OPTIONS FOR MULTISPECIES MANAGEMENT OBJECTIVES FOR TROPICAL TUNAS

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SUMMARY

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is in the process of adopting Management Procedures (MP) for the most important tuna stocks under its purview. The Management Strategy Evaluation (MSE) process aims at providing support for a robust management framework and, for tropical tunas, it started in 2018 with a design of the steps to develop a multispecies MSE process. One of the key components of the MSE process is the adoption of management objectives for the stocks of interest. For tropical tunas, a multispecies management framework is being developed and therefore, contrary to other MSEs developed in ICCAT and other tuna RFMOs, the management objectives need to be multispecies too. In this work we propose a series of alternative multispecies management objectives based on ICES mixed fisheries management framework and recent scientific publications.

RÉSUMÉ

La Commission internationale pour la conservation des thonidés de l'Atlantique (ICCAT) est en train d'adopter des procédures de gestion (MP) pour les principaux stocks de thonidés relevant de sa compétence. Le processus d'évaluation de la stratégie de gestion (MSE) vise à soutenir un cadre de gestion solide et, pour les thonidés tropicaux, il a commencé en 2018 avec la conception des étapes pour développer un processus de MSE multi-stocks. L'un des éléments clés du processus de MSE est l'adoption d'objectifs de gestion pour les stocks concernés. Pour les thonidés tropicaux, un cadre de gestion multi-stocks est en cours d'élaboration et, par conséquent, contrairement à d'autres MSE élaborées par l'ICCAT et d'autres ORGP thonières, les objectifs de gestion doivent également être multi-stocks. Dans ce travail, nous proposons une série d'objectifs de gestion multi-stocks alternatifs basés sur le cadre de gestion des pêcheries mixtes du CIEM et sur des publications scientifiques récentes.

RESUMEN

La Comisión Internacional para la Conservación del Atún Atlántico (ICCAT) está adoptando procedimientos de ordenación (MP) para los stocks de túnidos más importantes bajo su supervisión. El proceso de evaluación de estrategias de ordenación (MSE) tiene como objetivo proporcionar apoyo para un marco de ordenación sólido. En el caso de los túnidos tropicales, comenzó en 2018 con un diseño de los pasos para desarrollar un proceso de MSE multistock. Uno de los componentes clave del proceso de MSE es la adopción de objetivos de ordenación para los stocks de interés. En el caso de los túnidos tropicales, se está desarrollando un marco de ordenación multistock y, por lo tanto, al contrario que en otras MSE desarrollados en ICCAT y otras OROP de túnidos, los objetivos de ordenación también deben ser multistock. En este trabajo proponemos una serie de objetivos alternativos de ordenación multistock basados en el marco de ordenación de pesquerías mixtas de ICES y en publicaciones científicas recientes.

KEYWORDS

Tropical tunas, bigeye, yellowfin, skipjack, MSE, management objectives

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1. Introduction

The productivity of fisheries is driven by the capacity of fish stocks to respond to fishing pressure and it is determined by fish life-history traits (Wang, Shen et al. 2020; Froese, Zeller et al. 2021) and fishing gear selectivity (Svedäng and Hornborg 2014). Tunas sustain some the of world's most valuable fisheries and dominate marine ecosystems worldwide (Juan-Jordá, Mosqueira et al. 2011). The management of tunas is responsibility of tuna Regional Fishery Management Organizations (tRFMO), including the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), the Inter-American Tropical Tuna Commission (IATTC), the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC), and the Western Central Pacific Fisheries Commission (WCPFC). Most of the management organizations have aimed at achieving the maximum sustainable yield (MSY), an equilibrium point at which the capacity of fish stocks to replace the harvested biomass is maximized and, therefore, fisheries' long-term average catch is maximized too. MSY has represented the management objective and the benchmark on which many fisheries agencies have developed their management frameworks, including tRFMOs. In summary, maximizing catch has been considered a management objective and, the biomass and fishing mortality at MSY (B_{MSY} and F_{MSY}) have been the benchmarks that have guided fisheries management.

However, there is agreement that achieving MSY for one stock may impose constraints for the management of other stocks. This is particularly evident for demersal stocks, harvested with low selectivity gears such as bottom trawls and therefore, highly multispecific by nature (ICES 2015). Tropical tunas (bigeye, yellowfin and skipjack) are captured by purse seine, longline, gillnet, baitboat and other artisanal gears, often simultaneously and therefore, tropical tunas are candidates for the implementation of a multispecies management scheme. As a first step, management objectives that address the multispecies nature of tropical tunas need to be developed. For this, we present options developed for mixed fisheries in the International Council for the Exploration of the Seas (ICES). This will help identify the multispecies Management Procedures that will be designed to achieve multispecies objectives in tropical tuna fisheries. In this context, the development of Management Procedures should also consider the interactions between gears and the three tropical tunas.

