

FISHING TO THE LIMITS:

The trouble with maximum sustainable yield and the need for target and limit reference points

Introduction

For more than 80 years, the health of global fish stocks has been measured against the yardstick of “maximum sustainable yield,” or MSY. Looking only at individual species of fish being targeted, fisheries managers pursued the ideal of allowing fishing at the highest possible rate that a population could be expected to withstand on average. The goal of fishing to the level of MSY (F_{MSY}) was embraced by the world community and incorporated into several important international agreements, including the United Nations Convention on the Law of the Sea (UNCLOS).

Today, it is widely recognized that managing fisheries with the aim of maximizing catches is too risky, given natural environmental fluctuations, increased stresses on the marine environment, and the role of target fish species in their ecosystems (and the consequences of unmanaged removal). Limited information regarding catch levels, the impact of management measures, and the condition of the fish population adds to the uncertainty. Acknowledging these shortcomings, the international community agreed in 1995 to apply a precautionary approach to managing fish stocks on



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Introduction to MSY

Definitions:

- MSY: The largest average yield (or catch) that can continuously be taken from a species' stock under existing environmental conditions.
- B_{MSY} : The long-term average biomass level (the weight of all the fish in a specific stock) needed to maintain MSY.
- F_{MSY} : The fishing mortality rate (the rate at which fish are removed from a stock through fishing) that results in B_{MSY} for a fish stock.

History: MSY was developed in the 1930s and gained prominence in fisheries management during the 1950s.

Pluses: Provides fisheries managers with a value for the theoretical level of maximum sustainable catch.

Minuses:

- Inaccurate assumptions on population biology and life history parameters can lead to flawed MSY values.
- MSY does not account for any fishing impacts on associated and dependent species.
- It does not incorporate precaution or allow for unpredictability in the environment.
- It generally treats all individuals in a given stock as identical, ignoring important aspects of population structure such as size or age classes and different rates of growth, survival, and reproduction.
- Illegal, unregulated, and unreported (IUU) fishing and data gaps add to the uncertainty.
- Even the most closely monitored and best-understood fish stocks can behave unpredictably.

Takeaway Message: Using MSY as a solitary management target (i.e., MSY as a fixed catch that can be taken year after year) is problematic because it ignores changes in the marine environment and will always be based on limited data.

the high seas. The U.N. Fish Stocks Agreement (UNFSA) calls for precautionary standards—“target” and “limit” reference points—that are designed to account for uncertainty and to keep fishing within sustainable limits.

This briefing paper explores the limitations of management regimes based solely on single-species MSY and explains the need for new regimes for high seas fisheries based on precautionary target and limit reference points.

Target and Limit Reference Points: A precautionary approach to fisheries management

