African Longfin Eel (*Anguilla mossambica*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, January 2015
Revised, October 2016 and January 2017

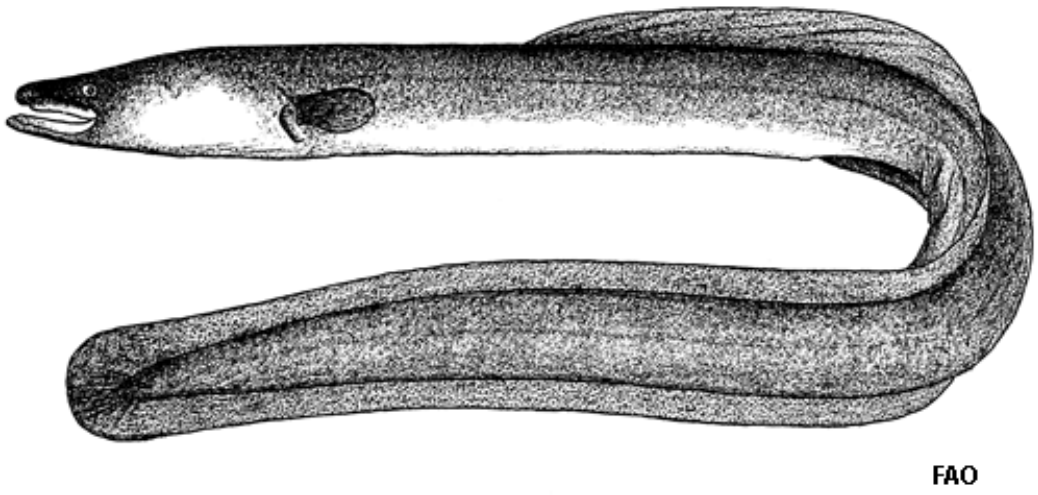

Image: FAO. Licensed under a Creative Commons Attribution-Noncommercial 3.0 Unported License. Available: http://fishbase.org/photos/PicturesSummary.php?StartRow=1&ID=1276& what=species&TotRec=4. (October 2016).

1 Native Range, and Status in the United States

Native Range

From Froese and Pauly (2016):

"Western Indian Ocean: east coast rivers of Africa from Kenya south to Cape Agulhas, also Madagascar and other western Indian Ocean islands. Moves well inland."

From Jacoby and Gollock (2014):

"This species is endemic to the South Western Indian Ocean (SWIO). Along the east coast of Africa, *A. mossambica* is found in rivers from Kenya south to Cape Agulhas, also found on Madagascar and other western Indian Ocean islands (Mascarene: Réunion and Mauritius Islands, Comoros: Mayotte Island and the Seychelles: Mahé and Praslin

Islands). *Anguilla mossambica,* endemic to the Malagasy area, is also the most common anguillid species in the Eastern Cape, South Africa and in eastern Madagascar (Robinet *et al*. 2008)."

Status in the United States

Anguilla mossambica has not been reported in the United States.

Means of Introductions in the United States
Anguilla mossambica has not been reported in the United States.

Remarks
From Silfvergrip (2009):

"**Synonymy**: *Muraena mossambica* Peters 1852, *Anguilla delalandi* Kaup 1856, *Anguilla capensis* Kaup 1860.
Common names: African longfin eel (English: Kenya, UK, USA), Afrikanischer Langflossenaal (German: Germany), Afrikansk ål (Danish: Denmark), Anguilla de aleta larga de Africa (Spanish: Spain), Anguille à longue nageoire (French: France), Anguille du Mozambique (French: Comoros, Madagascar, Mauritius, Mayotte, Reunion), Enguia moçambicana (Portuguese: Mozambique), Geelbekpaling (Afrikaans: South Africa), Longfin eel (English: Kenya, South Africa, Zimbabwe), Mkunga (Pokomo: Kenya; Swahili: Tanzania), Mukunga (Pokomo: Kenya), Namanhongholo (Lom: Mozambique [Schneider et al. 2005]), Namunyokolo
(Macu: Mozambique [Schneider et al. 2005]), Nghoyo (Chuw: Mozambique [Schneider et al. 2005]), Ngove (Tong: Mozambique [Schneider et al. 2005]), Nikhonono (Chuw: Mozambique [Schneider et al. 2005]), Úhoř mosambický (Czech: Czech Rep), Xanfitima (Rong: Mozambique [Schneider et al. 2005]), Z'amab (Creole, French: Comoros, Madagascar, Mauritius, Mayotte, Reunion), Z'anguille (Creole, French: Comoros, Madagascar, Mauritius, Mayotte, Reunion), угорь мозамбийкский (Russian: Russian Fed), 莫桑比克鰻鱺 (Traditional Chinese: China), 莫桑比克鳗鲡 (Simplified Chinese: China)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2016):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Osteichthyes

Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Elopomorpha
Order Anguilliformes
Suborder Anguilloidei
Family Anguillidae
Genus Anguilla Schrank, 1798
Species *Anguilla mossambica* (Peters, 1852)"

"Taxonomic Status: Current Standing: valid"

Size, Weight, and Age Range

From Froese and Pauly (2016):

"Maturity: Lm ? range ? - ? cm Max length: 150 cm TL male/unsexed; [Castle 1984]; 120.0 cm SL (female); max. published weight: 750.00 g [Bruton et al. 1982]; […] max. reported age: 20 years [Keith et al. 1999]"

From Jacoby and Gollock (2014):

"Generation Length (years): 10"

Environment

From Froese and Pauly (2016):

"Marine; freshwater; brackish; demersal; catadromous [Riede 2004]."

Climate/Range

From Froese and Pauly (2016):

"Tropical, preferred ?; 25°N - 35°S"

Distribution Outside the United States

Native

From Froese and Pauly (2016):

"Western Indian Ocean: east coast rivers of Africa from Kenya south to Cape Agulhas, also Madagascar and other western Indian Ocean islands. Moves well inland.

From Jacoby and Gollock (2014):

"This species is endemic to the South Western Indian Ocean (SWIO). Along the east coast of Africa, *A. mossambica* is found in rivers from Kenya south to Cape Agulhas, also found on Madagascar and other western Indian Ocean islands (Mascarene: Réunion and Mauritius

Islands, Comoros: Mayotte Island and the Seychelles: Mahé and Praslin Islands). Anguilla mossambica, endemic to the Malagasy area, is also the most common anguillid species in the Eastern Cape, South Africa and in eastern Madagascar (Robinet et al. 2008)."

Introduced

Anguilla mossambica has not been confirmed as established outside its native range.
From Froese and Pauly (2016):

"Reported from New Caledonia [Thollot 1996]."

"New Caledonia Occurrence: questionable"

Means of Introduction Outside the United States

Anguilla mossambica has not been confirmed as established outside its native range.

From Lin et al. (2015):

"A list of non-native species introduced internationally into China […] contribution to aquaculture production in China
Species: *Anguilla mossambica* (African longfin eel)
Native range: West Indian Ocean
Year of introduction: 2007
Distribution in China: South China
Negative effects in local environment? Unknown
Production (ton) in China (2011): –
Major reference: Fan et al. (2008)"

Short description

From Froese and Pauly (2016):

"Dorsal spines (total): 0; Anal spines: 0. Olive to greyish black dorsally, lighter ventrally [Castle 1986]. Caudal fin confluent with dorsal and anal."

From Silfvergrip (2009):

"*Anguilla mossambica* larger than 200 mm total length can be identified from all other species in the genus by a unique set of characters. Dorsal fin anterior margin typically 13.5-15.5% of TL in advance of anus. Mouth comparatively large, about one third of head length. Maxillary tooth band without toothless area. Coloration plain, without distinct markings. Vertebrae 100–106"

Biology

From Jacoby and Gollock (2014):

"*Anguilla mossambica* is a demersal, catadromous eel. Spending the majority of its life in both quiet and fast flowing freshwater, brackish and coastal habitat, this eel makes one spawning migration to the open ocean where it is then thought to die (Réveillac et al. 2009). Arriving at the coast as transparent glass eels, these eels begin to gain pigment becoming elvers that ascend rivers mainly at night and overcome waterfalls and walls of small dams in order to migrate upstream towards suitable growth habitat. Like other anguillids, however, there is likely to be a portion of the population that remain almost exclusively in coastal habitat without making prolonged ascents into freshwater habitat (Tsukamoto [et al.] 1998). The behavioural strategies of these non-migrant sea eels (sea residents) are explained by a latitudinal cline in the difference in food availability between marine and freshwater habitats (Tsukamoto and Arai 2001). Elvers in the Eastern Cape, South Africa arrive in considerably higher numbers in the summer than during the winter or spring months (Wasserman et al. 2012). Although the adults are usually fairly sedentary, otolith microchemistry suggests that some individuals are inter-habitat migrants that move between freshwater and saltwater habitats (Lin et al. 2012). Females can attain lengths of up to 120 cm and are generally longer and heavier than males (Froese and Pauly 2011). This eel is carnivorous, eating dead and/or living prey but especially aquatic insects, crabs and fish. After feeding in freshwater for ten years or more (McEwan and Hecht 1984), adults assume a silver ventral colouration, the eyes become enlarged and they return to sea to breed."

