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MARINE update 59

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Fishing, climate change and North East Atlantic cod stocks

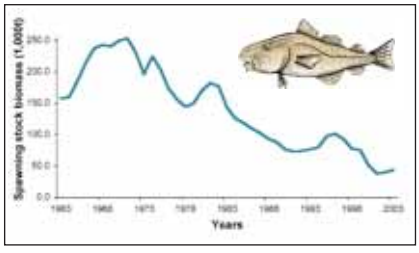
INTRODUCTION

Disentangling the impacts of environmental change and commercial fisheries on fish populations is problematic and controversial. The responses of fish stocks to the combined effects of climate change and fishing pressure are not currently sufficiently understood to allow exact separation of their respective effects. The current overfishing by UK and European fleets has led to the decline of many commercial fish stocks in the north-east Atlantic. Climate change is likely to be making matters worse. This report focuses on the Atlantic cod (Gadus morhua), a predatory, bottom-dwelling, cold-water species of high economic importance that has been subject to significant declines in stock abundance in UK waters in recent decades. We highlight the need to manage the interaction of fishing with other pressures such as climate change to assist with adaptation in a rapidly changing world.

The Atlantic cod Gadus Morhua, a cold-water, preatory fish that has been subject to declining abundance in recent decade.

NORTH SEA COD FISHERIES

Cod has been over-exploited in the north-east Atlantic since the late 1960s and some stocks have now declined below safe biological thresholds. For example all North Sea stocks have suffered prolonged decline in abundance, with the lowest recruitment of cod for 30 years occurring in 1997. Catches of cod have decreased with this decreasing abundance and have consisted predominantly of young, largely immature fish under three years old.



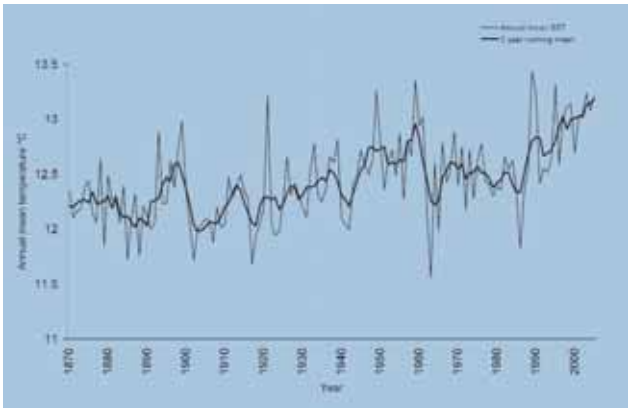
Spawning Stock Biomass of Atlantic cod in the North Sea. The rise in cod Spawning stock biomass during the 1960s has been attributed to climatic influences, whilst the decline, since then has been largely blamed on high fishing pressure. Data: MFA, 2005

Sustainable harvesting relies on sufficient spawning stock biomass (SSB) to ensure continued adequate recruitment into the fishery. A particular concern for the North Sea fishery is the current pattern of exploitation with age, where the one and two year classes are already fully exploited before they can reach maturity and reproduce. Some fish are now reproducing at a younger age in response to fishing pressure, which is leading to a reduction in recruitment as large, older females produce many more eggs than young fish.

At the end of the 20th century, the number of one-year-old cod recruits recorded in the North Sea was at or below the long-term average for more than a

decade. If exploitation rates remain as high as in the 1990s, only 4% of the one-year-old stock will survive to reach four years of age, and recruitment into the spawning stock will continue to occur at very low levels. The current rate of decline is very steep and beyond maximum sustainable yield (MSY), making the complete collapse of some stocks extremely likely. When cod populations decline to low abundances they are more vulnerable to other factors such as climate change, especially since the buffer of a long adult lifespan is reduced by fishing pressure to leave only the younger age classes.

CLIMATE CHANGE



Annual mean surface temperature in the Western English channel (1879 – 2005). Data provided by kind permission of the British Atmospheric Data Centre

The marine climate of the north-east Atlantic has been warming faster than the global average rate of change since the 1980s. British coastal waters have shown a general warming trend, with annual sea surface temperatures (SST) increasing by up to 1ºC. Seasonal differences in the rate of warming have also been detected, with winter sea temperatures increasing at a greater rate than summer temperatures since the 1980s.

