FISHERIES

# Fish reproductive-energy output increases disproportionately with body size

**Diego R. Barneche,[1]*† D. Ross Robertson,[2] Craig R. White,[1] Dustin J. Marshall[1]**

**Body size determines total reproductive-energy output. Most theories assume reproductive output is a fixed proportion of size, with respect to mass, but formal macroecological tests are lacking. Management based on that assumption risks underestimating the contribution of larger mothers to replenishment, hindering sustainable harvesting. We test this assumption in marine fishes with a phylogenetically controlled meta-analysis of the intraspecific mass scaling of reproductive-energy output. We show that larger mothers reproduce disproportionately more than smaller mothers in not only fecundity but also total reproductive energy. Our results reset much of the theory on how reproduction scales with size and suggest that larger mothers contribute disproportionately to population replenishment. Global change and overharvesting cause fish sizes to decline; our results provide quantitative estimates of how these declines affect fisheries and ecosystem-level productivity.**

How does reproductive output scale with body size? Despite the august history of this question (*1*, *2*), theoreticians, fisheries scientists, and field biologists still disagree about the answer (tables S1 and S2). Resolving this uncertainty is essential for understanding the forces driving the evolution of body size in general and for managing fish stocks sustainably. Most life-history models, mechanistic theories of growth, and fisheries models assume that reproductive output scales isometrically with female mass (table S1)—that is, for every increase in female somatic mass, there is a constant proportional increase in reproductive output (Fig. 1A, dashed line). Under such a model, the reproductive output of one 2-kg fish is equal to that of two 1-kg fish.

In contrast to most theoreticians and fisheries models, field biologists have repeatedly suggested that fish fecundity may increase disproportionately with body mass within species (that is, it scales hyperallometrically; table S2) (*3*, *4*). Thus, two 1-kg fish would have less reproductive output than a single 2-kg fish (Fig. 1). This discrepancy between theory and empiricism takes on particular importance because reproductive output drives the replenishment of fisheries (*3*). Energy investment into individual offspring may also change with female size, such that larger mothers produce larger offspring, which survive better (*4*, *5*). Many life-history models make explicit assumptions about the energy devoted to reproductive tissue (table S1). Therefore, understanding how reproductive output scales with female size requires not only fecundity estimates but also estimates of how egg size and egg energy scale with female size. Such an understanding would (i) improve the management of exploited populations and protected areas by better estimating the relationship between standing biomass and egg production (*3*, *4*, *6*) and (ii) allow direct tests of energy-budget models that characterize changes in reproductive allocation over ontogeny (*7*).

Here we perform a meta-analysis of intraspecific mass scaling of total reproductive-energy output (fecundity × egg volume × egg energy), with controls for phylogenetic nonindependence, for 342 species of marine fishes from 15 orders (*8*). We collected data on how egg energy content scales with egg volume within and among a subset of species ($n$ = 1366 clutches from 126 species). We estimated scaling of both egg characteristics and fecundity because these traits could trade off against each other, resulting in no net relationship between maternal size and reproductive output. For example, if larger mothers produce more, but smaller, offspring, net reproductive output might not change with maternal size.

Fish fecundity varied from 11 to 57,600,000 eggs per clutch, spanning about seven orders of magnitude. Fish fecundity scaled hyperallometrically (a power-function relationship with an exponent greater than 1) with body mass (*8*) (Fig. 2A). In this analysis, 140 (79.1%) of the 177 species presented hyperallometric mass scaling of fecundity.

The volume of individual eggs varied from 0.01 to 344.8 mm$^3$ and increased hypoallometrically with female body mass. A 1.2-fold increase in egg volume would be expected with an increase in body mass from 0.3 to 1.3 kg (Fig. 2B), hence strengthening the effect of female mass on total reproductive output. Considering only the species for which we had both fecundity and egg-volume data ($n$ = 45), we find a hyperallometric relationship between female mass and total reproductive volume (that is, fecundity × egg volume) [average scaling exponent = 1.21; 95% credible interval (CI) 1.07 to 1.37; table S6] (*8*).

Energy content of individual eggs varied from 0.07 to 299.41 J. Egg energy scaled hypoallometrically with egg volume (Fig. 2C). That is, larger eggs have slightly less energy content per unit volume than smaller eggs but still have a greater energy content in absolute terms. The combination of this relationship and the relationship between female mass and egg volume still yields a positive, hypoallometric relationship between female size and per-egg energy content (*8*).

By combining the posterior distributions of model parameters from the three models above (*8*), we were able to estimate how the average total reproductive-energy output changes with body size for marine fish. Total reproductive-energy output per spawning scales hyperallometrically with female body mass (mean scaling exponent = 1.29; 95% CI 1.20 to 1.38). An estimate of mass scaling of fecundity in the commercially important Atlantic cod (*Gadus morhua*) illustrates these scaling effects. If fecundity scaled isometrically with mass, then 15 2-kg female cod would produce the same number of eggs as 1 30-kg female. Instead, we find that a single 30-kg female produces more eggs than ~28 2-kg females (weighing a total of 56 kg). Further, because egg volume and egg energy content also increase with female size, a 30-kg female actually spawns a batch of eggs with a total energy content ~37 times as high as that of a batch of eggs from a single 2-kg female (Fig. 1B); assuming an isometric relationship would underestimate this difference by 147%.

Unsurprisingly, substantial variation in reproductive-energy output exists among species, and a small proportion of species (5.0%) show isometric or hypoallometric scaling (Fig. 3). Nevertheless, hyperallometric reproductive scaling holds for almost all species (95.0%) and is consistent for the subset of nine species for which we had data on all three relationships of interest (table S7) and for three studies in which all the data came from the same populations (table S8). Thus, larger females have disproportionately higher fecundity and produce offspring of greater size, content, and possibly quality. Assuming that larger mothers take part in at least as many reproductive bouts each reproductive season as smaller mothers [which seems likely (*4*)], these relationships may explain why larger fish are so important for the replenishment of marine fish populations (*6*, *9*).

Marine protected areas (MPAs) increase the size of fish by 28% on average (*7*). Because the per-capita reproductive output of fish increases with size, the potential for MPAs to replenish populations has been underestimated. For example, for the widow rockfish, *Sebastes entomelas*, an MPA could enhance population replenishment by 60 and 74% for fecundity and reproductive-energy output, respectively—no such increase would be predicted if reproductive output was assumed to be isometric (*8*).

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Our results also reveal the insidious costs of global change. Fish sizes are predicted to decrease in some instances as temperatures rise with global warming. For example, a 1.5°C increase in sea surface temperature will decrease fish lengths by ~15% in the Mediterranean (*10*). On the basis of our estimates, such a size decrease would incur a 50% per-capita reduction in fecundity for Atlantic mackerel, *Scomber scombrus* (*8*). Such effects would exacerbate the impacts of predicted decreases in total fish biomass associated with warming—warmer oceans will likely have fewer fish and much lower reproductive output (*11*).

Here we show that hyperallometry of reproductive-energy output is not the exception but rather the rule for marine fishes, a relationship that fisheries models now need to incorporate. For example, balanced harvesting approaches to fishing, which are the subject of intense debate (*12*, *13*), emphasize somatic productivity alone and assume isometric reproduction. Our results confirm the suspicion (*3*) that such assumptions severely underestimate the importance of larger females for population replenishment (*6*, *7*, *9*). Worryingly, many exploited species have declined in size as result of overharvesting, and our findings suggest that such declines will massively reduce reproductive output and recruitment (*14*).

Because our results formally establish a general hyperallometric body-mass scaling of reproductive output in marine fishes, they also have direct implications for fundamental theory. Most theories of growth and life history assume that reproductive output scales isometrically with size, hence underestimating the advantages of growing larger, although some branches of theory do anticipate our findings (table S1). However, even among studies that anticipate hyperallometric scaling, some assume that energy content of reproductive tissues stays constant with body size (table S1); our results contradict this core assumption for fishes, at least.

Future studies will establish whether our results are general across groups of organisms other than marine fishes, thus helping determine the generality of conclusions about the putative evolutionary advantages of large size to mothers. All

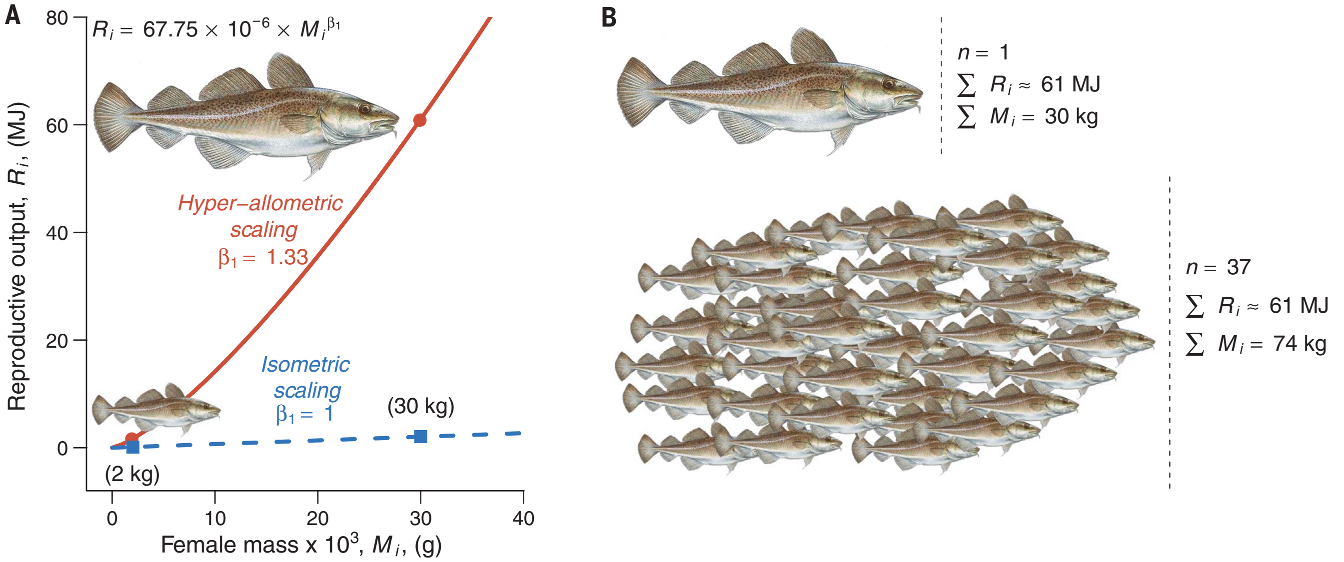

**Fig. 1. Hyperallometric scaling of reproductive-energy output.** (**A**) Hyperallometric ($\beta_1 = 1.33$, solid red curve; see table S7) and isometric mass scaling ($\beta_1 = 1$, dashed blue curve) relationships for the Atlantic cod, *G. morhua*. Fish sizes span more than one order of magnitude in mass (2 versus 30 kg). (**B**) Total population-level biomass ($\sum M_i$) required to produce the same reproductive output ($\sum R_i$, in megajoules) for two populations of fish with hyperallometric scaling that differ in the mass of the individual fish, where *i* is individuals: The standing-biomass ratio differs by ~2.5-fold (that is, 74 versus 30 kg) from the larger individual to the population with smaller individuals. [Illustration credit: Diane Rome Peebles]

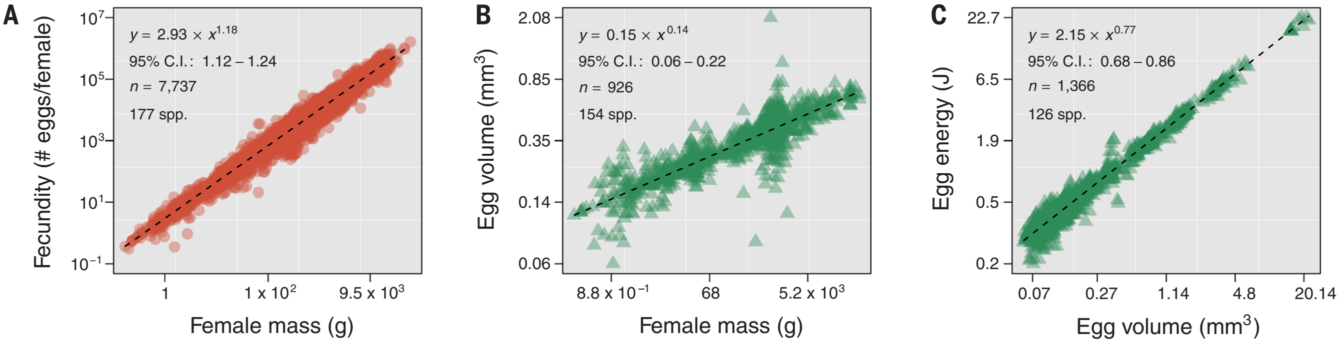

**Fig. 2. Scaling relationships of fish reproductive traits.** (**A**) Relationship between fecundity and female mass. Red circles represent individual clutches. (**B**) Mass scaling of egg volume. (**C**) Volume scaling of egg energy content. Green triangles represent independent observations [egg volume and egg energy content in (B) and (C), respectively]. The *y* axes were corrected for species-specific deviations on the intercept and scaling exponent, which were obtained using Bayesian phylogenetic hierarchical modeling. Equations in the top-left corners depict average fixed effects; 95% CI is Bayesian credible interval for the scaling exponent; *n* is the total number of observations. Dashed black lines depict average model fits. Species and family names and the data summary and contributions for the three models [shown in (A), (B), and (C)] (*8*) are provided in tables S3 to S5, respectively. Note both axes are logged.

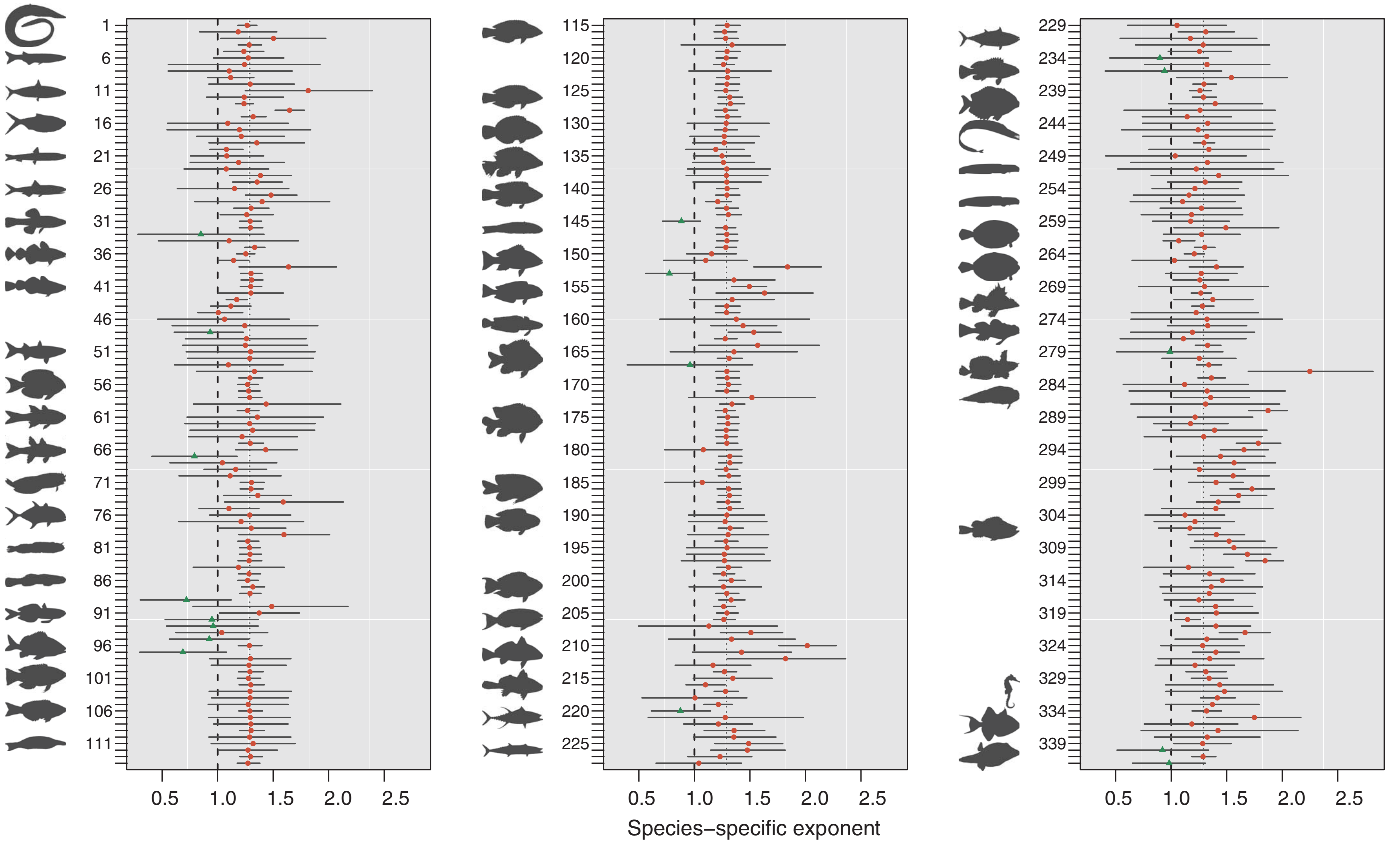

**Fig. 3. Species-specific reproductive-energy mass-scaling exponents.** Average exponents and 95% CIs (shown by horizontal bars) for 342 species were obtained by combining species-specific (when available) posterior estimates from models in Fig. 2, A to C (*8*). If a species was not present in a given data set, we used the population-level fixed-effect posterior estimates for the model in question. The dashed line represents the reproductive isometry reference point; the dotted line represents the average fixed-effect exponent value. Red circles and green triangles represent species whose scaling exponents are greater than and less than 1, respectively. Fish silhouettes depict the major clades represented in this figure. See table S7 for species and family names and estimates of reproductive energy–output slopes.

else being equal, size declines reduce the capacity of marine fish populations to replenish, particularly if increased egg size increases recruitment success [but see (*15*)]. Our findings prove particularly relevant in light of body-size declines of major fishery species owing to overharvesting and climate change (*10*, *16*, *17*) and suggest that the reproductive consequences of these size declines will be dramatic.

## REFERENCES AND NOTES

1. R. E. Earll, in *National Oceanic and Atmospheric Administration Report of the United States Commissioner of Fisheries*, S. F. Baird, Ed. (Government Printing Office, San Diego, 1881), pp. 395–426.
2. R. J. H. Beverton, S. J. Holt, *On the Dynamics of Exploited Fish Populations* (Fishery Investigations Series II, Her Majesty's Stationery Office, London, 1957), vol. 19.
3. C. T. Marshall, C. L. Needle, A. Thorsen, O. S. Kjesbu, N. A. Yaragina, *Can. J. Fish. Aquat. Sci.* **63**, 980–994 (2006).
4. M. A. Hixon, D. W. Johnson, S. M. Sogard, *ICES J. Mar. Sci.* **71**, 2171–2185 (2014).
5. J. N. Lim, A. M. Senior, S. Nakagawa, *Evolution* **68**, 2306–2318 (2014).
6. C. Birkeland, P. K. Dayton, *Trends Ecol. Evol.* **20**, 356–358 (2005).
7. S. E. Lester *et al.*, *Mar. Ecol. Prog. Ser.* **384**, 33–46 (2009).
8. Materials and methods are available as supplementary materials.
9. R. Beldade *et al.*, *Proc. R. Soc. Lond. B Biol. Sci.* **279**, 2116–2121 (2012).
10. I. van Rijn, Y. Buba, J. DeLong, M. Kiflawi, J. Belmaker, *Glob. Chang. Biol.* **23**, 3667–3674 (2017).
11. D. R. Barneche *et al.*, *Ecol. Lett.* **17**, 1067–1076 (2014).
12. K. H. Andersen *et al.*, *ICES J. Mar. Sci.* **73**, 1651–1655 (2016).
13. R. Froese *et al.*, *ICES J. Mar. Sci.* **73**, 1640–1650 (2016).
14. M. Heino *et al.*, *ICES J. Mar. Sci.* **70**, 707–721 (2013).
15. D. J. Marshall, S. S. Heppell, S. B. Munch, R. R. Warner, *Ecology* **91**, 2862–2873 (2010).
16. C. J. Harvey, N. Tolimieri, P. S. Levin, *Ecol. Appl.* **16**, 1502–1515 (2006).
17. M. J. Genner *et al.*, *Glob. Change Biol.* **16**, 517–527 (2010).

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## SUPPLEMENTARY MATERIALS

www.sciencemag.org/content/360/6389/642/suppl/DC1
Materials and Methods
Fig. S1
Tables S1 to S8
References (*18*–*244*)

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# Supplementary Materials for

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Materials and Methods
Fig. S1
Tables S1 to S8
References

## Materials and Methods

### Fecundity and egg size data compilation

We compiled data from multiple previous compilations that provided references on female fecundity (number of eggs per female) and size, as well as egg size (diameter in mm), for different species of marine fishes (*4*, *18–23*). We used only raw data from original references (data extracted from tables or directly from figures using DataThief software). We also investigated papers cited in these original references, repeating this process exhaustively. We also searched systematically Google Scholar in English, Spanish and Portuguese using the key words *fish* and *fecundity*, reviewing the first 200 studies returned in each language. We later separated this compilation into two sub datasets: 1) a dataset containing paired records between female fecundity and size ($n$ = 7,737 from 134 studies between 1880 to 2015, including 177 species) and 2) another dataset containing egg size and female size measurements ($n$ = 926 from 84 studies between 1905 to 2015, including 154 species). A subset of observations overlapped between these two datasets (i.e. paired measurements of female size, fecundity, and egg size; $n$ = 1,538, 45 spp.), and were used to analyze the relationship between total egg-volume (i.e. egg-volume × fecundity, in $\text{mm}^3$) and female size (see Statistical analyses below). We only collected data from studies measuring individuals in the wild, or individuals that were transferred from the wild to an aquarium facility before the measurements. For the fecundity dataset, 98.4% of the observations ($n$ = 7,613) were exclusively from wild-based observations, corresponding to 98.9% ($n$ = 175) of the original number of species. Removing measurements that were performed in the lab did not alter our results (Fecundity–Mass model $\beta_1 = 1.18$; 95% CI: 1.11 – 1.24; see Results section; also see Statistical analyses below for parameter notation). For the egg size dataset, 96.2% of the observations ($n$ = 891) were exclusively from wild-based observations, corresponding to 96.8% ($n$ = 149) of the original number of species. Removing measurements that were performed in the lab did not alter our results (Egg-volume–Mass model $\beta_1 = 0.15$; 95% CI: 0.07 – 0.23; see Results section). In the egg size dataset, if a study provided multiple body size measurements for the females but only one population-level average egg size, we took the median body size across females. For eggs that present ellipsoidal, elongated shapes, we used both diameters (long, $l$, and short, $s$) to first calculate the volume

($V = (4/3) \times \pi \times (l/2) \times (s/2)^2$), and then back transform to diameter of sphere with equivalent volume ($[((V \times 3)/(4 \times \pi))^{(1/3)}] \times 2$). All egg size measurements were transformed to spherical volume, $V$ (mm$^3$; $V = (4/3) \times \pi \times r^3$, where $r$ is radius).

Studies generally reported female length, so we transformed these measured lengths (mm), $l$, into mass (g), $m$, by using the standard length-mass equation $m = al^b$ (where $a$ is a normalization (g cm$^{-b}$) and $b$ is an exponent that characterizes any changes in shape over ontogeny). The species-specific length-mass conversion parameters were downloaded from FishBase (*24*) (April 2017). For those species with multiple pairs of parameters, we used the pair with the highest quality score provided in FishBase. For those species that did not have any parameters, we used an approximation provided by FishBase that is obtained using a Bayesian method which is based on relationship estimates for the genus-body shape of the species in question (*25*).

### Quantifying egg energetic content

Fish eggs and data on their volume, dry weight and energy content were collected by DRR with help from collaborators. A total of 1,111 measurements from 111 species were sampled following standard techniques (*26*). Collections took place in Japan, Indonesia, Australia, the Marquesas Archipelago, Panama, the USA, Canada, and Corsica. Eggs from Panama, USA, and Canada were collected from both Atlantic and Pacific coasts. Eggs from Corsica were oven-dried (the lab had no freeze-drier), everything else was freeze dried. Removing the data from Corsica did not alter our results (Egg-energy–Volume model $\beta_1$ = 0.77; 95% CI: 0.65 – 0.88; see Results section).

The determination of average dry weight and energy content of an egg in a clutch also followed standard practice (*26*). Each sample of eggs was first carefully cleaned of all debris under a microscope, then rinsed ~6 times in distilled water, and finally stored in a -80˚C freezer. Subsequently each sample was lyophilized for at least 8 h and stored in a desiccator at -80˚C. To determine the average dry weight of an egg, a subsample of ~20 counted, intact dried eggs was weighed on a (daily calibrated) Cahn Model 28 Microbalance, after the desiccator containing the samples had been allowed to warm to room temperature (~24˚C) in an air-conditioned room. After this the energy density (Joules mg$^{-1}$ dry weight) of the sample was determined using a Phillipson Microbomb Calorimeter (Gentry Instruments) calibrated with a sample of Benzoic acid at the beginning of each day's set of measurements. Average energy content of an egg of each clutch was calculated as (average energy density of the clutch) × (the average dry weight of an egg in that clutch).

We also compiled data from 9 studies that measured both egg-volume and egg-weight (dry weight in mg; $n = 255$ observations, 15 spp.). Egg-weight was transformed to energy (Joules) based on Ref. (*27*) and our own data (Fig. S1), which show that egg-energy scales isometrically with egg-weight, with an average of ~25 Joules $\text{mg}^{-1}$ of egg dry weight.

Statistical analyses

Because we are interested in quantifying the mass scaling of fish fecundity and egg size, as well as the volume scaling of egg-energy content, we applied three linear hierarchical models with the same structure:

$$\ln Y = (\ln\beta_0 + \ln\gamma_{0spp} + \ln\gamma_{0phy}) + (\beta_1 + \gamma_{1spp})\ln X + \ln\varepsilon, \tag{1}$$

where $\ln Y$ represents a natural log-transformed response vector (fecundity in Fecundity–Mass model, egg-volume in Egg-volume–Mass model, egg-energy in Egg-energy–Volume model, and total egg-volume (i.e. fecundity × egg-volume) in Total-volume–Mass), $\ln\beta_0$ is a fixed-effect intercept, $\ln\gamma_{0spp}$ and $\ln\gamma_{0phy}$ are respectively vectors of random-effect coefficients that account for residual intercept deviations attributable to species uniqueness and patterns of relatedness as described by the phylogeny, $\beta_1$ is a fixed-effect slope for the natural log-transformed predictor vector, $\ln X$ (female mass in Fecundity–Mass, Egg-volume–Mass models and Total-volume–Mass, and egg-volume in Egg-energy–Volume model), $\gamma_{1spp}$ is a vector of random-effect coefficients that account for residual slope deviations attributable to species uniqueness, and $\ln\varepsilon$ is the model unexplained residual variation.

Phylogenetic relatedness might influence broad-scale variation in life-history traits (*28*). From an evolutionary perspective, closely related species might have a higher likelihood of sharing some ancestral-state trait (*29*), such as egg-type (pelagic, demersal, brooded). At the same time, species may present unique variations in traits that are independent of phylogenetic relatedness. From a technical perspective, both of these unmeasured biological factors (i.e. species uniqueness and relatedness) likely contribute to variance in a particular life-history trait (*30*) and, consequently, it is desirable to account for both of these possible effects. To do so, we created a tree from the Open Tree of Life (OTL) using the *rotl* R package (*31*) v. 3.0.3 in order to test for significant phylogenetic heritability in our models (*32*). We first downloaded the full Actinopterygii tree from OTL ($n$ = 38,941 tips) and then added species from our dataset that were missing in the tree: the Pomacentridae species relationship followed a recent consensus topology (*33*) and we inserted them as a sister group to the Labridae as those are the only two families on the database belonging to Labroidei. One Centropomidae (*Centropomus undecimalis*) and one Latidae (*Lates calcarifer*) were inserted as a sister group to Carangidae (*34*). One Apogonidae (*Apogon doederleini*) was inserted right next to the other Apogonidae species in the tree. This tree was pruned to retain focal species only (i.e. individually for each model), and then used to derive a variance-covariance matrix based on Brownian evolution. The trees included a total of 20, 16, 8, and 2 polytomies for the Fecundity–Mass, Egg-volume–Mass, Egg-energy–Volume, and Total-volume–Mass models respectively. Branch lengths are unknown for the phylogeny, so the arbitrary method of Grafen (*35*) was applied, whereby branch lengths are set to a length equal to the number of descendant tips minus one.

In Fecundity–Mass and Total-volume–Mass, fixed effects were assigned informative priors following a Gaussian distribution ($\beta_1$: mean = 1, standard deviation = 2; $\ln\beta_0$: mean = 3, standard deviation = 3) to speed up model convergence. In Egg-volume–Mass and Egg-energy–Volume, fixed effects were assigned weakly informative priors following a Gaussian distribution. In all models, random effects were assigned weakly informative priors following a Gaussian distribution. Random-effect coefficients ($\ln\gamma_{0spp}$, $\ln\gamma_{0phy}$ and $\gamma_{1spp}$) are distributed with means of zero, hence representing actual deviations from the fixed effects. Standard deviations ($\sigma\left[\ln\gamma_{0spp}\right]$, $\sigma\left[\ln\gamma_{0phy}\right]$, $\sigma\left[\gamma_{1spp}\right]$ and $\sigma\left[\ln\varepsilon\right]$) were also assigned weakly informative priors following a Student-*t* distribution. We account for the phylogenetic non-independence among species by weighting the phylogenetic-relatedness standard deviation ($\sigma\left[\ln\gamma_{0phy}\right]$) by a variance-covariance matrix, $A$, which was obtained from the tips of the phylogeny (i.e. $\sigma\left[\ln\gamma_{0phy}\right] * A$, with $A$ being obtained using the *ape* R package (*36*) version 5.0). The phylogenetic heritability (equivalent to Pagel's $\lambda$ (*29*, *30*)), was estimated as the proportion of total variance, conditioned on the fixed effects, attributable to the random effect of phylogeny (i.e. $\sigma^2\left[\ln\gamma_{0phy}\right]/(\sigma^2\left[\ln\gamma_{0phy}\right]+\sigma^2\left[\ln\gamma_{0spp}\right]+\sigma^2\left[\ln\varepsilon\right])$). It captured 78.9% (95% CI: 62.2% – 90.2%), 89.3% (95% CI: 80.6% – 95.2%), 98.2% (95% CI: 96.2% – 99.3%), and 5.6% (95% CI: 0.0% – 30.7%) of the variance observed in the residuals in Fecundity–Mass, Egg-volume–Mass, Egg-energy–Volume, and Total-volume–Mass models respectively. The posterior distributions of model parameters were estimated using Markov chain Monte Carlo (MCMC) methods using the *brms* R package (*37*) version 2.1.0. For Fecundity–Mass and Total-volume–Mass, we constructed four chains of 15,000 steps, including 7,500-step warm-up periods, so a total of 30,000 steps were retained to estimate posterior distributions (i.e. (15,000 - 7,500) × 4 = 30,000). For Egg-volume–Mass and Egg-energy–Volume, we constructed four chains of 6,000 steps, including 3,000-step warm-up periods, so a total of 12,000 steps were retained to estimate posterior distributions (i.e. (6,000 - 3,000) × 4 = 12,000). Number of chains were tuned in order to achieve model convergence (i.e. $\widehat{R}=1$).

The dataset used to run Fecundity–Mass includes multiple observations within species, with clades (e.g. families) having different representation (e.g. many species of the genus *Sebastes*, but no other genera within Sebastidae). Thus, it is possible that the average within-species mass-scaling slope across species would be strongly influenced by a particular clade. To verify this source of potential bias, we also ran an alternative version of equation 1 whereby we included random slopes attributable to phylogeny-related effects (i.e. adding a $\gamma_{1phy}$ to the model). This alternative model was compared to the simpler Fecundity–Mass model using leave-one-out cross-validation (LOO), which, similarly to widely applicable information criterion (WAIC), is a fully Bayesian model selection procedure for estimating pointwise out-of-sample prediction accuracy (*38*, *39*). For each model, we calculated the expected log pointwise predictive density ($\widehat{elpd}_{loo}$) using the log-likelihood evaluated at the posterior simulations of the parameter values (*39*). We calculated *p*-values for the pairwise differences in $\widehat{elpd}_{loo}$ ($\Delta\widehat{elpd}_{loo}$) using standard errors (s.e.) and a normal probability density function. This method of calculating s.e.'s is reliable for data sets with many observations (*n* = 7,737 in our analysis) because the distribution of $\Delta\widehat{elpd}_{loo}$ is well approximated by a normal distribution (*39*). Although the alternative model had higher average predictive accuracy than Fecundity–Mass, it was not significantly higher ($p = 0.4498$), and we therefore retained Fecundity–Mass, which is simpler. We also compared Fecundity–Mass, Egg-volume–Mass, and Egg-energy–Volume models each against a more complex version which included an interaction between scaling slope and spawning mode (categorical fixed effect with 6 levels added to Fecundity–Mass: demersal, internal brooding, mouth brooder, pelagic, pouch brooder, scatterer; 6 levels added to Egg-volume–Mass: demersal, internal brooding, mouth brooder, pelagic, pouch brooder, scatterer; 3 levels added to Egg-energy–Volume: demersal, mouth brooder, pelagic) to test for an effect of spawning mode on the estimated scaling slopes after accounting for phylogenetic effects. However, in our three datasets, spawning mode and phylogeny are strongly confounded, and adding an interaction term did not improve model fit significantly for any of the three models ($p = 0.9116$ in Fecundity–Mass; $p = 0.5492$ in Egg-volume–Mass; $p = 0.3053$ in Egg-energy–Volume). Model comparison was implemented using the *loo* R package (*39*) version 1.1.0.

