

**TITLE**

Fish reproductive-energy output increases disproportionately with body size

**AUTHORS**

Barneche, DR; Robertson, DR; White, CR; et al.

**JOURNAL**

Science

**DEPOSITED IN ORE**

05 March 2019

This version available at

<http://hdl.handle.net/10871/36268>

---

**COPYRIGHT AND REUSE**

Open Research Exeter makes this work available in accordance with publisher policies.

**A NOTE ON VERSIONS**

The version presented here may differ from the published version. If citing, you are advised to consult the published version for pagination, volume/issue and date of publication

## **Fish reproductive-energy output increases disproportionately with body size**

Diego R. Barneche<sup>1,§</sup>, D. Ross Robertson<sup>2</sup>, Craig R. White<sup>1</sup>, Dustin J. Marshall<sup>1</sup>

<sup>1</sup>Centre for Geometric Biology / School of Biological Sciences, Monash University, Clayton Vic. 3800, Australia

<sup>2</sup>Smithsonian Tropical Research Institute, Balboa, Panama

<sup>§</sup>School of Life and Environmental Sciences, The University of Sydney, Sydney NSW 2006, Australia

**Keywords:** body size, ectotherms, life-history theory, geometric biology

**Correspondence to:** D.R.B.; Email: barnechedr@gmail.com; Phone: +61 (2) 9351 2779; Address: School of Life and Environmental Sciences, The University of Sydney, Sydney NSW 2006, Australia.

**Body size determines total reproductive-energy output. Most theories assume reproductive output is a fixed proportion of size 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 intra-specific mass scaling of reproductive-energy output. We show that larger mothers reproduce disproportionately more than smaller mothers, not only via 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 over-harvesting cause fish sizes to decline; our results provide quantitative estimates of how these declines impact 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 generally, 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 (i.e. it scales hyper-allometrically; 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 significance 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  $\times$  egg-volume  $\times$  egg-energy), with controls for phylogenetic non-independence, 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 ( $n = 1,366$  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 make 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  $\sim 7$  orders of magnitude. Fish fecundity scaled hyper-allometrically (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 hyper-allometric mass scaling of fecundity.

The volume of individual eggs varied from  $0.01 \text{ mm}^3$  to  $344.8 \text{ mm}^3$  and increased hypo-

allometrically with female body mass. A 1.2-fold increase in egg volume would be expected between a 0.3 and 1.3 kg female (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 hyper-allometric relationship between female mass and total reproductive volume (average scaling exponent = 1.21; 95% C.I.: 1.07 – 1.37; Table S6) (8).

Energy content of individual eggs varied from 0.07 J to 299.41 J. Egg-energy scaled hypo-allometrically with egg-volume (Fig. 2C). In other words, 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, hypo-allometric 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 hyper-allometrically with female body mass (mean scaling exponent = 1.29; 95% C.I.: 1.20 – 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 fifteen 2-kg female cod would produce the same number of eggs as one 30-kg female. Instead, we find that a single 30-kg female produces more eggs than ~28 females of 2-kg (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 higher than that of 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 hypo-allometric scaling (Fig. 3). Nevertheless, hyper-allometric reproductive scaling holds for the vast majority (95.0%) of species, is consistent for the subset of 9 species for which we had data on all three relationships of interest (Table S7), and for 3 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).

Our results also reveal 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 SST will decrease fish lengths by ~15% in the Mediterranean (10). Based on 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).

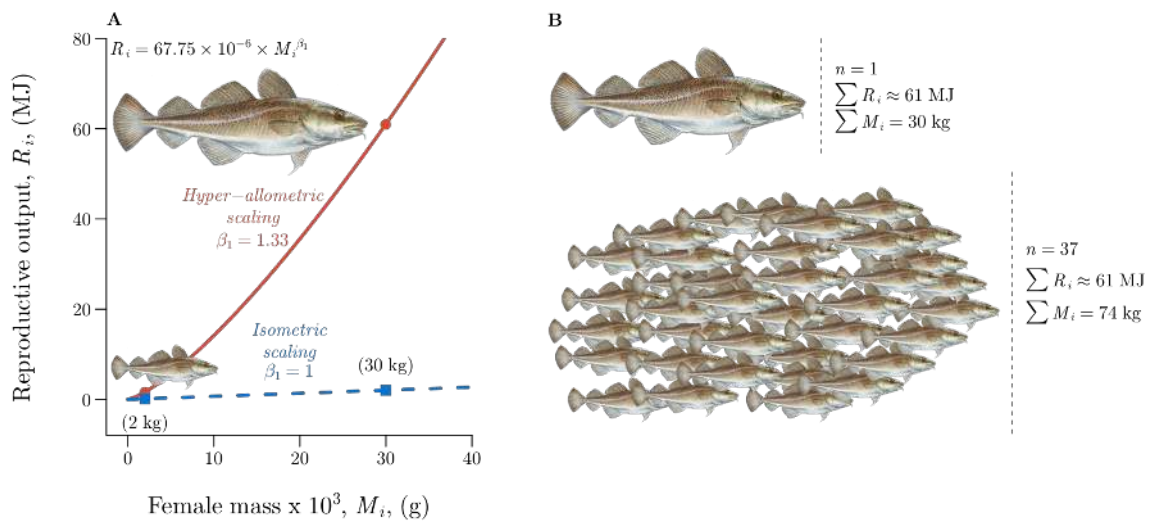
Here we show that hyper-allometry of reproductive-energy output is not the exception but the rule for marine fishes: a relationship that fisheries models now need to incorporate. For example, balanced harvesting approaches to fishing, which are subject of intense debate (12, 13), emphasize somatic productivity 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 over-harvesting and our findings suggest that such declines will massively reduce reproductive output and recruitment (14).

Because our results formally establish a general hyper-allometric 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

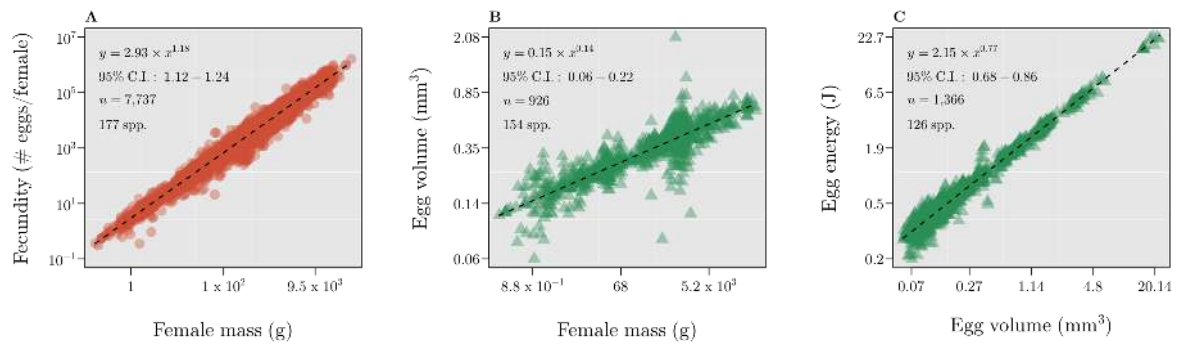
of theory do anticipate our findings (Table S1). However, even among studies that anticipate hyper-allometric scaling, some assume energy content of reproductive tissues stays constant with body size (Table S1) – our results contradict this core assumption for fishes at least.

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

## Figure Legends

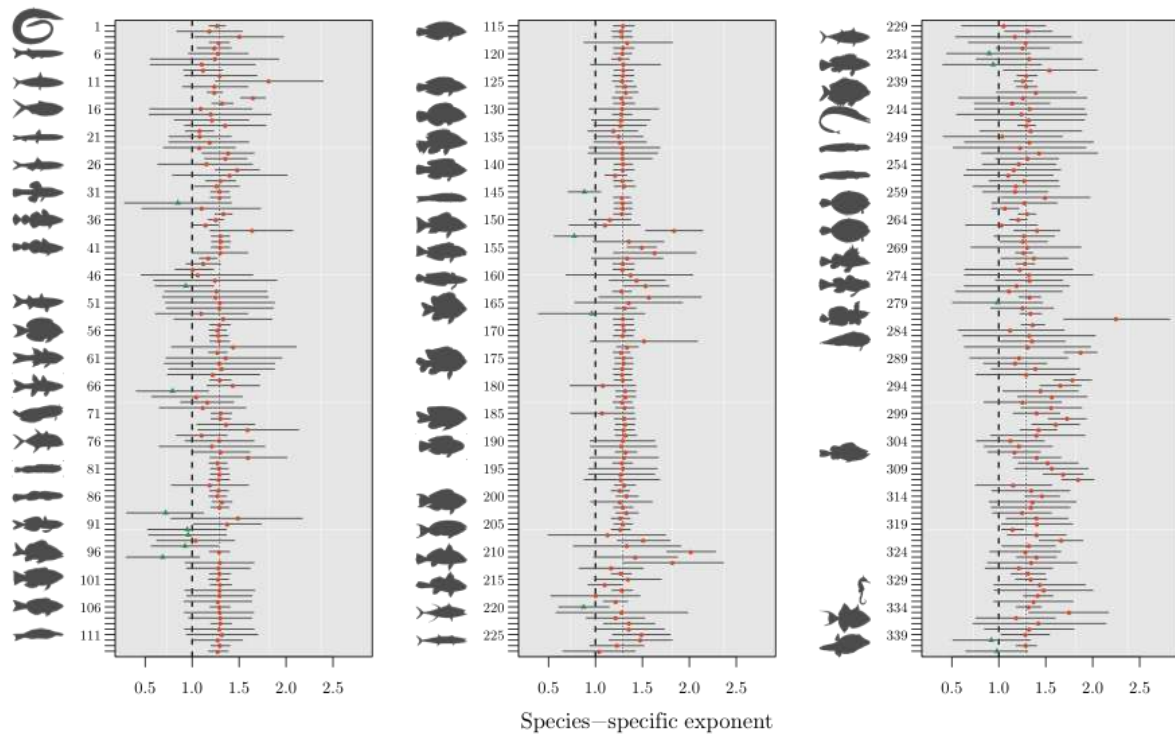


**Fig. 1. Hyper-allometric scaling of reproductive-energy output.** **A**, Hyper-allometric (Atlantic Cod *Gadus morhua*:  $\beta_1 = 1.33$ , solid red curve; see Table S7), and isometric mass scaling ( $\beta_1 = 1$ , dashed blue curve) relationships. Fish sizes span more than one order of magnitude in mass (2 kg vs. 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 hyper-allometric scaling differing in individual mass: the standing-biomass ratio differs by  $\sim 2.5$ -fold (i.e. 74 kg / 30 kg) from the larger individual to the population with smaller individuals. Cod illustration: ©Diane Rome Peebles.



**Fig. 2. Scaling relationships of fish reproductive traits.** **A**, Relationship between fecundity and female mass. Red circles represents 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). 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% C.I. = Bayesian credible intervals for the scaling exponent;  $n$  = the total number of observations. Dashed black lines depict average model fits. Species and family names, as well as data summary and contributions for the three models ( $\delta$ ) are respectively provided in Tables S3–5. Note both axes are logged.





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

## References and Notes

1. R. E. Earll, in *National Oceanic and Atmospheric Administration report of the 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* (Her Majesty's Stationery Office, London, UK, 1957), vol. XIX of *Fishery investigations, Series II*.
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. *Canadian Journal of Fisheries and Aquatic Sciences*. **63**, 980–994 (2006).
4. M. A. Hixon, D. W. Johnson, S. M. Sogard, BOFFFFs: On the importance of conserving old-growth age structure in fishery populations. *ICES Journal of Marine Science*. **71**, 2171 (2014).
5. J. N. Lim, A. M. Senior, S. Nakagawa, Heterogeneity in individual quality and reproductive trade-offs within species. *Evolution*. **68**, 2306–2318 (2014).
6. C. Birkeland, P. K. Dayton, The importance in fishery management of leaving the big ones. *Trends in Ecology & Evolution*. **20**, 356–358 (2005).
7. S. E. Lester *et al.*, Biological effects within no-take marine reserves: A global synthesis. *Marine Ecology Progress Series*. **384**, 33–46 (2009).
8. Materials and methods are available as supplementary materials.
9. R. Beldade *et al.*, Larger female fish contribute disproportionately more to self-replenishment. *Proceedings of the Royal Society of London B: Biological Sciences*. **279**, 2116–2121 (2012).
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. *Global Change Biology*. **23**, 3667–3674 (2017).
11. D. R. Barneche *et al.*, Scaling metabolism from individuals to reef-fish communities at

- broad spatial scales. *Ecology Letters*. **17**, 1067–1076 (2014).
12. K. H. Andersen *et al.*, Assumptions behind size-based ecosystem models are realistic. *ICES Journal of Marine Science*. **73**, 1651 (2016).
13. R. Froese *et al.*, A critique of the balanced harvesting approach to fishing. *ICES Journal of Marine Science*. **73**, 1640 (2016).
14. M. Heino *et al.*, Can fisheries-induced evolution shift reference points for fisheries management? *ICES Journal of Marine Science*. **70**, 707–721 (2013).
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).
16. C. J. Harvey, N. Tolimieri, P. S. Levin, Changes in body size, abundance, and energy allocation in rockfish assemblages of the Northeast Pacific. *Ecological Applications*. **16**, 1502–1515 (2006).
17. M. J. Genner *et al.*, Body size-dependent responses of a marine fish assemblage to climate change and fishing over a century-long scale. *Global Change Biology*. **16**, 517–527 (2010).

### References exclusive to Supplementary Material

18. R. A. Fritzsche, *Development of fishes of the mid-atlantic bight: An atlas of egg, larval and juveniles stages* (Fish; Wildlife Service U.S. Department of Interior, 1978), vol. V.
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).
20. M. A. Elgar, Evolutionary compromise between a few large and many small eggs: Comparative evidence in teleost fish. *Oikos*. **59**, 283–287 (1990).
21. H. G. Moser, *The early stages of fishes in the California current region. Atlas no. 33* (Allen Press, Lawrence, Kansas, USA, 1996).
22. S. Einum, I. A. Fleming, Does within-population variation in fish egg size reflect maternal influences on optimal values? *The American Naturalist*. **160**, 756–765 (2002).
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).
24. R. Froese, D. Pauly, FishBase (2017).
25. R. Froese, J. T. Thorson, R. B. Reyes, A Bayesian approach for estimating length-weight relationships in fishes. *Journal of Applied Ichthyology*. **30**, 78–85 (2014).
26. D. R. Robertson, R. Collin, Inter- and intra-specific variation in egg size among reef fishes across the Isthmus of Panama. *Frontiers in Ecology and Evolution*. **2**, 84 (2015).
27. E. Kamler, Parent–egg–progeny relationships in teleost fishes: An energetics perspective. *Reviews in Fish Biology and Fisheries*. **15**, 399 (2005).
28. M. Lynch, Methods for the analysis of comparative data in evolutionary biology. *Evolution*. **45**, 1065–1080 (1991).
29. M. Pagel, Inferring the historical patterns of biological evolution. *Nature*. **401**, 877–884 (1999).
30. J. D. Hadfield, S. Nakagawa, General quantitative genetic methods for comparative biology: Phylogenies, taxonomies and multi-trait models for continuous and categorical characters. *Journal of Evolutionary Biology*. **23**, 494–508 (2010).
31. F. Michonneau, J. W. Brown, D. J. Winter, *Methods in Ecology and Evolution*, in press, doi:10.1111/2041-210X.12593.
32. E. A. Housworth, E. P. Martins, M. Lynch, The phylogenetic mixed model. *The American Naturalist*. **163**, 84–96 (2004).
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). *The American Naturalist*. **181**, 94–113 (2013).
34. R. Betancur-R. *et al.*, The tree of life and a new classification of bony fishes. *PLOS Currents Tree of Life*. **1** (2013), doi:10.1371/currents.tol.53ba26640df0ccaee75bb165c8c26288.
35. A. Grafen, The phylogenetic regression. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*. **326**, 119–157 (1989).
36. E. Paradis, J. Claude, K. Strimmer, APE: Analyses of phylogenetics and evolution in R

- language. *Bioinformatics*. **20**, 289–290 (2004).
37. P. Bürkner, brms: An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software, Articles*. **80**, 1–28 (2017).
38. M. B. Hooten, N. T. Hobbs, A guide to Bayesian model selection for ecologists. *Ecological Monographs*. **85**, 3–28 (2015).
39. A. Vehtari, A. Gelman, J. Gabry, loo: Efficient leave-one-out cross-validation and WAIC for Bayesian models (2016), (available at <https://github.com/jgabry/loo>).
40. M. Gadgil, W. H. Bossert, Life historical consequences of natural selection. *The American Naturalist*. **104**, 1–24 (1970).
41. D. A. Roff, An allocation model of growth and reproduction in fish. *Canadian Journal of Fisheries and Aquatic Sciences*. **40**, 1395–1404 (1983).
42. D. A. Roff, The evolution of life history parameters in teleosts. *Canadian Journal of Fisheries and Aquatic Sciences*. **41**, 989–1000 (1984).
43. M. J. Reiss, The allometry of reproduction: Why larger species invest relatively less in their offspring. *Journal of theoretical Biology*. **113**, 529–544 (1985).
44. J. Kozłowski, J. Uchmanski, Optimal individual growth and reproduction in perennial species with indeterminate growth. *Evolutionary Ecology*. **1**, 214–230 (1987).
45. J. Kozłowski, Optimal allocation of resources explains interspecific life-history patterns in animals with indeterminate growth. *Proceedings of the Royal Society of London B: Biological Sciences*. **263**, 559–566 (1996).
46. G. B. West, J. H. Brown, B. J. Enquist, A general model for ontogenetic growth. *Nature*. **413**, 628–631 (2001).
47. E. L. Charnov, T. F. Turner, K. O. Winemiller, Reproductive constraints and the evolution of life histories with indeterminate growth. *Proceedings of the National Academy of Sciences*. **98**, 9460–9464 (2001).
48. E. L. Charnov, Reproductive effort, offspring size and benefit/cost ratios in the classification of life histories. **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. *Proceedings of the Royal Society of London B: Biological Sciences*. **271**, 1625–1631 (2004).
50. D. A. Roff, E. Heibo, V. L. A., The importance of growth and mortality costs in the evolution of the optimal life history. *Journal of Evolutionary Biology*. **19**, 1920–1930 (2006).
51. C. Quince, P. A. Abrams, B. J. Shuter, N. P. Lester, Biphasic growth in fish I: Theoretical foundations. *Journal of Theoretical Biology*. **254**, 197–206 (2008).
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. *Journal of Sea Research*. **62**, 93–105 (2009).
53. S. A. L. M. Kooijman, *Dynamic energy budget theory for metabolic organisation* (Cambridge University Press, 2010).
54. J. D. Arendt, Size-fecundity relationships, growth trajectories, and the temperature-size rule for ectotherms. *Evolution*. **65**, 43–51 (2011).
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. *Fishery Bulletin*. **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).
57. E. L. Charnov, H. Gislason, J. G. Pope, Evolutionary assembly rules for fish life histories. *Fish and Fisheries*. **14**, 213–224 (2013).
58. D. S. Boukal, U. Diechmann, K. Enberg, M. Heino, C. Jørgensen, Life-history implications of the allometric scaling of growth. *Journal of Theoretical Biology*. **359**, 199–207 (2014).
59. S. A. L. M. Kooijman, K. Lika, Comparative energetics of the 5 fish classes on the basis of dynamic energy budgets. *Journal of Sea Research*. **94**, 19–28 (2014).
60. C. V. Minte-Vera, M. N. Maunder, J. M. Casselman, S. E. Campana, Growth functions that

- incorporate the cost of reproduction. *Fisheries Research*. **180**, 31–44 (2016).
61. M. Jusup *et al.*, Physics of metabolic organization. *Physics of life reviews*. **20**, 1–39 (2017).
62. M. Mangel, The inverse life-history problem, size-dependent mortality and two extensions of results of Holt and Beverton. *Fish and Fisheries*. **18**, 1192–1200 (2017).
63. I. M. Smallegange, H. Caswell, M. E. M. Toorians, d. A. M., Mechanistic description of population dynamics using dynamic energy budget theory incorporated into integral projection models. *Methods in Ecology and Evolution*. **8**, 146–154 (2017).
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*. *Ecological Modelling*. **191**, 383–415 (2006).
65. C. Jørgensen, Ø. Fisker, State-dependent energy allocation in cod *Gadus morhua*. *Canadian Journal of Fisheries and Aquatic Sciences*. **63**, 186–199 (2006).
66. K. Enberg, C. Jørgensen, M. Mangel, Fishing-induced evolution and changing reproductive ecology of fish: The evolution of steepness. *Canadian Journal of Fisheries and Aquatic Sciences*. **67**, 1708–1719 (2010).
67. A. M. Eikeset, A. Richter, E. S. Dunlop, U. Dieckmann, N. C. Stenseth, Economic repercussions of fisheries-induced evolution. *Proceedings of the National Academy of Sciences*. **110**, 12259–12264 (2013).
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. *Ecological Applications*. **24**, 38–54 (2014).
69. K. H. Andersen, J. E. Beyer, Size structure, not metabolic scaling rules, determines fisheries reference points. *Fish and Fisheries*. **16**, 1–22 (2015).
70. A. M. Eikeset *et al.*, Roles of density-dependent growth and life history evolution in accounting for fisheries-induced trait changes. *Proceedings of the National Academy of Sciences of the United States of America*. **113**, 15030–15035 (2016).
71. F. Zimmermann, C. Jørgensen, Bioeconomic consequences of fishing-induced evolution:

- A model predicts limited impact on net present value. *Canadian Journal of Fisheries and Aquatic Sciences*. **72**, 612–624 (2015).
72. M. Hartvig, K. H. Andersen, J. E. Beyer, Food web framework for size-structured populations. *Journal of Theoretical Biology*. **272**, 113–122 (2011).
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. *Geoscientific Model Development*. **9**, 1545–1565 (2016).
74. L. Blueweiss *et al.*, Relationships between body size and some life history parameters. *Oecologia*. **37**, 257–272 (1978).
75. R. J. Wootton, in *Symposia of the zoological society of london* (Academic Press, 1979; <http://www.sidalc.net/cgi-bin/wxis.exe/?IsisScript=libri.xis&method=post&formato=2&cantidad=1&expresion=mfn=016476>), vol. 44, pp. 133–159.
76. W. R. J., Constraints in the evolution of fish life histories. *Netherlands Journal of Zoology*. **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**, 1–4 (2011).
78. E. J. Dick, S. Beyer, M. Mangel, S. Ralston, A meta-analysis of fecundity in rockfishes (genus *Sebastes*). *Fisheries Research*. **187**, 73–85 (2017).
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)* (MOIP, Moscow, Russia, 1941).
80. L. Fishelson, O. Gon, Comparative oogenesis in cardinal fishes (Apogonidae, Perciformes), with special focus on the adaptive structures of the egg envelopes. *Environmental Biology of Fishes*. **81**, 397–414 (2008).
81. A. W. H. Turnpenny, R. N. Bamber, P. A. Henderson, Biology of the sand-smelt (*Atherina presbyter* Valenciennes) around Fawley power station. *Journal of Fish Biology*. **18**, 417–427 (1981).
82. W. F. Thompson, J. B. Thompson, “The spawning of the grunion (*Leuresthes tenuis*),”



- Fish bulletin* (California State Printing Office, Sacramento, USA, 1964), pp. 1–30.
83. A. Moresco, thesis, Fundação Universidade Federal do Rio Grande; Fundação Universidade Federal do Rio Grande, Rio Grande, RS, Brasil (2006).
84. H. Kacem, L. Neifar, The reproductive biology of the grey triggerfish *Balistes capricus* (Pisces: Balistidae) in the Gulf of Gabès (south-eastern Mediterranean Sea). *Journal of the Marine Biological Association of the United Kingdom*. **94**, 1531–1537 (2014).
85. E. T. Lang, G. R. Fitzhugh, Oogenesis and fecundity type of gray triggerfish in the Gulf of Mexico. *Marine and Coastal Fisheries*. **7**, 338–348 (2015).
86. L. Locatello, F. C. Neat, Reproductive allocation in *Aidablennius sphyinx* (Teleostei, Blenniidae): Females lay more eggs faster when paired with larger males. *Journal of Experimental Zoology Part A: Comparative Experimental Biology*. **303A**, 922–926 (2005).
87. R. N. Gibson, I. A. Ezzi, The biology of the scaldfish, *Arnoglossus laterna* (Walbaum) on the west coast of Scotland. *Journal of Fish Biology*. **17**, 565–575 (1980).
88. L. S. J. Hales, Distribution, abundance, reproduction, food habits, age, and growth of round scad, *Decapterus punctatus*, in the South Atlantic Bight. *Fishery Bulletin*. **85**, 251–268 (1987).
89. P. B. Pinheiro, thesis, Universidade Federal de Pernambuco; Universidade Federal de Pernambuco, Recife, PE, Brasil (2004).
90. J. de Ciechomski, M. C. Cassia, Reproducción y fecundidad del surel (*Trachurus picturatus australis*). *Revista de Investigación y Desarrollo Pesquero*. **2**, 39–45 (1980).
91. V. Caballero-Chávez, Reproducción y fecundidad del robalo blanco (*Centropomus undecimalis*) en el suroeste de Campeche. *Ciencia Pesquera*. **19**, 35–45 (2011).
92. N. Veerappanm, M. Ramanathan, V. Ramaiyan, Maturation and spawning biology of *Amblygaster sirm* from Parangipettai, southeast coast of India. *Journal of the Marine Biological Association of 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 Journal of Marine Science*. **63**, 493–503

(2006).

