Estrategias de ordenación para atunes tropicales en el OPO SAC-15-08

Tropical tuna harvest strategies in the EPO SAC-15-08

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Harvest strategies

Harvest strategies (management strategies, management procedures) are integrated combinations of **agreed** upon **data inputs**, **analyses** applied to that data and the **harvest control rule** used to determine **specific management actions** (e.g., catch quotas, length of fishing seasons) designed to achieve **management objectives**.

Management objectives

- General objectives are defined in IATTC's **Antigua Convention**'s Article VII (c) stating:

"(…) to ensure the long-term conservation and sustainable use of the fish and to maintain or restore the populations of harvested species at levels of abundance which can produce the maximum sustainable yield"

- From Article II:

*"(…) ensure the long-term **conservation** and **sustainable use** of the fish (...)"*

- From Article IV Apply the **Precautionary Approach**:

"(...) be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures."

Management objectives

- General objectives need to be converted into operational objectives, in terms of the values of performance statistics.
- Operational objectives include performance metrics, probabilities and timeframes that allow to evaluate how alternative harvest strategies perform using MSE
- Progress have been made IATTC MSE Workshops into developing more specific objectives
- The staff is recommending additional workshops in 2024 and 2025 to further refine objectives and other harvest strategy elements, along with their evaluation for BET.

Objetivos, cantidades, indicadores de desempeño
Objectives, quantities, performance indicators

OBJECTIVE	Quantity	Performance Indicators
Safety *Maintain stock above limit reference points*	*Equilibrium virgin spawning biomass* S_0 • *< 10% probability SB below 7.7% of* S_0 • *< 5% probability SB below 7.7% of* S_0 < 10% P SB < Smsy Flim (< 5% *P* F > Fmsy)	Ratio of S_{yr} over S_0 Probability calculated over projected 30 years (All years, any year by replicates)
Status Maintain stock in green quadrant of Kobe plot	SB≧ dynamic SB_{MSY} and $F<F_{MSY}$ • *60% probability* • *75% probability*	% of simulated runs falling in Kobe's green quadrant Probability calculated over projected 30 years
Stability Maintain low variability of catch and effort limits, gradual changes in management measures. Caps at 10% (effort), 15% (catch)	Standard deviation of annual catch, effort Average interannual proportional change (catch, effort)	% change in catch and/or effort between years Calculated over projected 3, 15 and 30 years
Yield/Abundance Maintain catches/effort/CPUE above historical ranges	Average catch/effort/CPUE by fishery (PS and LL) • *1994-2019 (since FAD expansion)* • *2017-2019 (latest status quo)*	Ratio of projected 3, 15 and 30-year average catch/effort/CPUE by fishery over historical period
Status quo Maintain the stock at levels near the (2017-2019) status quo	Spawning biomass, Index (LL CPUE)	Ratio of projected 3, 15 and 30-year average SB, Index (LL CPUE) over status quo period (2017-2019)

IATTC Target and Limit Reference Points

- IATTC adopted interim limit and target reference points in 2014.
- Limit (LRP):
  - *B* and *F* associated with a 50% reduction in unfished equilibrium recruitment (50%R_0) using a conservative stock-recruitment relationship (steepness, or h = 0.75).
- Target (TRP):
  - Biomass (*B*) and Fishing mortality rate (*F*) corresponding to maximum sustainable yield (B_{MSY} and F_{MSY})
  - Move from equilibrium to dynamic targets in 2020
  - Adoption of proxy targets in 2023
  - Revisited by staff in 2024 (SAC-15-05)

