MSY - Maximum Sustainable Yield

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Why is it important to know about maximum sustainable yield (MSY)?

To manage human take from the wild, one needs to know how much can be safely taken without depleting the resource one wants to take from, and without otherwise negatively impacting the environment. Fishing is no exception. As scientists and managers have discussed how much fish can be safely taken out of the sea one concept has become a key tool for fisheries management: maximum sustainable yield (MSY). In order to participate in the debate about fishing limits, one needs to have an understanding of the basics of the MSY concept. This briefing is aiming to provide this.

What is MSY?

In population ecology and economics, MSY is the largest average yield (catch) that can theoretically be taken from a species' stock over an indefinite period under constant environmental conditions. It is usually measured in tonnes. To have a viable and thriving fishing sector, the size of fish stocks must be above levels where they can produce the maximum sustainable yield over an indefinite timeframe.

B, Y, F: The alphabet soup of abbreviations for understanding MSY

When discussing fishing limits it is important to differentiate between stock biomass, fishing yield and fishing rates which are all important in determining how much fish can safely be caught over a given period of time for a specific fishery:

B: Biomass is simply the body-weight of all the fish of one specific stock in the water. B does not differentiate age, gender etc. It is measured in tonnes.

Y: Yield is the catch, i.e. the fish taken out of the water through fishing. It is measured in tonnes.

MSY: Maximum sustainable yield is, theoretically, the largest yield (catch) that can be taken from a specific fish stock over an indefinite period under constant environmental conditions. It is measured in tonnes.

F: F is the fishing mortality rate i.e. the catch relative to the size of the stock (the proportion of fish caught and removed by fishing).

B_{MSY}: B_{MSY} is the biomass that enables a fish stock to deliver the maximum sustainable yield. In theory, B_{MSY} is the population size at the point of maximum growth rate. The surplus biomass that is produced by the population at B_{MSY} is the maximum sustainable yield that can be harvested without reducing the population.

F_{MSY}: F_{MSY} is the maximum rate of fishing mortality (the proportion of a fish stock caught and removed by fishing) resulting eventually, usually a very long time frame, in a population size of B_{MSY}. F_{MSY} is a constant and can be applied to any stock that is not impaired in its reproductive capacity.

MEY: The maximum economic yield (MEY) is the value of the largest positive difference between total revenues and total costs of fishing (including the cost of labour and capital). MEY is typically achieved at catches that are 10-20% smaller than MSY.

F_{MEY}: F_{MEY} is the fishing mortality (the proportion of fish caught and removed by fishing) resulting in MEY. F_{MEY} is typically 10-20% smaller than F_{MSY}.

MSY, B_{MSY} and F_{MSY}, as well as MEY, B_{MEY} and, F_{MEY} are reference points which are expected to remain fixed unless the environment changes or better data become available. Conversely B, Y and F may change every year, and in the EU context are also corrected retroactively (backwards in time) by the International Council for the Exploration of the Seas (ICES).

When is a fish stock overfished, and what is overfishing?

The European Commission considers a fish stock to be overfished when its biomass is below B_{MSY}. In that situation, it is unable to produce the maximum sustainable yield. Overfishing occurs when more than the sustainable share is taken out of a given fish stock, i.e. when the fishing rate is above F_{MSY}. The biomass of the stock will then diminish. Overfishing can occur whether a stock is above B_{MSY} or not.

How can an overfished stock be brought to a level where it can produce the maximum sustainable yield?

In order to allow an overfished stock to rebuild to B_{MSY}, the fishing rate F has to be set at F_{MSY} or below. The lower F, the faster a stock can recover and the sooner it will be possible to take the maximum sustainable yield. As the stock grows, fishers will be rewarded with higher and more stable yields then were previously attainable.

How can overfishing be stopped?

It is simple to stop overfishing, but not necessarily easy: for a fish stock that is already at or above B_{MSY}, fishing pressure should not exceed F_{MSY}. To stop overfishing of an overfished stock, the same applies. However, to bring the stock back to B_{MSY} or above, in a defined timeframe, fishing pressure needs to be reduced even further below F_{MSY} (there is even a formula how to calculate F depending on the desired timeframe). It is simple to do this as fishing pressure is a human intervention and as such manageable. It is not necessarily easy, as for stocks that are currently being overfished the fishing limits will have to be reduced by quite a substantial amount. This will impact the sector, with less fish allowed to be caught.