## Estimating total reproductive-energy output

We estimated the average mass scaling of total reproductive-energy output per spawning per female by combining the estimated responses from our three Bayesian models. Specifically, considering that Fecundity–Mass, Egg-volume–Mass, and Egg-energy–Volume models can be translated into

$$\text{Fecundity} = \beta_{0M1}\text{Mass}^{\beta_{1M1}} \tag{2}$$

$$\text{Egg-volume} = \beta_{0M2}\text{Mass}^{\beta_{1M2}} \tag{3}$$

$$\text{Egg-energy} = \beta_{0M3}\text{Egg-volume}^{\beta_{1M3}}, \tag{4}$$

where $\beta_0$ and $\beta_1$ respectively represent average fixed-effect intercepts and slopes from Models $M1-3$, one can first predict the expected egg-energy for a female of given mass,

$$\text{Egg-energy} = \beta_{0M3}\beta_{0M2}^{\beta_{1M3}}\text{Mass}^{\beta_{1M2}\times\beta_{1M3}} \tag{5}$$

and then multiply this expectation by the expected fecundity for the same given mass, yielding

$$\text{Total reproductive-energy output} = \beta_{0M1}\beta_{0M3}\beta_{0M2}^{\beta_{1M3}}\text{Mass}^{\beta_{1M1}+(\beta_{1M2}\times\beta_{1M3})} \tag{6}$$

This estimate was calculated 10,000 times by randomly sampling from each of the models' posterior distributions in order to fully propagate each parameter uncertainty. We note that this approach is very conservative, as the parameter estimates from each model are completely independent from each other (i.e. it is not possible to compute the covariance among parameters from different models) and therefore the total propagated error is likely to be overinflated. Thus, if the compound 95% credible intervals for the mass scaling slope are indeed greater than 1 we can safely assume that the average total reproductive-energy output scales super-linearly with body mass.

### Exploring subsets of the data for which we have overlapping metrics

We used statistical methods to generate total reproductive-energy output because, for most species, we did not have all four metrics of interest (i.e. body size, fecundity, egg size, and egg energy). However, for 45 species ($n$ = 1,538), we had both female size-fecundity, and female size-egg size data and so we could estimate the female size-total reproductive volume relationship for that subset directly. Like the complete dataset, the analysis of this subset revealed hyper-allometric scaling between female size and total reproductive volume where the predicted exponent was greater than 1 (1.21; 95% CI: 1.07 – 1.37; Table S6). For 9 species, we had data on all three relationships of interest and for that restricted group, the mean scaling exponent between female size and reproductive energy output was again hyper-allometric: 1.18 (see species marked with an asterisk in Table S7). Finally, for just 3 species, we had data on all four variables of interest (female size, fecundity, egg-volume, and egg-energy) where all four came from the same study and population. For this very small group, we again found evidence of hyper-allometric scaling in two of the three species and isometry for the third species (Table S8).

## Calculating reproductive loss: MPAs and ocean warming

In the main text, we show that, for the widow rockfish *Sebastes entomelas*, the benefits of an MPA to population replenishment for fecundity and reproductive-energy output are respectively 60% and 74% under hyper-allometric scaling. These numbers were calculated assuming a fixed standing biomass of 1 tonne both inside and outside an MPA, a baseline size of 30 cm outside the MPA (~350 g), and a size of 38.4 cm (i.e. 28% larger in length (*7*)) inside the MPA (~748 g). Thus, we have 2,857 individuals outside vs. 1,337 individuals inside the MPA. The hyper-allometric species-specific fecundity ($\beta_0 = 0.19$, $\beta_1 = 1.62$; Table S3) and reproductive-energy output ($\beta_0 = 220.14$, $\beta_1 = 1.73$; Table S7) parameters for this species were used to calculate both the total fecundity and reproductive-energy output outside (fecundity = $2{,}857 \times 0.19 \times 350^{1.62} = 7{,}178{,}837$ eggs; reproductive-energy = $2{,}857 \times 220.14 \times 350^{1.73} = 15{,}843{,}346{,}454$ J) and inside (fecundity = $1{,}337 \times 0.19 \times 748^{1.62} = 11{,}497{,}558$ eggs; reproductive-energy = $1{,}337 \times 220.14 \times 748^{1.73} = 27{,}585{,}453{,}858$ J) the MPA. Therefore, $(11{,}497{,}558 / 7{,}178{,}837 - 1) \times 100 \approx 60\%$, and $(27{,}585{,}453{,}858 / 15{,}843{,}346{,}454 - 1) \times 100 \approx 74\%$.

We also showed that a 15% decrease in fish length due to a warming of 1.5°C (*10*) would incur a 50% per-capita reduction in fecundity for Atlantic mackerel, *Scomber scombrus*. These were calculated assuming a baseline size of 50 cm before (~925 g), and a size of 42.5 cm (i.e. 15% smaller, ~561 g) after warming. The species-specific fecundity ( $\beta_0 = 3.73$, $\beta_1 = 1.38$; Table S3) parameters for this species were used to calculate fecundity before ($3.73 \times 925^{1.38} = 46{,}236$ eggs) and after ($3.73 \times 561^{1.38} = 23{,}189$ eggs) warming. Therefore, $(1 - 23{,}189 / 46{,}236) \times 100 \approx 50\%$.

## Relationship between egg-energy and female size

In the main text, we state that the combination of the relationship between egg-energy and egg-volume with the relationship between egg-volume and female mass yields a positive, hypo-allometric relationship between female size and per-egg energy content. This is because egg-energy $\propto$ mass$^{1.18 \times 0.77} \approx$ mass $^{0.91}$ (equation 5).

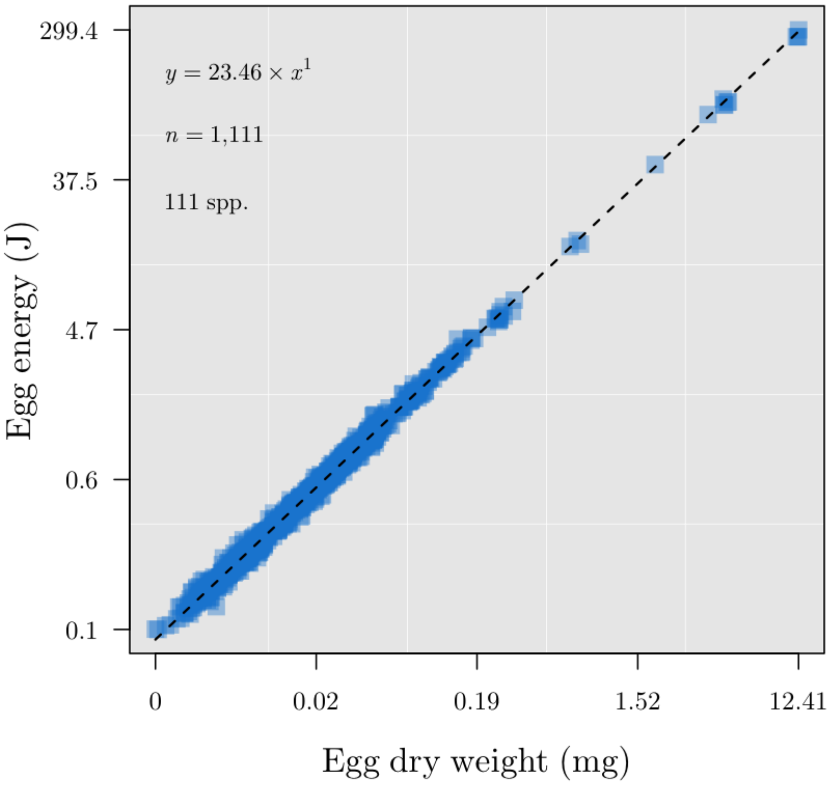

**Fig. S1. Relationship between egg energy (J) and egg dry weight (mg).** All data collected experimentally by D. Ross Robertson.

**Table S1. Summary of models that make explicit predictions or assumptions** regarding the relationship between female body size and reproductive output. Reproductive output is characterized in a variety of ways in these models, from fraction of the growing season devoted to reproduction to ratios of gonad mass to somatic mass. * indicates studies that make explicit assumptions about the energy content of reproductive materials and how that scales with body size (all assume isometric scaling of energy content). FGO and VGO = Fixed and Variable (respectively) allocation to reproduction.

| Study | Model type | Scaling | Prediction or Assumption | Refs |
|---|---|---|---|---|
| Gadgil and Bossert (1970) | Life history | Hyperallometric | Prediction | (*40*) |
| Roff (1983) | Life history | Isometric | Assumption | (*41*) |
| Roff (1984) | Life history | Isometric | Assumption | (*42*) |
| Reiss (1985) | Life history | Hypoallometric | Prediction | (*43*) |
| Kozłowski and Uchmanksi (1987) | Life history | Variable | Prediction | (*44*) |
| Kozłowski (1996) | Life history | Variable | Prediction | (*45*) |
| West *et al.* (2001) | Life history | Isometric | Assumption | (*46*) |
| Charnov *et al.* (2001) | Life history | Isometric | Assumption | (*47*) |
| Charnov (2002) | Life history | Isometric | Assumption | (*48*) |
| Lester *et al.* (2004) | Life history | Isometric* | Assumption | (*49*) |
| Roff *et al.* (2006) | Life history | Isometric | Assumption | (*50*) |
| Quince *et al.* (2008; FGO) | Life history | Isometric* | Assumption | (*51*) |
| Quince *et al.* (2008; VGO) | Life history | Hyperallometric* | Prediction | (*51*) |
| Pecquerie *et al.* (2009) | Life history | Isometric | Assumption | (*52*) |
| Koojiman (2010) | Life history | Isometric* | Assumption | (*53*) |
| Arendt (2011) | Life history | Isometry | Assumption | (*54*) |
| Onishi *et al.* (2012) | Life history | Hyperallometric | Assumption | (*55*) |
| Brunel *et al.* (2013) | Life history | Isometric | Assumption | (*56*) |
| Charnov *et al.* (2013) | Life history | Isometric | Assumption | (*57*) |
| Boukal *et al.* (2014) | Life history | Isometric* | Assumption | (*58*) |
| Koojiman and Lika (2014) | Life history | Isometric* | Assumption | (*59*) |
| Minte-Vera *et al.* (2016) | Life history | Isometric* | Assumption | (*60*) |
| Jusup *et al.* (2017) | Life history | Isometric | Assumption | (*61*) |
| Mangel (2017) | Life history | Hyperallometric | Assumption | (*62*) |
| Smallegange *et al.* (2017) | Life history | Isometric | Assumption | (*63*) |
| Beverton and Holt (1957) | Fisheries | Isometric | Assumption | (*2*) |
| Scott *et al.* (2006) | Fisheries | Hyperallometric | Assumption | (*64*) |
| Jørgensen and Fisken (2006) | Fisheries | Isometric* | Assumption | (*65*) |
| Enberg *et al.* (2010) | Fisheries | Isometric | Assumption | (*66*) |
| Eikeset *et al.* (2013) | Fisheries | Isometric | Assumption | (*67*) |
| Lester *et al.* (2014) | Fisheries | Isometric | Assumption | (*68*) |
| Andersen and Beyer (2015) | Fisheries | Isometric | Assumption | (*69*) |
| Eikeset *et al.* (2016) | Fisheries | Isometric | Assumption | (*70*) |
| Andersen *et al.* (2016) | Fisheries | Isometric | Assumption | (*12*) |
| Zimmerman and Jørgensen (2016) | Fisheries | Isometric | Assumption | (*71*) |
| Hartvig *et al.* (2011) | Food web | Isometric | Assumption | (*72*) |
| Carozza *et al.* (2016) | Food web | Isometric | Assumption | (*73*) |

**Table S2. Summary table of the major compilations** of fish reproductive scaling relationships (both within and among species). Note that where scaling relationships used length rather than mass, we assumed that mass scaled to length$^3$.

| Study | Interspecific/intraspecific | Relationship | Allometric Scaling | Refs |
|---|---|---|---|---|
| Blueweiss *et al.* (1978) | Inter- | Size-fecundity | Hypo- | (*74*) |
| Blueweiss *et al.* (1978) | Inter- | Size-egg size | Hypo- | (*74*) |
| Wootton (1979) | Intra- | Size-fecundity | Hyper- | (*75*) |
| Roff (1983) | Intra- | Size-fecundity | Hyper- | (*41*) |
| Duarte and Alcaraz (1989) | Inter- | Size-fecundity | Hypo- | (*19*) |
| Duarte and Alcaraz (1989) | Inter- | Size-egg size | None | (*19*) |
| Wootton (1992) | Inter- | Size-egg size | Iso- | (*76*) |
| Hayward and Gillooly (2011) | Inter- | Size-fecundity | Iso- | (*77*) |
| Hixon *et al.* (2014) | Intra- | Size-fecundity | Hyper- | (*4*) |
| Dick *et al.* (2017) | Intra- | Size-fecundity | Hyper- | (*78*) |

**Table S3. Summary of data used for Fecundity–Mass model.** This table shows summary stats of raw data used in Fecundity–Mass model (Fig. 2A). **OTL** = Open Tree of Life Identifier; **SM** = Spawning Mode (D = demersal, P = pelagic, S = scatterer, BM/BP/BI = mouth/pouch/internal brooder – all brooders have no parental provisioning post fertilization); **F3** = Number ID in Fig. 3; $\beta_1$ **/ 2.5% / 97.5%** = Estimates (mean and 95% Bayesian credible intervals) of species-specific fecundity mass-scaling exponents as obtained from Fecundity–Mass model (see Materials and Methods); **n** = number of independent observations for each species.

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **n** | **Fecundity range** | **Mass range (g)** | **Refs** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agonidae | *Leptagonus decagonus* | ott3632024 | D | 269 | 1.16 | 0.66 | 1.67 | 1 | 577 | 32.32 | (*79*) |
| Apogonidae | *Cheilodipterus macrodon* | ott965176 | BM | 59 | 1.27 | 0.71 | 1.83 | 1 | 2,600 | 110.09 | (*80*) |
| Apogonidae | *Holapogon maximus* | ott3635086 | BM | 61 | 1.24 | 0.71 | 1.77 | 1 | 1,800 | 48.48 | (*80*) |
| Apogonidae | *Jaydia hungi* | ott3634955 | BM | 62 | 1.23 | 0.73 | 1.73 | 1 | 800 | 20.36 | (*80*) |
| Apogonidae | *Ostorhinchus cookii* | ott102070 | BM | 63 | 1.25 | 0.76 | 1.74 | 1 | 500 | 15.91 | (*80*) |
| Apogonidae | *Ostorhinchus cyanosoma* | ott638185 | BM | 64 | 1.09 | 0.65 | 1.53 | 1 | 650 | 6.02 | (*80*) |
| Apogonidae | *Siphamia tubifer* | ott5860863 | BM | 67 | 0.86 | 0.52 | 1.19 | 1 | 240 | 0.29 | (*80*) |
| Apogonidae | *Taeniamia lineolata* | ott775407 | BM | 68 | 1.07 | 0.65 | 1.49 | 1 | 400 | 3.35 | (*80*) |
| Atherinidae | *Atherina presbyter* | ott669918 | D | 2 | 1.09 | 0.9 | 1.28 | 33 | 935 – 11,407 | 1.47 – 13.70 | (*81*) |
| Atherinopsidae | *Leuresthes tenuis* | ott274466 | D | 3 | 1.39 | 0.93 | 1.87 | 7 | 475 – 2,705 | 15.99 – 31.31 | (*82*) |
| Atherinopsidae | *Odontesthes argentinensis* | ott93287 | D | 6 | 1.17 | 0.86 | 1.48 | 24 | 3,422 – 27,980 | 41.62 – 244.65 | (*83*) |
| Balistidae | *Balistes capriscus* | ott135140 | S | 335 | 1.61 | 1.42 | 1.8 | 172 | 32,919 – 1,996,500 | 192.48 – 1002.07 | (*84*); (*85*) |
| Blenniidae | *Aidablennius sphynx* | ott898527 | D | 70 | 1.07 | 0.68 | 1.46 | 1 | 655 | 0.63 | (*86*) |
| Bothidae | *Arnoglossus laterna* | ott696263 | P | 258 | 0.98 | 0.6 | 1.37 | 2 | 7,092 – 59,574 | 2.68 – 9.09 | (*87*) |
| Carangidae | *Decapterus punctatus* | ott705034 | P | 74 | 1.28 | 0.84 | 1.72 | 2 | 6,200 – 51,000 | 16.71 – 53.59 | (*88*) |
| Carangidae | *Elagatis bipinnulata* | ott705026 | P | 75 | 0.99 | 0.73 | 1.25 | 29 | 469,590 – 2,635,300 | 1378.72 – 7075.53 | (*89*) |
| Carangidae | *Trachurus picturatus* | ott174574 | P | 77 | 1.13 | 0.65 | 1.62 | 8 | 23,630 – 48,816 | 38.10 – 73.11 | (*90*) |
| Centropomidae | *Centropomus undecimalis* | ott317368 | P | 79 | 1.49 | 1.08 | 1.9 | 15 | 578,160 – 10,289,069 | 2711.08 – 7993.41 | (*91*) |
| Clupeidae | *Amblygaster sirm* | ott328216 | P | 11 | 1.57 | 1.13 | 2.04 | 33 | 20,281 – 140,411 | 34.39 – 57.50 | (*92*) |
| Clupeidae | *Clupea harengus* | ott1005932 | D | 14 | 1.54 | 1.42 | 1.66 | 419 | 19,355 – 265,161 | 140.27 – 533.37 | (*93*) |
| Clupeidae | *Ethmalosa fimbriata* | ott658559 | P | 16 | 0.89 | 0.56 | 1.23 | 32 | 15,816 – 51,901 | 182.55 – 582.47 | (*94*) |
| Clupeidae | *Nematalosa vlaminghi* | ott328199 | P | 17 | 1.15 | 0.59 | 1.71 | 1 | 90,451 | 111.79 | (*95*) |
| Clupeidae | *Opisthonema libertate* | ott437031 | P | 18 | 1.1 | 0.7 | 1.5 | 58 | 22,025 – 106,958 | 91.39 – 204.30 | (*96*) |
| Clupeidae | *Opisthonema medirastre* | ott1195 | P | 19 | 1.24 | 0.82 | 1.67 | 46 | 17,941 – 107,063 | 80.90 – 169.98 | (*97*) |
| Clupeidae | *Sardinops sagax* | ott121238 | P | 20 | 0.97 | 0.83 | 1.11 | 185 | 3,083 – 33,483 | 26.53 – 118.21 | (*98*) |
| Clupeidae | *Spratelloides gracilis* | ott39732 | D | 21 | 0.99 | 0.74 | 1.26 | 18 | 594 – 5,913 | 0.20 – 0.86 | (*99*) |
| Clupeidae | *Strangomera bentincki* | ott648871 | P | 22 | 1.08 | 0.65 | 1.49 | 10 | 5,901 – 10,414 | 11.25 – 24.31 | (*100*) |
| Cottidae | *Artediellus atlanticus* | ott654509 | D | 273 | 1.32 | 0.82 | 1.81 | 1 | 88.5 | 23.32 | (*79*) |
| Cottidae | *Enophrys bison* | ott290389 | D | 274 | 1.13 | 0.55 | 1.7 | 2 | 18,800 – 31,900 | 197.53 – 241.50 | (*101*) |
| Cottidae | *Icelus bicornis* | ott3632116 | D | 276 | 1.1 | 0.6 | 1.59 | 1 | 440 | 14.79 | (*79*) |
| Cottidae | *Triglops pingelii* | ott568671 | D | 277 | 1.12 | 0.63 | 1.62 | 1 | 600 | 22.25 | (*79*) |
| Cyclopteridae | *Cyclopteropsis mcalpini* | ott3631993 | D | 279 | 1.04 | 0.63 | 1.46 | 1 | 65 | 2.80 | (*79*) |
| Engraulidae | *Anchoviella lepidentostole* | ott610213 | P | 23 | 0.97 | 0.59 | 1.35 | 24 | 14,395 – 37,191 | 9.36 – 21.80 | (*102*) |
| Engraulidae | *Cetengraulis mysticetus* | ott1064953 | P | 24 | 1.23 | 0.98 | 1.47 | 86 | 9,810 – 79,010 | 25.10 – 71.50 | (*103*) |
| Engraulidae | *Engraulis anchoita* | ott648864 | P | 25 | 1.26 | 1.12 | 1.4 | 159 | 1,641 – 36,464 | 5.44 – 39.01 | (*104*) |
| Engraulidae | *Engraulis mordax* | ott29754 | P | 26 | 1.16 | 0.76 | 1.56 | 21 | 8,673 – 35,561 | 10.47 – 23.98 | (*105*) |
| Engraulidae | *Engraulis ringens* | ott211981 | P | 27 | 1.35 | 1.14 | 1.56 | 149 | 3,067 – 34,977 | 10.78 – 39.92 | (*106*); (*100*); (*107*) |
| Exocoetidae | *Hirundichthys affinis* | ott837204 | D | 7 | 1.21 | 0.63 | 1.79 | 2 | 7,398 – 10,021 | 218.16 – 255.62 | (*108*) |
| Gadidae | *Boreogadus saida* | ott877055 | P | 33 | 0.89 | 0.41 | 1.38 | 1 | 48,500 | 18.48 | (*79*) |
| Gadidae | *Eleginus nawaga* | ott450082 | D | 34 | 1.12 | 0.57 | 1.66 | 1 | 40,500 | 74.86 | (*79*) |
| Gadidae | *Gadus morhua* | ott5860467 | P | 35 | 1.23 | 1.18 | 1.28 | 428 | 151,700 – 21,496,000 | 1036.67 – 24086.31 | (*109*); (*110*); (*111*); (*112*) |
| Gadidae | *Merlangius merlangus* | ott635911 | P | 37 | 1.03 | 0.92 | 1.15 | 178 | 95,555 – 1,443,958 | 94.88 – 1467.11 | (*113*) |

**Table S3** *Continued.*

| Family | Species | OTL | SM | F3 | $\beta_1$ | 2.5% C.I. | 97.5% C.I. | n | Fecundity range | Mass range (g) | Refs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gadidae | *Micromesistius australis* | ott1091056 | P | 38 | 1.56 | 1.37 | 1.76 | 96 | 2,658 – 81,300 | 188.76 – 1017.03 | (*114*) |
| Gasterosteidae | *Gasterosteus aculeatus* | ott111122 | D | 45 | 0.91 | 0.78 | 1.04 | 110 | 48 – 523 | 0.33 – 3.03 | (*115*); (*116*) |
| Gobiidae | *Elacatinus oceanops* | ott638369 | D | 89 | 0.8 | 0.44 | 1.15 | 1 | 375 | 0.25 | (*117*) |
| Gobiidae | *Gobiosoma robustum* | ott1064480 | D | 90 | 1.35 | 0.76 | 1.95 | 1 | 695 | 158.08 | (*118*) |
| Gobiidae | *Paragobiodon echinocephalus* | ott940827 | D | 92 | 0.87 | 0.5 | 1.24 | 1 | 716 | 0.23 | (*119*) |
| Gobiidae | *Paragobiodon lacunicolus* | ott758973 | D | 93 | 0.88 | 0.53 | 1.24 | 1 | 635 | 0.23 | (*119*) |
| Gobiidae | *Paragobiodon xanthosoma* | ott770378 | D | 94 | 0.96 | 0.61 | 1.32 | 1 | 293 | 0.23 | (*119*) |
| Gobiidae | *Pomatoschistus minutus* | ott1048873 | D | 95 | 0.82 | 0.46 | 1.17 | 28 | 1,430 – 4,070 | 1.53 – 3.11 | (*120*) |
| Haemulidae | *Haemulopsis corvinaeformis* | ott177515 | P | 97 | 0.52 | 0.3 | 0.75 | 2 | 15,056 – 83,316 | 0.93 – 51.66 | (*108*) |
| Hemiramphidae | *Hemiramphus brasiliensis* | ott953384 | D | 8 | 0.84 | 0.44 | 1.24 | 2 | 2,200 – 4,000 | 21.01 – 111.47 | (*108*) |
| Hemitripteridae | *Hemitripterus americanus* | ott160287 | D | 282 | 1.22 | 0.78 | 1.66 | 6 | 1,039 – 22,194 | 303.44 – 1004.16 | (*121*) |
| Hexagrammidae | *Oxylebius pictus* | ott131554 | D | 284 | 0.92 | 0.44 | 1.41 | 22 | 12,789 – 25,621 | 32.22 – 63.30 | (*122*) |
| Labridae | *Thalassoma bifasciatum* | ott907850 | P | 145 | 0.75 | 0.6 | 0.9 | 66 | 79 – 5,140 | 0.52 – 4.60 | * |
| Latidae | *Lates calcarifer* | ott6362446 | P | 150 | 1.04 | 0.83 | 1.26 | 25 | 2,062,100 – 47,202,800 | 2945.25 – 32293.52 | (*123*) |
| Liparidae | *Careproctus reinhardti* | ott1065176 | D | 285 | 1.23 | 0.62 | 1.83 | 1 | 300 | 357.25 | (*79*) |
| Liparidae | *Paraliparis bathybius* | ott309222 | BM | 287 | 1.25 | 0.68 | 1.82 | 1 | 428 | 122.99 | (*79*) |
| Lutjanidae | *Lutjanus campechanus* | ott642863 | P | 151 | 1 | 0.62 | 1.37 | 9 | 160,000 – 900,000 | 1350.00 – 5850.00 | (*124*) |
| Lutjanidae | *Lutjanus carponotatus* | ott333348 | P | 152 | 1.72 | 1.51 | 1.93 | 55 | 4,451 – 750,512 | 77.08 – 485.66 | (*125*) |
| Lutjanidae | *Lutjanus synagris* | ott943184 | P | 153 | 0.67 | 0.46 | 0.87 | 39 | 23,000 – 160,000 | 198.00 – 2100.00 | (*126*) |
| Lutjanidae | *Ocyurus chrysurus* | ott943183 | P | 154 | 1.25 | 0.88 | 1.61 | 21 | 14,268 – 166,651 | 221.70 – 734.70 | (*127*) |
| Lutjanidae | *Rhomboplites aurorubens* | ott642869 | P | 155 | 1.39 | 1.24 | 1.53 | 41 | 4,350 – 1,792,070 | 158.61 – 2994.94 | (*128*) |
| Malacanthidae | *Caulolatilus microps* | ott39883 | P | 156 | 1.47 | 1.22 | 1.73 | 43 | 83,470 – 4,120,570 | 762.87 – 4527.12 | (*129*) |
| Merlucciidae | *Merluccius gayi* | ott323082 | P | 42 | 1.19 | 0.9 | 1.48 | 50 | 45,041 – 399,890 | 523.49 – 3390.80 | (*130*) |
| Merlucciidae | *Merluccius hubbsi* | ott757316 | P | 43 | 1.06 | 0.99 | 1.14 | 251 | 37,817 – 2,537,392 | 261.48 – 5782.35 | (*131*) |
| Merlucciidae | *Merluccius merluccius* | ott5860466 | P | 44 | 0.93 | 0.77 | 1.1 | 209 | 32,665 – 578,510 | 626.18 – 3465.51 | (*132*) |
| Monacanthidae | *Brachaluteres jacksonianus* | ott333693 | S | 336 | 1.2 | 0.83 | 1.56 | 1 | 114 | 1.24 | (*133*) |
| Monacanthidae | *Eubalichthys bucephalus* | ott3631310 | S | 337 | 1.32 | 0.73 | 1.91 | 2 | 9,000 – 39,500 | 355.86 – 524.85 | (*134*) |
| Monacanthidae | *Oxymonacanthus longirostris* | ott333706 | S | 338 | 1.31 | 0.91 | 1.72 | 3 | 100 – 200 | 3.30 – 3.79 | (*135*) |
| Monacanthidae | *Rudarius ercodes* | ott511593 | S | 340 | 0.83 | 0.48 | 1.17 | 3 | 2,560 – 8,180 | 1.25 – 5.78 | (*136*) |
| Moronidae | *Dicentrarchus labrax* | ott3549 | P | 157 | 1.23 | 0.85 | 1.6 | 16 | 290,390 – 2,043,126 | 1000.00 – 3800.00 | (*137*) |
| Mugilidae | *Chelon labrosus* | ott777079 | P | 46 | 1.09 | 0.58 | 1.61 | 13 | 353,000 – 745,000 | 1240.00 – 2300.00 | (*138*) |
| Mugilidae | *Chelon ramada* | ott668241 | P | 47 | 1.18 | 0.62 | 1.73 | 2 | 581,000 – 1,243,000 | 850.00 – 1450.00 | (*138*) |
| Mugilidae | *Mugil cephalus* | ott418648 | P | 48 | 1.01 | 0.93 | 1.1 | 95 | 43,182 – 4,800,000 | 42.77 – 3760.17 | (*139*); (*140*); (*141*) |
| Mugilidae | *Mugil curema* | ott418643 | P | 49 | 1.15 | 0.6 | 1.69 | 8 | 295,081 – 488,956 | 222.87 – 371.93 | (*142*) |
| Mugilidae | *Mugil hospes* | ott779937 | P | 50 | 1.14 | 0.58 | 1.7 | 1 | 178,277 | 114.11 | (*142*) |
| Mugilidae | *Mugil liza* | ott779933 | P | 51 | 1.19 | 0.61 | 1.75 | 1 | 1,776,309 | 1201.53 | (*142*) |
| Mugilidae | *Mugil trichodon* | ott246901 | P | 52 | 1.18 | 0.62 | 1.73 | 1 | 100,346 | 112.33 | (*142*) |
| Mugilidae | *Planiliza subviridis* | ott823526 | P | 53 | 1.07 | 0.66 | 1.48 | 12 | 38,167 – 145,883 | 11.69 – 28.41 | (*143*) |
| Nototheniidae | *Lepidonotothen nudifrons* | ott260052 | D | 160 | 1.27 | 0.69 | 1.84 | 1 | 2,500 | 117.20 | (*144*) |
| Osmeridae | *Mallotus villosus* | ott225330 | D | 54 | 1.22 | 0.7 | 1.74 | 34 | 6,700 – 14,300 | 18.07 – 26.43 | (*145*) |
| Paralichthyidae | *Paralichthys dentatus* | ott1019735 | P | 259 | 1.06 | 0.91 | 1.2 | 134 | 460,059 – 4,202,538 | 2627.81 – 20166.83 | (*146*) |
| Paralichthyidae | *Paralichthys patagonicus* | ott654479 | P | 260 | 1.38 | 0.91 | 1.85 | 24 | 20,084 – 156,527 | 709.32 – 1465.65 | (*147*) |
| Plesiopidae | *Acanthoclinus fuscus* | ott3633802 | D | 164 | 1.46 | 0.94 | 2.01 | 7 | 42,756 – 438,961 | 232.38 – 475.62 | (*148*) |
| Pleuronectidae | *Hippoglossoides platessoides* | ott223665 | P | 262 | 0.96 | 0.83 | 1.09 | 154 | 25,700 – 258,000 | 24.83 – 255.51 | (*149*); (*150*) |
| Pleuronectidae | *Pleuronectes platessa* | ott408337 | P | 264 | 1.11 | 1.04 | 1.18 | 486 | 28,800 – 754,600 | 189.13 – 3022.59 | (*151*) |

