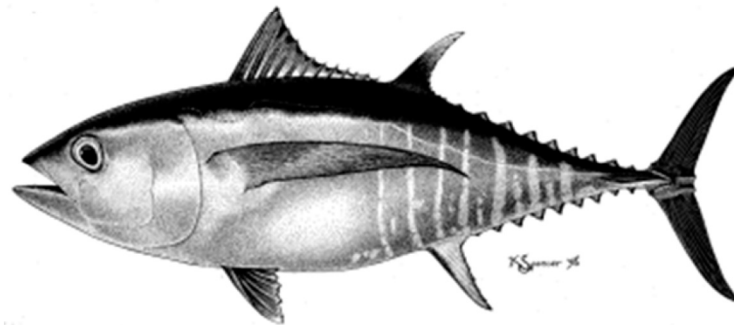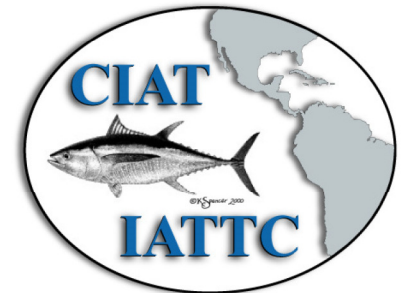# Simulation testing of reference points for bigeye tuna (*Thunnus obesus*) in the eastern Pacific Ocean

SAC-08-05e(iii)

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IATTC Reference Points

- IATTC adopted target (TRP) and limit (LRP) reference points in 2014.

- Target:
