14: 429-459.

Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Mar Mamm Sci 22: 446-464.

Benoit-Bird K, Au W (2003) Hawaiian spinner dolphins aggregate midwater food resources through cooperative foraging. J Acoust Soc Am 114: 2300.

Cannier A, Petiau E (2006) Environmental variables affecting the residence of spinner Dolphins (*Stenella longirostris*) in a Bay of Tahiti (French Polynesia). Aquat Mamm 32: 202-211

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Cockroft VG (1990) Dolphin catches in the Natal shark nets, 1980 to 1988. S Afr J Wildl Res 20: 44-51.

Cramer KL, Perryman WL, Gerrodette T (2008) Declines in reproductive output in two dolphin populations depleted by the yellowfin tuna purse-seine fishery. Mar Ecol Prog Ser 369: 273-285.

Davis RW, Fargion GS, May N, Leming TD, Baumgartner M, Evans WE, Hansen LJ, Mullin K (1998) Physical habitat of cetaceans along the continental slope in the north-central and western Gulf of Mexico. Mar Mamm Sci 14: 490-507.

Delfour F (2007) Hawaiian spinner dolphins and the growing dolphin watching activity in Oahu. J Mar Biol Assoc UK 87: 109-112.

Dolar MLL, Leatherwood SJ, Wood CJ, Alava MNR, Hill CL, Aragones LV (1994) Directed Fisheries for Cetaceans in the Philippines. Rep Int Whal Comm 44: 439-449.

Dolar MLL, Perrin WF, Taylor BL, Kooyman GL, Alava MNR (2006) Abundance and distributional ecology of cetaceans in the central Philippines. J Cetacean Res Manage 8: 93-111.

Dolar MLL, Walker WA, Kooyman GL, Perrin WF (2003) Comparative feeding ecology of spinner dolphins (*Stenella longirostris*) and Fraser's dolphins (*Lagenodelphis hosei*) in the Sulu Sea. Mar Mamm Sci 19: 1-19.

Fish FE, Nicastro AJ, Weihs D (2006) Dynamics of the aerial maneuvers of spinner dolphins. J Exp Biol 209: 590-598.

Forney KA, Kobayashi DR (2007) Updated estimates of mortality and injury of cetaceans in the Hawaii-based longline fishery, 1994-2005. NOAA Tech Memo NMFS SWFSC- 412, 35 pp.

Gannier A (2002) Cetaceans of the Marquesas Islands (French Polynesia): distribution and relative abundance as obtained from a small boat dedicated survey. Aquat Mamm 28: 198-210.

Gerrodette T (2002) Tuna-dolphin issue. In: Perrin WF, Wursig B and Thewissen JGM (eds), Encyclopedia of Marine Mammals, pp. 1269-1273. Academic Press, San Diego, California, USA.

Gerrodette T, Forcada J (2005) Non-recovery of two spotted and spinner dolphin populations in the eastern tropical Pacific Ocean. Mar Ecol Prog Ser 291: 1-21.

Gerrodette T, Watters G, Forcada J (2005) Preliminary estimates of 2003 dolphin abundance in the eastern tropical Pacific. SWFSC. Admin Rep LJ-05-05

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Stenella longirostris*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

IATTC Inter-American Tropical Tuna Commission (2009) Annual Report 2007: 113 pp.

Ilangakoon A (1997) Species composition, seasonal variation, sex ratio and body length of small cetaceans caught off west, south-west and south coast of Sri Lanka. J Bombay Nat Hist Soc 94: 298-306.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA, Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Johnston DW, Robbins J, Chapla ME, Mattila DK, Andrews KR (2008) Diversity, habitat associations and stock structure of odontocete cetaceans in the waters of American Samoa, 2003-06. J Cetacean Res Manage10: 59-66.

Kajiwara N, Kamikawa S, Ramu K, Ueno D, Yamada TK, Subramanian A, Lam PKS, Jefferson TA, Prudente M, Chung K-H, Tanabe S (2006) Geographical distribution of polybrominated diphenyl ethers (PBDEs) and organochlorines in small cetaceans from Asian waters. Chemosphere 64 : 287-295.

Karuppiah S, Subramanian A, Obbard JP (2005) Organochlorine residues in odontocete species from the southeast coast of India. Chemosphere 60 : 891-897.

Karczmarski L, Würsig B, Gailey G, Larson KW, Vanderlip C (2005) Spinner dolphins in a remote Hawaiian atoll: social grouping and population structure. Behav Ecol 16: 675-685

Kiszka J, Ersts PJ, Ridoux V (2007) Cetacean diversity around the Mozambique Channel Island of Mayotte (Comoros archipelago). J Cetacean Res Manage 9: 105-109.

Larese JP, Chivers SJ (2008) Age estimates for female eastern and whitebelly spinner dolphins (*Stenella longirostris*) incidentally killed in the eastern tropical Pacific tuna purse-seine fishery from 1973-82. J Cetacean Res Manage 10: 169-177.

Lennert-Cody CE, Minami M, Hall MA (2004) Incidental mortality of dolphins in the eastern Pacific Ocean purse-seine fishery: correlates and their spatial association. J Cetacean Res Manage 6: 151-163.

Marten K, Psarakos S (1999) Long-term site fidelity and possible long-term associations of wild spinner dolphins (*Stenella longirostris*) seen off Oahu, Hawaii. Mar Mamm Sci 15: 1329-1336.

Mullin KD (2007) Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. 26 pp. Available from: NMFS, Southeast Fisheries Science Center, P.O. Drawer 1207, Pascagoula, MS 39568.

Norris KS, Würsig B, Wells RS, Würsig M (1994) The Hawaiian spinner dolphin. U Cal Press, Berkeley, Cal., USA.

Oremus M, Poole MM, Steel D, Baker CS (2007) Isolation and interchange among insular spinner dolphin communities in the South Pacific revealed by individual identification and genetic diversity. Mar Ecol Prog Ser 336: 275-289.

Perrin WF (1990) Subspecies of *Stenella longirostris* (Mammalia: Cetacea: Delphinidae). Proc Biol Soc Washington 103 (2): 453- 463.

Perrin WF (1998) *Stenella longirostris*. Mamm Spec 599: 1-7.

Perrin WF (1999) Selected examples of small cetaceans at risk. In: Conservation and management of marine mammals (Twiss JR, Reeves RR, eds.) Smithsonian Institution Press, Washington DC, pp. 296-310.

Perrin WF (2009) Spinner dolphin - *Stenella longirostris*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) 2nd ed. Academic Press, Amsterdam, pp. 1100-1103.

Perrin WF, Gilpatrick JW JR (1994) Spinner dolphin - *Stenella longirostris* (Gray, 1828). In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 99-128.

Perrin, WF, Mesnick, SL (2003) Sexual ecology of the spinner dolphin, *Stenella longirostris*: geographic variation in mating system. Marine Mammal Science 19:462-483.

Perrin WF, Dolar MLL, Robineau D (1999) Spinner dolphins (*Stenella longirostris*) of the western Pacific and Southeast Asia: Pelagic and shallow-water forms. Mar Mamm Sci 15: 1029-1053.

Perryman WL, Westlake RL (1998) A new geographic form of the spinner dolphin, *Stenella longirostris*, detected with aerial photogrammetry. Mar Mamm Sci 14: 38-50.

Psarakos S, Herzing DL, Marten K (2003) Mixed-species associations between pantropical spotted dolphins (*Stenella attenuata*) and Hawaiian spinner dolphins (*Stenella longirostris*) off Oahu, Hawaii. Aquat Mamm 29: 390-395.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP/CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy Spec Pub 4 , Lawrence, KS. USA.

Ruelas Inzunza JR, Horvat M, Perez Cortes H, Paez Osuna F (2003) Methylmercury and total mercury distribution in tissues of gray whales *Eschrichtius robustus* and spinner dolphins *Stenella longirostris* stranded along the lower Gulf of California, Mexico. Cienc Mar 29: 1-8.

Sazima I, Sazima C, Silva JMJr (2003) The cetacean offal connection: Feces and vomits of spinner dolphins as a food source for reef fishes. Bull Mar Sci 72:151-160.

Silva JMJr, Silva FJL, Sazima I (2005) Two presumed interspecific hybrids in the genus *Stenella* (Delphinidae) in the tropical West Atlantic. Aquat Mamm 31: 468-472.

Smith BD, Thant UH, Lwin JM, Shaw CD (1997a) Investigation of cetaceans in the Ayeyarwady river and northern Coastal waters in Myanmar. Asian Marine Biology 14: 173-194.

Smith BD, Jefferson TA, Leatherwood S, Ho DT, Van TC, Hai QL (1997b) Investigations of marine mammals in Vietnam. Asian Marine Biology 14: 145-172.

Smith BD, Tun MT (2008) A note on the species occurrence, distributional ecology and fisheries interactions of cetaceans in the Mergui (Myeik) Archipelago, Myanmar. J Cetacean Res Manage 10: 37-44.

Tanabe S, Subramanian A, Ramesh A, Kumaran PL, Miyazaki N, Tatsukawa R (1993) Persistent organochlorine residues in dolphins from the Bay of Bengal, south India. Mar Pollut Bull 26: 311-316.

Timmel G, Courbis S, Sargeant-Green H, Markowitz H (2008) Effects of human traffic on the movement patterns of Hawaiian spinner dolphins (*Stenella longirostris*) in Kealakekua Bay, Hawaii. Aquat Mamm 34: 402-411.

Velayudham P, Venkataramanujam K (1995) Distribution of trace metals in *Stenella longirostris*. Aqua Int 3(3): 26-30.

Velayutham P, Venkataramanujam K, Ramadhas V, Nair PGV (1994) Distribution of mercury in different organs of the spinner dolphin, *Stenella longirostris*. Nutrients And Bioactive Substances In Aquatic Organisms. Papers Presented In The Symposium Held In Cochin, India 16 17 September 1993. Eds.: Devadasan K, Mukundan MK, Antony PD, Nair P GV, Perigreen PA, Joseph J. Cochin India Society Of Fisheries 286-289.