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. *Journal of Fish Biology*. **21**, 485–496 (1982).
95. C. F. Chubb, I. C. Potter, The reproductive biology and estuarine movements of the gizzard shad, *Nematalosa vlaminghi* (Munro). *Journal of Fish Biology*. **25**, 527–543 (1984).
96. J. A. Rodríguez, J. A. Palacios, A. L. Chavarría, Fecundidad y época de desove del arenque hebra *Opisthonema libertate* (Pisces: Clupeidae) en el Golfo de Nicoya, Costa Rica. *Uniciencia*. **3**, 87–93 (1986).
97. J. A. Rodríguez, J. A. Palacios, A. L. Chavarría, Época de maduración y fecundidad de la sardina gallera *Opisthonema medirastre* y *O. bulleri* (Pisces: Clupeidae) en la Costa Pacífica Central de Costa Rica. *Revista de Biología Tropical*. **37**, 49–54 (1989).
98. B. L. P. Alvarez, thesis, Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico 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. *Journal of Fish Biology*. **27**, 229–237 (1985).
100. L. A. Cubillos *et al.*, Spatial and temporal changes in batch fecundity of common sardine and anchovy off central and southern Chile (2002–2007). *Ciencias Marinas*. **37**, 547–564 (2011).
101. E. E. DeMartini, Spatial aspects of reproduction in buffalo sculpin, *Enophrys bison*. *Environmental Biology of Fishes*. **3**, 331–336 (1978).
102. J. N. Souza, M. T. D. Giamas, H. Vermulm Júnior, Tipo de desova e fecundidade em *Anchoiella lepidentostole* (Fowler, 1911). *Revista da Faculdade de Medicina Veterinária e Zootecnia da Universidade de São Paulo*. **25**, 251–260 (1988).
103. C. L. Petterson, Fecundity of the anchoveta (*Cetengraulis mysticetus*) in the Gulf of Panama. *Bulletin of the Inter-American tropical tuna commission*. **VI**, 55–68 (1961).
104. M. Pájaro, G. J. Macchi, S. R. P., Fecundidad y frecuencia reproductiva de las poblaciones bonaerense y patagónica de anchoita argentina (*Engraulis anchoite*). *Revista de Inves-*

*tigación y Desarrollo Pesquero*. **11**, 19–38 (1997).

105. J. L. Laroche, S. L. Richardson, Reproduction of northern anchovy, *Engraulis mordax*, off Oregon and Washington. *Fishery Bulletin*. **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 *et al.*, Estratégias reprodutivas de sete espécies de peixes das águas costeiras do Rio Grande do Norte, Brasil. *HOLOS*. **6**, 107–122 (2015).

109. A. W. May, Fecundity of Atlantic cod. *Journal of the Fisheries Research Board of Canada*. **24**, 1531–1551 (1967).

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*. *Marine Ecology Progress Series*. **235**, 235–256 (2002).

111. O. Kjesbu, P. Witthames, P. Solemdal, M. G. Walker, Temporal variations in the fecundity of Arcto-Norwegian cod (*Gadus morhua*) in response to natural changes in food and temperature. *Journal of Sea Research*. **40**, 303–321 (1998).

112. E. Oosthuizen, N. Daan, Egg fecundity and maturity of North Sea cod, *Gadus morhua*. *Netherlands Journal of Sea Research*. **8**, 378–397 (1974).

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 Journal of Marine Science*. **36**, 42 (1974).

114. R. P. Sánchez, J. D. de Ciechowski, E. M. Acha, Estudios sobre reproducción y fecundidad de la polaca (*Micromesistius australis* Norma 1937) en el Mar Argentino. *Revista de Investigación y Desarrollo Pesquero*. **6**, 21–43 (1986).

115. R. J. Wootton, Fecundity of the three-spined stickleback, *Gasterosteus aculeatus* (L.). *Journal of Fish Biology*. **5**, 683–688 (1973).

116. A. J. Crivelli, R. H. Britton, Life history adaptations of *Gasterosteus aculeatus* in a

- Mediterranean wetland. *Environmental Biology of Fishes*. **18**, 109–125 (1987).
117. R. J. Valenti, The embryology of the neon goby, *Gobiosoma oceanops*. *Copeia*. **1972**, 477–482 (1972).
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. *Marine Behaviour and Physiology*. **3**, 283–293 (1976).
120. M. C. Healey, Gonad development and fecundity of the sand goby, *Gobius minutus* Pallas. *Transactions of the American Fisheries Society*. **100**, 520–526 (1971).
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).
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. *Environmental Biology of Fishes*. **5**, 33–47 (1980).
123. T. L. O. Davis, Estimation of fecundity in barramundi, *Lates calcarifer* (Bloch), using an automatic particle counter. *Marine and Freshwater Research*. **35**, 111–118 (1984).
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).
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, México (2009).

128. C. B. Grimes, G. R. Huntsman, Reproductive biology of the vermilion snapper, *Rhomboplites aurorubens*, from North Carolina and South Carolina. *Fishery Bulletin*. **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. *Fishery Bulletin*. **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. *Investigaciones Marinas*. **26**, 31–40 (1998).

131. G. J. Macchi, M. Pájaro, M. D. Ehrlich, “Fecundidad parcial y frecuencia reproductiva del efectivo patagónico de merluza (*Merluccius hubbsi*),” *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. *Fisheries Research*. **104**, 111–122 (2010).

133. H. Kawase, Spawning behavior of the pygmy leatherjacket *Brachaluteres jacksonianus* (Monacanthidae) in southeastern Australia. *Ichthyological Research*. **52**, 194–197 (2005).

134. H. Kawase, Reproductive ecology of the black reef leatherjacket, *Eubalichthys bucephalus* (Monacanthidae) in temperate Australia. *Ichthyological Research*. **55**, 294–298 (2008).

135. G. W. Barlow, Spawning, eggs and larvae of the longnose filefish *Oxymonacanthus longirostris*, a monogamous coralivore. *Environmental Biology of Fishes*. **20**, 183–194 (1987).

136. H. Kawase, A. Nakazono, Embryonic and pre-larval development and otolith increments in two filefishes, *Rudarius ercodes* and *Paramonacanthus japonicus* (Monacanthidae). *Japanese Journal of Ichthyology*. **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. *Journal of*

- Fish Biology*. **36**, 141–148 (1990).
138. C. F. Hickling, A contribution to the natural history of the English grey mullets [Pisces, Mugilidae]. *Journal of the Marine Biological Association of the United Kingdom*. **50**, 609–633 (1970).
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. *Fishery Bulletin*. **85**, 187–200 (1987).
140. H. P. Das, The fecundity of grey mullet *Mugil cephalus* L. along the Goa Coast. *Mahasagar*. **10** (1977) (available at <http://ijs.nio.org/index.php/msagar/article/view/1451>).
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. *Journal of Fish Biology*. **19**, 1–10 (1981).
142. L. Alvarez-Lajonchere, The fecundity of mullet (Pisces, Mugilidae) from Cuban waters. *Journal of Fish Biology*. **21**, 607–613 (1982).
143. E. H. Chan, T. E. Chua, Reproduction in the greenback grey mullet, *Liza subviridis* (Valenciennes, 1836). *Journal of Fish Biology*. **16**, 505–519 (1980).
144. N. B. Marshall, Egg size in Arctic, Antarctic and deep-sea fishes. *Evolution*. **7**, 328–341 (1953).
145. E. S. Tereshchenko, The dynamics of population fecundity in Barents Sea capelin. *ICES Journal of Marine Science*. **59**, 976 (2002).
146. W. W. Morse, Reproduction of the summer flounder, *Paralichthys dentatus* (L.). *Journal of Fish Biology*. **19**, 189–203 (1981).
147. G. J. Macchi, J. M. D. de Astarola, Ciclo reproductivo y fecundidad del lenguado, *Paralichthys patagonicus* Jordan, en Jordan y Goss 1889. *Revista de Investigación y Desarrollo Pesquero*. **10**, 73–83 (1996).
148. S. M. Sogard, S. A. Berkeley, R. Fisher, Maternal effects in rockfishes *Sebastes* spp.: A comparison among species. *Marine Ecology Progress Series*. **360**, 227–236 (2008).
149. T. B. Bagenal, Annual variations in fish fecundity. *Journal of the Marine Biological As-*

*sociation of the United Kingdom*. **36**, 377–382 (1957).

150. T. B. Bagenal, The breeding and fecundity of the Long Rough Dab *Hippoglossoides platessoides* (Fabr.) and the associated cycle in condition. *Journal of the Marine Biological Association of the United Kingdom*. **36**, 339–375 (1957).

151. A. D. Rijnsdorp, Changes in fecundity of female North Sea plaice (*Pleuronectes platessa* L.) between three periods since 1900. *ICES Journal of Marine Science*. **48**, 253 (1991).

152. L. J. Buckley *et al.*, Winter flounder *Pseudopleuronectes americanus* reproductive success. II. Effects of spawning time and female size on size, composition and viability of eggs and larvae. *Marine Ecology Progress Series*. **74**, 125–135 (1991).

153. A. C. Gundersen, O. S. Kjesbu, K. H. Nedreaas, A. Stene, Fecundity of Northeast Arctic Greenland halibut (*Reinhardtius hippoglossoides*). *Journal of Northwest Atlantic Fishery Science*. **25**, 29–36 (1999).

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. *Ciencias Marinas*. **32**, 65–71 (2006).

155. W. C. Cummings, thesis, University of Miami; University Microfilms, Inc., Ann Arbor, Michigan, USA (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. *Bulletin of Marine Science*. **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. *Marine Biology*. **143**, 593–601 (2003).

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. *Revista Brasileira de Zoologia*. **24**, 419–425 (2007).

159. O. Marcus, K. Kusemiju, Some aspects of the reproductive biology of the clupeid *Ilisha*

- africana* (Bloch) off the Lagos Coast, Nigeria. *Journal of Fish Biology*. **25**, 679–689 (1984).
160. S. F. Hildebrand, L. E. Cable, “Development and life history of fourteen teleostean fishes at Beaufort, N. C.” *Bulletin of the United States Bureaus of Fisheries* (United States Government Printing Office, Washington, DC, USA, 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. *Fishery Bulletin*. **82**, 501–511 (1984).
162. F. G. Azeredo, “Fecundidade e tamanho ideal de captura em peixes Sciaenidae (Teleostei),” *Honours thesis* (Universidade Federal do Paraná, Curitiba, Brasil, 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 unneatus* (Sciaenidae), off California. *Fishery Bulletin*. **82**, 179–198 (1984).
164. S. W. Ross, Reproduction of the banded drum, *Larimus fasciatus*, in North Carolina. *Fishery Bulletin*. **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. *Boletín. Instituto Español de Oceanografía*. **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. *Fishery Bulletin*. **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. *Journal of the Faculty of Marine Science and Technol-*



ogy Tokai University. **8**, 27–36 (1974).

170. L. S. Emerson, M. G. Walker, P. R. Witthames, A stereological method for estimating fish fecundity. *Journal of Fish Biology*. **36**, 721–730 (1990).

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. *Fishery Bulletin*. **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**, 1–16 (2013).

175. G. W. Bane, *The biology of the yellowfin tuna, Thunnus albacares (Bonnaterre) in the Gulf of Guinea* (Cornell University Press, Ithaca, NY, USA, 1963), vol. 2.

176. R. E. J. Baglin, Reproductive biology of western Atlantic bluefin tuna. *Fishery Bulletin*. **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. *Fishery Bulletin*. **75**, 369–403 (1977).

178. L. A. Lisovenko, in *Soviet fisheries investigations in the Northeast Pacific / Sovetskie rybokhozyaistvennyye 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,” *Fisheries research papers* (Washington Department of Fisheries, Washington USA, 1964), pp. 51–67.

180. R. D. Stanley, A. R. Kronlund, Life history characteristics for silvergray rockfish (*Se-*

*bastes brevispinis*) in British Columbia waters and the implications for stock assessment and management. *Fishery Bulletin*. **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; Atmospheric Administration, Seattle, WA, USA, 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; Atmospheric Administration, Seattle, WA, USA, 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; Atmospheric Administration, Seattle, WA, USA, 2009), pp. 1–43.

184. J. B. Phillips, “Life history studies on ten species of rockfish (genus *Sebastes*),” *Fish bulletin* (The Resources Agency of California - Department of Fish; Game, San Diego, CA, USA, 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. *Fishery Bulletin*. **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* (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*). *Fishery Bulletin*. **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. *Environmental Biology of Fishes*. **98**, 81–100 (2015).

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 techni-*

- cal report of fisheries and aquatic sciences* (Division de la Productivité des 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. *Ciencias Marinas*. **41**, 107–124 (2015).
191. K. Schmidt, thesis, California State University; California State University, Monterey Bay (2014).
192. D. F. S. Raitt, W. B. Hall, On the fecundity of the redfish, *Sebastes marinus* (L.). *ICES Journal of Marine Science*. **31**, 237 (1967).
193. M. S. Love, K. Johnson, Aspects of the life histories of grass rockfish, *Sebastes rastrelliger*, and brown rockfish, *S. auriculatus*, from southern California. *Fishery Bulletin*. **87**, 100–109 (1998).
194. M. S. Love, W. V. Westphal, Growth, reproduction, and food habits of olive rockfish, *Sebastes serranoides*, off central California. *Fishery Bulletin*. **79**, 533–545 (1981).
195. K. V. Drevetnyak, A. I. Kluev, in *2005 ices annual science conference and applications for fisheries science* (Aberdeen, UK, 2005), pp. 1–11.
196. W. P. Nagelkerken, “Biology of the Graysby, *Epinephelus cruentatus*, of the coral reef of Curaçao,” *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. *Marine Biology*. **73**, 211–220 (1983).
198. R. Abu-Hakima, Aspects of the reproductive biology of the grouper, *Epinephelus tauvina* (Forskål), in Kuwaiti waters. *Journal of Fish Biology*. **30**, 213–222 (1987).
199. V. Nólh-Quiñones, T. Brulé, C. Doralice, E. Pérez, in *Proceedings of the 63rd Gulf and Caribbean Fisheries Institute* (San Juan, Puerto Rico, 2010), pp. 207–210.
200. E. A. Wassef, H. A. A. Hady, Breeding biology of rabbitfish *Siganus canaliculatus*

- (Siganidae) in mid Arabian Gulf. *Fisheries Research*. **33**, 159–166 (1997).
201. P. R. Witthames, M. G. 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. *Netherlands Journal of Sea Research*. **34**, 45–58 (1995).
202. R. Abu-Hakima, Some aspects of the reproductive biology of *Acanthopagrus* spp. (Family: Sparidae). *Journal of Fish Biology*. **25**, 515–526 (1984).
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. *Transactions of the American Fisheries Society*. **113**, 166–177 (1984).
204. S. Pati, Maturation and spawning of Chinese pomfret *Pampus chinensis* (Euphrasen) from Orissa coast. *Indian Journal of Fisheries*. **26** (1979) (available at <http://epubs.icar.org.in/ejournal/index.php/IJF/article/view/12045>).
205. R. B. Silveira, thesis, Pontificia Universidade Católica do Rio Grande do Sul, Porto Alegre, RS, Brasil (2005).
206. J. D. Brown, thesis, University of Florida; University of Florida, FL, USA (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. *Environmental Biology of Fishes*. **21**, 207–221 (1988).
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. *Journal of Fish Biology*. **47**, 1063–1080 (1995).
209. A. R. S. Vieira, thesis, Universidade de Lisboa; Universidade de Lisboa, Lisboa, Portugal (2007).
210. N. Silverberg, H. M. Edenborn, G. Ouellet, P. Béland, Direct evidence of a mesopelagic fish, *Melanostigma atlanticum* (Zoaridae) spawning within bottom sediments. *Environmental Biology of Fishes*. **20**, 195–202 (1987).
211. L. Smith, E. H. Atz, J. C. Tyler, Aspects of oral brooding in the cardinalfish *Cheilodipterus affinis* Poey (Apogonidae). *American Museum Novitates*. **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*. *Journal of Fish Biology*. **31**, 697–704 (1987).

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

214. M. Akazaki, Biological studies on a dragonet, *Synchiropus altivelis* (Temminck et Schlegel). *Japanese Journal of Ichthyology*. **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 Commission Internationale pour L'Exploration 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. *Journal of Fish Biology*. **31**, 675–682 (1987).

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. *Chesapeake Science*. **3**, 173–205 (1962).

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*. *Fishery Bulletin*. **82**, 85–95 (1984).

220. J. D. de Ciechowski, Development of the larvae and variations in the size of the eggs of the argentine anchovy, *Engraulis anchoita* Hubbs and Marini. *ICES Journal of Marine Science*. **30**, 281 (1966).

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).

222. J. E. R. Cunningham, E. K. Balon, Early ontogeny of *Adinia xenica* (Pisces, Cyprinodon-

- tiformes): 1. The development of embryos in hiding. *Environmental Biology of Fishes*. **14**, 115–166 (1985).
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. *Journal of Fish Biology*. **32**, 923–930 (1988).
224. C. Geevarghese, P. A. John, Maturation and spawning of a gobiid fish, *Oligolepis acutipennis* (Cuv. & Val.), from the south-west coast of India. *Journal of Fish Biology*. **23**, 611–624 (1983).
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. *Environmental Biology of Fishes*. **31**, 229–260 (1991).
226. N. Raventos, S. Planes, Maternal size effects on early life traits of the temperate fish *Symphodus roissali*. *Aquatic Biology*. **4**, 1–6 (2008).
227. A. J. E. Lönnberg, The fishes of the Swedish South Polar Expedition. *Wissenschaftliche Ergebnisse der Schwedischen Südpolar-Expedition, 1901-1903 / 5*. **5**, 1–69 (1905).
228. C. M. Crawford, Development of eggs and larvae of the flounders *Rhombosolea tapirina* and *Ammotretis rostratus* (Pisces: Pleuronectidae). *Journal of Fish Biology*. **29**, 325–334 (1986).
229. D. M. Buñag, Spawning habits of some Philippine tuna based on diameter measurements of the ovarian ova. *The Philippine Journal of 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*. **15**, 79–84 (1962).
232. L. R. Rivas, A preliminary report on the spawning of the western North Atlantic bluefin tuna (*Thunnus thynnus*) in the straits of Florida. *Bulletin of Marine Science of the Gulf and Caribbean*. **4**, 302–322 (1954).
233. W. G. Pearcy, Egg masses and early developmental stages of the scorpaenid fish, *Sebas-*

- tolobus*. *Journal of the Fisheries Research Board of Canada*. **19**, 1169–1173 (1962).
234. N. Devauchelle, J. Alexandre, N. Le Corre, Y. Letty, Spawning of sole (*Solea solea*) in captivity. *Aquaculture*. **66**, 125–147 (1987).
235. I. Braga Goncalves, I. Ahnesjö, C. Kvarnemo, The relationship between female body size and egg size in pipefishes. *Journal of Fish Biology*. **78**, 1847–1854 (2011).
236. J. R. Hunter, R. Leong, The spawning energetics of female northern anchovy, *Engraulis mordax*. *Fishery Bulletin*. **79**, 215–230 (1981).
237. L. R. Castro, Claramunt G., 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. *Marine Ecology Progress Series*. **381**, 237–248 (2009).
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. *Environmental Biology of Fishes*. **41**, 369–402 (1994).
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. *Journal of Fish Biology*. **31**, 1–20 (1987).
240. D. A. Fletcher, R. J. Wootton, A hierarchical response to differences in ration size in the reproductive performance of female three-spined sticklebacks. *Journal of Fish Biology*. **46**, 657–668 (1995).
241. N. Devauchelle, D. Coves, The characteristics of sea bass (*Dicentrarchus labrax*) eggs: Description, biochemical composition and hatching performances. *Aquatic Living Resources*. **1**, 223–230 (1988).
242. R. N. Finn, H. J. Fyhn, M. S. Evjen, Respiration and nitrogen metabolism of Atlantic halibut eggs (*Hippoglossus hippoglossus*). *Marine Biology*. **108**, 11–19 (1991).
243. R. G. Bradford, R. L. Stephenson, Egg weight, fecundity, and gonad weight variability among Northwest Atlantic herring (*Clupea harengus*) populations. *Canadian Journal of Fisheries and Aquatic Sciences*. **49**, 2045–2054 (1992).
244. D. R. Robertson, S. E. Swearer, K. Kaufmann, E. B. Brothers, Settlement vs. environ-

mental dynamics in a pelagic-spawning reef fish at Caribbean Panama. *Ecological Monographs*. **69**, 195–218 (1999).

