Food and Agriculture Organization of the United Nations

A school of yellowfin tuna in a purse seine net

ISSF 2012, Jeff Muir

Toward a Management Procedure for Yellowfin Tuna in the Indian Ocean

YELLOWFIN TUNA (*Thunnus albacares*) is an important target for fisheries in the Indian Ocean, playing a vital role in supporting valuable commercial fisheries, coastal livelihoods, economic development, and food security. Uniquely, over half of the catch is taken by artisanal fisheries. Robust management measures are therefore critical, especially in the face of environmental changes. This chartbook provides a comprehensive overview of the stock status, management progress by the Regional Fishery Management Organization (RFMO) authority, the Indian Ocean Tuna Commission (IOTC), and the role of management procedures (MPs) in ensuring the long-term sustainability of this resource. By creating a science-based, pre-agreed framework for regulating yellowfin fisheries to meet management objectives, MP development offers a pathway to stabilize the stock and secure its benefits to both people and the ecosystem for the long-term. The MP process should be prioritized, with the goal of adopting an MP for yellowfin tuna by 2027.

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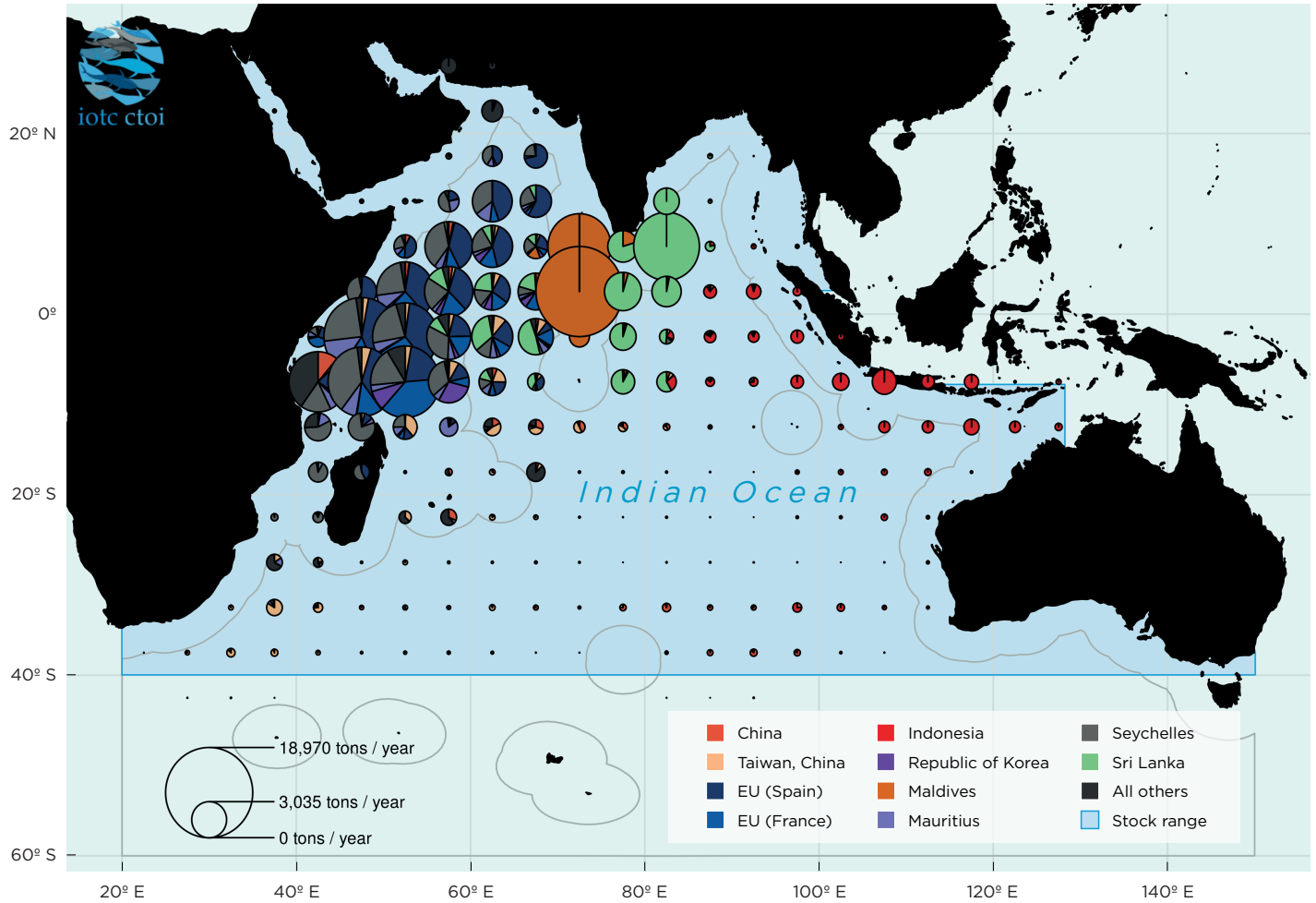
CHART 1:

INDIAN OCEAN YELLOWFIN TUNA: DISTRIBUTION AND CATCH BY FISHING NATION

This map highlights the distribution of yellowfin tuna catch in 2023 by IOTC member governments across the Indian Ocean, overlaid on the stock's geographic range. This highly migratory species thrives in warm, open ocean environments spanning tropical and subtropical waters, often associating with thermoclines (i.e., a transition layer between warmer surface water and cooler deep waters) and areas of high productivity. The broad distribution and numerous fishing nations illustrated in the map showcase the stock's importance to coastal and pelagic ecosystems and its value to fisheries across the region.