Van Waerebeek K, Gallagher M, Baldwin R, Papastavrou V, Al Lawati SM (1999) Morphology and distribution of the spinner dolphin, *Stenella longirostris*, rough-toothed dolphin, *Steno bredanensis* and melon-headed whale, *Peponocephala electra*, from waters off the Sultanate of Oman. J Cetacean Res Manage 1: 167-177.

Van Waerebeek K, Ndiaye E, Djiba A, Diallo M, Murphy P, Jallow A, Camara A, Ndiaye P, Tous P (2000) A survey of the conservation status of cetaceans in Senegal, the Gambia and Guinea-Bissau. UNEP/CMS Secretariat, Bonn, Germany, 80 pp.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, editors (2009) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Zerbini AN, Kotas JE (1998) A note on cetacean bycatch in pelagic driftnetting off southern Brazil. Rep Int Whal Comm 48: 519-524.

3.68. Steno bredanensis

Baird RW, Webster DL, Mahaffy SD, McSweeney DJ, Schorr GS, Ligon AD (2008) Site fidelity and association patterns in a deep-water dolphin: Rough-toothed dolphins (*Steno bredanensis*) in the Hawaiian Archipelago. Mar Mamm Sci 24: 535-553.

Barlow J (2006) cetacean abundance in hawaiian water estimated from a summer/fall survey in 2002. Mar Mamm Sci 22: 446-464.

Carwardine M (1995) Whales, dolphins and porpoises. Dorling Kindersley, London, UK, 257 pp.

Ferrero RC, Hodder J, Cesarone J (1994) Recent strandings of rough-toothed dolphins (*Steno bredanensis*) on the Oregon and Washington coasts. Mar Mamm Sci 10: 114-116.

Gannier A (2002) Cetaceans of the Marquesas Islands (French Polynesia): distribution and relative abundance as obtained from a small boat dedicated survey. Aquat Mamm 28: 198-210

Gannier A, West KL (2005) Distribution of the rough-toothed dolphin (*Steno bredanensis*) around the Windward Islands (French Polynesia). Pac Sci 59: 17-24

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Steno bredanensis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>

Huang JS, Jia XP, Gan JL (2007) Distribution and toxicity assessment of polychlorinated biphenyls (PCBs) in tissues of rough-toothed dolphin (*Steno bredanensis*) from Dapeng Bay, Guangdong, China. J Fish Sci China 14: 974-980

Hucke-Gaete R (2000) Review of the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA (2009) Rough-toothed dolphin - *Steno bredanensis*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.). Second Edition. Academic Press, Amsterdam, pp. 990-992.

Johnston DW, Robbins J, Chapla ME, Mattila DK, Andrews KR (2008) Diversity, habitat associations and stock structure of odontocete cetaceans in the waters of American Samoa, 2003-06. J Cetacean Res Manage 10: 59-66.

Kuczaj SA, Yeater DB (2007) Observations of rough-toothed dolphins (*Steno bredanensis*) off the coast of Utila, Honduras. J Mar Biol Assoc UK 87:141-148

Maigret J (1995) *Steno bredanensis* - Rauhzahn-Delphin. In: Handbuch der Säugetiere Europas. Band 6: Meeressäuger. Teil 1A: Wale und Delphine 1 (Niethammer J, Krapp F, eds.) Aula-Verlag, Wiesbaden, Germany, pp. 269-280.

Marsili L, Focardi S (1997) Chlorinated hydrocarbon HCB, DDTs and PCBs levels in cetaceans stranded along the Italian coasts: An overview. Env Mon Ass 45: 129-180.

MacLeod CD, Bennett E (2007) Pantropical spotted dolphins (*Stenella attenuata*) and other cetaceans around St Helena in the tropical south-eastern Atlantic. J Mar Biol Assoc UK 87: 339-344

Miyazaki N, Perrin WF (1994) Rough-toothed dolphin *Steno bredanensis* (Lesson, 1828) In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 5: The first book of dolphins. Academic Press, London, pp. 1-22.

Monteiro NC, Alves JTT, Avila FJC, Campos AA, Costa AF, Silva CPN, Furtado NMAA (2000) Impact of fisheries on the tucuxi (*Sotalia fluviatilis*) and rough-toothed dolphin (*Steno bredanensis*) populations off Ceara state, northeastern Brazil. Aquat Mamm 26: 49-56.

Ott PH, Danilewicz D (1996) Southward range extension of *Steno bredanensis* in the southwest Atlantic and new records of *Stenella coeruleoalba* for Brazilian waters. Aquat Mamm 22: 185-189.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Pitman RL, Stinchcomb C (2002) Rough-toothed dolphins (*Steno bredanensis*) as predators of mahimahi (*Coryphaena hippurus*). Pac Sci 56: 447-450

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mamma-logy, Special Publication 4, Lawrence, KS. USA.

Ritter F (2002) Behavioural observations of rough-toothed dolphins (*Steno bredanensis*) off La Gomera, Canary Islands (1995-2000), with special reference to their interactions with humans. Aquat Mamm 28: 46-59.

Tuerk KJS, Kucklick JR, Becker PR, Stapleton HM, Baker JE (2005) Persistent organic pollutants in two dolphin species with focus on toxaphene and polybrominated diphenyl ethers. Environ Sci Technol 39: 692.

Wade PR, Gerrodette T (1993) Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep Int Whal Comm 43: 477-493

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, editors (2008) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Weir CR (2007) Occurrence and distribution of cetaceans off northern Angola, 2004/05. J Cetacean Res Manage 9: 225-239.

3.69. Tasmacetus shepherdi

Hucke-Gaete R (2000) Review of the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Mead JG (2009) Shepherd's beaked whale - *Tasmacetus shepherdi*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 1011-1014.

Mead JG (2002) Shepherd's beaked whale - *Tasmacetus shepherdi*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 1078-1081.

Mead JG (1989) Shepherd's Beaked Whale - *Tasmacetus shepherdi* Olivier, 1937. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 309-320.

Mead JG, Payne RS (1975) A specimen of the Tasman beaked whale *Tasmacetus shepherdi* from Argentina J Mammal 56: 213-218

Pitman RL, van Helden AL, Best PB, Pym A (2006) Shepherd's beaked whale (*Tasmacetus shepherdi*): information on appearance and biology based on strandings and at-sea observations. Mar Mamm Sci 22: 744-755

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Tasmacetus shepherdi*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>.

3.70. Tursiops aduncus

Amir O, Berggren P, Jiddawi NS (2007) Reproductive biology of the male Indo-Pacific bottlenose dolphin (*Tursiops aduncus*). 5th Western Indian Ocean Marine Science Association Scientific Symposium; Science, Policy and Management pressures and responses in the Western Indian Ocean region; Book of Abstracts.

Amir OA, Berggren P, Jiddawi P (2002) The incidental catch of dolphins in gillnet fisheries in Zanzibar, Tanzania. West Indian Ocean J Mar Sci 1: 155-162

Amir OA, Berggren P, Ndaro SGM, Jiddawi NS (2005a) Feeding ecology of the Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) incidentally caught in the gillnet fisheries off Zanzibar, Tanzania. Estuar Coast Shelf Sci 63: 429-437

Amir OA, Jiddawi NS, Berggren P (2005b) The occurrence and distribution of dolphins in Zanzibar, Tanzania, with domments on the differences between two species of *Tursiops*. West Indian Ocean J Mar Sci 4: 85-93

Chilvers BL, Corkeron PJ (2003) Abundance of Indo-Pacific bottlenose dolphins, *Tursiops aduncus*, off Point Lookout, Queensland, Australia. Mar Mamm Sci 19: 85-95

Connor RC, Heithaus MR, Barre LM (2001) Complex social structure, alliance stability and mating access in a bottlenose dolphin 'super-alliance'. Proc R Soc Lond B: Biol Sci 268: 263-267.

Connor RC, Smolker R, Bejder L (2006) Synchrony, social behaviour and alliance affiliation in Indian Ocean bottlenose dolphins, *Tursiops aduncus*. Anim Behav 72: 1371-1378

Cribb N (2006) density estimates and habitat charcterizations of bottlenose dolphins (*Tursiops aduncus*) in the Adelaide Dolphin Sanctuary, South Australia. HS Thesis, Flinders U., 84 pp.

Curry BE, Smith J (1997) Phylogeographic structure of the bottlenose dolphin (*Tursiops truncatus*): stock identification and implications for management. In: A. E. Dizon, S. J. Chivers and W. F. Perrin (eds), Molecular genetics of marine mammals, pp. 227-247. The Society of Marine Mammalogy, Allen Press, Lawrence.

Fury CA, Harrison PL (2008) Abundance, site fidelity and range patterns of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in two Australian subtropical estuaries. Mar Freshw Res 59:1015-1027

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Tursiops aduncus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Heithaus MR (2001) Shark attacks on bottlenose dolphins (*Tursiops aduncus*) in Shark Bay, Western Australia: Attack rate, bite scar frequencies, and attack seasonality. Mar Mamm Sci 17: 526-539

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Lavery TJ, Butterfield N, Kemper CM, Reid RJ, Sanderson K (2008) Metals and selenium in the liver and bone of three dolphin species from South Australia, 1988-2004. Sci Total Environ 390: 77-85

Lavery TJ, Kemper CM, Sanderson K, Schultz CG, Coyle P, Mitchell JG, Seuront L (2009) Heavy metal toxicity of kidney and bone tissues in South Australian adult bottlenose dolphins (*Tursiops aduncus*). Mar Environ Res 67 : 1-7.

Lukoschek V, Chilvers BL (2008) A robust baseline for bottlenose dolphin abundance in coastal Moreton Bay: a large carnivore living in a region of escalating anthropogenic impacts. Wildl Res 35 : 593-605

Möller LM, Beheregaray LB (2001) Coastal bottlenose dolphins from south-eastern Australia are *Tursiops aduncus* according to sequences of the mitochondrial DNA control region. Mar Mamm Sci 17: 249-263.