The North Atlantic Oscillation (NAO) is the main index of winter atmospheric circulation over the North Atlantic. During positive NAO years, warmer, wetter winters occur and seawater temperatures are warmer around the UK. When the NAO switches to a negative phase, winter SST around the British coastline is colder. Over the last 25 years the frequency and magnitude of NAO positive-index events have increased, and winter SSTs have become milder in British coastal waters.

Global climate models have forecast further warming of 0.5ºC to 1.0ºC (depending on emissions scenarios) in seas around Britain during the 21st century. Regional models predict even greater rises in areas such as the English Channel, which may warm by as much as 4ºC. The frequency and strength of NAO positive-phase events have also been forecast to increase as global warming continues, increasing the frequency of mild, wet winters with higher sea temperatures.

EFFECTS OF CLIMATE CHANGE ON FISHERIES

The effects of climate change on fish populations are likely to be diverse and difficult to predict. They will also vary, depending on whether the species are cold water in origin (e.g. cod, haddock, herring) or warm water (e.g. red mullet, hake, sea bream).

Increasing environmental temperatures may have a detrimental effect on cod stocks around the British Isles. From 1988 to the present decade, annual recruitment of North Sea cod has been lower than in the three previous decades, with 1997 and 1998 the poorest on record. The NAO index has been correlated with this poor recruitment success, with poorer recruitment in NAO positive years – though this may also be linked to greatly reduced stock sizes. Therefore climate may have an underlying influence on the stock size of most cod populations in the north-east Atlantic via the direct effects that environmental temperature have on larval growth and survival. Additionally, indirect effects impact on cod through changes in the availability of their main food source, a small shrimp-like copepod called Calanus finmarchicus. The location, magnitude and size of zooplankton production have changed dramatically, and this affects food availability for cod larvae. The main food source for cod larvae has moved some 1,000km north and has halved in abundance.

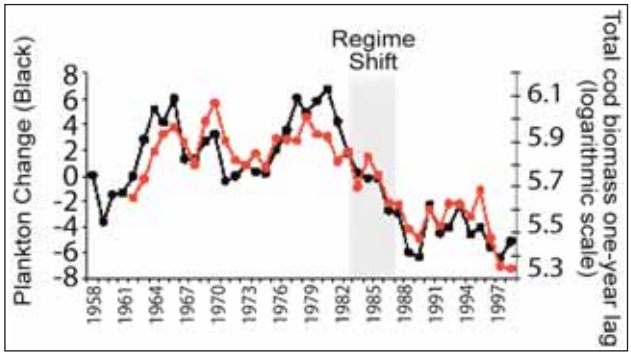
Timing is also critical and, as stock densities are reduced by fishing, mismatch between release of larvae and food supply is more likely in warmer climatic periods. Thus climate change may increase the risk of poor recruitment when spawning stock biomass is low. There are other possible impacts: adult cod seem to require lower temperatures than juveniles; metabolic costs may be greater at higher temperatures

Cod Larva, Gadus morhua, showing large eye yolk sac

(e.g. fish need more food); and food may become limited, leading to higher mortality and slower growth. The main influence of climate is likely to be on reproductive success and fishing distribution.

Historically, changes in pelagic species have long been linked to climate; an example being fluctuations between cold water herring and warm water pilchard (sardine) occurring in the western English Channel back as far as the Middle Ages. Similarly, for bottom-dwelling fish, a "gadoid outburst" in the North Sea was driven by an increase in cod recruitment during an episode of cooler climatic conditions despite increased fishing mortality between the 1960s and 1980s. (This outburst was a sudden, huge increase in stocks of cod and related species such as haddock that occurred in response to a switch to cooler climatic conditions in the North Sea between the 1960s and 1980s.)