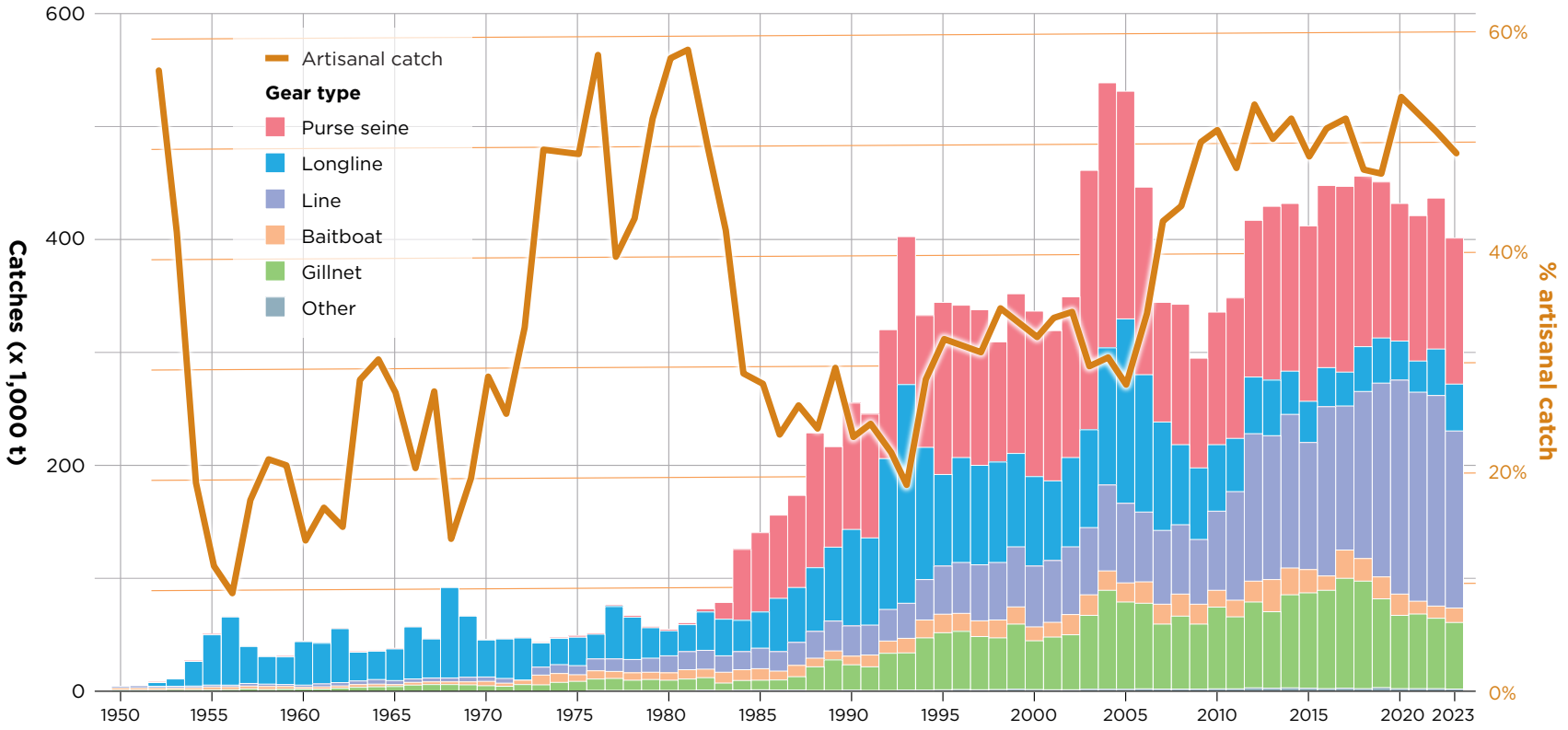
Source: IOTC

CHART 2:

YELLOWFIN TUNA CATCH BY GEAR

This chart provides an overview of yellowfin tuna catch over time in the Indian Ocean, categorized by fishing gear type. The data highlight the diversity of fishing practices, from artisanal and semi-industrial gears such as handlines and small-scale nets to industrial methods like purse seines and longlines. Artisanal fisheries account for more than half of the catch, unusual for large, commercial tuna fisheries. These fisheries are vital to local communities in the region, supporting livelihoods and food security, but artisanal gillnetting has a very high bycatch rate that threatens some populations of sharks, rays, marine mammals, and seabirds.