"This species is considered to breed east of Madagascar but moves southwest on its way to the Mozambique coast and South African rivers. The age of leptocephali - the larval form of the species - increases as they are found further south from the proposed spawning area and therefore it is suggested that individuals are transported southwards by the South Equatorial Current (SEC); the migration pathways in this species are estimated to be in the order of 1,000 to 2,000 km long (Réveillac et al. 2009). Of the three species that inhabit the Malagasy area (*A. mossambica, A. marmorata* and *A. bicolor*), *A. mossambica* have the slowest otolith growth rate due to its most southern distribution (Robinet et al. 2008)."

Human uses

From Froese and Pauly (2016):

"Fisheries: commercial; aquaculture: commercial; gamefish: yes"

From Jacoby and Gollock (2014):

"The various life stages, ranging from juvenile to adult, of all anguillid species are harvested and traded on a global scale for consumption"

"Species of *Anguilla* are traded internationally as live eels for farming and consumption, as fresh, frozen and smoked/prepared eels for consumption and as skins and leather products for fashion accessories. Global trade data collated by the FAO for live, fresh, frozen and smoked/prepared anguillid species (non species-specific) are available for the period 1976-2009. According to FAO data, global annual *Anguilla* exports averaged

around 20,000 tonnes in the late 1970s (valued annually at 55-95 million US dollars), after which annual exports showed a steady increase to a maximum of over 130,000 tonnes in 2000 (valued at over 1000 million US dollars). Since then annual exports have been declining, to just over 80,000 tonnes in 2008 and 2009 (valued at over 800 million US dollars). By weight, China and Taiwan are responsible for nearly 75% of these exports and Japan for over 75% of all imports (FAO 2013)."

"There are no FAO catch data for *A. mossambica*, however according to FAO trade data from the early 1990s, annual exports of frozen eels from Madagascar have averaged 10 tonnes and there are also some intermittent exports of this commodity from South Africa. Exports of live eels commenced in 1998, with regular yearly exports from Madagascar since then, averaging approx. 5 tonnes per year and reaching 9 tonnes in 2009. There are also records of live eel exports from Mozambique and Tanzania (FAO 2013). These exports include all life stages and could include a number of other species of Anguilla with overlapping ranges (including *A. marmorata* and *A. bicolor*), however it is known that there has been a recent increase in demand for *A. mossambica* glass eels to be exported to East Asia for farming."

"Eel farming, which is responsible for over 90% of all *Anguilla* production worldwide (averaging at 280,000 tonnes per year since 2007, (FAO 2013), is reliant on wild-caught juvenile eels or glass eels, as raising eel larvae to the glass eel stage in captivity has only had limited success to date. The first known records of imports of live glass eel into Asia from Madagascar are from 2005, and since then they have been fluctuating from 20 kg to nearly 4,000 kg per year (in 2012), with the majority being imported into Hong Kong. Investment into sustainable fisheries and farming of eels in Madagascar and Mauritius, in particular of *A. mossambica*, has been reported in recent years (FIS 2010) and various Malagasy companies are now offering live eels for sale via B2B marketplaces/trade platforms such as Alibaba. In 2012, the press reported the intentions of a Japanese company to import one tonne of live *A. mossambica* from Madagascar every week for half the price of eels cultivated in Japan, in order to help the industry fulfil consumer demand (Anon. 2012)."

Diseases

From Froese and Pauly (2016):

"Aeromonosis, Bacterial diseases
Anguillicola Infestation 2, Parasitic infestations (protozoa, worms, etc.)
Mugilicola Infestation, Parasitic infestations (protozoa, worms, etc.)
Pseudomonas infection 2, Bacterial diseases"

From Weyl et al. (2014):
"*Anguillicoloides papernai* (adult)"
"*A. papernai* (larva)"
"*Heliconema africanum*"
"*Spinitectus* sp."