**Table S3** *Continued.*

| Family | Species | OTL | SM | F3 | $\beta_1$ | 2.5% C.I. | 97.5% C.I. | n | Fecundity range | Mass range (g) | Refs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pleuronectidae | *Pseudopleuronectes americanus* | ott261419 | D | 265 | 0.99 | 0.63 | 1.35 | 17 | 192,240 – 1,390,495 | 332.81 – 1322.71 | (*152*) |
| Pleuronectidae | *Reinhardtius hippoglossoides* | ott835141 | P | 266 | 1.3 | 1.07 | 1.53 | 88 | 6,761 – 70,394 | 970.70 – 5331.71 | (*153*) |
| Pomacanthidae | *Pomacanthus zonipectus* | ott826472 | P | 165 | 1.25 | 0.69 | 1.81 | 5 | 25,456 – 62,401 | 160.12 – 211.09 | (*154*) |
| Pomacentridae | *Abudefduf saxatilis* | ott405751 | D | 167 | 0.94 | 0.43 | 1.44 | 1 | 31,088 | 22.12 | (*155*) |
| Pomacentridae | *Acanthochromis polyacanthus* | ott100410 | D | 172 | 1.41 | 0.85 | 1.96 | 15 | 245.6 – 573.1 | 87.19 – 124.17 | (*156*) |
| Pomacentridae | *Pomacentrus coelestis* | ott622060 | D | 180 | 1.02 | 0.75 | 1.29 | 81 | 1,391 – 6,213 | 1.27 – 3.26 | (*157*) |
| Pomacentridae | *Stegastes fuscus* | ott3635543 | D | 185 | 0.96 | 0.63 | 1.3 | 14 | 1,759 – 14,856 | 3.92 – 14.19 | (*158*) |
| Pristigasteridae | *Ilisha africana* | ott741177 | P | 28 | 1.3 | 0.78 | 1.82 | 1 | 5,227 | 37.69 | (*159*) |
| Sciaenidae | *Bairdiella chrysoura* | ott761907 | P | 207 | 1.09 | 0.56 | 1.62 | 1 | 52,800 | 54.91 | (*160*) |
| Sciaenidae | *Cynoscion regalis* | ott5860595 | P | 208 | 1.49 | 1.24 | 1.73 | 29 | 90,019 – 2,163,872 | 554.68 – 3969.46 | (*161*) |
| Sciaenidae | *Cynoscion striatus* | ott267367 | P | 209 | 1.23 | 0.66 | 1.79 | 5 | 45,347 – 98,573 | 178.46 – 230.71 | (*162*) |
| Sciaenidae | *Genyonemus lineatus* | ott1027240 | P | 210 | 1.9 | 1.66 | 2.15 | 44 | 1,038 – 36,701 | 78.67 – 401.10 | (*163*) |
| Sciaenidae | *Isopisthus parvipinnis* | ott133138 | P | 211 | 1.31 | 0.88 | 1.76 | 8 | 4,280 – 51,604 | 19.18 – 44.36 | (*162*) |
| Sciaenidae | *Larimus breviceps* | ott924070 | P | 212 | 1.71 | 1.2 | 2.25 | 6 | 5,463 – 165,132 | 73.67 – 144.63 | (*162*) |
| Sciaenidae | *Larimus fasciatus* | ott897432 | P | 213 | 1.03 | 0.86 | 1.2 | 81 | 17,639 – 315,972 | 8.75 – 59.86 | (*164*) |
| Sciaenidae | *Macrodon ancylodon* | ott99076 | P | 215 | 1.24 | 0.89 | 1.59 | 21 | 26,210 – 217,632 | 155.00 – 500.00 | (*165*) |
| Sciaenidae | *Micropogonias furnieri* | ott742890 | P | 216 | 0.99 | 0.83 | 1.16 | 85 | 44,733 – 776,006 | 315.49 – 2485.35 | (*166*); (*167*) |
| Sciaenidae | *Paralonchurus brasiliensis* | ott160812 | P | 218 | 0.89 | 0.42 | 1.35 | 16 | 11,497 – 86,034 | 44.15 – 94.52 | (*162*) |
| Sciaenidae | *Seriphus politus* | ott827210 | P | 219 | 1.11 | 1 | 1.22 | 143 | 2,314 – 125,632 | 7.44 – 85.10 | (*168*) |
| Sciaenidae | *Stellifer rastrifer* | ott362452 | P | 220 | 0.76 | 0.5 | 1.02 | 44 | 1,544 – 263,392 | 21.73 – 107.90 | (*162*) |
| Scombridae | *Auxis rochei* | ott713972 | P | 221 | 1.18 | 0.59 | 1.78 | 1 | 75,000 | 453.17 | (*169*) |
| Scombridae | *Scomber scombrus* | ott70561 | P | 225 | 1.38 | 1.08 | 1.68 | 27 | 151,916 – 1,491,192 | 190.50 – 832.39 | (*170*) |
| Scombridae | *Scomberomorus cavalla* | ott70546 | P | 226 | 1.37 | 1.26 | 1.49 | 75 | 69,264 – 12,206,888 | 886.37 – 28991.83 | (*171*); (*172*) |
| Scombridae | *Scomberomorus maculatus* | ott266387 | P | 227 | 1.12 | 0.84 | 1.4 | 14 | 525,000 – 7,411,000 | 550.00 – 4150.00 | (*173*); (*1*) |
| Scombridae | *Thunnus alalunga* | ott833194 | P | 228 | 0.93 | 0.56 | 1.32 | 69 | 263,100 – 2,813,400 | 14094.95 – 25217.33 | (*174*) |
| Scombridae | *Thunnus albacares* | ott833188 | P | 229 | 0.99 | 0.57 | 1.4 | 4 | 1,300,000 – 5,431,000 | 32593.36 – 57119.99 | (*175*) |
| Scombridae | *Thunnus thynnus* | ott358607 | P | 231 | 1.31 | 0.83 | 1.79 | 27 | 13,600,000 – 57,600,000 | 1336.98 – 2861.01 | (*176*) |
| Sebastidae | *Sebastes alutus* | ott480735 | BI | 288 | 1.76 | 1.6 | 1.93 | 88 | 4,500 – 270,000 | 255.24 – 1429.15 | (*177*); (*178*) |
| Sebastidae | *Sebastes atrovirens* | ott480732 | BI | 289 | 1.11 | 0.59 | 1.62 | 17 | 67,927 – 528,987 | 268.54 – 471.51 | (*148*) |
| Sebastidae | *Sebastes auriculatus* | ott480729 | BI | 290 | 1.06 | 0.74 | 1.39 | 35 | 51,619 – 338,540 | 391.43 – 1455.21 | (*179*) |
| Sebastidae | *Sebastes brevispinis* | ott1057081 | BI | 291 | 1.28 | 0.81 | 1.76 | 22 | 496,000 – 1,252,000 | 1448.00 – 2832.00 | (*180*) |
| Sebastidae | *Sebastes carnatus* | ott1057074 | BI | 292 | 1.19 | 0.67 | 1.7 | 11 | 77,671 – 236,038 | 499.24 – 1054.02 | (*148*) |
| Sebastidae | *Sebastes caurinus* | ott1057078 | BI | 293 | 1.68 | 1.49 | 1.86 | 54 | 15,642 – 640,052 | 247.45 – 2343.44 | (*179*); (*181*) |
| Sebastidae | *Sebastes chlorostictus* | ott1057068 | BI | 294 | 1.55 | 1.34 | 1.76 | 64 | 17,198 – 761,362 | 246.06 – 1252.35 | (*182*); (*183*) |
| Sebastidae | *Sebastes constellatus* | ott1057062 | BI | 295 | 1.34 | 0.95 | 1.73 | 21 | 31,781 – 248,490 | 224.89 – 655.33 | (*182*) |
| Sebastidae | *Sebastes crameri* | ott1057065 | BI | 296 | 1.46 | 1.1 | 1.82 | 12 | 36,600 – 609,800 | 491.77 – 2582.59 | (*184*) |
| Sebastidae | *Sebastes dallii* | ott1088425 | BI | 297 | 1.15 | 0.75 | 1.55 | 23 | 3,744 – 18,131 | 17.90 – 44.78 | (*182*) |
| Sebastidae | *Sebastes diploproa* | ott1057059 | BI | 298 | 1.45 | 1.13 | 1.77 | 15 | 14,400 – 303,700 | 85.27 – 559.21 | (*184*) |
| Sebastidae | *Sebastes elongatus* | ott531065 | BI | 299 | 1.3 | 1.06 | 1.53 | 25 | 8,707 – 296,799 | 56.35 – 567.53 | (*182*) |
| Sebastidae | *Sebastes entomelas* | ott531068 | BI | 300 | 1.62 | 1.43 | 1.81 | 110 | 55,600 – 1,102,844 | 443.86 – 2398.20 | (*185*); (*182*); (*184*) |
| Sebastidae | *Sebastes flavidus* | ott531059 | BI | 301 | 1.5 | 1.25 | 1.74 | 49 | 48,400 – 969,715 | 395.33 – 2310.74 | (*184*); (*182*) |
| Sebastidae | *Sebastes goodei* | ott531047 | BI | 302 | 1.32 | 1.13 | 1.5 | 62 | 29,200 – 961,809 | 351.87 – 2426.91 | (*182*); (*184*) |
| Sebastidae | *Sebastes helvomaculatus* | ott531044 | BI | 303 | 1.29 | 0.81 | 1.79 | 5 | 183,000 – 1,652,000 | 105.65 – 322.55 | (*186*) |
| Sebastidae | *Sebastes hopkinsi* | ott9589 | BI | 304 | 1.01 | 0.66 | 1.36 | 39 | 8,332 – 39,559 | 61.99 – 228.24 | (*182*) |
| Sebastidae | *Sebastes jordani* | ott9592 | BI | 305 | 1.1 | 0.75 | 1.47 | 10 | 6,200 – 50,100 | 28.36 – 168.04 | (*184*) |

**Table S3** *Continued.*

| Family | Species | OTL | SM | F3 | $\beta_1$ | 2.5% C.I. | 97.5% C.I. | n | Fecundity range | Mass range (g) | Refs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sebastidae | *Sebastes levis* | ott9598 | BI | 306 | 1.06 | 0.79 | 1.34 | 27 | 181,001 – 1,941,579 | 1367.68 – 7660.85 | (*182*) |
| Sebastidae | *Sebastes melanops* | ott9604 | BI | 307 | 1.3 | 1.05 | 1.54 | 226 | 214,367 – 1,498,862 | 1165.81 – 2799.49 | (*187*) |
| Sebastidae | *Sebastes melanostomus* | ott9607 | BI | 308 | 1.41 | 1.11 | 1.73 | 42 | 174,874 – 1,177,889 | 864.30 – 2919.60 | (*188*); (*186*) |
| Sebastidae | *Sebastes mentella* | ott1088432 | BI | 309 | 1.46 | 1.37 | 1.55 | 227 | 1,457 – 115,846 | 162.42 – 1284.55 | (*189*); (*190*) |
| Sebastidae | *Sebastes miniatus* | ott9611 | BI | 310 | 1.58 | 1.37 | 1.78 | 59 | 63,300 – 2,647,282 | 1022.07 – 10240.11 | (*182*); (*184*) |
| Sebastidae | *Sebastes mystinus* | ott9616 | BI | 311 | 1.74 | 1.58 | 1.9 | 151 | 10,369 – 524,554 | 192.42 – 983.32 | (*148*); (*191*) |
| Sebastidae | *Sebastes norvegicus* | ott1088441 | BI | 312 | 1.06 | 0.89 | 1.23 | 67 | 19,810 – 336,700 | 434.15 – 3204.64 | (*192*); (*190*) |
| Sebastidae | *Sebastes ovalis* | ott582324 | BI | 313 | 1.23 | 0.82 | 1.64 | 39 | 52,356 – 212,399 | 425.50 – 1019.60 | (*186*); (*188*) |
| Sebastidae | *Sebastes paucispinis* | ott582321 | BI | 314 | 1.35 | 1.18 | 1.53 | 75 | 20,000 – 2,297,900 | 724.86 – 6193.24 | (*182*); (*184*) |
| Sebastidae | *Sebastes pinniger* | ott582318 | BI | 315 | 1.26 | 0.79 | 1.73 | 10 | 260,600 – 1,897,600 | 1506.08 – 4055.36 | (*184*) |
| Sebastidae | *Sebastes rastrelliger* | ott582315 | BI | 316 | 1.23 | 0.82 | 1.65 | 2 | 80,000 – 760,000 | 386.67 – 2211.98 | (*193*) |
| Sebastidae | *Sebastes rosaceus* | ott212767 | BI | 317 | 1.14 | 0.84 | 1.44 | 23 | 12,992 – 94,936 | 43.53 – 172.48 | (*182*) |
| Sebastidae | *Sebastes rosenblatti* | ott582311 | BI | 318 | 1.29 | 0.97 | 1.61 | 26 | 4,880 – 93,370 | 47.04 – 171.78 | (*182*) |
| Sebastidae | *Sebastes rufus* | ott884513 | BI | 319 | 1.3 | 0.93 | 1.67 | 27 | 67,051 – 606,888 | 672.05 – 2143.58 | (*182*) |
| Sebastidae | *Sebastes saxicola* | ott884510 | BI | 320 | 1.04 | 0.94 | 1.14 | 43 | 4,376 – 230,000 | 13.98 – 452.33 | (*182*); (*184*) |
| Sebastidae | *Sebastes semicinctus* | ott795707 | BI | 321 | 1.29 | 0.99 | 1.61 | 46 | 3,275 – 30,867 | 18.95 – 85.87 | (*182*) |
| Sebastidae | *Sebastes serranoides* | ott884519 | BI | 322 | 1.56 | 1.34 | 1.78 | 83 | 29,597 – 524,048 | 287.54 – 1198.45 | (*194*) |
| Sebastidae | *Sebastes viviparus* | ott99016 | BI | 323 | 1.21 | 0.94 | 1.49 | 32 | 1,770 – 29,047 | 69.51 – 324.99 | (*195*) |
| Serranidae | *Cephalopholis cruentata* | ott12880 | P | 232 | 1.18 | 0.7 | 1.66 | 12 | 86,204 – 615,387 | 142.95 – 414.81 | (*196*) |
| Serranidae | *Epinephelus aeneus* | ott306171 | P | 233 | 1.15 | 0.87 | 1.42 | 27 | 404,056 – 12,589,242 | 967.53 – 6975.90 | (*197*) |
| Serranidae | *Epinephelus fasciatus* | ott534146 | P | 234 | 0.78 | 0.34 | 1.21 | 9 | 254,732 – 879,038 | 395.33 – 1435.81 | (*197*) |
| Serranidae | *Epinephelus marginatus* | ott733897 | P | 235 | 1.22 | 0.65 | 1.78 | 2 | 257,657 – 606,246 | 758.70 – 1197.83 | (*197*) |
| Serranidae | *Epinephelus tauvina* | ott218649 | P | 236 | 0.9 | 0.51 | 1.29 | 4 | 850,186 – 2,904,912 | 1062.45 – 6012.89 | (*198*) |
| Serranidae | *Mycteroperca tigris* | ott207413 | P | 237 | 1.43 | 0.95 | 1.93 | 2 | 890,000 – 10,490,000 | 3130.04 – 7720.75 | (*199*) |
| Siganidae | *Siganus canaliculatus* | ott199059 | S | 241 | 1.25 | 1.05 | 1.44 | 27 | 35,494 – 1,555,688 | 59.67 – 870.20 | (*200*) |
| Soleidae | *Solea solea* | ott710233 | P | 268 | 1.15 | 1.07 | 1.24 | 323 | 50,400 – 1,577,100 | 117.75 – 1194.75 | (*201*) |
| Sparidae | *Acanthopagrus latus* | ott760733 | P | 242 | 1.16 | 0.58 | 1.73 | 5 | 1,362,137 – 2,152,993 | 426.21 – 660.47 | (*202*) |
| Sparidae | *Archosargus rhomboidalis* | ott724892 | P | 243 | 0.91 | 0.69 | 1.13 | 23 | 18,274 – 161,107 | 15.05 – 156.17 | (*203*) |
| Sparidae | *Sparidentex hasta* | ott845300 | P | 244 | 1.21 | 0.73 | 1.69 | 6 | 308,273 – 1,693,365 | 2604.06 – 6288.57 | (*202*) |
| Stromateidae | *Pampus chinensis* | ott916290 | P | 245 | 1.14 | 0.56 | 1.71 | 8 | 80,400 – 93,100 | 647.18 – 876.77 | (*204*) |
| Syngnathidae | *Hippocampus reidi* | ott630138 | BP | 326 | 1.24 | 0.76 | 1.72 | 3 | 725 – 914 | 10.00 – 12.30 | (*205*) |
| Syngnathidae | *Micrognathus crinitus* | ott3642321 | BP | 327 | 1.11 | 0.79 | 1.43 | 1 | 21.7 | 0.17 | (*206*) |
| Syngnathidae | *Syngnathus floridae* | ott774435 | BP | 330 | 1.16 | 0.74 | 1.58 | 1 | 357.6 | 3.03 | (*206*) |
| Syngnathidae | *Syngnathus louisianae* | ott774414 | BP | 331 | 1.22 | 0.77 | 1.69 | 1 | 664.7 | 8.36 | (*206*) |
| Syngnathidae | *Syngnathus scovelli* | ott251400 | BP | 333 | 1.2 | 0.83 | 1.58 | 1 | 55.6 | 0.88 | (*206*) |
| Tetraodontidae | *Canthigaster valentini* | ott701127 | S | 342 | 0.97 | 0.77 | 1.18 | 66 | 419 – 1,928 | 2.32 – 9.09 | (*207*) |
| Trachichthyidae | *Hoplostethus atlanticus* | ott816600 | P | 9 | 1.01 | 0.81 | 1.21 | 166 | 9,776 – 93,849 | 661.58 – 2509.01 | (*208*) |
| Trichiuridae | *Aphanopus carbo* | ott113465 | P | 246 | 1.18 | 0.71 | 1.66 | 14 | 228,950 – 961,440 | 1950.46 – 4169.05 | (*209*) |
| Zoarcidae | *Gymnelus viridis* | ott729337 | D | 248 | 1.26 | 0.8 | 1.74 | 1 | 11 | 13.80 | (*79*) |
| Zoarcidae | *Lycodes esmarkii* | ott841648 | D | 249 | 0.93 | 0.38 | 1.48 | 1 | 1,200 | 4659.64 | (*79*) |
| Zoarcidae | *Lycodes eudipleurostictus* | ott905435 | D | 250 | 1.23 | 0.65 | 1.8 | 1 | 186.5 | 183.60 | (*79*) |
| Zoarcidae | *Lycodes frigidus* | ott539690 | D | 251 | 1.09 | 0.49 | 1.68 | 1 | 500 | 1207.55 | (*79*) |
| Zoarcidae | *Lycodes pallidus* | ott178074 | D | 252 | 1.23 | 0.71 | 1.76 | 1 | 60 | 50.90 | (*79*) |
| Zoarcidae | *Lycodes vahlii* | ott178063 | D | 255 | 1.04 | 0.59 | 1.49 | 1 | 37.5 | 7.04 | (*79*) |
| Zoarcidae | *Melanostigma atlanticum* | ott3633033 | D | 256 | 0.94 | 0.52 | 1.35 | 3 | 36 – 56 | 3.94 – 7.54 | (*210*) |

* This is original data collected by the second author (D. Ross Robertson). Fish size were measured in standard length (mm), and total volume was measured as described in ref. (*244*). Then, for each female, clutch dry weight was obtained, and a subsample of 50 eggs was obtained to estimate individual egg weight. Fecundity was estimated as the ratio between clutch dry weight and average individual egg weight.

**Table S4. Summary of data used for Egg-volume–Mass model.** This table shows summary stats of raw data used in Egg-volume–Mass model (Fig. 2B). **OTL** = Open Tree of Life Identifier; **SM** = Spawning Mode (D = demersal, P = pelagic, S = scatterer, BM/BP/BI = mouth/pouch/internal brooder – all brooders have no parental provisioning post fertilization); $\beta_1$ **/ 2.5% / 97.5%** = Estimates (mean and 95% Bayesian credible intervals) of species-specific egg-volume mass-scaling exponents as obtained from Egg-volume–Mass model (see Materials and Methods); **n** = number of independent observations for each species.

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **n** | **Egg-volume range (mm$^3$)** | **Mass range (g)** | **Refs** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agonidae | *Leptagonus decagonus* | ott3632024 | D | 269 | 0.17 | -0.23 | 0.55 | 1 | 4.189 | 32.32 | (*79*) |
| Apogonidae | *Cheilodipterus macrodon* | ott965176 | BM | 59 | 0.21 | -0.25 | 0.66 | 1 | 0.113 | 110.09 | (*80*) |
| Apogonidae | *Holapogon maximus* | ott3635086 | BM | 61 | 0.15 | -0.29 | 0.57 | 1 | 0.180 | 48.48 | (*80*) |
| Apogonidae | *Jaydia hungi* | ott3634955 | BM | 62 | 0.08 | -0.31 | 0.46 | 1 | 0.268 | 20.36 | (*80*) |
| Apogonidae | *Ostorhinchus cookii* | ott102070 | BM | 63 | 0.07 | -0.3 | 0.43 | 1 | 0.268 | 15.91 | (*80*) |
| Apogonidae | *Ostorhinchus cyanosoma* | ott638185 | BM | 64 | 0.18 | -0.14 | 0.49 | 1 | 0.113 | 6.02 | (*80*) |
| Apogonidae | *Paroncheilus affinis* | ott974576 | BM | 66 | 0.33 | -0.02 | 0.67 | 1 | 0.034 | 8.39 | (*211*) |
| Apogonidae | *Siphamia tubifer* | ott5860863 | BM | 67 | -0.09 | -0.35 | 0.15 | 1 | 0.905 | 0.29 | (*80*) |
| Apogonidae | *Taeniamia lineolata* | ott775407 | BM | 68 | -0.04 | -0.34 | 0.26 | 1 | 0.524 | 3.35 | (*80*) |
| Atherinidae | *Atherina presbyter* | ott669918 | D | 2 | 0.12 | -0.26 | 0.5 | 1 | 0.839 | 7.47 | (*81*) |
| Atherinopsidae | *Menidia menidia* | ott189767 | D | 5 | 0.07 | -0.16 | 0.29 | 20 | 0.624 – 0.860 | 3.48 – 14.03 | (*212*) |
| Balistidae | *Balistes capriscus* | ott135140 | S | 335 | 0.18 | -0.32 | 0.67 | 1 | 0.039 | 378.39 | (*85*) |
| Bathydraconidae | *Akarotaxis nudiceps* | ott682053 | D | 69 | -0.03 | -0.4 | 0.33 | 1 | 9.203 | 16.00 | (*213*) |
| Blenniidae | *Aidablennius sphynx* | ott898527 | D | 70 | 0.06 | -0.28 | 0.39 | 1 | 0.195 | 0.63 | (*86*) |
| Bothidae | *Arnoglossus laterna* | ott696263 | P | 258 | 0.27 | -0.05 | 0.61 | 1 | 0.056 | 5.27 | (*87*) |
| Callionymidae | *Synchiropus sechellensis* | ott3632718 | P | 73 | 0.23 | -0.16 | 0.63 | 1 | 0.268 | 10.06 | (*214*) |
| Carangidae | *Decapterus punctatus* | ott705034 | P | 74 | 0.41 | 0.01 | 0.82 | 1 | 0.024 | 31.62 | (*88*) |
| Carangidae | *Trachurus mediterraneus* | ott174577 | P | 76 | 0.14 | -0.33 | 0.6 | 1 | 0.271 | 364.39 | (*215*) |
| Carangidae | *Trachurus picturatus* | ott174574 | P | 77 | 0.1 | -0.25 | 0.46 | 8 | 0.194 – 0.194 | 38.10 – 73.11 | (*90*) |
| Carangidae | *Trachurus trachurus* | ott472429 | P | 78 | 0.16 | -0.21 | 0.54 | 3 | 0.342 – 0.435 | 140.72 – 317.47 | (*216*); (*215*) |
| Channichthyidae | *Pagetopsis macropterus* | ott708993 | D | 84 | 0.01 | -0.52 | 0.53 | 1 | 33.510 | 273.22 | (*217*) |
| Clupeidae | *Alosa mediocris* | ott491656 | D | 10 | 0.14 | -0.33 | 0.65 | 1 | 1.732 | 664.33 | (*218*) |
| Clupeidae | *Amblygaster sirm* | ott328216 | P | 11 | 0.32 | -0.11 | 0.77 | 1 | 0.048 | 42.93 | (*92*) |
| Clupeidae | *Brevoortia patronus* | ott107260 | P | 12 | 0.08 | -0.36 | 0.52 | 2 | 0.905 – 1.124 | 119.37 – 173.32 | (*219*) |
| Clupeidae | *Ethmalosa fimbriata* | ott658559 | P | 16 | 0.25 | -0.32 | 0.81 | 1 | 0.039 | 362.80 | (*94*) |
| Clupeidae | *Nematalosa vlaminghi* | ott328199 | P | 17 | 0.07 | -0.39 | 0.51 | 1 | 0.748 | 111.79 | (*95*) |
| Clupeidae | *Spratelloides gracilis* | ott39732 | D | 21 | 0.12 | -0.16 | 0.38 | 1 | 0.180 | 0.59 | (*99*) |
| Congiopodidae | *Zanclorhynchus spinifer* | ott255677 | P | 271 | 0.25 | -0.2 | 0.71 | 1 | 0.268 | 104.29 | (*213*) |
| Cottidae | *Artediellus atlanticus* | ott654509 | D | 273 | -0.12 | -0.53 | 0.25 | 1 | 33.510 | 23.32 | (*79*) |
| Cottidae | *Enophrys bison* | ott290389 | D | 274 | 0.25 | -0.22 | 0.72 | 2 | 2.572 – 4.189 | 197.53 – 241.50 | (*101*) |
| Cottidae | *Gymnocanthus tricuspis* | ott654474 | D | 275 | 0.19 | -0.28 | 0.65 | 1 | 3.764 | 179.34 | (*79*) |
| Cottidae | *Icelus bicornis* | ott3632116 | D | 276 | 0.12 | -0.26 | 0.51 | 1 | 8.181 | 14.79 | (*79*) |
| Cottidae | *Triglops pingelii* | ott568671 | D | 277 | -0.01 | -0.39 | 0.35 | 1 | 14.137 | 22.25 | (*79*) |
| Cyclopteridae | *Cyclopteropsis mcalpini* | ott3631993 | D | 279 | -0.07 | -0.38 | 0.23 | 1 | 65.450 | 2.80 | (*79*) |
| Cyclopteridae | *Eumicrotremus spinosus* | ott1097394 | D | 280 | 0.09 | -0.34 | 0.52 | 1 | 29.764 | 60.65 | (*79*) |
| Engraulidae | *Cetengraulis mysticetus* | ott1064953 | P | 24 | 0.2 | 0.04 | 0.36 | 86 | 0.048 – 0.113 | 25.10 – 71.50 | (*103*) |
| Engraulidae | *Engraulis anchoita* | ott648864 | P | 25 | 0.12 | -0.1 | 0.35 | 25 | 0.796 – 1.232 | 9.16 – 28.94 | (*220*) |

**Table S4** *Continued.*

| Family | Species | OTL | SM | F3 | $\beta_1$ | 2.5% C.I. | 97.5% C.I. | n | Egg-volume range (mm$^3$) | Mass range (g) | Refs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Engraulidae | *Engraulis mordax* | ott29754 | P | 26 | -0.02 | -0.37 | 0.32 | 1 | 1.023 | 14.74 | (*105*) |
| Exocoetidae | *Hirundichthys affinis* | ott837204 | D | 7 | 0.04 | -0.47 | 0.54 | 1 | 8.181 | 255.62 | (*108*) |
| Fundulidae | *Fundulus heteroclitus* | ott4134765 | D | 29 | 0.15 | -0.04 | 0.35 | 26 | 2.310 – 5.806 | 3.36 – 14.51 | (*221*) |
| Fundulidae | *Fundulus xenicus* | ott839523 | D | 30 | 0.11 | -0.19 | 0.4 | 1 | 3.131 | 1.75 | (*222*) |
| Gadidae | *Boreogadus saida* | ott877055 | P | 33 | -0.06 | -0.43 | 0.31 | 1 | 2.550 | 18.48 | (*79*) |
| Gadidae | *Eleginus nawaga* | ott450082 | D | 34 | -0.02 | -0.46 | 0.4 | 1 | 2.572 | 74.86 | (*79*) |
| Gadidae | *Gadus morhua* | ott5860467 | P | 35 | 0.12 | 0.03 | 0.2 | 67 | 0.975 – 2.040 | 1382.51 – 24086.31 | (*110*) |
| Gadidae | *Melanogrammus aeglefinus* | ott635904 | P | 36 | 0.08 | 0.02 | 0.14 | 142 | 1.018 – 1.736 | 111.75 – 2235.27 | (*223*) |
| Gadidae | *Micromesistius australis* | ott1091056 | P | 38 | 0.1 | -0.43 | 0.59 | 2 | 0.211 – 0.211 | 891.18 – 891.18 | (*114*) |
| Gasterosteidae | *Gasterosteus aculeatus* | ott111122 | D | 45 | 0.24 | -0.07 | 0.54 | 1 | 1.732 | 1.11 | (*116*) |
| Gobiidae | *Elacatinus oceanops* | ott638369 | D | 89 | -0.1 | -0.36 | 0.15 | 1 | 0.776 | 0.25 | (*117*) |
| Gobiidae | *Gobiosoma robustum* | ott1064480 | D | 90 | 0.18 | -0.31 | 0.65 | 1 | 0.130 | 158.08 | (*118*) |
| Gobiidae | *Oligolepis acutipennis* | ott767535 | D | 91 | 0.25 | -0.21 | 0.7 | 1 | 0.022 | 25.48 | (*224*) |
| Gobiidae | *Paragobiodon echinocephalus* | ott940827 | D | 92 | 0.1 | -0.17 | 0.37 | 1 | 0.144 | 0.23 | (*119*) |
| Gobiidae | *Paragobiodon lacunicolus* | ott758973 | D | 93 | 0.1 | -0.18 | 0.37 | 1 | 0.144 | 0.23 | (*119*) |
| Gobiidae | *Paragobiodon xanthosoma* | ott770378 | D | 94 | 0.1 | -0.17 | 0.37 | 1 | 0.144 | 0.23 | (*119*) |
| Haemulidae | *Haemulopsis corvinaeformis* | ott177515 | P | 97 | 0.21 | -0.2 | 0.63 | 1 | 0.031 | 51.66 | (*108*) |
| Hemiramphidae | *Hemiramphus brasiliensis* | ott953384 | D | 8 | 0.34 | -0.13 | 0.83 | 1 | 0.268 | 111.47 | (*108*) |
| Hemitripteridae | *Hemitripterus americanus* | ott160287 | D | 282 | 1.34 | 0.88 | 1.77 | 6 | 0.641 – 36.087 | 303.44 – 1004.16 | (*121*) |
| Hexagrammidae | *Oxylebius pictus* | ott131554 | D | 284 | 0.3 | -0.1 | 0.72 | 2 | 1.150 – 1.437 | 46.13 – 87.76 | (*122*) |
| Labridae | *Anampses caeruleopunctatus* | ott372276 | D | 98 | 0.15 | -0.32 | 0.63 | 1 | 0.134 | 331.12 | (*225*) |
| Labridae | *Anampses twistii* | ott762167 | P | 99 | 0.12 | -0.31 | 0.54 | 1 | 0.151 | 85.50 | (*225*) |
| Labridae | *Cheilinus fasciatus* | ott155291 | P | 103 | 0.14 | -0.33 | 0.63 | 1 | 0.137 | 637.55 | (*225*) |
| Labridae | *Cheilinus oxycephalus* | ott195575 | P | 104 | 0.14 | -0.3 | 0.59 | 1 | 0.125 | 114.33 | (*225*) |
| Labridae | *Cheilinus trilobatus* | ott924675 | P | 105 | 0.12 | -0.35 | 0.58 | 1 | 0.131 | 1556.96 | (*225*) |
| Labridae | *Coris gaimard* | ott1092680 | P | 107 | 0.15 | -0.33 | 0.62 | 1 | 0.134 | 294.30 | (*225*) |
| Labridae | *Coris variegata* | ott3636534 | P | 108 | 0.15 | -0.28 | 0.58 | 1 | 0.113 | 82.58 | (*225*) |
| Labridae | *Epibulus insidiator* | ott120301 | P | 110 | 0.14 | -0.35 | 0.61 | 1 | 0.154 | 1215.59 | (*225*) |
| Labridae | *Gomphosus varius* | ott358606 | P | 111 | 0.18 | -0.3 | 0.65 | 1 | 0.090 | 239.62 | (*225*) |
| Labridae | *Halichoeres biocellatus* | ott1015700 | P | 112 | 0.12 | -0.23 | 0.46 | 1 | 0.122 | 14.76 | (*225*) |
| Labridae | *Halichoeres hortulanus* | ott694390 | P | 118 | 0.16 | -0.31 | 0.63 | 1 | 0.113 | 228.47 | (*225*) |
| Labridae | *Halichoeres melanurus* | ott627330 | P | 122 | 0.15 | -0.29 | 0.59 | 1 | 0.131 | 53.47 | (*225*) |
| Labridae | *Hemigymnus fasciatus* | ott924674 | P | 130 | 0.14 | -0.3 | 0.58 | 1 | 0.195 | 2850.00 | (*225*) |
| Labridae | *Labrichthys unilineatus* | ott302371 | P | 132 | 0.11 | -0.29 | 0.51 | 1 | 0.168 | 50.73 | (*225*) |
| Labridae | *Labroides dimidiatus* | ott302377 | P | 133 | 0.11 | -0.23 | 0.46 | 1 | 0.137 | 17.95 | (*225*) |
| Labridae | *Labropsis micronesica* | ott3636703 | P | 134 | 0.01 | -0.32 | 0.34 | 1 | 0.258 | 10.96 | (*225*) |
| Labridae | *Labropsis xanthonota* | ott3636702 | P | 135 | 0.08 | -0.25 | 0.42 | 1 | 0.165 | 13.01 | (*225*) |
| Labridae | *Macropharyngodon meleagris* | ott552117 | P | 136 | 0.1 | -0.25 | 0.46 | 1 | 0.141 | 20.06 | (*225*) |
| Labridae | *Novaculichthys taeniourus* | ott456983 | P | 137 | 0.15 | -0.32 | 0.63 | 1 | 0.108 | 413.18 | (*225*) |