Yearly yellowfin catch by gear type and percentage artisanal catch (1950-2023)



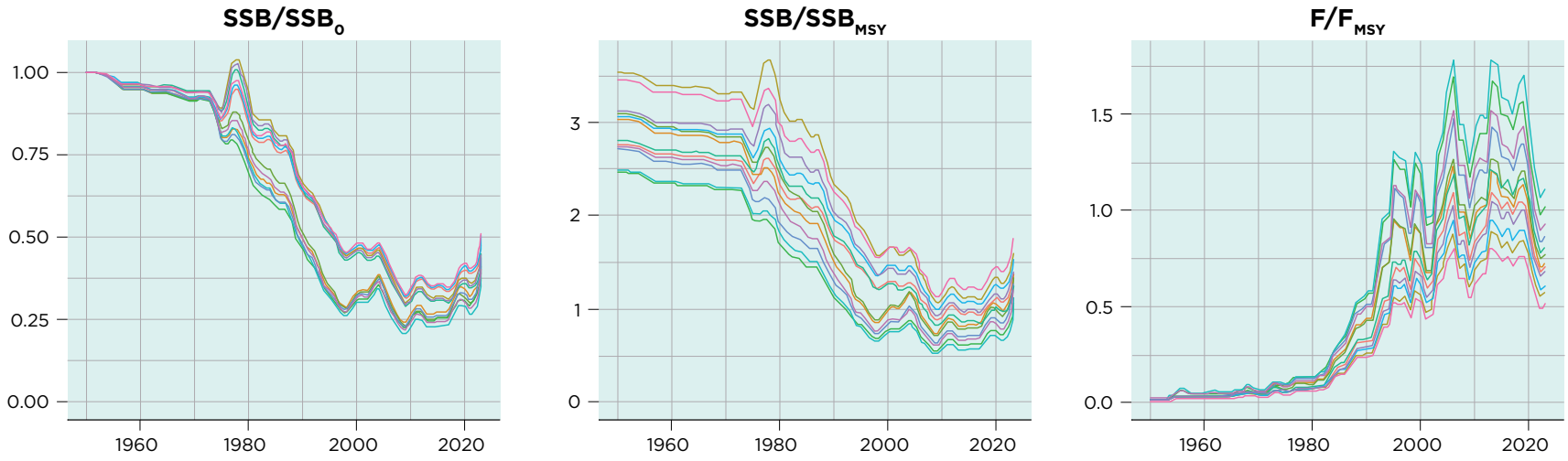
Source: IOTC

CHART 3:

TRENDS IN BIOMASS AND FISHING MORTALITY FOR YELLOWFIN TUNA

This chart illustrates the trends in spawning stock biomass (SSB) and fishing mortality (F) for yellowfin tuna in the Indian Ocean under a range of assumptions, according to the 2024 stock assessment (IOTC, 2024). The relationship between these variables reflects the health of the stock and the intensity of fishing pressure over time, respectively. Stock status is estimated relative to reference points based on maximum sustainable yield (MSY) for SSB and F, with $SSB/SSB_{MSY} < 1$ indicating an overfished stock and $F/F_{MSY} > 1$ indicating that a stock is undergoing overfishing. SSB relative to the unfished spawning stock biomass (SSB_0) is also shown for comparison. Observing these trends is crucial for assessing stock sustainability and determining whether current fishing practices align with management targets and reference points.