2. Options for multispecies objectives

The following multispecies management objectives stem from the idea of maximizing the sustainable production of fisheries. The Atlantic Ocean tropical tunas are estimated somewhat in the range of their maximum productivity with Eastern and Western Atlantic skipjack estimated at 1.60 of SSB_{MSY}, bigeye at 0.94 of SSB_{MSY} and yellowfin at 1.17 of SSB_{MSY} (SCRS 2019, 2021, 2022). When fluctuating around MSY, catch remains relatively large and offers several options to develop multispecies management objectives:

a) *Multispecies MSY (MMSY).* This concept is illustrated in **Figure 1**, which is taken from (Worm, Hilborn et al. 2009) and represents the effect of progressively increasing a fixed pattern of exploitation rate across a fish community or marine ecosystem. For this figure, a multispecies MSY is defined as being in the maximum yield that can be taken from a marine species community in the long run (Thorpe 2019).

   Another figure, adapted from (Merino, Quetglas *et al.*, 2015) also illustrates the single stocks and multispecies MSY by combining the equilibrium curves of single species and the resulting overall catch expressed as the sum of four stocks (**Figure 2**). When considering the multispecies MSY as a management objective, it is assumed that a fishery manager or RFMO will aim at extracting as much yield from the system as possible without damaging the community structure in such a way that makes it non sustainable overall (Thorpe 2019). Adopting a multispecies MSY implicitly means recognizing that this will be achieved by keeping some stocks overfished (at levels below that of MSY, hake in **Figure 2**) and others will remain underfished (red mullet, red shrimp and Norwegian lobster in **Figure 2**).

   In the Atlantic Ocean tropical tuna context, the MSY's of yellowfin (121,298 tons) and Eastern skipjack (216,617 tons) are larger than bigeye's (86,833 tons). Therefore, it is expected that the multispecies MSY will be achieved by maximizing catch of skipjack and yellowfin and the dynamics of bigeye be adapted to the other two stocks' productivity. However, the trade-offs between the three stocks interaction, fishing mortality and sustainability need to be analysed in a specifically built multispecies Management Strategy Evaluation (MSE) framework.

Also, this and other multispecies objectives may receive different views from different fleets, depending on the nature of their fisheries (e.g. longline fleets that catch bigeye and yellowfin, but not skipjack). Furthermore, the inclusion or not in the MMSY of stocks beyond tropical tunas should be evaluated (e.g. small tunas, which are relevant for coastal countries of the Atlantic Ocean).

b) *Pretty Good Yield (PGY).* This concept (Hilborn 2010) refers to a range of policies that provide good yield while also producing other desired output such as increased stability, reduced risk and ensuring long term sustainability. PGY is defined as the sustainable yield at least 80% of the MSY, which are generally obtained over a broad range of stock sizes represented relative to their unfished levels (SSBF=0). In general, under this concept, all stocks can be maintained at values of abundance larger than that relative to SSB_{MSY} with little expected loss of yield. Hilborn (2010) defines a range of PGY for different stock size expressed as biomass relative to $SSB_{F=0}$ and the steepness parameter of stock-recruitment relationships (**Figure 3**). Overall, 30-40% of unfished stock size is considered as robust to any uncertainty about steepness (Hilborn 2010), which is the most uncertain parameter used in stock assessments (Merino, Murua et al. 2020).

Further estimates of the PGY range for tropical tunas and the trade-offs between the state of exploitation of the three stocks would need to be investigated using MSE.

c) *All stocks in the green quadrant of the Kobe plot.* This management objective is aligned with the objectives United Nations Sustainable Development Goals (SDG), and in particular, with Goal 14 ('*Fish below water'*) and Target 14.4., which aims to "*restore fish stocks (…) at least to levels that can produce the maximum sustainable yield as determined by their biological characteristics"* (UN 2015). The idea is to manage fisheries so that no single fish stock is exploited at levels below its biomass at MSY and with a fishing mortality larger than the fishing mortality at MSY. In the current ICCAT tropical tuna fisheries context, this would mean adopting the necessary measures to reduce the fishing mortality for bigeye, which is the stock in worse condition. In a multispecies context, this would mean that yellowfin and skipjack would probably remain underfished. The trade-offs between the level of exploitation of the three stocks need to be analyzed in a specifically built multispecies MSE framework too. A minimum standard for the probabilities of being in the green quadrant of the Kobe plot would need to be adopted.