## **Table S4** *Continued.*

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **n** | **Egg-volume range (mm$^3$)** | **Mass range (g)** | **Refs** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Labridae | *Oxycheilinus unifasciatus* | ott352271 | P | 138 | 0.14 | -0.33 | 0.6 | 1 | 0.151 | 263.59 | (*225*) |
| Labridae | *Pseudocheilinus hexataenia* | ott712600 | P | 139 | 0.14 | -0.25 | 0.53 | 1 | 0.113 | 36.29 | (*225*) |
| Labridae | *Symphodus roissali* | ott876619 | D | 142 | 0.06 | -0.11 | 0.23 | 10 | 0.180 – 0.225 | 4.11 – 22.47 | (*226*) |
| Liparidae | *Careproctus reinhardti* | ott1065176 | D | 285 | 0.12 | -0.36 | 0.6 | 1 | 40.765 | 357.25 | (*79*) |
| Liparidae | *Liparis fabricii* | ott496423 | D | 286 | 0.22 | -0.22 | 0.66 | 1 | 7.148 | 60.36 | (*79*) |
| Liparidae | *Paraliparis bathybius* | ott309222 | BM | 287 | 0.08 | -0.37 | 0.53 | 1 | 36.087 | 122.99 | (*79*) |
| Lutjanidae | *Lutjanus carponotatus* | ott333348 | P | 152 | 0.15 | -0.15 | 0.45 | 4 | 0.032 – 0.042 | 90.62 – 431.79 | (*125*) |
| Malacanthidae | *Caulolatilus microps* | ott39883 | P | 156 | 0.21 | -0.25 | 0.67 | 1 | 0.258 | 2274.90 | (*129*) |
| Merlucciidae | *Merluccius merluccius* | ott5860466 | P | 44 | 0.24 | 0.15 | 0.35 | 209 | 0.258 – 0.963 | 626.18 – 3465.51 | (*132*) |
| Monacanthidae | *Brachaluteres jacksonianus* | ott333693 | S | 336 | -0.02 | -0.29 | 0.24 | 1 | 0.212 | 1.24 | (*133*) |
| Monacanthidae | *Eubalichthys bucephalus* | ott3631310 | S | 337 | 0.13 | -0.35 | 0.6 | 1 | 0.204 | 434.98 | (*134*) |
| Monacanthidae | *Oxymonacanthus longirostris* | ott333706 | S | 338 | 0.01 | -0.3 | 0.31 | 1 | 0.180 | 3.62 | (*135*) |
| Monacanthidae | *Paramonacanthus japonicus* | ott3631319 | S | 339 | 0.13 | -0.2 | 0.46 | 1 | 0.078 | 7.40 | (*136*) |
| Monacanthidae | *Rudarius ercodes* | ott511593 | S | 340 | 0.11 | -0.18 | 0.4 | 1 | 0.078 | 2.98 | (*136*) |
| Mugilidae | *Chelon labrosus* | ott777079 | P | 46 | -0.05 | -0.46 | 0.33 | 13 | 0.090 – 0.410 | 1240.00 – 2300.00 | (*138*) |
| Mugilidae | *Chelon ramada* | ott668241 | P | 47 | 0.08 | -0.39 | 0.52 | 2 | 0.050 – 0.050 | 850.00 – 1450.00 | (*138*) |
| Mugilidae | *Mugil cephalus* | ott418648 | P | 48 | -0.11 | -0.51 | 0.27 | 2 | 0.082 – 0.144 | 702.39 – 1833.16 | (*141*); (*139*) |
| Mugilidae | *Planiliza subviridis* | ott823526 | P | 53 | 0.04 | -0.32 | 0.41 | 1 | 0.157 | 17.13 | (*143*) |
| Nototheniidae | *Lepidonotothen nudifrons* | ott260052 | D | 160 | 0.15 | -0.31 | 0.6 | 1 | 2.806 | 117.20 | (*144*) |
| Nototheniidae | *Patagonotothen longipes* | ott430554 | D | 161 | 0.33 | -0.03 | 0.71 | 1 | 0.524 | 17.05 | (*227*) |
| Nototheniidae | *Patagonotothen sima* | ott874773 | D | 162 | 0.46 | 0.17 | 0.76 | 1 | 0.128 | 2.43 | (*227*) |
| Paralichthyidae | *Paralichthys dentatus* | ott1019735 | P | 259 | 0.16 | -0.25 | 0.56 | 1 | 0.524 | 7935.57 | (*146*) |
| Pleuronectidae | *Ammotretis rostratus* | ott600529 | P | 261 | 0.11 | -0.33 | 0.56 | 4 | 0.508 – 0.572 | 356.19 – 563.87 | (*228*) |
| Pleuronectidae | *Pseudopleuronectes americanus* | ott261419 | D | 265 | 0.07 | -0.16 | 0.31 | 17 | 0.221 – 0.333 | 332.81 – 1322.71 | (*152*) |
| Pleuronectidae | *Rhombosolea tapirina* | ott867269 | P | 267 | 0.11 | -0.3 | 0.51 | 5 | 0.221 – 0.268 | 272.82 – 553.92 | (*228*) |
| Pomacentridae | *Abudefduf saxatilis* | ott405751 | D | 167 | 0.02 | -0.38 | 0.41 | 1 | 0.369 | 22.12 | (*155*) |
| Pomacentridae | *Pomacentrus coelestis* | ott622060 | D | 180 | 0.08 | -0.21 | 0.36 | 9 | 0.119 – 0.239 | 1.81 – 2.46 | (*157*) |
| Pristigasteridae | *Ilisha africana* | ott741177 | P | 28 | 0.14 | -0.26 | 0.53 | 1 | 0.322 | 37.69 | (*159*) |
| Scaridae | *Cetoscarus bicolor* | ott1041720 | P | 190 | 0.14 | -0.29 | 0.59 | 1 | 0.221 | 3384.72 | (*225*) |
| Scaridae | *Chlorurus sordidus* | ott436737 | P | 191 | 0.14 | -0.34 | 0.62 | 1 | 0.169 | 442.00 | (*225*) |
| Scaridae | *Hipposcarus longiceps* | ott465039 | P | 193 | 0.16 | -0.31 | 0.62 | 1 | 0.257 | 1527.80 | (*225*) |
| Scaridae | *Scarus forsteni* | ott548869 | P | 195 | 0.14 | -0.33 | 0.62 | 1 | 0.229 | 1077.09 | (*225*) |
| Scaridae | *Scarus frenatus* | ott436725 | P | 196 | 0.13 | -0.34 | 0.59 | 1 | 0.173 | 1851.12 | (*225*) |
| Scaridae | *Scarus globiceps* | ott514869 | P | 197 | 0.11 | -0.36 | 0.58 | 1 | 0.241 | 272.43 | (*225*) |
| Scaridae | *Scarus schlegeli* | ott514881 | P | 201 | 0.12 | -0.34 | 0.56 | 1 | 0.167 | 2441.14 | (*225*) |
| Sciaenidae | *Bairdiella chrysoura* | ott761907 | P | 207 | 0.05 | -0.38 | 0.47 | 1 | 0.172 | 54.91 | (*160*) |
| Sciaenidae | *Cynoscion regalis* | ott5860595 | P | 208 | 0.13 | -0.35 | 0.59 | 1 | 0.113 | 2018.26 | (*161*) |
| Sciaenidae | *Larimus fasciatus* | ott897432 | P | 213 | 0.18 | -0.21 | 0.57 | 1 | 0.058 | 25.23 | (*164*) |
| Scombridae | *Auxis rochei* | ott713972 | P | 221 | 0.13 | -0.35 | 0.62 | 1 | 0.362 | 453.17 | (*169*) |

**Table S4** *Continued.*

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **n** | **Egg-volume range (mm$^3$)** | **Mass range (g)** | **Refs** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Scombridae | *Euthynnus affinis* | ott308760 | P | 222 | 0.05 | -0.35 | 0.45 | 3 | 0.123 – 0.191 | 5941.53 – 7549.52 | (*229*) |
| Scombridae | *Katsuwonus pelamis* | ott308754 | P | 223 | 0.23 | -0.11 | 0.58 | 10 | 0.144 – 0.248 | 2957.32 – 6503.90 | (*229*) |
| Scombridae | *Sarda sarda* | ott833175 | P | 224 | 0.23 | -0.24 | 0.7 | 1 | 1.124 | 1985.06 | (*230*) |
| Scombridae | *Scomberomorus cavalla* | ott70546 | P | 226 | 0.14 | -0.27 | 0.55 | 1 | 0.456 | 6702.24 | (*171*) |
| Scombridae | *Thunnus albacares* | ott833188 | P | 229 | 0.09 | -0.13 | 0.3 | 5 | 0.144 – 0.197 | 4620.11 – 43292.47 | (*229*); (*175*) |
| Scombridae | *Thunnus obesus* | ott358613 | P | 230 | 0.17 | -0.15 | 0.49 | 1 | 0.615 | 36847.75 | (*231*) |
| Scombridae | *Thunnus thynnus* | ott358607 | P | 231 | -0.17 | -0.68 | 0.27 | 6 | 0.074 – 0.697 | 1690.13 – 2103.10 | (*232*); (*176*) |
| Sebastidae | *Sebastes mentella* | ott1088432 | BI | 309 | 0.14 | -0.36 | 0.62 | 1 | 0.685 | 690.02 | (*190*) |
| Sebastidae | *Sebastes norvegicus* | ott1088441 | BI | 312 | 0.12 | -0.37 | 0.61 | 1 | 0.685 | 1153.76 | (*190*) |
| Sebastidae | *Sebastolobus altivelis* | ott811927 | P | 324 | 0.14 | -0.35 | 0.61 | 1 | 1.023 | 288.33 | (*233*) |
| Serranidae | *Cephalopholis cruentata* | ott12880 | P | 232 | 0.14 | -0.33 | 0.63 | 1 | 0.078 | 220.12 | (*196*) |
| Serranidae | *Epinephelus tauvina* | ott218649 | P | 236 | 0.05 | -0.43 | 0.51 | 1 | 0.048 | 3094.02 | (*198*) |
| Siganidae | *Siganus canaliculatus* | ott199059 | S | 241 | 0.19 | -0.29 | 0.68 | 1 | 0.018 | 245.10 | (*200*) |
| Soleidae | *Solea solea* | ott710233 | P | 268 | 0.13 | -0.16 | 0.43 | 23 | 1.202 – 1.583 | 17000.00 – 51000.00 | (*234*) |
| Sparidae | *Acanthopagrus latus* | ott760733 | P | 242 | 0.14 | -0.35 | 0.63 | 1 | 0.100 | 570.93 | (*202*) |
| Sparidae | *Archosargus rhomboidalis* | ott724892 | P | 243 | 0.3 | -0.14 | 0.74 | 1 | 0.014 | 71.27 | (*203*) |
| Sparidae | *Sparidentex hasta* | ott845300 | P | 244 | 0.16 | -0.27 | 0.6 | 1 | 0.100 | 4986.75 | (*202*) |
| Stromateidae | *Pampus chinensis* | ott916290 | P | 245 | 0.14 | -0.34 | 0.63 | 1 | 0.606 | 741.00 | (*204*) |
| Syngnathidae | *Entelurus aequoreus* | ott971459 | BP | 325 | 0.29 | 0.03 | 0.54 | 9 | 0.358 – 0.779 | 3.99 – 12.09 | (*235*) |
| Syngnathidae | *Micrognathus crinitus* | ott3642321 | BP | 327 | 0.14 | -0.09 | 0.35 | 1 | 0.796 | 0.17 | (*206*) |
| Syngnathidae | *Nerophis ophidion* | ott806821 | BP | 328 | 0.17 | -0.05 | 0.39 | 19 | 0.158 – 0.864 | 0.72 – 2.27 | (*235*) |
| Syngnathidae | *Syngnathus acus* | ott774440 | BP | 329 | 0.21 | 0.02 | 0.4 | 19 | 6.118 – 11.706 | 12.97 – 62.60 | (*235*) |
| Syngnathidae | *Syngnathus floridae* | ott774435 | BP | 330 | 0.37 | 0.07 | 0.66 | 1 | 0.322 | 3.03 | (*206*) |
| Syngnathidae | *Syngnathus louisianae* | ott774414 | BP | 331 | 0.33 | 0 | 0.67 | 1 | 0.524 | 8.36 | (*206*) |
| Syngnathidae | *Syngnathus rostellatus* | ott774411 | BP | 332 | 0.3 | 0.12 | 0.49 | 18 | 0.398 – 1.327 | 0.39 – 1.10 | (*235*) |
| Syngnathidae | *Syngnathus scovelli* | ott251400 | BP | 333 | 0.22 | -0.04 | 0.46 | 1 | 0.796 | 0.88 | (*206*) |
| Syngnathidae | *Syngnathus typhle* | ott251396 | BP | 334 | 0.18 | 0.02 | 0.33 | 25 | 2.031 – 5.610 | 0.96 – 6.44 | (*235*) |
| Tetraodontidae | *Canthigaster valentini* | ott701127 | S | 342 | 0.01 | -0.33 | 0.34 | 1 | 0.180 | 4.18 | (*207*) |
| Trichiuridae | *Aphanopus carbo* | ott113465 | P | 246 | 0.18 | -0.27 | 0.64 | 1 | 0.806 | 2814.83 | (*209*) |
| Zoarcidae | *Gymnelus viridis* | ott729337 | D | 248 | 0.11 | -0.24 | 0.44 | 1 | 52.645 | 13.80 | (*79*) |
| Zoarcidae | *Lycodes esmarkii* | ott841648 | D | 249 | 0.16 | -0.25 | 0.57 | 1 | 113.097 | 4659.64 | (*79*) |
| Zoarcidae | *Lycodes eudipleurostictus* | ott905435 | D | 250 | 0.13 | -0.34 | 0.58 | 1 | 75.766 | 183.60 | (*79*) |
| Zoarcidae | *Lycodes frigidus* | ott539690 | D | 251 | 0.18 | -0.29 | 0.65 | 1 | 179.594 | 1207.55 | (*79*) |
| Zoarcidae | *Lycodes pallidus* | ott178074 | D | 252 | 0.25 | -0.16 | 0.65 | 1 | 22.449 | 50.90 | (*79*) |
| Zoarcidae | *Lycodes polaris* | ott34255 | D | 253 | 0.16 | -0.27 | 0.58 | 1 | 47.713 | 73.29 | (*79*) |
| Zoarcidae | *Lycodes reticulatus* | ott752411 | D | 254 | 0.04 | -0.46 | 0.54 | 1 | 344.791 | 271.32 | (*79*) |
| Zoarcidae | *Lycodes vahlii* | ott178063 | D | 255 | 0.17 | -0.15 | 0.47 | 1 | 33.510 | 7.04 | (*79*) |
| Zoarcidae | *Melanostigma atlanticum* | ott3633033 | D | 256 | 0.22 | -0.08 | 0.5 | 3 | 11.494 – 20.580 | 3.94 – 7.54 | (*210*) |
| Zoarcidae | *Pachycara brachycephalum* | ott203179 | D | 257 | 0.12 | -0.35 | 0.58 | 1 | 65.450 | 150.21 | (*213*) |

**Table S5. Summary of data used for Egg-energy–Volume model.** This table shows summary stats of raw data used in Egg-energy–Volume model (Fig. 2C). **OTL** = Open Tree of Life Identifier; **SM** = Spawning Mode (D = demersal, P = pelagic, S = scatterer, BM/BP/BI = mouth/pouch/internal brooder – all brooders have no parental provisioning post fertilization); $\beta_1$ **/ 2.5% / 97.5%** = Estimates (mean and 95% Bayesian credible intervals) of species-specific egg-energy volume-scaling exponents as obtained from Egg-energy–Volume model (see Materials and Methods); **n** = number of independent measurements for each species.

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **n** | **Egg-energy range (J)** | **Egg-volume range (mm$^3$)** | **Refs** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acanthuridae | *Acanthurus coeruleus* | ott324283 | P | 55 | 0.76 | 0.34 | 1.19 | 6 | 0.24 – 0.29 | 0.136 – 0.163 | * |
| Acanthuridae | *Acanthurus nigrofuscus* | ott605289 | P | 56 | 0.62 | 0.29 | 0.92 | 14 | 0.16 – 0.32 | 0.085 – 0.112 | * |
| Acanthuridae | *Acanthurus triostegus* | ott467300 | P | 57 | 0.68 | 0.34 | 1.03 | 4 | 0.20 – 0.23 | 0.079 – 0.095 | * |
| Acanthuridae | *Zebrasoma scopas* | ott199073 | P | 58 | 0.74 | 0.31 | 1.17 | 8 | 0.22 – 0.36 | 0.121 – 0.141 | * |
| Agonidae | *Podothecus sachi* | ott590745 | D | 270 | 0.59 | 0.27 | 0.92 | 3 | 14.90 – 16.19 | 1.720 – 1.720 | * |
| Apogonidae | *Cheilodipterus quinquelineatus* | ott364614 | BM | 60 | 0.61 | 0.2 | 1 | 2 | 0.96 – 1.06 | 0.298 – 0.377 | * |
| Apogonidae | *Ostorhinchus cyanosoma* | ott638185 | BM | 64 | 0.71 | 0.31 | 1.1 | 5 | 0.49 – 0.67 | 0.105 – 0.140 | * |
| Apogonidae | *Ostorhinchus doederleini* | ott687634 | BM | 65 | 0.78 | 0.31 | 1.26 | 1 | 1.16 | 0.233 | * |
| Atherinopsidae | *Membras gilberti* | ott680137 | D | 4 | 0.72 | 0.29 | 1.15 | 5 | 3.70 – 4.20 | 0.852 – 1.066 | * |
| Blenniidae | *Ophioblennius atlanticus* | ott282319 | D | 71 | 0.87 | 0.49 | 1.27 | 28 | 0.62 – 0.94 | 0.124 – 0.154 | * |
| Blenniidae | *Ophioblennius steindachneri* | ott155044 | D | 72 | 0.84 | 0.51 | 1.17 | 24 | 0.38 – 0.80 | 0.102 – 0.140 | * |
| Chaenopsidae | *Acanthemblemaria hancocki* | ott57340 | D | 80 | 0.63 | 0.27 | 0.97 | 42 | 1.34 – 2.44 | 0.303 – 0.403 | * |
| Chaenopsidae | *Acanthemblemaria rivasi* | ott57343 | D | 81 | 0.74 | 0.48 | 0.99 | 36 | 2.28 – 3.48 | 0.477 – 0.696 | * |
| Chaenopsidae | *Neoclinus uninotatus* | ott3639321 | D | 82 | 0.77 | 0.45 | 1.09 | 1 | 5.41 | 1.345 | * |
| Chaetodontidae | *Chaetodon capistratus* | ott264060 | P | 83 | 0.71 | 0.25 | 1.15 | 8 | 0.29 – 0.43 | 0.154 – 0.184 | * |
| Clupeidae | *Brevoortia tyrannus* | ott107265 | P | 13 | 0.39 | 0.1 | 0.67 | 1 | 0.98 | 2.456 | * |
| Clupeidae | *Clupea pallasii* | ott9666 | D | 15 | 0.97 | 0.64 | 1.29 | 4 | 4.87 – 6.04 | 1.564 – 1.667 | * |
| Coryphaenidae | *Coryphaena hippurus* | ott223663 | P | 85 | 0.71 | 0.34 | 1.06 | 1 | 4.17 | 2.600 | * |
| Cottidae | *Alcichthys elongatus* | ott3632242 | D | 272 | 0.69 | 0.31 | 1.05 | 4 | 5.69 – 7.09 | 1.420 – 1.420 | * |
| Cyclopteridae | *Aptocyclus ventricosus* | ott989887 | D | 278 | 1.03 | 0.68 | 1.37 | 1 | 46.35 | 2.430 | * |
| Engraulidae | *Engraulis mordax* | ott29754 | P | 26 | 0.84 | 0.58 | 1.11 | 2 | 0.43 – 1.24 | 0.172 – 0.520 | (*236*) |
| Engraulidae | *Engraulis ringens* | ott211981 | P | 27 | 0.91 | 0.49 | 1.34 | 2 | 0.86 – 0.98 | 0.284 – 0.322 | (*237*) |
| Fundulidae | *Lucania goodei* | ott84261 | D | 31 | 0.78 | 0.46 | 1.1 | 1 | 7.50 | 1.193 | (*238*) |
| Fundulidae | *Lucania parva* | ott839518 | D | 32 | 0.79 | 0.41 | 1.17 | 1 | 5.77 | 0.828 | (*238*) |
| Gadidae | *Gadus morhua* | ott5860467 | P | 35 | 0.87 | 0.72 | 1.03 | 16 | 2.05 – 3.30 | 1.033 – 1.640 | (*239*) |
| Gadidae | *Melanogrammus aeglefinus* | ott635904 | P | 36 | 0.87 | 0.74 | 1.01 | 60 | 2.17 – 3.72 | 1.166 – 1.957 | (*239*) |
| Gadidae | *Merlangius merlangus* | ott635911 | P | 37 | 0.79 | 0.61 | 0.98 | 40 | 1.07 – 1.95 | 0.587 – 0.998 | (*239*) |
| Gadidae | *Pollachius pollachius* | ott1014047 | P | 39 | 0.83 | 0.62 | 1.04 | 14 | 1.50 – 1.73 | 0.728 – 0.860 | (*239*) |
| Gadidae | *Pollachius virens* | ott62649 | P | 40 | 0.87 | 0.65 | 1.1 | 8 | 1.43 – 1.85 | 0.656 – 0.790 | (*239*) |
| Gadidae | *Trisopterus esmarkii* | ott926146 | P | 41 | 0.82 | 0.59 | 1.04 | 31 | 1.20 – 1.75 | 0.604 – 0.891 | (*239*) |
| Gasterosteidae | *Gasterosteus aculeatus* | ott111122 | D | 45 | 0.4 | 0.05 | 0.74 | 3 | 2.57 – 2.91 | 2.915 – 3.246 | (*240*) |
| Gobiidae | *Coryphopterus dicrus* | ott37549 | D | 86 | 0.62 | 0.29 | 0.94 | 11 | 0.27 – 0.33 | 0.082 – 0.108 | * |
| Gobiidae | *Coryphopterus glaucofraenum* | ott494031 | D | 87 | 0.95 | 0.69 | 1.22 | 20 | 0.10 – 0.31 | 0.064 – 0.093 | * |
| Gobiidae | *Coryphopterus personatus* | ott740192 | D | 88 | 0.77 | 0.51 | 1.02 | 28 | 0.13 – 0.31 | 0.059 – 0.082 | * |
| Haemulidae | *Haemulon flavolineatum* | ott432196 | P | 96 | 0.73 | 0.28 | 1.17 | 5 | 0.56 – 0.63 | 0.318 – 0.350 | * |
| Hemitripteridae | *Blepsias cirrhosus* | ott446859 | D | 281 | 1.1 | 0.83 | 1.38 | 1 | 114.86 | 3.170 | * |
| Hemitripteridae | *Hemitripterus villosus* | ott438425 | D | 283 | 1.27 | 1.03 | 1.51 | 4 | 271.44 – 299.41 | 4.520 – 4.520 | * |
| Hexagrammidae | *Oxylebius pictus* | ott131554 | D | 284 | 0.66 | 0.27 | 1.04 | 1 | 5.50 | 1.465 | * |
| Labridae | *Bodianus axillaris* | ott548889 | P | 100 | 0.76 | 0.31 | 1.23 | 2 | 0.32 – 0.33 | 0.195 – 0.204 | * |

**Table S5** *Continued.*

| Family | Species | OTL | SM | F3 | $\beta_1$ | 2.5% C.I. | 97.5% C.I. | n | Egg-energy range (J) | Egg-volume range (mm$^3$) | Refs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Labridae | *Bodianus diplotaenia* | ott919235 | P | 101 | 0.67 | 0.19 | 1.11 | 10 | 0.16 – 0.32 | 0.172 – 0.211 | * |
| Labridae | *Bodianus rufus* | ott372258 | P | 102 | 0.82 | 0.37 | 1.29 | 4 | 0.30 – 0.45 | 0.179 – 0.218 | * |
| Labridae | *Clepticus parrae* | ott948303 | P | 106 | 0.76 | 0.33 | 1.19 | 6 | 0.24 – 0.35 | 0.151 – 0.166 | * |
| Labridae | *Doratonotus megalepis* | ott763958 | P | 109 | 0.84 | 0.43 | 1.26 | 9 | 0.10 – 0.15 | 0.080 – 0.098 | * |
| Labridae | *Halichoeres bivittatus* | ott694396 | P | 113 | 0.8 | 0.47 | 1.13 | 17 | 0.12 – 0.22 | 0.094 – 0.129 | * |
| Labridae | *Halichoeres chierchiae* | ott615862 | P | 114 | 0.64 | 0.21 | 1.06 | 15 | 0.15 – 0.31 | 0.125 – 0.166 | * |
| Labridae | *Halichoeres chloropterus* | ott1015715 | P | 115 | 0.79 | 0.36 | 1.23 | 3 | 0.15 – 0.18 | 0.086 – 0.103 | * |
| Labridae | *Halichoeres dispilus* | ott762170 | P | 116 | 0.63 | 0.18 | 1.04 | 15 | 0.07 – 0.19 | 0.093 – 0.115 | * |
| Labridae | *Halichoeres garnoti* | ott665840 | P | 117 | 0.69 | 0.27 | 1.11 | 15 | 0.17 – 0.29 | 0.117 – 0.162 | * |
| Labridae | *Halichoeres hortulanus* | ott694390 | P | 118 | 0.94 | 0.57 | 1.31 | 2 | 0.13 – 0.14 | 0.095 – 0.101 | * |
| Labridae | *Halichoeres maculipinna* | ott955368 | P | 119 | 0.78 | 0.34 | 1.22 | 6 | 0.13 – 0.18 | 0.090 – 0.107 | * |
| Labridae | *Halichoeres margaritaceus* | ott694405 | P | 120 | 0.74 | 0.46 | 1.01 | 5 | 0.13 – 0.18 | 0.077 – 0.092 | * |
| Labridae | *Halichoeres marginatus* | ott694408 | P | 121 | 0.55 | 0.19 | 0.9 | 3 | 0.20 – 0.24 | 0.096 – 0.105 | * |
| Labridae | *Halichoeres melanurus* | ott627330 | P | 122 | 0.79 | 0.33 | 1.24 | 6 | 0.19 – 0.22 | 0.111 – 0.114 | * |
| Labridae | *Halichoeres miniatus* | ott694399 | P | 123 | 0.81 | 0.45 | 1.16 | 3 | 0.15 – 0.19 | 0.097 – 0.114 | * |
| Labridae | *Halichoeres nebulosus* | ott1015709 | P | 124 | 0.78 | 0.34 | 1.21 | 1 | 0.18 | 0.093 | * |
| Labridae | *Halichoeres nicholsi* | ott694402 | P | 125 | 0.71 | 0.28 | 1.13 | 2 | 0.20 – 0.25 | 0.137 – 0.138 | * |
| Labridae | *Halichoeres notospilus* | ott694414 | P | 126 | 0.96 | 0.64 | 1.28 | 3 | 0.13 – 0.14 | 0.094 – 0.099 | * |
| Labridae | *Halichoeres pictus* | ott173446 | P | 127 | 1 | 0.57 | 1.46 | 4 | 0.16 – 0.43 | 0.115 – 0.154 | * |
| Labridae | *Halichoeres poeyi* | ott38828 | P | 128 | 0.68 | 0.24 | 1.1 | 15 | 0.19 – 0.28 | 0.117 – 0.143 | * |
| Labridae | *Halichoeres trimaculatus* | ott942026 | P | 129 | 0.8 | 0.35 | 1.25 | 6 | 0.14 – 0.18 | 0.088 – 0.099 | * |
| Labridae | *Hemigymnus fasciatus* | ott924674 | P | 130 | 0.75 | 0.29 | 1.22 | 1 | 0.37 | 0.181 | * |
| Labridae | *Hemigymnus melapterus* | ott302368 | P | 131 | 0.67 | 0.25 | 1.1 | 6 | 0.30 – 0.43 | 0.143 – 0.186 | * |
| Labridae | *Novaculichthys taeniourus* | ott456983 | P | 137 | 0.72 | 0.3 | 1.13 | 6 | 0.12 – 0.21 | 0.085 – 0.101 | * |
| Labridae | *Stethojulis bandanensis* | ott201174 | P | 140 | 0.79 | 0.49 | 1.08 | 2 | 0.12 – 0.12 | 0.069 – 0.071 | * |
| Labridae | *Symphodus mediterraneus* | ott730049 | D | 141 | 0.78 | 0.33 | 1.22 | 1 | 1.05 | 0.236 | * |
| Labridae | *Symphodus roissali* | ott876619 | D | 142 | 0.49 | 0.1 | 0.86 | 10 | 0.89 – 1.01 | 0.200 – 0.280 | * |
| Labridae | *Symphodus rostratus* | ott553190 | D | 143 | 0.75 | 0.37 | 1.12 | 6 | 1.09 – 1.23 | 0.266 – 0.305 | * |
| Labridae | *Symphodus tinca* | ott787184 | D | 144 | 0.87 | 0.45 | 1.28 | 3 | 1.17 – 1.35 | 0.251 – 0.271 | * |
| Labridae | *Thalassoma bifasciatum* | ott907850 | P | 145 | 0.94 | 0.64 | 1.23 | 15 | 0.08 – 0.15 | 0.072 – 0.092 | * |
| Labridae | *Thalassoma hardwicke* | ott102998 | P | 146 | 0.69 | 0.43 | 0.95 | 7 | 0.11 – 0.14 | 0.058 – 0.068 | * |
| Labridae | *Thalassoma jansenii* | ott1094748 | P | 147 | 0.77 | 0.51 | 1.02 | 6 | 0.11 – 0.13 | 0.060 – 0.075 | * |
| Labridae | *Thalassoma lucasanum* | ott1094750 | P | 148 | 0.78 | 0.5 | 1.05 | 15 | 0.09 – 0.16 | 0.065 – 0.083 | * |
| Labridae | *Thalassoma lunare* | ott948286 | P | 149 | 0.71 | 0.44 | 0.97 | 5 | 0.12 – 0.13 | 0.065 – 0.074 | * |
| Moronidae | *Dicentrarchus labrax* | ott3549 | P | 157 | 0.81 | 0.5 | 1.13 | 17 | 2.35 – 3.67 | 0.776 – 1.232 | (*241*) |
| Mullidae | *Parupeneus multifasciatus* | ott295485 | P | 158 | 0.76 | 0.28 | 1.23 | 4 | 0.26 – 0.31 | 0.126 – 0.137 | * |
| Muraenesocidae | *Muraenesox cinereus* | ott479856 | P | 1 | 0.59 | 0.35 | 0.82 | 7 | 3.20 – 5.79 | 2.070 – 6.290 | * |
| Nemipteridae | *Scolopsis bilineata* | ott463069 | P | 159 | 0.76 | 0.29 | 1.22 | 1 | 0.45 | 0.227 | * |
| Pinguipedidae | *Parapercis snyderi* | ott3635246 | P | 163 | 0.67 | 0.25 | 1.08 | 6 | 0.25 – 0.35 | 0.131 – 0.203 | * |
| Pleuronectidae | *Hippoglossus hippoglossus* | ott408328 | P | 263 | 0.84 | 0.74 | 0.95 | 6 | 37.25 – 40.75 | 15.150 – 16.056 | (*242*) |
| Pleuronectidae | *Pleuronectes platessa* | ott408337 | P | 264 | 0.68 | 0.56 | 0.81 | 41 | 5.22 – 7.96 | 2.802 – 4.489 | (*151*) |
| Pleuronectidae | *Pseudopleuronectes americanus* | ott261419 | D | 265 | 0.5 | 0.14 | 0.85 | 2 | 1.25 – 1.28 | 0.230 – 0.463 | * |
| Pomacentridae | *Abudefduf bengalensis* | ott318931 | D | 166 | 0.92 | 0.51 | 1.32 | 6 | 1.23 – 1.59 | 0.227 – 0.262 | * |