Reference Points: Limit Reference Points

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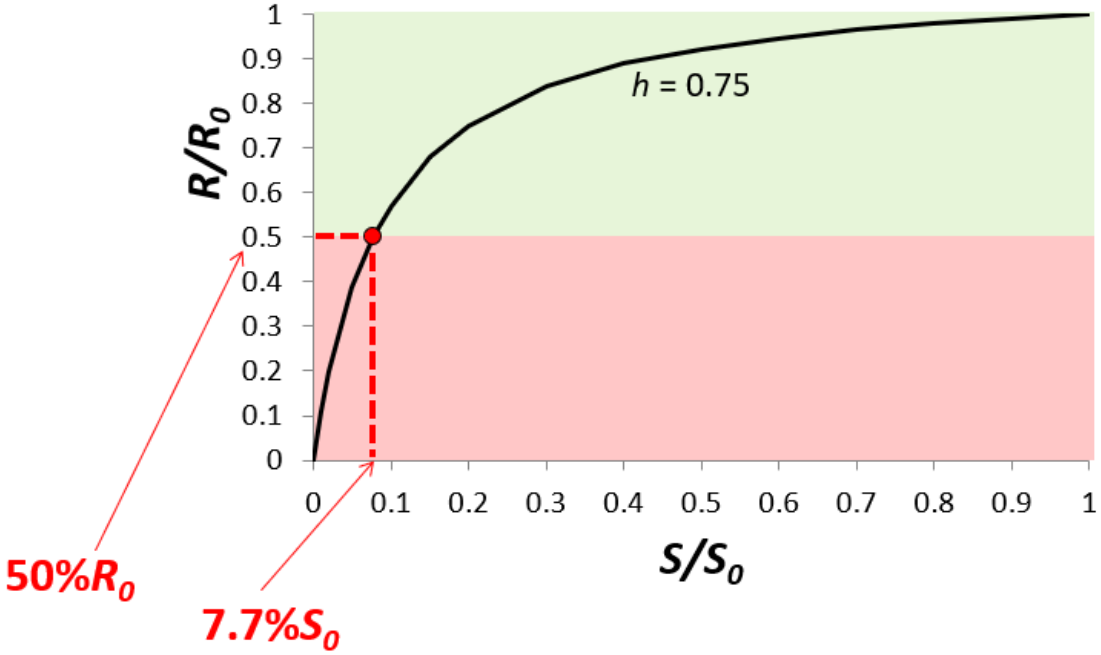


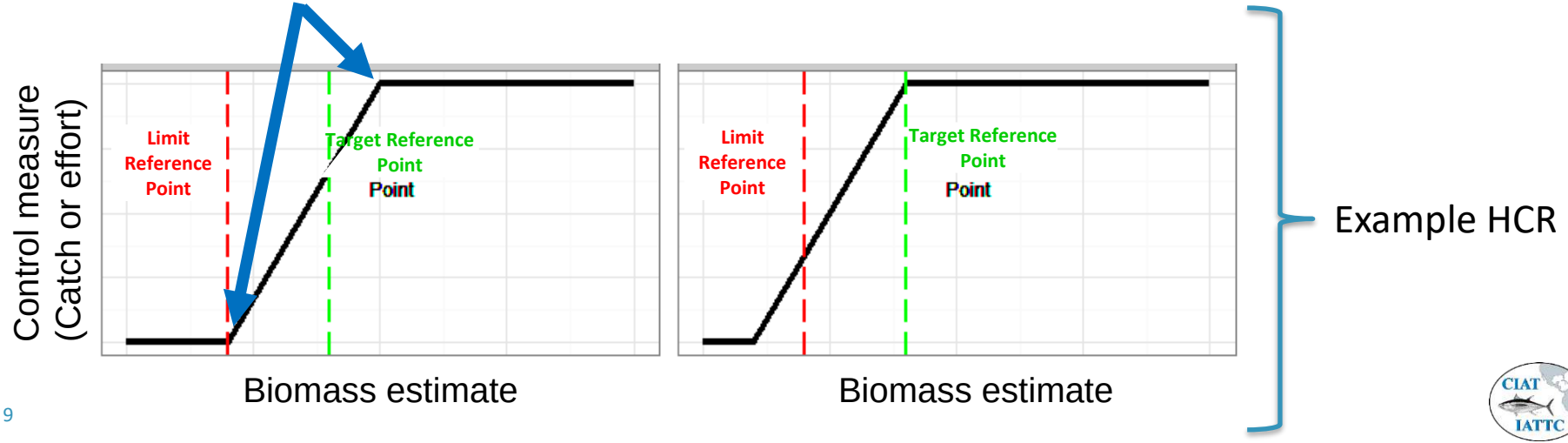
Reference Points: Target Reference Points

- Target (TRP):
  - Biomass (*B*) and Fishing mortality rate (*F*) corresponding to maximum sustainable yield (MSY): (B_{MSY} and F_{MSY})
  - Moved from equilibrium to dynamic targets in 2020
  - Adoption of proxy targets in 2023
  - Revisited by staff in 2024 (SAC-15-05): staff proposed $S_{MSY}/S_0 = 0.3$

Reference Points and HCR Control Points

- Current HCR uses Reference Points
- Harvest Control Rules (HCR) can have **arbitrary control parameters**
- **Formal Reference Points** (**limit**, **target**) can be used to evaluate the performance of the HCR (but they do not need to be part of the HCR)

Control parameters (trigger reference points)



Harvest Control Rule (HCR)

C-16-02, C-23-06 have a HCR with target, limit reference points. **But:**

- HCR has not been fully evaluated using simulation
- No alternative HCR which could be better (e.g., more robust to uncertainty) has been adopted yet
- HCR does not specify what management actions are to be implemented
- HCR does not have a mechanism calculating magnitude of management actions
- Probabilities around targets are not specified

C-16-02 has elements of a management strategy, but it is not fully specified

Management measures for tropical tunas in the EPO

- Limited entry for new purse-seine vessels
- Fishing Capacity should remain constant
- Recommendations of IATTC Scientific Staff to implement Harvest Control Rule using a time closure of the fishery (vessels can choose among two periods)
- Duration of closure calculated using an *F* multiplier from the stock assessments of tropical tunas, adjusted given changes in fleet capacity.