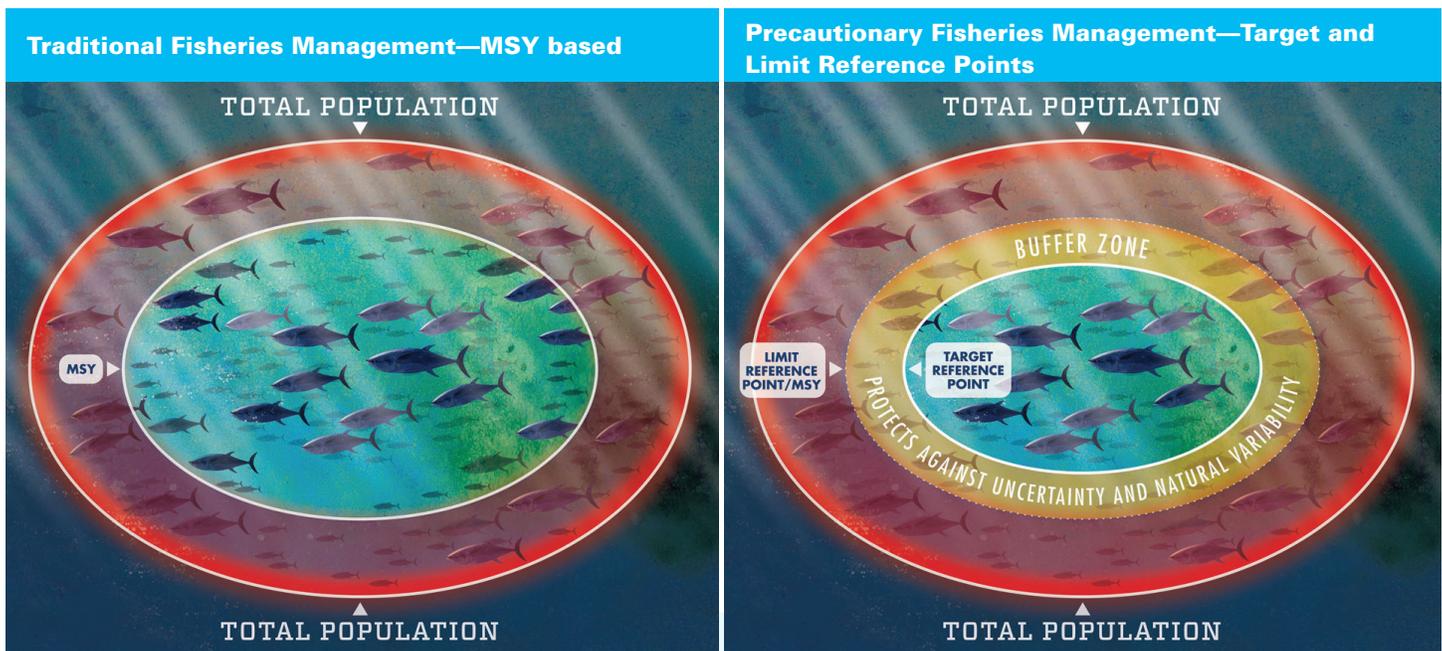
In 1977, P.A. Larkin published his seminal article, “An Epitaph for the Concept of Maximum Sustainable Yield,” signaling the growing awareness within the scientific community of MSY’s many flaws and limitations.¹ Even as the goal of achieving and maintaining MSY was being incorporated into international agreements such as UNCLOS and the treaties establishing many of the world’s regional fisheries management organizations (RFMOs), scientists were questioning the sustainability of management regimes based solely on MSY.²

A holistic and precautionary approach to fisheries management was called for more than 35 years ago—one that accounted for both the uncertainty inherent to fisheries and the complex interactions between commercial fish stocks and the wider marine ecosystem. This concept of

precautionary management for our planet’s natural capital came into the international spotlight at the 1992 Earth Summit in Rio de Janeiro. The 154 countries present agreed that responsible resource management required the application of the precautionary principle, meaning that management should be more cautious when information is uncertain, unreliable, or inadequate,³ as is often the case in fisheries. This concept was subsequently enshrined in the Rio Declaration⁴ as well as the 1995 UNFSA.⁵

In fisheries, the precautionary approach entails developing management policies and strategies that account for the inherent risks and uncertainties. Fundamental to this approach is the idea of using two reference points for fisheries management: a **limit reference point** intended to constrain catch within safe biological limits, and a **target reference point** intended to meet management objectives, such as desired biological, social, and economic outcomes.⁶

Annex II of the UNFSA provides guidance on the precautionary management of highly migratory and straddling fish stocks (see Appendix 1). It explains that management strategies should be designed so that target reference points are “not exceeded on average” and “the risk of exceeding limit reference points is very low.”⁷ Typically, this type of management builds in responsive measures—such as fishing effort reductions or temporary closures to the fishery—that are triggered when reference points are surpassed.⁸ **The use of target and limit reference points essentially creates a buffer to protect against the possibility of overfishing, allowing fisheries managers to respond to unexpected changes in a stock’s status before the health of the resource is seriously threatened.**



Traditional fisheries management, as shown above left, fails to account for uncertainty in the fishery and could lead to fishing over MSY, which would potentially damage the future of the stock as well as the value of the catch. In a precautionary approach to fisheries management, as shown above right, a buffer is created to account for the uncertainties and to prevent the overfishing of the stock.

Introduction to Target and Limit Reference Points

Definitions:

- **Limit reference point**—A point intended to constrain catches within safe biological limits. F_{MSY} is considered the minimum standard for limit reference points. Management strategies should be designed so that the risk of exceeding this limit is very low.
- **Target reference point**—A point intended to meet management objectives. Management strategies should be designed so that the target reference point is not exceeded on average.

