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Two Tools Can Help Make Ecosystem-Based Fisheries Management a Global Reality

Harvest strategies and management strategy evaluation offer a pathway to incorporating ecosystem considerations into fishery governance

Overview

Around the globe, fisheries managers tasked with overseeing high-value fisheries have, for decades, considered individual species in isolation, implementing management measures that fail to account for the needs of the broader ocean ecosystem or the emerging threats of climate change. But this siloed approach does not need to persist; a better model is available. Ecosystem-based fisheries management (EBFM) harnesses advances in scientific knowledge to comprehensively consider how the interactions among species, fisheries and a changing ocean should affect how much fishing is allowed and how it is done.

However, the transition to EBFM has been slow. Despite numerous international and domestic mandates to implement EBFM dating back to the 1990s, managers have faced several challenges, including inadequate governance structures and processes; a lack of data, especially on habitats and lower-value species; and insufficient scientific tools and models.[1] And although scientists and managers in some regions have developed benchmarks for evaluating progress towards EBFM, precise objectives have not been widely defined.

Fortunately, two related tools already in use—harvest strategies and management strategy evaluation—can be adopted in domestic waters or for shared stocks, including on the high seas, where decisions are made by regional fisheries management organizations (RFMOs), to help managers worldwide integrate EBFM into their practices. This brief looks at these tools and how they could ease the transition to EBFM.

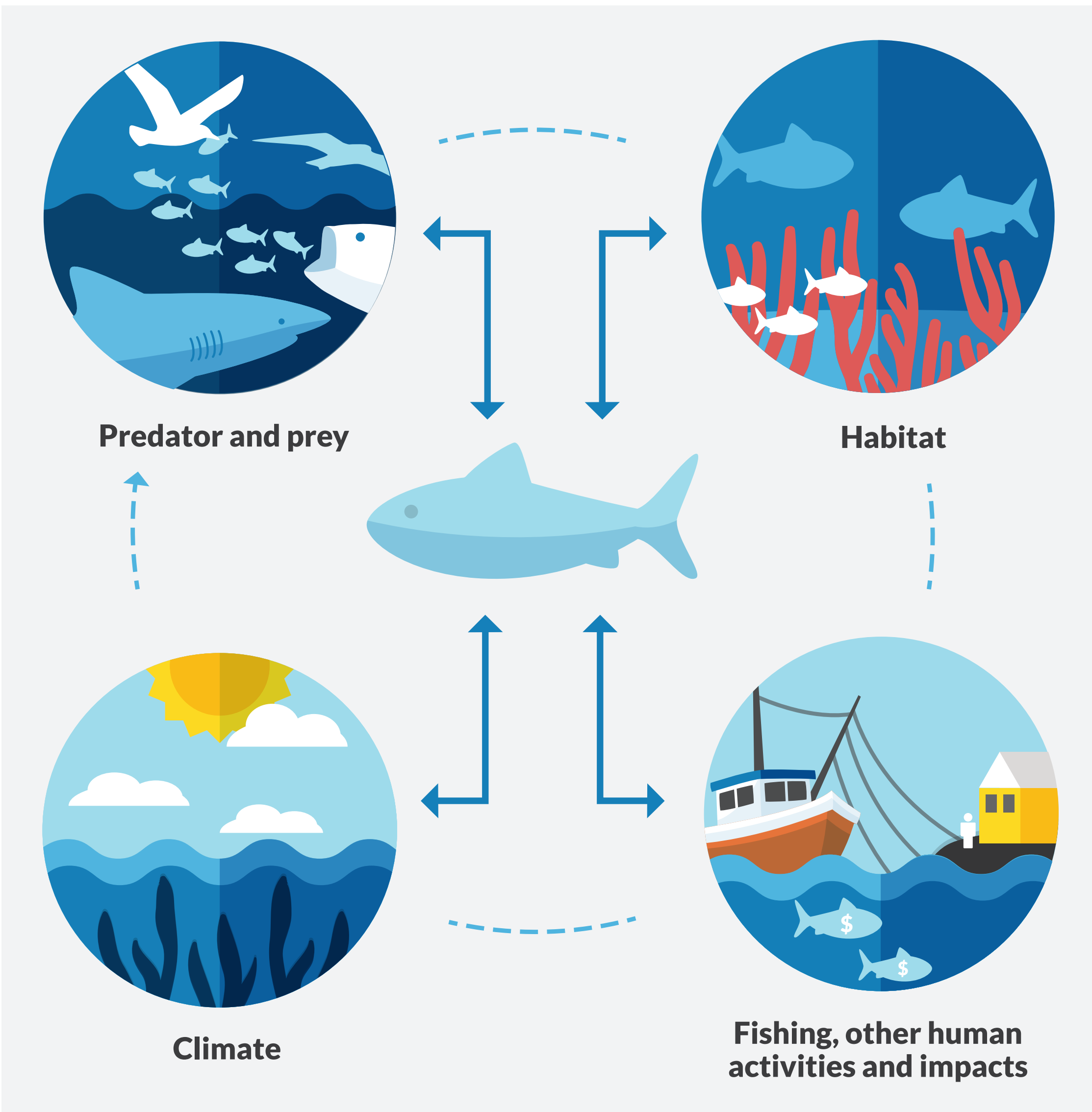
What is ecosystem-based fisheries management?

