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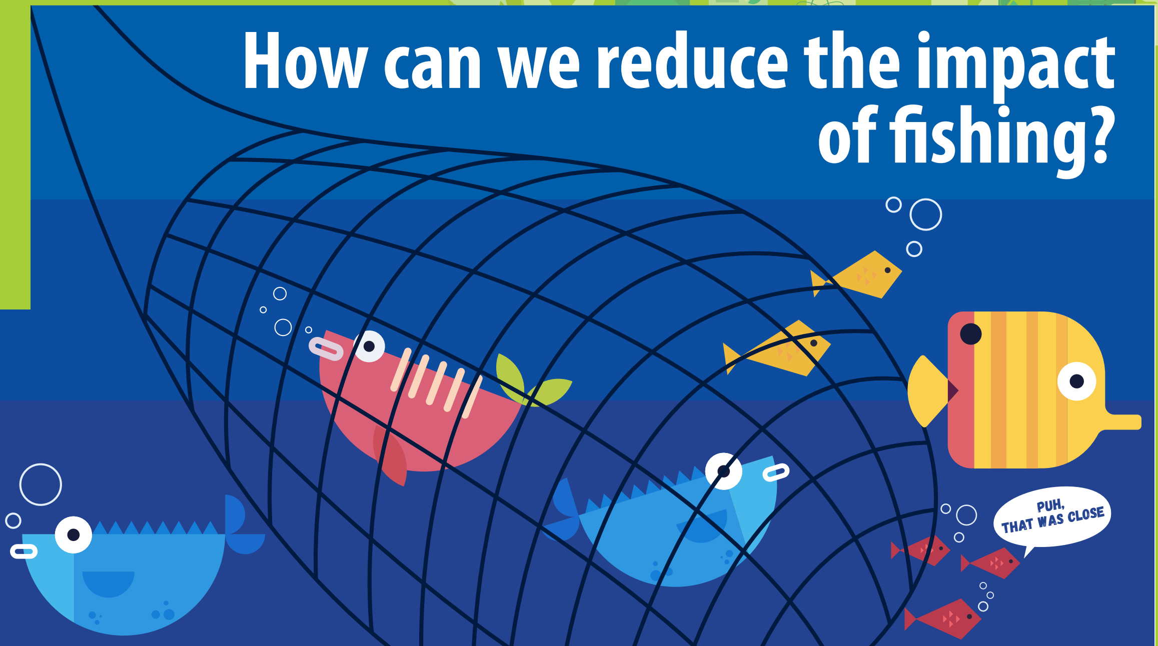
How can we reduce the impact of fishing?



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Abstract

How many times do you think you have eaten fish this year? Fish is delicious and it's really good for you, but we need to make sure that we don't over-fish our seas and oceans (Fig. 1). That way there are enough fish left to feed us for all the years to come. We propose three simple rules for *fisheries* management, which would reduce the impact of fishing on the major fish species. The rules would also help to rebalance the *ecosystems* and reduce the damage that fishing causes when boats scrape their nets over the seabed to catch fish.

Figure 1:
Large fishing nets allow for a 400 ton catch of mackerel in one big sweep.

Introduction

Governments all over the world have created laws to reduce the impact of fishing. Their main goal is to make sure we always have enough fish in our seas and oceans. To help put these laws into practical use, we propose three simple rules for fisheries management.

These are:

1) Take less than nature does

We recommend setting catch limits of fish at half the number of fish that die naturally (the *natural mortality rate*). Fish die naturally from predation, disease, natural hazards, and old age.

2) Keep population sizes to larger than half of what they would be naturally

Fishing shouldn't reduce fish populations to below half of their natural levels (the levels they had before we started fishing them). If populations fall below this level, ecosystems may become unstable as the fish can't carry out their roles as *prey* or *predators*.

3) Let fish grow and make baby fish

We should allow individual fish within a population to grow and *reproduce* before we catch them. Fish usually reproduce when they have grown close to $^{2}/_{3}$rd of their maximum size. We call this the *Optimum Length*. We recommend modifying fishing gear so that on average, fish can reach the *Optimum Length*.

We carried out this study to test the effectiveness of these three rules.

Methods

We created a new equation to work out the *Best Starting Length* for fishing. When the smallest fish caught are of this length, then the average fish in the catch would be of Optimum Length.

Then, we used mathematical models to calculate the biomass of the *fish stock* (the number of tons of fish remaining in the sea) and the amount of catch. These models are based on four parameters:

- how fast fish are growing in length and weight (= growth rate)
- how fish die naturally (for instance, of predation or diseases) (= natural mortality)
- the proportion of fish caught each year (= the fishing rate)
- the starting length for fishing

Our models allowed us to test the effects of our three simple rules and to compare the results with the current situation of fisheries. As a test, we applied our models to the North Sea cod (Fig. 2).