However, depending on the fishery, the time needed until catches first regain and then exceed previous levels can be only a few years. Without action to stop overfishing, a stock could collapse with deeper and longer-term impacts on both the fishing sector and the marine environment.

What did EU member states commit to in 2002?

In line with the requirements from the United Nations Convention on the Law of the Sea (UNCLOS) and the United Nations Fish Stocks Agreement (UNFSA), EU member states committed themselves at the Earth Summit in Johannesburg to, "Maintain or restore stocks to levels that can produce the maximum sustainable yield with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 2015;" (JPOI Article 31a). At the time, the "where possible" was introduced to accommodate developing countries that would first need to establish an infrastructure that would allow them to monitor and assess stock levels. The EU already had this infrastructure in 2002.

What does the Commission's proposed Basic Regulation of the Common Fisheries Policy state?

Article 2, paragraph 1, of the proposed regulation for the Common Fisheries Policy, COM(2011) 425 final, states the following: "The Common Fisheries Policy shall apply the precautionary approach to fisheries management, and shall aim to ensure exploitation of living marine biological resources that restores and maintains populations of harvested species above levels which can produce the maximum sustainable yield, not later than 2015." We interpret this to mean that stock size should reach or exceed B_{MSY} by 2015 – which would be in accordance with the commitments made by the EU in Johannesburg in 2002.

What do Commission officials <u>say</u> they are proposing?

When asked about the above MSY target, Commissioner Damanaki and DG Mare staff usually state that the proposed CFP regulation should be interpreted to mean that sustainable exploitation rates (F_{MSY}) should be reached by 2015. This interpretation is not consistent with the international commitments agreed to in Johannesburg. It would mean that that fish biomass would recover only very slowly, and maximum sustainable yield may not be attained for several stocks for a long time.

What is required to secure EU fish stocks above a level capable of producing MSY by 2015?

Stocks that are already at or above B_{MSY} levels should be fished at rates slightly below F_{MSY}, to account for scientific uncertainty and fluctuations in stock sizes. Fishing below F_{MSY} would also bring economic benefits (see below "Is maximum economic yield an option?"). In order to restore stocks that are below B_{MSY} to above levels where they can produce maximum sustainable yield, fishing pressure needs to be further relieved to enable the stocks to recover. The larger the reduction, the faster the recovery.

What about data deficient stocks?

The majority of the stocks fished in EU waters are currently assessed as 'data-poor'. However, there are NO biological or scientific reasons why fishing pressure in 2015 cannot be at rates below F_{MSY} or below a proxy in the case of data-poor stocks. Australia, New Zealand and the USA use proxies for MSY and historic catch levels for data-poor stocks.

What about mixed fisheries?

In mixed fisheries, F_{MSY} should be set according to the most vulnerable stock. It is possible to have all stocks at the same time above B_{MSY}, but not exactly at B_{MSY} levels. However, B_{MSY} is typically a target set for a single species, so a joint B_{MSY} target in a multi-species context would mean that some species would be fished below MSY, and some overfished, with the risk that sensitive ones might collapse.

What if a stock is in such a bad state that it cannot recover to B_{MSY} by 2015 even if fishing were to stop completely?

Since 2002, EU member states have been aware that they committed themselves to reaching MSY by 2015. However, action has largely been too slow and too late, so that most EU fish stocks are still in a severely overfished state, i.e. with a biomass well below B_{MSY}. For such stocks, fishing pressure must be substantially below F_{MSY}, with a clear timeline for when each fish stock should reach B_{MSY}.

Is maximum economic yield an option?

Maximum Economic Yield (MEY) is the value of the largest positive difference between total revenues and total costs of fishing (including the cost of labour and capital). Typically, mortality rate F_{MEY} is slightly below F_{MSY}, resulting in marginally less than the maximum sustainable yield. However, much less fishing effort is used, with fewer associated costs, to take the maximum economic yield, and higher biomass levels reduce fluctuations in fishing opportunities. Consequently, it is an economically attractive option, i.e. a cheaper way of ending up with almost the same amount of fish. It is also environmentally more desirable as it reduces environmental pressures such as engine emissions and negative impacts on the wider marine environment.

Is there a win-win scenario?

Clearly, there are many losers if the fisheries management status quo prevails. Fish stocks won't recover, and fishers will have even less fish to catch, resulting in more job losses and hardship. According to the European Commission only 9% of stocks are likely to still be in sustainable state by 2022 if the status quo persists. With some short term pain there could be gain for all: for fishers the yield would increase, the marine environment would be in a better state, and European consumers would have a more secure fish supply.