The effects of climate vary between geographic regions. For example, increases in cod abundance have been recorded in areas where fishing pressure is lower, such as in the south-west of Britain, despite increasing sea temperatures. This suggests complex, interacting processes may be responsible for these contrasting responses.



RECOMMENDATIONS

Overfishing, coupled with poor recruitment in warmer conditions as the climate changes, endanger the long-term sustainability of cod stocks in UK waters. There are, however, contrasting views of the future of cod fisheries. The gloomiest view is that in a warming climate, recruitment may never reach the level of the 1960s and 1970s again, even if the spawning stock biomass were allowed to recover. A more optimistic view is that if fishing mortality is reduced, cod stocks could recover in as little as six years.

Temperature effects on cod need to be factored into stock assessments and catch forecasts containing environmental and population data to reduce the risk of catastrophic stock collapses like those seen in the north-west Atlantic. Adaptive management should focus on fishing and climate change interactions, given that we are committed to continuing temperature rises due to the greenhouse gases that have already been released. We concur with the UK Marine Climate Change Impact Partnership report (available at www.mccip.org.uk/arc), which emphasises that "fishing remains the main pressure on commercial fish stocks". Climate change makes matters worse for over-fished coldwater species. Thus a precautionary approach is especially required for coldwater species at their range limits in the seas around the UK.

Calanus finmarchicus, many commercial fish larvae feed on Calanus and reduced concentrations may be a factor in the in the decline of the cod population off Newfoundland

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wwf.org.uk/filelibrary/pdf/cc_cod_report.pdf

WWF RECOMMENDATIONS

Stressed marine systems are more vulnerable to climate change and it is important to reduce pressures on the ecosystem. This includes reducing pressures from overfishing, habitat destruction and pollution. The massive changes ahead for marine ecosystems will affect the livelihoods of millions of people globally, one billion of whom rely on fish as their main protein source.

The forthcoming Climate Change Bill target to reduce UK CO_2 emissions by 60% by 2050 must be delivered through binding annual targets to reduce UK CO_2 by at least 3% year on year. Any delay in reductions will make it harder or impossible to achieve the 2050 target. Also, the Stern Report shows, postponing emissions cuts will carry far greater economic costs than facing up to them now.

Rise in average global temperature must be kept below 2Degrees Celsius and global emissions need to peak and decline in the next 10 years. The marine environment has a role to play in this. Oil and gas production from the UK seas, cumulatively and indirectly, account for the equivalent of about 70% of the UK's CO_2 emissions. However, UK seas also have a huge potential for generating renewable energy. There is also the potential of storing CO_2 in Carbon Capture and Storage under the sea bed. This must sit within a mitigation framework which drives down energy consumption and improves energy efficiency. All of these activities should be managed through Marine Spatial Planning as part of the forthcoming Marine Bill.

Fish stocks in the north-east Atlantic, especially the North Sea, have been impacted heavily owing to sustained overfishing by modern fleets brought about by political mis-management of stocks. It seems unlikely that global climate warming is the primary factor causing the decline in fish numbers, but evidence suggests that it may be exerting additional pressures on already overexploited stocks preventing them recovering. Indirect effects of climate change on the availability of prey for juvenile fish are additionally predicted to be detrimental to the recovery of fish stocks.

There is a need to take immediate measures to give stocks a chance to rebuild and sustain themselves despite environmental changes brought about by climate change. There needs to be both an increase in numbers of fish as well as mixed age structures within populations as this has been shown to enable populations of fish to survive major changes in climatic conditions.

However, although climate change is likely one of the factors responsible for non-recovery of cod in the North Sea, the bottom line is too many fish are still being removed from the sea and fisheries are not sustainable at current levels of fishing effort. Future policy must take both factors into account when deciding upon future fisheries management.

- UK emissions must be cut by 3% annually though binding targets in the Climate Change Bill; global emissions must peak and decline within 10 years
- Fishing mortality of cod must be reduced immediately to give stocks every change to sustain themselves against environmental change.

The mission of WWF is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:
· conserving the world's biological diversity
· ensuring that the use of renewable resources is sustainable
· promoting the reduction of pollution and wasteful consumption

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