RISK ANALYSIS FOR MANAGEMENT OF THE TROPICAL TUNA FISHERY IN THE EPO, 2020

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Outline

- Background
  - Previous issues with the EPO tropical tuna assessments
  - Workplan to improve the tropical tuna assessments
  - Uncertainty
- Objectives of the risk analysis
- The staff's pragmatic approach
- Results of the risk analysis
  - Current stock status (YFT and BET)
  - Decision analysis for different durations of the temporal closure
- Conclusions

Issues with EPO tropical tuna stock assessments

- Management advice based on a “best assessment” approach
- *F* multiplier from the YFT and BET base case assessment models used to determine the duration of the seasonal closure
- 2018: BET assessment model not reliable enough to determine closure (SAC-09 INF-B)
  - Assessment overly sensitive to new data (mainly for the indices of abundance from the longline fishery)
  - Other issues
- 2019: Same conclusion extended to YFT assessment (SAC-10 INF-F)

2018-2020: Workplan to improve the stock assessments of tropical tuna

2017	
Collaboration with Japanese scientists on identifying targeting changes	Report, SAC-09
2018	
February: CAPAM workshop on the development of spatiotemporal models of fishery catch-per-unit-effort data to derive indices of relative abundance (Special Issue of Fisheries Research)	SAC-09-09
Developing a spatially structured stock assessment for bigeye tuna and other model improvements	Project I.1.a
October: CAPAM workshop on spatial stock assessment models focusing on bigeye tuna	Project X.1.a
2019	
January: Workshop to evaluate differences in bigeye tuna age estimation methods and resulting growth models utilized in current stock assessments by the IATTC and WCPFC	Project E.2.b
February: Workshop to improve the longline indices of abundance of bigeye and yellowfin tunas in the EPO	Project H.1.d
March: Independent review of bigeye assessment (report)	Project T.1.a
May: SAC-10, exploratory bigeye and yellowfin assessments	SAC-10 INF-G
Oct-Nov: Construct indices of abundance and composition data for longline fleets	Project H.1.e
Nov-Dec: Yellowfin tuna assessment independent review	Project T.1.b
2020	
May: Benchmark bigeye and yellowfin assessments	Report, SAC-11
July: New management recommendations to the Commission	IATTC annual meeting

- Both external reviews suggested a variety of alternative models rather than a replacement for base case
- Change from “best assessment” to a risk analysis approach which considers multiple models

Uncertainty

- There is uncertainty in stock assessments (e.g. parameter uncertainty, structural/model uncertainty, others)

- IATTC HCR for tropical tunas (Resolution C-16-02) addresses uncertainty through probability statements:
  - "if the probability that *F* will exceed the limit reference point (F_{LIMIT}) is greater than 10%, as soon as is practical management measures shall be established that have a probability of at least 50% of reducing *F* to the target level (F_{MSY}) or less, and a probability of less than 10% that *F* will exceed F_{LIMIT}."

- Two approaches ongoing which incorporate uncertainty (*Antigua Convention, Precautionary Approach*):
  - Management Strategy Evaluation (MSE): ongoing workplan at IATTC (2018-2023)
  - A new pragmatic risk analysis approach to evaluate the risk of exceeding RPs

Objectives of the risk analysis

- Current stock status: At current levels of *F*, estimate the probability (*P*) (risk) of exceeding *RPs* specified in Resolution C-16-02:
  a) $P(F>F_{MSY})$, $P(F>F_{LIMIT})$
  b) $P(S<S_{MSY})$, $P(S<S_{LIMIT})$

- Decision analysis: Under alternative durations of the purse-seine closure, estimate the probability of exceeding the RPs:
  a) $P[F(\text{closure days})> F_{MSY}]$, $P[F(\text{closure days})>F_{LIMIT}]$
  b) $P[S(\text{closure days})< S_{MSY}]$, $P[S(\text{closure days})<S_{LIMIT}]$

The staff's pragmatic risk analysis approach

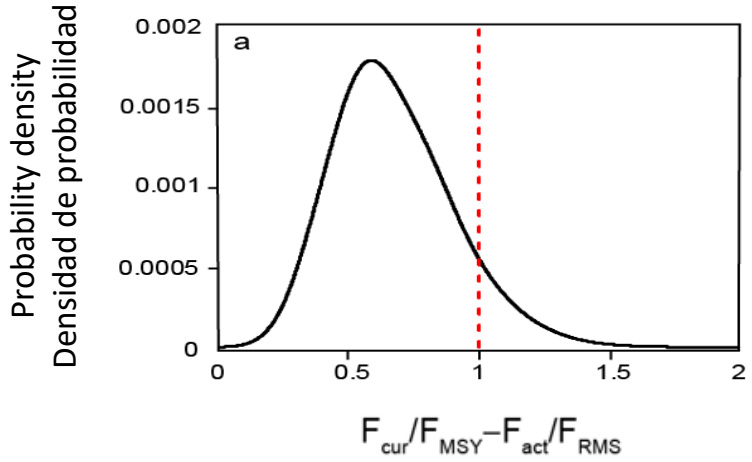
Described in Maunder et al. 2020 (SAC-11 INF-F):

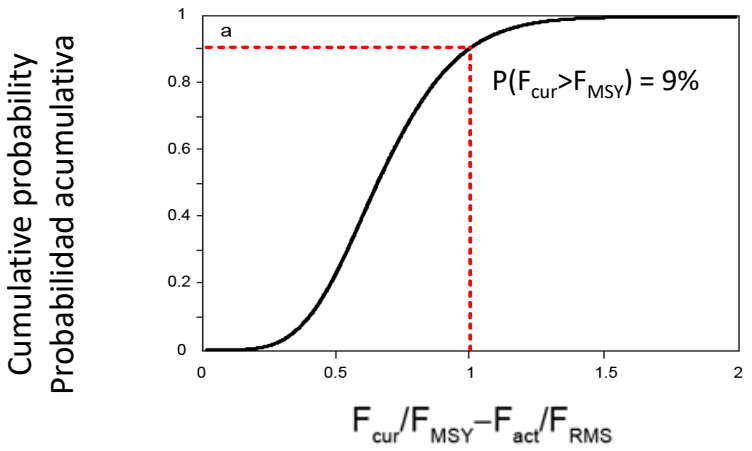
1. **Identify alternative hypotheses** ('*states of nature*') about the population dynamics of the stock that address the main issues in the assessments
   - **YFT**: SAC-11-J; **BET**: SAC-11 INF-F
2. **Implement stock assessment models representing alternative hypotheses**
   - **YFT**: SAC-11-07; **BET**: SAC-11-06
3. **Assign relative weights to each hypothesis (model)**
   - **YFT:** SAC-11 INF-J; **BET**: SAC-11 INF-F
4. **Compute combined probability distributions for management quantities using model relative weights**
   - **YFT** and **BET:** SAC-11-08

YFT CURRENT STOCK STATUS

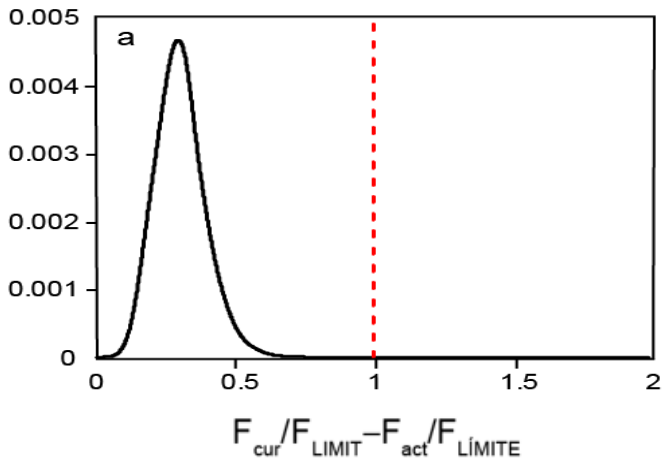
YFT: F_{cur} probability distributions relative to RPs

