European Commission

Science for Environment Policy

Ocean acidification — caused by climate change — likely to reduce the survival rate of Atlantic cod larvae

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The impact of ocean acidification — caused by increased carbon dioxide (CO_2) emissions dissolving in sea water — on Atlantic cod larvae has been assessed in a new study. The researchers estimate that, under scenarios which might be reached at the end of the century, ocean acidification could double the mortality rate of cod larvae, reducing replenishment of juvenile fish into cod fisheries to 24% of previous recruitment.

Sea-temperature changes resulting from climate changes can alter the ranges of marine species. Human CO_2 emissions are also absorbed into the oceans, resulting in ocean acidification. When dissolved in seawater, higher concentrations of CO_2 lower the pH and, therefore, increase the acidity of the water. Fish eggs and larvae are more sensitive to environmental change than adult fish, and pH changes can affect survival rates and tissue and organ development as well as influencing sensory abilities, such as smell and behaviour. The survival of eggs and larvae influences fish-stock recruitment (the replenishment of young fish into the fished population) and, therefore, the continued exploitation of commercially important species, such as Atlantic cod (*Gadus morhua*).

This study examined the survival of Atlantic cod larvae in response to ocean acidification. Two experiments were carried out on eggs and larvae from the Western Baltic and Arcto-Norwegian Barents Sea stock. Eggs and larvae produced from adult cod caught in each region were kept in tanks where the CO_2 concentrations, temperature, light and food levels could be controlled. CO_2 concentrations were altered to simulate current CO_2 and high CO_2 levels and, therefore, assess the impact of future rises in CO_2 emissions. Hatched larvae were then monitored for up to 25 days to determine survival rate, which was measured by counting dead larvae at the bottom of the tanks daily.

To account for current CO_2 levels, eggs and larvae were kept at concentrations of between 400 and 500 microatmospheres (µatm — a measure of gas pressure) of CO_2. To assess future CO_2 rise, the atmospheric CO_2 level was raised to between 1 000 and 1 200 µatm, which is in line with levels forecast by the end of the century. For the Barents Sea experiment, larvae were also provided with different amounts of food to assess the impact of different feeding conditions. Using the experimental results, the impact of increased CO_2 levels was then modelled to assess how larval survival rates would affect recruitment into cod populations.

At higher CO_2 concentrations, daily mortality rates of larvae doubled in both experiments, from 9% to 20% in the Western Baltic Sea stock, and from 7% to 13% in the Barents Sea stock. The different food densities had no significant effect on mortality rates in the Barents Sea experiment, indicating that cod larvae were still adversely affected by ocean acidification even when there was enough prey available for growth.

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Spawning fish, such as cod, typically have low survival rates even under optimum environmental conditions and with sufficient food resources. The researchers say that the fact that survival rates decreased to a similar extent in two different cod stocks and under different feeding regimes indicates that ocean acidification is likely to have a major effect on Atlantic cod larvae survival and, therefore, recruitment into the adult population.

This study on cod did not account for the possibility that the adult cod may develop adaptations to increased CO_2 levels, which may reduce the negative impact on their offspring. The researchers say this effect is difficult to test experimentally in adult fish in temperate oceans. However, as climate change is happening at a rate that is unprecedented in our planet's history (much faster than most evolutionary processes), the positive effect of adaptation is likely limited and the precautionary principle should be followed.

The researchers say that only one other study has looked at the survival of a fish species under ocean acidification, but it focused on a species with little commercial value. Atlantic cod is one of the most important species of commercial fish, and collapses in its stocks in certain regions have been experienced over previous decades. The researchers say that the potential loss of recruitment from larvae shown in this study has the capacity to be as damaging to fish stocks as previous population collapses due to overfishing. As such, any future management of exploitation must directly consider effects induced by global change.