d) *Management of one stock of interest.* This is similar to the previous option but instead of focusing on the most depleted stock, the overall fishing mortality would be modulated by the fishing mortality applied to the stock that raises the major interest for the fishery managers. For example, this could be leading the stock that reaches the higher market value towards MSY while the dynamics of the other stocks would be driven by the fishing mortality applied to this. Instead of market value, the interest in the conservation of one species might be driven by other socioeconomic factors such as its historic or cultural value.

e) *Achieving Target Reference Points (TRP) for one specific stock (e.g. WCPFC).* This is somewhat a step further from the previous two. In the WCPFC, the identification of interim TRPs is being supported by MSE. Specific analyses evaluate the consequences for each stock and fishery of different depletion levels consistent with specified historical conditions and stock risk levels (WCPFC 2021). For each depletion level of one stock, changes in biomass for other stocks are evaluated using fishing effort scalars for purse seine and catch for longline (Table 1). In this evaluation, relatively large values of sustainable catch (94-98% of MSY) are achieved by maintaining the depletion of bigeye between 29-49%. The depletion for skipjack and yellowfin also remains at safe levels (between 34% and 54% of $SSB_{F=0}$). This type of analysis is comparable to the items described in c) and d), where a desired state for one key species is defined, which modulates fishing effort and therefore, the dynamics of the other stocks are modulated too. These analyses also require the development of multispecies simulation frameworks or multispecies MSE.

3. Discussion

This document aims to be a first step in the necessary dialogue between scientists and managers in the MSE process for Atlantic tropical tunas. The adoption of management objectives is necessary for a better design of candidate MPs and adequate performance indicators.

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Median depletion level (%$SB_{F=0}$)	Change in SB (%$SB_{F=0}$) from 2012-2015 average	Change in SB (%$SB_{F=0}$) from 2015-2018 average	Change in fishing from 2016-2018 levels	Median total equilibrium yield (%MSY)	Risk $SB/SB_{F=0}$ < LRP	Rel. YPR	Rel. SPR	Notes	Equiv. SKJ $SB/SB_{F=0}$	Equiv. YFT $SB/SB_{F=0}$
48%	+30%	+17%	0%	95%	0%	1	1	Base 2016-2018 conditions	43%	59%
33%	-10%	-20%	+54%	98%	10%	1.21	0.65	Avg. 2012-2015 – 10%	35%	43%
37%	0%	-10%	+38%	98%	3%	1.17	0.76	Avg. 2012-2015	37%	46%
41%	+10%	0%	+24%	98%	0%	1.12	0.86	Avg. 2012-2015 + 10%	39%	48%
49%	+34%	+21%	-4%	94%	0%	0.98	1.02	Avg. depletion 2000-04	44%	54%
32%	-12%	-21%	+55%	98%	10%	1.22	0.64	10% risk re LRP	35%	43%
29%	-23%	-30%	+70%	98%	20%	1.24	0.54	20% risk re LRP	34%	41%

Table. 1. Median bigeye depletion levels and corresponding change in SSB from 2012-2015 and 2015-2018 average levels, change in purse seine fishing effort and longline catch (scalar) from baseline (2016-2018) levels, median equilibrium yield (% of MSY), risk of falling below the agreed LRP and spawner and yield-per recruit levels relative to 2016-2018 average. The equivalent depletion levels that would result for skipjack and yellowfin for each candidate bigeye TRP are provided in the last two columns (WCPFC 2021).