**Table S5** *Continued.*

| Family | Species | OTL | SM | F3 | $\beta_1$ | 2.5% C.I. | 97.5% C.I. | n | Egg-energy range (J) | Egg-volume range ($mm^3$) | Refs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pomacentridae | *Abudefduf saxatilis* | ott405751 | D | 167 | 0.67 | 0.27 | 1.05 | 48 | 0.87 – 1.17 | 0.171 – 0.214 | * |
| Pomacentridae | *Abudefduf septemfasciatus* | ott129790 | D | 168 | 0.77 | 0.36 | 1.18 | 10 | 1.06 – 1.29 | 0.221 – 0.237 | * |
| Pomacentridae | *Abudefduf sordidus* | ott1053071 | D | 169 | 0.79 | 0.42 | 1.17 | 8 | 1.07 – 1.47 | 0.233 – 0.269 | * |
| Pomacentridae | *Abudefduf troschelii* | ott961357 | D | 170 | 0.87 | 0.54 | 1.21 | 44 | 0.57 – 1.13 | 0.133 – 0.172 | * |
| Pomacentridae | *Abudefduf vaigiensis* | ott1053067 | D | 171 | 0.76 | 0.37 | 1.16 | 13 | 0.76 – 1.01 | 0.137 – 0.178 | * |
| Pomacentridae | *Chromis atrilobata* | ott436999 | D | 173 | 1.1 | 0.84 | 1.35 | 6 | 0.31 – 0.40 | 0.075 – 0.088 | * |
| Pomacentridae | *Chromis atripectoralis* | ott741423 | D | 174 | 0.67 | 0.41 | 0.9 | 5 | 0.48 – 0.59 | 0.066 – 0.091 | * |
| Pomacentridae | *Chromis multilineata* | ott437016 | D | 175 | 0.83 | 0.6 | 1.04 | 14 | 0.35 – 0.50 | 0.070 – 0.081 | * |
| Pomacentridae | *Hypsypops rubicundus* | ott847666 | D | 176 | 0.84 | 0.59 | 1.07 | 7 | 1.54 – 1.93 | 0.401 – 0.453 | * |
| Pomacentridae | *Microspathodon bairdii* | ott237630 | D | 177 | 0.73 | 0.33 | 1.09 | 10 | 0.57 – 0.78 | 0.133 – 0.175 | * |
| Pomacentridae | *Microspathodon chrysurus* | ott847660 | D | 178 | 0.72 | 0.42 | 1.02 | 38 | 0.42 – 0.79 | 0.109 – 0.140 | * |
| Pomacentridae | *Microspathodon dorsalis* | ott205758 | D | 179 | 0.77 | 0.5 | 1.04 | 24 | 0.51 – 0.87 | 0.115 – 0.196 | * |
| Pomacentridae | *Stegastes acapulcoensis* | ott3635554 | D | 181 | 0.96 | 0.69 | 1.21 | 22 | 0.33 – 0.56 | 0.092 – 0.103 | * |
| Pomacentridae | *Stegastes adustus* | ott323181 | D | 182 | 0.97 | 0.76 | 1.18 | 40 | 0.26 – 0.62 | 0.077 – 0.115 | * |
| Pomacentridae | *Stegastes diencaeus* | ott729161 | D | 183 | 0.72 | 0.33 | 1.08 | 18 | 0.62 – 0.82 | 0.133 – 0.156 | * |
| Pomacentridae | *Stegastes flavilatus* | ott3635541 | D | 184 | 0.9 | 0.69 | 1.09 | 27 | 0.21 – 0.58 | 0.069 – 0.118 | * |
| Pomacentridae | *Stegastes leucostictus* | ott100830 | D | 186 | 0.89 | 0.48 | 1.27 | 41 | 1.03 – 1.45 | 0.213 – 0.261 | * |
| Pomacentridae | *Stegastes partitus* | ott345269 | D | 187 | 0.94 | 0.77 | 1.13 | 40 | 0.19 – 0.54 | 0.061 – 0.088 | * |
| Pomacentridae | *Stegastes planifrons* | ott665837 | D | 188 | 0.84 | 0.48 | 1.2 | 19 | 0.45 – 0.91 | 0.127 – 0.151 | * |
| Pomacentridae | *Stegastes variabilis* | ott323173 | D | 189 | 0.96 | 0.59 | 1.33 | 24 | 0.45 – 0.84 | 0.133 – 0.172 | * |
| Scaridae | *Chlorurus sordidus* | ott436737 | P | 191 | 0.67 | 0.26 | 1.05 | 6 | 0.18 – 0.29 | 0.099 – 0.121 | * |
| Scaridae | *Cryptotomus roseus* | ott321483 | P | 192 | 0.97 | 0.61 | 1.33 | 10 | 0.10 – 0.16 | 0.092 – 0.110 | * |
| Scaridae | *Scarus flavipectoralis* | ott1041716 | P | 194 | 0.71 | 0.31 | 1.11 | 2 | 0.22 – 0.23 | 0.122 – 0.124 | * |
| Scaridae | *Scarus frenatus* | ott436725 | P | 196 | 0.68 | 0.27 | 1.07 | 2 | 0.25 – 0.27 | 0.121 – 0.123 | * |
| Scaridae | *Scarus globiceps* | ott514869 | P | 197 | 0.79 | 0.35 | 1.23 | 1 | 0.24 | 0.137 | * |
| Scaridae | *Scarus iseri* | ott686634 | P | 198 | 0.87 | 0.43 | 1.3 | 5 | 0.20 – 0.24 | 0.132 – 0.144 | * |
| Scaridae | *Scarus niger* | ott14311 | P | 199 | 0.56 | 0.16 | 0.95 | 3 | 0.24 – 0.32 | 0.118 – 0.123 | * |
| Scaridae | *Scarus psittacus* | ott514872 | P | 200 | 1.06 | 0.71 | 1.41 | 5 | 0.11 – 0.16 | 0.097 – 0.110 | * |
| Scaridae | *Scarus schlegeli* | ott514881 | P | 201 | 0.64 | 0.22 | 1.05 | 4 | 0.23 – 0.27 | 0.125 – 0.137 | * |
| Scaridae | *Scarus spinus* | ott419732 | P | 202 | 0.77 | 0.4 | 1.15 | 2 | 0.19 – 0.22 | 0.107 – 0.111 | * |
| Scaridae | *Sparisoma atomarium* | ott686627 | P | 203 | 1.04 | 0.65 | 1.43 | 2 | 0.10 – 0.13 | 0.103 – 0.109 | * |
| Scaridae | *Sparisoma aurofrenatum* | ott686624 | P | 204 | 0.57 | 0.15 | 0.96 | 5 | 0.19 – 0.29 | 0.117 – 0.130 | * |
| Scaridae | *Sparisoma radians* | ott214109 | P | 205 | 0.78 | 0.47 | 1.08 | 6 | 0.10 – 0.18 | 0.090 – 0.109 | * |
| Scaridae | *Sparisoma rubripinne* | ott686642 | P | 206 | 0.58 | 0.17 | 0.99 | 5 | 0.22 – 0.28 | 0.128 – 0.135 | * |
| Sciaenidae | *Cynoscion regalis* | ott5860595 | P | 208 | 0.18 | -0.22 | 0.54 | 10 | 0.62 – 2.38 | 0.349 – 0.534 | * |
| Sciaenidae | *Leiostomus xanthurus* | ott1052160 | P | 214 | 0.62 | 0.12 | 1.07 | 1 | 0.61 | 0.276 | * |
| Sciaenidae | *Micropogonias undulatus* | ott987393 | P | 217 | 0.69 | 0.18 | 1.16 | 1 | 0.68 | 0.220 | * |
| Serranidae | *Epinephelus fasciatus* | ott534146 | P | 234 | 0.85 | 0.44 | 1.28 | 14 | 0.14 – 0.31 | 0.171 – 0.215 | * |
| Serranidae | *Serranus tabacarius* | ott284266 | P | 238 | 0.79 | 0.39 | 1.18 | 4 | 0.39 – 0.47 | 0.331 – 0.343 | * |
| Serranidae | *Serranus tigrinus* | ott807897 | P | 239 | 0.54 | 0.07 | 0.96 | 15 | 0.19 – 0.31 | 0.148 – 0.209 | * |
| Serranidae | *Serranus tortugarum* | ott511782 | P | 240 | 0.75 | 0.32 | 1.19 | 15 | 0.22 – 0.44 | 0.200 – 0.248 | * |
| Soleidae | *Solea solea* | ott710233 | P | 268 | 0.77 | 0.42 | 1.12 | 13 | 2.02 – 3.41 | 1.202 – 1.583 | (*234*) |
| Tetraodontidae | *Canthigaster rostrata* | ott484093 | D | 341 | 0.73 | 0.26 | 1.19 | 1 | 0.69 | 0.122 | * |
| Trichodontidae | *Arctoscopus japonicus* | ott883978 | D | 247 | 0.79 | 0.58 | 1 | 5 | 92.66 – 110.46 | 18.077 – 22.358 | * |

* This is original data collected by the second author (D. Ross Robertson). All remaining species data come from studies that measured egg dry weight rather than energy. Based on (*27*) and our own data (see Fig. S1), we assumed that egg energy scaled isometrically with egg dry weight, with an average of ~25 J / mg of egg.

**Table S6. Summary of data used for Total-volume–Mass model. OTL** = Open Tree of Life Identifier; **SM** = Spawning Mode (D = demersal, P = pelagic, S = scatterer, BM/BP/BI = mouth/pouch/internal brooder – all brooders have no parental provisioning post fertilization); **F3** = Number ID in Fig. 3; $\beta_1$ **/ 2.5% / 97.5%** = Estimates (mean and 95% Bayesian credible intervals) of species-specific total egg-volume mass-scaling exponents (see Materials and Methods); **n** = number of independent observations for each species.

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **n** | **Total egg-volume range (mm$^3$)** | **Mass range (g)** | **Refs** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Atherinidae | *Atherina presbyter* | ott669918 | D | 2 | 1.08 | 0.87 | 1.28 | 33 | 784.1 – 9,566 | 1.47 – 13.70 | (*81*) |
| Balistidae | *Balistes capriscus* | ott135140 | S | 335 | 1.13 | 0.75 | 1.51 | 64 | 13,123 – 77,449 | 272.64 – 696.02 | (*85*) |
| Bothidae | *Arnoglossus laterna* | ott696263 | P | 258 | 1.13 | 0.71 | 1.59 | 2 | 398 – 3,343 | 2.68 – 9.09 | (*87*) |
| Carangidae | *Decapterus punctatus* | ott705034 | P | 74 | 1.48 | 0.99 | 2.01 | 2 | 151.5 – 1,246 | 16.71 – 53.59 | (*88*) |
| Carangidae | *Trachurus picturatus* | ott174574 | P | 77 | 1.12 | 0.55 | 1.69 | 8 | 4,595 – 9,493 | 38.10 – 73.11 | (*90*) |
| Clupeidae | *Amblygaster sirm* | ott328216 | P | 11 | 1.74 | 1.22 | 2.34 | 33 | 967.7 – 6,699 | 34.39 – 57.50 | (*92*) |
| Clupeidae | *Ethmalosa fimbriata* | ott658559 | P | 16 | 0.91 | 0.51 | 1.3 | 32 | 613.5 – 2,013 | 182.55 – 582.47 | (*94*) |
| Clupeidae | *Spratelloides gracilis* | ott39732 | D | 21 | 0.98 | 0.69 | 1.28 | 18 | 106.7 – 1,062 | 0.20 – 0.86 | (*99*) |
| Cottidae | *Enophrys bison* | ott290389 | D | 274 | 1.14 | 0.4 | 1.91 | 2 | 48,362 – 133,622 | 197.53 – 241.50 | (*101*) |
| Engraulidae | *Cetengraulis mysticetus* | ott1064953 | P | 24 | 1.38 | 1.11 | 1.66 | 86 | 642.1 – 6,957 | 25.10 – 71.50 | (*103*) |
| Engraulidae | *Engraulis mordax* | ott29754 | P | 26 | 0.98 | 0.52 | 1.46 | 21 | 8,869 – 36,367 | 10.47 – 23.98 | (*105*) |
| Gadidae | *Gadus morhua* | ott5860467 | P | 35 | 1.51 | 1.36 | 1.66 | 67 | 923,939 – 36,102,635 | 1382.51 – 24086.31 | (*110*) |
| Gasterosteidae | *Gasterosteus aculeatus* | ott111122 | D | 45 | 0.91 | 0.51 | 1.31 | 2 | 330.8 – 905.9 | 0.80 – 1.50 | (*116*) |
| Hemitripteridae | *Hemitripterus americanus* | ott160287 | D | 282 | 2.43 | 1.83 | 3.08 | 6 | 2,313 – 800,914 | 303.44 – 1004.16 | (*121*) |
| Hexagrammidae | *Oxylebius pictus* | ott131554 | D | 284 | 0.73 | 0.46 | 1.01 | 43 | 14,712 – 42,473 | 32.22 – 148.53 | (*122*) |
| Lutjanidae | *Lutjanus carponotatus* | ott333348 | P | 152 | 1.81 | 1.59 | 2.03 | 55 | 154 – 31,682 | 77.08 – 485.66 | (*125*) |
| Malacanthidae | *Caulolatilus microps* | ott39883 | P | 156 | 1.5 | 1.22 | 1.79 | 43 | 21,548 – 1,063,744 | 762.87 – 4527.12 | (*129*) |
| Merlucciidae | *Merluccius merluccius* | ott5860466 | P | 44 | 1.17 | 0.99 | 1.34 | 209 | 10,066 – 557,218 | 626.18 – 3465.51 | (*132*) |
| Monacanthidae | *Eubalichthys bucephalus* | ott3631310 | S | 337 | 1.47 | 0.71 | 2.28 | 2 | 1,833 – 8,046 | 355.86 – 524.85 | (*134*) |
| Monacanthidae | *Oxymonacanthus longirostris* | ott333706 | S | 338 | 1.35 | 0.89 | 1.81 | 3 | 17.96 – 35.92 | 3.30 – 3.79 | (*135*) |
| Monacanthidae | *Rudarius ercodes* | ott511593 | S | 340 | 0.91 | 0.52 | 1.29 | 3 | 199.6 – 637.6 | 1.25 – 5.78 | (*136*) |
| Mugilidae | *Chelon labrosus* | ott777079 | P | 46 | 1.01 | 0.33 | 1.66 | 13 | 31,770 – 180,570 | 1240.00 – 2300.00 | (*138*) |
| Mugilidae | *Chelon ramada* | ott668241 | P | 47 | 1.23 | 0.49 | 1.98 | 2 | 29,050 – 62,150 | 850.00 – 1450.00 | (*138*) |
| Mugilidae | *Mugil cephalus* | ott418648 | P | 48 | 0.95 | 0.74 | 1.16 | 73 | 37,102 – 395,750 | 274.75 – 3760.17 | (*139*); (*141*) |
| Mugilidae | *Planiliza subviridis* | ott823526 | P | 53 | 1.02 | 0.56 | 1.5 | 12 | 6,011 – 22,974 | 11.69 – 28.41 | (*143*) |
| Paralichthyidae | *Paralichthys dentatus* | ott1019735 | P | 259 | 1.06 | 0.9 | 1.22 | 134 | 240,886 – 2,200,444 | 2627.81 – 20166.83 | (*146*) |
| Pleuronectidae | *Pseudopleuronectes americanus* | ott261419 | D | 265 | 0.99 | 0.58 | 1.4 | 17 | 64,023 – 416,296 | 332.81 – 1322.71 | (*152*) |
| Pomacentridae | *Pomacentrus coelestis* | ott622060 | D | 180 | 0.97 | 0.68 | 1.26 | 81 | 268.2 – 934.8 | 1.27 – 3.26 | (*157*) |
| Sciaenidae | *Cynoscion regalis* | ott5860595 | P | 208 | 1.51 | 1.24 | 1.79 | 29 | 10,181 – 244,728 | 554.68 – 3969.46 | (*161*) |
| Sciaenidae | *Larimus fasciatus* | ott897432 | P | 213 | 1.04 | 0.86 | 1.22 | 81 | 1,021 – 18,297 | 8.75 – 59.86 | (*164*) |
| Scombridae | *Scomberomorus cavalla* | ott70546 | P | 226 | 1.37 | 1.23 | 1.5 | 64 | 31,588 – 5,566,904 | 886.37 – 28991.83 | (*171*) |
| Scombridae | *Thunnus thynnus* | ott358607 | P | 231 | 1.18 | 0.58 | 1.78 | 27 | 1,001,262 – 4,240,637 | 1336.98 – 2861.01 | (*176*) |
| Sebastidae | *Sebastes mentella* | ott1088432 | BI | 309 | 1.44 | 1.14 | 1.75 | 54 | 7,152 – 79,378 | 381.88 – 1284.55 | (*190*) |
| Sebastidae | *Sebastes norvegicus* | ott1088441 | BI | 312 | 1.02 | 0.63 | 1.41 | 26 | 24,234 – 146,044 | 477.49 – 2037.78 | (*190*) |
| Serranidae | *Cephalopholis cruentata* | ott12880 | P | 232 | 1.22 | 0.65 | 1.79 | 12 | 6,720 – 47,971 | 142.95 – 414.81 | (*196*) |
| Serranidae | *Epinephelus tauvina* | ott218649 | P | 236 | 0.81 | 0.33 | 1.28 | 4 | 40,565 – 138,602 | 1062.45 – 6012.89 | (*198*) |
| Siganidae | *Siganus canaliculatus* | ott199059 | S | 241 | 1.27 | 1.05 | 1.48 | 27 | 649.8 – 28,482 | 59.67 – 870.20 | (*200*) |
| Soleidae | *Solea solea* | ott710233 | P | 268 | 1.81 | 1.28 | 2.41 | 23 | 25,862 – 5,699,096 | 17000.00 – 51000.00 | (*234*) |

**Table S6** *Continued.*

| Family | Species | OTL | SM | F3 | $\beta_1$ | 2.5% C.I. | 97.5% C.I. | n | Total egg-volume range ($\text{mm}^3$) | Mass range (g) | Refs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sparidae | *Acanthopagrus latus* | ott760733 | P | 242 | 1.11 | 0.35 | 1.87 | 5 | 135,589 – 214,311 | 426.21 – 660.47 | (*202*) |
| Sparidae | *Archosargus rhomboidalis* | ott724892 | P | 243 | 0.95 | 0.71 | 1.19 | 23 | 250.7 – 2,210 | 15.05 – 156.17 | (*203*) |
| Sparidae | *Sparidentex hasta* | ott845300 | P | 244 | 1.28 | 0.68 | 1.92 | 6 | 30,686 – 168,559 | 2604.06 – 6288.57 | (*202*) |
| Stromateidae | *Pampus chinensis* | ott916290 | P | 245 | 1.17 | 0.41 | 1.93 | 8 | 48,733 – 56,431 | 647.18 – 876.77 | (*204*) |
| Tetraodontidae | *Canthigaster valentini* | ott701127 | S | 342 | 0.98 | 0.76 | 1.2 | 66 | 75.25 – 346.3 | 2.32 – 9.09 | (*207*) |
| Trichiuridae | *Aphanopus carbo* | ott113465 | P | 246 | 1.27 | 0.68 | 1.87 | 14 | 184,493 – 774,750 | 1950.46 – 4169.05 | (*209*) |
| Zoarcidae | *Melanostigma atlanticum* | ott3633033 | D | 256 | 0.96 | 0.48 | 1.42 | 3 | 436.8 – 1,152 | 3.94 – 7.54 | (*210*) |

The above results were obtained with the subset of studies that contained paired measurements of fecundity (Table S3) and egg-volume (Table S4). This analysis was conducted by using the subset of studies that contained more than 1 observation.

**Table S7. Species-specific reproductive-energy output mass-scaling exponents.** This table contains all species present across the three main analyses in this study (Fecundity–Mass, Egg-volume–Mass, and Egg-energy–Volume models). **OTL** = Open Tree of Life Identifier; **SM** = Spawning Mode (D = demersal, P = pelagic, S = scatterer, BM/BP/BI = mouth/pouch/internal brooder – all brooders have no parental provisioning post fertilization); **F3** = Number ID in Fig. 3; **$\beta_1$ / 2.5% / 97.5%** = Estimates (mean and 95% Bayesian credible intervals) of reproductive-energy output mass-scaling exponents as obtained by combining posterior distributions of Fecundity–Mass, Egg-volume–Mass, and Egg-energy–Volume models (see Materials and Methods); **D1–3** = Is this species respectively present in Datasets 1 (Fecundity), 2 (Egg-volume), and/or 3 (Egg-energy)?

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **D1** | **D2** | **D3** |
|---|---|---|---|---|---|---|---|---|---|---|
| Acanthuridae | *Acanthurus coeruleus* | ott324283 | P | 55 | 1.29 | 1.19 | 1.41 | No | No | Yes |
| Acanthuridae | *Acanthurus nigrofuscus* | ott605289 | P | 56 | 1.27 | 1.18 | 1.37 | No | No | Yes |
| Acanthuridae | *Acanthurus triostegus* | ott467300 | P | 57 | 1.28 | 1.19 | 1.38 | No | No | Yes |
| Acanthuridae | *Zebrasoma scopas* | ott199073 | P | 58 | 1.29 | 1.19 | 1.4 | No | No | Yes |
| Agonidae | *Leptagonus decagonus* | ott3632024 | D | 269 | 1.3 | 0.71 | 1.87 | Yes | Yes | No |
| Agonidae | *Podothecus sachi* | ott590745 | D | 270 | 1.27 | 1.18 | 1.36 | No | No | Yes |
| Apogonidae | *Cheilodipterus macrodon* | ott965176 | BM | 59 | 1.44 | 0.78 | 2.11 | Yes | Yes | No |
| Apogonidae | *Cheilodipterus quinquelineatus* | ott364614 | BM | 60 | 1.27 | 1.18 | 1.37 | No | No | Yes |
| Apogonidae | *Holapogon maximus* | ott3635086 | BM | 61 | 1.36 | 0.72 | 1.95 | Yes | Yes | No |
| Apogonidae | *Jaydia hungi* | ott3634955 | BM | 62 | 1.29 | 0.71 | 1.88 | Yes | Yes | No |
| Apogonidae | *Ostorhinchus cookii* | ott102070 | BM | 63 | 1.32 | 0.75 | 1.87 | Yes | Yes | No |
| Apogonidae | *Ostorhinchus cyanosoma** | ott638185 | BM | 64 | 1.22 | 0.74 | 1.72 | Yes | Yes | Yes |
| Apogonidae | *Ostorhinchus doederleini* | ott687634 | BM | 65 | 1.29 | 1.19 | 1.41 | No | No | Yes |
| Apogonidae | *Paroncheilus affinis* | ott974576 | BM | 66 | 1.43 | 1.16 | 1.72 | No | Yes | No |
| Apogonidae | *Siphamia tubifer* | ott5860863 | BM | 67 | 0.79 | 0.41 | 1.18 | Yes | Yes | No |
| Apogonidae | *Taeniamia lineolata* | ott775407 | BM | 68 | 1.04 | 0.57 | 1.53 | Yes | Yes | No |
| Atherinidae | *Atherina presbyter* | ott669918 | D | 2 | 1.19 | 0.84 | 1.53 | Yes | Yes | No |
| Atherinopsidae | *Leuresthes tenuis* | ott274466 | D | 3 | 1.5 | 1.03 | 1.97 | Yes | No | No |
| Atherinopsidae | *Membras gilberti* | ott680137 | D | 4 | 1.28 | 1.19 | 1.4 | No | No | Yes |
| Atherinopsidae | *Menidia menidia* | ott189767 | D | 5 | 1.24 | 1.05 | 1.42 | No | Yes | No |
| Atherinopsidae | *Odontesthes argentinensis* | ott93287 | D | 6 | 1.28 | 0.96 | 1.6 | Yes | No | No |
| Balistidae | *Balistes capriscus* | ott135140 | S | 335 | 1.75 | 1.32 | 2.17 | Yes | Yes | No |
| Bathydraconidae | *Akarotaxis nudiceps* | ott682053 | D | 69 | 1.16 | 0.88 | 1.44 | No | Yes | No |
| Blenniidae | *Aidablennius sphynx* | ott898527 | D | 70 | 1.11 | 0.65 | 1.57 | Yes | Yes | No |
| Blenniidae | *Ophioblennius atlanticus* | ott282319 | D | 71 | 1.31 | 1.2 | 1.42 | No | No | Yes |
| Blenniidae | *Ophioblennius steindachneri* | ott155044 | D | 72 | 1.3 | 1.2 | 1.41 | No | No | Yes |
| Bothidae | *Arnoglossus laterna* | ott696263 | P | 258 | 1.18 | 0.73 | 1.64 | Yes | Yes | No |
| Callionymidae | *Synchiropus sechellensis* | ott3632718 | P | 73 | 1.36 | 1.05 | 1.67 | No | Yes | No |
| Carangidae | *Decapterus punctatus* | ott705034 | P | 74 | 1.59 | 1.06 | 2.13 | Yes | Yes | No |
| Carangidae | *Elagatis bipinnulata* | ott705026 | P | 75 | 1.1 | 0.83 | 1.37 | Yes | No | No |
| Carangidae | *Trachurus mediterraneus* | ott174577 | P | 76 | 1.29 | 0.93 | 1.66 | No | Yes | No |
| Carangidae | *Trachurus picturatus* | ott174574 | P | 77 | 1.21 | 0.65 | 1.77 | Yes | Yes | No |
| Carangidae | *Trachurus trachurus* | ott472429 | P | 78 | 1.3 | 1.01 | 1.61 | No | Yes | No |
| Centropomidae | *Centropomus undecimalis* | ott317368 | P | 79 | 1.6 | 1.19 | 2.01 | Yes | No | No |
| Chaenopsidae | *Acanthemblemaria hancocki* | ott57340 | D | 80 | 1.27 | 1.18 | 1.37 | No | No | Yes |
| Chaenopsidae | *Acanthemblemaria rivasi* | ott57343 | D | 81 | 1.29 | 1.2 | 1.38 | No | No | Yes |

**Table S7** *Continued.*

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **D1** | **D2** | **D3** |
|---|---|---|---|---|---|---|---|---|---|---|
| Clupeidae | *Amblygaster sirm* | ott328216 | P | 11 | 1.82 | 1.25 | 2.39 | Yes | Yes | No |
| Clupeidae | *Brevoortia patronus* | ott107260 | P | 12 | 1.24 | 0.9 | 1.59 | No | Yes | No |
| Clupeidae | *Brevoortia tyrannus* | ott107265 | P | 13 | 1.24 | 1.16 | 1.32 | No | No | Yes |
| Clupeidae | *Clupea harengus* | ott1005932 | D | 14 | 1.65 | 1.52 | 1.78 | Yes | No | No |
| Clupeidae | *Clupea pallasii* | ott9666 | D | 15 | 1.32 | 1.21 | 1.44 | No | No | Yes |
| Clupeidae | *Ethmalosa fimbriata* | ott658559 | P | 16 | 1.09 | 0.55 | 1.64 | Yes | Yes | No |
| Clupeidae | *Nematalosa vlaminghi* | ott328199 | P | 17 | 1.2 | 0.54 | 1.84 | Yes | Yes | No |
| Clupeidae | *Opisthonema libertate* | ott437031 | P | 18 | 1.21 | 0.81 | 1.6 | Yes | No | No |
| Clupeidae | *Opisthonema medirastre* | ott1195 | P | 19 | 1.35 | 0.92 | 1.78 | Yes | No | No |
| Clupeidae | *Sardinops sagax* | ott121238 | P | 20 | 1.08 | 0.93 | 1.23 | Yes | No | No |
| Clupeidae | *Spratelloides gracilis* | ott39732 | D | 21 | 1.08 | 0.76 | 1.42 | Yes | Yes | No |
| Clupeidae | *Strangomera bentincki* | ott648871 | P | 22 | 1.19 | 0.75 | 1.6 | Yes | No | No |
| Congiopodidae | *Zanclorhynchus spinifer* | ott255677 | P | 271 | 1.37 | 1.03 | 1.74 | No | Yes | No |
| Coryphaenidae | *Coryphaena hippurus* | ott223663 | P | 85 | 1.28 | 1.19 | 1.39 | No | No | Yes |
| Cottidae | *Alcichthys elongatus* | ott3632242 | D | 272 | 1.28 | 1.19 | 1.39 | No | No | Yes |
| Cottidae | *Artediellus atlanticus* | ott654509 | D | 273 | 1.22 | 0.64 | 1.79 | Yes | Yes | No |
| Cottidae | *Enophrys bison* | ott290389 | D | 274 | 1.32 | 0.64 | 2 | Yes | Yes | No |
| Cottidae | *Gymnocanthus tricuspis* | ott654474 | D | 275 | 1.33 | 0.97 | 1.68 | No | Yes | No |
| Cottidae | *Icelus bicornis* | ott3632116 | D | 276 | 1.19 | 0.63 | 1.75 | Yes | Yes | No |
| Cottidae | *Triglops pingelii* | ott568671 | D | 277 | 1.11 | 0.54 | 1.67 | Yes | Yes | No |
| Cyclopteridae | *Aptocyclus ventricosus* | ott989887 | D | 278 | 1.33 | 1.22 | 1.45 | No | No | Yes |
| Cyclopteridae | *Cyclopteropsis mcalpini* | ott3631993 | D | 279 | 0.99 | 0.51 | 1.47 | Yes | Yes | No |
| Cyclopteridae | *Eumicrotremus spinosus* | ott1097394 | D | 280 | 1.25 | 0.92 | 1.58 | No | Yes | No |
| Engraulidae | *Anchoviella lepidentostole* | ott610213 | P | 23 | 1.08 | 0.7 | 1.46 | Yes | No | No |
| Engraulidae | *Cetengraulis mysticetus* | ott1064953 | P | 24 | 1.39 | 1.11 | 1.66 | Yes | Yes | No |
| Engraulidae | *Engraulis anchoita* | ott648864 | P | 25 | 1.36 | 1.13 | 1.58 | Yes | Yes | No |
| Engraulidae | *Engraulis mordax** | ott29754 | P | 26 | 1.15 | 0.64 | 1.64 | Yes | Yes | Yes |
| Engraulidae | *Engraulis ringens* | ott211981 | P | 27 | 1.48 | 1.25 | 1.71 | Yes | No | Yes |
| Exocoetidae | *Hirundichthys affinis* | ott837204 | D | 7 | 1.24 | 0.56 | 1.92 | Yes | Yes | No |
| Fundulidae | *Fundulus heteroclitus* | ott4134765 | D | 29 | 1.3 | 1.15 | 1.46 | No | Yes | No |
| Fundulidae | *Fundulus xenicus* | ott839523 | D | 30 | 1.26 | 1.02 | 1.5 | No | Yes | No |
| Fundulidae | *Lucania goodei* | ott84261 | D | 31 | 1.29 | 1.2 | 1.4 | No | No | Yes |
| Fundulidae | *Lucania parva* | ott839518 | D | 32 | 1.3 | 1.2 | 1.41 | No | No | Yes |
| Gadidae | *Boreogadus saida* | ott877055 | P | 33 | 0.85 | 0.28 | 1.42 | Yes | Yes | No |
| Gadidae | *Eleginus nawaga* | ott450082 | D | 34 | 1.1 | 0.47 | 1.73 | Yes | Yes | No |
| Gadidae | *Gadus morhua** | ott5860467 | P | 35 | 1.33 | 1.25 | 1.43 | Yes | Yes | Yes |
| Gadidae | *Melanogrammus aeglefinus* | ott635904 | P | 36 | 1.25 | 1.17 | 1.34 | No | Yes | Yes |
| Gadidae | *Merlangius merlangus* | ott635911 | P | 37 | 1.14 | 1.01 | 1.28 | Yes | No | Yes |
| Gadidae | *Micromesistius australis* | ott1091056 | P | 38 | 1.64 | 1.19 | 2.07 | Yes | Yes | No |
| Gadidae | *Pollachius pollachius* | ott1014047 | P | 39 | 1.3 | 1.21 | 1.4 | No | No | Yes |
| Gadidae | *Pollachius virens* | ott62649 | P | 40 | 1.31 | 1.21 | 1.41 | No | No | Yes |
| Gadidae | *Trisopterus esmarkii* | ott926146 | P | 41 | 1.3 | 1.2 | 1.4 | No | No | Yes |
| Gasterosteidae | *Gasterosteus aculeatus** | ott111122 | D | 45 | 1.01 | 0.82 | 1.23 | Yes | Yes | Yes |
| Gobiidae | *Coryphopterus dicrus* | ott37549 | D | 86 | 1.27 | 1.18 | 1.37 | No | No | Yes |