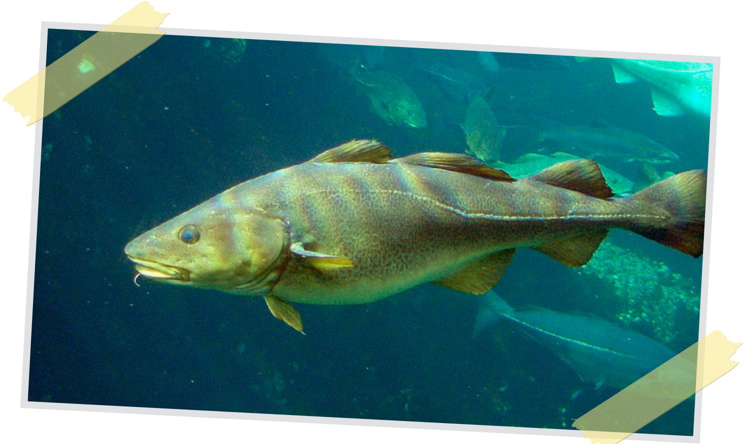

Figure 2:
Cod is a very popular fish to eat. So popular in fact, that the IUCN Red List of Threatened Species rates the Atlantic cod as vulnerable to extinction. Photograph by Hans-Petter Fjeld, distributed via a CC BY SA 2.5 license.

Results

Length at first capture

We found that for every rate of fishing, there is a Best Starting Length that will lead to maximum catches and to an average Optimum Length of fish in the catch (Fig. 3). This is typically achieved over the span of a few years, as the population size structure responds to the selectivity of the fishing gear.

Biomass

Reducing the fishing rate to half of natural mortality and starting fishing at the Best Starting Length would leave over 60% of the fish biomass in the ocean that was originally there before we started fishing. Such biomass would allow catches close to the sustainable maximum, at a lower cost of fishing because there are so many fish in the water. In contrast, most of the actual fisheries today exert much too high fishing pressure on much too small stocks and much too small fishes, resulting in low catches at high cost and high environmental impact (see right hand sides of lower curves in Figs. 3 and 4).

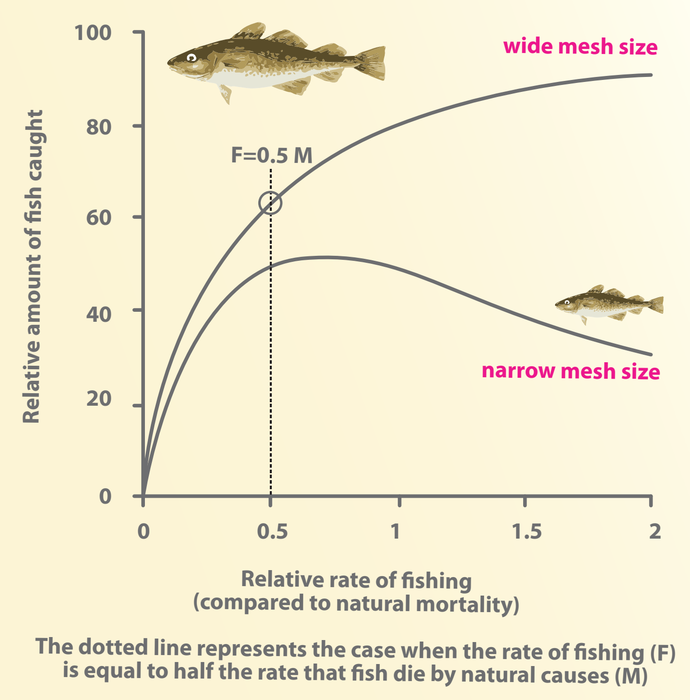

Figure 3:
Relative catch as a function of fishing pressure and of wide versus narrow mesh sizes used in the fishing gears. Note that the large versus the small cod applies to the amount of catch as well as to the average size of the fish in the catch.

If we catch fish at any size (even really tiny ones), what effect does this have on the amount of fish in the catches? Is the amount greater or smaller than if we put a lower limit on the length of the fish we catch?