Nanbu Y, Hirose J, Kubo N, Kishiro T, Shinomiya A (2006) Location and number of individuals of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in Kagoshima Bay. Mem Fac Fish Kagoshima Univ 55: 51-60

Natoli A, Peddemors VM, Hoelzel AR (2008) Population structure of bottlenose dolphins (*Tursiops aduncus*) impacted by bycatch along the east coast of South Africa. Conserv Genet 9: 627-636

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the Workshop on the Biology and Conservation of Small cetaceans and Dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Preen A (2004) Distribution, abundance and conservation status of dugongs and dolphins in the southern and western Arabian Gulf. Biol Conserv 118: 205-218.

Preen AR, Marsh H, Lawler IH, Prince RIT, Shepherd R (1997) Distribution and abundance of dugongs, turtles, dolphins and other megafauna in Shark Bay, Ningaloo Reef and Exmouth Gulf, Western Australia. Wildl Res 24:185-208.

Reeves RR, Brownell RL (2009) Indo-Pacific Bottlenose Dolphin Assessment Workshop: Solomon case study of Tursiops aduncus. Occasional Paper of the IUCN Species Survival Commission No. 40.

Shirakihara M, Shirakihara K, Tomonaga J, Takatsuki M (2002) A resident population of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in Amakusa, western Kyushu, Japan. Mar Mamm Sci 18: 30-41

Steiner A, Bossley M (2008) Some reproductive parameters of an estuarine population of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*). Aquat Mamm 34: 84-92

Stensland E (2004) Behavioural ecology of Indo-Pacific bottlenose and humpback dolphins. PhD Thesis, Stockholm Universtiy, Stockholm (Sweden). 118 pp.

Stensland E, Berggren P (2007) Behavioural changes in female Indo-Pacific bottlenose dolphins in response to boat-based tourism. Mar Ecol Prog Ser 332: 225-234.

Wang JY, Chou LS, White BN (1999) Mitochondrial DNA analysis of sympatric morphotypes of bottlenose dolphins (genus: *Tursiops*) in Chinese waters. Mol Ecol 8: 1603-1612.

Wang JY, Yang AC (2009) Indo-Pacific bottlenose dolphin (*Tursiops aduncus*). In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 602-608

Wells RS, Scott MD (2002) Bottlenose dolphins. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 122-125.

3.71. Tursiops truncatus

Ali O, Jiddawi NS (1999) Dolphin tourism and community participation in Zanzibar: The case of Kizimkazi Village. Conference on Advances on Marine Sciences in Tanzania Zanzibar Tanzania Ims 1999, p. 48.

Amir O, Jiddawi NS (2007) Stranding event of the common bottlenose dolphin (*Tursiops truncatus*) in the northern part of Zanzibar, April 2006 5th Western Indian Ocean Marine Science Association Scientific Symposium; Science, Policy and Management Pressures and Rresponses in the Western Indian Ocean region; Book of Abstracts.

Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Anim Conserv 9: 474-482.

Barlow J (2003) Preliminary estimates of the abundance of cetaceans along the U.S. west coast: 1991_2001. Southwest Fisheries Science Center Administrative Report LJ_03_03.

Bearzi G, Agazzi S, Bonizzoni S, Costa M, Azzellino A (2008) Dolphins in a bottle: abundance, residency patterns and conservation of bottlenose dolphins *Tursiops truncatus* in the semi-closed eutrophic Amvrakikos Gulf, Greece. Aquat Conserv: Mar Freshw Ecosyst 18: 130-146.

Bearzi G, Fortuna CM, Reeves RR (2009) Ecology and conservation of common bottlenose dolphins *Tursiops truncatus* in the Mediterranean Sea. Mamm Rev 39: 92-123.

Bearzi G, Politi E, Agazzi S, Bruno S, Costa M, Bonizzoni S (2005) Occurrence and present status of coastal dolphins (*Delphinus delphis* and *Tursiops truncatus*) in the eastern Ionian Sea. Aquat Conserv: Mar Freshwat Ecosyst 15: 243-257.

Bearzi M (2005) Aspects of the ecology and behaviour of bottlenose dolphins (*Tursiops truncatus*) in Santa Monica Bay, California. J Cetacean Res Manag 7: 75-83

Birkun JrAA (2008) *Tursiops truncatus* ssp. ponticus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Bloch D (1998) A review of marine mammals observed, caught or stranded over the last two centuries in Faroese Waters. Shetland Sea Mammal Report, 1997: 15-30.

Bloch D, Mikkelsen B (2000) Preliminary estimates on seasonal abundance and food consumption of Marine Mammals in Faroese Waters. NAMMCO WG on Marine Mammal and Fisheries Interactions. Copenhagen 17-18 February 2000. SC/8/EC/7: 1-16.

Brotons JM, Munilla Z, Grau AM, Rendell L (2008) Do pingers reduce interactions between bottlenose dolphins and nets around the Balearic Islands? Endang Species Res 5: 301-308

Burdett LG, McFee WE (2004) Bycatch of bottlenose dolphins in South Carolina, USA, and an evaluation of the atlantic blue crab fishery categorisation. J Cetacean Res Manag 6: 231-240.

Byrd BL, Hohn AA, Munden FH, Lovewell GN, Lo Piccolo RE (2008) Effects of commercial fishing regulations on stranding rates of bottlenose dolphin (*Tursiops truncatus*). Fish Bull 106: 72-81

Cañadas A, Hammond PS (2006) Model-based abundance estimates for bottlenose dolphins off southern Spain: implications for conservation and management. J Cetacean Res Manag 8: 13-27.

Carretta JV, Forney KA, Lowry MS, Barlow J, Baker J, Johnston D, Hanson, Muto MM, Lynch D, Carswell L (2009) U.S. Pacific Marine Mammal Stock Assessments: 2008. NOAA-TM-NMFS-SWFSC-434

Constantine R, Brunton DH, Dennis T (2004) Dolphin-watching tour boats change bottlenose dolphin (*Tursiops truncatus*) behaviour. Biol Conserv 117: 299-307.

Cox TM, Read AJ, Swanner D, Urian K, Waples D (2004) Behavioural responses of bottlenose dolphins, *Tursiops truncatus*, to gillnets and acoustic alarms. Biol Conserv 115: 203-212.

Defran RH, Weller DW, Kelly DL, Espinosa MA (1999) Range characteristics of Pacific coast bottlenose dolphins (*Tursiops truncatus*) in the Southern California Bight. Mar Mamm Sci 15: 381-393.

Dolar MLL, Perrin WF, Taylor BL, Kooyman GL, Alava MNR (2006) Abundance and distributional ecology of cetaceans in the central Philippines. J Cetacean Res Manage 8: 93-112.

Fair PA, Mitchum G, Hulsey TC, Adams J, Zolman E, McFee W, Wirth E, Bossart GD (2007) Polybrominated diphenyl ethers (PBDEs) in blubber of free-ranging bottlenose dolphins (*Tursiops truncatus*) from two southeast Atlantic estuarine areas. Arch Environ Contam Toxicol 53: 483-494

Fire SE, Fauquier D, Flewelling LJ, Henry M, Naar J, Pierce R, Wells RS (2007) Brevetoxin exposure in bottlenose dolphins (*Tursiops truncatus*) associated with *Karenia brevis* blooms in Sarasota Bay, Florida. Mar Biol 152: 827-834.

Focardi S, Corsolini S, Aurigi S, Pecetti G, Sanchez Hernandez JC (2000) Accumulation of butyltin compounds in dolphins stranded along the Mediterranean Coasts. Appl Organomet Chem 14: 48-56.

Forcada J, Gazo M, Aguilar A, Gonzalvo J, Fernandez-Contreras M (2004) Bottlenose dolphin abundance in the NW Mediterranean: Addressing heterogeneity in distribution. Mar Ecol Prog Ser 275: 275-287.

Forney KA (2007) Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. NOAA Tech Memo NMFS-SWFSC-406. 27 p.

Forney KA, Kobayashi DR (2007) Updated estimates of mortality and injury of cetaceans in the Hawaii-based longline fishery, 1994-2005. NOAA Tech Memo NMFS SWFSC. no. 412, 35 pp

Frodello JP, Romeo M, Viale D (2000) Distribution of mercury in the organs and tissues of five toothed-whale species of the Mediterranean. Env Poll 108: 447-452.

Gannon DP, Barros NB, Nowacek DP, Read AJ, Waples DM, Wells RS (2005) Prey detection by bottlenose dolphins, *Tursiops truncatus*: an experimental test of the passive listening hypothesis. Anim Behav 69: 709-720.

Gannon DP, Waples DM (2004) Diets of coastal bottlenose dolphins from the U.S. Mid-Atlantic coast differ by habitat. Mar Mamm Sci.20: 527-545.

Gomercic MD, Galov A, Gomercic T, Skrtic D, Curkovic S, Lucic H, Vukovic S, Arbanasic H, Gomercic H (2009) Bottlenose dolphin (*Tursiops truncatus*) depredation resulting in larynx strangulation with gill-net parts. Mar Mamm Sci 25: 392-401.

Gomez de Segura A, Crespo EA, Pedraza SN, Hammond PS, Raga JA (2006) Abundance of small cetaceans in waters of the central Spanish Mediterranean. Mar Biol 150: 149-160

Good C, Craig K, Hazen E, Crowder L, Read A (2006) Distribution of bottlenose Dolphins (*Tursiops truncatus*) in the northern Gulf of Mexico in relation to summertime hypoxic events. EOS Trans Am Geophys Union 87: 36

Goodwin L, Cotton PA (2004) Effects of boat traffic on the behaviour of bottlenose dolphins (*Tursiops truncatus*). Aquat Mamm 30: 279-283.