**Table S7** *Continued.*

| Family | Species | OTL | SM | F3 | $\beta_1$ | 2.5% C.I. | 97.5% C.I. | D1 | D2 | D3 |
|---|---|---|---|---|---|---|---|---|---|---|
| Gobiidae | *Coryphopterus glaucofraenum* | ott494031 | D | 87 | 1.32 | 1.21 | 1.42 | No | No | Yes |
| Gobiidae | *Coryphopterus personatus* | ott740192 | D | 88 | 1.29 | 1.2 | 1.39 | No | No | Yes |
| Gobiidae | *Elacatinus oceanops* | ott638369 | D | 89 | 0.72 | 0.3 | 1.12 | Yes | Yes | No |
| Gobiidae | *Gobiosoma robustum* | ott1064480 | D | 90 | 1.49 | 0.78 | 2.17 | Yes | Yes | No |
| Gobiidae | *Oligolepis acutipennis* | ott767535 | D | 91 | 1.37 | 1.02 | 1.74 | No | Yes | No |
| Gobiidae | *Paragobiodon echinocephalus* | ott940827 | D | 92 | 0.95 | 0.53 | 1.37 | Yes | Yes | No |
| Gobiidae | *Paragobiodon lacunicolus* | ott758973 | D | 93 | 0.96 | 0.54 | 1.37 | Yes | Yes | No |
| Gobiidae | *Paragobiodon xanthosoma* | ott770378 | D | 94 | 1.04 | 0.62 | 1.45 | Yes | Yes | No |
| Gobiidae | *Pomatoschistus minutus* | ott1048873 | D | 95 | 0.92 | 0.57 | 1.28 | Yes | No | No |
| Haemulidae | *Haemulon flavolineatum* | ott432196 | P | 96 | 1.29 | 1.19 | 1.4 | No | No | Yes |
| Haemulidae | *Haemulopsis corvinaeformis* | ott177515 | P | 97 | 0.69 | 0.3 | 1.08 | Yes | Yes | No |
| Hemiramphidae | *Hemiramphus brasiliensis* | ott953384 | D | 8 | 1.1 | 0.55 | 1.67 | Yes | Yes | No |
| Hemitripteridae | *Blepsias cirrhosus* | ott446859 | D | 281 | 1.34 | 1.23 | 1.45 | No | No | Yes |
| Hemitripteridae | *Hemitripterus americanus* | ott160287 | D | 282 | 2.25 | 1.69 | 2.82 | Yes | Yes | No |
| Hemitripteridae | *Hemitripterus villosus* | ott438425 | D | 283 | 1.36 | 1.24 | 1.49 | No | No | Yes |
| Hexagrammidae | *Oxylebius pictus** | ott131554 | D | 284 | 1.12 | 0.57 | 1.7 | Yes | Yes | Yes |
| Labridae | *Anampses caeruleopunctatus* | ott372276 | D | 98 | 1.3 | 0.93 | 1.66 | No | Yes | No |
| Labridae | *Anampses twistii* | ott762167 | P | 99 | 1.28 | 0.94 | 1.62 | No | Yes | No |
| Labridae | *Bodianus axillaris* | ott548889 | P | 100 | 1.29 | 1.19 | 1.41 | No | No | Yes |
| Labridae | *Bodianus diplotaenia* | ott919235 | P | 101 | 1.28 | 1.18 | 1.39 | No | No | Yes |
| Labridae | *Bodianus rufus* | ott372258 | P | 102 | 1.3 | 1.19 | 1.42 | No | No | Yes |
| Labridae | *Cheilinus fasciatus* | ott155291 | P | 103 | 1.29 | 0.92 | 1.67 | No | Yes | No |
| Labridae | *Cheilinus oxycephalus* | ott195575 | P | 104 | 1.29 | 0.95 | 1.64 | No | Yes | No |
| Labridae | *Cheilinus trilobatus* | ott924675 | P | 105 | 1.28 | 0.92 | 1.63 | No | Yes | No |
| Labridae | *Clepticus parrae* | ott948303 | P | 106 | 1.29 | 1.19 | 1.4 | No | No | Yes |
| Labridae | *Coris gaimard* | ott1092680 | P | 107 | 1.29 | 0.92 | 1.66 | No | Yes | No |
| Labridae | *Coris variegata* | ott3636534 | P | 108 | 1.3 | 0.96 | 1.63 | No | Yes | No |
| Labridae | *Doratonotus megalepis* | ott763958 | P | 109 | 1.3 | 1.2 | 1.42 | No | No | Yes |
| Labridae | *Epibulus insidiator* | ott120301 | P | 110 | 1.29 | 0.92 | 1.66 | No | Yes | No |
| Labridae | *Gomphosus varius* | ott358606 | P | 111 | 1.32 | 0.94 | 1.7 | No | Yes | No |
| Labridae | *Halichoeres biocellatus* | ott1015700 | P | 112 | 1.27 | 1.01 | 1.54 | No | Yes | No |
| Labridae | *Halichoeres bivittatus* | ott694396 | P | 113 | 1.3 | 1.2 | 1.4 | No | No | Yes |
| Labridae | *Halichoeres chierchiae* | ott615862 | P | 114 | 1.27 | 1.18 | 1.38 | No | No | Yes |
| Labridae | *Halichoeres chloropterus* | ott1015715 | P | 115 | 1.29 | 1.19 | 1.41 | No | No | Yes |
| Labridae | *Halichoeres dispilus* | ott762170 | P | 116 | 1.27 | 1.18 | 1.38 | No | No | Yes |
| Labridae | *Halichoeres garnoti* | ott665840 | P | 117 | 1.28 | 1.18 | 1.39 | No | No | Yes |
| Labridae | *Halichoeres hortulanus* | ott694390 | P | 118 | 1.34 | 0.88 | 1.82 | No | Yes | Yes |
| Labridae | *Halichoeres maculipinna* | ott955368 | P | 119 | 1.29 | 1.19 | 1.41 | No | No | Yes |
| Labridae | *Halichoeres margaritaceus* | ott694405 | P | 120 | 1.29 | 1.2 | 1.38 | No | No | Yes |
| Labridae | *Halichoeres marginatus* | ott694408 | P | 121 | 1.26 | 1.17 | 1.36 | No | No | Yes |
| Labridae | *Halichoeres melanurus* | ott627330 | P | 122 | 1.3 | 0.95 | 1.69 | No | Yes | Yes |
| Labridae | *Halichoeres miniatus* | ott694399 | P | 123 | 1.3 | 1.2 | 1.41 | No | No | Yes |
| Labridae | *Halichoeres nebulosus* | ott1015709 | P | 124 | 1.29 | 1.19 | 1.41 | No | No | Yes |

**Table S7** *Continued.*

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **D1** | **D2** | **D3** |
|---|---|---|---|---|---|---|---|---|---|---|
| Labridae | *Halichoeres nicholsi* | ott694402 | P | 125 | 1.28 | 1.18 | 1.39 | No | No | Yes |
| Labridae | *Halichoeres notospilus* | ott694414 | P | 126 | 1.32 | 1.21 | 1.43 | No | No | Yes |
| Labridae | *Halichoeres pictus* | ott173446 | P | 127 | 1.32 | 1.21 | 1.45 | No | No | Yes |
| Labridae | *Halichoeres poeyi* | ott38828 | P | 128 | 1.28 | 1.18 | 1.39 | No | No | Yes |
| Labridae | *Halichoeres trimaculatus* | ott942026 | P | 129 | 1.3 | 1.19 | 1.42 | No | No | Yes |
| Labridae | *Hemigymnus fasciatus* | ott924674 | P | 130 | 1.29 | 0.93 | 1.67 | No | Yes | Yes |
| Labridae | *Hemigymnus melapterus* | ott302368 | P | 131 | 1.28 | 1.18 | 1.39 | No | No | Yes |
| Labridae | *Labrichthys unilineatus* | ott302371 | P | 132 | 1.27 | 0.96 | 1.58 | No | Yes | No |
| Labridae | *Labroides dimidiatus* | ott302377 | P | 133 | 1.27 | 0.99 | 1.54 | No | Yes | No |
| Labridae | *Labropsis micronesica* | ott3636703 | P | 134 | 1.19 | 0.92 | 1.45 | No | Yes | No |
| Labridae | *Labropsis xanthonota* | ott3636702 | P | 135 | 1.25 | 0.99 | 1.51 | No | Yes | No |
| Labridae | *Macropharyngodon meleagris* | ott552117 | P | 136 | 1.26 | 0.99 | 1.54 | No | Yes | No |
| Labridae | *Novaculichthys taeniourus* | ott456983 | P | 137 | 1.29 | 0.94 | 1.68 | No | Yes | Yes |
| Labridae | *Oxycheilinus unifasciatus* | ott352271 | P | 138 | 1.29 | 0.93 | 1.66 | No | Yes | No |
| Labridae | *Pseudocheilinus hexataenia* | ott712600 | P | 139 | 1.29 | 0.99 | 1.6 | No | Yes | No |
| Labridae | *Stethojulis bandanensis* | ott201174 | P | 140 | 1.29 | 1.2 | 1.4 | No | No | Yes |
| Labridae | *Symphodus mediterraneus* | ott730049 | D | 141 | 1.29 | 1.19 | 1.41 | No | No | Yes |
| Labridae | *Symphodus roissali* | ott876619 | D | 142 | 1.21 | 1.1 | 1.33 | No | Yes | Yes |
| Labridae | *Symphodus rostratus* | ott553190 | D | 143 | 1.29 | 1.19 | 1.4 | No | No | Yes |
| Labridae | *Symphodus tinca* | ott787184 | D | 144 | 1.31 | 1.2 | 1.42 | No | No | Yes |
| Labridae | *Thalassoma bifasciatum* | ott907850 | P | 145 | 0.88 | 0.71 | 1.05 | Yes | No | Yes |
| Labridae | *Thalassoma hardwicke* | ott102998 | P | 146 | 1.28 | 1.19 | 1.37 | No | No | Yes |
| Labridae | *Thalassoma jansenii* | ott1094748 | P | 147 | 1.29 | 1.2 | 1.39 | No | No | Yes |
| Labridae | *Thalassoma lucasanum* | ott1094750 | P | 148 | 1.29 | 1.2 | 1.39 | No | No | Yes |
| Labridae | *Thalassoma lunare* | ott948286 | P | 149 | 1.28 | 1.19 | 1.38 | No | No | Yes |
| Latidae | *Lates calcarifer* | ott6362446 | P | 150 | 1.15 | 0.93 | 1.38 | Yes | No | No |
| Liparidae | *Careproctus reinhardti* | ott1065176 | D | 285 | 1.32 | 0.62 | 2.03 | Yes | Yes | No |
| Liparidae | *Liparis fabricii* | ott496423 | D | 286 | 1.36 | 1.02 | 1.71 | No | Yes | No |
| Liparidae | *Paraliparis bathybius* | ott309222 | BM | 287 | 1.31 | 0.64 | 1.98 | Yes | Yes | No |
| Lutjanidae | *Lutjanus campechanus* | ott642863 | P | 151 | 1.1 | 0.72 | 1.47 | Yes | No | No |
| Lutjanidae | *Lutjanus carponotatus* | ott333348 | P | 152 | 1.84 | 1.53 | 2.14 | Yes | Yes | No |
| Lutjanidae | *Lutjanus synagris* | ott943184 | P | 153 | 0.77 | 0.56 | 0.99 | Yes | No | No |
| Lutjanidae | *Ocyurus chrysurus* | ott943183 | P | 154 | 1.36 | 0.98 | 1.73 | Yes | No | No |
| Lutjanidae | *Rhomboplites aurorubens* | ott642869 | P | 155 | 1.49 | 1.34 | 1.65 | Yes | No | No |
| Malacanthidae | *Caulolatilus microps* | ott39883 | P | 156 | 1.63 | 1.19 | 2.07 | Yes | Yes | No |
| Merlucciidae | *Merluccius gayi* | ott323082 | P | 42 | 1.3 | 1 | 1.59 | Yes | No | No |
| Merlucciidae | *Merluccius hubbsi* | ott757316 | P | 43 | 1.17 | 1.08 | 1.27 | Yes | No | No |
| Merlucciidae | *Merluccius merluccius* | ott5860466 | P | 44 | 1.12 | 0.94 | 1.3 | Yes | Yes | No |
| Monacanthidae | *Brachaluteres jacksonianus* | ott333693 | S | 336 | 1.19 | 0.76 | 1.6 | Yes | Yes | No |
| Monacanthidae | *Eubalichthys bucephalus* | ott3631310 | S | 337 | 1.42 | 0.73 | 2.14 | Yes | Yes | No |
| Monacanthidae | *Oxymonacanthus longirostris* | ott333706 | S | 338 | 1.32 | 0.85 | 1.8 | Yes | Yes | No |
| Monacanthidae | *Paramonacanthus japonicus* | ott3631319 | S | 339 | 1.28 | 1.02 | 1.54 | No | Yes | No |
| Monacanthidae | *Rudarius ercodes* | ott511593 | S | 340 | 0.92 | 0.51 | 1.34 | Yes | Yes | No |
| Moronidae | *Dicentrarchus labrax* | ott3549 | P | 157 | 1.34 | 0.96 | 1.72 | Yes | No | Yes |

**Table S7** *Continued.*

| Family | Species | OTL | SM | F3 | $\beta_1$ | 2.5% C.I. | 97.5% C.I. | D1 | D2 | D3 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mugilidae | *Chelon labrosus* | ott777079 | P | 46 | 1.06 | 0.46 | 1.65 | Yes | Yes | No |
| Mugilidae | *Chelon ramada* | ott668241 | P | 47 | 1.24 | 0.59 | 1.9 | Yes | Yes | No |
| Mugilidae | *Mugil cephalus* | ott418648 | P | 48 | 0.93 | 0.61 | 1.23 | Yes | Yes | No |
| Mugilidae | *Mugil curema* | ott418643 | P | 49 | 1.26 | 0.71 | 1.8 | Yes | No | No |
| Mugilidae | *Mugil hospes* | ott779937 | P | 50 | 1.25 | 0.69 | 1.81 | Yes | No | No |
| Mugilidae | *Mugil liza* | ott779933 | P | 51 | 1.3 | 0.72 | 1.88 | Yes | No | No |
| Mugilidae | *Mugil trichodon* | ott246901 | P | 52 | 1.29 | 0.73 | 1.86 | Yes | No | No |
| Mugilidae | *Planiliza subviridis* | ott823526 | P | 53 | 1.1 | 0.61 | 1.59 | Yes | Yes | No |
| Mullidae | *Parupeneus multifasciatus* | ott295485 | P | 158 | 1.29 | 1.19 | 1.41 | No | No | Yes |
| Muraenesocidae | *Muraenesox cinereus* | ott479856 | P | 1 | 1.27 | 1.18 | 1.35 | No | No | Yes |
| Nemipteridae | *Scolopsis bilineata* | ott463069 | P | 159 | 1.29 | 1.19 | 1.41 | No | No | Yes |
| Nototheniidae | *Lepidonotothen nudifrons* | ott260052 | D | 160 | 1.38 | 0.69 | 2.04 | Yes | Yes | No |
| Nototheniidae | *Patagonotothen longipes* | ott430554 | D | 161 | 1.44 | 1.15 | 1.74 | No | Yes | No |
| Nototheniidae | *Patagonotothen sima* | ott874773 | D | 162 | 1.53 | 1.3 | 1.78 | No | Yes | No |
| Osmeridae | *Mallotus villosus* | ott225330 | D | 54 | 1.33 | 0.81 | 1.85 | Yes | No | No |
| Paralichthyidae | *Paralichthys dentatus* | ott1019735 | P | 259 | 1.18 | 0.83 | 1.52 | Yes | Yes | No |
| Paralichthyidae | *Paralichthys patagonicus* | ott654479 | P | 260 | 1.49 | 1.02 | 1.97 | Yes | No | No |
| Pinguipedidae | *Parapercis snyderi* | ott3635246 | P | 163 | 1.28 | 1.18 | 1.38 | No | No | Yes |
| Plesiopidae | *Acanthoclinus fuscus* | ott3633802 | D | 164 | 1.57 | 1.04 | 2.12 | Yes | No | No |
| Pleuronectidae | *Ammotretis rostratus* | ott600529 | P | 261 | 1.27 | 0.93 | 1.62 | No | Yes | No |
| Pleuronectidae | *Hippoglossoides platessoides* | ott223665 | P | 262 | 1.07 | 0.93 | 1.21 | Yes | No | No |
| Pleuronectidae | *Hippoglossus hippoglossus* | ott408328 | P | 263 | 1.3 | 1.21 | 1.39 | No | No | Yes |
| Pleuronectidae | *Pleuronectes platessa* | ott408337 | P | 264 | 1.21 | 1.12 | 1.3 | Yes | No | Yes |
| Pleuronectidae | *Pseudopleuronectes americanus** | ott261419 | D | 265 | 1.03 | 0.65 | 1.41 | Yes | Yes | Yes |
| Pleuronectidae | *Reinhardtius hippoglossoides* | ott835141 | P | 266 | 1.41 | 1.16 | 1.65 | Yes | No | No |
| Pleuronectidae | *Rhombosolea tapirina* | ott867269 | P | 267 | 1.27 | 0.95 | 1.59 | No | Yes | No |
| Pomacanthidae | *Pomacanthus zonipectus* | ott826472 | P | 165 | 1.36 | 0.78 | 1.93 | Yes | No | No |
| Pomacentridae | *Abudefduf bengalensis* | ott318931 | D | 166 | 1.31 | 1.21 | 1.43 | No | No | Yes |
| Pomacentridae | *Abudefduf saxatilis** | ott405751 | D | 167 | 0.96 | 0.39 | 1.52 | Yes | Yes | Yes |
| Pomacentridae | *Abudefduf septemfasciatus* | ott129790 | D | 168 | 1.29 | 1.19 | 1.4 | No | No | Yes |
| Pomacentridae | *Abudefduf sordidus* | ott1053071 | D | 169 | 1.29 | 1.2 | 1.41 | No | No | Yes |
| Pomacentridae | *Abudefduf troschelii* | ott961357 | D | 170 | 1.31 | 1.21 | 1.42 | No | No | Yes |
| Pomacentridae | *Abudefduf vaigiensis* | ott1053067 | D | 171 | 1.29 | 1.19 | 1.4 | No | No | Yes |
| Pomacentridae | *Acanthochromis polyacanthus* | ott100410 | D | 172 | 1.52 | 0.95 | 2.09 | Yes | No | No |
| Pomacentridae | *Chromis atrilobata* | ott436999 | D | 173 | 1.34 | 1.23 | 1.45 | No | No | Yes |
| Pomacentridae | *Chromis atripectoralis* | ott741423 | D | 174 | 1.28 | 1.19 | 1.37 | No | No | Yes |
| Pomacentridae | *Chromis multilineata* | ott437016 | D | 175 | 1.3 | 1.21 | 1.4 | No | No | Yes |
| Pomacentridae | *Hypsypops rubicundus* | ott847666 | D | 176 | 1.3 | 1.21 | 1.4 | No | No | Yes |
| Pomacentridae | *Microspathodon bairdii* | ott237630 | D | 177 | 1.29 | 1.19 | 1.39 | No | No | Yes |
| Pomacentridae | *Microspathodon chrysurus* | ott847660 | D | 178 | 1.29 | 1.19 | 1.39 | No | No | Yes |
| Pomacentridae | *Microspathodon dorsalis* | ott205758 | D | 179 | 1.29 | 1.2 | 1.39 | No | No | Yes |
| Pomacentridae | *Pomacentrus coelestis* | ott622060 | D | 180 | 1.08 | 0.73 | 1.43 | Yes | Yes | No |
| Pomacentridae | *Stegastes acapulcoensis* | ott3635554 | D | 181 | 1.32 | 1.22 | 1.43 | No | No | Yes |
| Pomacentridae | *Stegastes adustus* | ott323181 | D | 182 | 1.32 | 1.22 | 1.43 | No | No | Yes |

**Table S7** *Continued.*

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **D1** | **D2** | **D3** |
|---|---|---|---|---|---|---|---|---|---|---|
| Pomacentridae | *Stegastes diencaeus* | ott729161 | D | 183 | 1.28 | 1.19 | 1.39 | No | No | Yes |
| Pomacentridae | *Stegastes flavilatus* | ott3635541 | D | 184 | 1.31 | 1.21 | 1.41 | No | No | Yes |
| Pomacentridae | *Stegastes fuscus* | ott3635543 | D | 185 | 1.07 | 0.73 | 1.41 | Yes | No | No |
| Pomacentridae | *Stegastes leucostictus* | ott100830 | D | 186 | 1.31 | 1.2 | 1.43 | No | No | Yes |
| Pomacentridae | *Stegastes partitus* | ott345269 | D | 187 | 1.32 | 1.22 | 1.42 | No | No | Yes |
| Pomacentridae | *Stegastes planifrons* | ott665837 | D | 188 | 1.3 | 1.2 | 1.41 | No | No | Yes |
| Pomacentridae | *Stegastes variabilis* | ott323173 | D | 189 | 1.32 | 1.21 | 1.44 | No | No | Yes |
| Pristigasteridae | *Ilisha africana* | ott741177 | P | 28 | 1.4 | 0.79 | 2.01 | Yes | Yes | No |
| Scaridae | *Cetoscarus bicolor* | ott1041720 | P | 190 | 1.29 | 0.95 | 1.63 | No | Yes | No |
| Scaridae | *Chlorurus sordidus* | ott436737 | P | 191 | 1.28 | 0.95 | 1.65 | No | Yes | Yes |
| Scaridae | *Cryptotomus roseus* | ott321483 | P | 192 | 1.32 | 1.21 | 1.44 | No | No | Yes |
| Scaridae | *Hipposcarus longiceps* | ott465039 | P | 193 | 1.3 | 0.94 | 1.67 | No | Yes | No |
| Scaridae | *Scarus flavipectoralis* | ott1041716 | P | 194 | 1.28 | 1.19 | 1.39 | No | No | Yes |
| Scaridae | *Scarus forsteni* | ott548869 | P | 195 | 1.29 | 0.93 | 1.66 | No | Yes | No |
| Scaridae | *Scarus frenatus* | ott436725 | P | 196 | 1.27 | 0.93 | 1.63 | No | Yes | Yes |
| Scaridae | *Scarus globiceps* | ott514869 | P | 197 | 1.27 | 0.88 | 1.68 | No | Yes | Yes |
| Scaridae | *Scarus iseri* | ott686634 | P | 198 | 1.31 | 1.2 | 1.43 | No | No | Yes |
| Scaridae | *Scarus niger* | ott14311 | P | 199 | 1.26 | 1.17 | 1.36 | No | No | Yes |
| Scaridae | *Scarus psittacus* | ott514872 | P | 200 | 1.33 | 1.22 | 1.46 | No | No | Yes |
| Scaridae | *Scarus schlegeli* | ott514881 | P | 201 | 1.26 | 0.95 | 1.61 | No | Yes | Yes |
| Scaridae | *Scarus spinus* | ott419732 | P | 202 | 1.29 | 1.19 | 1.4 | No | No | Yes |
| Scaridae | *Sparisoma atomarium* | ott686627 | P | 203 | 1.33 | 1.22 | 1.46 | No | No | Yes |
| Scaridae | *Sparisoma aurofrenatum* | ott686624 | P | 204 | 1.26 | 1.17 | 1.37 | No | No | Yes |
| Scaridae | *Sparisoma radians* | ott214109 | P | 205 | 1.29 | 1.2 | 1.39 | No | No | Yes |
| Scaridae | *Sparisoma rubripinne* | ott686642 | P | 206 | 1.26 | 1.17 | 1.37 | No | No | Yes |
| Sciaenidae | *Bairdiella chrysoura* | ott761907 | P | 207 | 1.13 | 0.5 | 1.75 | Yes | Yes | No |
| Sciaenidae | *Cynoscion regalis** | ott5860595 | P | 208 | 1.51 | 1.23 | 1.79 | Yes | Yes | Yes |
| Sciaenidae | *Cynoscion striatus* | ott267367 | P | 209 | 1.33 | 0.77 | 1.91 | Yes | No | No |
| Sciaenidae | *Genyonemus lineatus* | ott1027240 | P | 210 | 2.02 | 1.76 | 2.28 | Yes | No | No |
| Sciaenidae | *Isopisthus parvipinnis* | ott133138 | P | 211 | 1.42 | 0.98 | 1.87 | Yes | No | No |
| Sciaenidae | *Larimus breviceps* | ott924070 | P | 212 | 1.82 | 1.3 | 2.36 | Yes | No | No |
| Sciaenidae | *Larimus fasciatus* | ott897432 | P | 213 | 1.17 | 0.83 | 1.51 | Yes | Yes | No |
| Sciaenidae | *Leiostomus xanthurus* | ott1052160 | P | 214 | 1.27 | 1.17 | 1.38 | No | No | Yes |
| Sciaenidae | *Macrodon ancylodon* | ott99076 | P | 215 | 1.35 | 0.99 | 1.7 | Yes | No | No |
| Sciaenidae | *Micropogonias furnieri* | ott742890 | P | 216 | 1.1 | 0.92 | 1.28 | Yes | No | No |
| Sciaenidae | *Micropogonias undulatus* | ott987393 | P | 217 | 1.28 | 1.18 | 1.4 | No | No | Yes |
| Sciaenidae | *Paralonchurus brasiliensis* | ott160812 | P | 218 | 1.01 | 0.53 | 1.47 | Yes | No | No |
| Sciaenidae | *Seriphus politus* | ott827210 | P | 219 | 1.22 | 1.09 | 1.34 | Yes | No | No |
| Sciaenidae | *Stellifer rastrifer* | ott362452 | P | 220 | 0.87 | 0.61 | 1.15 | Yes | No | No |
| Scombridae | *Auxis rochei* | ott713972 | P | 221 | 1.28 | 0.58 | 1.98 | Yes | Yes | No |
| Scombridae | *Euthynnus affinis* | ott308760 | P | 222 | 1.22 | 0.9 | 1.52 | No | Yes | No |
| Scombridae | *Katsuwonus pelamis* | ott308754 | P | 223 | 1.36 | 1.09 | 1.63 | No | Yes | No |
| Scombridae | *Sarda sarda* | ott833175 | P | 224 | 1.35 | 0.99 | 1.73 | No | Yes | No |
| Scombridae | *Scomber scombrus* | ott70561 | P | 225 | 1.49 | 1.18 | 1.8 | Yes | No | No |

**Table S7** *Continued.*

| **Family** | **Species** | **OTL** | **SM** | **F3** | $\beta_1$ | **2.5% C.I.** | **97.5% C.I.** | **D1** | **D2** | **D3** |
|---|---|---|---|---|---|---|---|---|---|---|
| Scombridae | *Scomberomorus cavalla* | ott70546 | P | 226 | 1.48 | 1.15 | 1.82 | Yes | Yes | No |
| Scombridae | *Scomberomorus maculatus* | ott266387 | P | 227 | 1.23 | 0.94 | 1.52 | Yes | No | No |
| Scombridae | *Thunnus alalunga* | ott833194 | P | 228 | 1.04 | 0.65 | 1.42 | Yes | No | No |
| Scombridae | *Thunnus albacares* | ott833188 | P | 229 | 1.05 | 0.61 | 1.5 | Yes | Yes | No |
| Scombridae | *Thunnus obesus* | ott358613 | P | 230 | 1.31 | 1.06 | 1.57 | No | Yes | No |
| Scombridae | *Thunnus thynnus* | ott358607 | P | 231 | 1.17 | 0.54 | 1.77 | Yes | Yes | No |
| Sebastidae | *Sebastes alutus* | ott480735 | BI | 288 | 1.87 | 1.7 | 2.05 | Yes | No | No |
| Sebastidae | *Sebastes atrovirens* | ott480732 | BI | 289 | 1.22 | 0.69 | 1.73 | Yes | No | No |
| Sebastidae | *Sebastes auriculatus* | ott480729 | BI | 290 | 1.17 | 0.84 | 1.51 | Yes | No | No |
| Sebastidae | *Sebastes brevispinis* | ott1057081 | BI | 291 | 1.39 | 0.92 | 1.86 | Yes | No | No |
| Sebastidae | *Sebastes carnatus* | ott1057074 | BI | 292 | 1.29 | 0.76 | 1.82 | Yes | No | No |
| Sebastidae | *Sebastes caurinus* | ott1057078 | BI | 293 | 1.78 | 1.59 | 1.99 | Yes | No | No |
| Sebastidae | *Sebastes chlorostictus* | ott1057068 | BI | 294 | 1.66 | 1.44 | 1.88 | Yes | No | No |
| Sebastidae | *Sebastes constellatus* | ott1057062 | BI | 295 | 1.44 | 1.05 | 1.84 | Yes | No | No |
| Sebastidae | *Sebastes crameri* | ott1057065 | BI | 296 | 1.57 | 1.2 | 1.94 | Yes | No | No |
| Sebastidae | *Sebastes dallii* | ott1088425 | BI | 297 | 1.25 | 0.84 | 1.67 | Yes | No | No |
| Sebastidae | *Sebastes diploproa* | ott1057059 | BI | 298 | 1.56 | 1.24 | 1.88 | Yes | No | No |
| Sebastidae | *Sebastes elongatus* | ott531065 | BI | 299 | 1.4 | 1.16 | 1.65 | Yes | No | No |
| Sebastidae | *Sebastes entomelas* | ott531068 | BI | 300 | 1.73 | 1.53 | 1.93 | Yes | No | No |
| Sebastidae | *Sebastes flavidus* | ott531059 | BI | 301 | 1.61 | 1.35 | 1.86 | Yes | No | No |
| Sebastidae | *Sebastes goodei* | ott531047 | BI | 302 | 1.42 | 1.23 | 1.62 | Yes | No | No |
| Sebastidae | *Sebastes helvomaculatus* | ott531044 | BI | 303 | 1.4 | 0.91 | 1.92 | Yes | No | No |
| Sebastidae | *Sebastes hopkinsi* | ott9589 | BI | 304 | 1.12 | 0.76 | 1.48 | Yes | No | No |
| Sebastidae | *Sebastes jordani* | ott9592 | BI | 305 | 1.21 | 0.85 | 1.57 | Yes | No | No |
| Sebastidae | *Sebastes levis* | ott9598 | BI | 306 | 1.17 | 0.89 | 1.44 | Yes | No | No |
| Sebastidae | *Sebastes melanops* | ott9604 | BI | 307 | 1.41 | 1.15 | 1.66 | Yes | No | No |
| Sebastidae | *Sebastes melanostomus* | ott9607 | BI | 308 | 1.52 | 1.21 | 1.84 | Yes | No | No |
| Sebastidae | *Sebastes mentella* | ott1088432 | BI | 309 | 1.56 | 1.17 | 1.95 | Yes | Yes | No |
| Sebastidae | *Sebastes miniatus* | ott9611 | BI | 310 | 1.69 | 1.47 | 1.9 | Yes | No | No |
| Sebastidae | *Sebastes mystinus* | ott9616 | BI | 311 | 1.85 | 1.67 | 2.01 | Yes | No | No |
| Sebastidae | *Sebastes norvegicus* | ott1088441 | BI | 312 | 1.16 | 0.75 | 1.56 | Yes | Yes | No |
| Sebastidae | *Sebastes ovalis* | ott582324 | BI | 313 | 1.35 | 0.93 | 1.75 | Yes | No | No |
| Sebastidae | *Sebastes paucispinis* | ott582321 | BI | 314 | 1.46 | 1.28 | 1.65 | Yes | No | No |
| Sebastidae | *Sebastes pinniger* | ott582318 | BI | 315 | 1.36 | 0.9 | 1.82 | Yes | No | No |
| Sebastidae | *Sebastes rastrelliger* | ott582315 | BI | 316 | 1.34 | 0.92 | 1.76 | Yes | No | No |
| Sebastidae | *Sebastes rosaceus* | ott212767 | BI | 317 | 1.25 | 0.94 | 1.56 | Yes | No | No |
| Sebastidae | *Sebastes rosenblatti* | ott582311 | BI | 318 | 1.4 | 1.08 | 1.73 | Yes | No | No |
| Sebastidae | *Sebastes rufus* | ott884513 | BI | 319 | 1.41 | 1.03 | 1.78 | Yes | No | No |
| Sebastidae | *Sebastes saxicola* | ott884510 | BI | 320 | 1.15 | 1.03 | 1.26 | Yes | No | No |
| Sebastidae | *Sebastes semicinctus* | ott795707 | BI | 321 | 1.4 | 1.09 | 1.72 | Yes | No | No |
| Sebastidae | *Sebastes serranoides* | ott884519 | BI | 322 | 1.66 | 1.43 | 1.89 | Yes | No | No |
| Sebastidae | *Sebastes viviparus* | ott99016 | BI | 323 | 1.32 | 1.03 | 1.6 | Yes | No | No |
| Sebastidae | *Sebastolobus altivelis* | ott811927 | P | 324 | 1.28 | 0.91 | 1.66 | No | Yes | No |

**Table S7** *Continued.*

| Family | Species | OTL | SM | F3 | $\beta_1$ | 2.5% C.I. | 97.5% C.I. | D1 | D2 | D3 |
|---|---|---|---|---|---|---|---|---|---|---|
| Serranidae | *Cephalopholis cruentata* | ott12880 | P | 232 | 1.29 | 0.68 | 1.89 | Yes | Yes | No |
| Serranidae | *Epinephelus aeneus* | ott306171 | P | 233 | 1.25 | 0.97 | 1.54 | Yes | No | No |
| Serranidae | *Epinephelus fasciatus* | ott534146 | P | 234 | 0.9 | 0.45 | 1.34 | Yes | No | Yes |
| Serranidae | *Epinephelus marginatus* | ott733897 | P | 235 | 1.32 | 0.76 | 1.89 | Yes | No | No |
| Serranidae | *Epinephelus tauvina* | ott218649 | P | 236 | 0.94 | 0.41 | 1.45 | Yes | Yes | No |
| Serranidae | *Mycteroperca tigris* | ott207413 | P | 237 | 1.54 | 1.05 | 2.05 | Yes | No | No |
| Serranidae | *Serranus tabacarius* | ott284266 | P | 238 | 1.29 | 1.2 | 1.41 | No | No | Yes |
| Serranidae | *Serranus tigrinus* | ott807897 | P | 239 | 1.26 | 1.16 | 1.36 | No | No | Yes |
| Serranidae | *Serranus tortugarum* | ott511782 | P | 240 | 1.29 | 1.19 | 1.41 | No | No | Yes |
| Siganidae | *Siganus canaliculatus* | ott199059 | S | 241 | 1.4 | 0.98 | 1.82 | Yes | Yes | No |
| Soleidae | *Solea solea** | ott710233 | P | 268 | 1.26 | 1.02 | 1.52 | Yes | Yes | Yes |
| Sparidae | *Acanthopagrus latus* | ott760733 | P | 242 | 1.26 | 0.57 | 1.94 | Yes | Yes | No |
| Sparidae | *Archosargus rhomboidalis* | ott724892 | P | 243 | 1.14 | 0.74 | 1.54 | Yes | Yes | No |
| Sparidae | *Sparidentex hasta* | ott845300 | P | 244 | 1.33 | 0.74 | 1.91 | Yes | Yes | No |
| Stromateidae | *Pampus chinensis* | ott916290 | P | 245 | 1.24 | 0.55 | 1.93 | Yes | Yes | No |
| Syngnathidae | *Entelurus aequoreus* | ott971459 | BP | 325 | 1.4 | 1.19 | 1.61 | No | Yes | No |
| Syngnathidae | *Hippocampus reidi* | ott630138 | BP | 326 | 1.35 | 0.88 | 1.83 | Yes | No | No |
| Syngnathidae | *Micrognathus crinitus* | ott3642321 | BP | 327 | 1.21 | 0.86 | 1.57 | Yes | Yes | No |
| Syngnathidae | *Nerophis ophidion* | ott806821 | BP | 328 | 1.31 | 1.13 | 1.5 | No | Yes | No |
| Syngnathidae | *Syngnathus acus* | ott774440 | BP | 329 | 1.34 | 1.18 | 1.51 | No | Yes | No |
| Syngnathidae | *Syngnathus floridae* | ott774435 | BP | 330 | 1.44 | 0.95 | 1.92 | Yes | Yes | No |
| Syngnathidae | *Syngnathus louisianae* | ott774414 | BP | 331 | 1.48 | 0.95 | 2 | Yes | Yes | No |
| Syngnathidae | *Syngnathus rostellatus* | ott774411 | BP | 332 | 1.42 | 1.26 | 1.58 | No | Yes | No |
| Syngnathidae | *Syngnathus scovelli* | ott251400 | BP | 333 | 1.37 | 0.95 | 1.79 | Yes | Yes | No |
| Syngnathidae | *Syngnathus typhle* | ott251396 | BP | 334 | 1.32 | 1.19 | 1.45 | No | Yes | No |
| Tetraodontidae | *Canthigaster rostrata* | ott484093 | D | 341 | 1.29 | 1.19 | 1.4 | No | No | Yes |
| Tetraodontidae | *Canthigaster valentini* | ott701127 | S | 342 | 0.98 | 0.65 | 1.31 | Yes | Yes | No |
| Trachichthyidae | *Hoplostethus atlanticus* | ott816600 | P | 9 | 1.12 | 0.91 | 1.33 | Yes | No | No |
| Trichiuridae | *Aphanopus carbo* | ott113465 | P | 246 | 1.32 | 0.74 | 1.91 | Yes | Yes | No |
| Trichodontidae | *Arctoscopus japonicus* | ott883978 | D | 247 | 1.29 | 1.2 | 1.39 | No | No | Yes |
| Zoarcidae | *Gymnelus viridis* | ott729337 | D | 248 | 1.34 | 0.8 | 1.88 | Yes | Yes | No |
| Zoarcidae | *Lycodes esmarkii* | ott841648 | D | 249 | 1.04 | 0.41 | 1.68 | Yes | Yes | No |
| Zoarcidae | *Lycodes eudipleurostictus* | ott905435 | D | 250 | 1.33 | 0.64 | 2.01 | Yes | Yes | No |
| Zoarcidae | *Lycodes frigidus* | ott539690 | D | 251 | 1.23 | 0.52 | 1.93 | Yes | Yes | No |
| Zoarcidae | *Lycodes pallidus* | ott178074 | D | 252 | 1.43 | 0.82 | 2.05 | Yes | Yes | No |
| Zoarcidae | *Lycodes polaris* | ott34255 | D | 253 | 1.31 | 0.97 | 1.64 | No | Yes | No |
| Zoarcidae | *Lycodes reticulatus* | ott752411 | D | 254 | 1.21 | 0.83 | 1.61 | No | Yes | No |
| Zoarcidae | *Lycodes vahlii* | ott178063 | D | 255 | 1.16 | 0.66 | 1.66 | Yes | Yes | No |
| Zoarcidae | *Melanostigma atlanticum* | ott3633033 | D | 256 | 1.1 | 0.63 | 1.58 | Yes | Yes | No |
| Zoarcidae | *Pachycara brachycephalum* | ott203179 | D | 257 | 1.27 | 0.9 | 1.63 | No | Yes | No |

The above results were obtained by combining the posterior distributions of parameter estimates from Models 1 (Table S3), 2 (Table S4), and 3 (Table S5) as described in the Materials and Methods Section. If a species was present in given dataset (i.e. fecundity, egg-volume, and/or egg-energy), we used the species-specific posterior distributions of parameter estimates as obtained using random effects. However, if the species was not present, we used the overall fixed-effects posterior distributions. Columns D1–D3 above indicate in which dataset a species was present. Only 9 species were present in all three datasets (marked with an *): *Abudefduf saxatilis*, *Cynoscion regalis*, *Engraulis mordax*, *Gadus morhua*, *Gasterosteus aculeatus*, *Ostorhinchus cyanosoma*, *Oxylebius pictus*, *Pseudopleuronectes americanus*, *Solea solea*. This is the same species list used to draw Fig. 3 in the main text.