## **Acknowledgments**

We would like to thank M Elgar for kindly sharing his life-history database with us. We thank L Chapman, B Comerford, and the Interlibrary Loan Team at Monash University for helping D.R.B. and D.J.M. compile the datasets. Many people expended a significant amount of effort by providing eggs to D.R.R. for calorimetric measurements. These included V Scholey, A Oliver, E Schultz, H Munehara, P Sikkell, L McKelvey, D Hoesey, J Elliott. Numerous people assisted with laboratory analyses of egg content: A Cedeno, E Pena, C Guerra. People assisting with field collections: U Schober, A Cedeno, S Swearer, L Gutierrez, E Paredes, C Guerra. We also thank OJ Luiz for comments on previous versions of the manuscript. **Funding:** This study was funded by the Centre for Geometric Biology, Monash University. **Author Contributions:** D.R.B., C.R.W. and D.J.M. conceived the study, D.R.B. and D.J.M. compiled data, D.R.R. collected the egg size and energy content data, D.J.M. compiled data on egg dry weight, D.R.B. compiled, standardized and analyzed the data, and wrote the first draft of the manuscript. All authors contributed substantially to revisions. **Competing interests:** None declared. **Data accessibility:** All data, metadata, and R code can be downloaded and cited as: “D. R. Barneche, D. R. Robertson, C. R. White, D. J. Marshall, Data and code from: Fish reproductive-energy output increases disproportionately with body size. *GitHub repository* (available at <https://github.com/dbarneche/fishFecundity>), doi: 10.5281/zenodo.1213118”.



## Supplementary Materials for

### **Fish reproductive-energy output increases disproportionately with body size**

Diego R. Barneche\*, D. Ross Robertson, Craig R. White, Dustin J. Marshall

\*Corresponding author. Email: [barnechedr@gmail.com](mailto:barnechedr@gmail.com)

#### **This PDF file includes:**

Materials and Methods

Fig. S1

Tables S1 to S8

## 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  $\times$  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,  $V$  ( $\text{mm}^3$ ;  $V = (4/3) \times \pi \times r^3$ , 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 ( $\text{g cm}^{-b}$ ) 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  $-80^\circ\text{C}$  freezer. Subsequently each sample was lyophilized for at least 8 h and stored in a desiccator at  $-80^\circ\text{C}$ . 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 ( $\sim 24^\circ\text{C}$ ) in an air-conditioned room. After this the energy density (Joules  $\text{mg}^{-1}$  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)  $\times$  (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  $\sim 25$  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:

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

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  $\times$  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  $\ln \epsilon$  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 ( $\sigma [\ln\gamma_{0spp}]$ ,  $\sigma [\ln\gamma_{0phy}]$ ,  $\sigma [\gamma_{1spp}]$  and  $\sigma [\ln\epsilon]$ ) 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 ( $\sigma [\ln\gamma_{0phy}]$ ) by a variance-covariance matrix,  $A$ , which was obtained from the tips of the phylogeny (i.e.  $\sigma [\ln\gamma_{0phy}] * A$ , 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.  $\sigma^2 [\ln\gamma_{0phy}] / (\sigma^2 [\ln\gamma_{0phy}] + \sigma^2 [\ln\gamma_{0spp}] + \sigma^2 [\ln\epsilon])$ ). 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.  $(15,000 - 7,500) \times 4 = 30,000$ ). 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.  $(6,000 - 3,000) \times 4 = 12,000$ ). Number of chains were tuned in order to achieve model convergence (i.e.  $\hat{R} = 1$ ).

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

$$\text{Fecundity} = \beta_{0M1} \text{Mass}^{\beta_{1M1}} \quad (2)$$

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

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

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,

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

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

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

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).



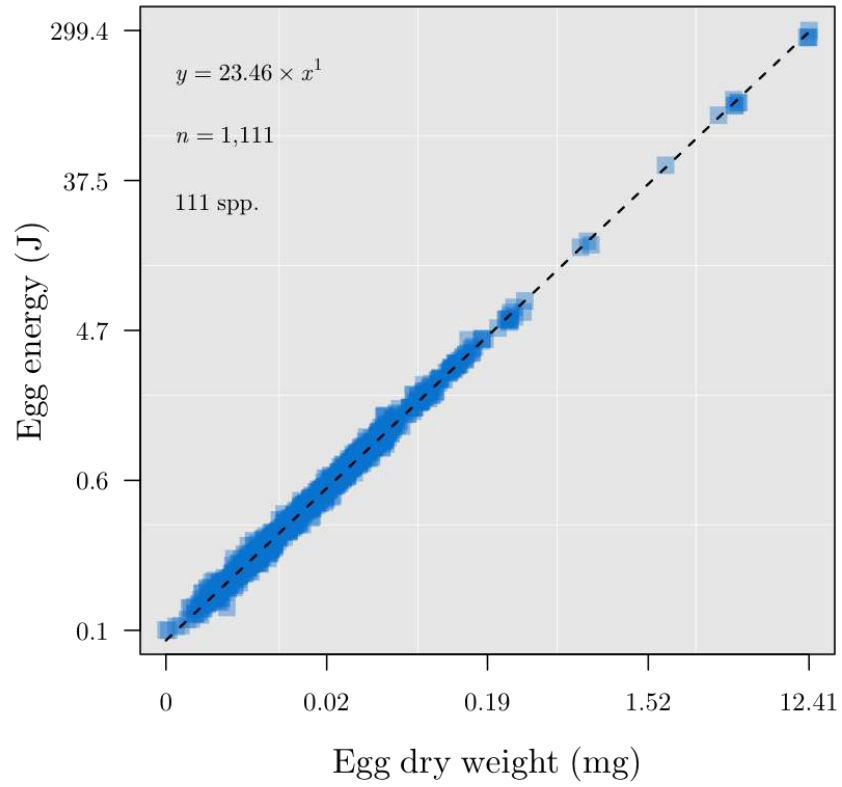
## Calculating reproductive loss: MPAs and ocean warming

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  $\propto \text{mass}^{1.18 \times 0.77} \approx \text{mass}^{0.91}$  (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 <i>et al.</i> (2001)	Life history	Isometric	Assumption	(46)
Charnov <i>et al.</i> (2001)	Life history	Isometric	Assumption	(47)
Charnov (2002)	Life history	Isometric	Assumption	(48)
Lester <i>et al.</i> (2004)	Life history	Isometric*	Assumption	(49)
Roff <i>et al.</i> (2006)	Life history	Isometric	Assumption	(50)
Quince <i>et al.</i> (2008; FGO)	Life history	Isometric*	Assumption	(51)
Quince <i>et al.</i> (2008; VGO)	Life history	Hyperallometric*	Prediction	(51)
Pecquerie <i>et al.</i> (2009)	Life history	Isometric	Assumption	(52)
Koojiman (2010)	Life history	Isometric*	Assumption	(53)
Arendt (2011)	Life history	Isometry	Assumption	(54)
Onishi <i>et al.</i> (2012)	Life history	Hyperallometric	Assumption	(55)
Brunel <i>et al.</i> (2013)	Life history	Isometric	Assumption	(56)
Charnov <i>et al.</i> (2013)	Life history	Isometric	Assumption	(57)
Boukal <i>et al.</i> (2014)	Life history	Isometric*	Assumption	(58)
Koojiman and Lika (2014)	Life history	Isometric*	Assumption	(59)
Minte-Vera <i>et al.</i> (2016)	Life history	Isometric*	Assumption	(60)
Jusup <i>et al.</i> (2017)	Life history	Isometric	Assumption	(61)
Mangel (2017)	Life history	Hyperallometric	Assumption	(62)
Smallegange <i>et al.</i> (2017)	Life history	Isometric	Assumption	(63)
Beverton and Holt (1957)	Fisheries	Isometric	Assumption	(2)
Scott <i>et al.</i> (2006)	Fisheries	Hyperallometric	Assumption	(64)
Jørgensen and Fisker (2006)	Fisheries	Isometric*	Assumption	(65)
Enberg <i>et al.</i> (2010)	Fisheries	Isometric	Assumption	(66)
Eikeset <i>et al.</i> (2013)	Fisheries	Isometric	Assumption	(67)
Lester <i>et al.</i> (2014)	Fisheries	Isometric	Assumption	(68)
Andersen and Beyer (2015)	Fisheries	Isometric	Assumption	(69)
Eikeset <i>et al.</i> (2016)	Fisheries	Isometric	Assumption	(70)
Andersen <i>et al.</i> (2016)	Fisheries	Isometric	Assumption	(12)
Zimmerman and Jørgensen (2016)	Fisheries	Isometric	Assumption	(71)
Hartvig <i>et al.</i> (2011)	Food web	Isometric	Assumption	(72)
Carozza <i>et al.</i> (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<sup>3</sup>.

