Fish stocks fluctuate with seawater temperature

January 17 2022

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Year-to-year fluctuations in seawater temperature are partly responsible for the much slower ups and downs in the abundance of marine fish stocks. This is the conclusion from a worldwide study by Wageningen University & Research, among others. Fish biologists have observed slow fluctuations in fish stocks for centuries, but the causes remained largely unclear. This study shows that fluctuations on timescales of

decades are naturally present in fish populations due to their sensitivity to water temperature.

How a fish population responds to temperature depends on the species' lifespan and its position in the food chain. For short-lived fish that feed on plankton, a favorable year in terms of climate quickly leads to population growth. This effect is considerably slower in long-lived predatory fish.

Climate change

The results can provide insight into the effects of climate change on marine fish populations. Climate change will not only lead to a gradual increase in seawater temperature but also to stronger year-to-year fluctuations in fish populations. The researchers, therefore, also ran simulations using climate change scenarios. Peter van der Sleen, a researcher at Wageningen University & Research, who led the study says that "the simulations do not spark hope: climate change may cause fish stocks to fluctuate more strongly, with consequences for the functioning of marine ecosystems and fisheries."

Annual rings in fish bones

The basis for this study is formed by research on growth rings in fish. Van der Sleen says "It may sound strange, growth rings of fish, but fish—just like trees—also form growth rings. They do this in their 'otolith', a bone-like structure analogous to our ear bones. A good year for a fish leads to a wide ring; a bad year to a narrow one." Based on annual ring data, the researchers established the linkages between seawater temperature and fish growth. "We used methods similar to those used to measure growth rings in trees", Van der Sleen explains. "It was an eye-opener to discover how sensitive fish growth is to

temperature fluctuations. For some of the fish species studied, lifetime otolith growth patterns matched almost perfectly with climatic patterns."

This, however, did not explain the slow fluctuations in fish populations: "What an individual fish does, in terms of growth, is not necessarily the same as the growth of a population as a whole. Much theoretical research has been done on the effect of demographic factors (such as species lifespan) on variations in population density. We have combined those insights with our results from fish otoliths."

The researchers' next step was to scale up the growth of individual fish to that of populations. Van der Sleen says that "due to a lack of data for the thousands of marine fish species we wanted to study, we constructed simple mathematical models. These simulate the effect of year-to-year fluctuations in temperature on fish populations, based on estimated lifespan and its position in the food chain. We were surprised to see that the slow fluctuations in fish stocks we simulated matched the variation in observed fish stocks very well."

The research was published in *Communications Biology*.

More information: Peter van der Sleen et al, Interannual temperature variability is a principal driver of low-frequency fluctuations in marine fish populations, *Communications Biology* (2022). DOI: 10.1038/s42003-021-02960-y

Provided by Wageningen University