Closure = 365- F_{MSY}/F * (365-current closure)/(capacity of previous year/previous 3-year average capacity)

Management measures for tropical tunas in the EPO

- “Corralito”: spatial closure (Sep. 29 to Oct. 29)
- Equivalent to 3 closure days for all EPO (SAC-05-16)
- Recent re-evaluation of this spatial closure (SAC-15 INF-M) consistent with the impact, but with substantial year-to-year variation (14 additional days of closure for BET in some years to an additional 4 days of fishing in others).

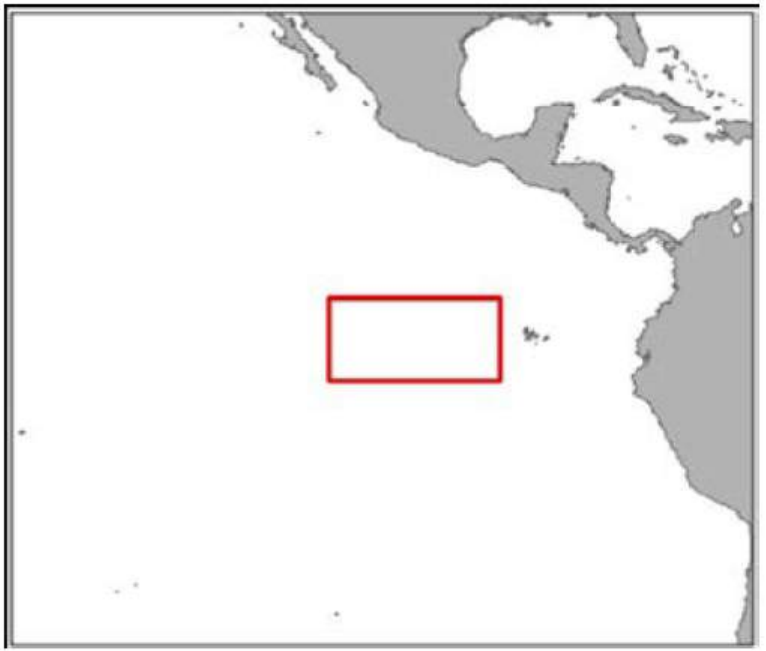


Figure 1. Closure area

Management measures for tropical tunas in the EPO

- Longline catch quotas by CPC
  - Not clear mechanisms to adjust quota levels

Management measures for tropical tunas in the EPO

- Fishing on FADs
- Total retention
- BET Individual Vessel Thresholds

Measures not adopted or adopted but changed over time

Some examples only, list is not complete

- Combination of temporal and spatial closures for purse seine (e.g. 2003, 2004)
- Individual vessel limits on purse seine BET catches (e.g. 2003)
- Additional closure days for the floating object fishery catching BET (e.g. 2006)
- Purse-seine catch limits (adopted, then back to closures 5 months later, 2017)
- Limits on the number of floating object and unassociated sets (2018, 2019)
- Limits on the number of floating object sets + ind. vessel daily active FADs (2020)

Data collected

- No data inputs agreed to use in management setting for tropical tunas in the EPO
- Similar data collected by the IATTC for decades and used in the stock assessments (catch, length compositions by fleet, and indices or relative abundance based on fishery CPUE)
- Other data recently available (e.g. sonar buoy Indices)
- Other data collected only occasionally so far (e.g. tagging data, biometric data)

- Often difficult to specify all data to implement a strategy, however risks if not doing so
  - e.g. recent inclusion of the IVT, paired to the enhanced monitoring program (EMP). If continuation of EMP is uncertain, needed to support the IVT, unclear how to maintain strategy

Assessment or Data analyses

- The assessment method and data analyses to be used for tropical tunas are not fully specified, changes over time based on considerations of “best available science” at the time.
  - e.g. changes from ASCALA to Stock Synthesis
  - e.g. changes from GLM to spatio-temporal analyses of CPUE and length compositions

- Difficult to specify and agree all specifications of stock assessments and data analyses on a harvest strategy approach, unless the assessment is relatively simple

Role of full stock assessment model in Management Strategy

- As only Estimation Model of Management Strategy
  - Often logistically and computationally impractical

- Decoupled from Management Strategy and HCR implementation or MP
  - Stock status determination relative to reference points
  - Operating model development and modeling research
  - Typically, assessment year different from MP management action year
  - Check exceptional circumstances and meta rules

