

Ask Dr. Pauly

What Are Stock Assessments?

One of the major tasks that fisheries scientists face, once they have documented a fishery's catch and fishing effort, is assessing the abundance, or "biomass," of the population, or "stock," of fish that the fishery exploits.

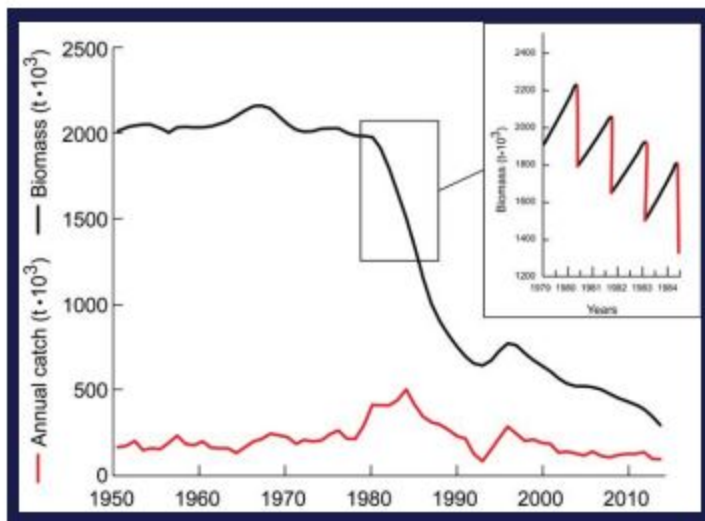
The goal here is to optimize the fishery, that is, for the catch to be set as high as possible but not so high that the population risks crashing, or cannot recover if it has previously been overfished. This is called the maximum sustainable yield, or MSY.

The stock assessments themselves are based on "fishery-independent" information obtained from research vessel surveys and complex computer models that integrate into a single framework the survey results with "fishery-dependent" data, such as the age and number of the fish that are caught and the number and properties of fishing gears. From this, and a vast number of assumptions, the presumed abundance of the stock and the suggested quota for the following year can be inferred.

Classical stock assessments, therefore, are not only extremely expensive — a research vessel survey lasting a week can cost several hundred thousand dollars — but also very demanding in terms of data and expertise. Thus, they are performed mainly in wealthier countries.



A diver helps corral skipjack tuna in the Philippines. Fisheries in less-developed nations are often data-deficient.



For the rest of the world simpler methods, often rules of thumb, have been used to assess stocks, and their inaccuracies have led to a situation where many countries overfish their marine resources without realizing it.

This can be overcome, however, through the development of methods suitable for use in data-sparse situations. A new approach, the CMSY method, infers a fishery's MSY from catch data – hence the acronym.

Essentially, the CMSY method requires only a computer and a time series of catch data, typically 20 or more years. Then, it proceeds as follows (warning: some math to follow):

1. Assume a carrying capacity (k) which equals the level of abundance, or "biomass," of a given species that can be accommodated in a given ecosystem, corresponding to the mean abundance of that species before it was exploited by the fishery.
2. Subtract the catch of the fishery's first year from the carrying capacity of that fishery (k).
3. Multiply that remaining biomass by the species' growth rate (r), which is reduced by the fact that biomass is close to carrying capacity.
4. Subtract the catch of the second year from the product of r times the residual biomass.
5. Repeat 3 and 4 for each year, taking account of the fact that r varies when the biomass changes.

Depending on the initial values of the carrying capacity and the species growth rate, this procedure will either crash the population (more catch will be removed than can be compensated for by biomass growth) or the population will remain present, or viable.

These steps are then repeated for a wide range of values. The few values of k and r which allow for population viability are averaged, and the averages are retained as best estimates. This might require 10,000 or more runs of steps 1 - 5, but computer time is cheap, and it can be substantially reduced by studying ranges of values previously known to produce viable trajectories.

The point is that, with catch data, and given simple constraints, one can estimate the carrying capacity and population growth rate. From these, MSY can be computed. Also, for every year with catch data, the ratio $B/BMSY$, that is, a measure of the abundance of fish (B) relative to that which allows MSY to be taken ($BMSY$) can be calculated, and used to set quotas.

The Sea Around Us initiative, with Oceana's support, has recently applied this method to the overwhelming majority of stocks contributing to the global fish catch, with catch data covering the years 1950 to 2014 – longer than for most stock assessments. The results can be found on seaaroundus.org for each of the world's marine ecoregions, providing useful data for science-based fisheries management at national and international levels.

¹ I will spare you the equations required to do this. Also, this presentation of the CMSY method is simplified; there is more to it than presented here, but it is still simple in principle.



Dr. Daniel Pauly is the founder and director of the Sea Around Us project at the University of British Columbia's Institute for the Oceans and Fisheries, and is a member of the Oceana board.