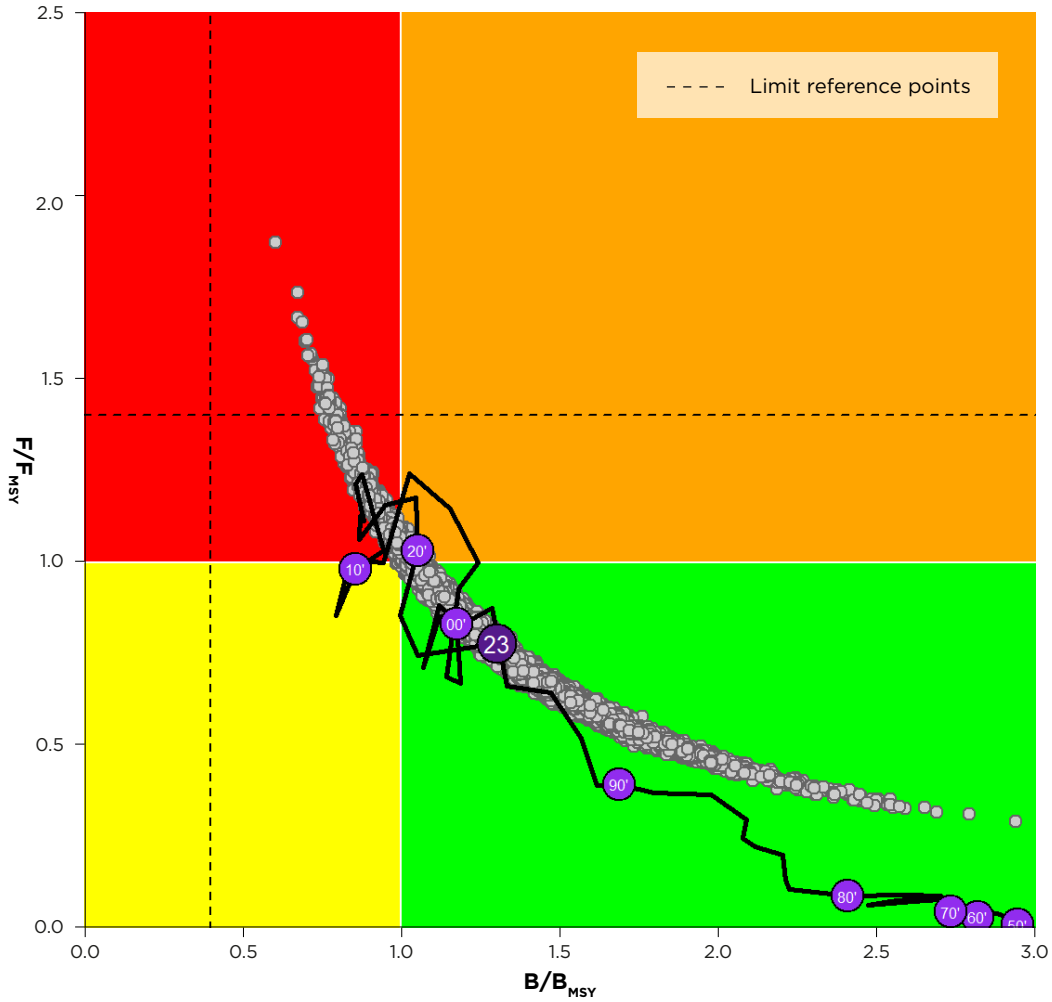
Following years of concerning stock status results, where the stock was estimated to be as low as 66% of the B_{MSY} target, the 2024 assessment found that the stock is not overfished nor subject to overfishing. However, the wide spread of potential results shown in the figures suggests that there is considerable uncertainty in the assessment, although almost all scenarios support the conclusion that the stock is no longer overfished nor subject to overfishing.



Source: IOTC Working Party on Tropical Tunas (2024)

CHART 4:

STOCK ASSESSMENT UNCERTAINTY

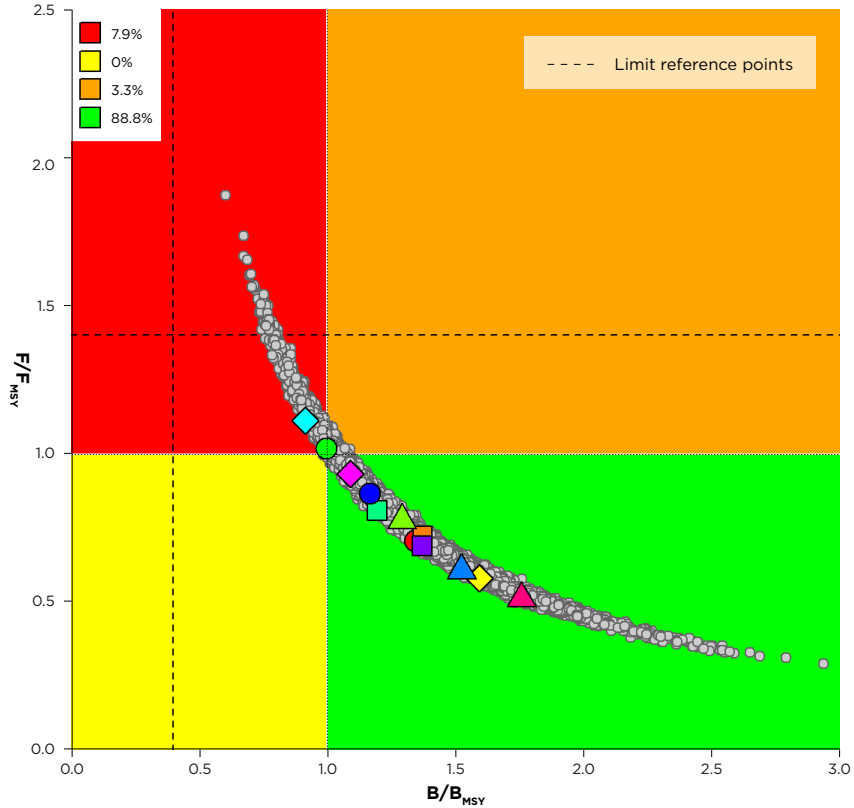


The 2024 stock assessment was deemed an improvement upon prior assessments, but considerable uncertainty remains. This is a Kobe Phase plot, with population size relative to the target of B_{MSY} on the horizontal axis and fishing mortality relative to the target of F_{MSY} on the vertical axis. The purple points show the median assessment results by decade, showing the trajectory from a healthy stock to an unhealthy stock and then recovering back to a healthy stock in the Kobe green quadrant. The gray points indicate the potential status estimates from the 2024 assessment, showing a huge range of uncertainty around the median, indicated by the large purple dot labeled '23' (as the 2024 stock assessment used data through 2023). While there is an 89% probability that the stock is in the green quadrant (i.e., not overfished, nor subject to overfishing), there are also individual models (gray dots) in the red quadrant, showing the opposite result (i.e., that the stock under those scenarios is both overfished and subject to overfishing). Indeed, IOTC's Scientific Committee was concerned about uncertainty, particularly associated with the CPUE (catch per unit effort, a key parameter in the stock assessment), and therefore was unable to provide management recommendations on the results beyond 2026.

