Fish recruitment in a changing environment

The future size of a fish stock depends upon recruitment, i.e. the number of fish surviving the first years of life. The numbers of eggs produced by the stock each year is related to the number of adult fish. These eggs must survive and develop through larval and juvenile stages to contribute to recruitment. Changes in the numbers of individuals which survive these first years are the result of fluctuations in the environment, in the amount of available prey and in the mortality suffered due to natural predators or fishing.

Reduction of the adult stock to low numbers can lead to a decrease in recruitment. In addition, fluctuations in the environment typically lead to year-to-year variability in recruitment. For species such as plaice, recruitment can show relatively little year-to-year variability (7 fold). North Sea cod shows a variability of around 9 fold, whilst for haddock, recruitment can fluctuate greatly (150 fold, Figure 1).

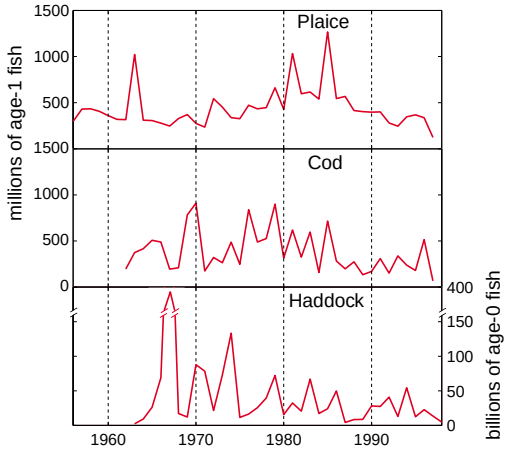
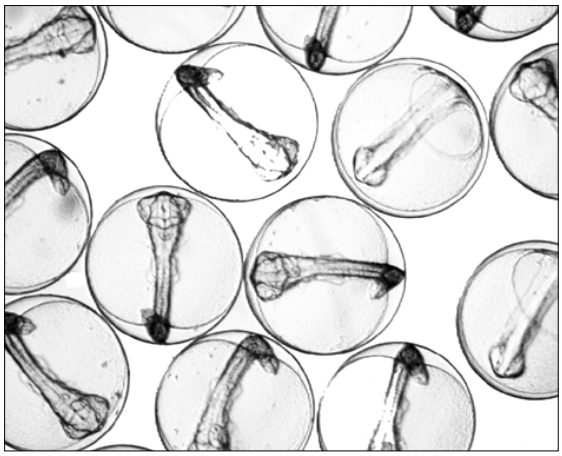


Figure 1. Year-to-year fluctuations in the number of young plaice, cod and haddock in the North Sea.



(Clive Fox, CEFAS)

Each female cod spawns around 8 million eggs. Only a very small fraction will make it to the stage of an adult fish.

Recruitment studies focus on the respective contributions of changes in the adult stock and fluctuations in the environment to the recruitment of young fish. One method used, is to compare the patterns of past changes in recruitment, parental stock size and environmental factors.

Using such techniques, it has been shown that recruitment of cod and plaice in the seas around the UK is related to sea temperature. For both species, recent reductions in levels of recruitment have been associated with increases in sea temperatures. For North Sea cod, low levels of recruitment are also associated with reduced spawning stock size (Figure 2 overleaf). This shows how both spawning stock size and environment can interact to affect recruitment.

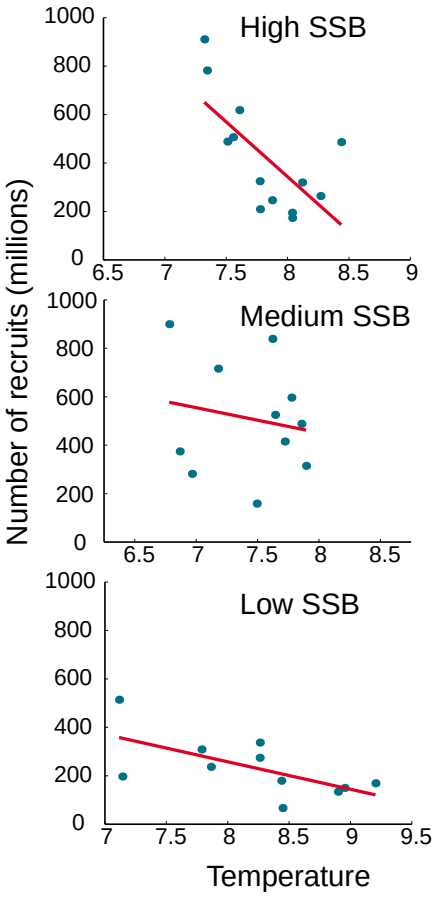


Figure 2. *North Sea cod: The relationship between recruitment and temperature in the North Sea for three levels of spawning stock biomass (SSB). The effect of temperature is more pronounced when the biomass of adults is high (top). When the adult biomass is low (bottom), the effect of temperature is reduced and recruitment is limited to low levels.*

(Roger Harris, PML)

Copepods are small (approx. 1mm) crustaceans. They constitute an important food resource for fish larvae and some adult fish like herring.

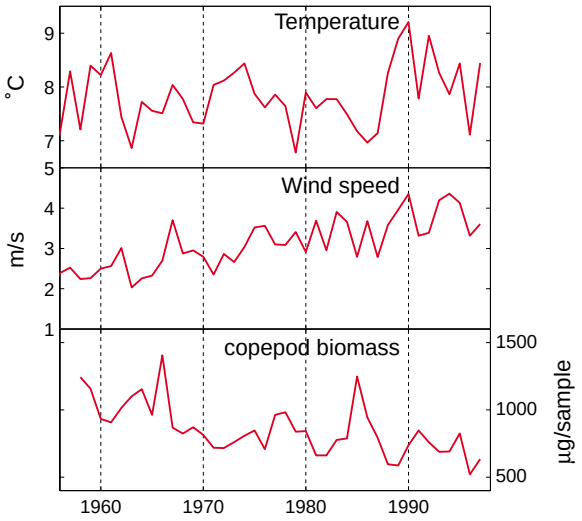


Figure 3. *Some environmental changes in the North Sea: Fluctuations in the sea surface temperature, with a marked increase in average temperatures in the 1990s (top). Changes in average wind speeds showing a gradual increase over the past four decades (middle). At the same time, the abundance of copepods (small crustaceans which constitute a large fraction of larval fish prey) has declined (bottom).*

Aside from increases in temperature, noticeable changes in other environmental factors have occurred in the North Sea during the past four decades. For example, average wind speeds have nearly doubled and a strong decline in the abundance of prey for fish larvae has occurred (Figure 3). Such changes may impact the feeding and growth of fish at the larval stages.

Although it is not possible to directly control factors such as sea temperature, wind or prey abundance, changes in the environment clearly influence recruitment and the future size of fish stocks. A better understanding of the relationships between environment, parental stock and recruitment will contribute to the design of more robust management methods for these stocks.

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