<b>Study</b>	<b>Interspecific/intraspecific</b>	<b>Relationship</b>	<b>Allometric Scaling</b>	<b>Refs</b>
Blueweiss <i>et al.</i> (1978)	Inter-	Size-fecundity	Hypo-	(74)
Blueweiss <i>et al.</i> (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 <i>et al.</i> (2014)	Intra-	Size-fecundity	Hyper-	(4)
Dick <i>et al.</i> (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	<i>Leptagonus decagonus</i>	ott3632024	D	269	1.16	0.66	1.67	1	577	32.32	(79)
Apogonidae	<i>Cheilodipterus macrodon</i>	ott965176	BM	59	1.27	0.71	1.83	1	2,600	110.09	(80)
Apogonidae	<i>Holapogon maximus</i>	ott3635086	BM	61	1.24	0.71	1.77	1	1,800	48.48	(80)
Apogonidae	<i>Jaydia hungi</i>	ott3634955	BM	62	1.23	0.73	1.73	1	800	20.36	(80)
Apogonidae	<i>Ostorhinchus cookii</i>	ott102070	BM	63	1.25	0.76	1.74	1	500	15.91	(80)
Apogonidae	<i>Ostorhinchus cyanosoma</i>	ott638185	BM	64	1.09	0.65	1.53	1	650	6.02	(80)
Apogonidae	<i>Siphamia tubifer</i>	ott5860863	BM	67	0.86	0.52	1.19	1	240	0.29	(80)
Apogonidae	<i>Taeniamia lineolata</i>	ott775407	BM	68	1.07	0.65	1.49	1	400	3.35	(80)
Atherinidae	<i>Atherina presbyter</i>	ott669918	D	2	1.09	0.9	1.28	33	935 – 11,407	1.47 – 13.70	(81)
Atherinopsidae	<i>Leuresthes tenuis</i>	ott274466	D	3	1.39	0.93	1.87	7	475 – 2,705	15.99 – 31.31	(82)
Atherinopsidae	<i>Odontesthes argentinensis</i>	ott93287	D	6	1.17	0.86	1.48	24	3,422 – 27,980	41.62 – 244.65	(83)
Balistidae	<i>Balistes capriscus</i>	ott135140	S	335	1.61	1.42	1.8	172	32,919 – 1,996,500	192.48 – 1002.07	(84); (85)
Blenniidae	<i>Aidablennius sphyinx</i>	ott898527	D	70	1.07	0.68	1.46	1	655	0.63	(86)
Bothidae	<i>Arnoglossus laterna</i>	ott696263	P	258	0.98	0.6	1.37	2	7,092 – 59,574	2.68 – 9.09	(87)
Carangidae	<i>Decapterus punctatus</i>	ott705034	P	74	1.28	0.84	1.72	2	6,200 – 51,000	16.71 – 53.59	(88)
Carangidae	<i>Elagatis bipinnulata</i>	ott705026	P	75	0.99	0.73	1.25	29	469,590 – 2,635,300	1378.72 – 7075.53	(89)
Carangidae	<i>Trachurus picturatus</i>	ott174574	P	77	1.13	0.65	1.62	8	23,630 – 48,816	38.10 – 73.11	(90)
Centropomidae	<i>Centropomus undecimalis</i>	ott317368	P	79	1.49	1.08	1.9	15	578,160 – 10,289,069	2711.08 – 7993.41	(91)
Clupeidae	<i>Amblygaster sirm</i>	ott328216	P	11	1.57	1.13	2.04	33	20,281 – 140,411	34.39 – 57.50	(92)
Clupeidae	<i>Clupea harengus</i>	ott1005932	D	14	1.54	1.42	1.66	419	19,355 – 265,161	140.27 – 533.37	(93)
Clupeidae	<i>Ethmalosa fimbriata</i>	ott658559	P	16	0.89	0.56	1.23	32	15,816 – 51,901	182.55 – 582.47	(94)
Clupeidae	<i>Nematalosa vlaminghi</i>	ott328199	P	17	1.15	0.59	1.71	1	90,451	111.79	(95)
Clupeidae	<i>Opisthonema libertate</i>	ott437031	P	18	1.1	0.7	1.5	58	22,025 – 106,958	91.39 – 204.30	(96)
Clupeidae	<i>Opisthonema medirastre</i>	ott1195	P	19	1.24	0.82	1.67	46	17,941 – 107,063	80.90 – 169.98	(97)
Clupeidae	<i>Sardinops sagax</i>	ott121238	P	20	0.97	0.83	1.11	185	3,083 – 33,483	26.53 – 118.21	(98)
Clupeidae	<i>Spratelloides gracilis</i>	ott39732	D	21	0.99	0.74	1.26	18	594 – 5,913	0.20 – 0.86	(99)
Clupeidae	<i>Strangomera bentincki</i>	ott648871	P	22	1.08	0.65	1.49	10	5,901 – 10,414	11.25 – 24.31	(100)
Cottidae	<i>Artediiellus atlanticus</i>	ott654509	D	273	1.32	0.82	1.81	1	88.5	23.32	(79)
Cottidae	<i>Enophrys bison</i>	ott290389	D	274	1.13	0.55	1.7	2	18,800 – 31,900	197.53 – 241.50	(101)
Cottidae	<i>Icelus bicornis</i>	ott3632116	D	276	1.1	0.6	1.59	1	440	14.79	(79)
Cottidae	<i>Triglops pingelii</i>	ott568671	D	277	1.12	0.63	1.62	1	600	22.25	(79)
Cyclopteridae	<i>Cyclopteropsis mcalpini</i>	ott3631993	D	279	1.04	0.63	1.46	1	65	2.80	(79)
Engraulidae	<i>Anchoiella lepidontostole</i>	ott610213	P	23	0.97	0.59	1.35	24	14,395 – 37,191	9.36 – 21.80	(102)
Engraulidae	<i>Cetengraulis mysticetus</i>	ott1064953	P	24	1.23	0.98	1.47	86	9,810 – 79,010	25.10 – 71.50	(103)
Engraulidae	<i>Engraulis anchoita</i>	ott648864	P	25	1.26	1.12	1.4	159	1,641 – 36,464	5.44 – 39.01	(104)
Engraulidae	<i>Engraulis mordax</i>	ott29754	P	26	1.16	0.76	1.56	21	8,673 – 35,561	10.47 – 23.98	(105)
Engraulidae	<i>Engraulis ringens</i>	ott211981	P	27	1.35	1.14	1.56	149	3,067 – 34,977	10.78 – 39.92	(106); (100); (107)
Exocoetidae	<i>Hirundichthys affinis</i>	ott837204	D	7	1.21	0.63	1.79	2	7,398 – 10,021	218.16 – 255.62	(108)
Gadidae	<i>Boreogadus saida</i>	ott877055	P	33	0.89	0.41	1.38	1	48,500	18.48	(79)
Gadidae	<i>Eleginus nawaga</i>	ott450082	D	34	1.12	0.57	1.66	1	40,500	74.86	(79)
Gadidae	<i>Gadus morhua</i>	ott5860467	P	35	1.23	1.18	1.28	428	151,700 – 21,496,000	1036.67 – 24086.31	(109); (110); (111); (112)
Gadidae	<i>Merlangius merlangus</i>	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	<i>Micromesistius australis</i>	ott1091056	P	38	1.56	1.37	1.76	96	2,658 – 81,300	188.76 – 1017.03	(114)
Gasterosteidae	<i>Gasterosteus aculeatus</i>	ott111122	D	45	0.91	0.78	1.04	110	48 – 523	0.33 – 3.03	(115); (116)
Gobiidae	<i>Elacatinus oceanops</i>	ott638369	D	89	0.8	0.44	1.15	1	375	0.25	(117)
Gobiidae	<i>Gobiosoma robustum</i>	ott1064480	D	90	1.35	0.76	1.95	1	695	158.08	(118)
Gobiidae	<i>Paragobiodon echinocephalus</i>	ott940827	D	92	0.87	0.5	1.24	1	716	0.23	(119)
Gobiidae	<i>Paragobiodon lacunicolus</i>	ott758973	D	93	0.88	0.53	1.24	1	635	0.23	(119)
Gobiidae	<i>Paragobiodon xanthosoma</i>	ott770378	D	94	0.96	0.61	1.32	1	293	0.23	(119)
Gobiidae	<i>Pomatoschistus minutus</i>	ott1048873	D	95	0.82	0.46	1.17	28	1,430 – 4,070	1.53 – 3.11	(120)
Haemulidae	<i>Haemulopsis corvinaeformis</i>	ott177515	P	97	0.52	0.3	0.75	2	15,056 – 83,316	0.93 – 51.66	(108)
Hemiramphidae	<i>Hemiramphus brasiliensis</i>	ott953384	D	8	0.84	0.44	1.24	2	2,200 – 4,000	21.01 – 111.47	(108)
Hemirhamphidae	<i>Careproctus reinhardti</i>	ott160287	D	282	1.22	0.78	1.66	6	1,039 – 22,194	303.44 – 1004.16	(121)
Hexagrammidae	<i>Oxylebius pictus</i>	ott131554	D	284	0.92	0.44	1.41	22	12,789 – 25,621	32.22 – 63.30	(122)
Labridae	<i>Thalassoma bifasciatum</i>	ott907850	P	145	0.75	0.6	0.9	66	79 – 5,140	0.52 – 4.60	*
Latidae	<i>Lates calcarifer</i>	ott6362446	P	150	1.04	0.83	1.26	25	2,062,100 – 47,202,800	2945.25 – 32293.52	(123)
Liparidae	<i>Careproctus reinhardti</i>	ott1065176	D	285	1.23	0.62	1.83	1	300	357.25	(79)
Liparidae	<i>Paraliparis bathybius</i>	ott309222	BM	287	1.25	0.68	1.82	1	428	122.99	(79)
Lutjanidae	<i>Lutjanus campechanus</i>	ott642863	P	151	1	0.62	1.37	9	160,000 – 900,000	1350.00 – 5850.00	(124)
Lutjanidae	<i>Lutjanus carponotatus</i>	ott333348	P	152	1.72	1.51	1.93	55	4,451 – 750,512	77.08 – 485.66	(125)
Lutjanidae	<i>Lutjanus synagris</i>	ott943184	P	153	0.67	0.46	0.87	39	23,000 – 160,000	198.00 – 2100.00	(126)
Lutjanidae	<i>Ocyurus chrysurus</i>	ott943183	P	154	1.25	0.88	1.61	21	14,268 – 166,651	221.70 – 734.70	(127)
Lutjanidae	<i>Rhomboplites aurorubens</i>	ott642869	P	155	1.39	1.24	1.53	41	4,350 – 1,792,070	158.61 – 2994.94	(128)
Malacanthidae	<i>Caulolatilus microps</i>	ott39883	P	156	1.47	1.22	1.73	43	83,470 – 4,120,570	762.87 – 4527.12	(129)
Merlucciidae	<i>Merluccius gayi</i>	ott323082	P	42	1.19	0.9	1.48	50	45,041 – 399,890	523.49 – 3390.80	(130)
Merlucciidae	<i>Merluccius hubbsi</i>	ott757316	P	43	1.06	0.99	1.14	251	37,817 – 2,537,392	261.48 – 5782.35	(131)
Merlucciidae	<i>Merluccius merluccius</i>	ott5860466	P	44	0.93	0.77	1.1	209	32,665 – 578,510	626.18 – 3465.51	(132)
Monacanthidae	<i>Brachaluteres jacksonianus</i>	ott333693	S	336	1.2	0.83	1.56	1	114	1.24	(133)
Monacanthidae	<i>Eubalichthys bucephalus</i>	ott3631310	S	337	1.32	0.73	1.91	2	9,000 – 39,500	355.86 – 524.85	(134)
Monacanthidae	<i>Oxymonacanthus longirostris</i>	ott333706	S	338	1.31	0.91	1.72	3	100 – 200	3.30 – 3.79	(135)
Monacanthidae	<i>Rudarius ercodes</i>	ott511593	S	340	0.83	0.48	1.17	3	2,560 – 8,180	1.25 – 5.78	(136)
Moronidae	<i>Dicentrarchus labrax</i>	ott33549	P	157	1.23	0.85	1.6	16	290,390 – 2,043,126	1000.00 – 3800.00	(137)
Mugilidae	<i>Chelon labrosus</i>	ott777079	P	46	1.09	0.58	1.61	13	353,000 – 745,000	1240.00 – 2300.00	(138)
Mugilidae	<i>Chelon ramada</i>	ott668241	P	47	1.18	0.62	1.73	2	581,000 – 1,243,000	850.00 – 1450.00	(138)
Mugilidae	<i>Mugil cephalus</i>	ott418648	P	48	1.01	0.93	1.1	95	43,182 – 4,800,000	42.77 – 3760.17	(139); (140); (141)
Mugilidae	<i>Mugil curema</i>	ott418643	P	49	1.15	0.6	1.69	8	295,081 – 488,956	222.87 – 371.93	(142)
Mugilidae	<i>Mugil hospes</i>	ott779937	P	50	1.14	0.58	1.7	1	178,277	114.11	(142)
Mugilidae	<i>Mugil liza</i>	ott779933	P	51	1.19	0.61	1.75	1	1,776,309	1201.53	(142)
Mugilidae	<i>Mugil trichodon</i>	ott246901	P	52	1.18	0.62	1.73	1	100,346	112.33	(142)
Mugilidae	<i>Planiliza subviridis</i>	ott823526	P	53	1.07	0.66	1.48	12	38,167 – 145,883	11.69 – 28.41	(143)
Nototheniidae	<i>Lepidonotothen nudifrons</i>	ott260052	D	160	1.27	0.69	1.84	1	2,500	117.20	(144)
Osmeridae	<i>Mallotus villosus</i>	ott225330	D	54	1.22	0.7	1.74	34	6,700 – 14,300	18.07 – 26.43	(145)
Paralichthyidae	<i>Paralichthys dentatus</i>	ott1019735	P	259	1.06	0.91	1.2	134	460,059 – 4,202,538	2627.81 – 20166.83	(146)
Paralichthyidae	<i>Paralichthys patagonicus</i>	ott654479	P	260	1.38	0.91	1.85	24	20,084 – 156,527	709.32 – 1465.65	(147)
Plesiopidae	<i>Acanthoclinus fuscus</i>	ott3633802	D	164	1.46	0.94	2.01	7	42,756 – 438,961	232.38 – 475.62	(148)
Pleuronectidae	<i>Hippoglossoides platessoides</i>	ott223665	P	262	0.96	0.83	1.09	154	25,700 – 258,000	24.83 – 255.51	(149); (150)
Pleuronectidae	<i>Pleuronectes platessa</i>	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	<i>Pseudopleuronectes americanus</i>	ott261419	D	265	0.99	0.63	1.35	17	192,240 – 1,390,495	332.81 – 1322.71	(152)
Pleuronectidae	<i>Reinhardtius hippoglossoides</i>	ott835141	P	266	1.3	1.07	1.53	88	6,761 – 70,394	970.70 – 5331.71	(153)
Pomacanthidae	<i>Pomacanthus zonipectus</i>	ott826472	P	165	1.25	0.69	1.81	5	25,456 – 62,401	160.12 – 211.09	(154)
Pomacentridae	<i>Abudefduf saxatilis</i>	ott405751	D	167	0.94	0.43	1.44	1	31,088	22.12	(155)
Pomacentridae	<i>Acanthochromis polyacanthus</i>	ott100410	D	172	1.41	0.85	1.96	15	245.6 – 573.1	87.19 – 124.17	(156)
Pomacentridae	<i>Pomacentrus coelestis</i>	ott622060	D	180	1.02	0.75	1.29	81	1,391 – 6,213	1.27 – 3.26	(157)
Pomacentridae	<i>Stegastes fuscus</i>	ott3635543	D	185	0.96	0.63	1.3	14	1,759 – 14,856	3.92 – 14.19	(158)
Pristigasteridae	<i>Ilisha africana</i>	ott741177	P	28	1.3	0.78	1.82	1	5,227	37.69	(159)
Sciaenidae	<i>Bairdiella chrysoura</i>	ott761907	P	207	1.09	0.56	1.62	1	52,800	54.91	(160)
Sciaenidae	<i>Cynoscion regalis</i>	ott5860595	P	208	1.49	1.24	1.73	29	90,019 – 2,163,872	554.68 – 3969.46	(161)
Sciaenidae	<i>Cynoscion striatus</i>	ott267367	P	209	1.23	0.66	1.79	5	45,347 – 98,573	178.46 – 230.71	(162)
Sciaenidae	<i>Genyonemus lineatus</i>	ott1027240	P	210	1.9	1.66	2.15	44	1,038 – 36,701	78.67 – 401.10	(163)
Sciaenidae	<i>Isoipisthus parvipinnis</i>	ott133138	P	211	1.31	0.88	1.76	8	4,280 – 51,604	19.18 – 44.36	(162)
Sciaenidae	<i>Larimus breviceps</i>	ott924070	P	212	1.71	1.2	2.25	6	5,463 – 165,132	73.67 – 144.63	(162)
Sciaenidae	<i>Larimus fasciatus</i>	ott897432	P	213	1.03	0.86	1.2	81	17,639 – 315,972	8.75 – 59.86	(164)
Sciaenidae	<i>Macrodon ancylodon</i>	ott99076	P	215	1.24	0.89	1.59	21	26,210 – 217,632	155.00 – 500.00	(165)
Sciaenidae	<i>Micropogonias furnieri</i>	ott742890	P	216	0.99	0.83	1.16	85	44,733 – 776,006	315.49 – 2485.35	(166); (167)
Sciaenidae	<i>Paralichthys brasiliensis</i>	ott160812	P	218	0.89	0.42	1.35	16	11,497 – 86,034	44.15 – 94.52	(162)
Sciaenidae	<i>Seriplus politus</i>	ott827210	P	219	1.11	1	1.22	143	2,314 – 125,632	7.44 – 85.10	(168)
Sciaenidae	<i>Stellifer rastriifer</i>	ott362452	P	220	0.76	0.5	1.02	44	1,544 – 263,392	21.73 – 107.90	(162)
Scorbridae	<i>Auxis rochei</i>	ott713972	P	221	1.18	0.59	1.78	1	75,000	453.17	(169)
Scorbridae	<i>Scomber scombrus</i>	ott70561	P	225	1.38	1.08	1.68	27	151,916 – 1,491,192	190.50 – 832.39	(170)
Scorbridae	<i>Scomberomorus cavalla</i>	ott70546	P	226	1.37	1.26	1.49	75	69,264 – 12,206,888	886.37 – 28991.83	(171); (172)
Scorbridae	<i>Scomberomorus maculatus</i>	ott266387	P	227	1.12	0.84	1.4	14	525,000 – 7,411,000	550.00 – 4150.00	(173); (1)
Scorbridae	<i>Thunnus alalunga</i>	ott833194	P	228	0.93	0.56	1.32	69	263,100 – 2,813,400	14094.95 – 25217.33	(174)
Scorbridae	<i>Thunnus albacares</i>	ott833188	P	229	0.99	0.57	1.4	4	1,300,000 – 5,431,000	32593.36 – 57119.99	(175)
Scorbridae	<i>Thunnus thynnus</i>	ott358607	P	231	1.31	0.83	1.79	27	13,600,000 – 57,600,000	1336.98 – 2861.01	(176)
Sebastidae	<i>Sebastes alutus</i>	ott480735	BI	288	1.76	1.6	1.93	88	4,500 – 270,000	255.24 – 1429.15	(177); (178)
Sebastidae	<i>Sebastes atrovirens</i>	ott480732	BI	289	1.11	0.59	1.62	17	67,927 – 528,987	268.54 – 471.51	(148)
Sebastidae	<i>Sebastes auriculatus</i>	ott480729	BI	290	1.06	0.74	1.39	35	51,619 – 338,540	391.43 – 1455.21	(179)
Sebastidae	<i>Sebastes brevispinis</i>	ott1057081	BI	291	1.28	0.81	1.76	22	496,000 – 1,252,000	1448.00 – 2832.00	(180)
Sebastidae	<i>Sebastes carnatus</i>	ott1057074	BI	292	1.19	0.67	1.7	11	77,671 – 236,038	499.24 – 1054.02	(148)
Sebastidae	<i>Sebastes caurinus</i>	ott1057078	BI	293	1.68	1.49	1.86	54	15,642 – 640,052	247.45 – 2343.44	(179); (181)
Sebastidae	<i>Sebastes chlorostictus</i>	ott1057068	BI	294	1.55	1.34	1.76	64	17,198 – 761,362	246.06 – 1252.35	(182); (183)
Sebastidae	<i>Sebastes constellatus</i>	ott1057062	BI	295	1.34	0.95	1.73	21	31,781 – 248,490	224.89 – 655.33	(182)
Sebastidae	<i>Sebastes crameri</i>	ott1057065	BI	296	1.46	1.1	1.82	12	36,600 – 609,800	491.77 – 2582.59	(184)
Sebastidae	<i>Sebastes dallii</i>	ott1088425	BI	297	1.15	0.75	1.55	23	3,744 – 18,131	17.90 – 44.78	(182)
Sebastidae	<i>Sebastes diploproa</i>	ott1057059	BI	298	1.45	1.13	1.77	15	14,400 – 303,700	85.27 – 559.21	(184)
Sebastidae	<i>Sebastes elongatus</i>	ott531065	BI	299	1.3	1.06	1.53	25	8,707 – 296,799	56.35 – 567.53	(182)
Sebastidae	<i>Sebastes entomelas</i>	ott531068	BI	300	1.62	1.43	1.81	110	55,600 – 1,102,844	443.86 – 2398.20	(185); (182); (184)
Sebastidae	<i>Sebastes flavidus</i>	ott531059	BI	301	1.5	1.25	1.74	49	48,400 – 969,715	395.33 – 2310.74	(184); (182)
Sebastidae	<i>Sebastes goodei</i>	ott531047	BI	302	1.32	1.13	1.5	62	29,200 – 961,809	351.87 – 2426.91	(182); (184)
Sebastidae	<i>Sebastes helvomaculatus</i>	ott531044	BI	303	1.29	0.81	1.79	5	183,000 – 1,652,000	105.65 – 322.55	(186)
Sebastidae	<i>Sebastes hopkinsi</i>	ott9589	BI	304	1.01	0.66	1.36	39	8,332 – 39,559	61.99 – 228.24	(182)
Sebastidae	<i>Sebastes jordani</i>	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	<i>Sebastes levis</i>	ott9598	BI	306	1.06	0.79	1.34	27	181,001 – 1,941,579	1367.68 – 7660.85	(182)
Sebastidae	<i>Sebastes melanops</i>	ott9604	BI	307	1.3	1.05	1.54	226	214,367 – 1,498,862	1165.81 – 2799.49	(187)
Sebastidae	<i>Sebastes melanostomus</i>	ott9607	BI	308	1.41	1.11	1.73	42	174,874 – 1,177,889	864.30 – 2919.60	(188); (186)
Sebastidae	<i>Sebastes mentella</i>	ott1088432	BI	309	1.46	1.37	1.55	227	1,457 – 115,846	162.42 – 1284.55	(189); (190)
Sebastidae	<i>Sebastes miniatus</i>	ott9611	BI	310	1.58	1.37	1.78	59	63,300 – 2,647,282	1022.07 – 10240.11	(182); (184)
Sebastidae	<i>Sebastes mystinus</i>	ott9616	BI	311	1.74	1.58	1.9	151	10,369 – 524,554	192.42 – 983.32	(148); (191)
Sebastidae	<i>Sebastes norvegicus</i>	ott1088441	BI	312	1.06	0.89	1.23	67	19,810 – 336,700	434.15 – 3204.64	(192); (190)
Sebastidae	<i>Sebastes ovalis</i>	ott582324	BI	313	1.23	0.82	1.64	39	52,356 – 212,399	425.50 – 1019.60	(186); (188)
Sebastidae	<i>Sebastes paucispinis</i>	ott582321	BI	314	1.35	1.18	1.53	75	20,000 – 2,297,900	724.86 – 6193.24	(182); (184)
Sebastidae	<i>Sebastes pinniger</i>	ott582318	BI	315	1.26	0.79	1.73	10	260,600 – 1,897,600	1506.08 – 4055.36	(184)
Sebastidae	<i>Sebastes rastrelliger</i>	ott582315	BI	316	1.23	0.82	1.65	2	80,000 – 760,000	386.67 – 2211.98	(193)
Sebastidae	<i>Sebastes rosaceus</i>	ott212767	BI	317	1.14	0.84	1.44	23	12,992 – 94,936	43.53 – 172.48	(182)