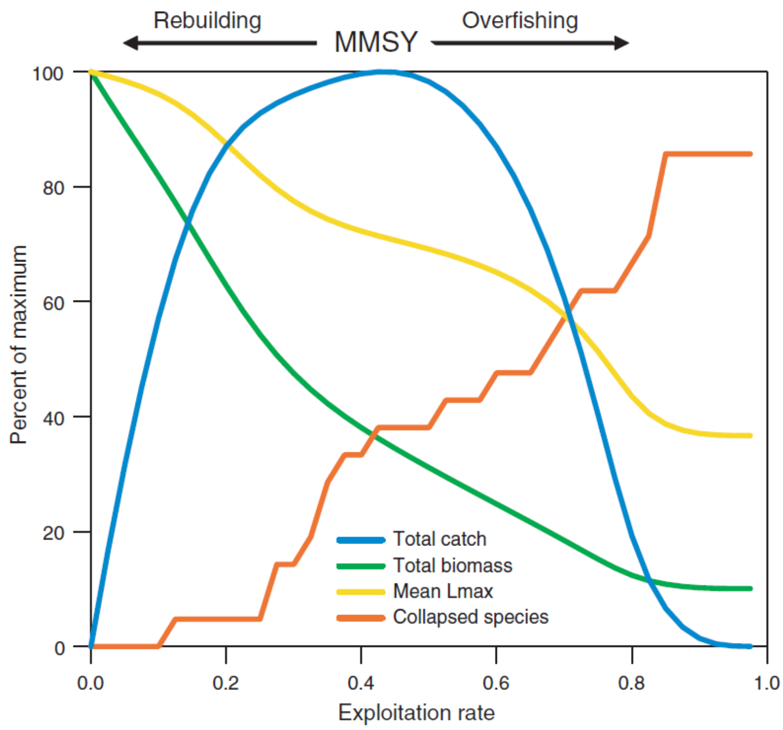

Figure 1. Effects of increasing exploitation rate on a model fish community. Exploitation rate is the proportion of available fish biomass caught in each year. Mean Lmax refers to the average maximum length that the species in the community can attain. Figure taken from (Worm, Hilborn et al. 2009).

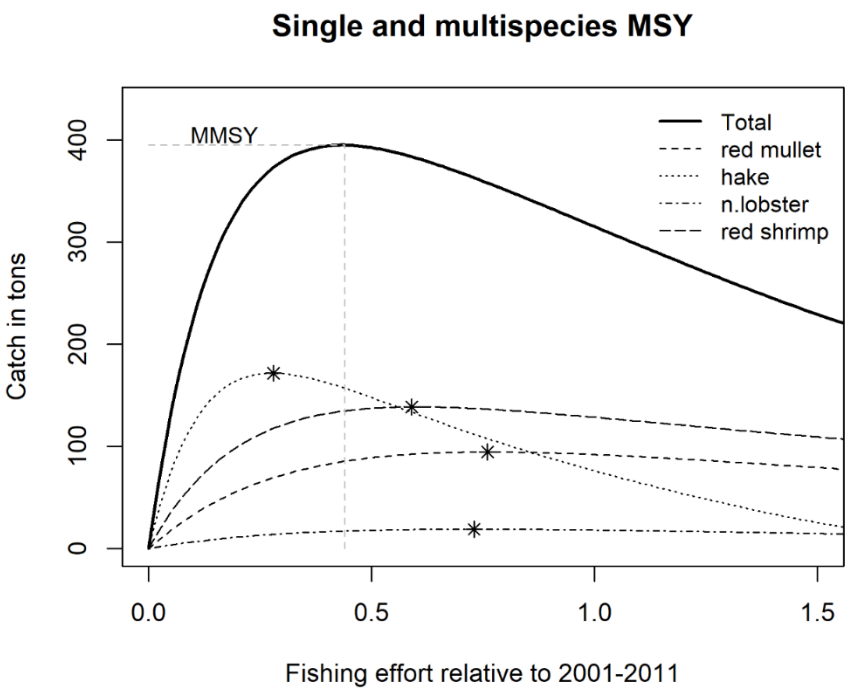

Figure 2. Catch at equilibrium of four species exploited by a Mediterranean trawl fishery as a function of fishing effort relative to the observed from 2001 to 2011. Asterisks indicate each species coordinates at MSY (Merino, Quetglas et al. 2015).

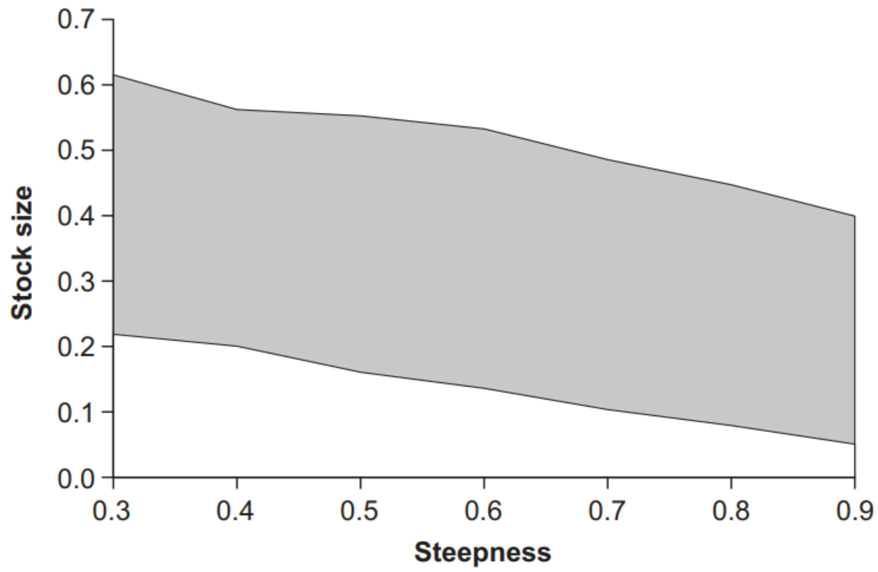

Figure 3. The region of PGY plotted versus steepness and stock size (level of depletion) from Hilborn (2010).