Setting Precautionary Reference Points: MSY as the limit

Traditional fisheries management regimes essentially treated F_{MSY} as a target. Limit reference points, if used at all, were set above this level at a point where catches were already exceeding levels that were sustainable in the long term. A precautionary approach, on the other hand, treats MSY as the outer limit of what is acceptable in managing a particular stock.⁹ As stated in UNFSA:

Limit reference points set boundaries which are intended to constrain harvesting within safe biological limits within which the stocks can produce maximum sustainable yield.... The fishing mortality rate which generates maximum sustainable yield should be regarded as a minimum standard for limit reference points.¹⁰



PHOTO: RICHARD ELLIS, SEAPICS

In other words, although fisheries managers may choose to set even more precautionary limits, they must at least constrain catches within MSY. Management targets should be set even more conservatively to account for uncertainty in the fishery and to promote management objectives other than catch, such as preserving the stock's role in the broader ecosystem or maximizing the economic value of the

catch. As a limit or ceiling, F_{MSY} is a useful management tool and should not be abandoned. To bring high seas fisheries management in line with best practices, MSY-based limits should be coupled with precautionary management targets that seek to return biomass levels to sustainable levels where stocks have fallen to MSY or below, or to prevent such a situation from occurring.

Limited Progress

Despite the clear mandate in UNFSA and the agreement reached by Heads of State in Rio,¹¹ the precautionary principle has yet to be implemented beyond a few notable examples. Consequently, most of the world's fisheries are in danger of overexploitation. Several RFMOs operate under outdated mandates established before the adoption of the UNFSA and continue to manage the fish species under their remit with the goal of achieving MSY. Even among the few RFMOs that have committed to using target and limit reference points, implementation has been incomplete.

Only two of the five major tuna RFMOs—the Inter-American Tropical Tuna Commission (IATTC) and the Western and Central Pacific Fisheries Commission (WCPFC)—have committed to applying target and limit reference points, but neither has implemented them to date. The Antigua Convention, which entered into force in 2010, replaced and strengthened the IATTC's original mandate by requiring the Commission to apply the precautionary approach in accordance with the UNFSA and the Food and Agriculture Organization of the United Nations (FAO) Code of Conduct for Responsible Fisheries.¹²

The WCPFC Convention endorses the UNFSA approach to target and limit reference points even more strongly. It makes Annex II of UNFSA “an integral part” of the Convention and requires the Commission to “determine, on the basis of the best scientific information available, stock-specific reference points and the action to be taken if they are exceeded.”

Despite these commitments, IATTC has not established target and limit reference points for any of the species it manages. Meanwhile, the WCPFC has been making slow progress, but target and limit reference points have not been adopted for any fishery in the convention area.¹³

Positive examples do exist, however:

- The Northwest Atlantic Fisheries Organization (NAFO) has developed a Precautionary Approach Framework that prescribes the use of “buffer” and limit reference points. In accordance with the UNFSA, the framework states that limit reference points for fishing mortality (F_{lim}) cannot exceed the mortality level expected to produce MSY (F_{MSY}).¹⁴ NAFO has adopted reference points for the capelin fishery and is in the process of developing them for shrimp.
- The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has adopted precautionary target and limit reference points for krill fisheries as part of a suite of progressive, ecosystem-based management tools.¹⁵

Conclusion

Scientists today have a much better understanding of the ocean ecosystem than they did 80 years ago, when the concept of MSY was introduced. Experts widely recognize that managing fish populations to MSY is risky for both fishermen and ecosystems. In order to maintain sustainable fisheries and healthy and resilient ocean habitats, fisheries management must account for limited information, unpredictable environmental fluctuations, and increased stresses on the marine environment.

The international community has agreed on a way forward. States and RFMOs must act to implement the precautionary principle by establishing target and limit reference points for the fisheries they manage. Although some progress has been made, there is still a long way to go.