Sebastidae	<i>Sebastes rosenblatti</i>	ott582311	BI	318	1.29	0.97	1.61	26	4,880 – 93,370	47.04 – 171.78	(182)
Sebastidae	<i>Sebastes rufus</i>	ott884513	BI	319	1.3	0.93	1.67	27	67,051 – 606,888	672.05 – 2143.58	(182)
Sebastidae	<i>Sebastes saxicola</i>	ott884510	BI	320	1.04	0.94	1.14	43	4,376 – 230,000	13.98 – 452.33	(182); (184)
Sebastidae	<i>Sebastes semicinclus</i>	ott795707	BI	321	1.29	0.99	1.61	46	3,275 – 30,867	18.95 – 85.87	(182)
Sebastidae	<i>Sebastes serranoides</i>	ott884519	BI	322	1.56	1.34	1.78	83	29,597 – 524,048	287.54 – 1198.45	(194)
Sebastidae	<i>Sebastes viviparus</i>	ott99016	BI	323	1.21	0.94	1.49	32	1,770 – 29,047	69.51 – 324.99	(195)
Serranidae	<i>Cephalopholis cruentata</i>	ott12880	P	232	1.18	0.7	1.66	12	86,204 – 615,387	142.95 – 414.81	(196)
Serranidae	<i>Epinephelus aeneus</i>	ott306171	P	233	1.15	0.87	1.42	27	404,056 – 12,589,242	967.53 – 6975.90	(197)
Serranidae	<i>Epinephelus fasciatus</i>	ott534146	P	234	0.78	0.34	1.21	9	254,732 – 879,038	395.33 – 1435.81	(197)
Serranidae	<i>Epinephelus marginatus</i>	ott733897	P	235	1.22	0.65	1.78	2	257,657 – 606,246	758.70 – 1197.83	(197)
Serranidae	<i>Epinephelus tauvina</i>	ott218649	P	236	0.9	0.51	1.29	4	850,186 – 2,904,912	1062.45 – 6012.89	(198)
Serranidae	<i>Mycteroperca tigris</i>	ott207413	P	237	1.43	0.95	1.93	2	890,000 – 10,490,000	3130.04 – 7720.75	(199)
Siganidae	<i>Siganus canaliculatus</i>	ott199059	S	241	1.25	1.05	1.44	27	35,494 – 1,555,688	59.67 – 870.20	(200)
Soleidae	<i>Solea solea</i>	ott710233	P	268	1.15	1.07	1.24	323	50,400 – 1,577,100	117.75 – 1194.75	(201)
Sparidae	<i>Acanthopagrus latus</i>	ott760733	P	242	1.16	0.58	1.73	5	1,362,137 – 2,152,993	426.21 – 660.47	(202)
Sparidae	<i>Archosargus rhomboidalis</i>	ott724892	P	243	0.91	0.69	1.13	23	18,274 – 161,107	15.05 – 156.17	(203)
Sparidae	<i>Sparidentex hasta</i>	ott845300	P	244	1.21	0.73	1.69	6	308,273 – 1,693,365	2604.06 – 6288.57	(202)
Stromateidae	<i>Pampus chinensis</i>	ott916290	P	245	1.14	0.56	1.71	8	80,400 – 93,100	647.18 – 876.77	(204)
Syngnathidae	<i>Hippocampus reidi</i>	ott630138	BP	326	1.24	0.76	1.72	3	725 – 914	10.00 – 12.30	(205)
Syngnathidae	<i>Micrognathus crinitus</i>	ott3642321	BP	327	1.11	0.79	1.43	1	21.7	0.17	(206)
Syngnathidae	<i>Syngnathus floridae</i>	ott774435	BP	330	1.16	0.74	1.58	1	357.6	3.03	(206)
Syngnathidae	<i>Syngnathus louisianae</i>	ott774414	BP	331	1.22	0.77	1.69	1	664.7	8.36	(206)
Syngnathidae	<i>Syngnathus scovelli</i>	ott251400	BP	333	1.2	0.83	1.58	1	55.6	0.88	(206)
Tetraodontidae	<i>Canthigaster valentini</i>	ott701127	S	342	0.97	0.77	1.18	66	419 – 1,928	2.32 – 9.09	(207)
Trachichthyidae	<i>Hoplostethus atlanticus</i>	ott816600	P	9	1.01	0.81	1.21	166	9,776 – 93,849	661.58 – 2509.01	(208)
Trichiuridae	<i>Aphanopus carbo</i>	ott113465	P	246	1.18	0.71	1.66	14	228,950 – 961,440	1950.46 – 4169.05	(209)
Zoarcidae	<i>Gymnelus viridis</i>	ott729337	D	248	1.26	0.8	1.74	1	11	13.80	(79)
Zoarcidae	<i>Lycodes esmarkii</i>	ott841648	D	249	0.93	0.38	1.48	1	1,200	4659.64	(79)
Zoarcidae	<i>Lycodes eudipleurostictus</i>	ott905435	D	250	1.23	0.65	1.8	1	186.5	183.60	(79)
Zoarcidae	<i>Lycodes frigidus</i>	ott539690	D	251	1.09	0.49	1.68	1	500	1207.55	(79)
Zoarcidae	<i>Lycodes pallidus</i>	ott178074	D	252	1.23	0.71	1.76	1	60	50.90	(79)
Zoarcidae	<i>Lycodes vahlII</i>	ott178063	D	255	1.04	0.59	1.49	1	37.5	7.04	(79)
Zoarcidae	<i>Melanostigma atlanticum</i>	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 <sup>3</sup> )	Mass range (g)	Refs
Agonidae	<i>Leptagonus decagonus</i>	ott3632024	D	269	0.17	-0.23	0.55	1	4.189	32.32	(79)
Apogonidae	<i>Cheilodipterus macrodon</i>	ott965176	BM	59	0.21	-0.25	0.66	1	0.113	110.09	(80)
Apogonidae	<i>Holapogon maximus</i>	ott3635086	BM	61	0.15	-0.29	0.57	1	0.180	48.48	(80)
Apogonidae	<i>Jaydia hungi</i>	ott3634955	BM	62	0.08	-0.31	0.46	1	0.268	20.36	(80)
Apogonidae	<i>Ostorhinchus cookii</i>	ott102070	BM	63	0.07	-0.3	0.43	1	0.268	15.91	(80)
Apogonidae	<i>Ostorhinchus cyanosoma</i>	ott638185	BM	64	0.18	-0.14	0.49	1	0.113	6.02	(80)
Apogonidae	<i>Paroncheilus affinis</i>	ott974576	BM	66	0.33	-0.02	0.67	1	0.034	8.39	(211)
Apogonidae	<i>Siphamia tubifer</i>	ott5860863	BM	67	-0.09	-0.35	0.15	1	0.905	0.29	(80)
Apogonidae	<i>Taeniamia lineolata</i>	ott775407	BM	68	-0.04	-0.34	0.26	1	0.524	3.35	(80)
Atherinidae	<i>Atherina presbyter</i>	ott669918	D	2	0.12	-0.26	0.5	1	0.839	7.47	(81)
Atherinopsidae	<i>Menidia menidia</i>	ott189767	D	5	0.07	-0.16	0.29	20	0.624 – 0.860	3.48 – 14.03	(212)
Balistidae	<i>Balistes capriscus</i>	ott135140	S	335	0.18	-0.32	0.67	1	0.039	378.39	(85)
Bathyracidae	<i>Akarotaxis nudiceps</i>	ott682053	D	69	-0.03	-0.4	0.33	1	9.203	16.00	(213)
Blenniidae	<i>Aidablennius sphyinx</i>	ott898527	D	70	0.06	-0.28	0.39	1	0.195	0.63	(86)
Bothidae	<i>Arnoglossus laterna</i>	ott696263	P	258	0.27	-0.05	0.61	1	0.056	5.27	(87)
Callionymidae	<i>Synchiropus sechellensis</i>	ott3632718	P	73	0.23	-0.16	0.63	1	0.268	10.06	(214)
Carangidae	<i>Decapterus punctatus</i>	ott705034	P	74	0.41	0.01	0.82	1	0.024	31.62	(88)
Carangidae	<i>Trachurus mediterraneus</i>	ott174577	P	76	0.14	-0.33	0.6	1	0.271	364.39	(215)
Carangidae	<i>Trachurus picturatus</i>	ott174574	P	77	0.1	-0.25	0.46	8	0.194 – 0.194	38.10 – 73.11	(90)
Carangidae	<i>Trachurus trachurus</i>	ott472429	P	78	0.16	-0.21	0.54	3	0.342 – 0.435	140.72 – 317.47	(216); (215)
Channichthyidae	<i>Pagetopsis macropterus</i>	ott708993	D	84	0.01	-0.52	0.53	1	33.510	273.22	(217)
Clupeidae	<i>Alosa mediocris</i>	ott491656	D	10	0.14	-0.33	0.65	1	1.732	664.33	(218)
Clupeidae	<i>Amblygaster sirm</i>	ott328216	P	11	0.32	-0.11	0.77	1	0.048	42.93	(92)
Clupeidae	<i>Brevoortia patronus</i>	ott107260	P	12	0.08	-0.36	0.52	2	0.905 – 1.124	119.37 – 173.32	(219)
Clupeidae	<i>Ethmalosa fimbriata</i>	ott658559	P	16	0.25	-0.32	0.81	1	0.039	362.80	(94)
Clupeidae	<i>Nematalosa vlaminghi</i>	ott328199	P	17	0.07	-0.39	0.51	1	0.748	111.79	(95)
Clupeidae	<i>Spratelloides gracilis</i>	ott39732	D	21	0.12	-0.16	0.38	1	0.180	0.59	(99)
Congiopodidae	<i>Zanclorhynchus spinifer</i>	ott255677	P	271	0.25	-0.2	0.71	1	0.268	104.29	(213)
Cottidae	<i>Artediellus atlanticus</i>	ott654509	D	273	-0.12	-0.53	0.25	1	33.510	23.32	(79)
Cottidae	<i>Enophrys bison</i>	ott290389	D	274	0.25	-0.22	0.72	2	2.572 – 4.189	197.53 – 241.50	(101)
Cottidae	<i>Gymnocanthus tricuspis</i>	ott654474	D	275	0.19	-0.28	0.65	1	3.764	179.34	(79)
Cottidae	<i>Icelus bicornis</i>	ott3632116	D	276	0.12	-0.26	0.51	1	8.181	14.79	(79)
Cottidae	<i>Triglops pingelii</i>	ott568671	D	277	-0.01	-0.39	0.35	1	14.137	22.25	(79)
Cyclopteridae	<i>Cyclopteropsis mcalpini</i>	ott3631993	D	279	-0.07	-0.38	0.23	1	65.450	2.80	(79)
Cyclopteridae	<i>Eumicrotremus spinosus</i>	ott1097394	D	280	0.09	-0.34	0.52	1	29.764	60.65	(79)
Engraulidae	<i>Cetengraulis mysticetus</i>	ott1064953	P	24	0.2	0.04	0.36	86	0.048 – 0.113	25.10 – 71.50	(103)
Engraulidae	<i>Engraulis anchoita</i>	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 <sup>3</sup> )	Mass range (g)	Refs
Engraulidae	<i>Engraulis mordax</i>	ott29754	P	26	-0.02	-0.37	0.32	1	1.023	14.74	(105)
Exocoetidae	<i>Hirundichthys affinis</i>	ott837204	D	7	0.04	-0.47	0.54	1	8.181	255.62	(108)
Fundulidae	<i>Fundulus heteroclitus</i>	ott4134765	D	29	0.15	-0.04	0.35	26	2.310 – 5.806	3.36 – 14.51	(221)
Fundulidae	<i>Fundulus xenicus</i>	ott839523	D	30	0.11	-0.19	0.4	1	3.131	1.75	(222)
Gadidae	<i>Boreogadus saida</i>	ott877055	P	33	-0.06	-0.43	0.31	1	2.550	18.48	(79)
Gadidae	<i>Eleginus nawaga</i>	ott450082	D	34	-0.02	-0.46	0.4	1	2.572	74.86	(79)
Gadidae	<i>Gadus morhua</i>	ott5860467	P	35	0.12	0.03	0.2	67	0.975 – 2.040	1382.51 – 24086.31	(110)
Gadidae	<i>Melanogrammus aeglefinus</i>	ott635904	P	36	0.08	0.02	0.14	142	1.018 – 1.736	111.75 – 2235.27	(223)
Gadidae	<i>Micromesistius australis</i>	ott1091056	P	38	0.1	-0.43	0.59	2	0.211 – 0.211	891.18 – 891.18	(114)
Gasterosteidae	<i>Gasterosteus aculeatus</i>	ott111122	D	45	0.24	-0.07	0.54	1	1.732	1.11	(116)
Gobiidae	<i>Elacatinus oceanops</i>	ott638369	D	89	-0.1	-0.36	0.15	1	0.776	0.25	(117)
Gobiidae	<i>Gobiosoma robustum</i>	ott1064480	D	90	0.18	-0.31	0.65	1	0.130	158.08	(118)
Gobiidae	<i>Oligolepis acutipennis</i>	ott767535	D	91	0.25	-0.21	0.7	1	0.022	25.48	(224)
Gobiidae	<i>Paragobiodon echinocephalus</i>	ott940827	D	92	0.1	-0.17	0.37	1	0.144	0.23	(119)
Gobiidae	<i>Paragobiodon lacunicolus</i>	ott758973	D	93	0.1	-0.18	0.37	1	0.144	0.23	(119)
Gobiidae	<i>Paragobiodon xanthosoma</i>	ott770378	D	94	0.1	-0.17	0.37	1	0.144	0.23	(119)
Haemulidae	<i>Haemulopsis corvinaeformis</i>	ott177515	P	97	0.21	-0.2	0.63	1	0.031	51.66	(108)
Hemiramphidae	<i>Hemiramphus brasiliensis</i>	ott953384	D	8	0.34	-0.13	0.83	1	0.268	111.47	(108)
Hemitripterae	<i>Hemitripterus americanus</i>	ott160287	D	282	1.34	0.88	1.77	6	0.641 – 36.087	303.44 – 1004.16	(121)
Hexagrammidae	<i>Oxylebius pictus</i>	ott131554	D	284	0.3	-0.1	0.72	2	1.150 – 1.437	46.13 – 87.76	(122)
Labridae	<i>Anampses caeruleopunctatus</i>	ott372276	D	98	0.15	-0.32	0.63	1	0.134	331.12	(225)
Labridae	<i>Anampses twistii</i>	ott762167	P	99	0.12	-0.31	0.54	1	0.151	85.50	(225)
Labridae	<i>Cheilinus fasciatus</i>	ott155291	P	103	0.14	-0.33	0.63	1	0.137	637.55	(225)
Labridae	<i>Cheilinus oxycephalus</i>	ott195575	P	104	0.14	-0.3	0.59	1	0.125	114.33	(225)
Labridae	<i>Cheilinus trilobatus</i>	ott924675	P	105	0.12	-0.35	0.58	1	0.131	1556.96	(225)
Labridae	<i>Coris gaimard</i>	ott1092680	P	107	0.15	-0.33	0.62	1	0.134	294.30	(225)
Labridae	<i>Coris variegata</i>	ott3636534	P	108	0.15	-0.28	0.58	1	0.113	82.58	(225)
Labridae	<i>Epibulus insidiator</i>	ott120301	P	110	0.14	-0.35	0.61	1	0.154	1215.59	(225)
Labridae	<i>Gomphosus varius</i>	ott358606	P	111	0.18	-0.3	0.65	1	0.090	239.62	(225)
Labridae	<i>Halichoeres biocellatus</i>	ott1015700	P	112	0.12	-0.23	0.46	1	0.122	14.76	(225)
Labridae	<i>Halichoeres hortulanus</i>	ott694390	P	118	0.16	-0.31	0.63	1	0.113	228.47	(225)
Labridae	<i>Halichoeres melanurus</i>	ott627330	P	122	0.15	-0.29	0.59	1	0.131	53.47	(225)
Labridae	<i>Hemigymnus fasciatus</i>	ott924674	P	130	0.14	-0.3	0.58	1	0.195	2850.00	(225)
Labridae	<i>Labrichthys unilineatus</i>	ott302371	P	132	0.11	-0.29	0.51	1	0.168	50.73	(225)
Labridae	<i>Labroides dimidiatus</i>	ott302377	P	133	0.11	-0.23	0.46	1	0.137	17.95	(225)
Labridae	<i>Labropsis micronesica</i>	ott3636703	P	134	0.01	-0.32	0.34	1	0.258	10.96	(225)
Labridae	<i>Labropsis xanthonota</i>	ott3636702	P	135	0.08	-0.25	0.42	1	0.165	13.01	(225)
Labridae	<i>Macropharyngodon meleagris</i>	ott552117	P	136	0.1	-0.25	0.46	1	0.141	20.06	(225)
Labridae	<i>Novaculichthys taeniourus</i>	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 <sup>3</sup> )	Mass range (g)	Refs
Labridae	<i>Oxycheilinus unifasciatus</i>	ott352271	P	138	0.14	-0.33	0.6	1	0.151	263.59	(225)
Labridae	<i>Pseudocheilinus hexataenia</i>	ott712600	P	139	0.14	-0.25	0.53	1	0.113	36.29	(225)
Labridae	<i>Symphodus roissali</i>	ott876619	D	142	0.06	-0.11	0.23	10	0.180 – 0.225	4.11 – 22.47	(226)
Liparidae	<i>Careproctus reinhardti</i>	ott1065176	D	285	0.12	-0.36	0.6	1	40.765	357.25	(79)
Liparidae	<i>Liparis fabricii</i>	ott496423	D	286	0.22	-0.22	0.66	1	7.148	60.36	(79)
Liparidae	<i>Paraliparis bathybius</i>	ott309222	BM	287	0.08	-0.37	0.53	1	36.087	122.99	(79)
Lutjanidae	<i>Lutjanus carponotatus</i>	ott333348	P	152	0.15	-0.15	0.45	4	0.032 – 0.042	90.62 – 431.79	(125)
Malacanthidae	<i>Caulolatilus microps</i>	ott39883	P	156	0.21	-0.25	0.67	1	0.258	2274.90	(129)
Merlucciidae	<i>Merluccius merluccius</i>	ott5860466	P	44	0.24	0.15	0.35	209	0.258 – 0.963	626.18 – 3465.51	(132)
Monacanthidae	<i>Brachaluteres jacksonianus</i>	ott333693	S	336	-0.02	-0.29	0.24	1	0.212	1.24	(133)
Monacanthidae	<i>Eubalichthys bucephalus</i>	ott3631310	S	337	0.13	-0.35	0.6	1	0.204	434.98	(134)
Monacanthidae	<i>Oxymonacanthus longirostris</i>	ott333706	S	338	0.01	-0.3	0.31	1	0.180	3.62	(135)
Monacanthidae	<i>Paramonacanthus japonicus</i>	ott3631319	S	339	0.13	-0.2	0.46	1	0.078	7.40	(136)
Monacanthidae	<i>Rudarius ercodes</i>	ott511593	S	340	0.11	-0.18	0.4	1	0.078	2.98	(136)
Mugilidae	<i>Chelon labrosus</i>	ott777079	P	46	-0.05	-0.46	0.33	13	0.090 – 0.410	1240.00 – 2300.00	(138)
Mugilidae	<i>Chelon ramada</i>	ott668241	P	47	0.08	-0.39	0.52	2	0.050 – 0.050	850.00 – 1450.00	(138)
Mugilidae	<i>Mugil cephalus</i>	ott418648	P	48	-0.11	-0.51	0.27	2	0.082 – 0.144	702.39 – 1833.16	(141); (139)
Mugilidae	<i>Planiliza subviridis</i>	ott823526	P	53	0.04	-0.32	0.41	1	0.157	17.13	(143)
Nototheniidae	<i>Lepidonotothen nudifrons</i>	ott260052	D	160	0.15	-0.31	0.6	1	2.806	117.20	(144)
Nototheniidae	<i>Patagonotothen longipes</i>	ott430554	D	161	0.33	-0.03	0.71	1	0.524	17.05	(227)
Nototheniidae	<i>Patagonotothen sima</i>	ott874773	D	162	0.46	0.17	0.76	1	0.128	2.43	(227)
Paralichthyidae	<i>Paralichthys dentatus</i>	ott1019735	P	259	0.16	-0.25	0.56	1	0.524	7935.57	(146)
Pleuronectidae	<i>Ammotretis rostratus</i>	ott600529	P	261	0.11	-0.33	0.56	4	0.508 – 0.572	356.19 – 563.87	(228)
Pleuronectidae	<i>Pseudopleuronectes americanus</i>	ott261419	D	265	0.07	-0.16	0.31	17	0.221 – 0.333	332.81 – 1322.71	(152)
Pleuronectidae	<i>Rhombosolea tapirina</i>	ott867269	P	267	0.11	-0.3	0.51	5	0.221 – 0.268	272.82 – 553.92	(228)
Pomacentridae	<i>Abudefduf saxatilis</i>	ott405751	D	167	0.02	-0.38	0.41	1	0.369	22.12	(155)
Pomacentridae	<i>Pomacentrus coelestis</i>	ott622060	D	180	0.08	-0.21	0.36	9	0.119 – 0.239	1.81 – 2.46	(157)
Pristigasteridae	<i>Ilisha africana</i>	ott741177	P	28	0.14	-0.26	0.53	1	0.322	37.69	(159)
Scaridae	<i>Cetoscarus bicolor</i>	ott1041720	P	190	0.14	-0.29	0.59	1	0.221	3384.72	(225)
Scaridae	<i>Chlorurus sordidus</i>	ott436737	P	191	0.14	-0.34	0.62	1	0.169	442.00	(225)
Scaridae	<i>Hipposcarus longiceps</i>	ott465039	P	193	0.16	-0.31	0.62	1	0.257	1527.80	(225)
Scaridae	<i>Scarus forsteni</i>	ott548869	P	195	0.14	-0.33	0.62	1	0.229	1077.09	(225)
Scaridae	<i>Scarus frenatus</i>	ott436725	P	196	0.13	-0.34	0.59	1	0.173	1851.12	(225)
Scaridae	<i>Scarus globiceps</i>	ott514869	P	197	0.11	-0.36	0.58	1	0.241	272.43	(225)
Scaridae	<i>Scarus schlegeli</i>	ott514881	P	201	0.12	-0.34	0.56	1	0.167	2441.14	(225)
Sciaenidae	<i>Bairdiella chrysoura</i>	ott761907	P	207	0.05	-0.38	0.47	1	0.172	54.91	(160)
Sciaenidae	<i>Cynoscion regalis</i>	ott5860595	P	208	0.13	-0.35	0.59	1	0.113	2018.26	(161)
Sciaenidae	<i>Larimus fasciatus</i>	ott897432	P	213	0.18	-0.21	0.57	1	0.058	25.23	(164)
Scombriidae	<i>Auxis rochei</i>	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 <sup>3</sup> )	Mass range (g)	Refs
Scombridae	<i>Euthynnus affinis</i>	ott308760	P	222	0.05	-0.35	0.45	3	0.123 – 0.191	5941.53 – 7549.52	(229)
Scombridae	<i>Katsuwonus pelamis</i>	ott308754	P	223	0.23	-0.11	0.58	10	0.144 – 0.248	2957.32 – 6503.90	(229)
Scombridae	<i>Sarda sarda</i>	ott833175	P	224	0.23	-0.24	0.7	1	1.124	1985.06	(230)
Scombridae	<i>Scomberomorus cavalla</i>	ott70546	P	226	0.14	-0.27	0.55	1	0.456	6702.24	(171)
Scombridae	<i>Thunnus albacares</i>	ott833188	P	229	0.09	-0.13	0.3	5	0.144 – 0.197	4620.11 – 43292.47	(229); (175)
Scombridae	<i>Thunnus obesus</i>	ott358613	P	230	0.17	-0.15	0.49	1	0.615	36847.75	(231)
Scombridae	<i>Thunnus thynnus</i>	ott358607	P	231	-0.17	-0.68	0.27	6	0.074 – 0.697	1690.13 – 2103.10	(232); (176)
Sebastidae	<i>Sebastes mentella</i>	ott1088432	BI	309	0.14	-0.36	0.62	1	0.685	690.02	(190)
Sebastidae	<i>Sebastes norvegicus</i>	ott1088441	BI	312	0.12	-0.37	0.61	1	0.685	1153.76	(190)
Sebastidae	<i>Sebastolobus altivelis</i>	ott811927	P	324	0.14	-0.35	0.61	1	1.023	288.33	(233)
Serranidae	<i>Cephalopholis cruentata</i>	ott12880	P	232	0.14	-0.33	0.63	1	0.078	220.12	(196)
Serranidae	<i>Epinephelus tauvina</i>	ott218649	P	236	0.05	-0.43	0.51	1	0.048	3094.02	(198)
Siganidae	<i>Siganus canaliculatus</i>	ott199059	S	241	0.19	-0.29	0.68	1	0.018	245.10	(200)