Source: IOTC Working Party on Tropical Tunas (2024)

CHART 5:

ACCOUNTING FOR UNCERTAINTY



This page highlights the main uncertainties identified in the 2024 stock assessment. A management procedure (MP) developed using management strategy evaluation (MSE) could account for this considerable uncertainty to provide more robust management advice than is possible with the stock assessment since MSE does not require a decision of which assumption is more plausible but rather identifies the MP that will meet management objectives regardless of which assumption turns out to be true.

Each shape in the figure at left represents the stock status result for one of the final model runs from the 12 different plausible combinations of the uncertainties. The results range from the stock being overfished to the stock being 75% higher than the B_{MSY} target.

PRIMARY UNCERTAINTIES FOR INDIAN OCEAN YELLOWFIN TUNA

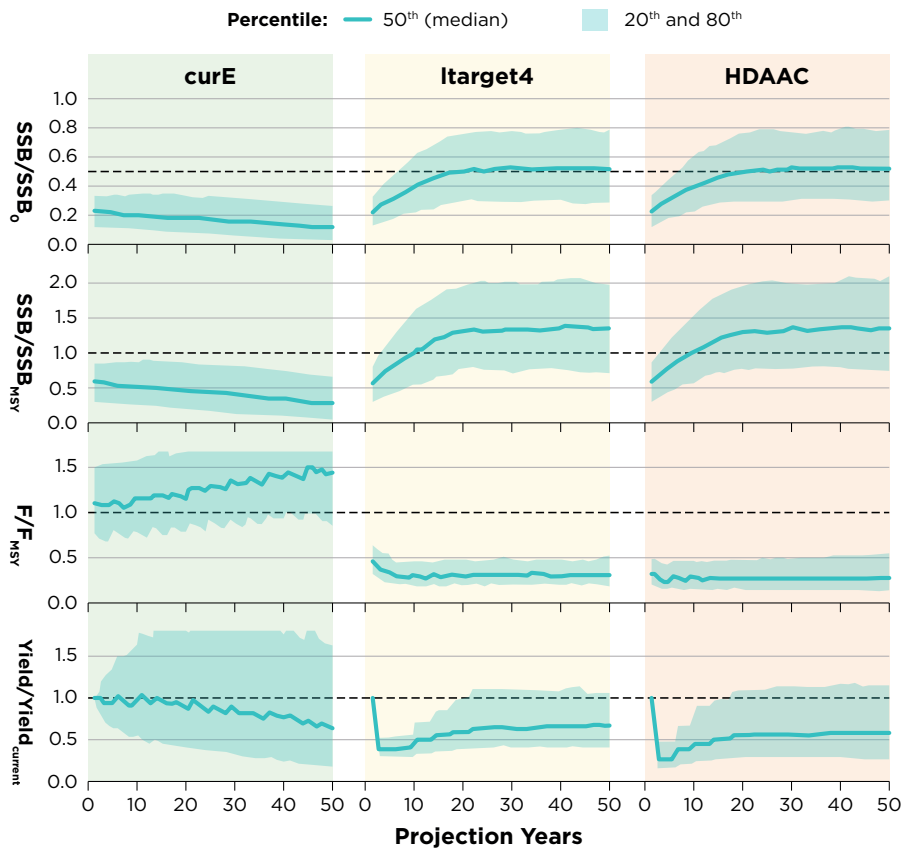
- Stock productivity as gauged by the steepness, an indicator of the relationship between spawning stock size and the number of young, or recruits, that they produce (0.7, 0.8, or 0.9)
- Increasing efficiency of fishing as measured by longline effort creep (0% or 0.5% per year)
- Fishery data uncertainties – whether or not to split the joint longline time series of catch per unit effort (CPUE); the joint Japan/South Korea/Chinese Taipei index is the most influential data input but is also highly uncertain
- Historical catch – assumed to be accurate, but it is likely not due to unreported landings, discards and illegal catch, misidentification, etc.
- Evidence of increasing fluctuations in stock productivity from year-to-year, which can be large

Source: IOTC Working Party on Tropical Tunas (2024)

CHART 6:

DEVELOPING MPS FOR HIGHLY UNCERTAIN STOCKS

An example from a sea cucumber fishery in California, USA



The MSE projection plots (20th, 50th (median), and 80th percentiles) for the biomass relative to unfished conditions (SSB/SSB_0; top row), biomass relative to SSB_{MSY} (SSB/SSB_{MSY}; second row), fishing mortality relative to F_{MSY} (F/F_{MSY}; third row), and expected yield relative to yield in current year (bottom row) for the current effort scenario (*curE*) and the two acceptable output controls. Note that the *HDAAC* method cannot be implemented due to a lack of sufficient data.