Hale PT, Barreto AS, Ross GJB (2000) Comparative morphology and distribution of the *aduncus* and *truncatus* forms of bottlenose dolphin *Tursiops* in the Indian and western Pacific Oceans. Aquat Mamm 26: 101-110.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B (2008) *Tursiops truncatus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hammond PS, McLeod K, Scheidat M (2006) SCANS II estimates of abundances. http://biology.st-andrews.ac.uk/scans2/inner-furtherInfo.html.

Hastie GD, Wilson B, Wilson LJ, Parsons KM, Thompson PM (2004) Functional mechanisms underlying cetacean distribution patterns: Hotspots for bottlenose dolphins are linked to foraging. Mar Biol 144: 397-403.

Henderson EE, Würsig B (2007) Behavior patterns of bottlenose dolphins in San Luis Pass, Texas. Gulf Mex Sci 25: 153-161.

Iwasaki T (2008) Japan. Progress report on small cetacean research April 2007 to March 2008, with statistical data for the calendar year 2007. International Whaling commission SM / 2008. http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h19_progress_report.pdf

Janik VM, Sayigh LS, Wells RS (2006) Signature whistle shape conveys identity information to bottlenose dolphins. Proc Natl Acad Sci USA 103: 8293-8297.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Jefferson TA, Webber MA Pitman RL (2008) Marine mammals of the world. Elsevier, Amsterdam, 573 pp.

Karuppiah S, Subramanian A, Obbard JP (2005) Organochlorine residues in odontocete species from the southeast coast of India. Chemosphere 60: 891-897.

Klatsky LJ, Wells RS, Sweeney JC (2007) Offshore bottlenose dolphins (*Tursiops truncatus*): movement and dive behavior near the Bermuda pedestal. J Mammal 88: 59-66.

Lahvis GP, Wells RS, Kuehl DW, Stewart JL, Rhinehart HL, Via CS (1995) decreased lymphocyte responses in free-ranging bottlenose dolphins (*Tursiops truncatus*) are associated with increased concentrations of PCBs and DDT in peripheral blood. Env Health Persp 103(Suppl 4): 67-72.

Le LTH, Takahashi S, Saeki K, Nakatani N, Tanabe S, Miyazaki N, Fujise Y (1999) High percentage of butyltin residues in total tin in the livers of cetaceans from Japanese coastal waters. Env Sci Tech 33: 1781-1786.

LeDuc RG, Perrin WF, Dizon AE (1999) Phylogenetic relationships among the delphinid cetaceans based on full cytochrome B sequences. Mar Mamm Sci 15: 619-648.

Litz JA, Garrison LP, Fieber LA, Martinez A, Contillo JP, Kucklick JR (2007) Fine-scale spatial variation of persistent organic pollutants in bottlenose dolphins (*Tursiops truncatus*) in Biscayne Bay, Florida. Environ Sci Technol 41: 7222-7228.

Maresh JL, Fish FE, Nowacek DP, Nowacek SM, Wells RS (2004) High performance turning capabilities during foraging by bottlenose dolphins (*Tursiops truncatus*). Mar Mamm Sci 20: 498-509.

Mattson MC, Thomas JA, Aubin DSt (2005) Effects of boat activity on the behavior of bottlenose dolphins (*Tursiops truncatus*) in waters Surrounding Hilton Head Island, South Carolina. Aquat Mamm 31: 133-140.

Maze K S, Würsig B (1999) Bottlenose dolphins of San Luis Pass, Texas: Occurrence patterns, site-fidelity, and habitat use. Aquat Mamm 25: 91-103.

McLellan WM, Friedlaender AS, Mead JG, Potter CW, Pabst DA (2003) Analysing 25 years of bottlenose dolphin (*Tursiops truncatus*) strandings along the Atlantic coast of the USA: do historic records support the coastal migratory stock hypothesis? J Cetacean Res Manage 4: 297-304.

Miyashita T (1993) Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Rep Int Whaling Comm 43: 417-437.

Mooney T, Nachtigall PE, Au WW, Breese M, Vlachos S (2006) The effects of noise intensity and exposure duration and potential protective mechanisms in the bottlenose Dolphin (*Tursiops truncatus*). EOS Trans Am Geophys Union 87: no. 36

Mooney TA, Nachtigall PE, Au WWL (2004) Target strength of a nylon monofilament and an acoustically enhanced gillnet: predictions of biosonar detection ranges. Aquat Mamm 30: 220-226.

Mullin KD (2007) Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. NMFS, Southeast Fisheries Science Center, 26 pp.

NAMMCO (2008) Report of the meeting of the management committee for cetaceans. September 2008, Sisimiut, Greenland.

NOAA (2009) Harmful algal blooms. http://oceanservice.noaa.gov/topics/coasts/hab/

Northridge S (2003) A preliminary assessment of dolphin bycatch in trawl fisheries in the English Channel. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Nowacek SM, Wells RS, Solow AR (2001) Short-term effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. Mar Mamm Sci 17: 673-688.

Pate SM (2008) Stomach content analysis of stranded bottlenose dolphins (*Tursiops truncatus*) in South Carolina. Masters Abstracts International 46, no. 05, 255 p

Peddemors VM (1999) Delphinids of southern Africa: A review of their distribution, status and life history. J Cetacean Res Manag 1: 157-165.

Pierrepont Jfde, Dubois B, Desormonts S, Santos MB, Robin JP (2005) Stomach contents of the English Channel cetaceans stranded on the coast of Normandy. J Mar Biol Assoc UK 85: 1539-1546

Pulster EL, Maruya KA (2008) Geographic specificity of Aroclor 1268 in bottlenose dolphins (*Tursiops truncatus*) frequenting the Turtle/Brunswick River Estuary, Georgia (USA). Sci Total Environ 393: 367-375.

Querouil S, Silva MA, Freitas L, Prieto R, Magalhaes S, Dinis A, Alves F, Matos JA, Mendonca D, Hammond PS, Santos RS (2007) High gene flow in oceanic bottlenose dolphins (*Tursiops truncatus*) of the North Atlantic. Conserv Genet. 8: 1405-1419.

Quintana-Rizzo E, Mann DA, Wells RS (2006) Estimated communication range of social sounds used by bottlenose dolphins (*Tursiops truncatus*). J Acoust Soc Am 120: 1671-1683

Read AJ (1999) Harbour porpoise - *Phocoena phocoena* (Linnaeus, 1758). In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 323-356.

Read A, Waples D, Urian K, Swanner D, Gannon D (2003) Behavioural interactions between bottlenose dolphins and gill nets in North Carolina, USA. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Reyes JC (1991) The conservation of small cetaceans: a review. Report prepared for the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. UNEP / CMS Secretariat, Bonn.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Spec Pub 4, Lawrence, KS. USA.

Sanino GP, Waerbeek Kvan, Bressem M-Fvan, Pastene LA (2005) A preliminary note on population structure in eastern South Pacific common bottlenose dolphins, *Tursiops truncatus*. J Cetacean Res Manag 7: 65-70.

Santos MB, Fernandez R, Lopez A, Martinez JA, Pierce GJ (2007) Variability in the diet of bottlenose dolphin, *Tursiops truncatus*, in Galician Waters, North-Western Spain, 1990-2005. J Mar Biol Assoc UK 87: 231-241

Sellas AB, Wells RS, Rosel PE (2005) Mitochondrial and nuclear DNA analyses reveal fine scale geographic structure in bottlenose dolphins (*Tursiops truncatus*) in the Gulf of Mexico. Conserv Genet 6: 715-728.

Sigurjònsson J, Gunnlaugsson T (1990) Distribution and abundance of cetaceans in Iceland and adjacent waters during sightings surveys July-August 1989. ICES C.M.1990/N:5

Sigurjònsson J, Gunnlaugsson T, Payne M (1989) Ship-board sightings surveys in Icelandic and adjacent waters June-July 1987. Rep Int Whal Comm 39: 395-409.

Silva MA, Prieto R, Magalhaes S, Seabra MI, Santos RS, Hammond PS (2008) Ranging patterns of bottlenose dolphins living in oceanic waters: implications for population structure. Mar Biol 156: 179-192.

Simoes Lopes PC, Fabian ME (1999) Residence patterns and site fidelity in bottlenose dolphins, *Tursiops truncatus* (Montagu) (Cetacea, Delphinidae) off southern Brazil. Rev Brasil Zool 16: 1017-1024.

Sini MI, Canning SJ, Stockin KA, Pierce GJ (2005) Bottlenose dolphins around Aberdeen harbour, north-east Scotland: a short study of habitat utilization and the potential effects of boat traffic. J Mar Biol Assoc UK 85:1547-1554.

Sykes R, Allen J, Owens C (2003) Factors influencing the seasonal distribution of sightings of bottlenose dolphins (*Tursiops truncatus*) along the Dorset coast. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Tanaka S (1987) Satellite radio tracking of bottlenose dolphins *Tursiops truncatus*. Nippon Suisan Gakkaishi Bull Jap Soc Sci Fish 53: 1327-1338.

Van Waerebeek K, Sequeira M, Williamson C, Sanino GP, Gallego P, Carmo P (2006) Live-captures of common bottlenose dolphins *Tursiops truncatus* and unassessed bycatch in Cuban waters: evidence of sustainability found wanting. Lat Amer J Aquat Mamm 5: 39-48.

Viaud-Martinez KA, Brownell RL, Komnenou A, Bohonak AJ (2008) Genetic isolation and morphological divergence of

Black Sea bottlenose dolphins. Biol Conserv 141: 1600-1611.

Wade PR, Gerrodette T (1993) Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rep Int Whaling Comm 43: 477-493.

Wafo E, Sarrazin L, Diana C, Dhermain F, Schembri T, Lagadec V, Pecchia M, Rebouillon P (2005) Accumulation and distribution of organochlorines (PCBs and DDTs) in various organs of *Stenella coeruleoalba* and a *Tursiops truncatus* from Mediterranean littoral environment (France). Sci Total Environ 348: 115-127.

Wang JY, Chou LS, White BN (2000) Osteological differences between the two sympatric forms of bottlenose dolphins (genus *Tursiops*) in Chinese waters. J Zool Lond 252: 147-162.