Soleidae	<i>Solea solea</i>	ott710233	P	268	0.13	-0.16	0.43	23	1.202 – 1.583	17000.00 – 51000.00	(234)
Sparidae	<i>Acanthopagrus latus</i>	ott760733	P	242	0.14	-0.35	0.63	1	0.100	570.93	(202)
Sparidae	<i>Archosargus rhomboidalis</i>	ott724892	P	243	0.3	-0.14	0.74	1	0.014	71.27	(203)
Sparidae	<i>Sparidentex hasta</i>	ott845300	P	244	0.16	-0.27	0.6	1	0.100	4986.75	(202)
Stromateidae	<i>Pampus chinensis</i>	ott916290	P	245	0.14	-0.34	0.63	1	0.606	741.00	(204)
Syngnathidae	<i>Entelurus aequoreus</i>	ott971459	BP	325	0.29	0.03	0.54	9	0.358 – 0.779	3.99 – 12.09	(235)
Syngnathidae	<i>Micrognathus crinitus</i>	ott3642321	BP	327	0.14	-0.09	0.35	1	0.796	0.17	(206)
Syngnathidae	<i>Nerophis ophidion</i>	ott806821	BP	328	0.17	-0.05	0.39	19	0.158 – 0.864	0.72 – 2.27	(235)
Syngnathidae	<i>Syngnathus acus</i>	ott774440	BP	329	0.21	0.02	0.4	19	6.118 – 11.706	12.97 – 62.60	(235)
Syngnathidae	<i>Syngnathus floridae</i>	ott774435	BP	330	0.37	0.07	0.66	1	0.322	3.03	(206)
Syngnathidae	<i>Syngnathus louisianae</i>	ott774414	BP	331	0.33	0	0.67	1	0.524	8.36	(206)
Syngnathidae	<i>Syngnathus rostellatus</i>	ott774411	BP	332	0.3	0.12	0.49	18	0.398 – 1.327	0.39 – 1.10	(235)
Syngnathidae	<i>Syngnathus scovelli</i>	ott251400	BP	333	0.22	-0.04	0.46	1	0.796	0.88	(206)
Syngnathidae	<i>Syngnathus typhle</i>	ott251396	BP	334	0.18	0.02	0.33	25	2.031 – 5.610	0.96 – 6.44	(235)
Tetraodontidae	<i>Canthigaster valentini</i>	ott701127	S	342	0.01	-0.33	0.34	1	0.180	4.18	(207)
Trichiuridae	<i>Aphanopus carbo</i>	ott113465	P	246	0.18	-0.27	0.64	1	0.806	2814.83	(209)
Zoarcidae	<i>Gymnelus viridis</i>	ott729337	D	248	0.11	-0.24	0.44	1	52.645	13.80	(79)
Zoarcidae	<i>Lycodes esmarkii</i>	ott841648	D	249	0.16	-0.25	0.57	1	113.097	4659.64	(79)
Zoarcidae	<i>Lycodes eudipleurostictus</i>	ott905435	D	250	0.13	-0.34	0.58	1	75.766	183.60	(79)
Zoarcidae	<i>Lycodes frigidus</i>	ott539690	D	251	0.18	-0.29	0.65	1	179.594	1207.55	(79)
Zoarcidae	<i>Lycodes pallidus</i>	ott178074	D	252	0.25	-0.16	0.65	1	22.449	50.90	(79)
Zoarcidae	<i>Lycodes polaris</i>	ott34255	D	253	0.16	-0.27	0.58	1	47.713	73.29	(79)
Zoarcidae	<i>Lycodes reticulatus</i>	ott752411	D	254	0.04	-0.46	0.54	1	344.791	271.32	(79)
Zoarcidae	<i>Lycodes vahlII</i>	ott178063	D	255	0.17	-0.15	0.47	1	33.510	7.04	(79)
Zoarcidae	<i>Melanostigma atlanticum</i>	ott3633033	D	256	0.22	-0.08	0.5	3	11.494 – 20.580	3.94 – 7.54	(210)
Zoarcidae	<i>Pachycara brachycephalum</i>	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 <sup>3</sup> )	Refs
Acanthuridae	<i>Acanthurus coeruleus</i>	ott324283	P	55	0.76	0.34	1.19	6	0.24 – 0.29	0.136 – 0.163	*
Acanthuridae	<i>Acanthurus nigrofuscus</i>	ott605289	P	56	0.62	0.29	0.92	14	0.16 – 0.32	0.085 – 0.112	*
Acanthuridae	<i>Acanthurus triostegus</i>	ott467300	P	57	0.68	0.34	1.03	4	0.20 – 0.23	0.079 – 0.095	*
Acanthuridae	<i>Zebrasoma scopas</i>	ott199073	P	58	0.74	0.31	1.17	8	0.22 – 0.36	0.121 – 0.141	*
Agonidae	<i>Podothecus sachi</i>	ott590745	D	270	0.59	0.27	0.92	3	14.90 – 16.19	1.720 – 1.720	*
Apogonidae	<i>Cheilodipterus quinquelineatus</i>	ott364614	BM	60	0.61	0.2	1	2	0.96 – 1.06	0.298 – 0.377	*
Apogonidae	<i>Ostorhinchus cyanosoma</i>	ott638185	BM	64	0.71	0.31	1.1	5	0.49 – 0.67	0.105 – 0.140	*
Apogonidae	<i>Ostorhinchus doederleini</i>	ott687634	BM	65	0.78	0.31	1.26	1	1.16	0.233	*
Atherinopsidae	<i>Membras gilberti</i>	ott680137	D	4	0.72	0.29	1.15	5	3.70 – 4.20	0.852 – 1.066	*
Blenniidae	<i>Ophioblennius atlanticus</i>	ott282319	D	71	0.87	0.49	1.27	28	0.62 – 0.94	0.124 – 0.154	*
Blenniidae	<i>Ophioblennius steindachneri</i>	ott155044	D	72	0.84	0.51	1.17	24	0.38 – 0.80	0.102 – 0.140	*
Chaenopsidae	<i>Acanthemblemaria hancocki</i>	ott57340	D	80	0.63	0.27	0.97	42	1.34 – 2.44	0.303 – 0.403	*
Chaenopsidae	<i>Acanthemblemaria rivasi</i>	ott57343	D	81	0.74	0.48	0.99	36	2.28 – 3.48	0.477 – 0.696	*
Chaenopsidae	<i>Neoclinus uninotatus</i>	ott3639321	D	82	0.77	0.45	1.09	1	5.41	1.345	*
Chaetodontidae	<i>Chaetodon capistratus</i>	ott264060	P	83	0.71	0.25	1.15	8	0.29 – 0.43	0.154 – 0.184	*
Clupeidae	<i>Brevoortia tyrannus</i>	ott107265	P	13	0.39	0.1	0.67	1	0.98	2.456	*
Clupeidae	<i>Clupea pallasii</i>	ott9666	D	15	0.97	0.64	1.29	4	4.87 – 6.04	1.564 – 1.667	*
Coryphaenidae	<i>Coryphaena hippurus</i>	ott223663	P	85	0.71	0.34	1.06	1	4.17	2.600	*
Cottidae	<i>Alcichthys elongatus</i>	ott3632242	D	272	0.69	0.31	1.05	4	5.69 – 7.09	1.420 – 1.420	*
Cyclopteridae	<i>Aptocyclus ventricosus</i>	ott989887	D	278	1.03	0.68	1.37	1	46.35	2.430	*
Engraulidae	<i>Engraulis mordax</i>	ott29754	P	26	0.84	0.58	1.11	2	0.43 – 1.24	0.172 – 0.520	(236)
Engraulidae	<i>Engraulis ringens</i>	ott211981	P	27	0.91	0.49	1.34	2	0.86 – 0.98	0.284 – 0.322	(237)
Fundulidae	<i>Lucania goodei</i>	ott84261	D	31	0.78	0.46	1.1	1	7.50	1.193	(238)
Fundulidae	<i>Lucania parva</i>	ott839518	D	32	0.79	0.41	1.17	1	5.77	0.828	(238)
Gadidae	<i>Gadus morhua</i>	ott5860467	P	35	0.87	0.72	1.03	16	2.05 – 3.30	1.033 – 1.640	(239)
Gadidae	<i>Melanogrammus aeglefinus</i>	ott635904	P	36	0.87	0.74	1.01	60	2.17 – 3.72	1.166 – 1.957	(239)
Gadidae	<i>Merlangius merlangus</i>	ott635911	P	37	0.79	0.61	0.98	40	1.07 – 1.95	0.587 – 0.998	(239)
Gadidae	<i>Pollachius pollachius</i>	ott1014047	P	39	0.83	0.62	1.04	14	1.50 – 1.73	0.728 – 0.860	(239)
Gadidae	<i>Pollachius virens</i>	ott62649	P	40	0.87	0.65	1.1	8	1.43 – 1.85	0.656 – 0.790	(239)
Gadidae	<i>Trisopterus esmarkii</i>	ott926146	P	41	0.82	0.59	1.04	31	1.20 – 1.75	0.604 – 0.891	(239)
Gasterosteidae	<i>Gasterosteus aculeatus</i>	ott111122	D	45	0.4	0.05	0.74	3	2.57 – 2.91	2.915 – 3.246	(240)
Gobiidae	<i>Coryphopterus dicrus</i>	ott37549	D	86	0.62	0.29	0.94	11	0.27 – 0.33	0.082 – 0.108	*
Gobiidae	<i>Coryphopterus glaucofraenum</i>	ott494031	D	87	0.95	0.69	1.22	20	0.10 – 0.31	0.064 – 0.093	*
Gobiidae	<i>Coryphopterus personatus</i>	ott740192	D	88	0.77	0.51	1.02	28	0.13 – 0.31	0.059 – 0.082	*
Haemulidae	<i>Haemulon flavolineatum</i>	ott432196	P	96	0.73	0.28	1.17	5	0.56 – 0.63	0.318 – 0.350	*
Hemipteridae	<i>Blepsias cirrhosus</i>	ott446859	D	281	1.1	0.83	1.38	1	114.86	3.170	*
Hemipteridae	<i>Hemipteris villosus</i>	ott438425	D	283	1.27	1.03	1.51	4	271.44 – 299.41	4.520 – 4.520	*
Hexagrammidae	<i>Oxylebius pictus</i>	ott131554	D	284	0.66	0.27	1.04	1	5.50	1.465	*
Labridae	<i>Bodianus axillaris</i>	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 <sup>3</sup> )	Refs
Labridae	<i>Bodianus diplotaenia</i>	ott919235	P	101	0.67	0.19	1.11	10	0.16 – 0.32	0.172 – 0.211	*
Labridae	<i>Bodianus rufus</i>	ott372258	P	102	0.82	0.37	1.29	4	0.30 – 0.45	0.179 – 0.218	*
Labridae	<i>Clepticus parrae</i>	ott948303	P	106	0.76	0.33	1.19	6	0.24 – 0.35	0.151 – 0.166	*
Labridae	<i>Doratonotus megalepis</i>	ott763958	P	109	0.84	0.43	1.26	9	0.10 – 0.15	0.080 – 0.098	*
Labridae	<i>Halichoeres bivittatus</i>	ott694396	P	113	0.8	0.47	1.13	17	0.12 – 0.22	0.094 – 0.129	*
Labridae	<i>Halichoeres chierchiae</i>	ott615862	P	114	0.64	0.21	1.06	15	0.15 – 0.31	0.125 – 0.166	*
Labridae	<i>Halichoeres chloropterus</i>	ott1015715	P	115	0.79	0.36	1.23	3	0.15 – 0.18	0.086 – 0.103	*
Labridae	<i>Halichoeres dispilus</i>	ott762170	P	116	0.63	0.18	1.04	15	0.07 – 0.19	0.093 – 0.115	*
Labridae	<i>Halichoeres garnoti</i>	ott665840	P	117	0.69	0.27	1.11	15	0.17 – 0.29	0.117 – 0.162	*
Labridae	<i>Halichoeres hortulanus</i>	ott694390	P	118	0.94	0.57	1.31	2	0.13 – 0.14	0.095 – 0.101	*
Labridae	<i>Halichoeres maculipinna</i>	ott955368	P	119	0.78	0.34	1.22	6	0.13 – 0.18	0.090 – 0.107	*
Labridae	<i>Halichoeres margaritaceus</i>	ott694405	P	120	0.74	0.46	1.01	5	0.13 – 0.18	0.077 – 0.092	*
Labridae	<i>Halichoeres marginatus</i>	ott694408	P	121	0.55	0.19	0.9	3	0.20 – 0.24	0.096 – 0.105	*
Labridae	<i>Halichoeres melanurus</i>	ott627330	P	122	0.79	0.33	1.24	6	0.19 – 0.22	0.111 – 0.114	*
Labridae	<i>Halichoeres miniatus</i>	ott694399	P	123	0.81	0.45	1.16	3	0.15 – 0.19	0.097 – 0.114	*
Labridae	<i>Halichoeres nebulosus</i>	ott1015709	P	124	0.78	0.34	1.21	1	0.18	0.093	*
Labridae	<i>Halichoeres nicholsi</i>	ott694402	P	125	0.71	0.28	1.13	2	0.20 – 0.25	0.137 – 0.138	*
Labridae	<i>Halichoeres notospilus</i>	ott694414	P	126	0.96	0.64	1.28	3	0.13 – 0.14	0.094 – 0.099	*
Labridae	<i>Halichoeres pictus</i>	ott173446	P	127	1	0.57	1.46	4	0.16 – 0.43	0.115 – 0.154	*
Labridae	<i>Halichoeres poeyi</i>	ott38828	P	128	0.68	0.24	1.1	15	0.19 – 0.28	0.117 – 0.143	*
Labridae	<i>Halichoeres trimaculatus</i>	ott942026	P	129	0.8	0.35	1.25	6	0.14 – 0.18	0.088 – 0.099	*
Labridae	<i>Hemigymmus fasciatus</i>	ott924674	P	130	0.75	0.29	1.22	1	0.37	0.181	*
Labridae	<i>Hemigymmus melapterus</i>	ott302368	P	131	0.67	0.25	1.1	6	0.30 – 0.43	0.143 – 0.186	*
Labridae	<i>Novaculichthys taeniourus</i>	ott456983	P	137	0.72	0.3	1.13	6	0.12 – 0.21	0.085 – 0.101	*
Labridae	<i>Stethojulis bandanensis</i>	ott201174	P	140	0.79	0.49	1.08	2	0.12 – 0.12	0.069 – 0.071	*
Labridae	<i>Symphodus mediterraneus</i>	ott730049	D	141	0.78	0.33	1.22	1	1.05	0.236	*
Labridae	<i>Symphodus roissali</i>	ott876619	D	142	0.49	0.1	0.86	10	0.89 – 1.01	0.200 – 0.280	*
Labridae	<i>Symphodus rostratus</i>	ott553190	D	143	0.75	0.37	1.12	6	1.09 – 1.23	0.266 – 0.305	*
Labridae	<i>Symphodus tinca</i>	ott787184	D	144	0.87	0.45	1.28	3	1.17 – 1.35	0.251 – 0.271	*
Labridae	<i>Thalassoma bifasciatum</i>	ott907850	P	145	0.94	0.64	1.23	15	0.08 – 0.15	0.072 – 0.092	*
Labridae	<i>Thalassoma hardwicke</i>	ott102998	P	146	0.69	0.43	0.95	7	0.11 – 0.14	0.058 – 0.068	*
Labridae	<i>Thalassoma janseni</i>	ott1094748	P	147	0.77	0.51	1.02	6	0.11 – 0.13	0.060 – 0.075	*
Labridae	<i>Thalassoma lucasanum</i>	ott1094750	P	148	0.78	0.5	1.05	15	0.09 – 0.16	0.065 – 0.083	*
Labridae	<i>Thalassoma lunare</i>	ott948286	P	149	0.71	0.44	0.97	5	0.12 – 0.13	0.065 – 0.074	*
Moronidae	<i>Dicentrarchus labrax</i>	ott3549	P	157	0.81	0.5	1.13	17	2.35 – 3.67	0.776 – 1.232	(241)
Mullidae	<i>Parupeneus multifasciatus</i>	ott295485	P	158	0.76	0.28	1.23	4	0.26 – 0.31	0.126 – 0.137	*
Muraenesocidae	<i>Muraenesox cinereus</i>	ott479856	P	1	0.59	0.35	0.82	7	3.20 – 5.79	2.070 – 6.290	*
Nemipteridae	<i>Scolopsis bilineata</i>	ott463069	P	159	0.76	0.29	1.22	1	0.45	0.227	*
Pinguipedidae	<i>Parapercis snyderi</i>	ott3635246	P	163	0.67	0.25	1.08	6	0.25 – 0.35	0.131 – 0.203	*
Pleuronectidae	<i>Hippoglossus hippoglossus</i>	ott408328	P	263	0.84	0.74	0.95	6	37.25 – 40.75	15.150 – 16.056	(242)
Pleuronectidae	<i>Pleuronectes platessa</i>	ott408337	P	264	0.68	0.56	0.81	41	5.22 – 7.96	2.802 – 4.489	(151)
Pleuronectidae	<i>Pseudopleuronectes americanus</i>	ott261419	D	265	0.5	0.14	0.85	2	1.25 – 1.28	0.230 – 0.463	*
Pomacentridae	<i>Abudefduf bengalensis</i>	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 <sup>3</sup> )	Refs
Pomacentridae	<i>Abudefduf saxatilis</i>	ott405751	D	167	0.67	0.27	1.05	48	0.87 – 1.17	0.171 – 0.214	*
Pomacentridae	<i>Abudefduf septemfasciatus</i>	ott129790	D	168	0.77	0.36	1.18	10	1.06 – 1.29	0.221 – 0.237	*
Pomacentridae	<i>Abudefduf sordidus</i>	ott1053071	D	169	0.79	0.42	1.17	8	1.07 – 1.47	0.233 – 0.269	*
Pomacentridae	<i>Abudefduf troschelii</i>	ott961357	D	170	0.87	0.54	1.21	44	0.57 – 1.13	0.133 – 0.172	*
Pomacentridae	<i>Abudefduf vaigiensis</i>	ott1053067	D	171	0.76	0.37	1.16	13	0.76 – 1.01	0.137 – 0.178	*
Pomacentridae	<i>Chromis atrilobata</i>	ott436999	D	173	1.1	0.84	1.35	6	0.31 – 0.40	0.075 – 0.088	*
Pomacentridae	<i>Chromis atripectoralis</i>	ott741423	D	174	0.67	0.41	0.9	5	0.48 – 0.59	0.066 – 0.091	*
Pomacentridae	<i>Chromis multilineata</i>	ott437016	D	175	0.83	0.6	1.04	14	0.35 – 0.50	0.070 – 0.081	*
Pomacentridae	<i>Hypsypops rubicundus</i>	ott847666	D	176	0.84	0.59	1.07	7	1.54 – 1.93	0.401 – 0.453	*
Pomacentridae	<i>Microspathodon bairdii</i>	ott237630	D	177	0.73	0.33	1.09	10	0.57 – 0.78	0.133 – 0.175	*
Pomacentridae	<i>Microspathodon chrysurus</i>	ott847660	D	178	0.72	0.42	1.02	38	0.42 – 0.79	0.109 – 0.140	*
Pomacentridae	<i>Microspathodon dorsalis</i>	ott205758	D	179	0.77	0.5	1.04	24	0.51 – 0.87	0.115 – 0.196	*
Pomacentridae	<i>Stegastes acapulcoensis</i>	ott3635554	D	181	0.96	0.69	1.21	22	0.33 – 0.56	0.092 – 0.103	*
Pomacentridae	<i>Stegastes adustus</i>	ott323181	D	182	0.97	0.76	1.18	40	0.26 – 0.62	0.077 – 0.115	*
Pomacentridae	<i>Stegastes dienaecus</i>	ott729161	D	183	0.72	0.33	1.08	18	0.62 – 0.82	0.133 – 0.156	*
Pomacentridae	<i>Stegastes flavilatus</i>	ott3635541	D	184	0.9	0.69	1.09	27	0.21 – 0.58	0.069 – 0.118	*
Pomacentridae	<i>Stegastes leucostictus</i>	ott100830	D	186	0.89	0.48	1.27	41	1.03 – 1.45	0.213 – 0.261	*
Pomacentridae	<i>Stegastes partitus</i>	ott345269	D	187	0.94	0.77	1.13	40	0.19 – 0.54	0.061 – 0.088	*
Pomacentridae	<i>Stegastes planifrons</i>	ott665837	D	188	0.84	0.48	1.2	19	0.45 – 0.91	0.127 – 0.151	*
Pomacentridae	<i>Stegastes variabilis</i>	ott323173	D	189	0.96	0.59	1.33	24	0.45 – 0.84	0.133 – 0.172	*
Scaridae	<i>Chlorurus sordidus</i>	ott436737	P	191	0.67	0.26	1.05	6	0.18 – 0.29	0.099 – 0.121	*
Scaridae	<i>Cryptotomus roseus</i>	ott321483	P	192	0.97	0.61	1.33	10	0.10 – 0.16	0.092 – 0.110	*
Scaridae	<i>Scarus flavipectoralis</i>	ott1041716	P	194	0.71	0.31	1.11	2	0.22 – 0.23	0.122 – 0.124	*
Scaridae	<i>Scarus frenatus</i>	ott436725	P	196	0.68	0.27	1.07	2	0.25 – 0.27	0.121 – 0.123	*
Scaridae	<i>Scarus globiceps</i>	ott514869	P	197	0.79	0.35	1.23	1	0.24	0.137	*
Scaridae	<i>Scarus iseri</i>	ott686634	P	198	0.87	0.43	1.3	5	0.20 – 0.24	0.132 – 0.144	*
Scaridae	<i>Scarus niger</i>	ott14311	P	199	0.56	0.16	0.95	3	0.24 – 0.32	0.118 – 0.123	*
Scaridae	<i>Scarus psittacus</i>	ott514872	P	200	1.06	0.71	1.41	5	0.11 – 0.16	0.097 – 0.110	*
Scaridae	<i>Scarus schlegeli</i>	ott514881	P	201	0.64	0.22	1.05	4	0.23 – 0.27	0.125 – 0.137	*
Scaridae	<i>Scarus spinus</i>	ott419732	P	202	0.77	0.4	1.15	2	0.19 – 0.22	0.107 – 0.111	*
Scaridae	<i>Sparisoma atomarium</i>	ott686627	P	203	1.04	0.65	1.43	2	0.10 – 0.13	0.103 – 0.109	*
Scaridae	<i>Sparisoma aurofrenatum</i>	ott686624	P	204	0.57	0.15	0.96	5	0.19 – 0.29	0.117 – 0.130	*
Scaridae	<i>Sparisoma radians</i>	ott214109	P	205	0.78	0.47	1.08	6	0.10 – 0.18	0.090 – 0.109	*
Scaridae	<i>Sparisoma rubripinne</i>	ott686642	P	206	0.58	0.17	0.99	5	0.22 – 0.28	0.128 – 0.135	*
Sciaenidae	<i>Cynoscion regalis</i>	ott5860595	P	208	0.18	-0.22	0.54	10	0.62 – 2.38	0.349 – 0.534	*
Sciaenidae	<i>Leiostomus xanthurus</i>	ott1052160	P	214	0.62	0.12	1.07	1	0.61	0.276	*
Sciaenidae	<i>Micropogonias undulatus</i>	ott987393	P	217	0.69	0.18	1.16	1	0.68	0.220	*
Serranidae	<i>Epinephelus fasciatus</i>	ott534146	P	234	0.85	0.44	1.28	14	0.14 – 0.31	0.171 – 0.215	*
Serranidae	<i>Serranus tabacarius</i>	ott284266	P	238	0.79	0.39	1.18	4	0.39 – 0.47	0.331 – 0.343	*
Serranidae	<i>Serranus tigrinus</i>	ott807897	P	239	0.54	0.07	0.96	15	0.19 – 0.31	0.148 – 0.209	*
Serranidae	<i>Serranus tortugarum</i>	ott511782	P	240	0.75	0.32	1.19	15	0.22 – 0.44	0.200 – 0.248	*
Soleidae	<i>Solea solea</i>	ott710233	P	268	0.77	0.42	1.12	13	2.02 – 3.41	1.202 – 1.583	(234)
Tetraodontidae	<i>Canthigaster rostrata</i>	ott484093	D	341	0.73	0.26	1.19	1	0.69	0.122	*
Trichodontidae	<i>Arctoscopus japonicus</i>	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 <sup>3</sup> )	Mass range (g)	Refs
Atherinidae	<i>Atherina presbyter</i>	ott669918	D	2	1.08	0.87	1.28	33	784.1 – 9,566	1.47 – 13.70	(81)
Balistidae	<i>Balistes caprisus</i>	ott135140	S	335	1.13	0.75	1.51	64	13,123 – 77,449	272.64 – 696.02	(85)
Bothidae	<i>Arnoglossus laterna</i>	ott696263	P	258	1.13	0.71	1.59	2	398 – 3,343	2.68 – 9.09	(87)
Carangidae	<i>Decapterus punctatus</i>	ott705034	P	74	1.48	0.99	2.01	2	151.5 – 1,246	16.71 – 53.59	(88)
Carangidae	<i>Trachurus picturatus</i>	ott174574	P	77	1.12	0.55	1.69	8	4,595 – 9,493	38.10 – 73.11	(90)
Clupeidae	<i>Amblygaster sirm</i>	ott328216	P	11	1.74	1.22	2.34	33	967.7 – 6,699	34.39 – 57.50	(92)
Clupeidae	<i>Ethmalosa fimbriata</i>	ott658559	P	16	0.91	0.51	1.3	32	613.5 – 2,013	182.55 – 582.47	(94)