  - Biomass (B) and Fishing mortality rate (F) corresponding to maximum sustainable yield (B_{MSY} and F_{MSY})

- Limit:
  - Those associated with a 50% reduction in unfished recruitment ($50\%R_0$) using a conservative assumption of stock-recruitment relationship (steepness, or h = 0.75).

IATTC Limit Reference Point

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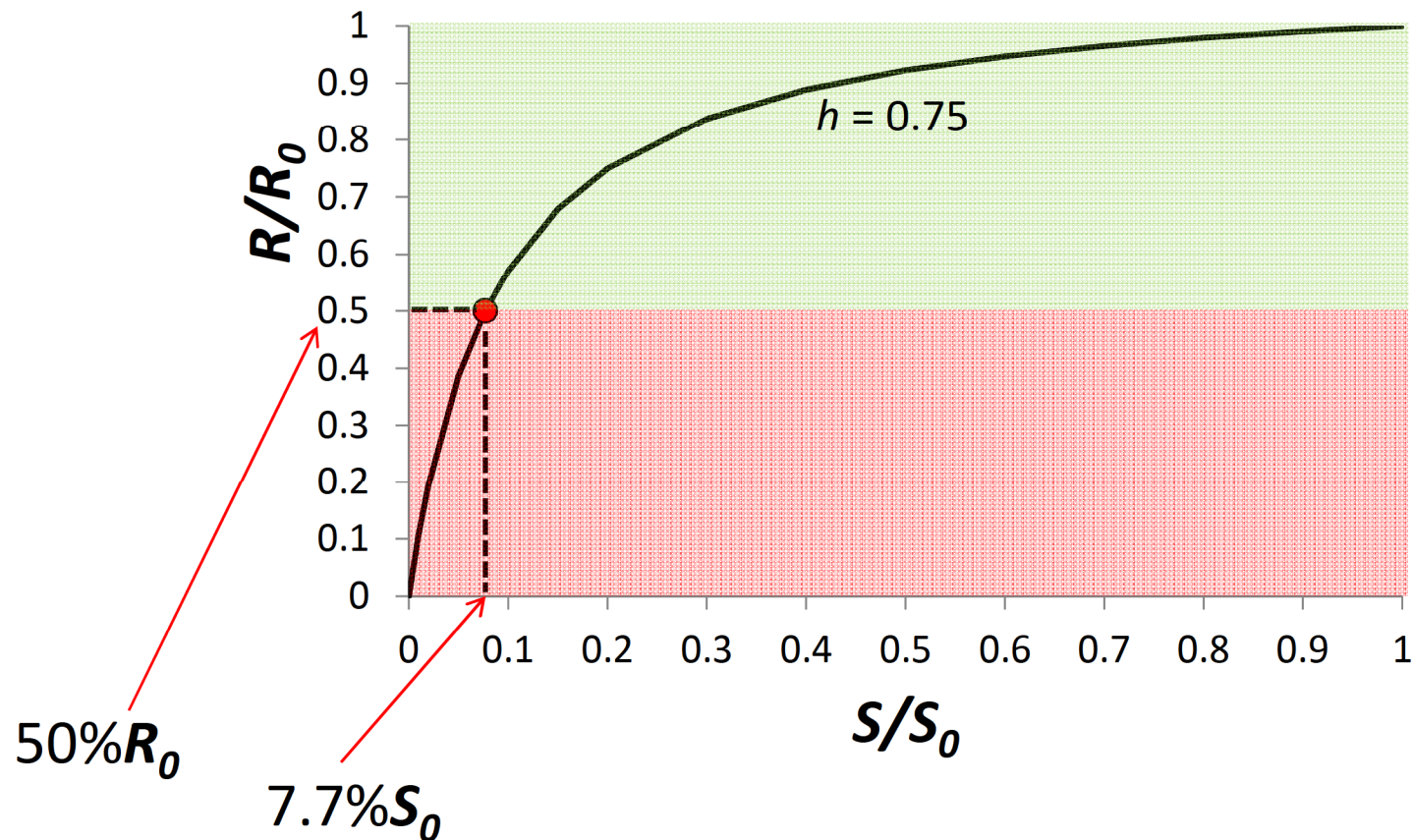
IATTC Harvest Control Rule