“Cestode (larva)”
“*Paraquimperia africana*”
“Nematode (cyst)”

“Impacts of [parasite] introductions can be severe, particularly when parasites infect hosts that have not evolved a resistance to them (Kennedy 2007). A good example is *Anguillicoloides crassus Kuwahara*, Niimi & Itagaki (*Anguillicola* according to Laetsch et al. 2012), a blood-feeding parasite of eel swimbladders that has spread from its natural host the Japanese eel *Anguilla japonica* Temminck & Schlegel to naïve eel hosts on four continents (Lefebvre et al. 2012). In naïve European eel *Anguilla anguilla* L., *A. crassus* are larger and more fecund and occur at higher prevalence and intensity than in their native host (Weclawski et al. 2013). This can result in severe impacts on the host population, and the A. crassus invasion is thought to have contributed to the decline in *A. anguilla* populations in Europe (Wirth & Bernatchez 2003; Wielgoss et al. 2008). […] The decline in European and Japanese eel stocks has resulted in an interest in African eel species, and Madagascar, currently the only African producer of eels, has recently started exporting eels to Hong Kong, the Republic of Korea and Japan (Crook & Nakamura 2013). The aim of the current study was to assess the parasite transfer risks associated with importing these eels. Fifty medium-sized (mean ± STD total length (TL) = 46.9 ± 4.5 cm, weight: 238.6 ± 77.9 g) yellow stage African longfin eel *Anguilla mossambica* Peters, the most common species inhabiting East Africa and Madagascan Rivers (Lin et al. 2012) and the natural host of A. papernai (Taraschewski et al. 2005), were obtained from a commercial eel supplier based in Madagascar. […] On arrival, eels were killed by concussion and destruction of the brain. Internal organs (gills, swimbladder, stomach and intestine) were dissected from the fish and examined for parasites, which were collected, identified to the lowest possible taxon and counted. […] No parasites were observed either on the skin or gills, but internal parasites were collected from most (92%) of the sample. These included *A. papernai* from the swimbladder and the gastrointestinal parasites *Heliconema africanum* (Linstow), a *Spinitectus* Fourment sp. and *Paraquimperia africana Moravec*, Boomker & Taraschewski. […] While *A. papernai*, *H. africanum* and *P. africana* are common parasites of *A. mossambica* (Taraschewski et al. 2005; Moravec, Weyl & Taraschewski 2013), no *Spinitectus* sp. or any cestodes have previously been documented from *A. mossambica*, and these should be considered a potential invasion risk to mainland Africa. Even more concerning is that the trade of live *A. mossambica* will most likely facilitate the transport of the *A. papernai, H. africanum* and *P. africana* to novel host systems in Asia. The results also illustrate the difficulty in dealing with internal parasites of fishes. Although African eels are susceptible to external parasites, including the global invader *Pseudodactylogyrus anguillae* (Yin & Sproston) (Parker, Weyl & Taraschewski 2011), the lack of external parasites was not surprising because the fish may have been treated using one of a variety of treatments available for external parasites (e.g. Buchmann & Bjerregaard 1990). Veterinary certification was most likely issued on the basis of their healthy, and parasite free, external appearance. Internally these fish were however heavily parasitized, and live *A. mossambica* are therefore a potential vector and their trade a potential pathway for new parasitic invasions.”

From O. Weyl, South African Institute for Aquatic Biodiversity, personal communication to B. Eltz, Connecticut Department of Energy and Environmental Protection (2014):

"My personal opinion is that *Anguillicola papernai* would probably be as invasive [as *Anguillicola crassus*]. We have some evidence that they also infect other eels (unpublished data)."

From K. Oliveira, University of Massachusetts, Dartmouth, personal communication to B. Eltz, Connecticut Department of Energy and Environmental Protection (2014):

"I do not have much experience with this species but would assume it could serve as a vector for parasites into the US. The swimbladder parasite (*A. crassus*) is believed to be brought into Europe through aquaculture (importing of *A. japonica*). This is also likely the source of the parasite's invasion into the US, although ballast water may be a factor in its spread to Canada. Any introduction of another species of *Anguilla* carries the same risk's [sic] to *A. rostrata* or possibly other non-anguillid species (*A. crassus* can use other species as a paratenic host), especially if it is a vector for viral or bacterial parasites. Without knowing the details of the "transplant" my best guess would be that any parasites or diseases of the transplanted eels would be transferable to our native species."