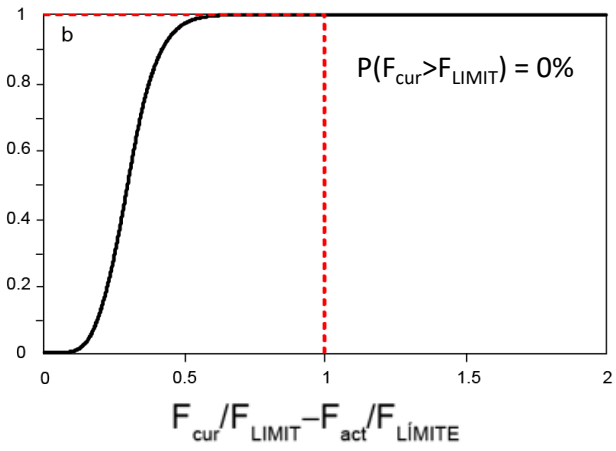
TARGET/OBJETIVO





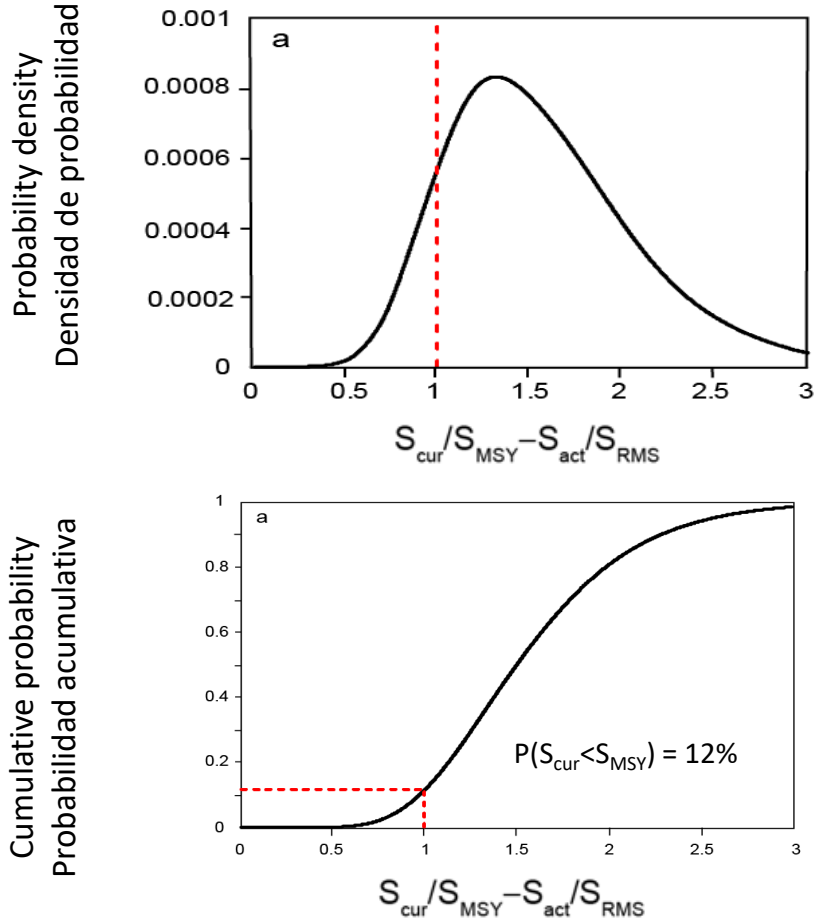
LIMIT/LÍMITE



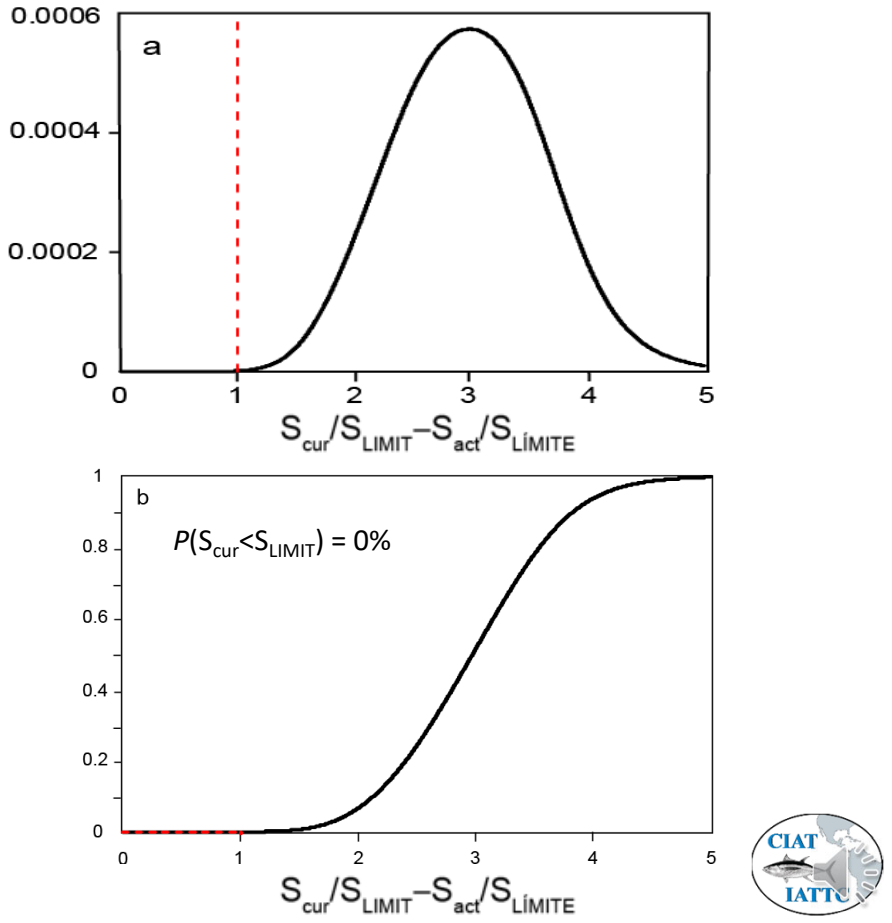


YFT: S_{cur} probability distributions relative to RPs

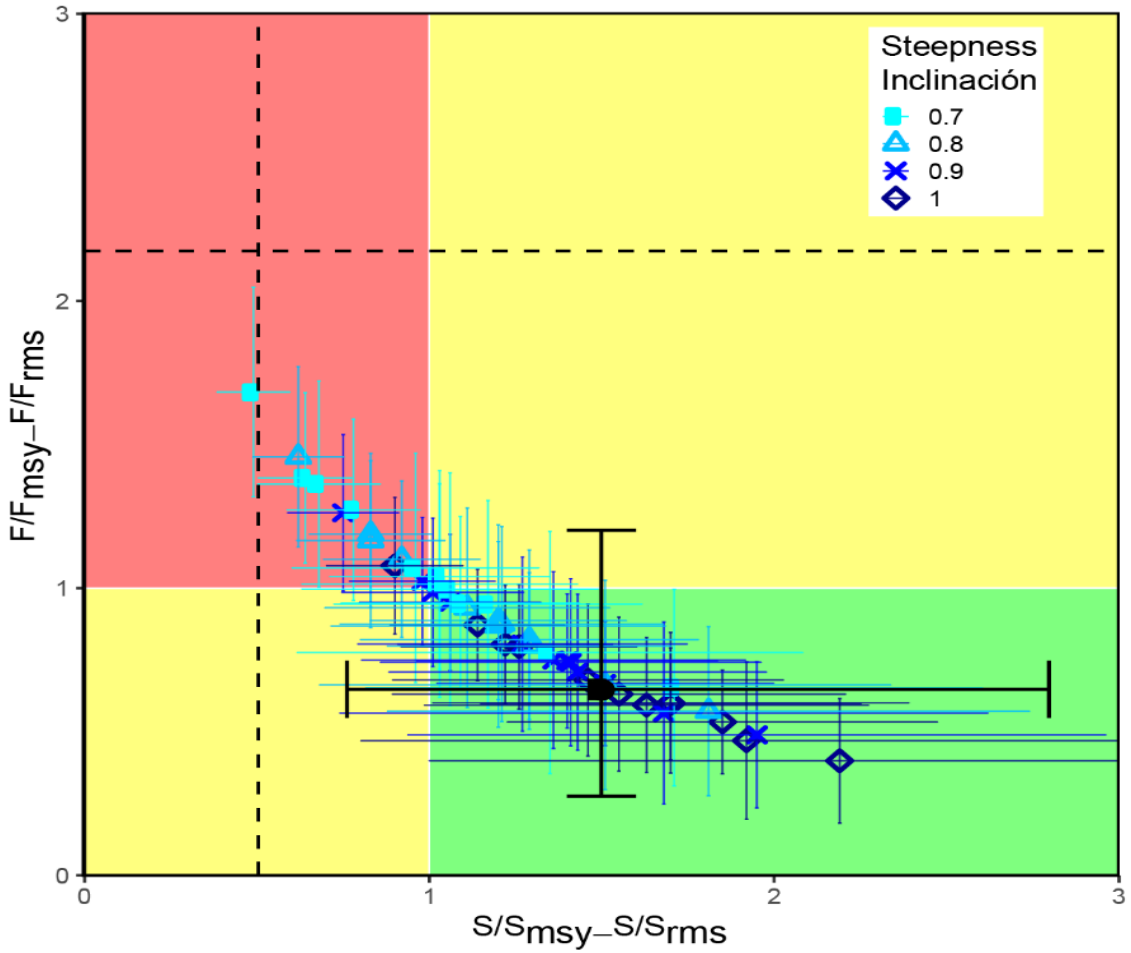
TARGET/OBJETIVO



LIMIT/LÍMITE

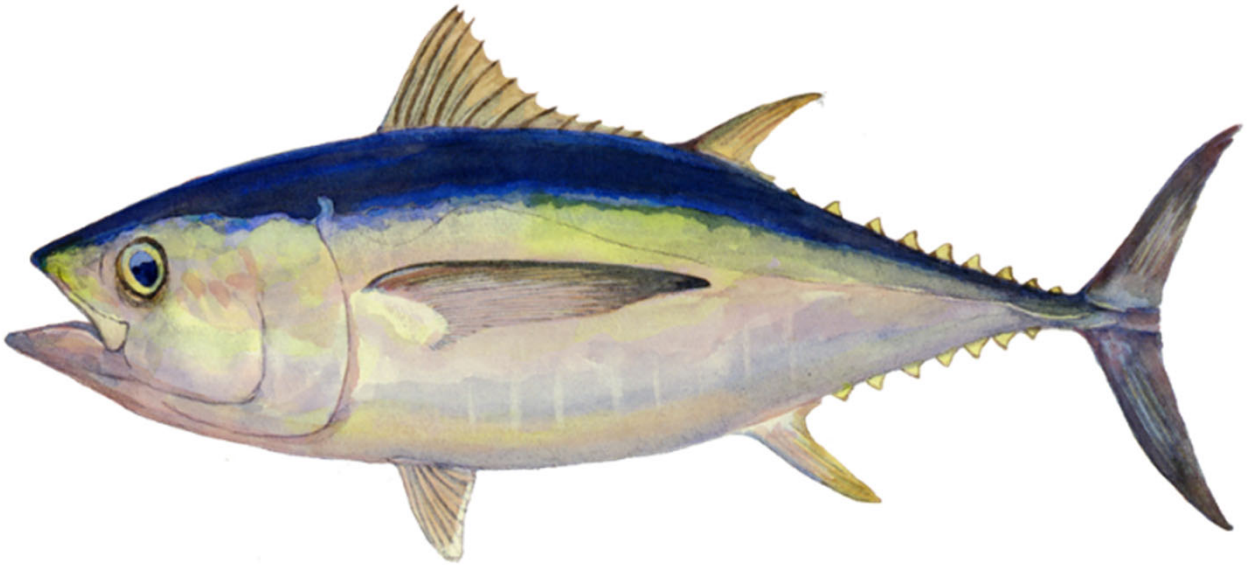


YFT: Current stock status (Kobe plot)