**Table S8. Summary statistics for ordinary least squares regressions** between total clutch dry weight (g) and female mass (g) for three studies that measured egg dry weight, fecundity and female size. The equation is: Clutch dry weight = $\beta_0 \times$ Female mass$^{\beta_1}$. Model fitting was conducted by taking the natural logarithm from both sides of the equation (i.e. equivalent to equation 1 in Materials and Methods). $\beta_0$ = intercept; $\beta_1$ = Mean scaling exponent; $\beta_1$ **S.E.** = Standard error of mean scaling exponent; **n** = number of independent measurements for each species.

| **Species** | $\beta_0$ | $\beta_1$ | $\beta_1$ **S.E.** | **n** | **Refs** |
|---|---|---|---|---|---|
| *Pseudopleuronectes americanus* | 0.01 | 1.32 | 0.12 | 17 | (*152*) |
| *Clupea harengus* | 0.02 | 1.01 | 0.11 | 45 | (*243*) |
| *Pomacentrus coelestis* | 0 | 1.54 | 0.09 | 247 | (*157*) |

## References and Notes

1. R. E. Earll, in *National Oceanic and Atmospheric Administration Report of the United States Commissioner of Fisheries*, S. F. Baird, Ed. (Government printing office, San Diego, 1881), pp. 395–426.

2. R. J. H. Beverton, S. J. Holt, *On the Dynamics of Exploited Fish Populations* (Fishery Investigations Series II, Her Majesty's Stationery Office, London, 1957), vol. 19.

3. C. T. Marshall, C. L. Needle, A. Thorsen, O. S. Kjesbu, N. A. Yaragina, Systematic bias in estimates of reproductive potential of an Atlantic cod (*Gadus morhua*) stock: Implications for stock–recruit theory and management. *Can. J. Fish. Aquat. Sci.* **63**, 980–994 (2006). doi:10.1139/f05-270

4. M. A. Hixon, D. W. Johnson, S. M. Sogard, BOFFFFs: On the importance of conserving old-growth age structure in fishery populations. *ICES J. Mar. Sci.* **71**, 2171–2185 (2014). doi:10.1093/icesjms/fst200

5. J. N. Lim, A. M. Senior, S. Nakagawa, Heterogeneity in individual quality and reproductive trade-offs within species. *Evolution* **68**, 2306–2318 (2014). doi:10.1111/evo.12446 Medline

6. C. Birkeland, P. K. Dayton, The importance in fishery management of leaving the big ones. *Trends Ecol. Evol.* **20**, 356–358 (2005). doi:10.1016/j.tree.2005.03.015 Medline

7. S. E. Lester, B. S. Halpern, K. Grorud-Colvert, J. Lubchenco, B. I. Ruttenberg, S. D. Gaines, S. Airamé, R. R. Warner, Biological effects within no-take marine reserves: A global synthesis. *Mar. Ecol. Prog. Ser.* **384**, 33–46 (2009). doi:10.3354/meps08029

8. Materials and methods are available as supplementary materials.

9. R. Beldade, S. J. Holbrook, R. J. Schmitt, S. Planes, D. Malone, G. Bernardi, Larger female fish contribute disproportionately more to self-replenishment. *Proc. R. Soc. Lond. B Biol. Sci.* **279**, 2116–2121 (2012). doi:10.1098/rspb.2011.2433 Medline

10. I. van Rijn, Y. Buba, J. DeLong, M. Kiflawi, J. Belmaker, Large but uneven reduction in fish size across species in relation to changing sea temperatures. *Glob. Chang. Biol.* **23**, 3667–3674 (2017). doi:10.1111/gcb.13688 Medline

11. D. R. Barneche, M. Kulbicki, S. R. Floeter, A. M. Friedlander, J. Maina, A. P. Allen, Scaling metabolism from individuals to reef-fish communities at broad spatial scales. *Ecol. Lett.* **17**, 1067–1076 (2014). doi:10.1111/ele.12309 Medline

12. K. H. Andersen, J. L. Blanchard, E. A. Fulton, H. Gislason, N. S. Jacobsen, T. van Kooten, Assumptions behind size-based ecosystem models are realistic. *ICES J. Mar. Sci.* **73**, 1651–1655 (2016). doi:10.1093/icesjms/fsv211

13. R. Froese, C. Walters, D. Pauly, H. Winker, O. L. F. Weyl, N. Demirel, A. C. Tsikliras, S. J. Holt, A critique of the balanced harvesting approach to fishing. *ICES J. Mar. Sci.* **73**, 1640–1650 (2016). doi:10.1093/icesjms/fsv122

14. M. Heino, L. Baulier, D. S. Boukal, B. Ernande, F. D. Johnston, F. M. Mollet, H. Pardoe, N. O. Therkildsen, S. Uusi-Heikkila, A. Vainikka, R. Arlinghaus, D. J. Dankel, E. S. Dunlop, A. M. Eikeset, K. Enberg, G. H. Engelhard, C. Jorgensen, A. T. Laugen, S.

Matsumura, S. Nussle, D. Urbach, R. Whitlock, A. D. Rijnsdorp, U. Dieckmann, Can fisheries-induced evolution shift reference points for fisheries management? *ICES J. Mar. Sci.* **70**, 707–721 (2013). doi:10.1093/icesjms/fst077

15. D. J. Marshall, S. S. Heppell, S. B. Munch, R. R. Warner, The relationship between maternal phenotype and offspring quality: Do older mothers really produce the best offspring? *Ecology* **91**, 2862–2873 (2010). doi:10.1890/09-0156.1 Medline

16. C. J. Harvey, N. Tolimieri, P. S. Levin, Changes in body size, abundance, and energy allocation in rockfish assemblages of the northeast Pacific. *Ecol. Appl.* **16**, 1502–1515 (2006). doi:10.1890/1051-0761(2006)016[1502:CIBSAA]2.0.CO;2 Medline

17. M. J. Genner, D. W. Sims, A. J. Southward, G. C. Budd, P. Masterson, M. McHugh, P. Rendle, E. J. Southall, V. J. Wearmouth, S. J. Hawkins, Body size-dependent responses of a marine fish assemblage to climate change and fishing over a century-long scale. *Glob. Change Biol.* **16**, 517–527 (2010). doi:10.1111/j.1365-2486.2009.02027.x

18. R. A. Fritzsche, *Development of Fishes of the Mid-Atlantic Bight: An Atlas of Egg, Larval, and Juvenile Stages* (Fish and Wildlife Service, U.S. Department of the Interior, 1978), vol. 5.

19. C. M. Duarte, M. Alcaraz, To produce many small or few large eggs: A size-independent reproductive tactic of fish. *Oecologia* **80**, 401–404 (1989). doi:10.1007/BF00379043 Medline

20. M. A. Elgar, Evolutionary compromise between a few large and many small eggs: Comparative evidence in teleost fish. *Oikos* **59**, 283–287 (1990). doi:10.2307/3545546

21. H. G. Moser, *The Early Stages of Fishes in the California Current Region. Atlas No. 33* (Allen Press, Lawrence, KS, 1996).

22. S. Einum, I. A. Fleming, Does within-population variation in fish egg size reflect maternal influences on optimal values? *Am. Nat.* **160**, 756–765 (2002). Medline

23. K. Kasimatis, C. Riginos, A phylogenetic analysis of egg size, clutch size, spawning mode, adult body size, and latitude in reef fishes. *Coral Reefs* **35**, 387–397 (2016). doi:10.1007/s00338-015-1380-1

24. R. Froese, D. Pauly, FishBase (2017); www.fishbase.org.

25. R. Froese, J. T. Thorson, R. B. Reyes Jr., A Bayesian approach for estimating length-weight relationships in fishes. *J. Appl. Ichthyology* **30**, 78–85 (2014). doi:10.1111/jai.12299

26. D. R. Robertson, R. Collin, Inter- and intra-specific variation in egg size among reef fishes across the Isthmus of Panama. *Front. Ecol. Evol.* **2**, 84 (2015). doi:10.3389/fevo.2014.00084

27. E. Kamler, Parent–egg–progeny relationships in teleost fishes: An energetics perspective. *Rev. Fish Biol. Fish.* **15**, 399–421 (2005). doi:10.1007/s11160-006-0002-y

28. M. Lynch, Methods for the analysis of comparative data in evolutionary biology. *Evolution* **45**, 1065–1080 (1991). doi:10.1111/j.1558-5646.1991.tb04375.x Medline

29. M. Pagel, Inferring the historical patterns of biological evolution. *Nature* **401**, 877–884 (1999). doi:10.1038/44766 Medline

30. J. D. Hadfield, S. Nakagawa, General quantitative genetic methods for comparative biology: Phylogenies, taxonomies and multi-trait models for continuous and categorical characters. *J. Evol. Biol.* **23**, 494–508 (2010). doi:10.1111/j.1420-9101.2009.01915.x Medline

31. F. Michonneau, J. W. Brown, D. J. Winter, rotl: An R package to interact with the Open Tree of Life data. *Methods Ecol. Evol.* **7**, 1476–1481 (2016). doi:10.1111/2041-210X.12593

32. E. A. Housworth, E. P. Martins, M. Lynch, The phylogenetic mixed model. *Am. Nat.* **163**, 84–96 (2004). doi:10.1086/380570 Medline

33. B. Frédérich, L. Sorenson, F. Santini, G. J. Slater, M. E. Alfaro, Iterative ecological radiation and convergence during the evolutionary history of damselfishes (Pomacentridae). *Am. Nat.* **181**, 94–113 (2013). doi:10.1086/668599 Medline

34. R. Betancur-R, R. E. Broughton, E. O. Wiley, K. Carpenter, J. A. López, C. Li, N. I. Holcroft, D. Arcila, M. Sanciangco, J. C. Cureton Ii, F. Zhang, T. Buser, M. A. Campbell, J. A. Ballesteros, A. Roa-Varon, S. Willis, W. C. Borden, T. Rowley, P. C. Reneau, D. J. Hough, G. Lu, T. Grande, G. Arratia, G. Ortí, The tree of life and a new classification of bony fishes. *PLOS Curr.* **5**, 1 (2013). doi:10.1371/currents.tol.53ba26640df0ccaee75bb165c8c26288 Medline

35. A. Grafen, The phylogenetic regression. *Philos. Trans. R. Soc. Lond. B Biol. Sci.* **326**, 119–157 (1989). doi:10.1098/rstb.1989.0106 Medline

36. E. Paradis, J. Claude, K. Strimmer, APE: Analyses of phylogenetics and evolution in R language. *Bioinformatics* **20**, 289–290 (2004). doi:10.1093/bioinformatics/btg412 Medline

37. P. Bürkner, brms: An R package for Bayesian multilevel models using Stan. *J. Stat. Softw.* **80**, 1–28 (2017).

38. M. B. Hooten, N. T. Hobbs, A guide to Bayesian model selection for ecologists. *Ecol. Monogr.* **85**, 3–28 (2015). doi:10.1890/14-0661.1

39. A. Vehtari, A. Gelman, J. Gabry, loo: Efficient leave-one-out cross-validation and WAIC for Bayesian models (2016); https://github.com/jgabry/loo.

40. M. Gadgil, W. H. Bossert, Life historical consequences of natural selection. *Am. Nat.* **104**, 1–24 (1970). doi:10.1086/282637

41. D. A. Roff, An allocation model of growth and reproduction in fish. *Can. J. Fish. Aquat. Sci.* **40**, 1395–1404 (1983). doi:10.1139/f83-161

42. D. A. Roff, The evolution of life history parameters in teleosts. *Can. J. Fish. Aquat. Sci.* **41**, 989–1000 (1984). doi:10.1139/f84-114

43. M. J. Reiss, The allometry of reproduction: Why larger species invest relatively less in their offspring. *J. Theor. Biol.* **113**, 529–544 (1985). doi:10.1016/S0022-5193(85)80037-0

44. J. Kozłowski, J. Uchmanski, Optimal individual growth and reproduction in perennial species with indeterminate growth. *Evol. Ecol.* **1**, 214–230 (1987). doi:10.1007/BF02067552

45. J. Kozłowski, Optimal allocation of resources explains interspecific life-history patterns in animals with indeterminate growth. *Proc. R. Soc. London Ser. B* **263**, 559–566 (1996). doi:10.1098/rspb.1996.0084

46. G. B. West, J. H. Brown, B. J. Enquist, A general model for ontogenetic growth. *Nature* **413**, 628–631 (2001). doi:10.1038/35098076 Medline

47. E. L. Charnov, T. F. Turner, K. O. Winemiller, Reproductive constraints and the evolution of life histories with indeterminate growth. *Proc. Natl. Acad. Sci. U.S.A.* **98**, 9460–9464 (2001). doi:10.1073/pnas.161294498 Medline

48. E. L. Charnov, Reproductive effort, offspring size and benefit/cost ratios in the classification of life histories. *Evol. Ecol. Res.* **4**, 749–758 (2002).

49. N. P. Lester, B. J. Shuter, P. A. Abrams, Interpreting the von Bertalanffy model of somatic growth in fishes: The cost of reproduction. *Proc. R. Soc. Lond. B Biol. Sci.* **271**, 1625–1631 (2004). doi:10.1098/rspb.2004.2778 Medline

50. D. A. Roff, E. Heibo, L. A. Vøllestad, The importance of growth and mortality costs in the evolution of the optimal life history. *J. Evol. Biol.* **19**, 1920–1930 (2006). doi:10.1111/j.1420-9101.2006.01155.x Medline

51. C. Quince, P. A. Abrams, B. J. Shuter, N. P. Lester, Biphasic growth in fish I: Theoretical foundations. *J. Theor. Biol.* **254**, 197–206 (2008). doi:10.1016/j.jtbi.2008.05.029 Medline

52. L. Pecquerie, P. Petitgas, S. A. L. M. Kooijman, Modeling fish growth and reproduction in the context of the dynamic energy budget theory to predict environmental impact on anchovy spawning duration. *J. Sea Res.* **62**, 93–105 (2009). doi:10.1016/j.seares.2009.06.002

53. S. A. L. M. Kooijman, *Dynamic Energy Budget Theory for Metabolic Organisation* (Cambridge Univ. Press, 2010).

54. J. D. Arendt, Size-fecundity relationships, growth trajectories, and the temperature-size rule for ectotherms. *Evolution* **65**, 43–51 (2011). doi:10.1111/j.1558-5646.2010.01112.x Medline

55. S. Ohnishi, T. Yamakawa, H. Okamura, T. Akamine, A note on the von Bertalanffy growth function concerning the allocation of surplus energy to reproduction. *Fish Bull.* **110**, 223–229 (2012).

56. T. Brunel, B. Ernande, F. M. Mollet, A. D. Rijnsdorp, Estimating age at maturation and energy-based life-history traits from individual growth trajectories with nonlinear mixed-effects models. *Oecologia* **172**, 631–643 (2013). doi:10.1007/s00442-012-2527-1 Medline

57. E. L. Charnov, H. Gislason, J. G. Pope, Evolutionary assembly rules for fish life histories. *Fish Fish.* **14**, 213–224 (2013). doi:10.1111/j.1467-2979.2012.00467.x

58. D. S. Boukal, U. Dieckmann, K. Enberg, M. Heino, C. Jørgensen, Life-history implications of the allometric scaling of growth. *J. Theor. Biol.* **359**, 199–207 (2014). doi:10.1016/j.jtbi.2014.05.022 Medline

59. S. A. L. M. Kooijman, K. Lika, Comparative energetics of the 5 fish classes on the basis of dynamic energy budgets. *J. Sea Res.* **94**, 19–28 (2014). doi:10.1016/j.seares.2014.01.015

60. C. V. Minte-Vera, M. N. Maunder, J. M. Casselman, S. E. Campana, Growth functions that incorporate the cost of reproduction. *Fish. Res.* **180**, 31–44 (2016). doi:10.1016/j.fishres.2015.10.023

61. M. Jusup, T. Sousa, T. Domingos, V. Labinac, N. Marn, Z. Wang, T. Klanjšček, Physics of metabolic organization. *Phys. Life Rev.* **20**, 1–39 (2017). doi:10.1016/j.plrev.2016.09.001 Medline

62. M. Mangel, The inverse life-history problem, size-dependent mortality and two extensions of results of Holt and Beverton. *Fish Fish.* **18**, 1192–1200 (2017). doi:10.1111/faf.12247

63. I. M. Smallegange, H. Caswell, M. E. M. Toorians, A. M. de Roos, Mechanistic description of population dynamics using dynamic energy budget theory incorporated into integral projection models. *Methods Ecol. Evol.* **8**, 146–154 (2017). doi:10.1111/2041-210X.12675

64. B. E. Scott, G. Marteinsdottir, G. A. Begg, P. J. Wright, O. S. Kjesbu, Effects of population size/age structure, condition and temporal dynamics of spawning on reproductive output in Atlantic cod *Gadus morhua*. *Ecol. Modell.* **191**, 383–415 (2006). doi:10.1016/j.ecolmodel.2005.05.015

65. C. Jørgensen, Ø. Fiksen, State-dependent energy allocation in cod *Gadus morhua*. *Can. J. Fish. Aquat. Sci.* **63**, 186–199 (2006). doi:10.1139/f05-209

66. K. Enberg, C. Jørgensen, M. Mangel, Fishing-induced evolution and changing reproductive ecology of fish: The evolution of steepness. *Can. J. Fish. Aquat. Sci.* **67**, 1708–1719 (2010). doi:10.1139/F10-090

67. A. M. Eikeset, A. Richter, E. S. Dunlop, U. Dieckmann, N. C. Stenseth, Economic repercussions of fisheries-induced evolution. *Proc. Natl. Acad. Sci. U.S.A.* **110**, 12259–12264 (2013). doi:10.1073/pnas.1212593110 Medline

68. N. P. Lester, B. J. Shuter, P. Venturelli, D. Nadeau, Life-history plasticity and sustainable exploitation: A theory of growth compensation applied to walleye management. *Ecol. Appl.* **24**, 38–54 (2014). doi:10.1890/12-2020.1 Medline

69. K. H. Andersen, J. E. Beyer, Size structure, not metabolic scaling rules, determines fisheries reference points. *Fish Fish.* **16**, 1–22 (2015). doi:10.1111/faf.12042

70. A. M. Eikeset, E. S. Dunlop, M. Heino, G. Storvik, N. C. Stenseth, U. Dieckmann, Roles of density-dependent growth and life history evolution in accounting for fisheries-induced trait changes. *Proc. Natl. Acad. Sci. U.S.A.* **113**, 15030–15035 (2016). doi:10.1073/pnas.1525749113 Medline

71. F. Zimmermann, C. Jørgensen, Bioeconomic consequences of fishing-induced evolution: A model predicts limited impact on net present value. *Can. J. Fish. Aquat. Sci.* **72**, 612–624 (2015). doi:10.1139/cjfas-2014-0006

72. M. Hartvig, K. H. Andersen, J. E. Beyer, Food web framework for size-structured populations. *J. Theor. Biol.* **272**, 113–122 (2011). doi:10.1016/j.jtbi.2010.12.006 Medline

73. D. A. Carozza, D. Bianchi, E. D. Galbraith, The ecological module of BOATS-1.0: A bioenergetically constrained model of marine upper trophic levels suitable for studies of fisheries and ocean biogeochemistry. *Geosci. Model Dev.* **9**, 1545–1565 (2016). doi:10.5194/gmd-9-1545-2016

74. L. Blueweiss, H. Fox, V. Kudzma, D. Nakashima, R. Peters, S. Sams, Relationships between body size and some life history parameters. *Oecologia* **37**, 257–272 (1978). doi:10.1007/BF00344996 Medline

75. R. J. Wootton, in *Symposia of the Zoological Society of London* (Academic Press, 1979), vol. 44, pp. 133–159.

76. R. J. Wootton, Constraints in the evolution of fish life histories. *Neth. J. Zool.* **42**, 291–303 (1992).

77. A. Hayward, J. F. Gillooly, The cost of sex: Quantifying energetic investment in gamete production by males and females. *PLOS ONE* **6**, e16557 (2011). doi:10.1371/journal.pone.0016557 Medline

78. E. J. Dick, S. Beyer, M. Mangel, S. Ralston, A meta-analysis of fecundity in rockfishes (genus *Sebastes*). *Fish. Res.* **187**, 73–85 (2017). doi:10.1016/j.fishres.2016.11.009

79. T. S. Rass, *Geograficheskie parallelizmy v stroenii kostistykh ryb severnykh morei (Analogous or parallel variations in structure and development of fishes in Northern and Arctic seas)* (Moscow Society of Naturalists, MOIP, Moscow, 1941).

80. L. Fishelson, O. Gon, Comparative oogenesis in cardinal fishes (Apogonidae, Perciformes), with special focus on the adaptive structures of the egg envelopes. *Environ. Biol. Fishes* **81**, 397–414 (2008). doi:10.1007/s10641-007-9211-z

81. A. W. H. Turnpenny, R. N. Bamber, P. A. Henderson, Biology of the sand-smelt (*Atherina presbyter* Valenciennes) around Fawley power station. *J. Fish Biol.* **18**, 417–427 (1981). doi:10.1111/j.1095-8649.1981.tb03783.x

82. W. F. Thompson, J. B. Thompson, "The spawning of the grunion (*Leuresthes tenuis*)," in *Fish Bulletin* (California State Printing Office, Sacramento, CA, 1964), pp. 1–30.

83. A. Moresco, thesis, Fundação Universidade Federal do Rio Grande, Rio Grande, RS, Brazil (2006).

84. H. Kacem, L. Neifar, The reproductive biology of the grey triggerfish *Balistes capriscus* (Pisces: Balistidae) in the Gulf of Gabès (south-eastern Mediterranean Sea). *J. Mar. Biol. Assoc. U. K.* **94**, 1531–1537 (2014). doi:10.1017/S0025315414000824

85. E. T. Lang, G. R. Fitzhugh, Oogenesis and fecundity type of gray triggerfish in the Gulf of Mexico. *Mar. Coast. Fish.* **7**, 338–348 (2015). doi:10.1080/19425120.2015.1069428

86. L. Locatello, F. C. Neat, Reproductive allocation in *Aidablennius sphynx* (Teleostei, Blenniidae): Females lay more eggs faster when paired with larger males. *J. Exp. Zool. A Comp. Exp. Biol.* **303**, 922–926 (2005). doi:10.1002/jez.a.204 Medline

87. R. N. Gibson, I. A. Ezzi, The biology of the scaldfish, *Arnoglossus laterna* (Walbaum) on the west coast of Scotland. *J. Fish Biol.* **17**, 565–575 (1980). doi:10.1111/j.1095-8649.1980.tb02788.x

88. L. S. J. Hales, Distribution, abundance, reproduction, food habits, age, and growth of round scad, *Decapterus punctatus*, in the South Atlantic Bight. *Fish Bull.* **85**, 251–268 (1987).

89. P. B. Pinheiro, thesis, Universidade Federal de Pernambuco, Recife, PE, Brazil (2004).

90. J. de Ciechomski, M. C. Cassia, Reproducción y fecundidad del surel (*Trachurus picturatus australis*). *Rev. Invest. Dessaro. Pesq.* **2**, 39–45 (1980).

91. V. Caballero-Chávez, Reproducción y fecundidad del robalo blanco (*Centropomus undecimalis*) en el suroeste de Campeche. *Cienc. Pesq.* **19**, 35–45 (2011).

92. N. Veerappanm, M. Ramanathan, V. Ramaiyan, Maturation and spawning biology of *Amblygaster sirm* from Parangipettai, southeast coast of India. *J. Mar. Biol. Assoc. India* **39**, 89–96 (1997).

93. G. J. Óskarsson, C. T. Taggart, Fecundity variation in Icelandic summer-spawning herring and implications for reproductive potential. *ICES J. Mar. Sci.* **63**, 493–503 (2006). doi:10.1016/j.icesjms.2005.10.002

94. J. Blay, K. N. Eyeson, Observations on the reproductive biology of the shad, *Ethmalosa fimbriata* (Bowdich), in the coastal waters of Cape Coast, Ghana. *J. Fish Biol.* **21**, 485–496 (1982). doi:10.1111/j.1095-8649.1982.tb02854.x

95. C. F. Chubb, I. C. Potter, The reproductive biology and estuarine movements of the gizzard shad, *Nematalosa vlaminghi* (Munro). *J. Fish Biol.* **25**, 527–543 (1984). doi:10.1111/j.1095-8649.1984.tb04899.x

96. J. A. Rodriguez, J. A. Palacios, A. L. Chavarría, Fecundidad y epoca de desove del arenque hebra *Opisthonema libertate* (Pisces: Clupeidae) en el Golfo de Nicoya, Costa Rica. *Uniciencia* **3**, 87–93 (1986).

97. J. A. Rodriguez, J. A. Palacios, A. L. Chavarra, Epoca de maduracin y fecundidad de la sardina gallera *Opisthonema medirastre* y *O. bulleri* (Pisces: Clupeidae) en la Costa Pacfica Central de Costa Rica. *Rev. Biol. Trop.* **37**, 49–54 (1989).

98. B. L. P. Alvarez, thesis, Centro Interdisciplinario de Ciencias Marinas, Instituto Politecnico Nacional, La Paz, Mexico (2008).

99. P. Dalzell, Some aspects of the reproductive biology of *Spratelloides gracilis* (Schlegel) in the Ysabel Passage, Papua New Guinea. *J. Fish Biol.* **27**, 229–237 (1985). doi:10.1111/j.1095-8649.1985.tb04023.x

100. L. A. Cubillos, C. Alarcon, C. Castillo-Jordan, G. Claramunt, C. Oyarzun, S. Gacitua, Spatial and temporal changes in batch fecundity of common sardine and anchovy off central and southern Chile (2002–2007). *Cienc. Mar.* **37** (4B), 547–564 (2011). doi:10.7773/cm.v37i4B.1749

101. E. E. DeMartini, Spatial aspects of reproduction in buffalo sculpin, *Enophrys bison*. *Environ. Biol. Fishes* **3**, 331–336 (1978). doi:10.1007/BF00000524

102. J. N. Souza, M. T. D. Giamas, H. Vermulm Júnior, Tipo de desova e fecundidade em *Anchoviella lepidentostole* (Fowler, 1911). *Revista da Faculdade de Medicina Veterinária e Zootecnia da Universidade de São Paulo* **25**, 251–260 (1988). doi:10.11606/issn.2318-3659.v25i2p251-260

103. C. L. Petterson, Fecundity of the anchoveta (*Cetengraulis mysticetus*) in the Gulf of Panama. *Bull. I-ATCC* **VI**, 55–68 (1961).

104. M. Pájaro, G. J. Macchi, R. P. Sánchez, Fecundidad y frecuencia reproductiva de las poblaciones bonaerense y patagonica de anchoita argentina (*Engraulis anchoite*). *Rev. Invest. Dessaro. Pesq.* **11**, 19–38 (1997).

105. J. L. Laroche, S. L. Richardson, Reproduction of northern anchovy, *Engraulis mordax*, off Oregon and Washington. *Fish Bull.* **7**, 603–618 (1980).

106. A. P. De La Matta, B. B. Díaz, Fecundidad, frecuencia de desove y estado de madurez gonadal de la anchovieta peruana durante el invierno austral 2001. *Informativo del Instituto del Mar del Perú* **32**, 119–122 (2004).

107. J. B. Miñano, Estudio de la fecundidad y ciclo sexual de la anchovieta (*Engraulis ringens*, J.) en la zona de Chimbote. *Boletín del Instituto del Mar del Perú* **I**, 505–552 (1968).

108. M. R. Oliveira, A. L. S. Morais, M. M. Carvalho, A. M. Silva, J. T. A. X. Lima, N. T. Chellappa, S. Chellappa, Estratégias reprodutivas de sete espécies de peixes das águas costeiras do Rio Grande do Norte, Brasil. *HOLOS* **6**, 107–122 (2015). doi:10.15628/holos.2015.3601

109. A. W. May, Fecundity of Atlantic cod. *J. Fish. Res. Board Can.* **24**, 1531–1551 (1967). doi:10.1139/f67-127

110. G. Marteinsdottir, G. A. Begg, Essential relationships incorporating the influence of age, size and condition on variables required for estimation of reproductive potential in Atlantic cod *Gadus morhua*. *Mar. Ecol. Prog. Ser.* **235**, 235–256 (2002). doi:10.3354/meps235235

111. O. Kjesbu, P. Witthames, P. Solemdal, M. Greer Walker, Temporal variations in the fecundity of Arcto-Norwegian cod (*Gadus morhua*) in response to natural changes in food and temperature. *J. Sea Res.* **40**, 303–321 (1998). doi:10.1016/S1385-1101(98)00029-X

112. E. Oosthuizen, N. Daan, Egg fecundity and maturity of North Sea cod, *Gadus morhua*. *Neth. J. Sea Res.* **8**, 378–397 (1974). doi:10.1016/0077-7579(74)90006-4

113. J. R. G. Hislop, W. B. Hall, The fecundity of whiting, *Merlangius merlangus* (L.) in the North Sea, the Minch and at Iceland. *ICES J. Mar. Sci.* **36**, 42–49 (1974). doi:10.1093/icesjms/36.1.42

114. R. P. Sánchez, J. D. de Ciechomski, E. M. Acha, Estudios sobre reproducción y fecundidad de la polaca (*Micromesistius australis* Norma 1937) en el Mar Argentino. *Rev. Invest. Dessaro. Pesq.* **6**, 21–43 (1986).