Rather than looking at one species in isolation, as traditional fisheries management does, EBFM accounts for the fact that each fish is part of a complex ecological system. EBFM acknowledges that other species, including humans; changes to habitat; and the climate affect every fish species. And that, in turn, fish populations—and the fisheries that target them—affect the ecosystem, such as through predator-prey relationships or when fishing gear damages habitat. (See Figure 1.) The science behind EBFM is well-established and expanding, and managers have identified EBFM as a strategy to meet their commitment to sustainably manage and protect marine ecosystems.

Figure 1

EBFM Accounts for the Ecosystem When Setting Rules and Measures for Each Population

How climate, habitat, human activities, fish populations and other species interact



Harvest strategies

The first tool RFMOs can use to help them integrate EBFM into their work is harvest strategies, also known as management procedures. Creating a harvest strategy is akin to agreeing to the rules before playing a game: Fisheries managers establish a pre-agreed, formulaic approach to setting fishing limits based on the status of a given fish population. Essential elements of successful harvest strategies include management objectives that outline a vision for the future of a fishery, reference points to define sustainability and harvest control rules (HCR) that set fishing opportunities, all of which require robust data collection and analysis. Critically, each of these elements can be structured to account for ecosystem considerations.

Like EBFM, harvest strategies are a form of "adaptive management"—that is, they promptly respond to ecosystem conditions to promote fishery stability, resilience and long-term sustainability. Further, both harvest strategies and EBFM use reference points—benchmarks for comparing the status of a stock or habitat to a desired or undesirable state—to identify targets, such as ideal population size or market price per fish. Reference points also can define risk thresholds to help avoid overfishing, stock collapse and other harms. But unlike EBFM, several fisheries are already using harvest strategies.[2] This presents a vital opportunity to harness advances in harvest strategies to make the jump from EBFM theory to on-the-water application.

Management objectives

Management objectives include not only legal mandates, such as maintaining sustainable population levels, but also other goals such as maximizing total catch, catch per effort rates and year-to-year stability in catches that together define the managers' strategy for a fishery. To integrate EBFM principles into their harvest strategies, managers can set management objectives for target and non-target species that consider the whole ecosystem, for instance, maintaining a species' productivity at a certain historical level, protecting a critical habitat, accounting for the target species' role in the marine food web or setting a cap on annual bycatch.