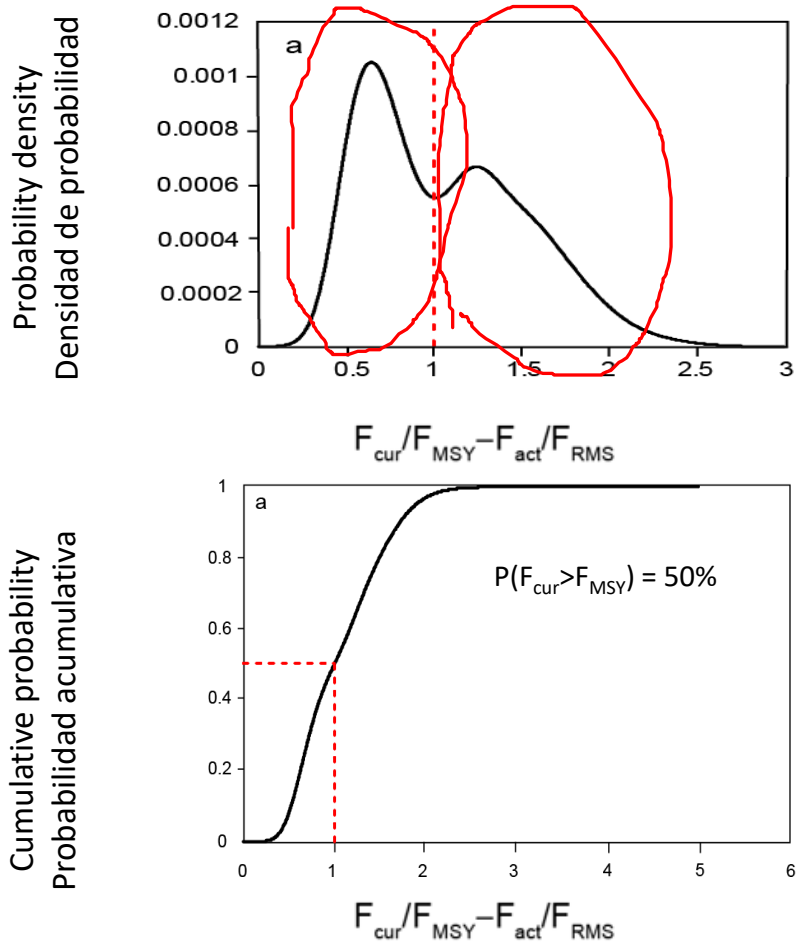
- TARGETS
  - Only 9% probability that F_{MSY} has been exceeded: $P(F_{cur}>F_{MSY}) = 9\%$
  - Only 12% probability that S_{cur} is below S_{MSY} : $P(S_{cur}<S_{MSY}) = 12\%$
- LIMITS
  - There is zero probability that either *S* and *F* limit reference points have been exceeded: $P(S_{cur}<S_{LIMIT}) = 0\%$; $P(F_{cur}>F_{LIMIT}) = 0\%$

