Fisheries-induced evolution adds a bonus to good management

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A new study published online by the *Proceedings of the National Academy of Sciences* (*PNAS*) is the first to determine whether genetic changes resulting from fishing pressure have any significant economic effects for the case of Atlantic cod. The study shows that evolutionary changes allow the individual fish to grow faster and mature earlier, which increases stock productivity and revenue for the fishermen.

However, if harvesting pressure is particularly high, genetic changes turn bad and cause economic costs.

The overexploitation of our oceans is worrisome for several reasons. One of the latest concerns is the idea that fishing pressure can be so high that it causes the fish stock to alter their genetic composition. In the academic community, it is widely debated whether historic harvesting pressure has been high enough to cause these genetic changes to occur. And if so, have these genetic changes had a positive or a negative effect on the fate of the fisheries and fishermen's revenues?

A new study carried out by scientists from Wageningen UR (University & Research centre), together with the University of Oslo and several international partners has looked at these questions in detail. "Today, evolutionary effects of fishing are not considered in management plans." explains Andries Richter, who worked on this study as part of his PhD research. "The main goal of our study was to investigate whether evolution has any economically significant effects."

The major challenge in answering this question is the fact that growth and reproduction schedules of individual fish do not only depend on their genetic code, but also on the state of the environment. Since marine systems are constantly in flux, it is notoriously difficult to disentangle what is genetic and what is environmental. To overcome this obstacle, the researchers developed a detailed model that closely resembles the population of Northeast Arctic cod, currently the largest cod stock in the world. The trick was to create two versions of the model – one in which genetic changes could occur and the other were the fish only responded to environmental changes.

What the authors found was that genetic changes occur even if fishing pressure is very small. Surprisingly, genetic changes can be good or bad depending on how high the harvest pressure is. In general, evolution

allows the fish to adapt by growing faster and maturing earlier, which is a good thing, because it facilitates having more offspring. But if harvesting pressure is high, genetic changes turn bad and cause economic costs. This happens because evolution facilitates higher growth, but this implies that the fish can be caught at younger ages, often before they have reproduced. While this is good news for the fisheries that are optimally managed, the many fish stocks that are overexploited may be in an even more dire state.

Furthermore, the study found that the key to successful management is a low harvesting rate – irrespective of whether evolution occurs or not. Does this mean that managers can safely ignore any evolutionary changes? "Definitely not" warns Andries Richter. "In this study we look only at cod, so it may be very different for other species. And we still know very little about wider ecosystem effects."

More information: www.pnas.org/content/early/201 … /1212593110.abstract

Provided by Wageningen University