Management Strategy Evaluation

- Ongoing MSE for bigeye Tuna (see C-15-07)
- Recent large changes in the modeling of BET in the EPO
  - -2020 benchmark BET assessment issues (bimodal results, recruitment shift)
  - -Review of data and modelling for tropical tuna assessments (Oct-Nov 2023)
  - -Substantial changes and improvements on modelling for BET assessment (2024)
- Revisiting Tropical Tuna reference points (SAC-15-05)
- Continue technical work on BET MSE during 2024
  - -Preliminary work with OMs based on last benchmark assessment (2020)
  - -Updated runs with OMs from current benchmark assessment (2024)
  - -Incorporate stakeholder feedback between preliminary and updated results
- Finalize BET MSE and plan to present results during 2025

Management Strategy: rules and metarules

Southern Bluefin Tuna (CCSBT)

Every year

Review of stock and fishery indicators

Exceptional circumstances?

Every 3 years

In depth stock assessment

Exceptional circumstances?

no

yes

no

yes

Apply MP-derived TAC

If exceptional circumstances, advise on other measures

no

Are exceptional circumstances so severe that immediate action on TAC is required?

yes

Invoke metarule

Do not apply MP-derived TAC

Advise on TAC

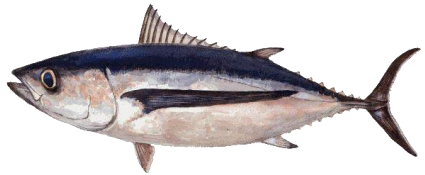
Beyond bigeye tuna MSE

- EPO tropical tuna fisheries have multispecies (BET, YFT, SKJ), multi-gear (PS, LL) and fishing modes (FAD, Dolphin, NOA) present several challenges:
  - More difficult to simulate and evaluate
  - Different objectives for different fisheries?
  - Weak-stock management? Or 3 species individually? or two species?
- Very few truly multispecies MSEs in the world, focus on gear interactions
- Need to discuss / plan as part of the next 5-year IATTC Scientific Strategic plan

Ejemplos de Estrategias de Ordenación en OROP atuneras
Examples of harvest strategies from tuna RFMOs

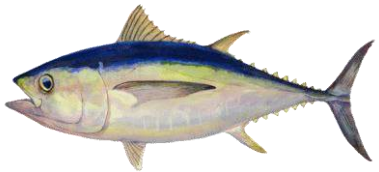
IATTC / WCPFC North Pacific Albacore tuna

Adopted in 2023, elements adopted gradually in previous years



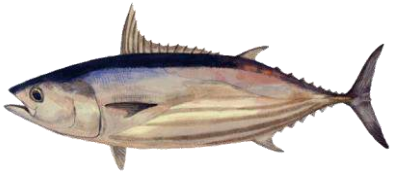
IOTC Bigeye tuna

Adopted in 2022, elements adopted in previous years



WCPFC Skipjack tuna

Adopted in 2022, run for the first time in 2023, implementing arrangements adopted in 2023, monitoring strategy adoption 2024



Tuna harvest strategies status available at https://harveststrategies.org, at each RFMO and in yearly reports by ISSF

Atún albacora del Pacifico Norte (CIAT-WCPFC)
North Pacific Albacore (IATTC-WCPFC)

Type of strategy: Model-based (full stock assessment)
Management cycle: 3 years
Strategy inputs: Regular stock assessment estimates
Management measures: work on fishing intensity to actual management action (SAC-15 INF-T)
Operating models: 4 representing plausibility and stock productivity
Management Objectives:

i. Maintain Spawning Stock Biomass (SSB) above the Limit Reference Point, with a probability of at least 80% over the next 10 years.
ii. Maintain depletion of total biomass around historical (2006-2015) average depletion over the next 10 years.
iii. Maintain fishing intensity (F) at or below the target reference point with a probability of at least 50% over the next 10 years.
iv. To the extent practicable, management changes (e.g., catch and/or effort) should be relatively gradual between years.

Atún albacora del Pacifico Norte
North Pacific Albacore

Performance Indicators:

a) Probability that SSB in any given year of the MSE forward simulation is above the LRP

b) Probability that depletion in any given year of the MSE forward simulation is above minimum historical (2006-2015) depletion.

c) Probability that catch in any given year of the MSE forward simulation is above average historical (1981-2010) catch.

d) Probability that catch averaged over years 7-13 of the simulation is above average historical (1981-2010) catch.

e) Probability that catch averaged over years 20-30 of the simulation is above average historical (1981-2010) catch.

f) Probability that a decrease in TAC (or catch for mixed control) is <30% between consecutive assessment periods (once every 3 years), excluding years where TAC=0.