BET CURRENT STOCK STATUS

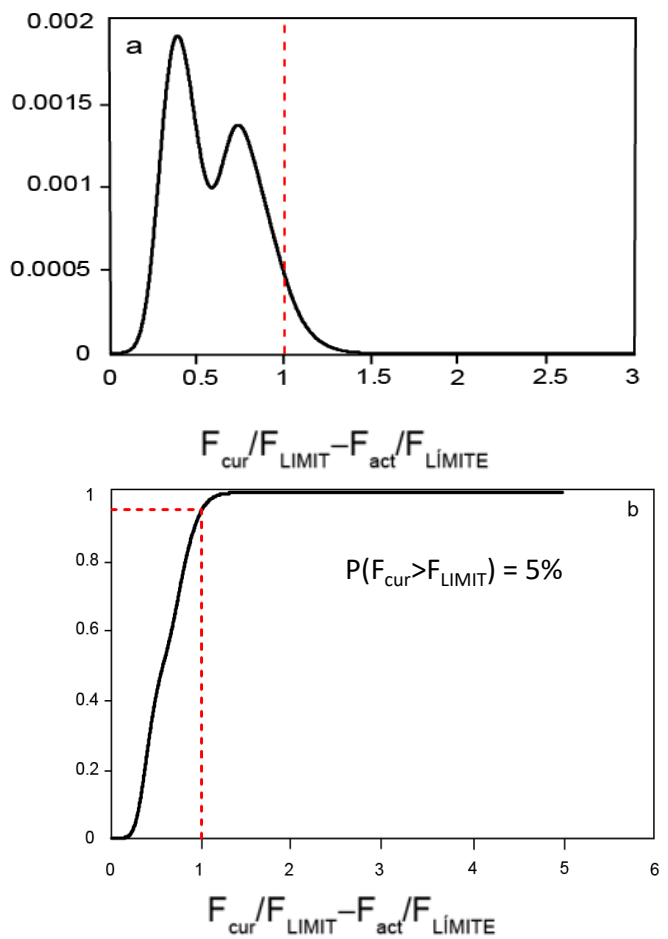


BET: F_{cur} probability distributions relative to RPs

TARGET/OBJETIVO

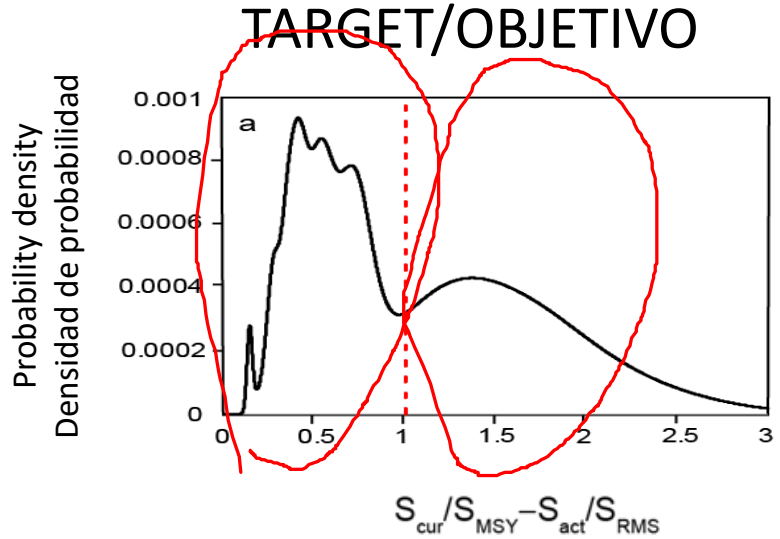


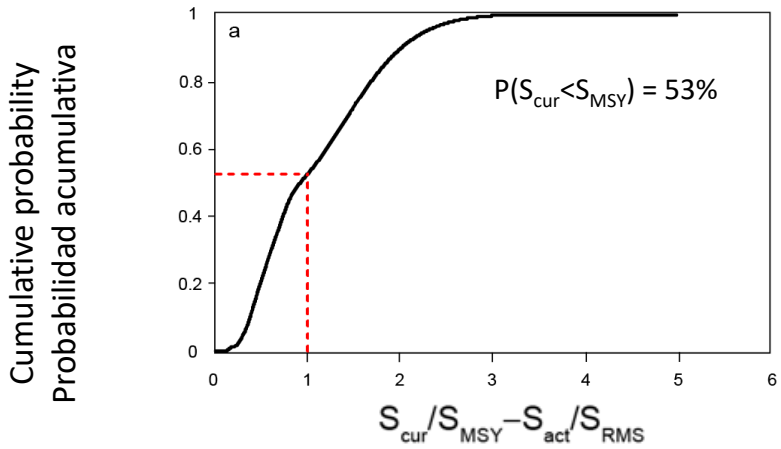
LIMIT/LÍMITE



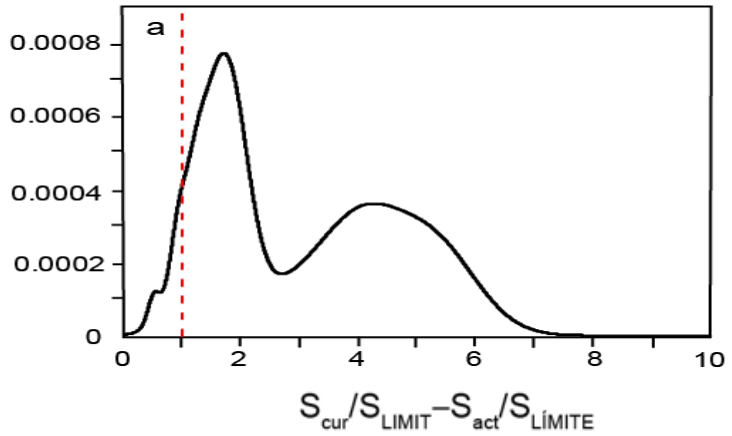
BET: S_{cur} probability distributions relative to RPs

