Effects of Size-Selective Mortality on the Evolution of Growth Rate in Fishes

Congressional legislation that aims to apply ecosystem considerations to fisheries management may be due in some part to Sea Grant research that showed how fish in populations in which the largest fish are consistently removed will be, over some generations, slower growing, earlier maturing and smaller in average size.

Size selection in fish

There are many who have noticed that fish being caught seem to be getting smaller and smaller over the years. What is going on? There is also much concern over declining fisheries. Yet there have not been any definitive answers to explain these declines. The reason is that for every species-- even for every population-- there is a different mix of factors influencing population sizes and trends within various fisheries. Such variation creates a complex situation for scientists and managers to analyze. There is always a need for more research and greater understanding of such complex systems. One area of promising new research involves evolutionary response of fishes to size selection from fishing.

In 2000 Dr. David O. Conover at the Marine Sciences Research Center at Stony Brook University embarked on a study to look at the effects of size selective fishing. The project used the Atlantic Silverside (*Menidia menidia*) in a laboratory setting as a model of the effects of various forms of size-selective mortality on life history evolution over multiple generations. Populations of silversides were kept in aquaria and experiments were run where in each generation size selective culling occurred. The cullings were such that the researchers were testing what happened when only the smallest 10% survived, the largest 10% survived, or lastly, when fish of random sizes were left.

Size variation in Atlantic Silversides
Photo courtesy of David Conover

Size selectivity causes evolutionary response

The project demonstrated that size selective selection pressures can lead to genetically fixed changes in the population after just a few generations. The experiments showed that mortality that consistently removes the largest fish results, in a population that grows slower, matures earlier, and has a smaller average adult size. The implications for fishery harvests are that in cases where the largest individuals are typically harvested and the smaller ones thrown back, evolutionary changes could occur that result in populations with smaller fish and lower productivity. This is an undesirable outcome for economically important species.

Though these are laboratory based experiments with a single species, the results have garnered much attention in the management, research and public press, including a July 2002 article in *Science*. This work demonstrated that management of fisheries resources might need to take into account the evolutionary changes brought about by how fish populations are harvested.

This research--along with other NYSG funded research conducted by Dr. Timothy Essington on squid fish interactions--has helped stimulate discussion among fisheries managers and researchers and contributed to a fundamental rethinking about how fisheries have traditionally been managed. That is from a single species approach to an interacting multi-species and evolutionary approach that treats species as part of dynamic and evolving ecosystems. By demonstrating hypothetically that size selective harvesting can lead to evolutionary changes in populations of harvested species, life cycle changes can occur such as age and size at first reproduction that have impacts in the ecosystem. This work has played a role in the reauthorization the Magnuson-Stevens Fishery Conservation and Management Act. A bill, HR 5051, calls on the Secretary of Commerce to draft guidelines for applying ecosystem considerations to fishery management plans (FMPs) and gives fishery councils the discretion to prepare Fishery Ecosystem Plans (FEPs) based on these guidelines.

Conover participated in an informational presentation to Congress that was organized by SeaWeb's COMPASS (Communication Partnership for Science and the Sea) to inform legislators about the implications of his research results on fisheries. Conover assisted Hon. Wayne Gilchrest (R-MD), who introduced HR 5051, with a "Dear Colleague" letter to Congress Members. The letter cites Conover's research as support for the bill's key provision of applying ecosystem considerations into fishery management. The research is stimulating further research and fellowships have been funded by National Sea Grant in the area.

Students

Two Sea Grant Scholars were part of this project. Stephan B. Munch received his PhD in 2002 and is now an assistant professor at Marine Sciences Research Center at Stony Brook University. Matthew Walsh completed his master's degree in 2004 and is currently pursuing his PhD at the University of California Riverside.

Publications

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