Clupeidae	<i>Spratelloides gracilis</i>	ott39732	D	21	0.98	0.69	1.28	18	106.7 – 1,062	0.20 – 0.86	(99)
Cottidae	<i>Enophrys bison</i>	ott290389	D	274	1.14	0.4	1.91	2	48,362 – 133,622	197.53 – 241.50	(101)
Engraulidae	<i>Cetengraulis mysticetus</i>	ott1064953	P	24	1.38	1.11	1.66	86	642.1 – 6,957	25.10 – 71.50	(103)
Engraulidae	<i>Engraulis mordax</i>	ott29754	P	26	0.98	0.52	1.46	21	8,869 – 36,367	10.47 – 23.98	(105)
Gadidae	<i>Gadus morhua</i>	ott5860467	P	35	1.51	1.36	1.66	67	923,939 – 36,102,635	1382.51 – 24086.31	(110)
Gasterosteidae	<i>Gasterosteus aculeatus</i>	ott111122	D	45	0.91	0.51	1.31	2	330.8 – 905.9	0.80 – 1.50	(116)
Hemirhamphidae	<i>Hemirhamphus americanus</i>	ott160287	D	282	2.43	1.83	3.08	6	2,313 – 800,914	303.44 – 1004.16	(121)
Hexagrammidae	<i>Oxylebius pictus</i>	ott131554	D	284	0.73	0.46	1.01	43	14,712 – 42,473	32.22 – 148.53	(122)
Lutjanidae	<i>Lutjanus carponotatus</i>	ott333348	P	152	1.81	1.59	2.03	55	154 – 31,682	77.08 – 485.66	(125)
Malacanthidae	<i>Caulolatilus microps</i>	ott39883	P	156	1.5	1.22	1.79	43	21,548 – 1,063,744	762.87 – 4527.12	(129)
Merlucciidae	<i>Merluccius merluccius</i>	ott5860466	P	44	1.17	0.99	1.34	209	10,066 – 557,218	626.18 – 3465.51	(132)
Monacanthidae	<i>Eubalichthys bucephalus</i>	ott3631310	S	337	1.47	0.71	2.28	2	1,833 – 8,046	355.86 – 524.85	(134)
Monacanthidae	<i>Oxymonacanthus longirostris</i>	ott333706	S	338	1.35	0.89	1.81	3	17.96 – 35.92	3.30 – 3.79	(135)
Monacanthidae	<i>Rudarius ercodes</i>	ott511593	S	340	0.91	0.52	1.29	3	199.6 – 637.6	1.25 – 5.78	(136)
Mugilidae	<i>Chelon labrosus</i>	ott777079	P	46	1.01	0.33	1.66	13	31,770 – 180,570	1240.00 – 2300.00	(138)
Mugilidae	<i>Chelon ramada</i>	ott668241	P	47	1.23	0.49	1.98	2	29,050 – 62,150	850.00 – 1450.00	(138)
Mugilidae	<i>Mugil cephalus</i>	ott418648	P	48	0.95	0.74	1.16	73	37,102 – 395,750	274.75 – 3760.17	(139); (141)
Mugilidae	<i>Planiliza subviridis</i>	ott823526	P	53	1.02	0.56	1.5	12	6,011 – 22,974	11.69 – 28.41	(143)
Paralichthyidae	<i>Paralichthys dentatus</i>	ott1019735	P	259	1.06	0.9	1.22	134	240,886 – 2,200,444	2627.81 – 20166.83	(146)
Pleuronectidae	<i>Pseudopleuronectes americanus</i>	ott261419	D	265	0.99	0.58	1.4	17	64,023 – 416,296	332.81 – 1322.71	(152)
Pomacentridae	<i>Pomacentrus coelestis</i>	ott622060	D	180	0.97	0.68	1.26	81	268.2 – 934.8	1.27 – 3.26	(157)
Sciaenidae	<i>Cynoscion regalis</i>	ott5860595	P	208	1.51	1.24	1.79	29	10,181 – 244,728	554.68 – 3969.46	(161)
Sciaenidae	<i>Larimus fasciatus</i>	ott897432	P	213	1.04	0.86	1.22	81	1,021 – 18,297	8.75 – 59.86	(164)
Scombridae	<i>Scomberomorus cavalla</i>	ott70546	P	226	1.37	1.23	1.5	64	31,588 – 5,566,904	886.37 – 28991.83	(171)
Scombridae	<i>Thunnus thynnus</i>	ott358607	P	231	1.18	0.58	1.78	27	1,001,262 – 4,240,637	1336.98 – 2861.01	(176)
Sebastidae	<i>Sebastes mentella</i>	ott1088432	BI	309	1.44	1.14	1.75	54	7,152 – 79,378	381.88 – 1284.55	(190)
Sebastidae	<i>Sebastes norvegicus</i>	ott1088441	BI	312	1.02	0.63	1.41	26	24,234 – 146,044	477.49 – 2037.78	(190)
Serranidae	<i>Cephalopholis cruentata</i>	ott12880	P	232	1.22	0.65	1.79	12	6,720 – 47,971	142.95 – 414.81	(196)
Serranidae	<i>Epinephelus tauvina</i>	ott218649	P	236	0.81	0.33	1.28	4	40,565 – 138,602	1062.45 – 6012.89	(198)
Siganidae	<i>Siganus canaliculatus</i>	ott199059	S	241	1.27	1.05	1.48	27	649.8 – 28,482	59.67 – 870.20	(200)
Soleidae	<i>Solea solea</i>	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 (mm <sup>3</sup> )	Mass range (g)	Refs
Sparidae	<i>Acanthopagrus latus</i>	ott760733	P	242	1.11	0.35	1.87	5	135,589 – 214,311	426.21 – 660.47	(202)
Sparidae	<i>Archosargus rhomboidalis</i>	ott724892	P	243	0.95	0.71	1.19	23	250.7 – 2,210	15.05 – 156.17	(203)
Sparidae	<i>Sparidentex hasta</i>	ott845300	P	244	1.28	0.68	1.92	6	30,686 – 168,559	2604.06 – 6288.57	(202)
Stromateidae	<i>Pampus chinensis</i>	ott916290	P	245	1.17	0.41	1.93	8	48,733 – 56,431	647.18 – 876.77	(204)
Tetraodontidae	<i>Canthigaster valentini</i>	ott701127	S	342	0.98	0.76	1.2	66	75.25 – 346.3	2.32 – 9.09	(207)
Trichiuridae	<i>Aphanopus carbo</i>	ott113465	P	246	1.27	0.68	1.87	14	184,493 – 774,750	1950.46 – 4169.05	(209)
Zoarcidae	<i>Melanostigma atlanticum</i>	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	<i>Acanthurus coeruleus</i>	ott324283	P	55	1.29	1.19	1.41	No	No	Yes
Acanthuridae	<i>Acanthurus nigrofuscus</i>	ott605289	P	56	1.27	1.18	1.37	No	No	Yes
Acanthuridae	<i>Acanthurus triostegus</i>	ott467300	P	57	1.28	1.19	1.38	No	No	Yes
Acanthuridae	<i>Zebrasoma scopas</i>	ott199073	P	58	1.29	1.19	1.4	No	No	Yes
Agonidae	<i>Leptagonus decagonus</i>	ott3632024	D	269	1.3	0.71	1.87	Yes	Yes	No
Agonidae	<i>Podothecus sachi</i>	ott590745	D	270	1.27	1.18	1.36	No	No	Yes
Apogonidae	<i>Cheilodipterus macrodon</i>	ott965176	BM	59	1.44	0.78	2.11	Yes	Yes	No
Apogonidae	<i>Cheilodipterus quinquelineatus</i>	ott364614	BM	60	1.27	1.18	1.37	No	No	Yes
Apogonidae	<i>Holapogon maximus</i>	ott3635086	BM	61	1.36	0.72	1.95	Yes	Yes	No
Apogonidae	<i>Jaydia hungi</i>	ott3634955	BM	62	1.29	0.71	1.88	Yes	Yes	No
Apogonidae	<i>Ostorhinchus cookii</i>	ott102070	BM	63	1.32	0.75	1.87	Yes	Yes	No
Apogonidae	<i>Ostorhinchus cyanosoma*</i>	ott638185	BM	64	1.22	0.74	1.72	Yes	Yes	Yes
Apogonidae	<i>Ostorhinchus doederleini</i>	ott687634	BM	65	1.29	1.19	1.41	No	No	Yes
Apogonidae	<i>Paroncheilus affinis</i>	ott974576	BM	66	1.43	1.16	1.72	No	Yes	No
Apogonidae	<i>Siphamia tubifer</i>	ott5860863	BM	67	0.79	0.41	1.18	Yes	Yes	No
Apogonidae	<i>Taeniamia lineolata</i>	ott775407	BM	68	1.04	0.57	1.53	Yes	Yes	No
Atherinidae	<i>Atherina presbyter</i>	ott669918	D	2	1.19	0.84	1.53	Yes	Yes	No
Atherinopsidae	<i>Leuresthes tenuis</i>	ott274466	D	3	1.5	1.03	1.97	Yes	No	No
Atherinopsidae	<i>Membras gilberti</i>	ott680137	D	4	1.28	1.19	1.4	No	No	Yes
Atherinopsidae	<i>Menidia menidia</i>	ott189767	D	5	1.24	1.05	1.42	No	Yes	No
Atherinopsidae	<i>Odontesthes argentinensis</i>	ott93287	D	6	1.28	0.96	1.6	Yes	No	No
Balistidae	<i>Balistes capriscus</i>	ott135140	S	335	1.75	1.32	2.17	Yes	Yes	No
Bathypagrusidae	<i>Akarotaxis nudiceps</i>	ott682053	D	69	1.16	0.88	1.44	No	Yes	No
Blenniidae	<i>Aidablennius sphyinx</i>	ott898527	D	70	1.11	0.65	1.57	Yes	Yes	No
Blenniidae	<i>Ophioblennius atlanticus</i>	ott282319	D	71	1.31	1.2	1.42	No	No	Yes
Blenniidae	<i>Ophioblennius steindachneri</i>	ott155044	D	72	1.3	1.2	1.41	No	No	Yes
Bothidae	<i>Arnoglossus laterna</i>	ott696263	P	258	1.18	0.73	1.64	Yes	Yes	No
Callionymidae	<i>Synchiropus sechellensis</i>	ott3632718	P	73	1.36	1.05	1.67	No	Yes	No
Carangidae	<i>Decapterus punctatus</i>	ott705034	P	74	1.59	1.06	2.13	Yes	Yes	No
Carangidae	<i>Elagatis bipinnulata</i>	ott705026	P	75	1.1	0.83	1.37	Yes	No	No
Carangidae	<i>Trachurus mediterraneus</i>	ott174577	P	76	1.29	0.93	1.66	No	Yes	No
Carangidae	<i>Trachurus picturatus</i>	ott174574	P	77	1.21	0.65	1.77	Yes	Yes	No
Carangidae	<i>Trachurus trachurus</i>	ott472429	P	78	1.3	1.01	1.61	No	Yes	No
Centropomidae	<i>Centropomus undecimalis</i>	ott317368	P	79	1.6	1.19	2.01	Yes	No	No
Chaenopsidae	<i>Acanthemblemaria hancocki</i>	ott57340	D	80	1.27	1.18	1.37	No	No	Yes
Chaenopsidae	<i>Acanthemblemaria rivasi</i>	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	<i>Amblygaster sirm</i>	ott328216	P	11	1.82	1.25	2.39	Yes	Yes	No
Clupeidae	<i>Brevoortia patronus</i>	ott107260	P	12	1.24	0.9	1.59	No	Yes	No
Clupeidae	<i>Brevoortia tyrannus</i>	ott107265	P	13	1.24	1.16	1.32	No	No	Yes
Clupeidae	<i>Clupea harengus</i>	ott1005932	D	14	1.65	1.52	1.78	Yes	No	No
Clupeidae	<i>Clupea pallasii</i>	ott9666	D	15	1.32	1.21	1.44	No	No	Yes
Clupeidae	<i>Ethmalosa fimbriata</i>	ott658559	P	16	1.09	0.55	1.64	Yes	Yes	No
Clupeidae	<i>Nematalosa vlaminghi</i>	ott328199	P	17	1.2	0.54	1.84	Yes	Yes	No
Clupeidae	<i>Opisthonema libertate</i>	ott437031	P	18	1.21	0.81	1.6	Yes	No	No
Clupeidae	<i>Opisthonema medirastre</i>	ott1195	P	19	1.35	0.92	1.78	Yes	No	No
Clupeidae	<i>Sardinops sagax</i>	ott121238	P	20	1.08	0.93	1.23	Yes	No	No
Clupeidae	<i>Spratelloides gracilis</i>	ott39732	D	21	1.08	0.76	1.42	Yes	Yes	No
Clupeidae	<i>Strangomera bentincki</i>	ott648871	P	22	1.19	0.75	1.6	Yes	No	No
Congiopodidae	<i>Zanclorhynchus spinifer</i>	ott255677	P	271	1.37	1.03	1.74	No	Yes	No
Coryphaenidae	<i>Coryphaena hippurus</i>	ott223663	P	85	1.28	1.19	1.39	No	No	Yes
Cottidae	<i>Alcichthys elongatus</i>	ott3632242	D	272	1.28	1.19	1.39	No	No	Yes
Cottidae	<i>Artediellus atlanticus</i>	ott654509	D	273	1.22	0.64	1.79	Yes	Yes	No
Cottidae	<i>Enophrys bison</i>	ott290389	D	274	1.32	0.64	2	Yes	Yes	No
Cottidae	<i>Gymnocanthus tricuspis</i>	ott654474	D	275	1.33	0.97	1.68	No	Yes	No
Cottidae	<i>Icelus bicornis</i>	ott3632116	D	276	1.19	0.63	1.75	Yes	Yes	No
Cottidae	<i>Triglops pingelii</i>	ott568671	D	277	1.11	0.54	1.67	Yes	Yes	No
Cyclopteridae	<i>Aptocyclus ventricosus</i>	ott989887	D	278	1.33	1.22	1.45	No	No	Yes
Cyclopteridae	<i>Cyclopteropsis mcalpini</i>	ott3631993	D	279	0.99	0.51	1.47	Yes	Yes	No
Cyclopteridae	<i>Eumicrotremus spinosus</i>	ott1097394	D	280	1.25	0.92	1.58	No	Yes	No
Engraulidae	<i>Anchoviella lepidentostole</i>	ott610213	P	23	1.08	0.7	1.46	Yes	No	No
Engraulidae	<i>Cetengraulis mysticetus</i>	ott1064953	P	24	1.39	1.11	1.66	Yes	Yes	No
Engraulidae	<i>Engraulis anchoita</i>	ott648864	P	25	1.36	1.13	1.58	Yes	Yes	No
Engraulidae	<i>Engraulis mordax*</i>	ott29754	P	26	1.15	0.64	1.64	Yes	Yes	Yes
Engraulidae	<i>Engraulis ringens</i>	ott211981	P	27	1.48	1.25	1.71	Yes	No	Yes
Exocoetidae	<i>Hirundichthys affinis</i>	ott837204	D	7	1.24	0.56	1.92	Yes	Yes	No
Fundulidae	<i>Fundulus heteroclitus</i>	ott4134765	D	29	1.3	1.15	1.46	No	Yes	No
Fundulidae	<i>Fundulus xenicus</i>	ott839523	D	30	1.26	1.02	1.5	No	Yes	No
Fundulidae	<i>Lucania goodei</i>	ott84261	D	31	1.29	1.2	1.4	No	No	Yes
Fundulidae	<i>Lucania parva</i>	ott839518	D	32	1.3	1.2	1.41	No	No	Yes
Gadidae	<i>Boreogadus saida</i>	ott877055	P	33	0.85	0.28	1.42	Yes	Yes	No
Gadidae	<i>Eleginus nawaga</i>	ott450082	D	34	1.1	0.47	1.73	Yes	Yes	No
Gadidae	<i>Gadus morhua*</i>	ott5860467	P	35	1.33	1.25	1.43	Yes	Yes	Yes
Gadidae	<i>Melanogrammus aeglefinus</i>	ott635904	P	36	1.25	1.17	1.34	No	Yes	Yes
Gadidae	<i>Merlangius merlangus</i>	ott635911	P	37	1.14	1.01	1.28	Yes	No	Yes
Gadidae	<i>Micromesistius australis</i>	ott1091056	P	38	1.64	1.19	2.07	Yes	Yes	No
Gadidae	<i>Pollachius pollachius</i>	ott1014047	P	39	1.3	1.21	1.4	No	No	Yes
Gadidae	<i>Pollachius virens</i>	ott62649	P	40	1.31	1.21	1.41	No	No	Yes
Gadidae	<i>Trisopterus esmarkii</i>	ott926146	P	41	1.3	1.2	1.4	No	No	Yes
Gasterosteidae	<i>Gasterosteus aculeatus*</i>	ott111122	D	45	1.01	0.82	1.23	Yes	Yes	Yes
Gobiidae	<i>Coryphopterus dicrus</i>	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	<i>Coryphopterus glaucofraenum</i>	ott494031	D	87	1.32	1.21	1.42	No	No	Yes
Gobiidae	<i>Coryphopterus personatus</i>	ott740192	D	88	1.29	1.2	1.39	No	No	Yes
Gobiidae	<i>Elacatinus oceanops</i>	ott638369	D	89	0.72	0.3	1.12	Yes	Yes	No
Gobiidae	<i>Gobiosoma robustum</i>	ott1064480	D	90	1.49	0.78	2.17	Yes	Yes	No
Gobiidae	<i>Oligolepis acutipennis</i>	ott767535	D	91	1.37	1.02	1.74	No	Yes	No
Gobiidae	<i>Paragobiodon echinocephalus</i>	ott940827	D	92	0.95	0.53	1.37	Yes	Yes	No
Gobiidae	<i>Paragobiodon lacunicolus</i>	ott758973	D	93	0.96	0.54	1.37	Yes	Yes	No
Gobiidae	<i>Paragobiodon xanthosoma</i>	ott770378	D	94	1.04	0.62	1.45	Yes	Yes	No
Gobiidae	<i>Pomatoschistus minutus</i>	ott1048873	D	95	0.92	0.57	1.28	Yes	No	No
Haemulidae	<i>Haemulon flavolineatum</i>	ott432196	P	96	1.29	1.19	1.4	No	No	Yes
Haemulidae	<i>Haemulopsis corvinaeformis</i>	ott177515	P	97	0.69	0.3	1.08	Yes	Yes	No
Hemiramphidae	<i>Hemiramphus brasiliensis</i>	ott953384	D	8	1.1	0.55	1.67	Yes	Yes	No
Hemitripteridae	<i>Blepsias cirrhosus</i>	ott446859	D	281	1.34	1.23	1.45	No	No	Yes
Hemitripteridae	<i>Hemitripteris americanus</i>	ott160287	D	282	2.25	1.69	2.82	Yes	Yes	No
Hemitripteridae	<i>Hemitripteris villosus</i>	ott438425	D	283	1.36	1.24	1.49	No	No	Yes
Hexagrammidae	<i>Oxylebius pictus*</i>	ott131554	D	284	1.12	0.57	1.7	Yes	Yes	Yes
Labridae	<i>Anampses caeruleopunctatus</i>	ott372276	D	98	1.3	0.93	1.66	No	Yes	No
Labridae	<i>Anampses twistii</i>	ott762167	P	99	1.28	0.94	1.62	No	Yes	No
Labridae	<i>Bodianus axillaris</i>	ott548889	P	100	1.29	1.19	1.41	No	No	Yes
Labridae	<i>Bodianus diplotaenia</i>	ott919235	P	101	1.28	1.18	1.39	No	No	Yes
Labridae	<i>Bodianus rufus</i>	ott372258	P	102	1.3	1.19	1.42	No	No	Yes
Labridae	<i>Cheilinus fasciatus</i>	ott155291	P	103	1.29	0.92	1.67	No	Yes	No
Labridae	<i>Cheilinus oxycephalus</i>	ott195575	P	104	1.29	0.95	1.64	No	Yes	No
Labridae	<i>Cheilinus trilobatus</i>	ott924675	P	105	1.28	0.92	1.63	No	Yes	No
Labridae	<i>Clepticus parrae</i>	ott948303	P	106	1.29	1.19	1.4	No	No	Yes
Labridae	<i>Coris gaimard</i>	ott1092680	P	107	1.29	0.92	1.66	No	Yes	No
Labridae	<i>Coris variegata</i>	ott3636534	P	108	1.3	0.96	1.63	No	Yes	No
Labridae	<i>Doratonotus megalepis</i>	ott763958	P	109	1.3	1.2	1.42	No	No	Yes
Labridae	<i>Epibulus insidiator</i>	ott120301	P	110	1.29	0.92	1.66	No	Yes	No
Labridae	<i>Gomphosus varius</i>	ott358606	P	111	1.32	0.94	1.7	No	Yes	No
Labridae	<i>Halichoeres biocellatus</i>	ott1015700	P	112	1.27	1.01	1.54	No	Yes	No
Labridae	<i>Halichoeres bivittatus</i>	ott694396	P	113	1.3	1.2	1.4	No	No	Yes
Labridae	<i>Halichoeres chierchiae</i>	ott615862	P	114	1.27	1.18	1.38	No	No	Yes
Labridae	<i>Halichoeres chloropterus</i>	ott1015715	P	115	1.29	1.19	1.41	No	No	Yes
Labridae	<i>Halichoeres dispilus</i>	ott762170	P	116	1.27	1.18	1.38	No	No	Yes
Labridae	<i>Halichoeres garnoti</i>	ott665840	P	117	1.28	1.18	1.39	No	No	Yes
Labridae	<i>Halichoeres hortulanus</i>	ott694390	P	118	1.34	0.88	1.82	No	Yes	Yes
Labridae	<i>Halichoeres maculipinna</i>	ott955368	P	119	1.29	1.19	1.41	No	No	Yes
Labridae	<i>Halichoeres margaritaceus</i>	ott694405	P	120	1.29	1.2	1.38	No	No	Yes
Labridae	<i>Halichoeres marginatus</i>	ott694408	P	121	1.26	1.17	1.36	No	No	Yes
Labridae	<i>Halichoeres melanurus</i>	ott627330	P	122	1.3	0.95	1.69	No	Yes	Yes
Labridae	<i>Halichoeres miniatus</i>	ott694399	P	123	1.3	1.2	1.41	No	No	Yes
Labridae	<i>Halichoeres nebulosus</i>	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	<i>Halichoeres nicholsi</i>	ott694402	P	125	1.28	1.18	1.39	No	No	Yes
Labridae	<i>Halichoeres notospilus</i>	ott694414	P	126	1.32	1.21	1.43	No	No	Yes
Labridae	<i>Halichoeres pictus</i>	ott173446	P	127	1.32	1.21	1.45	No	No	Yes
Labridae	<i>Halichoeres poeyi</i>	ott38828	P	128	1.28	1.18	1.39	No	No	Yes
Labridae	<i>Halichoeres trimaculatus</i>	ott942026	P	129	1.3	1.19	1.42	No	No	Yes
Labridae	<i>Hemigymnus fasciatus</i>	ott924674	P	130	1.29	0.93	1.67	No	Yes	Yes
Labridae	<i>Hemigymnus melapterus</i>	ott302368	P	131	1.28	1.18	1.39	No	No	Yes
Labridae	<i>Labrichthys unilineatus</i>	ott302371	P	132	1.27	0.96	1.58	No	Yes	No
Labridae	<i>Labroides dimidiatus</i>	ott302377	P	133	1.27	0.99	1.54	No	Yes	No
Labridae	<i>Labropsis micronesica</i>	ott3636703	P	134	1.19	0.92	1.45	No	Yes	No
Labridae	<i>Labropsis xanthonota</i>	ott3636702	P	135	1.25	0.99	1.51	No	Yes	No
Labridae	<i>Macropharyngodon meleagris</i>	ott552117	P	136	1.26	0.99	1.54	No	Yes	No
Labridae	<i>Novaculichthys taeniourus</i>	ott456983	P	137	1.29	0.94	1.68	No	Yes	Yes
Labridae	<i>Oxycheilinus unifasciatus</i>	ott352271	P	138	1.29	0.93	1.66	No	Yes	No
Labridae	<i>Pseudocheilinus hexataenia</i>	ott712600	P	139	1.29	0.99	1.6	No	Yes	No
Labridae	<i>Stethojulis bandanensis</i>	ott201174	P	140	1.29	1.2	1.4	No	No	Yes
Labridae	<i>Symphodus mediterraneus</i>	ott730049	D	141	1.29	1.19	1.41	No	No	Yes
Labridae	<i>Symphodus roissali</i>	ott876619	D	142	1.21	1.1	1.33	No	Yes	Yes
Labridae	<i>Symphodus rostratus</i>	ott553190	D	143	1.29	1.19	1.4	No	No	Yes
Labridae	<i>Symphodus tinca</i>	ott787184	D	144	1.31	1.2	1.42	No	No	Yes
Labridae	<i>Thalassoma bifasciatum</i>	ott907850	P	145	0.88	0.71	1.05	Yes	No	Yes