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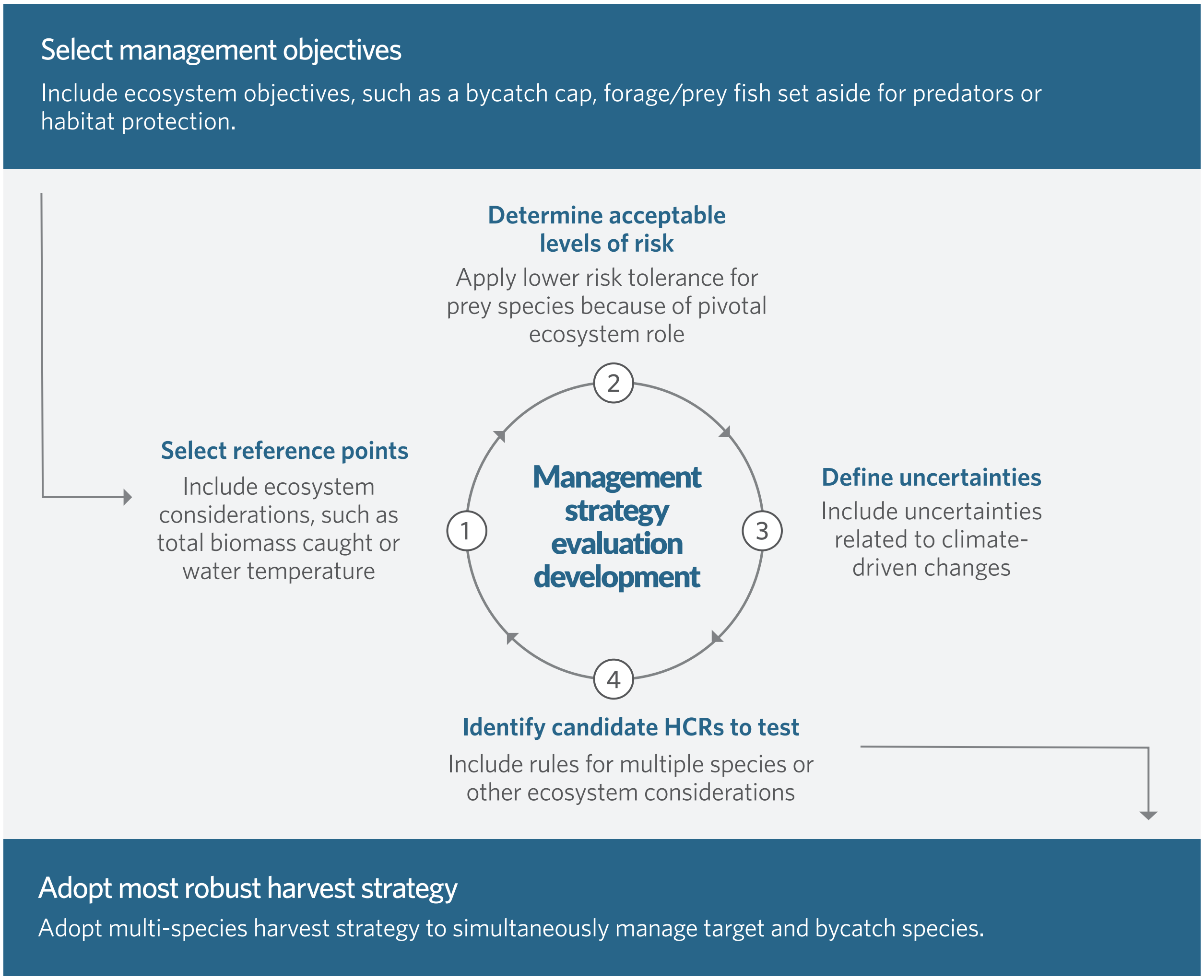
Figure 2

Ecosystem Considerations Can Be Integrated Into Many Elements of a Harvest Strategy

Sample approach to applying EBFM principles



Note: This graphic depicts the cycle of iterative exchanges among fishery scientists, managers and stakeholders during development of management strategy evaluations for eventual harvest strategy adoption.