g) Probability of SSB > SSBthreshold

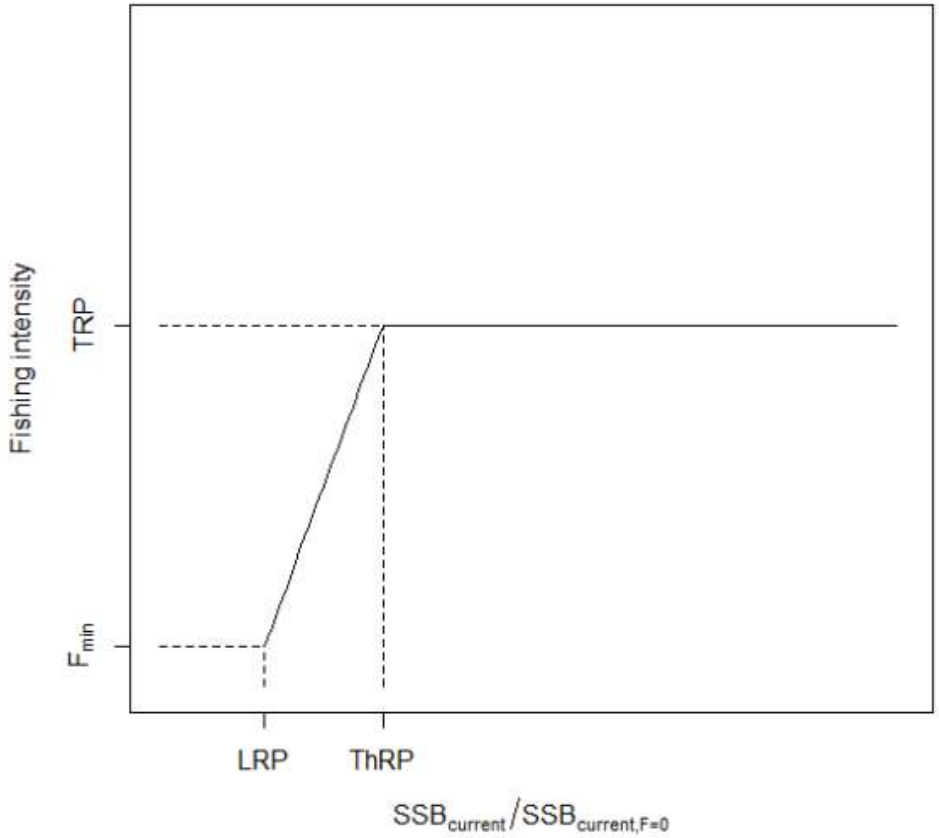
Atún albacora del Pacifico Norte
North Pacific Albacore

Limit reference point: LRP =14%$SSB_{current,F=0}$, which is 14% of the dynamic SSB_0.

Threshold reference point: $SSB_{threshold}$ = 30%$SSB_{current,F=0}$, which is 30% of the dynamic unfished spawning stock biomass.

Target reference point: TRP = F45%, which is the fishing intensity (*F*) level that results in the stock producing 45% of spawning potential ratio (SPR).

Atún albacora del Pacifico Norte - RCE
North Pacific Albacore - HCR



Atún albacora del Pacifico Norte
North Pacific Albacore

Exceptional circumstances:

Not been adopted yet, criteria developed (SAC-15 INF-S)

- Changes on stock and fleet dynamics beyond previously simulated in the MSE,
- Substantial changes in biology of the stock or fleet structure/or fishing operations
- Data collection required to produce the stock assessment is no longer available/appropriate to apply the adopted harvest strategy) and implementation
- Management action substantially different from what is prescribed by the HCRs

Atún patudo en IOTC
Bigeye tuna in IOTC

Type of strategy: Model-based (simple biomass dynamic model)
Management cycle: 3 years
Strategy inputs: catches and longline CPUE
Management measures: Catch quota
Operating models:
Reference set of 72 OMs, uncertainty combinations of different levels of:
1. Recruitment: number of age 1 fish; reflects stock productivity over time (3 levels)
2. Natural mortality: (3 levels)
3. Tag recapture: different weightings on the reliability of the tagging data (3 levels)
4. Assumed longline catchability trend: catchability increases in the longline fishery (2 levels)
5. Regional scaling of longline CPUE (2 levels)
6. Longline fishery selectivity (2 levels)
7. Effective Sample Size, determining how informative the size composition data is (2 levels)

Robustness set of 5 OMs, longline CPUE, overcatch implementation error (reported or not reported), 3% catchability increase, recruitment reduction shock (55% over 8 quarters)

Atún patudo en IOTC
Bigeye tuna in IOTC

Management Objectives:

a) Maintain the stock biomass in the green zone of the Kobe plot, while maximizing average catch and reducing the variation in TAC between management periods.

b) Spawning stock with 60% probability of achieving target reference point SB_{MSY} by 2034-2038;

c) Spawning stock avoids breaching interim limit reference point 50%BMSY with high probability