Wang JY, Yang AC (2009) Indo-Pacific bottlenose dolphin (*Tursiops aduncus*). In: Encyclopedia of marine mammals, 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 602-608.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, eds. (2009) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Wedekin LL, Daura-Jorge FG, Simoes-Lopes PC (2004) An Aggressive Interaction Between Bottlenose Dolphins (*Tursiops truncatus*) and Estuarine Dolphins (*Sotalia guianensis*) in Southern Brazil. Aquat Mamm 30: 391-397.

Weiss J (2006) Foraging habitats and associated preferential foraging specializations of bottlenose dolphin (*Tursiops truncatus*) mother-calf Pairs. Aquat Mamm 32: 10-19.

Wells RS, Rhineheart HL, Cunningham P, Whaley J, Baran M, Koberna C, Costa DP (1999) Long distance offshore movements of bottlenose dolphins. Mar Mamm Sci 15: 1098-1114.

Wells RS, Scott MD (1999) Bottlenose dolphin - *Tursiops truncatus* (Montagu, 1821) In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises. pp. 137-182.

Wells RS, Scott MD (2009) Common bottlenose dolphin - *Tursiops truncatus*. In: Encyclopedia of marine mammals 2nd Ed. (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, Amsterdam, pp. 249-255.

Wells RS, Tornero V, Borrell A, Aguilar A, Rowles TK, Rhinehart HL, Hofmann S,Jarman WM, Hohn AA, Sweeney JC (2005) Integrating life-history and reproductive success data to examine potential relationships with organochlorine compounds for bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. Sci Total Environ 349: 106-119.

Wilson B, Thompson PM, Hammond PS (1997) Habitat use by bottlenose dolphins: Seasonal distribution and stratified movement patterns in the Moray Firth, Scotland. J Appl Ecol 34: 1365-1374.

Wood CJ (1998) Movements of bottlenose dolphins around the south-west coast of Britain. J Zool 246: 155-164.

Yang G, Zhou K, Xu X, Leatherwood S (1999) A survey on the incidental catches of small cetaceans in coastal waters of China. Yingyong Shengtai Xuebao 10: 713-716.

Zollett EA, Read AJ (2005) Depredation of catch by bottlenose dolphins (*Tursiops truncatus*) in the Florida king mackerel (*Scomberomorus cavalla*) troll fishery. Fish Bull 104: 343-349.

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Arbelo M, De Quiros YB, Sierra E, Mendez M, Godinho A, Ramirez G, Caballero MJ, Fernandez A (2008) Atypical beaked whale mass stranding in Almeria's coasts: Pathological study. Bioacoustics 17: 295-297

Baird RW, Webster DL, McSweeney DJ, Ligon AD, Schorr GS, Barlow J (2006) Diving behaviour of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales in Hawai'i. Can J Zool 84: 1120-1128.

Baker CS, Lukoschek V, Lavery S, Dalebout ML, Yong-un M, Endo T, Funahashi N (2006) Incomplete reporting of whale, dolphin and porpoise 'bycatch' revealed by molecular monitoring of Korean markets. Anim Conserv 9: 474-482.

Barlow J, Ferguson MC, Perrin WF, Ballance L, Gerrodette T, Joyce G, Macleod CD, Mullin K, Palka DL, Waring G (2006) Abundance and densities of beaked and bottlenose whales (family Ziphiidae). J Cetacean Res Manage 7: 263-270.

Blanco C, Raga JA (2000) Cephalopod prey of two *Ziphius cavirostris* (Cetacea) stranded on the western Mediterranean coast. J Mar Biol Ass U K 80: 381-382.

Caldwell DK, Caldwell MC, Rathjen WF, Sullivan JR (1971) Cetaceans from the Lesser Antilles Island of St. Vincent. Fishery Bulletin, U.S. 69: 303-312.

Carwardine M (1995) Whales, Dolphins and Porpoises. Dorling Kindersley, London, UK, 257 pp.

Cox TM, Ragen TJ, Read AJ, Vos E and others (2006) Understanding the impacts of anthropogenic sound on beaked whales. J Cetacean Res Manag 7: 177-187.

Dalebout ML, Robertson KM, Frantzis A, Engelhaupt D, Mignucci-Giannoni AA, Rosario-Delestre RJ, Baker CS (2005) Worldwide structure of mtDNA diversity among Cuvier's beaked whales (*Ziphius cavirostris*): implications for threatened populations. Mol Ecol 14: 3353-3371.

Degollada E, Arbelo M, André M, Blanco A, Fernández A (2003) Preliminary ear analysis report of the 2002 Canary Islands *Ziphius* mass stranding. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

Frantzis A (1998) Does acoustic testing strand whales? Nature 392: 29.

Houston J (1991) Status of Cuvier's beaked whale, *Ziphius cavirostris*, in Canada. Can Field Nat 105: 215-218.

Jefferson TA, Leatherwood S, Webber MA (1993) FAO Species identification guide. Marine mammals of the world. UNEP/FAO, Rome, 320 pp.

Heyning JE (1989) Cuvier's beaked whale - *Ziphius cavirostris*. In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 4: River Dolphins and the Larger Toothed Whales. Academic Press, London, pp. 289-308.

Heyning JE (2002) Cuvier's beaked whale - *Ziphius cavirostris*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 305-307.

Heyning JE, Mead JG (2009) Cuvier's beaked whale - *Ziphius cavirostris*. In: Encyclopedia of marine mammals (Perrin WF, Würsig B, Thewissen JGM, eds.) Academic Press, San Diego, pp. 294-296.

Hucke-Gaete R (2000) Review of the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

Macleod CD, Santos MB, Pierce GJ (2003) Review of data on diets of beaked whales: Evidence of niche separation and geographic segregation. J Mar Biol Ass UK 83: 651-665.

MacLeod CD, Pierce GJ, Santos MB (2004) Geographic and temporal variations in strandings of beaked whales (Ziphiidae) on the coasts of the UK and the Republic of Ireland from 1800-2002. J Cetacean Res Manag 6: 79-86.

McSweeney DJ, Baird RW, Mahaffy SD (2007) Site Fidelity, Associations, and Movements of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) Beaked Whales Off the Island of Hawai'i. Mar Mamm Sci 23: 666-687.

Mignucci Giannoni AA, Pinto Rodriguez B, Velasco Escudero M (1999) Cetacean strandings in Puerto Rico and the Virgin Islands. J Cet Res Man 1: 191-198.

Miller, C (2007) Current State of Knowledge of Cetacean Threats, Diversity and Habitats in the Pacific Islands Region. WDCS Australasia Inc. pp. 98.

Mitchell E (1968) Northeast Pacific stranding distribution and seasonality of Cuvier's beaked whale, *Ziphius cavirostris*. Can J Zool 46: 265-279.

Mora Pinto D M, Munoz Hincapie M F, Mignucci Giannoni A A, Acero (1995) Marine mammal mortality and strandings along the Pacific Coast of Colombia. Rep Int Whal Comm 45: 427-429.

Moulins A, Rosso M, Nani B, Wuertz M (2007) Aspects of the Distribution of Cuvier's Beaked Whale (*Ziphius cavirostris*) in Relation to Topographic Features in the Pelagos Sanctuary (North-Western Mediterranean Sea). J Mar Biol Assoc UK 87: 177-186.

Nishiwaki M, Oguro N (1972) Catch of the Cuvier's beaked whales off Japan in recent years. Sci Rep Whales Res Inst, Tokyo 24: 35-41.

Notarbartolo Di Sciara G (1990) A note on the cetacean incidental catch in the Italian driftnet swordfish fishery, 1986-1988 (SC/41/SM3). Rep Int Whal Comm 41: 459-460.

Parsons ECM, Clark J, RossA, Simmonds MP (2007) The Conservation of British Cetaceans: A review of the threats and protection afforded to whales, dolphins and porpoises in UK Waters. Whale and Dolphin Conservation Society, 122 pp.

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand, 101 pp.

Rice DW (1998) Marine mammals of the world: systematics and distribution. Society for Marine Mammalogy, Special Publication Number 4 (Wartzok D, ed.), Lawrence, KS. USA.

Robineau D, Di Natale A (1995) *Ziphius cavirostris* - Cuvier-Schnabelwal. In: Handbuch der Säugetiere Europas. Meeressäuger. Teil IB: Wale und Delphine 2 (Robineau D, Duguy R and Klima M, eds.) Aula-Verlag, Wiesbaden, pp. 526-543.

Santos MB, Martin V, Arbelo M, Fernandez A, Pierce GJ (2007) Insights Into the Diet of Beaked Whales from the Atypical Mass Stranding in the Canary Islands in September 2002. J Mar Biol Assoc UK 87: 243-251.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL (2008) *Ziphius cavirostris*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>

Tyack PL, Johnson M, Soto NA, Sturlese A, Madsen PT (2006) Extreme diving of beaked whales. J Exp Biol 209: 4238-4253

Van Waerebeek K, Reyes JC, Luscombe BA (1988) Revisión de la distribución de pequeños cetáceos frente al Perú. pp. 345-51. In: H. Salzwedel, A. Landa (eds.). Recursos y Dinámica del Ecosistema de Afloramiento Peruano. Boletín del Instituto del Mar del Perú, Callao, Volumen Extraordinario.

Van Waerebeek K, Ofori-Danson PK, Debrah J (2009) The cetaceans of Ghana: a validated faunal checklist. West African Journal of Applied Ecology 15: 61-90.