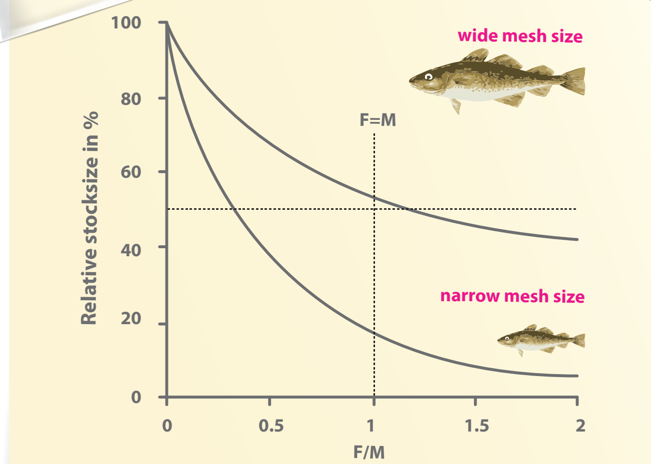

Figure 4:
Biomass of fish stock in the ocean relative to natural levels, based on the rate of fishing and on wide versus narrow mesh sizes used in the fishing gears. Note that large versus small cod refers to the biomass in the ocean as well as to the abundance of large fish (none left in the lower scenario).

As the rate of fishing increases, what effect does this have on the fish stock? Why do you think this is?

Discussion

We presented the Best Starting Length as a target fish size for the onset of fishing, which would result in maximum yields. If combined with low fishing mortality, this would allow to maintain large population sizes and lead to an average Optimum Length in the catch.

By using the Best Starting Length, we found that we can reduce the impact of fishing on the population and increase catches (yield) at the same time.

If we don't catch fish below the Best Starting Length, we can maximise fishing profits when fishing rates stay below natural mortality, with stock sizes above half of the natural size.

The rules that we proposed would reduce the impact of fishing by allowing all fish to mature and ensuring that on average, the population reaches the age and size where it can grow the most.

Our rules would achieve some of the goals of ecosystem-based fisheries management, such as rebuilding the populations of prey and predator species. With larger population sizes and greater catch, fishing boats wouldn't have to use fishing gear for as long, and they could use more selective equipment. This would reduce *bycatch* of unwanted or threatened species and habitat disturbance.

Conclusion

Why is it important to reduce the impact of fishing? If you would like to be able to eat fish at affordable prices in the future – then we need to protect fish populations.

Fish populations also are important for many other animals, like those that eat them. If fish populations decline, it has a negative effect on all animals in the ecosystem.

What can you do to help? Buying fish that is "sustainably sourced" and that is so large that it had a chance of reproducing before capture is one great way to show your support. Check out the website in the references section to see which fish are good to eat and how big they should be.

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Glossary of Key Terms

Best Starting Length – the size of fish when fishing begins that results in the average length of fish in the catch (and in the part of the population that is not caught) being the Optimum Length.

Biomass – the total weight of fish in the water.

Bycatch – the capture of species other than the one that you are trying to catch. This happens when we use fishing equipment that is not selective, like large nets.

Ecosystem – a biological community of interacting organisms and their physical environment.

Fertility – the ability of an animal to be able to reproduce. Animals have to grow and mature before they become fertile.

Fish stock – a population of a particular species of fish that is usually defined by the area where we find it. The fish stock we were studying was the North Sea cod.

Fisheries – the people, equipment, and organizations involved in catching fish for food, fun, or profit.

Natural mortality rate – the sum of the rates that fish die due to natural causes such as predation, disease, competition and old age.

Optimum Length – the length of a fish when it has reached its maximum body weight and level of *fertility*.

Population – a group of individuals from the same species that live in a certain area and reproduce more among themselves than with individuals from neighboring populations.

Predation – when one animal (the predator) eats another animal (the prey).

Predator – an animal that eats other animals.

Prey – an animal that is eaten by another animal.

Reproduction – creating offspring, or in more plain English: making babies. Animals have to reproduce to pass on their genes to their offspring before they get old and die (or are caught by fishers).

Check your understanding

1. Why is it important to have a balance of predators and prey in an ecosystem?

2. Some scientists think that fishing should be "unselective". They suggest that fisheries should catch fish of all species and sizes. Why do you think this might not be a good idea?

3. Looking at figures 2 & 3, which fishing strategy results in the lowest catch and biomass?

4. The most important economic factor for commercial fisheries is profitability – this is the difference between the money that the fishermen can sell their catch for, and the cost of fishing. Can you think of some of the costs of fishing, and why do you think that the rules in our study will help to reduce these costs?

5. If the science is so clear about the economic benefits of sustainable fishing, why are fishers not going for it? Why are they not willing to catch less for 2-3 years, to help the fish recover, if thereafter they can catch substantially more forever? Why do you think are managers and politicians not helping fishers to make the transition?