



# Harvest Strategies Glossary

## Overview

Harvest strategies are emerging as a critical innovation in fisheries management. Understanding the terms used to describe the many steps in the process will help fisheries managers and other stakeholders effectively apply the practices described in this toolkit. Consistent definitions provide a universal frame of reference for discussing harvest strategies and the concepts involved.

## Glossary

**B:** Biomass. The total weight of all organisms in a population or a defined part of the population.

**$B_0$ :** Virgin stock biomass or unfished stock biomass. The average biomass likely to exist before fishing began or at any point in time in the absence of fishing.

**$B_{MSY}$ :** The long-term average biomass that is achieved by fishing at a constant fishing mortality rate equal to  $F_{MSY}$ ; in other words, the average biomass able to produce maximum sustainable yield (MSY). Since it is an average, the biomass at any particular time may be different from  $B_{MSY}$  because of natural variability in productivity and breeding success, though the long-term average is maintained.

**Catch per unit effort (CPUE):** The amount of catch taken per unit of fishing effort, such as the number of fish per 1,000 hooks. Often used as a proxy for stock abundance.

**Conditioning:** The process of fitting an operating model (OM) to the available data as part of a management strategy evaluation (MSE). Conditioning the OM helps develop a set of plausible models and/or hypotheses of the stock and fishery that are consistent with the data and assumptions about uncertainty, as opposed to identifying one “best” scenario and ignoring alternative models and/or hypotheses when testing prospective harvest strategies.

**F:** The instantaneous fishing mortality rate. This is the fraction of the population (or year class or other defined group) that is expected to be caught at any single point in time. The annual fishing mortality rate is calculated using the formula  $1 - e^{-F}$ , where “e” is the mathematical constant known as Euler’s number. For example, an F of 0.54 means that 0.417, or 41.7 percent, of the population is caught each year.

**$F_{0.1}$ :** The fishing mortality rate at which the slope of the yield per recruit (YPR) curve is reduced to 10 percent of the value at the origin (the intercept of the x and y axes on a graph).  $F_{0.1}$  was developed to provide a fishing mortality rate that protects the spawning stock potential (see  $F_{X\%}$ ) while providing high yield per recruit. The 10 percent value is arbitrary; the same concepts can be applied with different percentage reductions in YPR, but 10 percent was developed as a more conservative alternative to  $F_{MAX}$ .

**$F_{MAX}$ :** A fishing mortality rate that produces the maximum yield per recruit (YPR). While this maximizes the YPR, this rate does not necessarily protect against a reduction in the number of recruits (i.e., recruitment overfishing) and consequent overdepletion.  $F_{0.1}$  was developed in response to the recognition that  $F_{MAX}$  was sometimes unsustainable.

**$F_{MED}$** : A fishing mortality rate that can be supported by the survival rate of new recruits observed in 50 percent of years.

**$F_{MSY}$** : A fishing mortality rate that, if applied constantly, would result in  $B_{MSY}$  and maximum sustainable yield (MSY) on average over the long term.

**$F_{X\%}$** : A fishing mortality rate that leads to X percent of the maximum spawning potential (e.g., egg production, recruits, spawners) that is obtained with no fishing.

**Growth overfishing**: Occurs when fish are harvested too small to maximize yield per recruit (YPR).

**Harvest control rule (HCR)**: A pre-agreed rule that describes how the harvest is to be managed based on selected indicator(s) of stock status. Also known as a decision rule.

**Harvest strategy**: A pre-agreed framework for making fisheries management decisions, such as setting quotas, that is designed to achieve specific management objectives. The strategy typically includes a monitoring program, stock assessment method, reference points and harvest control rules (HCRs). Also known as a management procedure or management strategy.

**Indicator**: A quantity that is measured or estimated and that is thought to be informative, directly or indirectly, about the state of the stock. Indicators can be quantitative or qualitative. When desired and undesired outcomes for the indicator are specified, the combination can be used to provide a performance indicator or performance measures. Used to measure the success in achieving management objectives. See *Performance metric*.

**Kobe plot**: A four-quadrant graphic that shows the status of a stock, the trajectory of the stock through time, or both. Stock abundance is on the horizontal axis, and fishing mortality is on the vertical axis. The axes are typically divided at  $B=B_{MSY}$  and  $F=F_{MSY}$ , respectively, and hence can graphically depict whether the stock is overfished and/or subject to overfishing.

**Kobe strategy matrix**: A table that shows the probability of achieving one or more management objectives (e.g., successful rebuilding, avoidance of overfishing) under alternative management scenarios (e.g., different total allowable catch [TAC] levels).