Threat to humans

From Froese and Pauly (2016):

"Harmless"

3 Impacts of Introductions

Anguilla mossambica has not been confirmed as established outside its native range.

4 Global Distribution

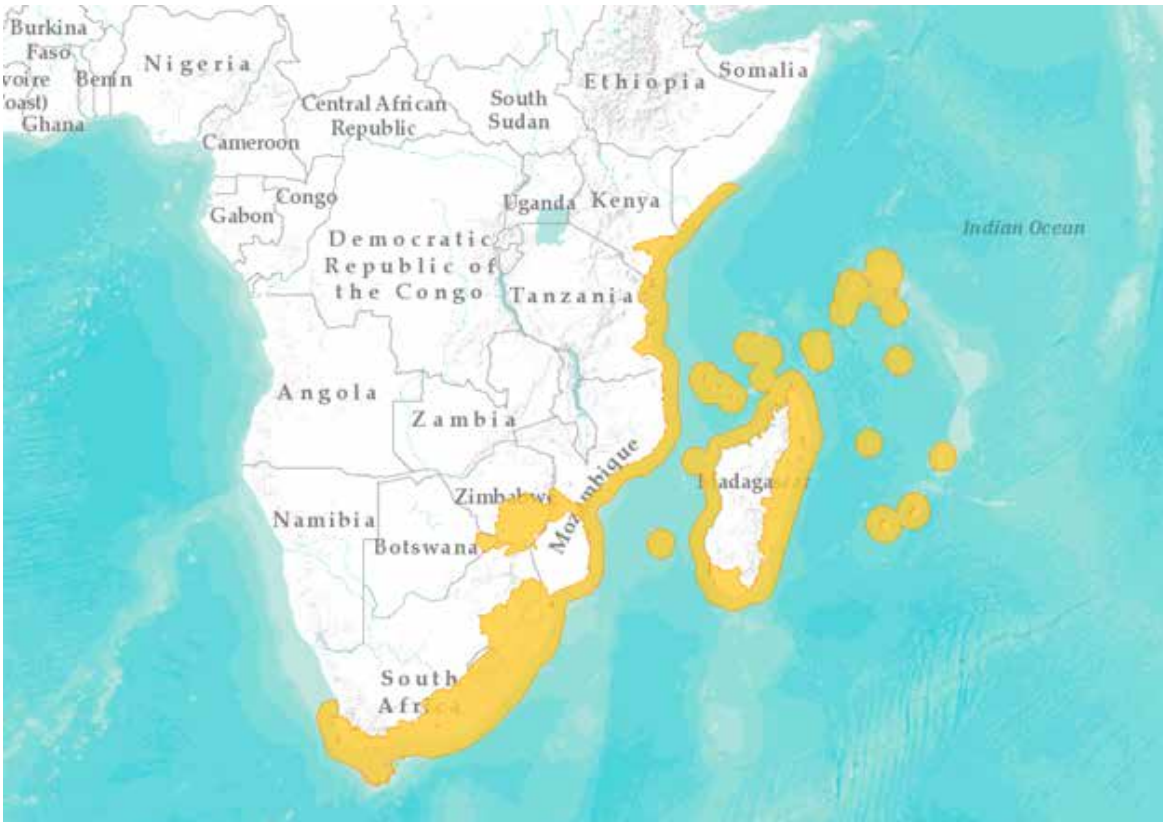

Figure 1. Known global distribution of *Anguilla mossambica*. Map from Jacoby and Gollock (2014).

5 Distribution within the United States

Anguilla mossambica has not been reported in the United States.

6 Climate Matching

Summary of Climate Matching Analysis

Anguilla mossambica is a catadromous species, living in freshwater and migrating to marine waters to breed. The RAMP (Sanders et al. 2014) climate match uses temperature and precipitation variables at land-based stations. No variables related to the marine environment are used in the match other than the location of the species in a marine environment that surrounds a land bas

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was higher in southern climates and lower in northern climates (Figure 3). State-by-state analysis reported high climate matches for Arizona, California, Florida, and Texas. A medium climate match was reported for New Mexico and Nevada. The Climate6 score

indicates a medium current climate match with Continental U.S. Climate6 scores between 0.005 and 0.103 indicate a medium climate match; Climate6 score for *A. mossambica* under current climate conditions was 0.051.