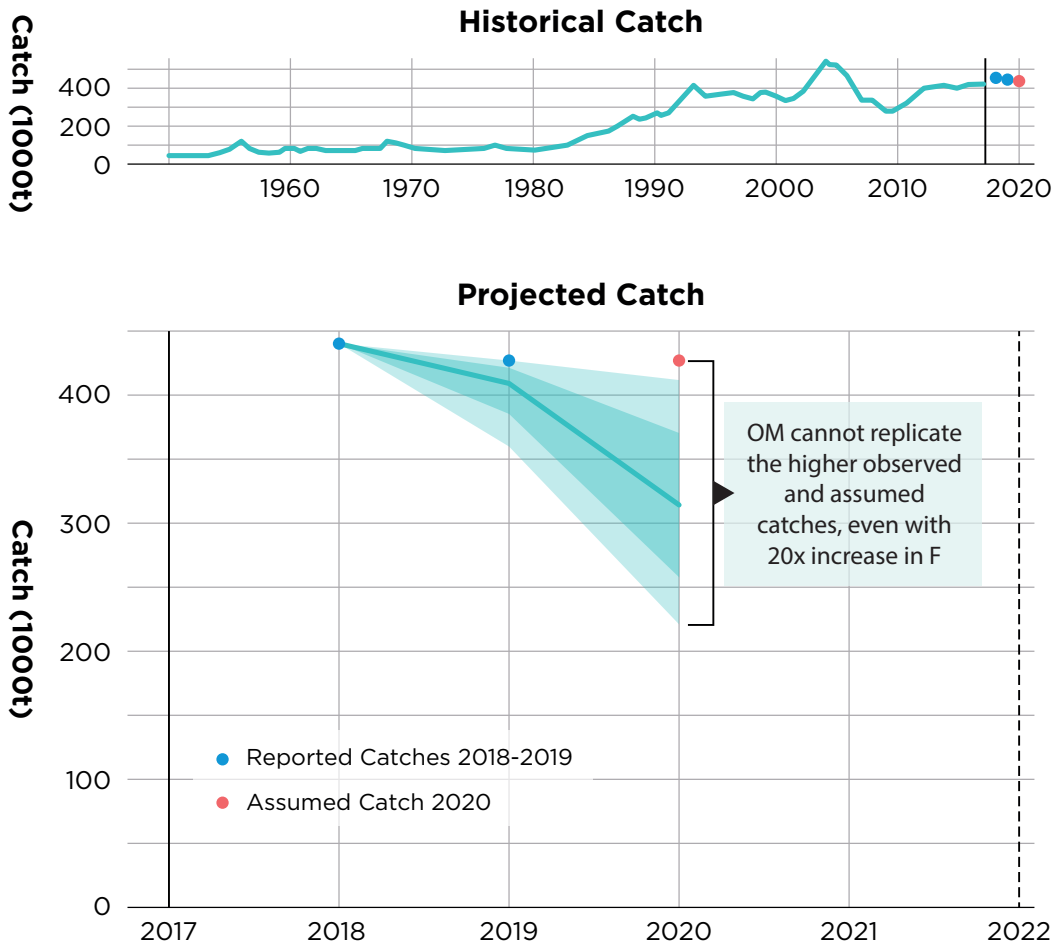
Source: DLM Toolkit

As discussed above, considerable uncertainties have confounded recent stock assessments for yellowfin tuna in the Indian Ocean. While these may be acceptable for determining current stock status, it can dramatically complicate predictions of future states. MSE offers a better alternative to account for those uncertainties. MSE has been used to test and develop MPs for a variety of data-limited and data-poor stocks where uncertainty is much higher than for IO yellowfin, ranging from invertebrates to groundfish to small tunas. There is even a specially designed MSE software package that addresses the unique challenges posed by data-limited fisheries. In the case of yellowfin, it might be wise to cluster the operating models (that is, the MSE's building blocks that each represent a combination of the assumed uncertainties) that suggest different stock statuses, selecting the MP that will be robust to different stock and fishery uncertainties and eventually achieve the target stock size regardless of initial status.

This example is for warty sea cucumbers in California, USA. The left column shows MSE results for an MP based on current effort levels, forecasting stock decline. The middle column shows MSE results for a data-poor MP that requires only recent CPUE and catch data. The third column shows a more data-rich MP, which would not be possible to implement for the stock given a dearth of information. The important finding is that the data-poor MP in the middle column has very similar, equally strong performance to the data-rich MP.

CHART 7:

REFLECTING ON PRIOR MSE WORK FOR YELLOWFIN TUNA



IOTC started its MP development work in 2013, with designation of target (B_{MSY}, F_{MSY}) and limit ($0.4\,B_{MSY}$, $1.4\,F_{MSY}$) reference points for the stock (Resolution 13/10). Phase 1 of the yellowfin MSE started in 2016, ramping up to multiple papers in 2020 and 2021. This earlier work on MSE was put on hold due to problems with the operating models (OMs) based on the failed assessment model at the time. When projecting forward in time, the models predicted declining catches and could not explain the higher levels of reported or assumed catch (see figures at left). This was believed to be due to structural issues in the stock assessment model. However, the most recent stock assessment has addressed many of the issues, and work has restarted based on the new assessment model. Should this still prove problematic, MSE can move forward with an alternative MSE approach that has been developed for IOTC's albacore MSE called the Approximate Bayesian Computation (ABC).