Waring GT, Quintal JM, Schwartz SL (eds.) (2001) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2001. NOAA Technical Memorandum NMFS-NE-168.(http://www.nefsc.noaa.gov/nefsc/publications/tm/tm168/index.htm)

5 Whale Dictionary

English

English:	Scientific:
Amazon river dolphin	*Inia geoffrensis*
Andrews' beaked whale	*Mesoplodon bowdoini*
Arnoux´s beaked whale	*Berardius arnuxii*
Atlantic humpback dolphin	*Sousa teuszii*
Atlantic spotted dolphin	*Stenella frontalis*
Atlantic white-sided dolphin	*Lagenorhynchus acutus*
Australian snubfin dolphin	*Orcaella heinsohni*
Baiji, Yangtse river-dolphin	*Lipotes vexillifer*
Baird's beaked whale	*Berardius bairdii*
Beluga	*Delphinapterus leucas*
Blainville's beaked whale	*Mesoplodon densirostris*
Burmeister's porpoise	*Phocoena spinipinnis*
Chilean dolphin	*Cephalorhynchus eutropia*
Clymene dolphin	*Stenella clymene*
Commerson's dolphin	*Cephalorhynchus commersonii*
Common bottlenose dolphin	*Tursiops truncatus*
Cuvier's beaked whale	*Ziphius cavirostris*
Dall's porpoise	*Phocoenoides dalli*
Dusky dolphin	*Lagenorhynchus obscurus*
Dwarf sperm whale	*Kogia sima*
False killer whale	*Pseudorca crassidens*
Finless porpoise	*Neophocaena phocaenoides*
Fraser's dolphin	*Lagenodelphis hosei*
Gervais' beaked whale	*Mesoplodon europaeus*
Ginkgo-toothed beaked whale	*Mesoplodon ginkgodens*
Gray's beaked whale	*Mesoplodon grayi*
Guiana dolphin	*Sotalia guianensis*
Harbour porpoise	*Phocoena phocoena*
Heaviside's dolphin	*Cephalorhynchus heavisidii*
Hector's beaked whale	*Mesoplodon hectori*
Hector's dolphin	*Cephalorhynchus hectori*
Hourglass dolphin	*Lagenorhynchus cruciger*
Hubbs' beaked whale	*Mesoplodon carlhubbsi*
Indo-Pacific beaked whale	*Indopacetus pacificus*
Indo-Pacific bottlenose dolphin	*Tursiops aduncus*
Indo-Pacific humpback dolphin	*Sousa chinensis*

English:	Scientific:
Irrawaddy dolphin	*Orcaella brevirostris*
Killer whale	*Orcinus orca*
La Plata dolphin	*Pontoporia blainvillei*
Layard's beaked whale	*Mesoplodon layardii*
Long-beaked common dolphin	*Delphinus capensis*
Long-finned pilot whale	*Globicephala melas*
Melon-headed whale	*Peponocephala electra*
Narwhal	*Monodon monoceros*
North Atlantic bottlenose whale	*Hyperoodon ampullatus*
Northern right-whale dolphin	*Lissodelphis borealis*
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
Pantropical spotted dolphin	*Stenella attenuata*
Peale's dolphin	*Lagenorhynchus australis*
Perrin's beaked whale	*Mesoplodon perrini*
Peruvian beaked whale	*Mesoplodon peruvianus*
Pygmy killer whale	*Feresa attenuata*
Pygmy sperm whale	*Kogia breviceps*
Risso's dolphin	*Grampus griseus*
Rough-toothed dolphin	*Steno bredanensis*
Short-beaked common dolphin	*Delphinus delphis*
Short-finned pilot whale	*Globicephala macrorhynchus*
South Asian river dolphin	*Platanista gangetica*
Southern bottlenose whale	*Hyperoodon planifrons*
Southern right-whale dolphin	*Lissodelphis peronii*
Sowerby's beaked whale	*Mesoplodon bidens*
Spade-toothed beaked whale	*Mesoplodon traversii*
Spectacled porpoise	*Phocoena dioptrica*
Sperm whale	*Physeter macrocephalus*
Spinner dolphin	*Stenella longirostris*
Stejneger's beaked whale	*Mesoplodon stejnegeri*
Striped dolphin	*Stenella coeruleoalba*
Tasman beaked whale	*Tasmacetus shepherdi*
True's beaked whale	*Mesoplodon mirus*
Tucuxi	*Sotalia fluviatilis*
Vaquita	*Phocoena sinus*
White-beaked dolphin	*Lagenorhynchus albirostris*

5 Whale Dictionary

French

French:	Scientific:
Baleine à bec de Cuvier	*Ziphius cavirostris*
Baleine à bec de Longman	*Indopacetus pacificus*
Baleine à bec de Travers	*Mesoplodon traversii*
Belouga, dauphin blanc	*Delphinapterus leucas*
Bérardien d'Arnoux	*Berardius arnuxii*
Bérardien de Baird	*Berardius bairdii*
Cachalot	*Physeter macrocephalus*
Cachalot nain	*Kogia sima*
Cachalot pygmée	*Kogia breviceps*
Céphalorhynque du Cap	*Cephalorhynchus heavisidii*
Dauphin à aileron retroussé d'Australie	*Orcaella heinsohni*
Dauphin à bec blanc	*Lagenorhynchus albirostris*
Dauphin à flancs blancs	*Lagenorhynchus acutus*
Dauphin à flancs blancs du Pacifique	*Lagenorhynchus obliquidens*
Dauphin à long bec	*Stenella longirostris*
Dauphin aptère austral	*Lissodelphis peronii*
Dauphin aptère boréal	*Lissodelphis borealis*
Dauphin blanc de Chine	*Sousa chinensis*
Dauphin bleu et blanc	*Stenella coeruleoalba*
Dauphin commun à court bec	*Delphinus delphis*
Dauphin commun à long bec	*Delphinus capensis*
Dauphin de Chine	*Lipotes vexillifer*
Dauphin de Clymène	*Stenella clymene*
Dauphin de Commerson	*Cephalorhynchus commersonii*
Dauphin de Fraser	*Lagenodelphis hosei*
Dauphin de La Plata	*Pontoporia blainvillei*
Dauphin d'Hector	*Cephalorhynchus hectori*
Dauphin de l'Irrawaddy	*Orcaella brevirostris*
Dauphin de Peale	*Lagenorhynchus australis*
Dauphin de Risso	*Grampus griseus*
Dauphin du Cameroun	*Sousa teuszii*
Dauphin du Chili	*Cephalorhynchus eutropia*
Dauphin obscur	*Lagenorhynchus obscurus*
Dauphin rose de l'Amazone	*Inia geoffrensis*
Dauphin sablier	*Lagenorhynchus cruciger*
Dauphin sténo	*Steno bredanensis*

French:	Scientific:
Dauphin tacheté	*Stenella attenuata*
Dauphin tacheté de l'Atlantique	*Stenella frontalis*
Faux-orque	*Pseudorca crassidens*
Globicéphale noir	*Globicephala melas*
Globicéphale tropical	*Globicephala macrorhynchus*
Grand dauphin	*Tursiops truncatus*
Grand dauphin de l'Océan Indien	*Tursiops aduncus*
Hyperoodon austral	*Hyperoodon planifrons*
Hyperoodon boréal	*Hyperoodon ampullatus*
Marsouin à lunettes	*Phocoena dioptrica*
Marsouin aptère	*Neophocaena phocaenoides*
Marsouin commun	*Phocoena phocoena*
Marsouin de Burmeister	*Phocoena spinipinnis*
Marsouin de Dall	*Phocoenoides dalli*
Marsouin du Golfe de Californie	*Phocoena sinus*
Mésoplodon de Andrews	*Mesoplodon bowdoini*
Mésoplodon de Blainville	*Mesoplodon densirostris*
Mésoplodon de Gervais	*Mesoplodon europaeus*
Mésoplodon de Gray	*Mesoplodon grayi*
Mésoplodon de Hector	*Mesoplodon hectori*
Mésoplodon de Hubbs	*Mesoplodon carlhubbsi*
Mésoplodon de Layard	*Mesoplodon layardii*
Mésoplodon de Nishiwaki	*Mesoplodon ginkgodens*
Mésoplodon de Perrin	*Mesoplodon perrini*
Mésoplodon de Sowerby	*Mesoplodon bidens*
Mésoplodon de Stejneger	*Mesoplodon stejnegeri*
Mésoplodon de True	*Mesoplodon mirus*
Mésoplodon du Pérou	*Mesoplodon peruvianus*
Narval	*Monodon monoceros*
Orque	*Orcinus orca*
Orque pygmée	*Feresa attenuata*
Péponocéphale	*Peponocephala electra*
Plataniste du Gange et de l'Indus	*Platanista gangetica*
Sotalie côtière	*Sotalia guianensis*
Sotalie fluviale	*Sotalia fluviatilis*
Tasmacète de Shepherd	*Tasmacetus shepherdi*

5 Whale Dictionary

Spanish

Spanish:	Scientific:
Ballena picuda de Andrews	*Mesoplodon bowdoini*
Ballena picuda de Blainville	*Mesoplodon densirostris*
Ballena picuda de Gervais	*Mesoplodon europaeus*
Ballena picuda de Gray	*Mesoplodon grayi*
Ballena picuda de Hector	*Mesoplodon hectori*
Ballena picuda de Hubbs	*Mesoplodon carlhubbsi*
Ballena picuda de Layard	*Mesoplodon layardii*
Ballena picuda de Nishiwaki	*Mesoplodon ginkgodens*
Ballena picuda de Perrin	*Mesoplodon perrini*
Ballena picuda de Shepherd	*Tasmacetus shepherdi*
Ballena picuda de Sowerby	*Mesoplodon bidens*
Ballena picuda de Stejneger	*Mesoplodon stejnegeri*
Ballena picuda de True	*Mesoplodon mirus*
Ballena picuda peruana	*Mesoplodon peruvianus*
Ballenato de Arnoux	*Berardius arnuxii*
Beluga, ballena blanca	*Delphinapterus leucas*
Bufeo	*Inia geoffrensis*
Cachalote	*Physeter macrocephalus*
Cachalote enano	*Kogia sima*
Cachalote pigmeo	*Kogia breviceps*
Calderón de aletas cortas	*Globicephala macrorhynchus*
Calderón negro	*Globicephala melas*
Carderón pequeño	*Peponocephala electra*
Costero	*Sotalia guianensis*
Delfín a aleta chata de Australia	*Orcaella heinsohni*
Delfín austral	*Lagenorhynchus australis*
Delfín blanco de China	*Sousa chinensis*
Delfín Chileno	*Cephalorhynchus eutropia*
Delfín Clymene	*Stenella clymene*
Delfín común a pico corto	*Delphinus delphis*
Delfín común a pico largo	*Delphinus capensis*
Delfín cruzado	*Lagenorhynchus cruciger*
Delfín de China	*Lipotes vexillifer*
Delfín de Commerson	*Cephalorhynchus commersonii*
Delfín de costados blancos	*Lagenorhynchus acutus*
Delfín de costados blancos del Pacífico	*Lagenorhynchus obliquidens*