Reference Points

To quantify management objectives, managers often use reference points, which can be developed for one fishery, a single species, a group of species, or even an entire ecosystem to specify population sizes and fishing levels to target or avoid. The two main types of references points are limit, which define the level beyond which fishing is no longer sustainable, and target, which define the ideal fishery state. The use of reference points in harvest strategies offers a further opportunity to implement EBFM.

As with management objectives, reference points can incorporate ecosystem considerations. For example, the U.S. Atlantic herring fishery sets target fishing mortality 20% below the sustainable level to leave enough herring in the water for their predators within the coastal pelagic food web, many of which are also valuable fished species.[3] Fishery managers developed this approach after extensive consultation with herring fishers; representatives of tuna fisheries; the conservation community, including birders and whale watch companies; and other stakeholders. This diverse input resulted in reference points (and management objectives) that account for herring's vital ecosystem role.

Fishery managers are also considering reference points, including ecosystem indicators—metrics that help determine needed management actions based on conditions in the wider habitat—to monitor the impacts of fisheries targeting tropical tunas on the ocean food web.[4] Ecosystem indicators for this effort could include sea surface temperature, chlorophyll-a or zooplankton concentrations, and trends in major ocean temperature oscillations, such as El Niño. Another possible indicator is total biomass caught, regardless of species, by trophic level, which could help fisheries managers assess certain ecosystem elements, but should be used cautiously to ensure that overall biomass does not outweigh the need for healthy populations of individual species.

Importantly these indicators all illuminate how the ecosystem might affect the target stock and fishery, but others are needed to explore the impact of the fishery on the ecosystem. Some options include total nontarget species biomass caught, total protected species biomass caught, and number of discarded or lost fishing gear elements.

Table 1

A Range of Ecosystem Indicators Can Be Considered in Fisheries Management Across the Ocean

Examples of considerations and objectives

Reference point	Indicator
Ecosystem productivity	Is large-scale overfishing occurring at the ecosystem level?
Target species	Augment single-species reference points using biological factors (natural mortality, recruitment, etc.) that react to environmental changes
	Mixed Species Target: Balance catches in mixed fisheries to protect the most vulnerable or "choke" stock (for example, bigeye tuna in tropical tuna fisheries)
	Multispecies maximum sustainable yield
	Reference points to ensure prey availability for predators
Nontarget species	Acceptable bycatch thresholds, by species
	Healthy population status objectives for noncommercial species
	Reference points to ensure prey availability for predators
	Food web integrity to ensure a balance of predators and prey
Habitat	Impacts on areas associated with vulnerable life history stages (spawning areas, nursery grounds, etc.)
	Seafloor integrity
Human dimension	Economic benefits for local communities, such as number of jobs supported
	Social equity and fairness

Once management objectives and ecosystem reference points are agreed, managers can determine what data they need to monitor progress and can develop the necessary ecosystem-level data collection protocols. The collected data will inform studies to evaluate the management system relative to the objectives and reference points to determine the needed action via the harvest control rule.

Harvest control rules

Harvest control rules are the operational component of a harvest strategy. HCRs determine fishing opportunities based on the status of a stock and fishery to achieve the agreed management objectives and target reference points. For example, if a stock grows, the rule will automatically trigger a corresponding increase in catch limits.

HCRs can also respond to ecosystem-level variables. For instance, managers of the U.S. Pacific sardine fishery use one of the only harvest control rules in the world that includes an ecosystem indicator: sea surface temperature. By considering this factor, the rule accounts for impacts of the broader ecosystem on the size and productivity of the sardine population. Warmer waters might affect species differently, harming some and benefiting others, for example, through differential larval survival rates. In addition, scientists have explored the implications of the HCR for sardine predators, namely brown pelicans and California sea lions, in recognition of the mutual effects among sardines and their ecosystem.[5]

Rules that include ecosystem indicators can initiate a range of management measures, such as multiple species-specific catch limits, size limits or area closures, to protect habitats or fish at critical life stages when environmental conditions change. This provides another mechanism for incorporating ecosystem considerations into harvest strategies, putting EBFM into practice.