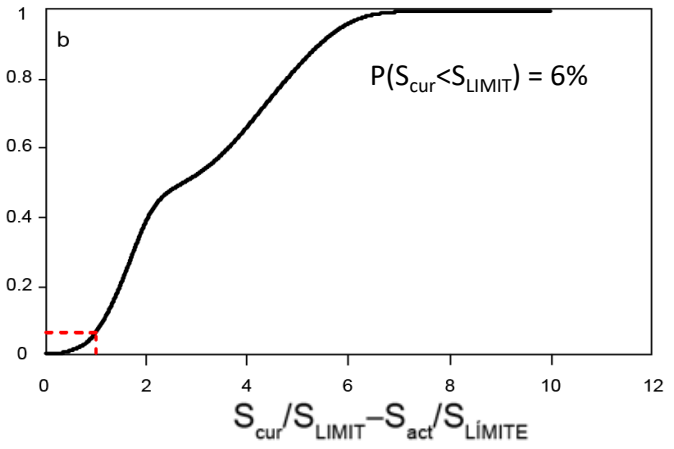
TARGET/OBJETIVO



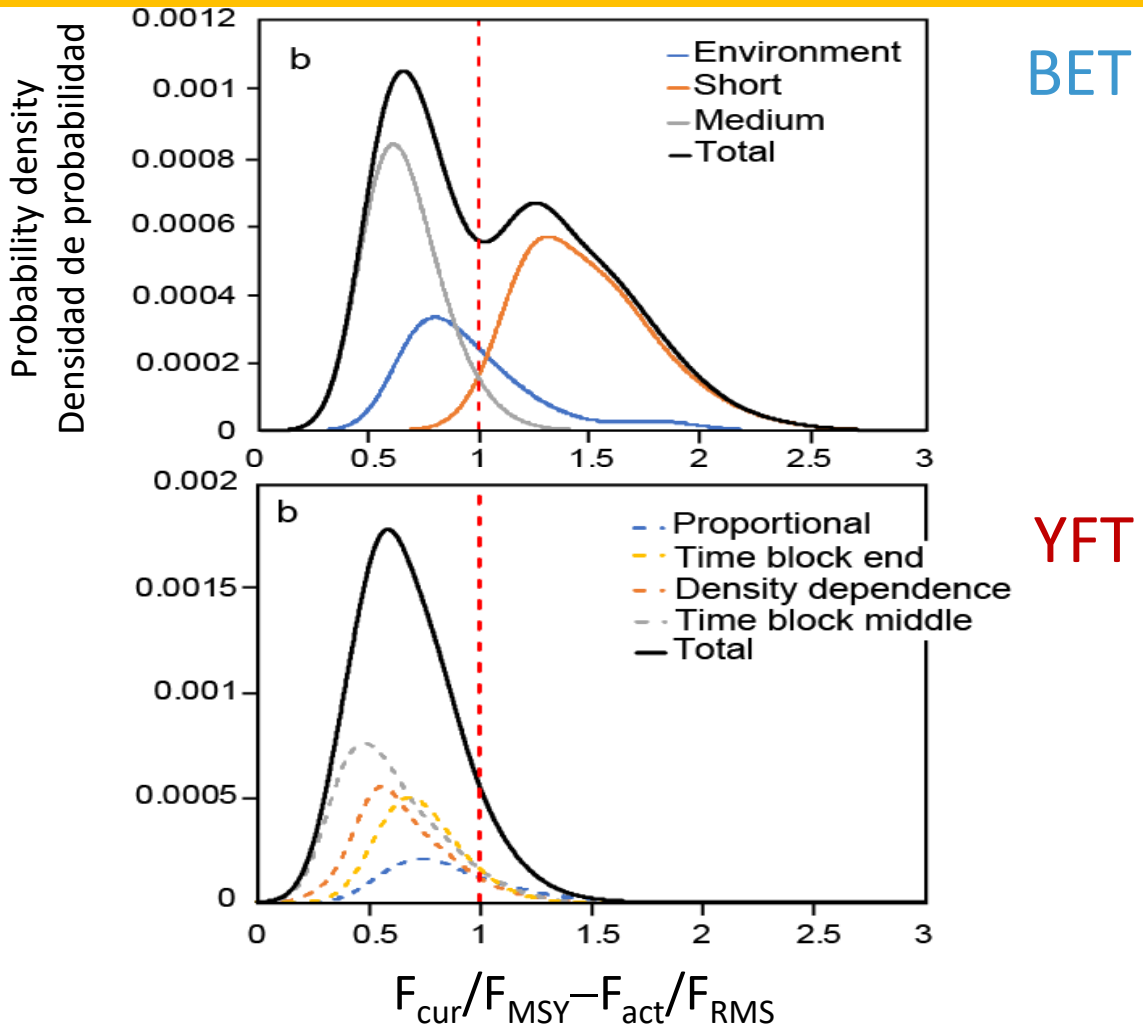


LIMIT/LÍMITE





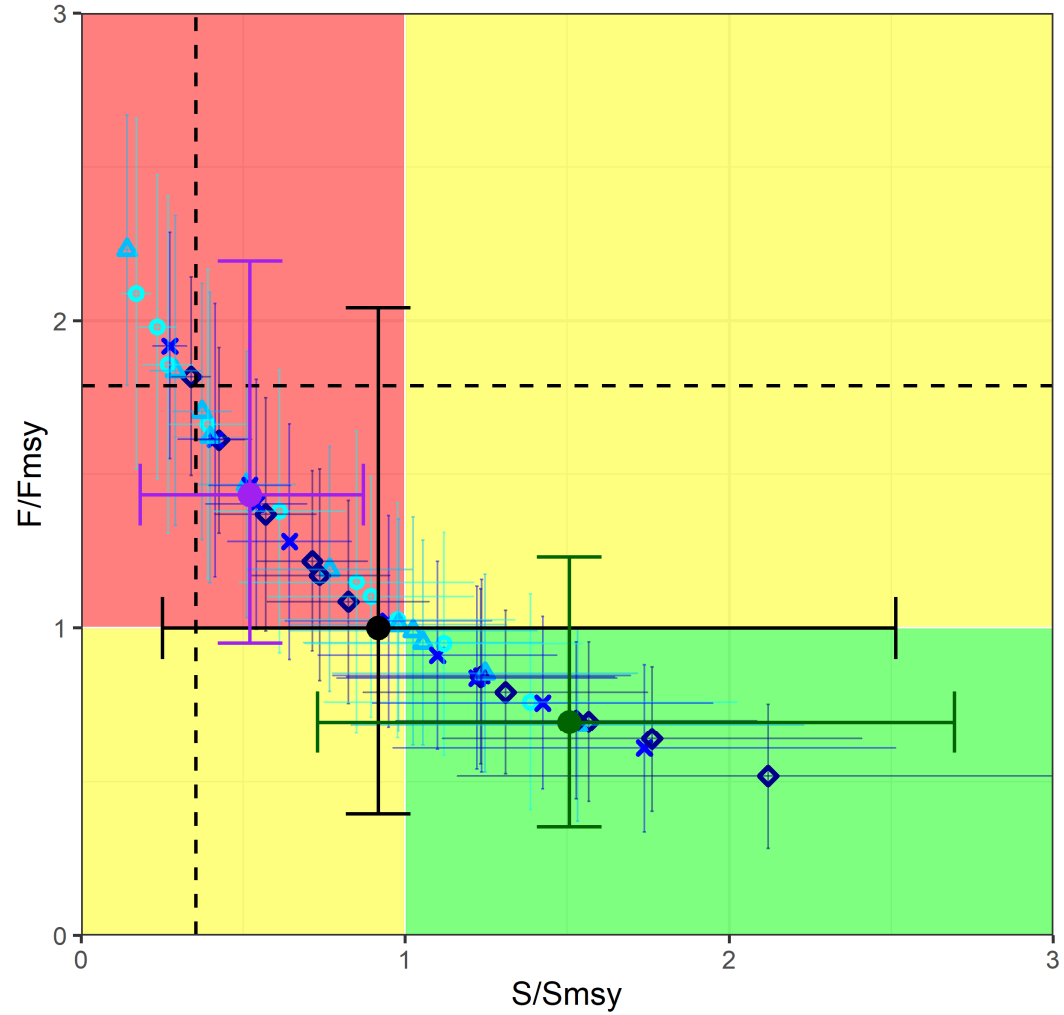
BET: Composition of F_{cur}/F_{MSY} prob. distribution



BET

YFT

BET: Current stock status (Kobe plot)



- TARGETS
  - 50% probability that F_{MSY} has been exceeded: $P(F_{cur}>F_{MSY}) = 50\%$
  - 53% probability that S_{cur} is below S_{MSY}: $P(S_{cur}<S_{MSY}) = 53\%$
- LIMITS
  - There probability that either *S* and *F* limit reference points have been exceeded is not negligible: $P(S_{cur}<S_{LIMIT}) = 6\%$; $P(F_{cur}>F_{LIMIT}) = 5\%$