Spanish:	**Scientific:**
Delfín de dientes rugosas	*Steno bredanensis*
Delfín de Fraser	*Lagenodelphis hosei*
Delfín de Héctor	*Cephalorhynchus hectori*
Delfín de pico blanco	*Lagenorhynchus albirostris*
Delfín de Risso	*Grampus griseus*
Delfín del Amazonas	*Sotalia fluviatilis*
Delfín del Cabo	*Cephalorhynchus heavisidii*
Delfín del Irrawaddy	*Orcaella brevirostris*
Delfín del rio Ganges e Indus	*Platanista gangetica*
Delfín jorobado del Atlántico	*Sousa teuszii*
Delfín liso austral	*Lissodelphis peronii*
Delfín liso del norte	*Lissodelphis borealis*
Delfín listado	*Stenella coeruleoalba*
Delfín manchado	*Stenella attenuata*
Delfín mular	*Tursiops truncatus*
Delfín mular del Oceano Indico	*Tursiops aduncus*
Delfín oscuro	*Lagenorhynchus obscurus*
Delfín pintado	*Stenella frontalis*
Estenela giradora	*Stenella longirostris*
Franciscana	*Pontoporia blainvillei*
Marsopa común	*Phocoena phocoena*
Marsopa de anteojos	*Phocoena dioptrica*
Marsopa de Dall	*Phocoenoides dalli*
Marsopa espinosa	*Phocoena spinipinnis*
Marsopa lisa	*Neophocaena phocaenoides*
Narval	*Monodon monoceros*
Orca	*Orcinus orca*
Orca falsa	*Pseudorca crassidens*
Orca pigmea	*Feresa attenuata*
Vaquita	*Phocoena sinus*
Zifio calderón austral	*Hyperoodon planifrons*
Zifio calderón boreal	*Hyperoodon ampullatus*
Zifio de Baird	*Berardius bairdii*
Zifio de Longman	*Indopacetus pacificus*
Ziphio de Cuvier	*Ziphius cavirostris*
Ziphio de Travers	*Mesoplodon traversii*

5 Whale Dictionary

German

German:	Scientific:
Amazonas-Delphin	*Inia geoffrensis*
Amazonas-Sotalia	*Sotalia fluviatilis*
Andrews-Zweizahnwal	*Mesoplodon bowdoini*
Australischer Stupsflossen-Delphin	*Orcaella heinsohni*
Baird-Schnabelwal	*Berardius bairdii*
Blainville-Zweizahnwal	*Mesoplodon densirostris*
Blau-Weißer Delphin	*Stenella coeruleoalba*
Borneo-Delphin	*Lagenodelphis hosei*
Breitschnabeldelphin	*Peponocephala electra*
Brillenschweinswal	*Phocoena dioptrica*
Burmeister-Schweinswal	*Phocoena spinipinnis*
Chile-Delphin	*Cephalorhynchus eutropia*
Chinesischer Flussdelphin	*Lipotes vexillifer*
Chinesischer Weißer Delphin	*Sousa chinensis*
Clymene-Delphin	*Stenella clymene*
Commerson-Delphin	*Cephalorhynchus commersonii*
Cuvier-Schnabelwal	*Ziphius cavirostris*
Dall-Hafenschweinswal	*Phocoenoides dalli*
Ganges- und Indus-Delphin	*Platanista gangetica*
Gervais-Zweizahnwal	*Mesoplodon europaeus*
Gewöhnlicher Kurzschnabel-Delphin	*Delphinus delphis*
Gewöhnlicher Langschnabel-Delphin	*Delphinus capensis*
Gray-Zweizahnwal	*Mesoplodon grayi*
Großer Tümmler	*Tursiops truncatus*
Großer Tümmler des Indischen Ozeans	*Tursiops aduncus*
Hafenschweinswal	*Phocoena sinus*
Heaviside-Delphin	*Cephalorhynchus heavisidii*
Hector-Delphin	*Cephalorhynchus hectori*
Hector-Schnabelwal	*Mesoplodon hectori*
Hubbs-Zweizahnwal	*Mesoplodon carlhubbsi*
Indischer Schweinswal	*Neophocaena phocaenoides*
Irrawaddy-Delphin	*Orcaella brevirostris*
Japanischer Schnabelwal	*Mesoplodon ginkgodens*
Kamerun-Flussdelphin	*Sousa teuszii*
Kleiner Pottwal	*Kogia sima*
Kleiner Schwertwal	*Pseudorca crassidens*

German:	**Scientific:**
Kurzflossen Grindwal	*Globicephala macrorhynchus*
Küsten-Sotalia	*Sotalia guianensis*
La Plata-Delphin	*Pontoporia blainvillei*
Langflossen-Grindwal	*Globicephala melas*
Layard-Zweizahnwal	*Mesoplodon layardii*
Narwal	*Monodon monoceros*
Nördlicher Entenwal, Dögling	*Hyperoodon ampullatus*
Nördlicher Glattdelphin	*Lissodelphis borealis*
Ostpazifischer Delphin	*Stenella longirostris*
Pazifischer Schnabelwal	*Indopacetus pacificus*
Peale-Delphin	*Lagenorhynchus australis*
Perrin-Zweizahnwal	*Mesoplodon perrini*
Peruanischer Schnabelwal	*Mesoplodon peruvianus*
Pottwal	*Physeter macrocephalus*
Rauhzahndelphin	*Steno bredanensis*
Rundkopfdelphin	*Grampus griseus*
Schlankdelphin, Fleckendelphin	*Stenella attenuata*
Schwarzdelphin	*Lagenorhynchus obscurus*
Schweinswal	*Phocoena phocoena*
Schwertwal	*Orcinus orca*
Shepherdwal	*Tasmacetus shepherdi*
Sowerby-Zweizahnwal	*Mesoplodon bidens*
Stejneger-Zweizahnwal	*Mesoplodon stejnegeri*
Stundenglas-Delphin	*Lagenorhynchus cruciger*
Südlicher Entenwal	*Hyperoodon planifrons*
Südlicher Glattdelphin	*Lissodelphis peronii*
Südlicher Schwarzwal	*Berardius arnuxii*
Travers-Zweizahnwal	*Mesoplodon traversii*
True-Zweizahnwal	*Mesoplodon mirus*
Weißschnauzendelphin	*Lagenorhynchus albirostris*
Weißseitendelphin	*Lagenorhynchus acutus*
Weißstreifendelphin	*Lagenorhynchus obliquidens*
Weißwal, Beluga	*Delphinapterus leucas*
Zügeldelphin	*Stenella frontalis*
Zwerggrindwal	*Feresa attenuata*
Zwergpottwal	*Kogia breviceps*

6 Geographical Grouping of Species

This review considers 72 species of small cetaceans and is organised alphabetically. For the aims of CMS, a geographical classification is attempted here. Because cetaceans know no boundaries, I have grouped the range maps of the species accounts into 9 geographical categories. However, the categories are not exclusive and some species may be found in more than one area. Please see individual species accounts for details.

A. Worldwide Temperate and Tropical Oceans

Delphinus capensis
Delphinus delphis
Feresa attenuata
Globicephala macrorhynchus
Grampus griseus
Kogia breviceps
Kogia sima
Lagenodelphis hosei
Mesoplodon densirostris
Orcinus orca
Peponocephala electra
Physeter macrocephalus
Pseudorca crassidens
Stenella attenuata
Stenella coeruleoalba
Stenella longirostris
Steno bredanensis
Tursiops truncatus
Ziphius cavirostris

B. North Atlantic Ocean

Delphinapterus leucas
Globicephala melas
Hyperoodon ampullatus
Lagenorhynchus acutus
Lagenorhynchus albirostris
Mesoplodon bidens
Mesoplodon mirus
Monodon monoceros
Orcinus orca
Phocoena phocoena
Physeter macrocephalus

C. Tropical Atlantic Ocean

Mesoplodon europaeus
Sousa teuszii
Stenella clymene
Stenella frontalis

D. South Africa only

Cephalorhynchus heavisidii

E. South America only

Cephalorhynchus commersonii
Cephalorhynchus eutropia
Inia geoffrensis
Lagenorhynchus australis
Phocoena spinipinnis
Pontoporia blainvillei
Sotalia fluviatilis
Sotalia guianensis

F. Tropical Pacific and Indian Ocean

Mesoplodon gingkodens

G. North and Eastern Pacific Ocean

Berardius bairdii
Delphinapterus leucas
Lagenorhynchus obliquidens
Lissodelphis borealis
Mesoplodon carlhubbsi
Mesoplodon perrini
Mesoplodon peruvianus
Mesoplodon stejnegeri
Orcinus orca
Phocoena phocoena
Phocoena sinus
Phocoenoides dalli
Physeter macrocephalus

H. Western Pacific and Indian Ocean

Cephalorhynchus hectori
Indopacetus pacificus
Lipotes vexillifer
Neophocaena phocaeonoides
Orcaella brevirostris
Orcaella heinsohni
Platanista gangetica
Sousa chinensis
Tursiops aduncus

I. Southern Ocean

Berardius arnuxii
Globicephala melas
Hyperoodon plaifrons
Lagenorhynchus cruciger
Lagenorhynchus obscurus
Lissodelphis peronii
Mesoplodon bowdoini
Mesoplodon grayi
Mesoplodon hectori
Mesoplodon layardii
Mesoplodon mirus
Mesoplodon traversii
Orcinus orca
Phocoena dioptrica
Physeter macrocephalus
Tasmacetus shepherdi