115. R. J. Wootton, Fecundity of the three-spined stickleback, *Gasterosteus aculeatus* (L.). *J. Fish Biol.* **5**, 683–688 (1973). doi:10.1111/j.1095-8649.1973.tb04504.x

116. A. J. Crivelli, R. H. Britton, Life history adaptations of *Gasterosteus aculeatus* in a Mediterranean wetland. *Environ. Biol. Fishes* **18**, 109–125 (1987). doi:10.1007/BF00002599

117. R. J. Valenti, The embryology of the neon goby, *Gobiosoma oceanops*. *Copeia* **1972**, 477–482 (1972). doi:10.2307/1442919

118. V. G. Springer, A. J. McErlean, Spawning seasons and growth of the code goby, *Gobiosoma robustum* (Pisces: Gobiidae), in the Tampa Bay area. *Tulane Studies in Zoology* **9**, 87–98 (1961).

119. B. Lassig, Field observations on the reproductive behaviour of *Paragobiodon* spp. (Osteichthyes: Gobiidae) at Heron Island Great Barrier Reef. *Mar. Behav. Physiol.* **3**, 283–293 (1976). doi:10.1080/10236247609378517

120. M. C. Healey, Gonad development and fecundity of the sand goby, *Gobius minutus* Pallas. *Trans. Am. Fish. Soc.* **100**, 520–526 (1971). doi:10.1577/1548-8659(1971)100<520:GDAFOT>2.0.CO;2

121. H. E. Warfel, D. Merriman, The spawning habits, eggs and larvae of the sea raven, *Hemitripterus americanus*, in southern New England. *Copeia* **1944**, 197–205 (1944). doi:10.2307/1438673

122. E. E. DeMartini, M. E. Anderson, Comparative survivorship and life history of painted greenling (*Oxylebius pictus*) in Puget Sound, Washington and Monterey Bay, California. *Environ. Biol. Fishes* **5**, 33–47 (1980). doi:10.1007/BF00000948

123. T. L. O. Davis, Estimation of fecundity in barramundi, *Lates calcarifer* (Bloch), using an automatic particle counter. *Mar. Freshw. Res.* **35**, 111–118 (1984). doi:10.1071/MF9840111

124. T. C. V. Gesteira, C. T. C. Ivo, Estudo da reprodução e fecundidade do pargo, *Lutjanus purpureus* Poey, do norte e nordeste do Brasil. *Arquivos de Ciências do Mar.* **13**, 109–112 (1973).

125. R. D. Evans, G. R. Russ, J. P. Kritzer, Batch fecundity of *Lutjanus carponotatus* (Lutjanidae) and implications of no-take marine reserves on the Great Barrier Reef, Australia. *Coral Reefs* **27**, 179–189 (2008). doi:10.1007/s00338-007-0309-8

126. T. C. V. Gesteira, C. A. S. Rocha, Estudo sobre a fecundidade do ariacó, *Lutjanus synagris* (Linnaeus), da costa do Estado do Ceará (Brasil). *Arquivos de Ciências do Mar.* **16**, 19–22 (1976).

127. A. R. Mena-Loría, thesis, Centro de Investigación y de Estudios Avanzados del Instituto Politecnico Nacional, Instituto Politecnico Nacional, Mérida, Yucatá, Mexico (2009).

128. C. B. Grimes, G. R. Huntsman, Reproductive biology of the vermilion snapper, *Rhomboplites aurorubens*, from North Carolina and South Carolina. *Fish Bull.* **78**, 137–146 (1980).

129. J. L. Ross, J. V. Merriner, Reproductive biology of the blueline tilefish, *Caulolatilus microps*, off North Carolina and South Carolina. *Fish Bull.* **81**, 553–568 (1983).

130. J. F. Cerna, C. Oyarzún, Talla de primera madurez sexual y fecundidad parcial de la merluza común (*Merluccius gayi*, Guichenot 1848) del área de la pesquería industrial de la zona de Talcahuano, Chile. *Investig. Mar.* **26**, 31–40 (1998). doi:10.4067/S0717-71781998002600004

131. G. J. Macchi, M. Pájaro, M. D. Ehrlich, "Fecundidad parcial y frecuencia reproductiva del efectivo patagónico de merluza (*Merluccius hubbsi*)," in *INIDEP informe técnico* (Mar del Plata: Instituto Nacional de Investigación y Desarrollo Pesquero, INIDEP, Mar del Plata, Argentina, 2006), pp. 1–13.

132. S. Mehault, R. Domínguez-Petit, S. Cerviño, F. Saborido-Rey, Variability in total egg production and implications for management of the southern stock of European hake. *Fish. Res.* **104**, 111–122 (2010). doi:10.1016/j.fishres.2010.03.019

133. H. Kawase, Spawning behavior of the pygmy leatherjacket *Brachaluteres jacksonianus* (Monacanthidae) in southeastern Australia. *Ichthyol. Res.* **52**, 194–197 (2005). doi:10.1007/s10228-005-0272-8

134. H. Kawase, Reproductive ecology of the black reef leatherjacket, *Eubalichthys bucephalus* (Monacanthidae) in temperate Australia. *Ichthyol. Res.* **55**, 294–298 (2008). doi:10.1007/s10228-007-0028-8

135. G. W. Barlow, Spawning, eggs and larvae of the longnose filefish *Oxymonacanthus longirostris*, a monogamous coralivore. *Environ. Biol. Fishes* **20**, 183–194 (1987). doi:10.1007/BF00004953

136. H. Kawase, A. Nakazono, Embryonic and pre-larval development and otolith increments in two filefishes, *Rudarius ercodes* and *Paramonacanthus japonicus* (Monacanthidae). *Jpn. J. Ichthyol.* **41**, 57–63 (1994).

137. I. Mayer, S. E. Shackley, P. R. Witthames, Aspects of the reproductive biology of the bass, *Dicentrarchus labrax* L. II. Fecundity and pattern of oocyte development. *J. Fish Biol.* **36**, 141–148 (1990). doi:10.1111/j.1095-8649.1990.tb05590.x

138. C. F. Hickling, A contribution to the natural history of the English grey mullets [Pisces, Mugilidae]. *J. Mar. Biol. Assoc. U. K.* **50**, 609–633 (1970). doi:10.1017/S0025315400004914

139. M. S. J. Greeley, D. R. Calder, R. A. Wallace, Oocyte growth and development in the striped mullet, *Mugil cephalus*, during seasonal ovarian recrudescence: Relationship to fecundity and size at maturity. *Fish Bull.* **85**, 187–200 (1987).

140. H. P. Das, The fecundity of grey mullet *Mugil cephalus* L. along the Goa Coast. *Mahasagar* **10**, 79–82 (1977).

141. E. I. L. Silva, S. S. De Silva, Aspects of the biology of grey mullet, *Mugil cephalus* L., adult populations of a coastal lagoon in Sri Lanka. *J. Fish Biol.* **19**, 1–10 (1981). doi:10.1111/j.1095-8649.1981.tb05806.x

142. L. Alvarez-Lajonchere, The fecundity of mullet (Pisces, Mugilidae) from Cuban waters. *J. Fish Biol.* **21**, 607–613 (1982). doi:10.1111/j.1095-8649.1982.tb02864.x

143. E. H. Chan, T. E. Chua, Reproduction in the greenback grey mullet, *Liza subviridis* (Valenciennes, 1836). *J. Fish Biol.* **16**, 505–519 (1980). doi:10.1111/j.1095-8649.1980.tb03730.x

144. N. B. Marshall, Egg size in Arctic, Antarctic and deep-sea fishes. *Evolution* **7**, 328–341 (1953). doi:10.1111/j.1558-5646.1953.tb00096.x

145. E. S. Tereshchenko, The dynamics of population fecundity in Barents Sea capelin. *ICES J. Mar. Sci.* **59**, 976–982 (2002). doi:10.1006/jmsc.2002.1257

146. W. W. Morse, Reproduction of the summer flounder, *Paralichthys dentatus* (L.). *J. Fish Biol.* **19**, 189–203 (1981). doi:10.1111/j.1095-8649.1981.tb05823.x

147. G. J. Macchi, J. M. D. de Astarola, Ciclo reproductivo y fecundidad del lenguado, *Paralichthys patagonicus* Jordan, en Jordan y Goss 1889. *Rev. Invest. Dessaro. Pesq.* **10**, 73–83 (1996).

148. S. M. Sogard, S. A. Berkeley, R. Fisher, Maternal effects in rockfishes *Sebastes* spp.: A comparison among species. *Mar. Ecol. Prog. Ser.* **360**, 227–236 (2008). doi:10.3354/meps07468

149. T. B. Bagenal, Annual variations in fish fecundity. *J. Mar. Biol. Assoc. U. K.* **36**, 377–382 (1957). doi:10.1017/S0025315400016866

150. T. B. Bagenal, The breeding and fecundity of the Long Rough Dab *Hippoglossoides platessoides* (Fabr.) and the associated cycle in condition. *J. Mar. Biol. Assoc. U. K.* **36**, 339–375 (1957). doi:10.1017/S0025315400016854

151. A. D. Rijnsdorp, Changes in fecundity of female North Sea plaice (*Pleuronectes platessa* L.) between three periods since 1900. *ICES J. Mar. Sci.* **48**, 253–280 (1991). doi:10.1093/icesjms/48.3.253

152. L. J. Buckley, A. S. Smigielski, T. A. Halavik, E. M. Caldarone, B. R. Burns, G. C. Laurence, Winter flounder *Pseudopleuronectes americanus* reproductive success. II. Effects of spawning time and female size on size, composition and viability of eggs and larvae. *Mar. Ecol. Prog. Ser.* **74**, 125–135 (1991). doi:10.3354/meps074125

153. A. C. Gundersen, O. S. Kjesbu, K. H. Nedreaas, A. Stene, Fecundity of Northeast Arctic Greenland halibut (*Reinhardtius hippoglossoides*). *J. Northwest Atl. Fish. Sci.* **25**, 29–36 (1999). doi:10.2960/J.v25.a3

154. M. Arellano-Martínez, B. P. Ceballos-Vázquez, L. Hernández-Olalde, F. Galván-Magaña, Fecundity of Cortez angelfish *Pomacanthus zonipectus* (Teleostei: Pomacanthidae) off Espiritu Santo Island, Gulf of California, Mexico. *Cienc. Mar.* **32** (1A), 65–71 (2006). doi:10.7773/cm.v32i1.64

155. W. C. Cummings, thesis, University of Miami (1968).

156. K. D. Kavanagh, Larval brooding in the marine damselfish *Acanthochromis polyacanthus* (Pomacentridae) is correlated with highly divergent morphology, ontogeny and life-history traits. *Bull. Mar. Sci.* **66**, 321–337 (2000).

157. T. Kokita, Potential latitudinal variation in egg size and number of a geographically widespread reef fish, revealed by common-environment experiments. *Mar. Biol.* **143**, 593–601 (2003). doi:10.1007/s00227-003-1104-x

158. L. de L. G. Souza, S. Chellappa, H. de C. B. Gurgel, Biologia reprodutiva do peixe-donzela, *Stegastes fuscus* Cuvier, em arrecifes rochosos no nordeste do Brasil. *Rev. Bras. Zool.* **24**, 419–425 (2007). doi:10.1590/S0101-81752007000200020

159. O. Marcus, K. Kusemiju, Some aspects of the reproductive biology of the clupeid *Ilisha africana* (Bloch) off the Lagos Coast, Nigeria. *J. Fish Biol.* **25**, 679–689 (1984). doi:10.1111/j.1095-8649.1984.tb04914.x

160. S. F. Hildebrand, L. E. Cable, "Development and life history of fourteen teleostean fishes at Beaufort, N. C.," in *Bulletin of the United States Bureaus of Fisheries* (U.S. Government Printing Office, Washington, DC, 1930), pp. 383–488.

161. G. R. Shepherd, C. B. Grimes, Reproduction of weakfish, *Cynoscion regalis*, in the New York Bight and evidence for geographically specific life history characteristics. *Fish Bull.* **82**, 501–511 (1984).

162. F. G. Azeredo, thesis, Universidade Federal do Paraná, Curitiba, Brazil, (2014).

163. M. S. Love, G. E. McGowen, W. Westphal, R. J. Lavenberg, L. Martin, Aspects of the life history and fishery of the white croaker, *Genyonemus uneatus* (Sciaenidae), off California. *Fish Bull.* **82**, 179–198 (1984).

164. S. W. Ross, Reproduction of the banded drum, *Larimus fasciatus*, in North Carolina. *Fish Bull.* **82**, 227–235 (1984).

165. A. E. A. de M. Vazzoler, Sôbre a fecundidade e a desova da pescada-foguete. *Boletim do Instituto Oceanográfico da Universidade de São Paulo* **13**, 117–122 (1963).

166. A. E. A., de M. Vazzoler, *Micropogon furnieri*: Fecundidade e tipo de desova. *Boletim do Instituto Oceanográfico da Universidade de São Paulo* **18**, 27–32 (1970).

167. G. J. Macchi, M. E. Acha, C. A. Lasta, Desove y fecundidad de la corvina rubia *Micropogonias furnieri* Desmarest, 1823 del estuario del Río de la Plata, Argentina. *Bol. Inst. Esp. Oceanogr.* **12**, 99–113 (1996).

168. E. E. DeMartini, R. K. Fountain, Ovarian cycling frequency and batch fecundity in the queenfish, *Seriphus politus*: Attributes representative of serial spawning fishes. *Fish Bull.* **79**, 547–560 (1981).

169. M. Inoue, Y. Iwasaki, M. Aoki, T. Kouhei, H. Nagaoka, Some notes on the artificial fertilization and rearing of larvae in frigate mackerel and yellowfin tuna, cultured with seawater-acclimatized *Chlorella* as a basic diet. *J. Fac. Mar. Sci. Technol. Tokai Univ.* **8**, 27–36 (1974).

170. L. S. Emerson, M. G. Walker, P. R. Witthames, A stereological method for estimating fish fecundity. *J. Fish Biol.* **36**, 721–730 (1990). doi:10.1111/j.1095-8649.1990.tb04326.x

171. J. H. Finucane, L. A. Collins, H. A. Brusher, C. H. Saloman, Reproductive biology of king mackerel, *Scomberomorus cavalla*, from the southeastern United States. *Fish Bull.* **84**, 841–850 (1986).

172. C. T. C. Ivo, Sobre a fecundidade da cavala, *Scomberomorus cavalla* (Cuvier), em águas costeiras do Estado do Ceará (Brasil). *Arquivos de Ciências do Mar.* **14**, 87–89 (1974).

173. T. C. V. Gesteira, Sobre a reprodução e fecundidade da serra, *Scomberomorus maculatus* (Mitchill), no Estado do Ceará. *Arquivos de Ciências do Mar.* **12**, 117–122 (1972).

174. J. H. Farley, A. J. Williams, S. D. Hoyle, C. R. Davies, S. J. Nicol, Reproductive dynamics and potential annual fecundity of South Pacific albacore tuna (*Thunnus alalunga*). *PLOS ONE* **8**, e60577 (2013). doi:10.1371/journal.pone.0060577 Medline

175. G. W. Bane, *The Biology of the Yellowfin Tuna, (Bonnaterre) in the Gulf of Guinea* (Cornell Univ. Press, 1963), vol. 2.

176. R. E. J. Baglin, Reproductive biology of western Atlantic bluefin tuna. *Fish Bull.* **80**, 121–134 (1982).

177. D. R. Gunderson, Population biology of Pacific Ocean perch, *Sebastes alutus*, stocks in the Washington-Queen Charlotte Sound region, and their response to fishing. *Fish Bull.* **75**, 369–403 (1977).

178. L. A. Lisovenko, in *Soviet Fisheries Investigations in the Northeast Pacific—Sovetskie rybokhozyaistvennye issledovaniya v severo-vostochnoi chasti Tikhogo okeana [Translated from Russian]*, P. A. Moiseev, Ed. (Israel Program for Scientific Translations, Jerusalem, Israel, 1965), pp. 162–169.

179. A. C. DeLacy, C. R. Hitz, R. L. Dryfoos, "Maturation, gestation, and birth of rockfish (*Sebasrodes*) from Washington and adjacent waters," in *Fisheries Research Papers* (Washington Department of Fisheries, WA, 1964), pp. 51–67.

180. R. D. Stanley, A. R. Kronlund, Life history characteristics for silvergray rockfish (*Sebastes brevispinis*) in British Columbia waters and the implications for stock assessment and management. *Fish Bull.* **103**, 670–684 (2005).

181. P. M. Washington, R. Gowan, D. H. Ito, "A biological report on eight species of rockfish (*Sebastes* spp.) from Puget Sound, Washington" (Northwest and Alaska Fisheries Center Processed Report, National Oceanic and Atmospheric Administration, Seattle, WA, 1978), pp. 1–50.

182. M. S. Love, P. Morris, M. McCrae, R. Collins, "Life history aspects of 19 rockfish species (Scorpaenidae: *Sebastes*) from the Southern California Bight" (NOAA Technical Report NMFS, National Oceanic and Atmospheric Administration, Seattle, WA, 1978), pp. 1–38.

183. D. Benet, E. Dick, D. Pearson, "Life history aspects of greenspotted rockfish (*Sebastes chlorostictus*) from central California" (NOAA Technical Report NMFS, National Oceanic and Atmospheric Administration, Seattle, WA, USA, 2009), pp. 1–43.

184. J. B. Phillips, "Life history studies on ten species of rockfish (genus *Sebastodes*)," in *Fish Bulletin 126* (The Resources Agency of California, Department of Fish and Game, San Diego, CA, 1964), pp. 1–70.

185. G. W. Boehlert, W. H. Barss, P. B. Lamberson, Fecundity of the widow rockfish, *Sebastes entomelas*, off the coast of Oregon. *Fish Bull.* **80**, 881–884 (1982).

186. V. A. Snytko, L. A. Borets, "Some data on fecundity of ocean perch in Vancouver-Oregon region" (Fisheries Research Board of Canada, Translation Series No. 2505, Department of the Environment, Fisheries Research Board of Canada Biological Station, Nanaimo, BC, Canada, 1973), pp. 249–251.

187. S. J. Bobko, S. A. Berkeley, Maturity, ovarian cycle, fecundity, and age-specific parturition of black rockfish (*Sebastes melanops*). *Fish Bull.* **102**, 418–429 (2004).

188. S. G. Beyer, S. M. Sogard, C. J. Harvey, J. C. Field, Variability in rockfish (*Sebastes* spp.) fecundity: Species contrasts, maternal size effects, and spatial differences. *Environ. Biol. Fishes* **98**, 81–100 (2015). doi:10.1007/s10641-014-0238-7

189. J.-F. St-Pierre, Y. de Lafontaine, “Fecundity and reproduction characteristics of beaked redfish (*Sebastes fasciatus* and *S. mentella*) in the Gulf of St. Lawrence” (Canadian Technical Report of Fisheries and Aquatic Sciences, Division de la Productivitédes Océans Institut Maurice-Lamontagne Ministère des Pêches et Océans, Mont-Joli, Québec, Canada, 1995), pp. 1–32.

190. F. Saborido-Rey, R. Domínguez-Petit, D. Garabana, Þ. Sigurðsson, Fecundity of *Sebastes mentella* and *Sebastes norvegicus* in the Irminger Sea and Icelandic waters. *Cienc. Mar.* **41**, 107–124 (2015). doi:10.7773/cm.v41i2.2500

191. K. Schmidt, thesis, California State University, Monterey Bay, CA (2014).

192. D. F. S. Raitt, W. B. Hall, On the fecundity of the redfish, *Sebastes marinus* (L.). *ICES J. Mar. Sci.* **31**, 237–245 (1967). doi:10.1093/icesjms/31.2.237

193. M. S. Love, K. Johnson, Aspects of the life histories of grass rockfish, *Sebastes rastrelliger*, and brown rockfish, *S. auriculatus*, from southern California. *Fish Bull.* **87**, 100–109 (1998).

194. M. S. Love, W. V. Westphal, Growth, reproduction, and food habits of olive rockfish, *Sebastes serranoldes*, off central California. *Fish Bull.* **79**, 533–545 (1981).

195. K. V. Drevetnyak, A. I. Kluev, in *2005 ICES Annual Science Conference and Applications for Fisheries Science* (International Council for the Exploration of the Seas, ICES, Aberdeen, UK, 2005), pp. 1–11.

196. W. P. Nagelkerken, “Biology of the Graysby, *Epinephelus cruentatus*, of the coral reef of Curaçao,” in *Studies on the Fauna of Curaçao and Other Caribbean Islands* (The Hague, 1979), pp. 1–118.

197. A. Bouain, Y. Siau, Observations on the female reproductive cycle and fecundity of three species of groupers (*Epinephelus)* from the southeast Tunisian seashores. *Mar. Biol.* **73**, 211–220 (1983). doi:10.1007/BF00406890

198. R. Abu-Hakima, Aspects of the reproductive biology of the grouper, *Epinephelus tauvina* (Forskål), in Kuwaiti waters. *J. Fish Biol.* **30**, 213–222 (1987). doi:10.1111/j.1095-8649.1987.tb05746.x

199. V. Nóh-Quiñones, T. Brulé, C. Doralice, E. Peréz, in *Proceedings of the 63rd Gulf and Caribbean Fisheries Institute* (Gulf and Caribbean Fisheries Institute, Marathon, FL, 2010), pp. 207–210.

200. E. A. Wassef, H. A. A. Hady, Breeding biology of rabbitfish *Siganus canaliculatus* (Siganidae) in mid Arabian Gulf. *Fish. Res.* **33**, 159–166 (1997). doi:10.1016/S0165-7836(97)00075-1

201. P. R. Witthames, M. Greer Walker, M. T. Dinis, C. L. Whiting, The geographical variation in the potential annual fecundity of dover sole *Solea solea* (L.) from European shelf waters during 1991. *Neth. J. Sea Res.* **34**, 45–58 (1995). doi:10.1016/0077-7579(95)90013-6

202. R. Abu-Hakima, Some aspects of the reproductive biology of *Acanthopagrus* spp. (Family: Sparidae). *J. Fish Biol.* **25**, 515–526 (1984). doi:10.1111/j.1095-8649.1984.tb04898.x

203. P. Chavance, C. Flores-Coto, A. Sanchez-Iturbe, Early life history and adult biomass of sea bream in the Terminos Lagoon, southern Gulf of Mexico. *Trans. Am. Fish. Soc.* **113**, 166–177 (1984). doi:10.1577/1548-8659(1984)113<166:ELHAAB>2.0.CO;2

204. S. Pati, On the maturation and spawning of Chinese pomfret *Pampus chinensis* (Euphrasen) from Orissa coast. *Indian J. Fish.* **26**, 150–162 (1979).

205. R. B. Silveira, thesis, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, RS, Brazil (2005).

206. J. D. Brown, thesis, University of Florida, FL (1972).

207. W. Gladstone, M. Westoby, Growth and reproduction in *Canthigaster valentini* (Pisces, Tetraodontidae): A comparison of a toxic reef fish with other reef fishes. *Environ. Biol. Fishes* **21**, 207–221 (1988). doi:10.1007/BF00004864

208. J. A. Koslow, J. Bell, P. Virtue, D. C. Smith, Fecundity and its variability in orange roughy: Effects of population density, condition, egg size, and senescence. *J. Fish Biol.* **47**, 1063–1080 (1995). doi:10.1111/j.1095-8649.1995.tb06030.x

209. A. R. S. Vieira, thesis, Universidade de Lisboa, Lisboa, Portugal (2007).

210. N. Silverberg, H. M. Edenborn, G. Ouellet, P. Béland, Direct evidence of a mesopelagic fish, *Melanostigma atlanticum* (Zoarcidae) spawning within bottom sediments. *Environ. Biol. Fishes* **20**, 195–202 (1987). doi:10.1007/BF00004954

211. L. Smith, E. H. Atz, J. C. Tyler, Aspects of oral brooding in the cardinalfish *Cheilodipterus affinis* Poey (Apogonidae). *Am. Mus. Novit.* **2456**, 1–11 (1971).

212. D. A. Bengtson, R. C. Barkman, W. J. Berry, Relationships between maternal size, egg diameter, time of spawning season, temperature, and length at hatch of Atlantic silverside, *Menidia menidia*. *J. Fish Biol.* **31**, 697–704 (1987). doi:10.1111/j.1095-8649.1987.tb05272.x

213. E. R. Waite, “Fishes,” in *Australasian Antarctic Expedition 1911–1914. Scientific Reports. Series C—Zoology and Botany* (Government Print, Adelaide, SA, Australia, 1916), pp. 1–92.

214. M. Akazaki, Biological studies on a dragonet, *Synchiropus altivelis* (Temminck et Schlegel). *Jpn. J. Ichthyol.* **5**, 146–152 (1957).

215. M. Demir, On the eggs and larvae of the *Trachurus trachurus* (L.) and *Trachurus mediterraneus* (Stdhnr.) from the Sea of Marmara and the Black Sea. *Rapports et procès-verbaux des réunions Comission Internationale pour LExploration Scientifique de la Mer Méditerranée*. **16**, 317–320 (1961).

216. R. K. Pipe, P. Walker, The effect of temperature on development and hatching of scad, *Trachurus trachurus* L., eggs. *J. Fish Biol.* **31**, 675–682 (1987). doi:10.1111/j.1095-8649.1987.tb05270.x

217. P. Pappenheim, Die fische der Deutschen Südpolar-Expedition 1901-1903. I. die fische der Antarktis und Subantarktis. *Deutsche Südpolar Expedition* **13**, 161–182 (1912).

218. R. J. Mansueti, Eggs, larvae, and young of the hickory shad, *Alosa mediocris*, with comments on its ecology in the estuary. *Chesap. Sci.* **3**, 173–205 (1962). doi:10.2307/1350995

219. W. F. Hettler, Description of eggs, larvae, and early juveniles of Gulf menhaden, *Brevoortia patronus*, and comparisons with Atlantic menhaden, *B. tyrannus*, and yellowfin menhaden, *B. smithi*. *Fish Bull.* **82**, 85–95 (1984).

220. J. D. de Ciechomski, Development of the larvae and variations in the size of the eggs of the argentine anchovy, *Engraulis anchoita* Hubbs and Marini. *ICES J. Mar. Sci.* **30**, 281–290 (1966). doi:10.1093/icesjms/30.3.281

221. G. Marteinsdottir, K. W. Able, Geographic variation in egg size among populations of the mummichog, *Fundulus heteroclitus* (Pisces: Fundulidae). *Copeia* **1988**, 471–478 (1988). doi:10.2307/1445889

222. J. E. R. Cunningham, E. K. Balon, Early ontogeny of *Adinia xenica* (Pisces, Cyprinodontiformes): 1. The development of embryos in hiding. *Environ. Biol. Fishes* **14**, 115–166 (1985). doi:10.1007/BF00000821

223. J. R. G. Hislop, The influence of maternal length and age on the size and weight of the eggs and the relative fecundity of the haddock, *Melanogrammus aeglefinus*, in British waters. *J. Fish Biol.* **32**, 923–930 (1988). doi:10.1111/j.1095-8649.1988.tb05435.x

224. C. Geevarghese, P. A. John, Maturation and spawning of a gobiid fish, *Oligolepis acutipennis* (Cuv. & Val.), from the south-west coast of India. *J. Fish Biol.* **23**, 611–624 (1983). doi:10.1111/j.1095-8649.1983.tb02941.x

225. P. L. Colin, L. J. Bell, Aspects of the spawning of labrid and scarid fishes (Pisces: Labroidei) at Enewetak Atoll, Marshall Islands with notes on other families. *Environ. Biol. Fishes* **31**, 229–260 (1991). doi:10.1007/BF00000690

226. N. Raventos, S. Planes, Maternal size effects on early life traits of the temperate fish *Symphodus roissali*. *Aquat. Biol.* **4**, 1–6 (2008). doi:10.3354/ab00086

227. A. J. E. Lönnberg, "The fishes of the Swedish South Polar Expedition," in *Wissenschaftliche Ergebnisse der Schwedischen Südpolar-Expedition, 1901–1903* (Lithographisches Institut des Generalstabs, Stockholm, 1905), vol. 5, pp. 1–69.

228. C. M. Crawford, Development of eggs and larvae of the flounders *Rhombosolea tapirina* and *Ammotretis rostratus* (Pisces: Pleuronectidae). *J. Fish Biol.* **29**, 325–334 (1986). doi:10.1111/j.1095-8649.1986.tb04949.x

229. D. M. Buñag, Spawning habits of some Philippine tuna based on diameter measurements of the ovarian ova. *Philippine J. Fisheries* **4**, 145–177 (1956).

230. M. Demir, N. Demir, in *Proceedings and Technical Papers* (General Fisheries Council for the Mediterranean, 1961), pp. 213–218.

231. S. Kumne, "A note on the fertilization of bigeye tuna, *Parathunnus mebachi* (Kishinouye)," *Report of Nankai Regional Fisheries Research Laboratory* (no. 15) (1962), pp. 79–84.

232. L. R. Rivas, A preliminary report on the spawning of the western North Atlantic bluefin tuna (*Thunnus thynnus*) in the straits of Florida. *Bull. Mar. Sci. Gulf Caribb.* **4**, 302–322 (1954).

233. W. G. Pearcy, Egg masses and early developmental stages of the scorpaenid fish, *Sebastolobus*. *J. Fish. Res. Board Can.* **19**, 1169–1173 (1962). doi:10.1139/f62-079

234. N. Devauchelle, J. Alexandre, N. Le Corre, Y. Letty, Spawning of sole (*Solea solea*) in capivity. *Aquaculture* **66**, 125–147 (1987). doi:10.1016/0044-8486(87)90227-4

235. I. Braga Goncalves, I. Ahnesjö, C. Kvarnemo, The relationship between female body size and egg size in pipefishes. *J. Fish Biol.* **78**, 1847–1854 (2011). doi:10.1111/j.1095-8649.2011.02984.x Medline

236. J. R. Hunter, R. Leong, The spawning energetics of female northern anchovy, *Engraulis mordax*. *Fish Bull.* **79**, 215–230 (1981).

237. L. R. Castro, G. Claramunt, M. C. Krautz, A. Llanos-Rivera, P. Moreno, Egg trait variation in anchoveta *Engraulis ringens*: A maternal response to changing environmental conditions in contrasting spawning habitats. *Mar. Ecol. Prog. Ser.* **381**, 237–248 (2009). doi:10.3354/meps07922

238. S. S. Crawford, E. K. Balon, Alternative life histories of the genus *Lucania*: 3. An ecomorphological explanation of altricial (*L. parva*) and precocial (*L. goodei*) species. *Environ. Biol. Fishes* **41**, 369–402 (1994). doi:10.1007/BF02197855

239. J. R. G. Hislop, M. A. Bell, Observations on the size, dry weight and energy content of the eggs of some demersal fish species from British marine waters. *J. Fish Biol.* **31**, 1–20 (1987). doi:10.1111/j.1095-8649.1987.tb05209.x

240. D. A. Fletcher, R. J. Wootton, A hierarchical response to differences in ration size in the reproductive performance of female three-spined sticklebacks. *J. Fish Biol.* **46**, 657–668 (1995). doi:10.1111/j.1095-8649.1995.tb01102.x

241. N. Devauchelle, D. Coves, The characteristics of sea bass (*Dicentrarchus labrax*) eggs: Description, biochemical composition and hatching performances. *Aquat. Living Resour.* **1**, 223–230 (1988). doi:10.1051/alr:1988022

242. R. N. Finn, H. J. Fyhn, M. S. Evjen, Respiration and nitrogen metabolism of Atlantic halibut eggs (*Hippoglossus hippoglossus*). *Mar. Biol.* **108**, 11–19 (1991). doi:10.1007/BF01313466

243. R. G. Bradford, R. L. Stephenson, Egg weight, fecundity, and gonad weight variability among Northwest Atlantic herring (*Clupea harengus*) populations. *Can. J. Fish. Aquat. Sci.* **49**, 2045–2054 (1992). doi:10.1139/f92-227

244. D. R. Robertson, S. E. Swearer, K. Kaufmann, E. B. Brothers, Settlement vs. environmental dynamics in a pelagic-spawning reef fish at Caribbean Panama. *Ecol. Monogr.* **69**, 195–218 (1999). doi:10.1890/0012-9615(1999)069[0195:SVEDIA]2.0.CO;2

Science

# Fish reproductive-energy output increases disproportionately with body size

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**Big mamas matter for fish**

The theoretical relationship between reproduction and body size has assumed that total mass relates directly to fecundity, regardless of the number of individuals involved. This assumption leads to fisheries management practices that suggest that one large female fish can be replaced by several smaller females. However, this assumption is incorrect. Barneche *et al.* show that larger females are far more productive than the same weight's worth of smaller females. Management practices that ignore the value of large females could contribute to unexplained declines seen in some fish stocks.

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