Management strategy evaluation

To develop their harvest strategies, managers use the second of the two EBFM-ready tools: management strategy evaluation (MSE), a science-based decision-making framework. MSE involves robust stakeholder engagement and accounts for risk and tradeoffs among competing objectives, such as maximizing catch and protecting stocks. All three features—science-based decisions, stakeholder participation and addressing tradeoffs—are fundamental to effective EBFM.

MSE assesses the performance of potential harvest strategies under a range of scenarios whether managers have robust or weak data about the subject stock. By accounting for the inherent uncertainty in a fishery or an ecosystem in a way that traditional stock assessments do not, MSE gives managers a fuller picture of the consequences of their management plans under various and changing environmental conditions and allows selection of harvest strategies that can account for that variability and still meet management objectives. Ecosystem considerations and relevant reference points can and should be added to MSE frameworks.

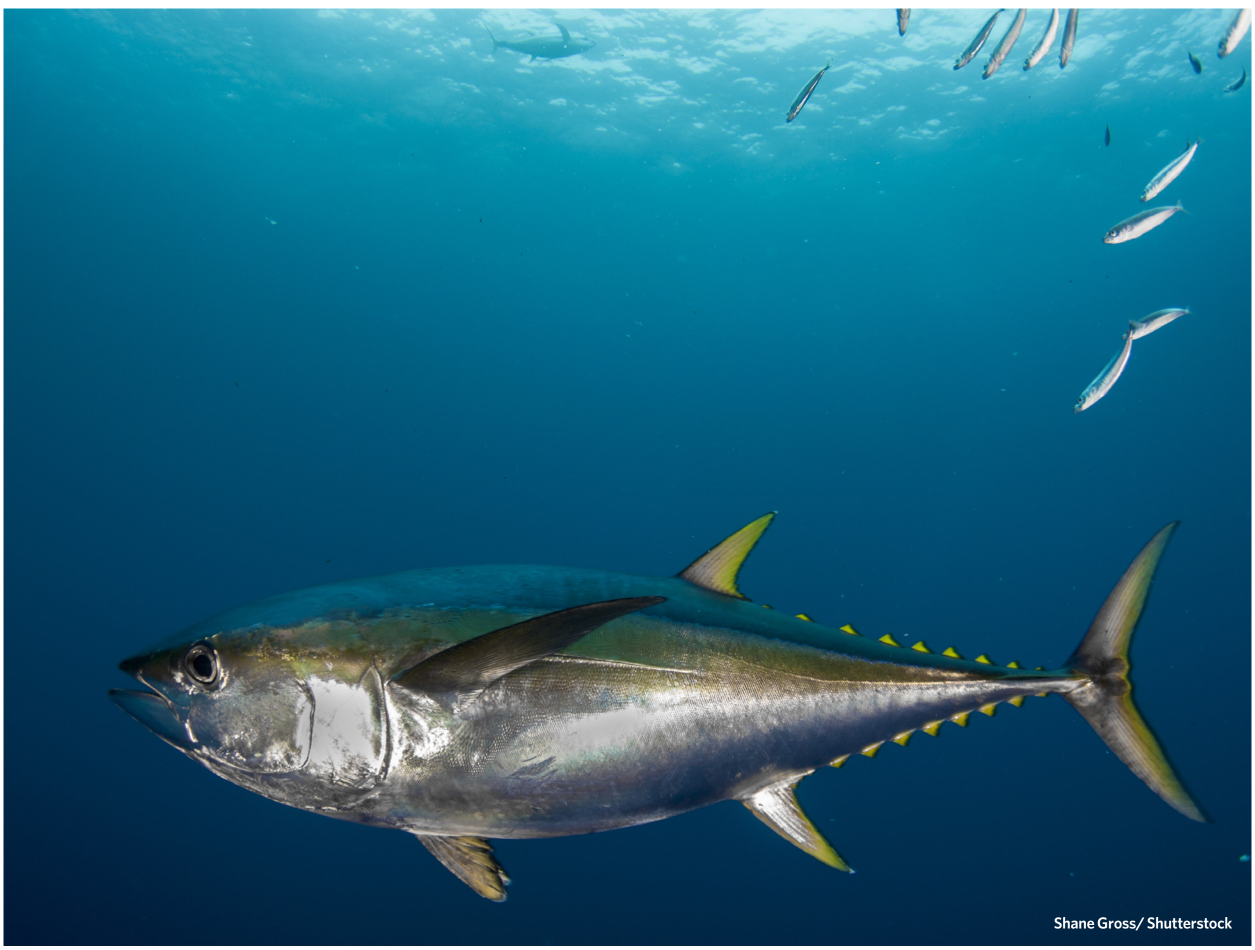
For example, scientists project that climate change will have myriad impacts on fish populations, including differences in productivity and shifts in distribution,[6] and they can use MSE to test how a multitude of climate change scenarios affect fisheries or stocks. Alternatively, they can incorporate existing climate models into an MSE to help ensure that their harvest strategies account for ecosystem variation caused by climate change.[7]