PHOTO: JEFF ROTMAN

APPENDIX I

ANNEX II: GUIDELINES FOR THE APPLICATION OF PRECAUTIONARY REFERENCE POINTS IN CONSERVATION AND MANAGEMENT OF STRADDLING FISH STOCKS AND HIGHLY MIGRATORY FISH STOCKS

1. A precautionary reference point is an estimated value derived through an agreed scientific procedure, which corresponds to the state of the resource and of the fishery, and which can be used as a guide for fisheries management.
2. Two types of precautionary reference points should be used: conservation, or limit, reference points and management, or target, reference points. Limit reference points set boundaries which are intended to constrain harvesting within safe biological limits within which the stocks can produce maximum sustainable yield. Target reference points are intended to meet management objectives.
3. Precautionary reference points should be stock-specific to account, inter alia, for the reproductive capacity, the resilience of each stock and the characteristics of fisheries exploiting the stock, as well as other sources of mortality and major sources of uncertainty.
4. Management strategies shall seek to maintain or restore populations of harvested stocks, and where necessary associated or dependent species, at levels consistent with previously agreed precautionary reference points. Such reference points shall be used to trigger

pre-agreed conservation and management action. Management strategies shall include measures which can be implemented when precautionary reference points are approached.

5. Fishery management strategies shall ensure that the risk of exceeding limit reference points is very low. If a stock falls below a limit reference point or is at risk of falling below such a reference point, conservation and management action should be initiated to facilitate stock recovery. Fishery management strategies shall ensure that target reference points are not exceeded on average.
6. When information for determining reference points for a fishery is poor or absent, provisional reference points shall be set. Provisional reference points may be established by analogy to similar and better-known stocks. In such situations, the fishery shall be subject to enhanced monitoring so as to enable revision of provisional reference points as improved information becomes available.
7. The fishing mortality rate which generates maximum sustainable yield should be regarded as a minimum standard for limit reference points. For stocks which are not overfished, fishery management strategies shall ensure that fishing mortality does not exceed that which corresponds to maximum sustainable yield, and that the biomass does not fall below a predefined threshold. For overfished stocks, the biomass which would produce maximum sustainable yield can serve as a rebuilding target.

Endnotes

- 1 P. A. Larkin, "An Epitaph for the Concept of Maximum Sustainable Yield," *Transactions of the American Fisheries Society* 106(1):1-11.
- 2 Pamela M. Mace, "A New Role for MSY in Single-Species and Ecosystem Approaches to Fisheries Stock Assessment and Management," *Fish and Fisheries* 2 (2001):4.
- 3 Report of the United Nations Conference on Environment and Development (Rio de Janeiro, 3-14 June 1992), Annex I, Rio Declaration on Environment and Development ("Rio Declaration"), A/CONF.151/26 (Vol. I); principle 15.
- 4 *Ibid.*
- 5 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks ("UNFSA"), 1542 A/CONF.164/37, 34 I.L.M.: art. 6 & annex II.154.
- 6 Terms defined in UNFSA, annex II, para. 3.
- 7 *Ibid.*, annex II, para. 5.
- 8 *Ibid.*, annex II, para. 4.
- 9 UNFSA, annex II, para. 7. See also Mace, *Op. cit.*, 17.

10 UNFSA, annex II, paras. 2 and 7.

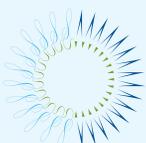
11 Report of the United Nations, *Op. cit.*, principle 15.

12 Convention for the Strengthening of the Inter-American Tropical Tuna Commission Established by the 1949 Convention Between the United States of America and the Republic of Costa Rica ("Antigua Convention"), art. iv, <http://www.iattc.org/IATTCdocumentationENG.htm>.

13 As part of its successful application to receive Marine Sustainability Council certification of its free-school tuna fishery, the Parties to the Nauru Agreement (PNA)—a group of western Pacific nations whose waters are home to the majority of the region's fish stocks—agreed to establish target and limit reference points for skipjack tuna within five years. The PNA has the option to do this unilaterally or through WCPFC. See "Updated Client Action Plan" (Dec. 8, 2011), http://www.msc.org/track-a-fishery/certified/pacific/pna_western_central_pacific_skipjack_tuna/assessment-downloads.

14 North Atlantic Fisheries Organization, NAFO Precautionary Approach Framework, NAFO/FC Doc. 04/18, (September 2004).

15 Andrew J. Constable, "International Implementation of the Ecosystem Approach to Achieve the Conservation of Antarctic Marine Living Resources" (paper presented at UNICPOLOS-7, New York, N.Y., June 2006).



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