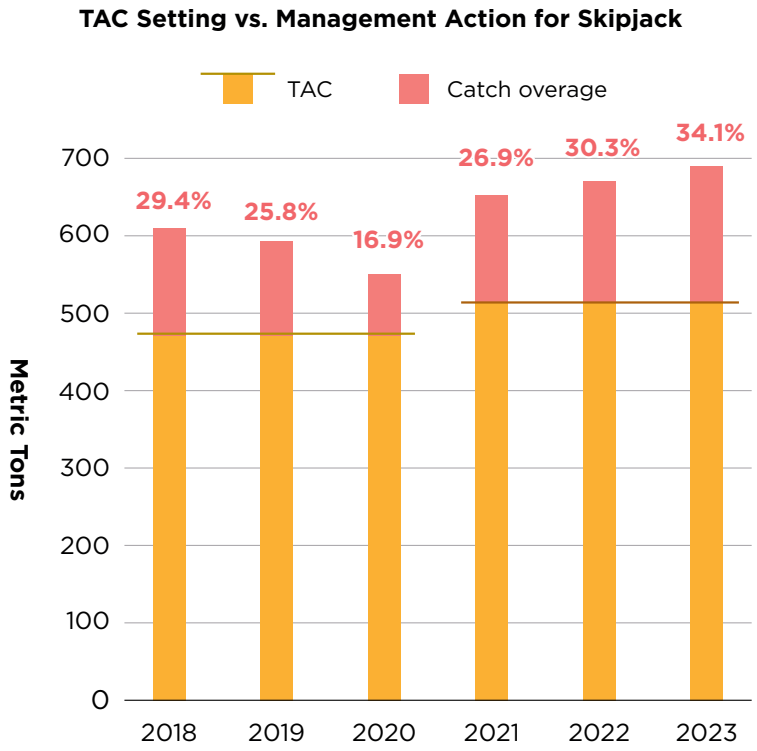
Source: IOTC Yellowfin Tuna MSE (2021)

CHART 8:

OVERCOMING OBSTACLES TO IMPLEMENTATION OF MANAGEMENT MEASURES

IOTC has faced considerable challenges over the past decade in achieving consensus on sustainable management practices, especially for yellowfin tuna, with multiple member governments objecting to measures. This has delayed and undermined efforts to implement effective management. MPs offer a clear solution to achieving consensus on management responses since they're pre-agreed.

However, even adopted, consensus-based MPs cannot ensure implementation. This chart shows the actual catch compared to the MP-based total allowable catch (TAC) for skipjack tuna, showing the lack of effective strategies to implement the agreed MP, including allocation of fishing opportunities. That said, the opposite is often true, where MPs can help to unblock allocation discussions by providing greater predictability in future catch limits. Positively, IOTC agreed in 2025 to interim catch limits that should help to finally constrain skipjack catches within the MP-based TAC.



Source: IOTC

CHART 9:

CURRENT YELLOWFIN TUNA SEAFOOD SUSTAINABILITY SCORES

FIP Title	P1 Score (Harvest Strategy)	P2 Score	P3 Score
Indian Ocean tuna - purse seine (SIOTI)			
Indian Ocean tuna - longline (Fue Shin)			
Indian Ocean tuna - purse seine (Dongwon Industries)			
Indian Ocean tuna - longline (FCF)			
Maldives yellowfin tuna			
Sri Lanka tuna and swordfish - longline			
Indonesia Indian Ocean skipjack, yellowfin and bigeye tuna - purse seine			
Indonesia Indian Ocean tuna and large pelagics - longline			
Indonesia Indian Ocean yellowfin tuna - handline			
Indonesia Indian Ocean yellowfin tuna - pole & line			

Fishery improvement projects (FIPs) are valuable assets to seafood market sustainability. They are a pragmatic, stepwise approach that brings together buyers, retailers, processors, suppliers, and other vital members of the supply chain to enhance the sustainability of a particular fishery, generally with the end goal of third-party certification and the profitable market access that comes with it. There are 10 different ongoing FIPs for Indian Ocean yellowfin tuna, all of which have an end goal of either Marine Stewardship Council (MSC) certification or full MSC assessment eventually leading to certification.

To pass MSC assessment and reach certification status, fisheries need to score an average of 80 or above. If any of the three principles score in the 60-79 range, they pass with conditions on the issues with a shortfall. This means that if the fishery resolves a specific area of concern within a set timeline, the fishery can be certified. A score of 59 or less on any single parameter is a fail.