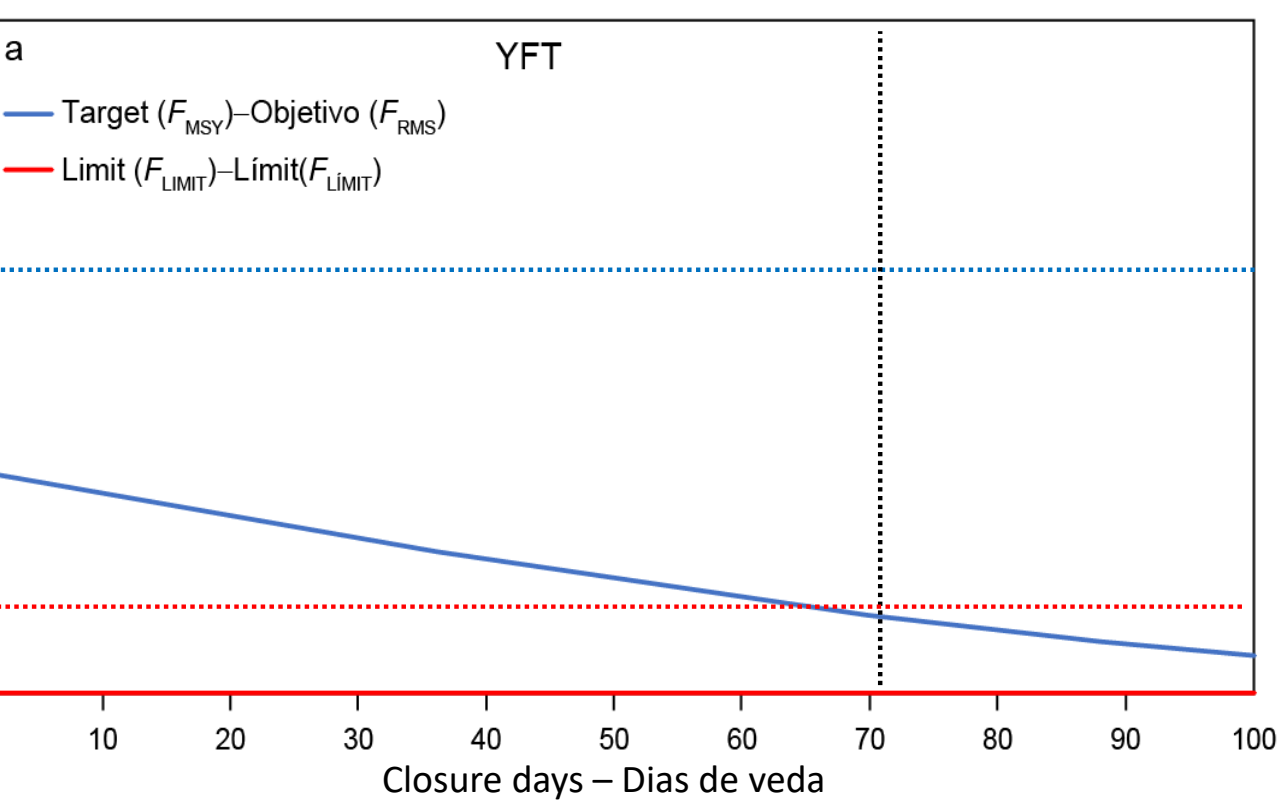
DECISION ANALYSIS

BET: Decision table

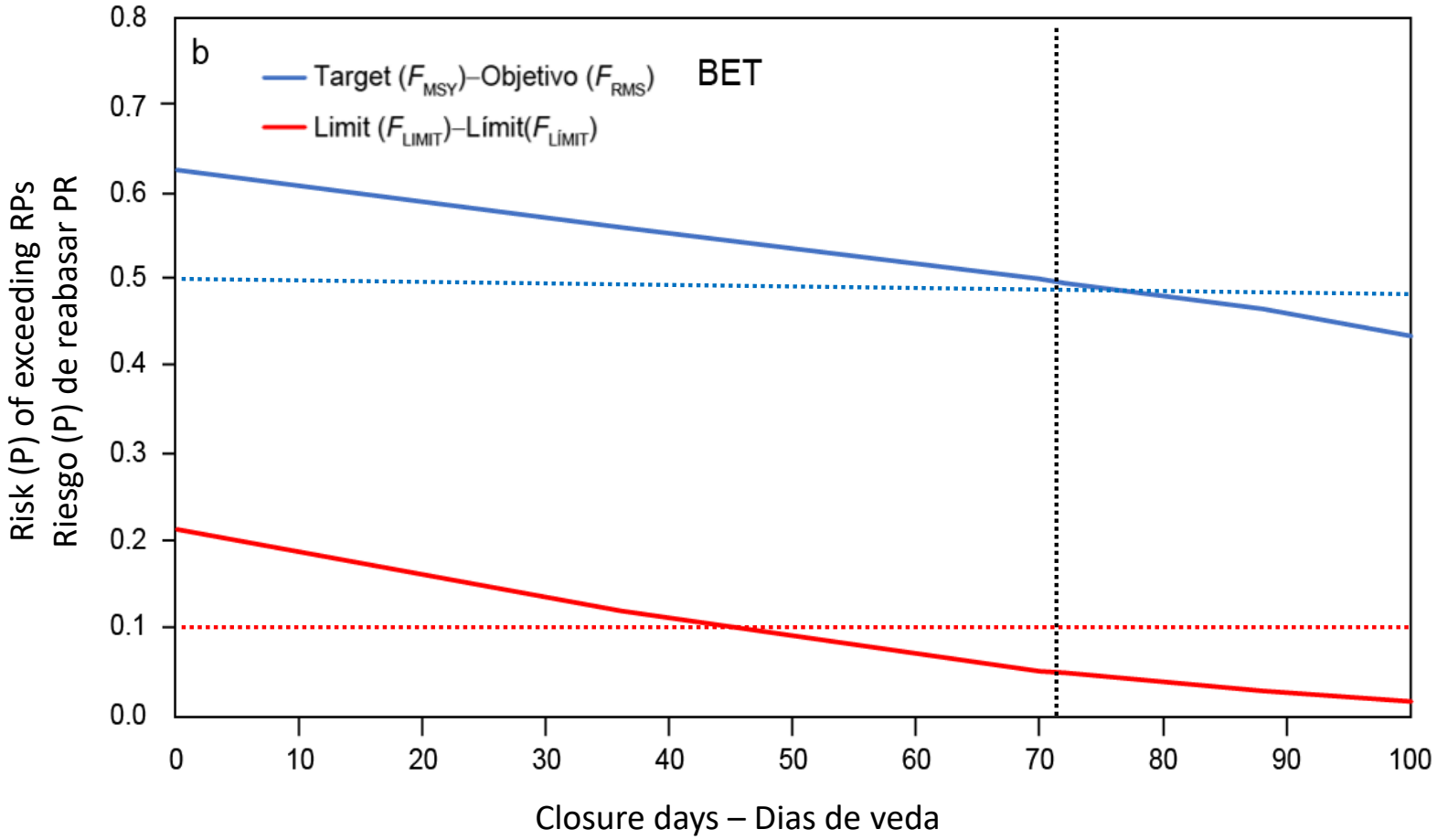
TABLE 4. *Decision table for bigeye tuna in the EPO.* See explanation of codes in Table BET.

Closure days	Env-Fix	Env-Gro	Env-Sel	Env-Mrt	Srt-Fix	Srt-Gro	Srt-Sel	Srt-Mrt	Mov	Gro	Sel	Mrt	Comb
P(model)	0.01	0.13	0.05	0.02	0.04	0.22	0.11	0.07	0.01	0.24	0.09	0.02	
$P(F>F_{MSY})$												Probability ≤50%	>50%
0	1.00	0.48	0.78	0.98	1.00	1.00	0.99	1.00	0.47	0.09	0.31	0.65	0.62
36	1.00	0.32	0.63	0.93	1.00	0.99	0.97	1.00	0.30	0.03	0.17	0.45	0.56
70	1.00	0.19	0.44	0.84	1.00	0.97	0.92	0.99	0.15	0.01	0.07	0.25	0.50
72	1.00	0.18	0.43	0.83	1.00	0.96	0.91	0.98	0.14	0.01	0.06	0.24	0.49
88	1.00	0.13	0.35	0.75	1.00	0.93	0.87	0.97	0.09	0.00	0.04	0.17	0.46
100	1.00	0.09	0.28	0.67	1.00	0.88	0.81	0.95	0.06	0.00	0.02	0.11	0.43
$P(F>F_{LIMIT})$												Probability ≤10%	>10%
0	0.97	0.00	0.04	0.17	0.89	0.39	0.37	0.57	0.00	0.00	0.00	0.00	0.21
36	0.79	0.00	0.01	0.06	0.67	0.19	0.18	0.33	0.00	0.00	0.00	0.00	0.12
70	0.33	0.00	0.00	0.01	0.38	0.07	0.06	0.14	0.00	0.00	0.00	0.00	0.05
72	0.30	0.00	0.00	0.01	0.36	0.06	0.06	0.13	0.00	0.00	0.00	0.00	0.05
88	0.11	0.00	0.00	0.00	0.25	0.03	0.03	0.08	0.00	0.00	0.00	0.00	0.03
100	0.04	0.00	0.00	0.00	0.17	0.02	0.02	0.04	0.00	0.00	0.00	0.00	0.02