To date, most use of MSE has focused on individual species, but to advance EBFM, managers should apply the framework to multiple species or broader ecosystem-level relationships when appropriate, particularly for fisheries that take several species or use bait from natural populations.[8] For example, the International Commission for the Conservation of Atlantic Tunas (ICCAT) recently completed an MSE to evaluate management impacts on the two distinct but overlapping stocks of Atlantic bluefin tuna.[9] A similar approach could be used for two or more species, whether targeted by fisheries or caught incidentally as bycatch.

MSE and Bycatch

Fisheries managers have sought to reduce bycatch and related mortality since long before EBFM was envisioned, but bycatch reduction is also a critical component of EBFM. Unfortunately, as is the case with broader EBFM adoption, RFMOs have tended to neglect bycatch reduction in part because of a focus on single-target species and lack of willingness among governments to modify fishing practices to avoid harmful impacts on non-target species, even when target species catch rates can be maintained.

MSE presents a transformative opportunity for the evaluation and reduction of bycatch. For example, ICCAT has partnered with a group of scientists on development of EcoTest, an open-source MSE tool to model an ecosystem with two target species, for instance (bigeye tuna and North Atlantic swordfish) and four bycatch species (blue shark, North Atlantic shortfin mako shark, blue marlin and white marlin).[10] The project aims to develop ecosystem indicators, evaluate outcomes under a variety of potential scenarios, and use the findings to design management for both the target and bycatch species. The two marlins have been classified as overfished since the early 1990s, and EcoTest has the potential to help secure their long-delayed recovery, and the Commission could eventually apply it to other bycatch species, including seabirds and sea turtles. And longer term, EcoTest could help other ocean basins and ecosystem complexes incorporate bycatch considerations in their MSEs.



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The tools in action

Although ecosystem-informed MSEs and harvest strategies are not yet in wide enough use globally, a few fisheries have taken innovative action. Their examples demonstrate the potential of these tools for advancing ecosystem-based fisheries management and offer models that other managers can adapt to meet their needs.