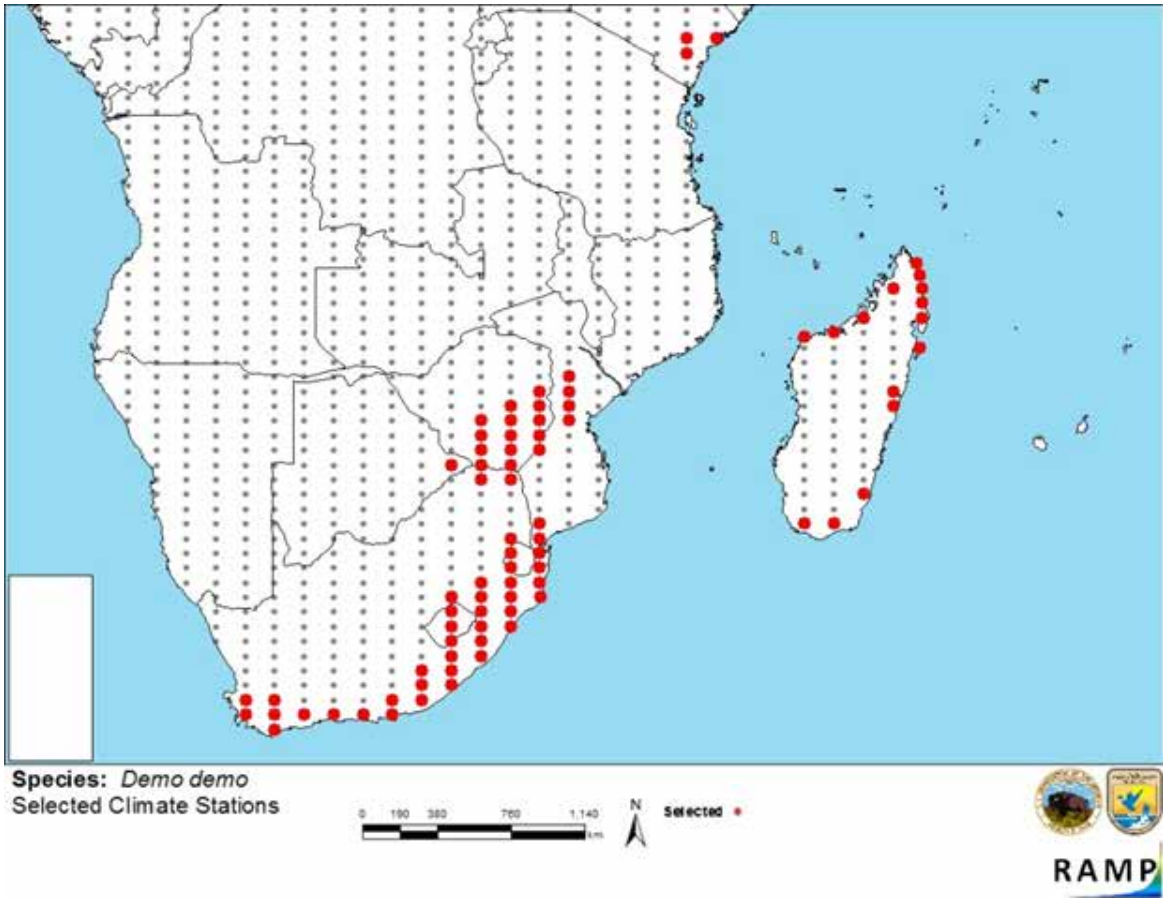

Figure 2. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (grey) for *Anguilla mossambica* climate matching. Source locations from Jacoby and Gollock (2014) and GBIF (2014).

