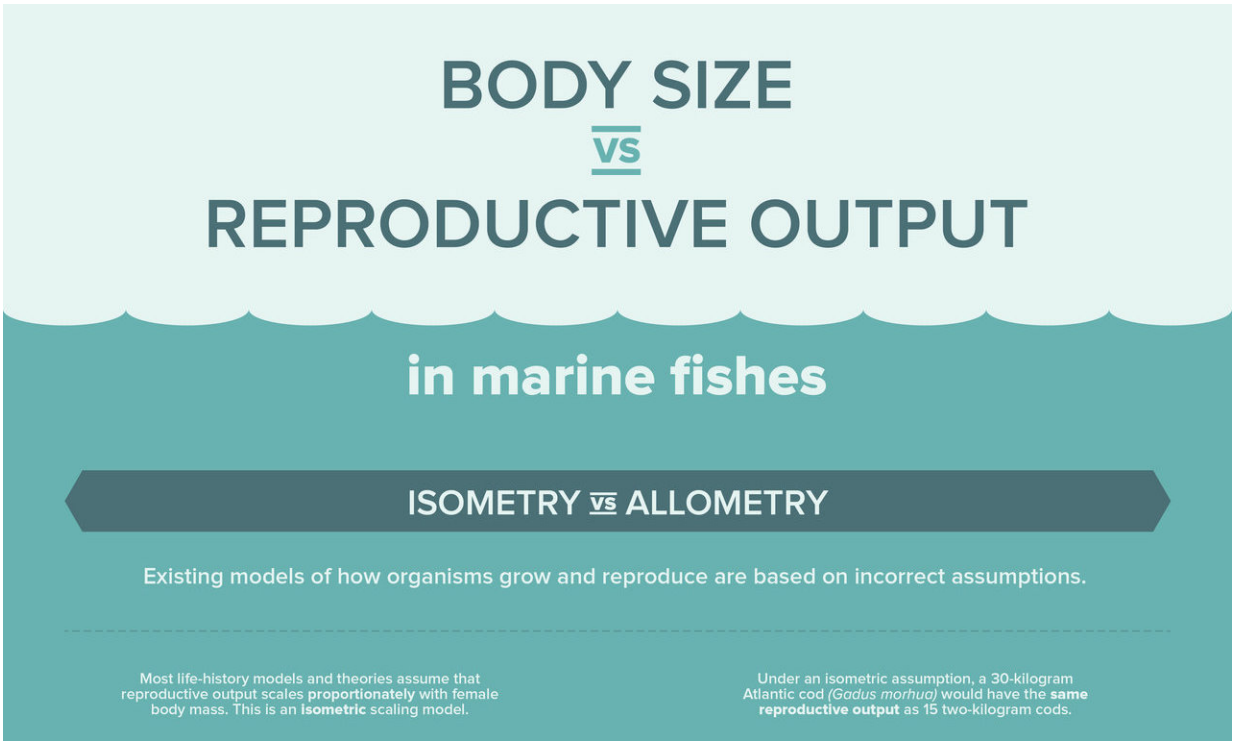
Big fish produce disproportionately more and bigger eggs

May 10 2018



This infographic shows how the scaling of reproductive-energy output in marine fishes affects our understanding of fisheries management, the efficacy of marine protected areas, and the impacts of climate change on fish stocks. Credit: Centre for Geometric Biology (Monash University)

What difference does it make whether an angler catches one big fish or two smaller fish, each half its weight? Experts assumed that big and

small fish invest the same proportion of their energy to make eggs. But a new report in *Science* by a Smithsonian biologist and colleagues shows that plus-sized females invest disproportionately more in the number of eggs and the size of individual eggs. Therefore, taking a single big fish has a bigger impact on the fish population than taking multiple small ones.

"Our results are critical for fisheries management: They tell us to reduce fishing pressure on large fish rather than smaller ones in order to maintain and replenish stocks," said staff scientist D. Ross Robertson at the Smithsonian Tropical Research Institute (STRI) in Panama. "We need to focus on reducing fishing pressure on large fish rather than exploiting them more heavily than small fish."

Led by Diego R. Barneche at Monash University's Centre for Geometric Biology and the University of Sydney, Robertson, along with evolutionary biologists Craig White and Dustin Marshall, also from Monash University, surveyed egg number, egg volume and energy invested in eggs by 342 different marine species, based on publications in Google Scholar about wild fish, as well as data on egg-quality of a range of species collected by Robertson.

The number of eggs laid by a single mother ranged from 11 to almost 58 million eggs per clutch. Egg volume ranged from a hundredth of a cubic millimeter to 0.345 cubic centimeters.

The energy content of eggs from fish collected at sites around the world from Japan to Corsica ranged from seven hundredths of a Joule to almost 300 Joules. Larger eggs have slightly less energy per unit volume than small eggs but a much higher energy content overall.Rather than finding a straight linear relationship: more weight implies more egg production, they found a power-function relationship: as weight goes up, the effort put into reproduction rises exponentially.

"There have always been two quite different explanations of the relationship between size and fecundity," Robertson said. "We collected enough data to identify what we think is generally the correct relationship."

From river systems, to trees, to genes, scientists are discovering that the properties of biological systems are often governed by power laws, rather than linear relationships. For example, scaling up the effective dosage of a drug in a mouse to the weight of a human resulted in overdoses, because the relationship was not linear. Also, ecologists working in Africa found that bigger species of savannah animals require disproportionately more space to live in than smaller animals.

"The realization that fecundity in marine fish is non-linear is important not only for managing commercial fish stocks to maintain and enhance their productivity, but also for understanding evolution and for managing invasive species such as lionfish, in which the big females seem to be concentrated in deep water," said Robertson.

More information: D.R. Barneche el al., "Fish reproductive-energy output increases disproportionately with body size," *Science* (2018). science.sciencemag.org/cgi/doi … 1126/science.aao6868

Provided by Smithsonian Tropical Research Institute