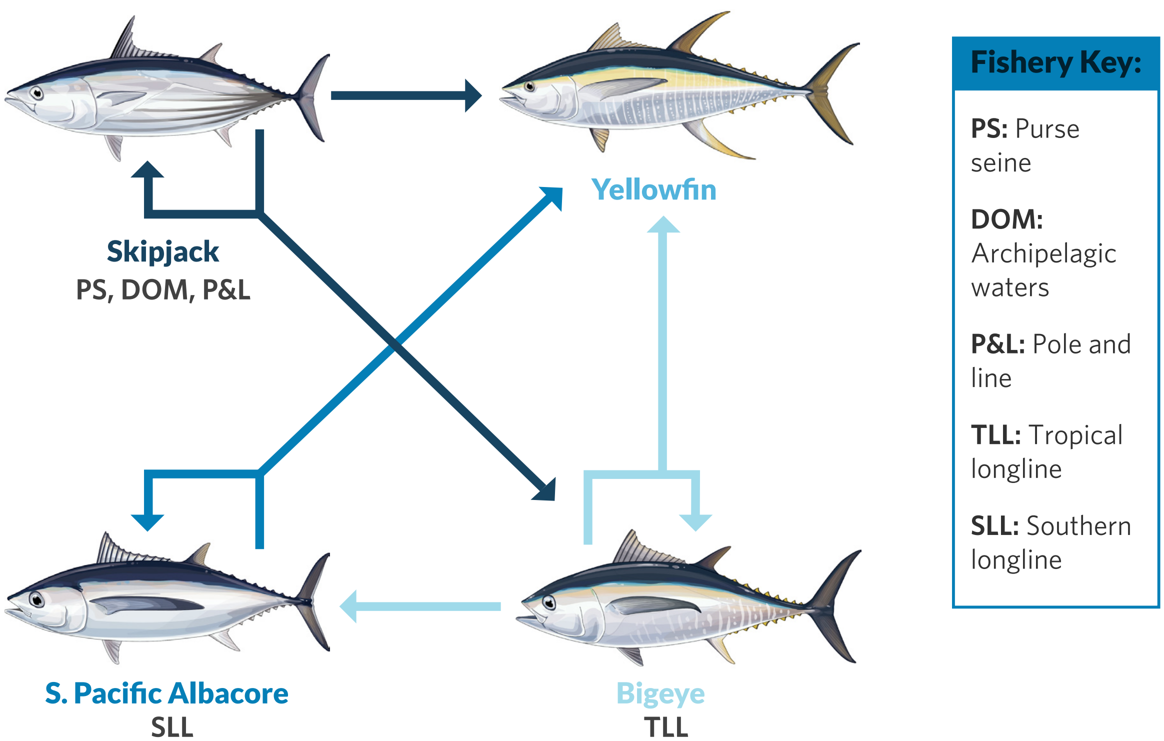
Tuna fisheries in the tropics that target skipjack tuna—a high volume, lower value fish that dominates the expansive canned tuna market—offer an example of an ecosystem-based MSE. Although skipjack tuna populations are healthy worldwide and have their own importance in pelagic ecosystem stability,[11] they school with other similarly sized tunas, notably juvenile yellowfin and bigeye tuna, which are depleted in some areas.

Managing such multispecies fisheries has posed a significant challenge for RFMOs. But RFMOs in the Atlantic and Pacific oceans are using MSE to find a path towards creation of harvest strategies for the three species as parts of a broader ecosystem in a way that balances the catch of healthy skipjack stocks with the recovery objectives for depleted tunas. Because certain fishing gear, such as purse seine nets, are most likely to catch multiple species, and others, particularly longlines, tend to catch only the larger, more valuable yellowfin and bigeye, the Western and Central Pacific managers are incorporating fishing sector-specific management into the MSE to account for the ecosystem impacts of various gear. (See Figure 3.)

Figure 3

RFMO Will Use 3 Harvest Strategies to Manage Multiple Stocks and Fisheries

Schematic of planned modeling and management framework for tropical tunas and South Pacific albacore



Note: The South Pacific albacore harvest strategy will also manage the Southern troll fishery for albacore.