Performance Indicators:

a) Average catches

b) Probability of initial catch decrease

c) Catch variability

d) Range of Biomass and Fishing mortality at the end of projection period

e) Probability B>BLIM over the projection period (in robustness test)

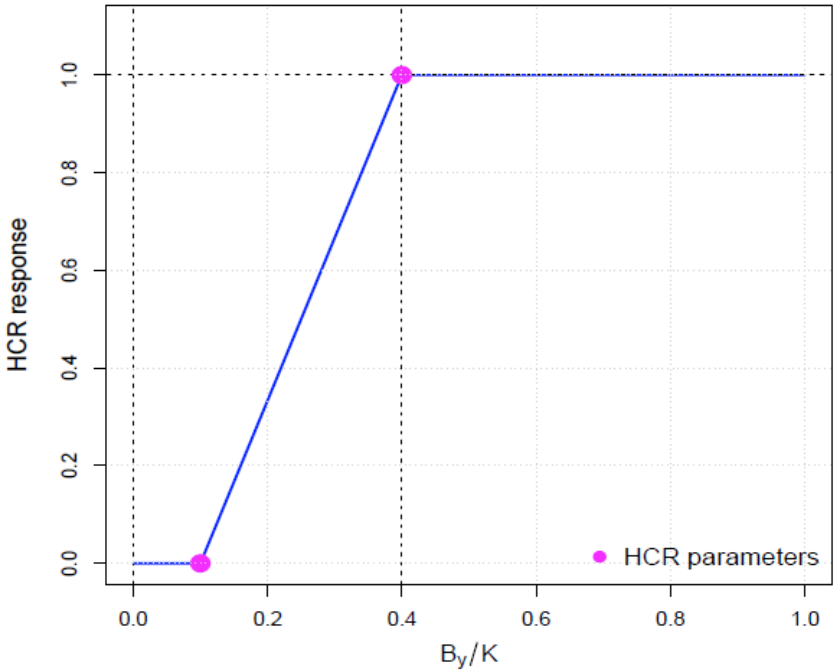
f) Probability F<FMSY over the projection period (in robustness test)

g) Recovery from a poor recruitment period (in robustness test)

Atún patudo en IOTC
Bigeye tuna in IOTC

Limit Reference Point (Interim): 50% B_{MSY} , 130% F
Target Reference Point (Interim): B_{MSY} , F_{MSY}
HCR control points:
40% and 10% of carrying capacity (K)

Exceptional circumstances:
Not adopted yet. If triggered, pre-existing TAC shall remain in place until new management action is agreed by the Commission.



Atún barrilete en WCPFC
Skipjack tuna in WCPFC

Type of strategy: model-based
Management cycle: 3 years
Strategy inputs: stock assessment spawning biomass ratio for latest year ($SB_{latest}/SB_{F=0, t1-t2}$),
Management measures: Effort or catch measures
Operating models:
Based on the 2019 skipjack stock assessment, 96 models, representing configurations of Recruitment Variability, Observation Error, Catch and effort, Size composition (ESS), Tag recaptures, Model Error, Steepness, Mixing period, Growth, Movement, El Nino/La Nina, DD catchability, Implementation Error and Effort creep.
Reference set (most plausible hypotheses, used to calculate performance metrics) and a robustness set (considered less likely but still plausible).

Atún barrilete en WCPFC
Skipjack tuna in WCPFC

Management Objectives:

To ensure that:

a) spawning potential depletion ratio is maintained on average at a level consistent with the target reference point;

b) the spawning potential depletion ratio is maintained above the limit reference point with a risk of the limit reference point being breached no greater than 20%

Performance Indicators:

a) Maintain SKJ, YFT, BET biomass at or above levels that provide fishery sustainability.

b) Maximize economic yield from the fishery (average expected catch).

c) Maintain acceptable CPUE.

d) Catch stability.

e) Effort stability: effort variation relative to a reference period.