- The IATTC has operated under the unofficial HCR of fishing at $F_{MSY,}$ adjusting fishing days
- Preliminary evaluation by Maunder et al. (2015)

IATTC Harvest Control Rule

Resolution C-16-02 (IATTC, 2016)

- Prevent the fishing mortality rate (F) from exceeding (F_{MSY})

- If the probability that F will exceed the LRP ($F_{0.5R0}$) is greater than 10%, implement as soon as is practical management measures that have a probability of at least 50% of reducing F to the TRP (F_{MSY}) or less, and a probability of less than 10% that F will exceed the LRP($F_{0.5R0}$)

- If the probability that the spawning biomass (S) is below the LRP ($S_{0.5R0}$) is greater than 10%, implement as soon as is practical management measures that have a probability of at least 50% of restoring S to the TRP (dynamic S_{MSY}) or greater, and a probability of less than 10% that S will go below $S_{0.5R0}$ in 2 generation-times or 5 years, whichever is greater.

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Management Strategy Evaluation (MSE)

- Bigeye tuna chosen because it historically dictates management of the purse-seine fishery in the EPO (last two years it was YFT).
- Operating model (OM) based on 2015 bigeye tuna stock assessment
  - Uses Stock Synthesis
  - Conditioned to the historical data
  - Ignores several sources of uncertainty
- Estimation model (EM) used in the management procedure (MP)
  - Simplified from actual stock assessment
  - Assessed every 3 years
- 30 year projection period
- Uncertainty
  - MP is tested under different EM misspecification
- Performance measures
  - Probability of exceeding the LRPs, because this would require drastic management restrictions on catch
  - Catch
- Testing a simplified HCR
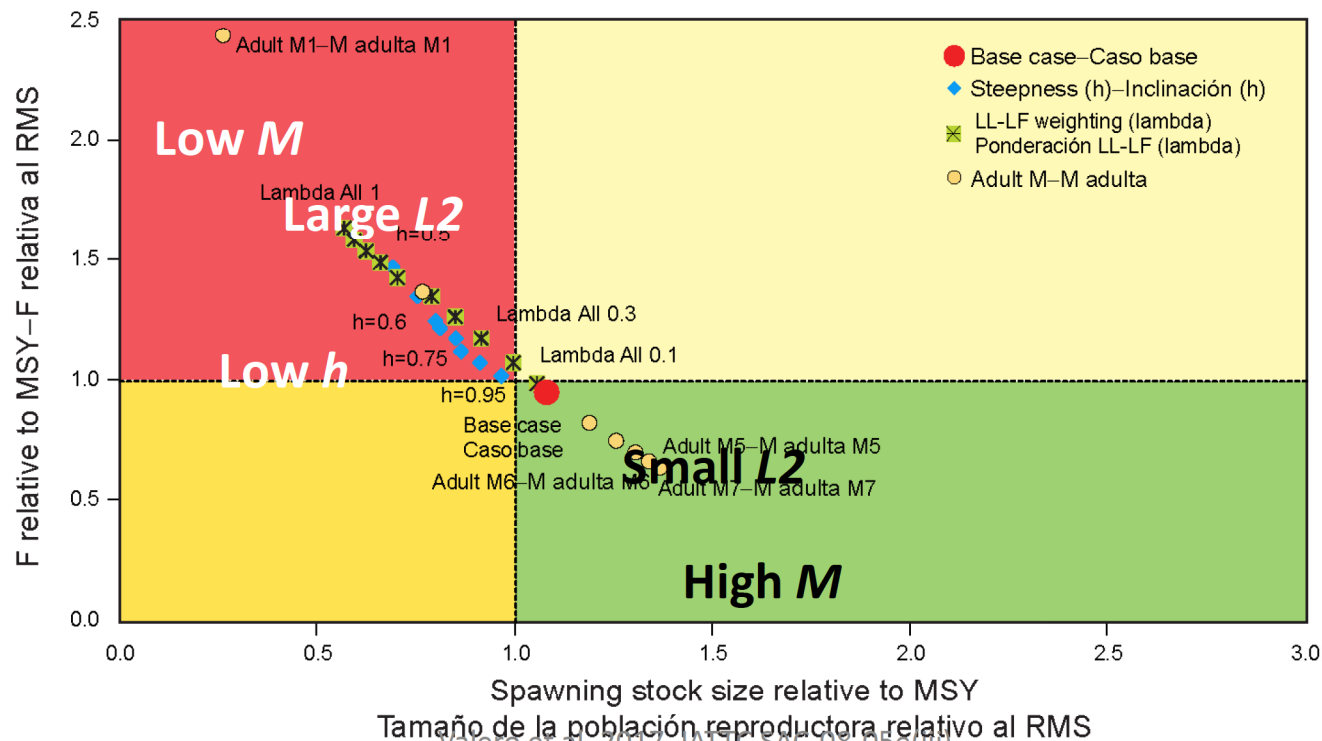
Management Strategy Evaluation (MSE)