Source: F. Scott et al., "Mixed-Fishery Harvest Strategy Update" (Western and Central Pacific Fisheries Commission, 2023), https://meetings.wcpfc.int/node/19381

Similarly, South Africa has managed its domestic anchovy and sardine fisheries using a joint MSE-based harvest strategy since 1994.[12] Bycatch of juvenile sardines in the anchovy fishery prompted this innovative, multispecies approach, which demonstrates that MSE and harvest strategies can be used for short-lived, small pelagic species that follow boom-and-bust population dynamics, particularly when fishing takes place. The harvest strategy includes catch limits for both species, as well as a bycatch limit for sardines.

EBFM in the Northeast Atlantic

The Northeast Atlantic is one region with immediate potential to implement EBFM using harvest strategies and MSE. Internationally shared stocks in the region, such as herring or mackerel, have traditionally been managed according to rules focused on achieving maximum sustainable yield for each species in isolation. But several coastal parties, including Norway, the European Union, and the United Kingdom, have statutory mandates to implement EBFM, including consideration of climate change impacts.

As these governments move to meet their obligations, they should leverage the expertise of the International Council for the Exploration of the Seas (ICES), the body responsible for providing managers in the region with scientific advice on fishing opportunities and ecosystem-based management. ICES already is advancing a scientific framework on EBFM and has started to deploy ecosystem focused, climate-adaptive MSEs and other multispecies models to evaluate harvest strategies, which it calls long-term management strategies, for North Sea herring, sandeel and other forage species.[13] But to provide advice on EBFM, the council needs more direction from managers on ecosystem objectives so they can be incorporated into the analyses and evaluations of harvest strategies.

Obtaining managers' input has proved difficult because of the complex, diverse and opaque fisheries governance regimes in the region. These include the North-East Atlantic Fisheries Commission, which operates as the area's high seas RFMO, and ad hoc coastal State consultations, which can be done bilaterally, trilaterally or multilaterally, depending on the fish stock in question. This piecemeal governance approach stifles innovation on key issues such as quota allocation, results in overfishing, and has delayed progress on EBFM.

To move forward, Northeast Atlantic fisheries managers should seek broad stakeholder involvement at all stages of the decision-making process and be ambitious about the scope of the scientific advice they seek from ICES. They should also set clear and comprehensive terms of reference when requesting that advice from scientists. These steps would improve understanding between managers and ICES, make the process more efficient, enhance accountability and help managers begin implementing ecosystem-focused practices.

Conclusion

Ecosystem-based fisheries management is a more holistic and sustainable approach to managing fisheries than traditional, single-species management approaches. By considering the entire ecosystem and environment and involving stakeholders in the decision-making process, EBFM can help to ensure the long-term health and productivity of fish populations and the habitats they are a part of. To date, however, despite decades of research on how to put EBFM into practice, implementation has been lacking. Fisheries managers can adopt MSE-based harvest strategies to swiftly move EBFM science and management from aspiration to reality.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Endnotes

1 See for example: United Nations Division for Ocean Affairs Law of the Sea, "The United Nations Agreement for Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Managment of Straddling Fish Stocks and Highly Migratory Fish Stocks (in Force as from 11 December 2001) Overview" (2020), Articles 5(d) and 5(e), https://www.un.org/depts/los/convention_agreements/convention_overview_fish_stocks.htm; "Norwegian Directorate of Fisheries, "The Marine Resources Act," accessed July 20, 2023, https://www.fiskeridir.no/English/Fisheries/Regulations/The-marine-resources-act; National Oceanic and Atmospheric Administration, Magnuson-Stevens Fishery Conservation and Management Act Provisions; Fisheries of the Northeastern United States; Amendment 8, 05/07/2023 (2021), https://www.federalregister.gov/documents/2021/01/11/2020-29127/magnuson-stevens-fishery-conservation-and-management-act-provisions-fisheries-of-the-northeastern; United Kingdom, Fisheries Act (2020), https://www.legislation.gov.uk/ukpga/2020/22/contents; European Union, Regulation (EU) No 1380/2013 [Common Fisheries Policy] (2013), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R1380.

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For further information, please visit: pewtrusts.org/harveststrategies

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