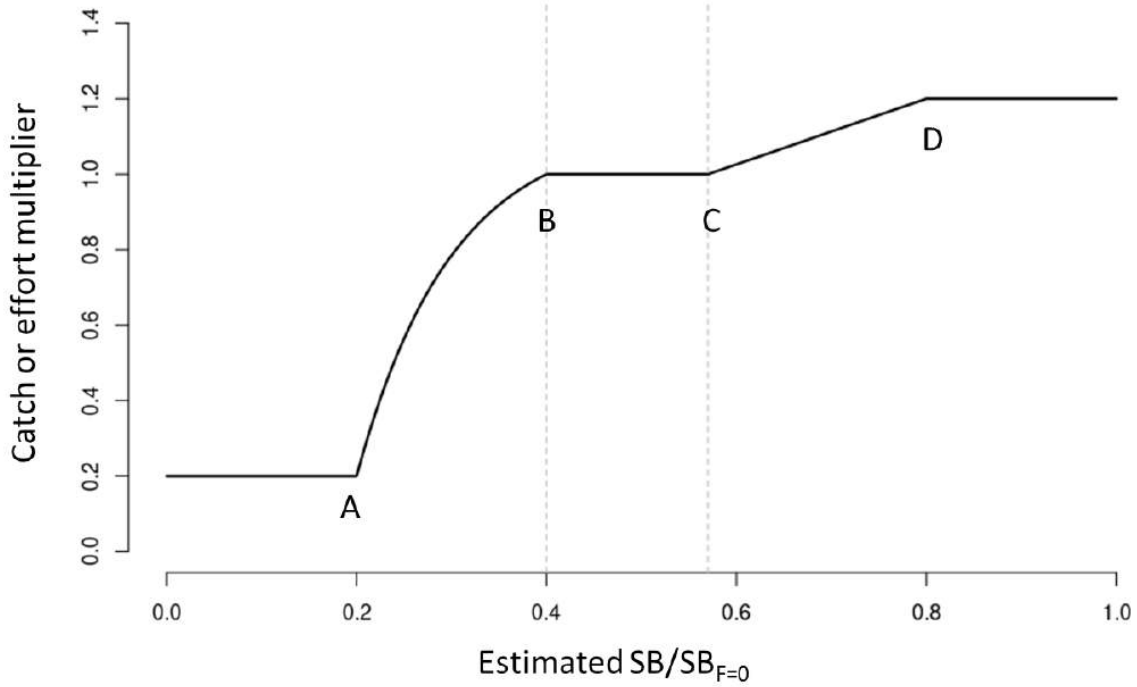
f) Proximity of SB/SBF=0 to the average SB/SBF=0 in 2018-21.

Atún barrilete en WCPFC
Skipjack tuna in WCPFC

Target reference point: calculated using two biomass depletion levels:
(a) the equilibrium SSB average depletion level over 2018-2021 and
(b) long-term equilibrium SSB that would be reached based on agreed baseline fishing effort.
The TRP is the average of both depletion levels, as medians from the stock assessment grid.

Limit reference point: 20 percent of the estimated recent (last 10 years) average spawning potential in the absence of fishing.

Atún barrilete en WCPFC - RCE
Skipjack tuna in WCPFC - HCR



Atún barrilete en WCPFC
Skipjack tuna in WCPFC

Exceptional circumstances:

Routine annual evaluation and detailed evaluation every 3 years with the stock assessment.
Exceptional circumstances include:

1) Persistent low recruitment outside the range for which the MP was tested;
2) Substantial improvements in knowledge on dynamics of the population which would have an appreciable effect on the operating models used to test the MP;
3) Non-availability of important input data resulting in an inability to run the MP;
4) Stock assessment biomass estimates substantially outside the range of simulated stock trajectories in the MP evaluations, calculated under the reference set of operating models;
5) significant increases in fisheries not affected by the MP impacting stock depletion;
6) Failure of reported catches/effort to be within range of the levels indicated by the MP; and
7) Persistent or strong negative outcome in indicators

Summary: EPO BET harvest strategy development

Type of strategy (proposed): Model-based (simple biomass dynamic model, age structured production model with recruitment deviates)
Management cycle (proposed): 1 or 3 years
Strategy inputs (proposed): total catch, Japanese longline index of relative abundance (CPUE)
Reference points: interim as defined in Resolution C-16-02 and its amendment C-23-06, also note staff proposed new proxy reference points for tropical tuna (SAC-15-05)

Operating models:
Based on 2024 BET stock assessment model grid (SAC-15-02, SAC-15-07). Main structural uncertainties of the BET MSE as alternative states of nature includes 36 models with different growth, selectivity for fisheries (asymptotic or all dome), steepness of the Beverton-Holt stock recruitment relationship (*h* values: 1.0, 0.9, 0.8), natural mortality and 3 rates of annual increase in longline catchability (0%, 1%, 2%).

Summary: EPO BET harvest strategy development

Management Objectives:

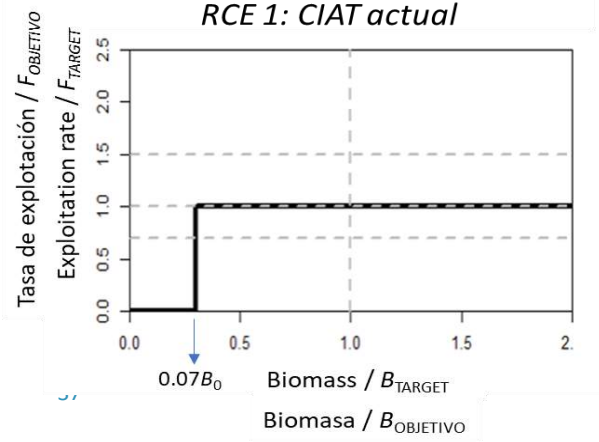
General objectives defined in IATTC's Antigua Convention *"(…) to ensure the long-term conservation and sustainable use of the fish and to maintain or restore the populations of harvested species at levels of abundance which can produce the maximum sustainable yield"*.