Labridae	<i>Thalassoma hardwicke</i>	ott102998	P	146	1.28	1.19	1.37	No	No	Yes
Labridae	<i>Thalassoma janseni</i>	ott1094748	P	147	1.29	1.2	1.39	No	No	Yes
Labridae	<i>Thalassoma lucasanum</i>	ott1094750	P	148	1.29	1.2	1.39	No	No	Yes
Labridae	<i>Thalassoma lunare</i>	ott948286	P	149	1.28	1.19	1.38	No	No	Yes
Latidae	<i>Lates calcarifer</i>	ott6362446	P	150	1.15	0.93	1.38	Yes	No	No
Liparidae	<i>Careproctus reinhardti</i>	ott1065176	D	285	1.32	0.62	2.03	Yes	Yes	No
Liparidae	<i>Liparis fabricii</i>	ott496423	D	286	1.36	1.02	1.71	No	Yes	No
Liparidae	<i>Paraliparis bathybius</i>	ott309222	BM	287	1.31	0.64	1.98	Yes	Yes	No
Lutjanidae	<i>Lutjanus campechanus</i>	ott642863	P	151	1.1	0.72	1.47	Yes	No	No
Lutjanidae	<i>Lutjanus carponotatus</i>	ott333348	P	152	1.84	1.53	2.14	Yes	Yes	No
Lutjanidae	<i>Lutjanus synagris</i>	ott943184	P	153	0.77	0.56	0.99	Yes	No	No
Lutjanidae	<i>Ocyurus chrysurus</i>	ott943183	P	154	1.36	0.98	1.73	Yes	No	No
Lutjanidae	<i>Rhomboplites aurorubens</i>	ott642869	P	155	1.49	1.34	1.65	Yes	No	No
Malacanthidae	<i>Caulolatilus microps</i>	ott39883	P	156	1.63	1.19	2.07	Yes	Yes	No
Merlucciidae	<i>Merluccius gayi</i>	ott323082	P	42	1.3	1	1.59	Yes	No	No
Merlucciidae	<i>Merluccius hubbsi</i>	ott757316	P	43	1.17	1.08	1.27	Yes	No	No
Merlucciidae	<i>Merluccius merluccius</i>	ott5860466	P	44	1.12	0.94	1.3	Yes	Yes	No
Monacanthidae	<i>Brachaluteres jacksonianus</i>	ott333693	S	336	1.19	0.76	1.6	Yes	Yes	No
Monacanthidae	<i>Eubalichthys bucephalus</i>	ott3631310	S	337	1.42	0.73	2.14	Yes	Yes	No
Monacanthidae	<i>Oxymonacanthus longirostris</i>	ott333706	S	338	1.32	0.85	1.8	Yes	Yes	No
Monacanthidae	<i>Paramonacanthus japonicus</i>	ott3631319	S	339	1.28	1.02	1.54	No	Yes	No
Monacanthidae	<i>Rudarius ercodes</i>	ott511593	S	340	0.92	0.51	1.34	Yes	Yes	No
Moronidae	<i>Dicentrarchus labrax</i>	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	<i>Chelon labrosus</i>	ott777079	P	46	1.06	0.46	1.65	Yes	Yes	No
Mugilidae	<i>Chelon ramada</i>	ott668241	P	47	1.24	0.59	1.9	Yes	Yes	No
Mugilidae	<i>Mugil cephalus</i>	ott418648	P	48	0.93	0.61	1.23	Yes	Yes	No
Mugilidae	<i>Mugil curema</i>	ott418643	P	49	1.26	0.71	1.8	Yes	No	No
Mugilidae	<i>Mugil hospes</i>	ott779937	P	50	1.25	0.69	1.81	Yes	No	No
Mugilidae	<i>Mugil liza</i>	ott779933	P	51	1.3	0.72	1.88	Yes	No	No
Mugilidae	<i>Mugil trichodon</i>	ott246901	P	52	1.29	0.73	1.86	Yes	No	No
Mugilidae	<i>Planiliza subviridis</i>	ott823526	P	53	1.1	0.61	1.59	Yes	Yes	No
Mullidae	<i>Parupeneus multifasciatus</i>	ott295485	P	158	1.29	1.19	1.41	No	No	Yes
Muraenesocidae	<i>Muraenesox cinereus</i>	ott479856	P	1	1.27	1.18	1.35	No	No	Yes
Nemipteridae	<i>Scolopsis bilineata</i>	ott463069	P	159	1.29	1.19	1.41	No	No	Yes
Nototheniidae	<i>Lepidonotothen nudifrons</i>	ott260052	D	160	1.38	0.69	2.04	Yes	Yes	No
Nototheniidae	<i>Patagonotothen longipes</i>	ott430554	D	161	1.44	1.15	1.74	No	Yes	No
Nototheniidae	<i>Patagonotothen sima</i>	ott874773	D	162	1.53	1.3	1.78	No	Yes	No
Osmeridae	<i>Mallotus villosus</i>	ott225330	D	54	1.33	0.81	1.85	Yes	No	No
Paralichthyidae	<i>Paralichthys dentatus</i>	ott1019735	P	259	1.18	0.83	1.52	Yes	Yes	No
Paralichthyidae	<i>Paralichthys patagonicus</i>	ott654479	P	260	1.49	1.02	1.97	Yes	No	No
Pinguipedidae	<i>Parapercis snyderi</i>	ott3635246	P	163	1.28	1.18	1.38	No	No	Yes
Plesiopidae	<i>Acanthoclinus fuscus</i>	ott3633802	D	164	1.57	1.04	2.12	Yes	No	No
Pleuronectidae	<i>Ammotretis rostratus</i>	ott600529	P	261	1.27	0.93	1.62	No	Yes	No
Pleuronectidae	<i>Hippoglossoides platessoides</i>	ott223665	P	262	1.07	0.93	1.21	Yes	No	No
Pleuronectidae	<i>Hippoglossus hippoglossus</i>	ott408328	P	263	1.3	1.21	1.39	No	No	Yes
Pleuronectidae	<i>Pleuronectes platessa</i>	ott408337	P	264	1.21	1.12	1.3	Yes	No	Yes
Pleuronectidae	<i>Pseudopleuronectes americanus*</i>	ott261419	D	265	1.03	0.65	1.41	Yes	Yes	Yes
Pleuronectidae	<i>Reinhardtius hippoglossoides</i>	ott835141	P	266	1.41	1.16	1.65	Yes	No	No
Pleuronectidae	<i>Rhombosolea tapirina</i>	ott867269	P	267	1.27	0.95	1.59	No	Yes	No
Pomacanthidae	<i>Pomacanthus zonipectus</i>	ott826472	P	165	1.36	0.78	1.93	Yes	No	No
Pomacentridae	<i>Abudefduf bengalensis</i>	ott318931	D	166	1.31	1.21	1.43	No	No	Yes
Pomacentridae	<i>Abudefduf saxatilis*</i>	ott405751	D	167	0.96	0.39	1.52	Yes	Yes	Yes
Pomacentridae	<i>Abudefduf septemfasciatus</i>	ott129790	D	168	1.29	1.19	1.4	No	No	Yes
Pomacentridae	<i>Abudefduf sordidus</i>	ott1053071	D	169	1.29	1.2	1.41	No	No	Yes
Pomacentridae	<i>Abudefduf troschelii</i>	ott961357	D	170	1.31	1.21	1.42	No	No	Yes
Pomacentridae	<i>Abudefduf vaigiensis</i>	ott1053067	D	171	1.29	1.19	1.4	No	No	Yes
Pomacentridae	<i>Acanthochromis polyacanthus</i>	ott100410	D	172	1.52	0.95	2.09	Yes	No	No
Pomacentridae	<i>Chromis atrilobata</i>	ott436999	D	173	1.34	1.23	1.45	No	No	Yes
Pomacentridae	<i>Chromis atripectoralis</i>	ott741423	D	174	1.28	1.19	1.37	No	No	Yes
Pomacentridae	<i>Chromis multilineata</i>	ott437016	D	175	1.3	1.21	1.4	No	No	Yes
Pomacentridae	<i>Hypsypops rubicundus</i>	ott847666	D	176	1.3	1.21	1.4	No	No	Yes
Pomacentridae	<i>Microspathodon bairdii</i>	ott237630	D	177	1.29	1.19	1.39	No	No	Yes
Pomacentridae	<i>Microspathodon chrysurus</i>	ott847660	D	178	1.29	1.19	1.39	No	No	Yes
Pomacentridae	<i>Microspathodon dorsalis</i>	ott205758	D	179	1.29	1.2	1.39	No	No	Yes
Pomacentridae	<i>Pomacentrus coelestis</i>	ott622060	D	180	1.08	0.73	1.43	Yes	Yes	No
Pomacentridae	<i>Stegastes acapulcoensis</i>	ott3635554	D	181	1.32	1.22	1.43	No	No	Yes
Pomacentridae	<i>Stegastes adustus</i>	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	<i>Stegastes diencaeus</i>	ott729161	D	183	1.28	1.19	1.39	No	No	Yes
Pomacentridae	<i>Stegastes flavilatus</i>	ott3635541	D	184	1.31	1.21	1.41	No	No	Yes
Pomacentridae	<i>Stegastes fuscus</i>	ott3635543	D	185	1.07	0.73	1.41	Yes	No	No
Pomacentridae	<i>Stegastes leucostictus</i>	ott100830	D	186	1.31	1.2	1.43	No	No	Yes
Pomacentridae	<i>Stegastes partitus</i>	ott345269	D	187	1.32	1.22	1.42	No	No	Yes
Pomacentridae	<i>Stegastes planifrons</i>	ott665837	D	188	1.3	1.2	1.41	No	No	Yes
Pomacentridae	<i>Stegastes variabilis</i>	ott323173	D	189	1.32	1.21	1.44	No	No	Yes
Pristigasteridae	<i>Ilisha africana</i>	ott741177	P	28	1.4	0.79	2.01	Yes	Yes	No
Scaridae	<i>Cetoscarus bicolor</i>	ott1041720	P	190	1.29	0.95	1.63	No	Yes	No
Scaridae	<i>Chlorurus sordidus</i>	ott436737	P	191	1.28	0.95	1.65	No	Yes	Yes
Scaridae	<i>Cryptotomus roseus</i>	ott321483	P	192	1.32	1.21	1.44	No	No	Yes
Scaridae	<i>Hipposcarus longiceps</i>	ott465039	P	193	1.3	0.94	1.67	No	Yes	No
Scaridae	<i>Scarus flavipectoralis</i>	ott1041716	P	194	1.28	1.19	1.39	No	No	Yes
Scaridae	<i>Scarus forsteni</i>	ott548869	P	195	1.29	0.93	1.66	No	Yes	No
Scaridae	<i>Scarus frenatus</i>	ott436725	P	196	1.27	0.93	1.63	No	Yes	Yes
Scaridae	<i>Scarus globiceps</i>	ott514869	P	197	1.27	0.88	1.68	No	Yes	Yes
Scaridae	<i>Scarus iseri</i>	ott686634	P	198	1.31	1.2	1.43	No	No	Yes
Scaridae	<i>Scarus niger</i>	ott14311	P	199	1.26	1.17	1.36	No	No	Yes
Scaridae	<i>Scarus psittacus</i>	ott514872	P	200	1.33	1.22	1.46	No	No	Yes
Scaridae	<i>Scarus schlegeli</i>	ott514881	P	201	1.26	0.95	1.61	No	Yes	Yes
Scaridae	<i>Scarus spinus</i>	ott419732	P	202	1.29	1.19	1.4	No	No	Yes
Scaridae	<i>Sparisoma atomarium</i>	ott686627	P	203	1.33	1.22	1.46	No	No	Yes
Scaridae	<i>Sparisoma aurofrenatum</i>	ott686624	P	204	1.26	1.17	1.37	No	No	Yes
Scaridae	<i>Sparisoma radians</i>	ott214109	P	205	1.29	1.2	1.39	No	No	Yes
Scaridae	<i>Sparisoma rubripinne</i>	ott686642	P	206	1.26	1.17	1.37	No	No	Yes
Sciaenidae	<i>Bairdiella chrysoura</i>	ott761907	P	207	1.13	0.5	1.75	Yes	Yes	No
Sciaenidae	<i>Cynoscion regalis*</i>	ott5860595	P	208	1.51	1.23	1.79	Yes	Yes	Yes
Sciaenidae	<i>Cynoscion striatus</i>	ott267367	P	209	1.33	0.77	1.91	Yes	No	No
Sciaenidae	<i>Genyonemus lineatus</i>	ott1027240	P	210	2.02	1.76	2.28	Yes	No	No
Sciaenidae	<i>Isopisthus parvipinnis</i>	ott133138	P	211	1.42	0.98	1.87	Yes	No	No
Sciaenidae	<i>Larimus breviceps</i>	ott924070	P	212	1.82	1.3	2.36	Yes	No	No
Sciaenidae	<i>Larimus fasciatus</i>	ott897432	P	213	1.17	0.83	1.51	Yes	Yes	No
Sciaenidae	<i>Leiostomus xanthurus</i>	ott1052160	P	214	1.27	1.17	1.38	No	No	Yes
Sciaenidae	<i>Macrodon ancylodon</i>	ott99076	P	215	1.35	0.99	1.7	Yes	No	No
Sciaenidae	<i>Micropogonias furnieri</i>	ott742890	P	216	1.1	0.92	1.28	Yes	No	No
Sciaenidae	<i>Micropogonias undulatus</i>	ott987393	P	217	1.28	1.18	1.4	No	No	Yes
Sciaenidae	<i>Paralanchurus brasiliensis</i>	ott160812	P	218	1.01	0.53	1.47	Yes	No	No
Sciaenidae	<i>Seriphus politus</i>	ott827210	P	219	1.22	1.09	1.34	Yes	No	No
Sciaenidae	<i>Stellifer rastrifer</i>	ott362452	P	220	0.87	0.61	1.15	Yes	No	No
Scombridae	<i>Auxis rochei</i>	ott713972	P	221	1.28	0.58	1.98	Yes	Yes	No
Scombridae	<i>Euthynnus affinis</i>	ott308760	P	222	1.22	0.9	1.52	No	Yes	No
Scombridae	<i>Katsuwonus pelamis</i>	ott308754	P	223	1.36	1.09	1.63	No	Yes	No
Scombridae	<i>Sarda sarda</i>	ott833175	P	224	1.35	0.99	1.73	No	Yes	No
Scombridae	<i>Scomber scombrus</i>	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	<i>Scomberomorus cavalla</i>	ott70546	P	226	1.48	1.15	1.82	Yes	Yes	No
Scombridae	<i>Scomberomorus maculatus</i>	ott266387	P	227	1.23	0.94	1.52	Yes	No	No
Scombridae	<i>Thunnus alalunga</i>	ott833194	P	228	1.04	0.65	1.42	Yes	No	No
Scombridae	<i>Thunnus albacares</i>	ott833188	P	229	1.05	0.61	1.5	Yes	Yes	No
Scombridae	<i>Thunnus obesus</i>	ott358613	P	230	1.31	1.06	1.57	No	Yes	No
Scombridae	<i>Thunnus thynnus</i>	ott358607	P	231	1.17	0.54	1.77	Yes	Yes	No
Sebastidae	<i>Sebastes alutus</i>	ott480735	BI	288	1.87	1.7	2.05	Yes	No	No
Sebastidae	<i>Sebastes atrovirens</i>	ott480732	BI	289	1.22	0.69	1.73	Yes	No	No
Sebastidae	<i>Sebastes auriculatus</i>	ott480729	BI	290	1.17	0.84	1.51	Yes	No	No
Sebastidae	<i>Sebastes brevispinis</i>	ott1057081	BI	291	1.39	0.92	1.86	Yes	No	No
Sebastidae	<i>Sebastes carnatus</i>	ott1057074	BI	292	1.29	0.76	1.82	Yes	No	No
Sebastidae	<i>Sebastes caurinus</i>	ott1057078	BI	293	1.78	1.59	1.99	Yes	No	No
Sebastidae	<i>Sebastes chlorostictus</i>	ott1057068	BI	294	1.66	1.44	1.88	Yes	No	No
Sebastidae	<i>Sebastes constellatus</i>	ott1057062	BI	295	1.44	1.05	1.84	Yes	No	No
Sebastidae	<i>Sebastes crameri</i>	ott1057065	BI	296	1.57	1.2	1.94	Yes	No	No
Sebastidae	<i>Sebastes dallii</i>	ott1088425	BI	297	1.25	0.84	1.67	Yes	No	No
Sebastidae	<i>Sebastes diploproa</i>	ott1057059	BI	298	1.56	1.24	1.88	Yes	No	No
Sebastidae	<i>Sebastes elongatus</i>	ott531065	BI	299	1.4	1.16	1.65	Yes	No	No
Sebastidae	<i>Sebastes entomelas</i>	ott531068	BI	300	1.73	1.53	1.93	Yes	No	No
Sebastidae	<i>Sebastes flavidus</i>	ott531059	BI	301	1.61	1.35	1.86	Yes	No	No
Sebastidae	<i>Sebastes goodei</i>	ott531047	BI	302	1.42	1.23	1.62	Yes	No	No
Sebastidae	<i>Sebastes helvomaculatus</i>	ott531044	BI	303	1.4	0.91	1.92	Yes	No	No
Sebastidae	<i>Sebastes hopkinsi</i>	ott9589	BI	304	1.12	0.76	1.48	Yes	No	No
Sebastidae	<i>Sebastes jordani</i>	ott9592	BI	305	1.21	0.85	1.57	Yes	No	No
Sebastidae	<i>Sebastes levis</i>	ott9598	BI	306	1.17	0.89	1.44	Yes	No	No
Sebastidae	<i>Sebastes melanops</i>	ott9604	BI	307	1.41	1.15	1.66	Yes	No	No
Sebastidae	<i>Sebastes melanostomus</i>	ott9607	BI	308	1.52	1.21	1.84	Yes	No	No
Sebastidae	<i>Sebastes mentella</i>	ott1088432	BI	309	1.56	1.17	1.95	Yes	Yes	No
Sebastidae	<i>Sebastes miniatus</i>	ott9611	BI	310	1.69	1.47	1.9	Yes	No	No
Sebastidae	<i>Sebastes mystinus</i>	ott9616	BI	311	1.85	1.67	2.01	Yes	No	No
Sebastidae	<i>Sebastes norvegicus</i>	ott1088441	BI	312	1.16	0.75	1.56	Yes	Yes	No
Sebastidae	<i>Sebastes ovalis</i>	ott582324	BI	313	1.35	0.93	1.75	Yes	No	No
Sebastidae	<i>Sebastes paucispinis</i>	ott582321	BI	314	1.46	1.28	1.65	Yes	No	No
Sebastidae	<i>Sebastes pinniger</i>	ott582318	BI	315	1.36	0.9	1.82	Yes	No	No
Sebastidae	<i>Sebastes rastrelliger</i>	ott582315	BI	316	1.34	0.92	1.76	Yes	No	No
Sebastidae	<i>Sebastes rosaceus</i>	ott212767	BI	317	1.25	0.94	1.56	Yes	No	No
Sebastidae	<i>Sebastes rosenblatti</i>	ott582311	BI	318	1.4	1.08	1.73	Yes	No	No
Sebastidae	<i>Sebastes rufus</i>	ott884513	BI	319	1.41	1.03	1.78	Yes	No	No
Sebastidae	<i>Sebastes saxicola</i>	ott884510	BI	320	1.15	1.03	1.26	Yes	No	No
Sebastidae	<i>Sebastes semicinctus</i>	ott795707	BI	321	1.4	1.09	1.72	Yes	No	No
Sebastidae	<i>Sebastes serranoides</i>	ott884519	BI	322	1.66	1.43	1.89	Yes	No	No
Sebastidae	<i>Sebastes viviparus</i>	ott99016	BI	323	1.32	1.03	1.6	Yes	No	No
Sebastidae	<i>Sebastolobus altivelis</i>	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	<i>Cephalopholis cruentata</i>	ott12880	P	232	1.29	0.68	1.89	Yes	Yes	No
Serranidae	<i>Epinephelus aeneus</i>	ott306171	P	233	1.25	0.97	1.54	Yes	No	No
Serranidae	<i>Epinephelus fasciatus</i>	ott534146	P	234	0.9	0.45	1.34	Yes	No	Yes
Serranidae	<i>Epinephelus marginatus</i>	ott733897	P	235	1.32	0.76	1.89	Yes	No	No
Serranidae	<i>Epinephelus tauvina</i>	ott218649	P	236	0.94	0.41	1.45	Yes	Yes	No
Serranidae	<i>Mycteroperca tigris</i>	ott207413	P	237	1.54	1.05	2.05	Yes	No	No
Serranidae	<i>Serranus tabacarius</i>	ott284266	P	238	1.29	1.2	1.41	No	No	Yes
Serranidae	<i>Serranus tigrinus</i>	ott807897	P	239	1.26	1.16	1.36	No	No	Yes
Serranidae	<i>Serranus tortugarum</i>	ott511782	P	240	1.29	1.19	1.41	No	No	Yes
Siganidae	<i>Siganus canaliculatus</i>	ott199059	S	241	1.4	0.98	1.82	Yes	Yes	No
Soleidae	<i>Solea solea*</i>	ott710233	P	268	1.26	1.02	1.52	Yes	Yes	Yes
Sparidae	<i>Acanthopagrus latus</i>	ott760733	P	242	1.26	0.57	1.94	Yes	Yes	No
Sparidae	<i>Archosargus rhomboidalis</i>	ott724892	P	243	1.14	0.74	1.54	Yes	Yes	No
Sparidae	<i>Sparidentex hasta</i>	ott845300	P	244	1.33	0.74	1.91	Yes	Yes	No
Stromateidae	<i>Pampus chinensis</i>	ott916290	P	245	1.24	0.55	1.93	Yes	Yes	No
Syngnathidae	<i>Entelurus aequoreus</i>	ott971459	BP	325	1.4	1.19	1.61	No	Yes	No
Syngnathidae	<i>Hippocampus reidi</i>	ott630138	BP	326	1.35	0.88	1.83	Yes	No	No
Syngnathidae	<i>Micrognathus crinitus</i>	ott3642321	BP	327	1.21	0.86	1.57	Yes	Yes	No
Syngnathidae	<i>Nerophis ophidion</i>	ott806821	BP	328	1.31	1.13	1.5	No	Yes	No
Syngnathidae	<i>Syngnathus acus</i>	ott774440	BP	329	1.34	1.18	1.51	No	Yes	No
Syngnathidae	<i>Syngnathus floridae</i>	ott774435	BP	330	1.44	0.95	1.92	Yes	Yes	No
Syngnathidae	<i>Syngnathus louisianae</i>	ott774414	BP	331	1.48	0.95	2	Yes	Yes	No
Syngnathidae	<i>Syngnathus rostellatus</i>	ott774411	BP	332	1.42	1.26	1.58	No	Yes	No
Syngnathidae	<i>Syngnathus scovelli</i>	ott251400	BP	333	1.37	0.95	1.79	Yes	Yes	No
Syngnathidae	<i>Syngnathus typhle</i>	ott251396	BP	334	1.32	1.19	1.45	No	Yes	No
Tetraodontidae	<i>Canthigaster rostrata</i>	ott484093	D	341	1.29	1.19	1.4	No	No	Yes
Tetraodontidae	<i>Canthigaster valentini</i>	ott701127	S	342	0.98	0.65	1.31	Yes	Yes	No
Trachichthyidae	<i>Hoplostethus atlanticus</i>	ott816600	P	9	1.12	0.91	1.33	Yes	No	No
Trichiuridae	<i>Aphanopus carbo</i>	ott113465	P	246	1.32	0.74	1.91	Yes	Yes	No
Trichodontidae	<i>Arctoscopus japonicus</i>	ott883978	D	247	1.29	1.2	1.39	No	No	Yes
Zoarcidae	<i>Gymnelus viridis</i>	ott729337	D	248	1.34	0.8	1.88	Yes	Yes	No
Zoarcidae	<i>Lycodes esmarkii</i>	ott841648	D	249	1.04	0.41	1.68	Yes	Yes	No
Zoarcidae	<i>Lycodes eudipleurostictus</i>	ott905435	D	250	1.33	0.64	2.01	Yes	Yes	No
Zoarcidae	<i>Lycodes frigidus</i>	ott539690	D	251	1.23	0.52	1.93	Yes	Yes	No
Zoarcidae	<i>Lycodes pallidus</i>	ott178074	D	252	1.43	0.82	2.05	Yes	Yes	No
Zoarcidae	<i>Lycodes polaris</i>	ott34255	D	253	1.31	0.97	1.64	No	Yes	No
Zoarcidae	<i>Lycodes reticulatus</i>	ott752411	D	254	1.21	0.83	1.61	No	Yes	No
Zoarcidae	<i>Lycodes vahlII</i>	ott178063	D	255	1.16	0.66	1.66	Yes	Yes	No
Zoarcidae	<i>Melanostigma atlanticum</i>	ott3633033	D	256	1.1	0.63	1.58	Yes	Yes	No
Zoarcidae	<i>Pachycara brachycephalum</i>	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 =  $\beta_0 \times \text{Female mass}^{\beta_1}$ . 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.

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