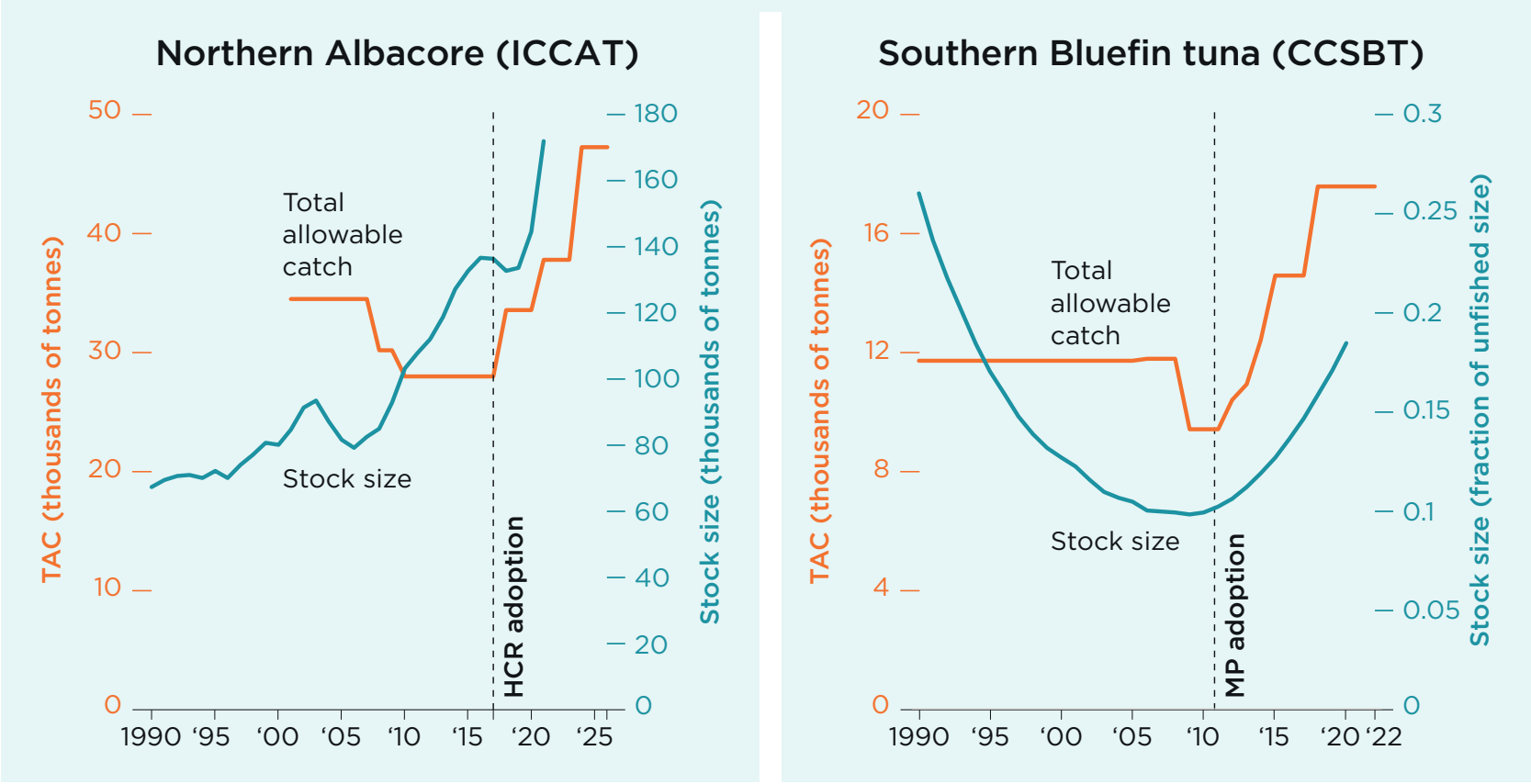
All Indian Ocean yellowfin FIPs either full pass or pass with conditions for the MSC measures of Principle 2 (P2, minimizing environmental impact) and Principle 3 (P3, effective management). However, new MSC guidelines (i.e., MSC Standard 3.1) require a full pass for the harvest strategy/management procedure score in Principle 1 (P1) for a fishery to be certified. All 10 Indian Ocean yellowfin FIPs fail P1, meaning that regardless of the passing scores for P2 and P3, all of them will eventually fail MSC assessment, preventing certification under Standard 3.1 due to the lack of an MSE-based MP.

Source: fisheryprogress.org

CHART 10:

MPS AS A TOOL FOR LONG-TERM SUSTAINABLE, PROFITABLE FISHERIES

Southern bluefin and North Atlantic albacore are the tuna stocks with the longest time under MP management. Following adoption, both stocks experienced recovery and considerable stock growth, concurrent with systematically increasing catches, illustrating the effectiveness of the MP approach. MPs offer a science-based, predictable, and responsive management approach that could confirm recovery and long-term productivity in the Indian Ocean yellowfin tuna fishery, all while easing decision-making in the controversial fishery, increasing food security in coastal communities, and opening the door to increased market access via sustainable seafood certifications. IOTC should prioritize its yellowfin tuna MSE process, with the goal of adopting an MP by 2027.



Source: ICCAT and CCSBT

Yellowfin tuna

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