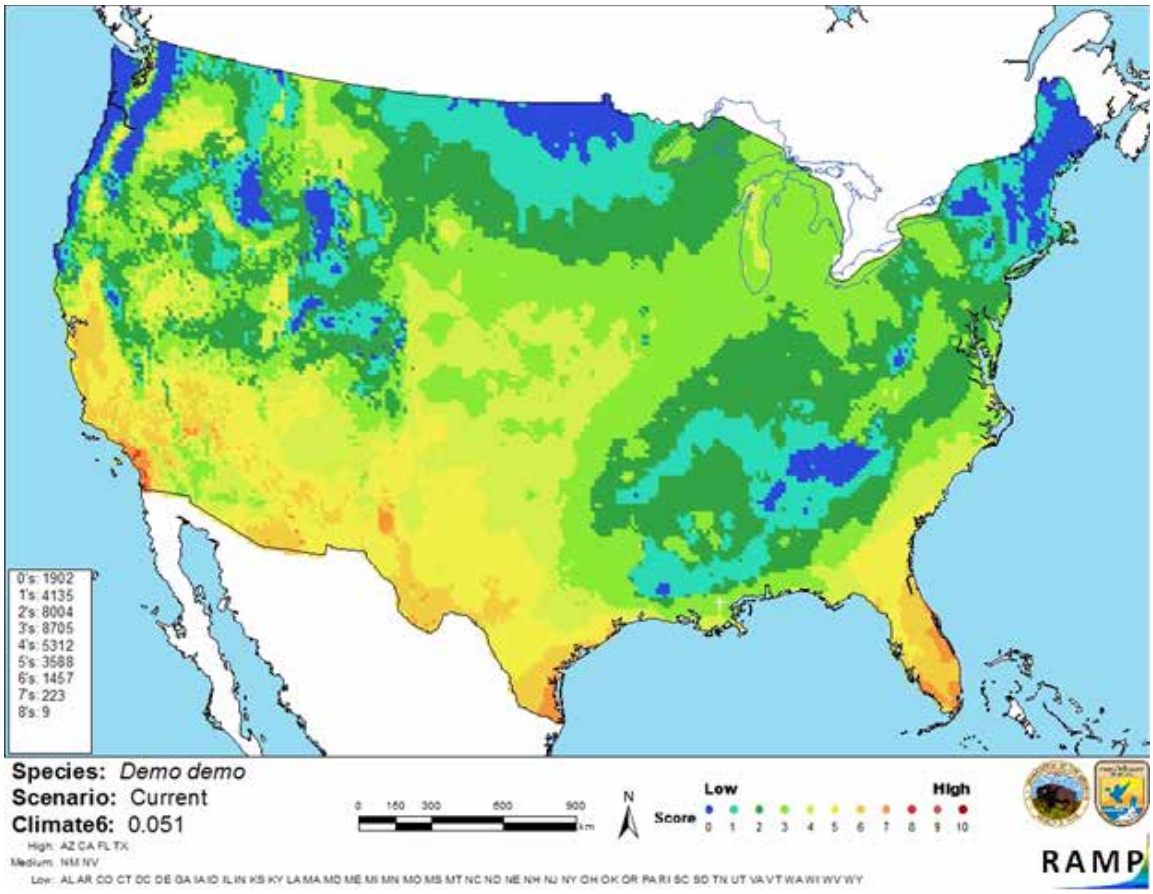

Figure 3. Map from RAMP (Sanders et al. 2014) of a current climate match for A*nguilla mossambica* in the continental United States based on source locations reported by Jacoby and Gollock (2014) and GBIF (2014). 0= Lowest match, 10=Highest match.

7 Certainty of Assessment

The certainty of this assessment is low. There are no records of introductions for *Anguilla mossambica*, so its history of invasiveness cannot not be evaluated.

8 Risk Assessment

Summary of Risk to the Continental United States

Anguilla mossambica is a catadromous eel native to the southwestern Indian Ocean. This species has not been reported as introduced or established outside its native range, so impacts of introductions could not be evaluated. However, *A. mossambica* may be transported outside its native range for farming and human consumption. The potential for the parasites of *A. mossambica* to cause significant, negative impacts to either the American eel (*Anguilla rostrata*) or other important U.S. native species requires further evaluation. However, the potential for the spread of the swimbladder nematode *Angullicoloides papernai* to *A. rostrata* may be high, given the recent invasive history

of another introduced swimbladder nematode *Anguillicola crassus*. Climate match to the continental U.S. is medium. Overall risk posed by *A. mossambica* is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3)**: Uncertain
- **Climate Match (Sec. 6):** Medium
- **Certainty of Assessment (Sec. 7):** Low
- **Overall Risk Assessment Category:** Uncertain

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

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10 References Quoted But Not Accessed

Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

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