7 Links

CONTRIBUTORS

All cetacean drawings Maurizio Würtz, Artescienza, Genoa
http://www.artescienza.org

All maps IUCN / SSC Cetacean Specialist Group and Global Mammal Assessment
http://www.redlist.org/

SPONSORS

Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area:
http://www.accobams.org

Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas:
http://www.ascobans.org

CMS: Convention on Migratory Species:
http://www.cms.int/index.html

Greenpeace, Germany:
www.greenpeace.de

International Fund for Animal Welfare (IFAW):
www.ifaw.org

Loro Parque Foundation, Tenerife, Spain:
http://www.loroparque-fundacion.org

WWF, Germany:
http://www.wwf.de/

SELECTED LINKS

Alaska Sea Grant Education:
http://seagrant.uaf.edu/index.html

Alfred-Wegener-Institute for Polar and Marine Research (AWI-Bremerhaven):
http://www.awi-bremerhaven.de

American Society of International Law – Wildlife Interest Group: resources relevant to small cetaceans
http://www.internationalwildlifelaw.org

Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS)
http://www.cms.int/documents/appendix/cms_app1_2.htm#appendix_I

Arctic Studies Center:
http://www.mnh.si.edu/arctic/html/tek.html

Azorean whale whatching base (in English)
http://www.espacotalassa.com

Aquaheart, Japan (in Japanese)
http://www.gem.hi-ho.ne.jp/aquaheart/aqua08.shtml

Baleines etc... (Marsouins, dauphins et baleines) in French:
http://baleines.etc.free.fr/index1.htm

Canadian museum of nature:
http://www.nature.ca

Canadian whaling report:
http://www.cmeps.org

Care and preservation of marine wildlife:
http://www.seafriends.org.nz/index.htm

Cetacea: whales, dolphins and porpoises:
http://www.cetacea.org/

Cetacean update of the 2008 IUCN Red List of Threatened Species
http://cmsdata.iucn.org/downloads/cetacean_table_for_website.pdf

CSI: Cetacean Society International
http://csiwhalesalive.org/index.html

CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora:
http://www.cites.org/

Conservation Breeding Specialist Group:
http://cbsg.org

Danish Mammal Atlas: Dansk Pattedyratlas (in Danish):
http://www.pattedyr.net

Don McMichael, Marine Artist:
http://www.donmcmichael.com/originals2.htm

European Cetacean Society:
http://www.europeancetaceansociety.eu/

Fishbase.org: all the fishes in the world:
http://fishbase.org

GROMS: Global register of migratory species:
http://www.groms.de/

INBIO: Instituto Nacional de Biodiversidad, Costa Rica (Marine Mammals, in spanish)
http://www.inbio.ac.cr/es/default.html

Innerspace Visions: professional pictures and photographs
http://www.seapics.com/

International year of biodiversity 2010:
http://www.cbd.int

Leibniz-Institute of Marine Science, IFM-Geomar
http://www.ifm-geomar.de

Metridium fields: underwater video-clips and photographs
http://www.metridium.com

NAMMCO - North Atlantic Marine Mammal Commission
http://www.nammco.no/

National Science Museum, Tokyo, Japan
http://www.kahaku.go.jp/english/index.html

Oregon coast aquarium, Newport:
http://www.aquarium.org

Paraty / Projecto Golfinhos: (in portuguese)
http://www.paraty.com.br/Golfinho.asp

Pelagos cetacean research institute, Greece
http://www.pelagosinstitute.gr

Sea Mammal Research Unit, University of St. Andrews, Scotland:
http://www.smru.st-andrews.ac.uk/

The Ocean Pages (in German)
http://www.ozeane.de

The Porpoise Page
http://www.theporpoisepage.com

Underwater bioacoustics and marine mammals
http://www.unipv.it/cibra

University of Michigan Museum of Zoology animal diversity web:
http://animaldiversity.ummz.umich.edu/index.html

U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments
http://www.nefsc.noaa.gov/publications/

Whales in Danmark (in Danish):
http://www.hvaler.dk

Whales, Dolphins and Men (in German):
http://www.cetacea.de

Whales on the net
http://www.whales.org.au/home.html

Whale Research Org (Video footage of *Mesoplodon densirostris*)
http://www.whaleresearch.org/main_beaked.htm

8.1 APPENDIX 1

High priority research and actions specified for small cetaceans in southern South America (Hucke-Gaete, 2000):

Fisheries interactions:

- Mathematical modelling of the effects of fishery interactions (both operational and ecological) on cetacean populations.
- Further identification of conflict areas between small cetaceans and fisheries.
- Collection of good field data on the basic ecosystem interactions.
- Establishment of monitoring studies to assess the magnitude of incidental and directed mortalities of small cetaceans.
- Impact of marine mammals on fisheries, particularly artisanal fishing activities. Solutions are urgently needed, like the ones under experimentation in the U.S. concerning bycatch in gillnets, which are having encouraging results).

Biological studies:

- Distribution and abundance of dolphin and porpoise populations and their fluctuations.
- Stock identity of sub-populations by means of morphological and molecular genetic studies.
- Natural history studies: sex and age structure, age at maturity, pregnancy rate and diet to assess possible effects of fisheries on populations.
- Possible effects of El Niño Southern Oscillation (ENSO) phenomenon over small cetacean populations in relation to their habitat and prey items.

Political and private support:

- Establish a collaborative network, under the sponsorship of the CMS, among scientists of the countries involved. This network will function as a discussion forum on how to cover high priority research areas, solve specific problems, and achieve and encourage the training of young scientists (courses, exchanges, and scholarships in ongoing research programmes). To be able to implement this, we urge the establishment of a small conservation fund for meetings and priority short term research.
- Regional reassessment of marine mammal species' conservation status by every government in close collaboration with scientists, in order to compare this status with the one informed by IUCN, and establish a local conservation regime.
- Further the adoption of precautionary principles by each government in the administration of fishing and faunal resources.
- Involve local, regional and national authorities in workshops to make them more willing to accept different points of view in the protection of marine resources.
- Involve the private sector in the solution of conservation problems.
- Urge the creation of Protected Marine Areas (Reserves) with an effective management by each country.

The implementation of inspectors (perhaps ad honorem) who must be authorized to enforce national regulations concerning marine mammal protection, should be assessed by each government.

Source:

Hucke-Gaete R ed. (2000) Review on the conservation status of small cetaceans in southern South America. UNEP/CMS Secretariat, Bonn, Germany, 24 pp.

8.2 APPENDIX 2

Summary of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia (Perrin et al. 1996):

The following list of recommendations was developed during discussions at the Workshop on the biology and conservation of small cetaceans and dugongs of southeast Asia (Perrin et al. 1996):

Incidental captures

- Incidental captures in fisheries are a major source of mortality of small cetaceans throughout Southeast Asia. There are few quantitative data on the species caught or the numbers of animals killed. In some countries, the introduction of laws prohibiting the incidental capture of marine mammals has increased the difficulty in obtaining information on such takes. The Workshop recommended that:
- studies on abundance and stock structure within the region be carried out using appropriate methodologies;
- all countries give high priority to research on the impact of the incidental catches of marine mammals in their waters;
- laws prohibiting the incidental capture of marine mammals be amended so that fishers who present specimens or data for scientific research are immune from prosecution;
- local people, institutions and governments be encouraged to participate directly in the planning and implementation of research on marine mammals and other aquatic resources and the resulting management and conservation programmes.

Documentation of marine mammal resources

Because it is very difficult to halt a major development once planning has reached an advanced stage, it would be more effective to alert a developer, the government or the local people to a potential problem prior to this stage. The Workshop therefore recommended that each country give high priority to the identification of coastal and riverine areas which support significant population of marine mammals, such as feeding and calving areas, and to the wide dissemination of this information in an effective format (e.g., GIS, coastal resource atlases, use of local language).

Training of national scientists

- Successful marine mammal research programmes in Southeast Asia will require professionally trained nationals. Successful programmes have been developed to train the nationals of several countries, especially Thailand and the Philippines. Expertise in marine mammal research is less well developed in most other countries in the region with the exception of Australia. The Workshop recommended that:
- UNEP, perhaps in cooperation with partners from the EGO and NGO community, sponsor regional training workshops in the methodologies required for marine mammal research such as those organised in South America (1986-87) and Africa (1992);
- countries with established expertise assist with the postgraduate training of scientists from the region.

International co-operation

Marine mammals do not recognize political boundaries, and research to support their conservation often requires international cooperation. The Workshop recommended that countries sharing contiguous aquatic environments supporting significant marine mammal populations endeavour to develop cooperative research programmes to provide the information required to develop effective management policies.

When international agencies fund large-scale assessments of natural resources in a region, it may be cost-effective to include marine mammal surveys in such projects. The Workshop recommended that:

- when UNEP is aware of such opportunities it suggest (in consultation with regional experts) that marine mammal surveys be considered in the planning of the project;
- the GEF Yellow Sea Project consider including cetacean surveys with the assistance of appropriate technical expertise from other countries, e.g. Japan.

There are several intergovernmental sources of funding for marine mammal research, including UNEP Regional Seas Programme, ASEAN Biodiversity Programme, and Biodiversity Convention Funding. The Workshop noted that the IUCN Cetacean Action Plan projects in Eastern and Southern Asia are being implemented largely through Ocean Park Conservation Foundation (OPCF) and its partners, e.g. Whales and Dolphin Conservation Society, WWF, and David Shepherd Foundation. The Workshop recommended that Governments in the region explore, either multilaterally or bilaterally, the development of a cooperative approach to inter-governmental funding and sourcing agencies.

Source:

Perrin WF, Dolar MLL, Alava MNR (1996) Report of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia. East Asia Seas Action Plan. UNEP(W)/EAS WG. 1/2, Bangkok, Thailand. 101 pp.

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