**Limit reference point (LRP)**: A benchmark for an indicator that defines an undesirable biological state of the stock. To keep the stock safe, the probability of violating an LRP should be very low. However, if an LRP is violated, immediate action—such as a suspension of fishing—should be taken to return the stock or fishery to the target level.

**M**: The instantaneous natural mortality rate. The part of the total mortality rate ( $F+M$ ) that is due to natural causes, including disease, predation and starvation.

**Management objectives**: Formally adopted goals for a stock and fishery. They include high-level or conceptual objectives often expressed in legislation, conventions or similar documents. They must also include operational objectives that are specific and measurable, with associated timelines and minimum required likelihood that they can be achieved. When management objectives are referred to in the context of harvest strategies, the latter, more specific definition applies.

**Management procedure (MP)**: See *Harvest strategy*.

**Management strategy evaluation (MSE)**: A simulation-based, analytical framework used to evaluate the performance of multiple harvest strategies relative to the pre-specified management objectives.

**Maximum sustainable yield (MSY):** The largest long-term average yield that can be taken from a stock under existing environmental conditions and a constant fishing mortality rate.

**Operating model (OM):** A core component of the management strategy evaluation (MSE) process used to test a harvest strategy. The OM simulates all relevant aspects of the harvest strategy so that the effects of alternative strategies can be measured and compared. Typically, the OM includes the resource/ecosystem dynamics, the observation process, the assessment process, the management decision process and the implementation of the management decision. Uncertainties in each of these processes are included. Multiple OMs based on varying assumptions are often used within a single MSE process to test the robustness of alternative harvest strategies.

**Performance metric:** A quantitative expression of a management objective used to evaluate how well the objectives are being achieved by determining the proximity of the current value of an indicator to the objective, often a reference point. Also known as performance statistics or performance indicators. See *Indicator*.

**Precautionary approach:** A management philosophy that requires consideration of risk reduction in decision-making, so that in the absence of full information, the decision taken results in the lowest risk to the stock.

**Recruitment:** The amount of new fish that join a defined group of fish each year—due to growth and/or migration. The defined group may be the exploited part of a population, which is described as recruitment to the fishery. The defined group also may be the whole population (fished or unfished) older than a certain age (e.g., age 1 or the age at maturity).

**Recruitment overfishing:** Occurs when adults are depleted to the point that they cannot replenish themselves. Without remedy, this will lead to stock collapse.

**Reference points:** Benchmarks in relation to indicators that are used to compare the current status of a fishery management system with a desirable or undesirable state.

**Risk:** The probability of a negative outcome in a fishery, such as stock collapse or breaching the limit reference point (LRP). In statistical terms, it is the probability of a negative outcome multiplied by its adverse effect.

**Robust:** A method that achieves the desired performance, as well as reliable and consistent outcomes, across a range of stated uncertainties and assumptions.

**Selectivity:** Measures the relative vulnerability of different age (size) classes to being caught by a specific fishing gear or fleet.

**Spawning potential ratio (SPR):** The lifetime contribution of spawning output (e.g., eggs) that a recruit is expected to provide under the stated fishing mortality, relative to its lifetime production without fishing. Often expressed as a percentage. For example,  $SPR_{50\%}$  means that under the specified fishing mortality rate, a recruit will on average produce half the eggs in its lifetime that it would have produced without fishing. See  $F_{x\%}$ .

**Spawning stock biomass (SSB):** The total weight of the sexually mature part (i.e., adults) of a population.

**Target reference point (TRP):** A benchmark for an indicator that defines the target fishery state that should be achieved and maintained. Creates a buffer zone to ensure that the limit reference point (LRP) is not breached. Can be based on one or more biological, ecological, social or economic considerations.

**Threshold reference point:** A benchmark that triggers a pre-defined management response to help the fishery remain close to the target reference point (TRP) and avoid breaching the limit reference point (LRP). Typically set between the TRP and the LRP. Also known as a *trigger reference point*.

**Trigger reference point:** See *Threshold reference point*.

**Uncertainty:** Results from a lack of perfect knowledge about one or more factors that affect stock assessments, estimation of reference points and management. Four main types of uncertainty are considered in fisheries: observation error (caused by biased data), process error (caused by natural population variability), model error (caused by incorrect assumptions or model structure) and implementation error (caused by failure to fully implement management measures).

**Yield per recruit (YPR):** The expected yield (measured by numbers, biomass, etc.) that a new recruit will produce over its lifetime under a stated fishing mortality and selectivity.

## Sources

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