Proposed objectives resulting from stakeholder input and IATTC MSE workshops (SAC-15-07)

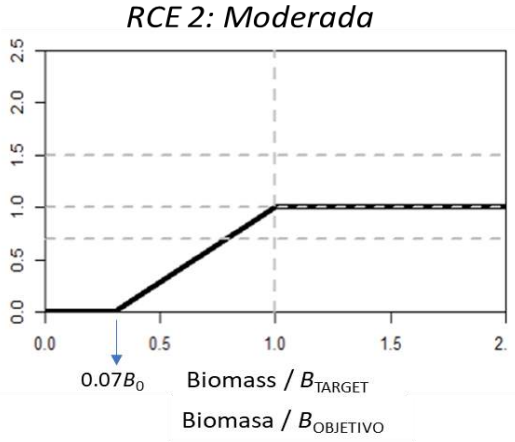
Performance Indicators: Not defined, alternatives from IATTC MSE workshops (SAC-15-07)

Harvest control rules:

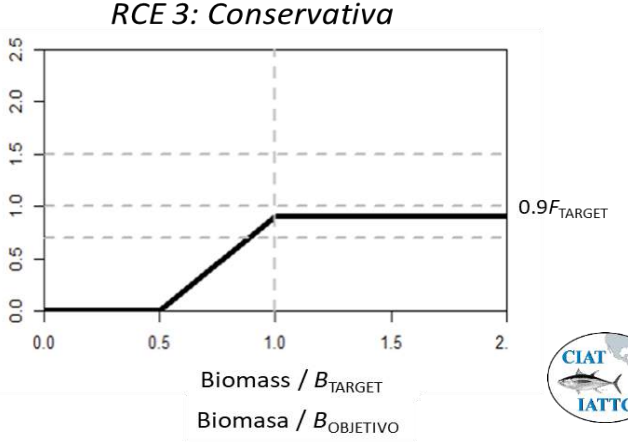
HCR 1: IATTC-like
RCE 1: CIAT actual



HCR 2: Moderate
RCE 2: Moderada



HCR 3: Conservative
RCE 3: Conservativa



Current approach: some uncertainties

- The recent risk analysis approach incorporates a range of stock assessment uncertainties into tropical tuna assessments.
- Risk assessments cannot always be completed given assessments may still be under development (SKJ) or undergoing major structural changes (YFT)
- Negotiations about management decisions creates management uncertainty. If objectives are not clear and the type of management measures are not stable over time, the decisions are not part of a proper, complete strategy.
- The need to decide by consensus* can create political/industrial uncertainty. No guarantee appropriate management will continue once a Resolution expires.

** Article IX of Antigua requires consensus. Just 1 of the 21 members that is not in agreement is enough to halt a decision.*

Relationship with Management Strategies

Harvest strategies (management strategies, management procedures) are the integrated combinations of **agreed** upon **data inputs**, **analyses** applied to that data and the **harvest control rule** used to determine **specific management actions** (e.g., catch quotas, length of fishing seasons) designed to achieve **management objectives**.

- In the IATTC context, data and analyses change as new research is conducted
- Management measures (e.g. closures) and other recommended management actions can change in their adoption (or not) or their implementation over time.
- Therefore, although there are elements of a Management Strategy in the IATTC, those elements could be defined and improved towards a more defined strategy, along with alternatives.

Current approach: Summary

Things that could be improved:

- Perception of stock can change rapidly: changes in methodology and data.
- Management inconsistencies could occur if objectives/data/rules/actions are not fully specified.
- Difficult to evaluate long term consequences of alternative decisions.
- Need to consider additional uncertainties, in addition to assessment uncertainty.
- Difficult to evaluate how alternative strategies achieve management objectives.
- By default, there is a tendency to a system of minimal management changes.
- The process can be contentious at times.
- Costly in the long-term: many assessments and many meetings.

Management Strategies

Current IATTC approach

- Current IATTC tropical tuna management advice depends on stock assessments
- Stock assessment can have problems:
  - Bigeye (2018) and yellowfin tunas (2019, 2024)
- The process is contentious and costly in the long-term: many assessments and many meetings.

Management Strategies

- IATTC adopted elements of a management strategy for tropical tunas
- Only general objectives adopted
- Complex management: several measures in addition to closures, not clear how to include this measures and alternatives in an MSE

Questions? / ¿Preguntas?