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OVERFISHING AND REBUILDING

OVERFISHING AND MAXIMUM SUSTAINABLE YIELD

Stocks can become *overfished* due to *overfishing*. These terms are defined in the Magnuson-Stevens Fishery Conservation and Management Act, which governs fisheries in Federal waters.

Overfishing occurs when the level of harvest is too high relative to the population size. A population may be considered overfished when it is driven too low.

TECHNICAL DETAILS

The "overfishing" threshold (called the maximum fishing mortality threshold, or MFMT) differs depending on a stock's size (biomass) in relation to maximum sustainable yield (MSY). The MSY is the maximum catch that can be taken over a period of time without causing stock biomass to decline. The population size or biomass estimated to produce MSY is denoted B_{MSY}.

A stock's productivity, or rate of growth, varies with the stock's spawning biomass,

The amount of fishing a stock can sustain depends on its productivity. When no fishing occurs on a fish stock, productivity is actually lower because growth and mortality of the stock are roughly balanced.

As biomass approaches the amount necessary for maximum sustainable yield (B_{MSY}), the population becomes more productive because there is less competition for resources, and the population generates more fish than needed to replace fish that die of natural causes. In fact, most fish populations can be fished well below their unfished biomass level (the stock size if fishing never occurred) and still be sustained and capable of returning to their unfished status. Thus, for very productive stocks, B_{MSY} can be a fraction of their estimated unfished biomass.

One of the main goals of fishery management is to keep stocks at B_{MSY}. If the population falls below that level, productivity will decrease because there aren't as many fish reproducing.

OVERFISHED

A fish stock is "overfished" when its population size (or biomass) falls below the minimum stock size threshold, or MSST, which is typically set at half of B_{MSY}. Stocks are then declared overfished by the National Marine Fisheries Service.

When a stock is declared overfished, the Council must develop measures to rebuild the stock. NMFS maintains a list of stocks it has declared subject to overfishing and/or overfished (see http://tinyurl.com/q5x2z56).

REBUILDING

The Magnuson-Stevens Act requires that every Council end overfishing and rebuild overfished stocks. Policies are in place to reduce catches of overfished species to a level that will allow their populations to rebuild to a healthy size. The process of rebuilding is guided by rebuilding plans covering each overfished species.

There are three important aspects to rebuilding: the size of the fish stock, the time needed to rebuild the stock, and the rate of fishing that allows the stock to increase to the target level (B_{MSY}). A rebuilding plan describes the policy measures that will be used to rebuild the fish stock.

REBUILDING TIME FRAME

Two boundaries, called T_{MIN} and T_{MAX}, are used to determine the amount of time required to rebuild a stock (the T stands for time). The minimum boundary (T_{MIN}) is set by calculating how long the stock would take to rebuild if no fish were caught. This depends on natural factors such as fish biology and ocean conditions. T_{MAX} is the maximum allowable time for stock rebuilding. It is set by Federal law, and is usually 10 years.

Because of their biology, some fish stocks cannot rebuild to B_{MSY} in less than 10 years even if no fishing occurs. In these cases, another standard is used. Scientists figure out how long an average generation is (how long it takes for mature fish to be replaced in the population) and add this to T_{MIN} (the natural rebuilding time if there were no fishing). The figure that results is the new high boundary, T_{MAX}.

REBUILDING ANALYSES

A rebuilding analysis presents estimates of the time to rebuild

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using different harvest levels.

Rebuilding analyses describe rebuilding in terms of probability, or the likelihood something will occur. Probability is also a measure of risk. If a particular course of action is less likely to produce the desired outcome, it may be considered riskier.

The rebuilding analyses that the Council uses to determine harvest policies estimate the probability that the overfished stock will rebuild by T_{MAX} with a given harvest level. These rebuilding probabilities represent a crucial policy choice: lower harvest levels result in a higher probability that the stock will rebuild in time, and vice versa.

T_{MIN} = how long a stock would take to rebuild if there was no fishing. Set by biology.

T_{Max} = the maximum allowable time allowed to rebuild a stock. Set by law.

B_{MSY} = the population size or biomass estimated to produce maximum sustainable yield (MSY)

MSY = the maximum catch that can be taken over a period of time without causing stock biomass to decline.

The median time to rebuild in a rebuilding analysis under any given harvest rate or strategy is the year predicted to have a 50% probability that the stock will reach B_{MSY} by this year. The Council usually uses this median time to rebuild as the target year (T_{TARGET}) in formulating its policy recommendation, as long as it's no greater than T_{MAX}. By court precedent and national policy, rebuilding probabilities cannot be less than 50%.

BALANCING TRADEOFFS

Rebuilding a stock is a tradeoff between sharply reducing catches in the short term to rebuild a stock quickly, or allowing some catch and waiting longer for a stock to rebuild.

In finding a balance between rebuilding and fishing, the Council is limited by the biology of the stock and by national policy. All other things being equal, a stock will rebuild fastest if there is no fishing at all, but this would be hard on fishing communities, and the Council is required to take community impacts into account.

Choosing a timeframe can be difficult and controversial. If managers choose a very early target date (only a few years after the lower time limit, T_{MIN}), then almost all fishing may have to be halted in order for the stock to recover. Catch limits may be too low to allow access to co-mingled, healthy target stocks. On the other hand, if managers opt for a target year far in the future (very close to the upper time limit, T_{MAX}), it will take longer for the population to rebuild.

REBUILDING PLANS

Once the Council has developed a rebuilding strategy, it is described in a rebuilding plan. The strategy is expressed as an annual catch limit. The Council then develops management measures to keep annual harvests within this limit.

The Council can't choose the values for many rebuilding plan elements. The dates for the "goalposts"—T_{MIN} and T_{MAX}—are determined based on guidelines established at the national level. Mean generation time is a biological characteristic that cannot be chosen by policymakers. The Council *is* able to choose a fishing mortality rate and the corresponding annual level of fishing.

EXAMPLE: DEVELOPING A REBUILDING PLAN FOR YELLOWEYE ROCKFISH

Yelloweye rockfish was declared overfished in 2002 and a rebuilding plan was first implemented in 2003. The yelloweye rebuilding plan has been revised three times since then.

Rebuilding Time Window

Based on the most recent yelloweye rebuilding analysis (2011), if there were no fishing at all beginning when the rebuilding plan was put in place in 2003, 2037 is the earliest date at which the stock would rebuild (T_{MIN}).

This is clearly more than the 10 years required by Federal law for species that are productive enough to rebuild that quickly, so the mean generation time (46 years) is added to T_{MIN}, resulting in a T_{MAX} of 2083.

Therefore, managers are required to manage fishing so that the stock recovers before 2083. In the last rebuilding plan, managers chose a target year (T_{TARGET}) of 2074 for rebuilding yelloweye. Taylor (2011) estimated a probability of 64% of rebuilding the stock by 2074.

Rebuilding probabilities are a way of measuring management risk. Managers can thus weigh the tradeoffs between short- and long-term benefits.

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