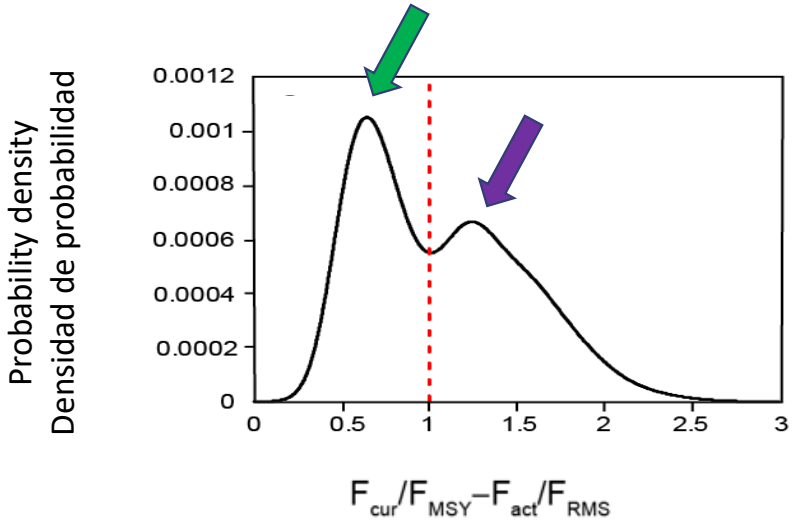
YFT: Risk curves for exceeding RPs

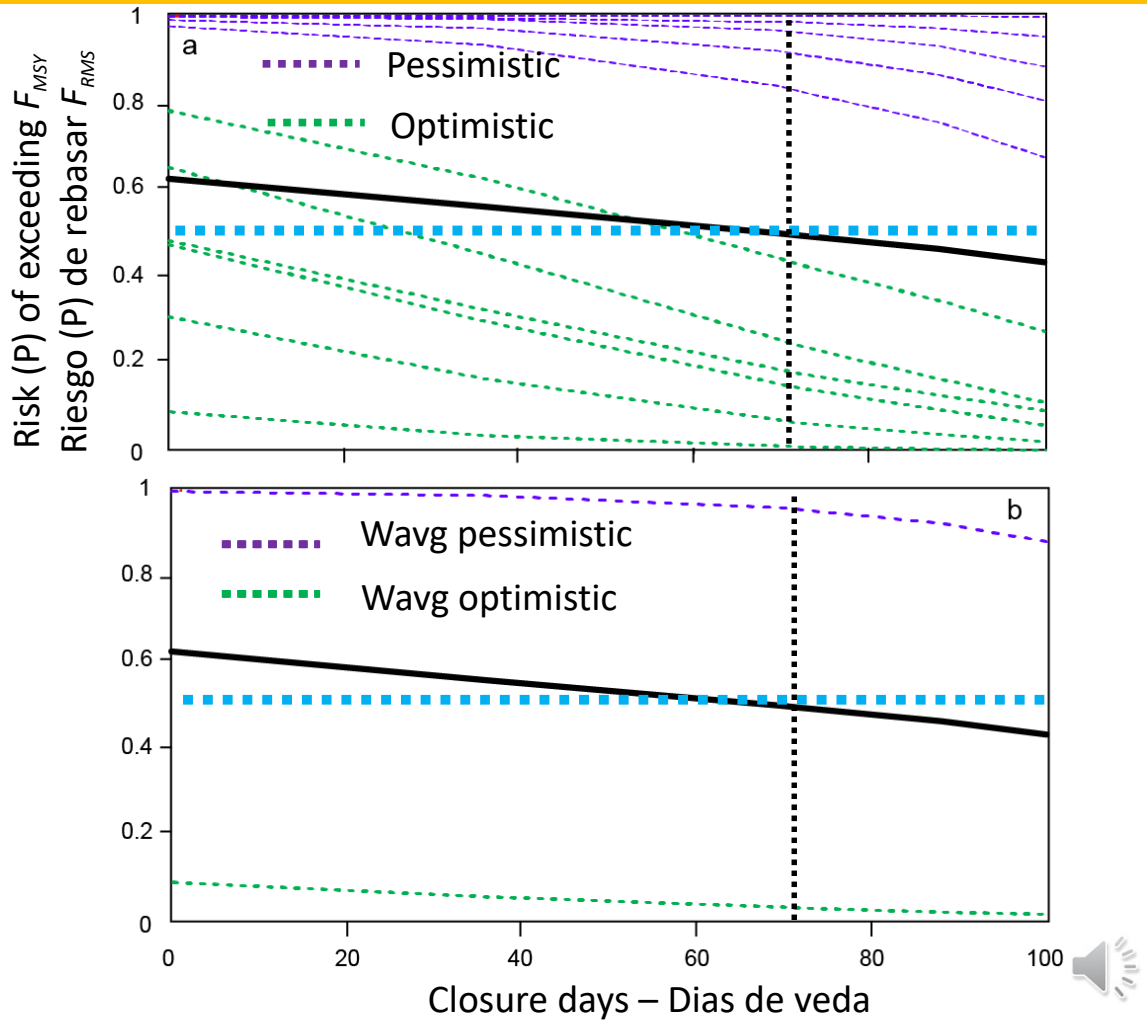


BET: Risk curves for exceeding RPs

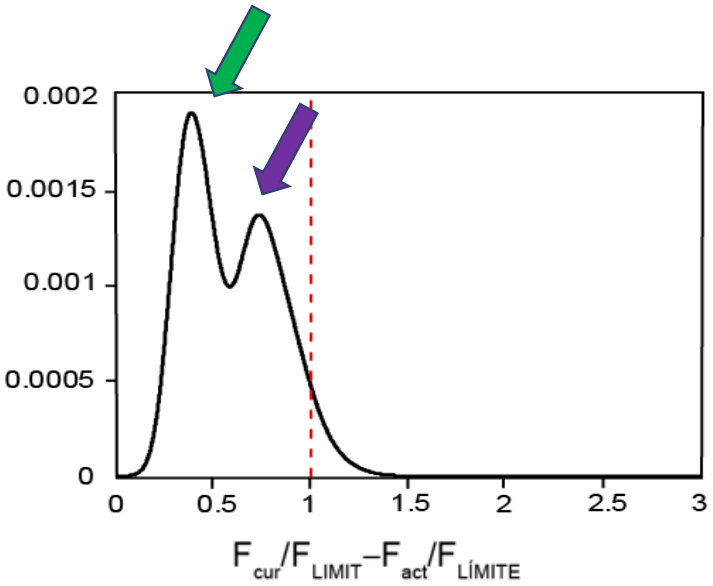


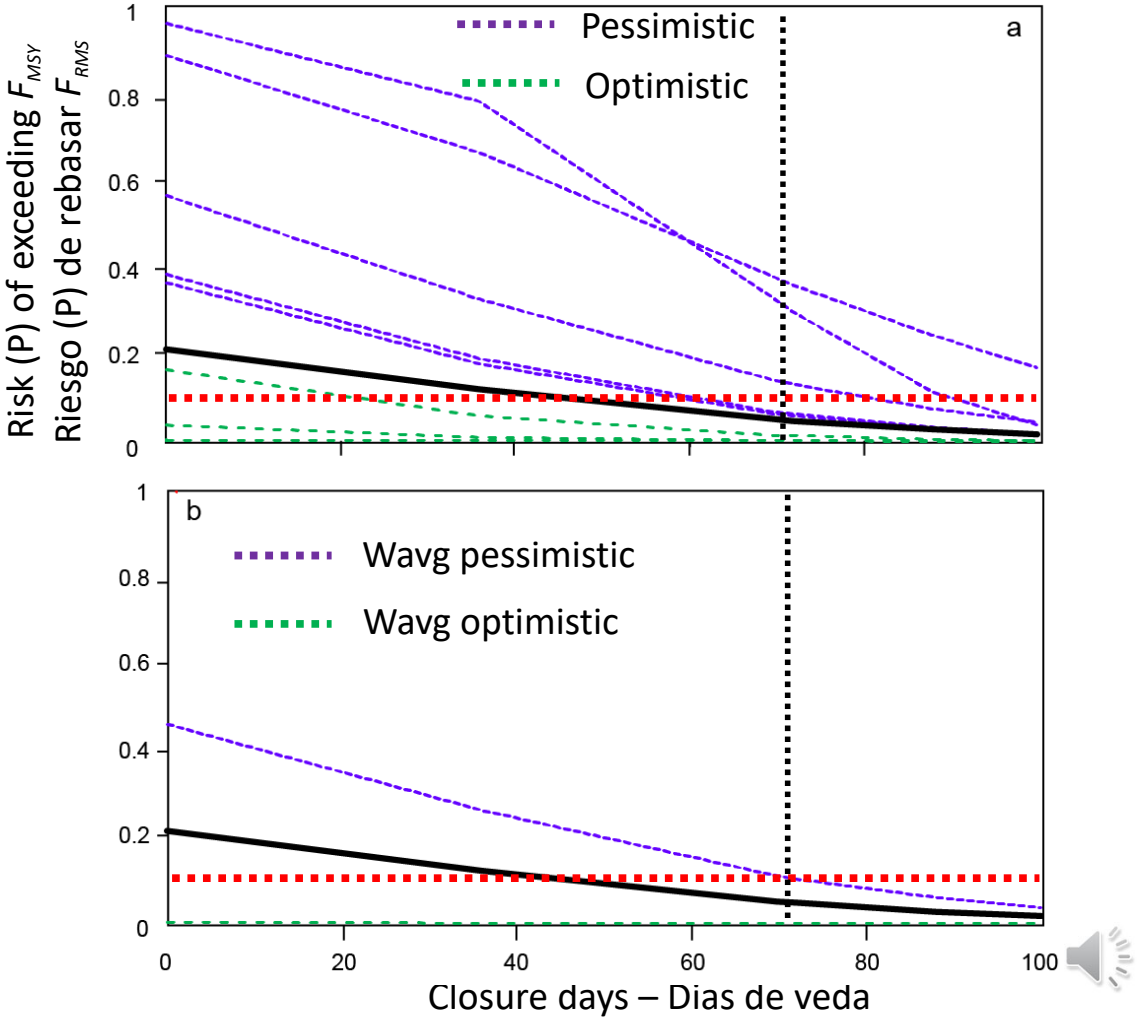
BET: Risk curves for exceeding F_{MSY}





BET: Risk curves for exceeding F_{LIMIT}





Conclusions: general

- The transition from the “best assessment approach” to risk analysis incorporating uncertainty significantly advances science and the formulation of management advice for tropical tuna at IATTC:

