



The ocean's fish are becoming smaller and start breeding at an increasingly younger age. An article by a group of international fishery biologists in *Science* in 2007 reported that this is a direct consequence of our current fishing methods. 'The fisheries industry is changing the hereditary characteristics of the fish that feed us,' says research leader Adriaan Rijnsdorp of the Wageningen Institute for Marine Resources & Ecosystem Studies (Wageningen IMARES). 'It might take too long to repair these genetic changes.'

# THE FUTURE OF SEAFOOD



Fish is a healthy food say nutrition scientists, while fishery biologists emphasise that the seas are at the point of being overfished. This is the complex situation in which scientists from Wageningen IMARES operate. Rijnsdorp started work in 1980 at the former Netherlands Institute for Fisheries (RIVO).

RIVO has been sampling fish caught by Dutch fishermen for decades. 'We noticed that plaice started breeding at an earlier age in the 1980s,' says Rijnsdorp, who wrote his PhD thesis on the phenomenon in 1992. 'It was a remarkable development as there were quite a lot of nutrients entering the North Sea from the rivers at that time. With plenty of food available in the waters, one would have expected first breeding plaice to get bigger. A more important factor, however, was that with the heavy fishing smaller fish had a greater chance of escaping the nets and those smaller fish passed their genetic characteristics onto the next generations.'

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### Darwinian debt

As part of a larger international project, Rijnsdorp resumed the project in 2000. Using eco-genetic models, the changes in sole and plaice from the North Sea were studied. 'Our results showed that our current fishing methods are building up a 'Darwinian debt',' Rijnsdorp explains. 'According to our models, this means that fish genes are changing rapidly. The fish will quickly decrease in size and, unfortunately, reducing the pressure of fishing will not necessarily result in the fish reverting back to their old sizes.'

The fisheries sector should work more intelligently as well as less intensively, continues the biologist. 'There are no simple solutions to this problem, but we think that our expertise can help find solutions. In the period that plaice breed, for instance, the fish gather in the southern part of the North Sea, including many more sizeable specimens. Fishermen should leave the fish undisturbed at this time and in that region. If they do fish, they catch a relatively high number of large specimens and prevent these larger fish from spreading their genes. After the breeding season, these specimens can avoid fishermen's nets more easily.'

## The ideal situation would be to make farm fish vegetarian

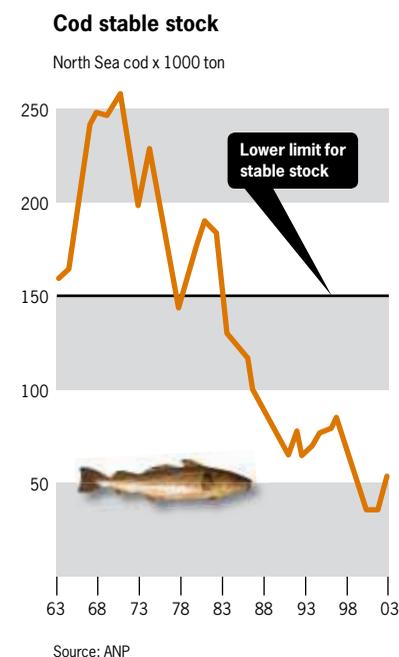
### Aquaculture

Intelligent fishing can play a major part in solving the oceans' ecological problems. But a common question is whether we should stop fishing altogether and switch to fish farming. 'This would only be part of the solution,' says Professor Johan Verreth, head of the Aquaculture and Fisheries group. 'The UN Food and Agriculture Organisation predicts that we will be eating more farmed fish than caught fish by 2030. The fisheries industry will never really disappear, however. In fact, intelligent fishing is a good thing because it contributes to a healthy ecological management of the oceans. Nonetheless, aquaculture will become the most important source of the fish we eat.' The demand for fish is still growing and the gap between supply and demand increasing. At the same time, consumers are demanding sustainable fish and this poses a huge challenge to scientists.

Sustainability is a multifaceted concept and there is no single solution. Consider fish feed, which contains large amounts of fish meal and fish oil produced from caught wild fish. Although the ideal situation would be to make farm fish vegetarian, this would not be a logical development: in evolution fish did not have to adapt to a vegetable diet. Fibres (non starch polysaccharides, NSP) that are abundant in plants are not easily digested and result in the production of slurry that has negative effects on the environment.

Scientists from the Aquaculture and Fisheries group have discovered that grain fibres have very different effects on fish, depending on species and nutrition habits. Grain fibres increase the viscosity of the chyme in the intestines, improving the consistency of the slurry. 'This was an important discovery,' Verreth explains. 'If the slurry does not immediately fall apart in water, it can more easily be filtered and the farm water stays clean.'

Contrary to typical carnivore seafish such as sea bass or salmon, in tilapia NSP was partially fermented and led to a deterioration of the slurry consistency. In short, the desired replacement of fish meal by vegetable ingredients can sometimes lead to an improvement but equally often to a deterioration of slurry quality. 'The research does show, however, that feed composition influences the physical quality of slurry and does therefore have a role to play in the further development of production systems. Our goal is to produce farm fish with as little residual waste and water use as possible.'



## Beamtrawl fishing

In 1999, the institute now known as Wageningen IMARES published a report that took the Dutch fisheries industry by storm. Author Han Lindenboom proved that the damage from Dutch fisheries to the Dutch coastal areas was 100,000 times greater than that being caused by the mining of gas and oil. 'And 100,000 was an understatement,' says Lindenboom. 'The current fishing methods have severely damaged the North Sea, where the seabed has been transformed into a ploughed-up plain in all but a few locations. Shellfish such as the ocean quahog are on the brink of extinction.'

According to Lindenboom, the cause is beamtrawl fishing. 'A net is kept open by a beam as it is dragged along the seabed, with chains following behind to unsettle the fish. Add in the fact that the North Sea is being fished intensively and that some areas are trawled by boats more than 50 times and you will understand the pressure the ecosystem is under.'

Lindeboom has for years been promoting the idea of having reserves in the North Sea that remain free from fishing. 'It looks like this might finally be happening,' Lindeboom says. 'At Wageningen IMARES, we are currently working on proposals for the Ministry of Agriculture, Nature and Food Quality. Brussels is also convinced that we will permanently destroy something special if we continue as we are.'



The logical solution to this problem is to start at the source and have fish produce less waste. For example, it is well known that the growth range among individual fish in closed farming systems is very large. Social behaviour (dominant fish eat the most) is usually given as an explanation, but there is no conclusive evidence that this is the case. The group's scientists have shown that the social hierarchy has very little impact and that a form of inherent feeding behaviour prevails. Fast eaters seem to be the most efficient animals: producing more growth with the same amount of feed.

This discovery has also introduced new perspectives for the further development of closed farming systems. Genetic differences can be used in selection: a more homogenous group of fish in a rearing container with a more efficient feed system that results in less production of slurry and therefore reduced waste emissions. These valuable findings will help make aquaculture more sustainable.