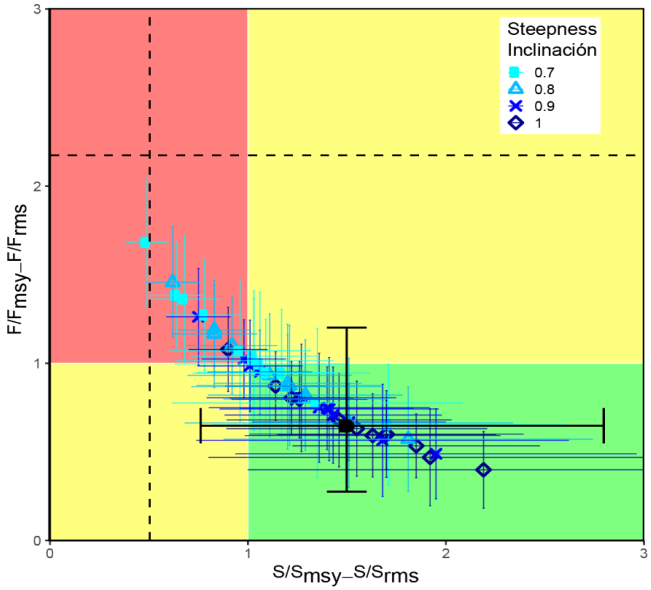
    1. The process resulted in the identification of a set of reference models (alternative *states of nature*)

    2. The approach provides a methodology for assigning relative weights to the plausibility of these alternative hypotheses

    3. The final product are probability statements for exceeding the reference points established in the HCR

Conclusions: YFT

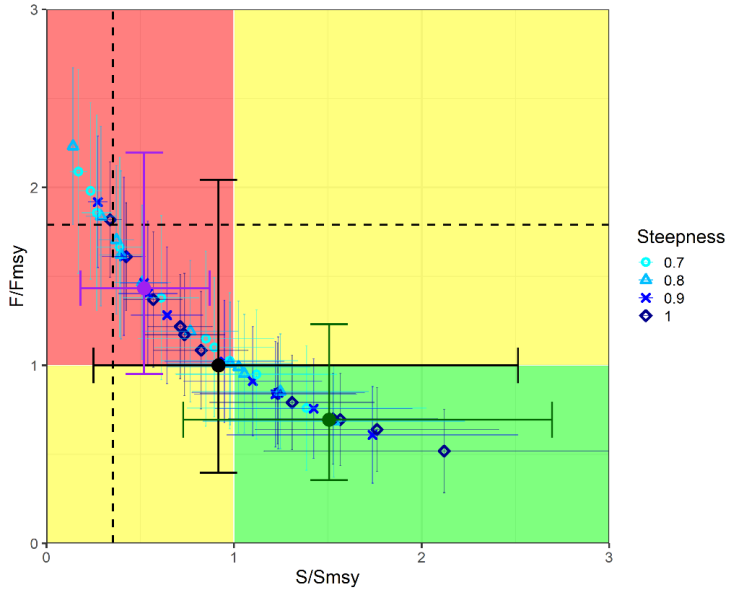
- The risk analysis ambiguously shows that the YFT stock is healthy
  - Targets: $P(F_{cur}>F_{MSY}) = 9\%$, $P(S_{cur}<S_{MSY}) = 12\%$
  - Limits: $P(F_{cur}>F_{LIMIT}) = 0\%$; $P(S_{cur}<S_{LIMIT}) = 0\%$

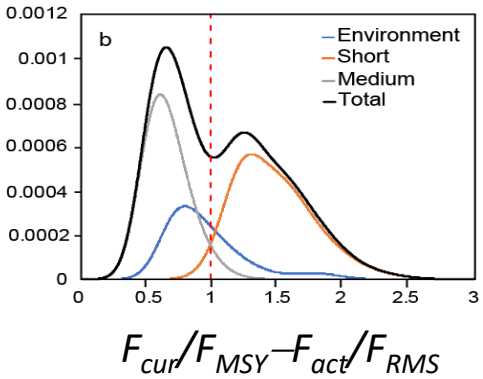


Conclusions: BET

- The risk analysis results are less clear for BET:
  - Targets: $P(F_{cur}>F_{MSY}) = 50\%$, $P(S_{cur}<S_{MSY}) = 53\%$
  - Limits: $P(F_{cur}>F_{LIMIT}) = 5\%$; $P(S_{cur}<S_{LIMIT}) = 6\%$

- The bimodal nature of the probability distributions indicates that the stock is either well below or well above the MSY levels
  - At this stage, the risk analysis for BET should not be used for optimal management





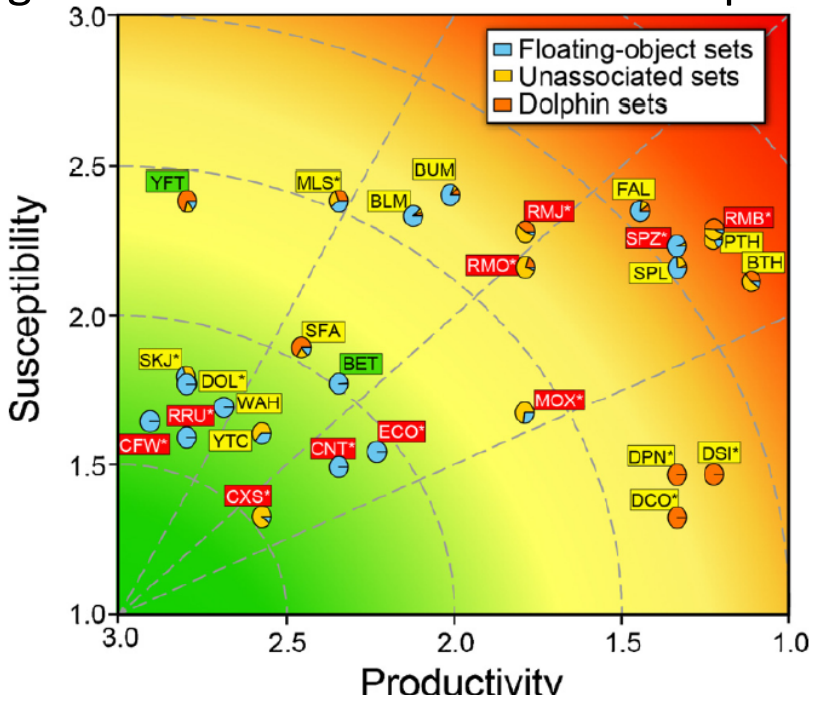
Conclusions: SKJ

- Traditional stock assessments have not been successful for SKJ
  - High productivity of the stock
  - Strong recruitment fluctuations which are strongly dependent on environment
  - Tagging program ongoing

- SKJ stock status indicators are produced on a yearly basis
  - Long-term trends in catch, catch per set and average size indicate increased *F* for SKJ
  - Are these rates sustainable?

Conclusions: SKJ (cont.)

- PSA rationale
  - SKJ and BET have similar susceptibility
  - SKJ more productive than BET
  - Adequate management measures for BET should protect SKJ



Staff's recommendations: rationale

- IATTC HCR for tropical tunas (Resolution C-16-02) addresses uncertainty through probability statements:
  - "if the probability that *F* will exceed the limit reference point (F_{LIMIT}) is greater than 10%, as soon as is practical management measures shall be established that have a probability of at least 50% of reducing *F* to the target level (F_{MSY}) or less, and a probability of less than 10% that *F* will exceed F_{LIMIT}."
- Based on precautionary grounds, the staff takes the risk analysis results of the BET pessimistic models for management advice:
  - $P(F_{cur}>F_{MSY}) = 95\%$; $P(F_{cur}>F_{LIMIT}) = 10\%$
- A status quo harvest strategy (72 day closure) is appropriate in the short-term
  - Since the probability that *F* will exceed the F_{LIMIT} is 10%, the current closure is adequate as long as *F* is not increased

Future work

- Continue Management Strategy Evaluation (MSE) workplan (2018-2023):
  - The IATTC risk analysis calculate *P* of exceeding RPs and does not replace MSE process
  - MSE process should be completed to:
    - Further specify management objectives and performance metrics (dialogue)
    - Further specify elements of the current harvest strategy (dialogue)
    - Elicit alterative harvest strategies (dialogue)
    - Evaluate the current and alternative harvest strategies (technical)

- MSE Workplan (through 2023)
  - Recent MSE Workshops
  - Proposal to continue funding after 2020

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Questions