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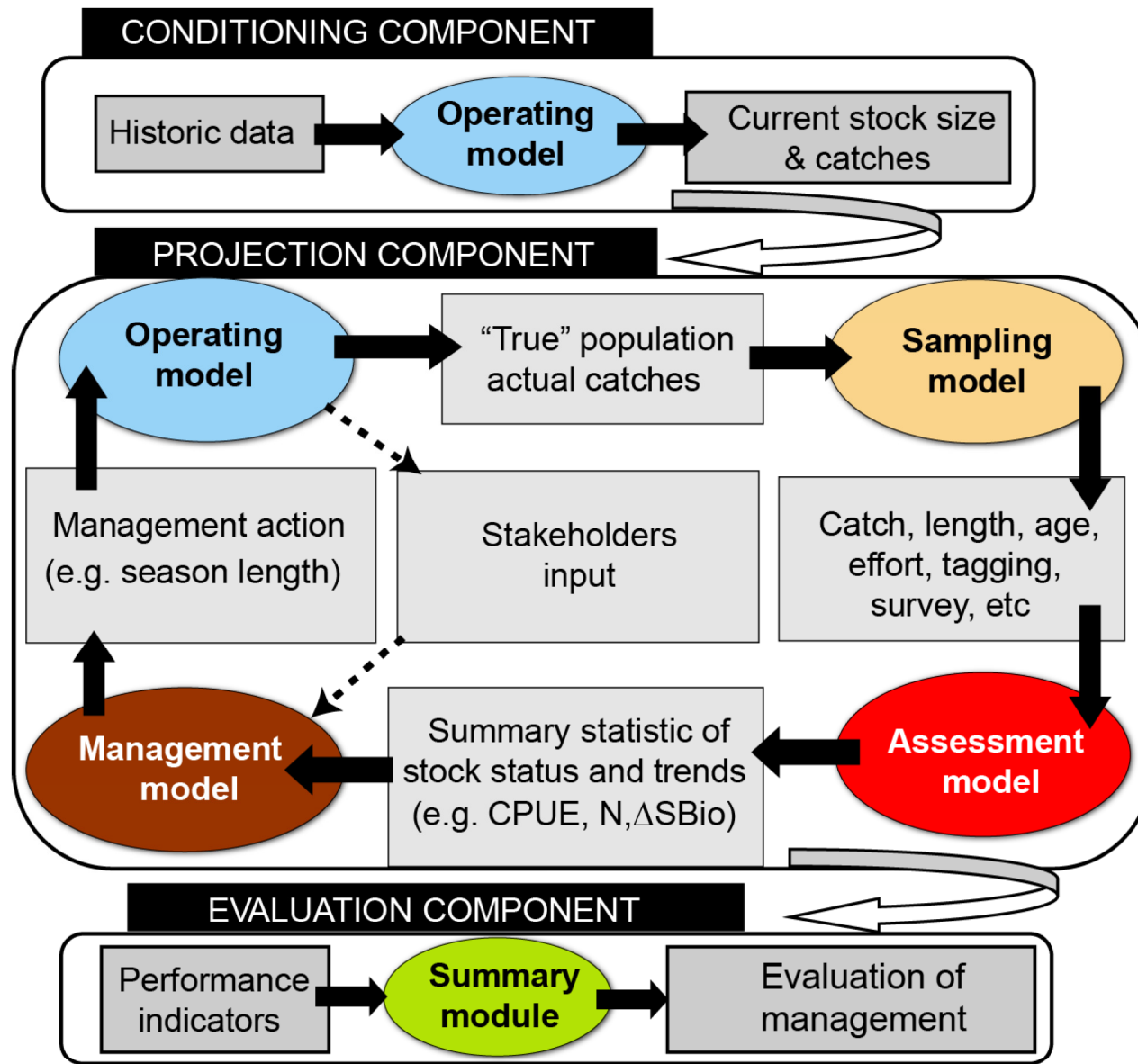
Key structural BET uncertainties

(Aires-da-Silva et al., 2017)

- Steepness of stock-recruitment relationship (h)
- Average size of the oldest fish (L_2) ⎫ Scenarios for
- Natural mortality levels (M) ⎬ MSE
⎭

- Weighting assigned to the size composition data

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Scenarios

Scenario	OM (Operating model)			EM (Estimation Model)		
	h	*M (age 0)*	*L2 (cm)*	*h*	*M (age 0)*	*L2 (cm)*
1	1	0.25	185.5	1	0.25	185.5
2	0.85	0.25	185.5			
3	0.75	0.25	185.5			
4	1	0.19	185.5			
5	1	0.31	185.5			
6	1	0.25	175.0			
7	1	0.25	195.0			

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Preliminary results

- The EM is positively biased, produces a more optimistic stock status than the OM
  - Both due to simplification of EM and recruitment dynamics
- The current LRP $0.5R_0$ is relatively insensitive to misspecifications of M or $L2$, but it is sensitive to h
- Need to conduct more analyses
- How frequently is LRP estimated to be exceeded & actually exceeded
- Will not know if we have exceeded the true limit

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Summary

- Management strategy evaluation for bigeye tuna is ongoing

- Preliminary results indicate the reference points and HCR appear to be reasonable, consistent with previous work (Maunder et al., 2015)

- Potential extensions to pacific wide BET, evaluation of alternative model approaches to resolve recruitment shifts

- Synergy with other projects, such as MSE for dorado, future possible MSE work for other stocks such as skipjack, yellowfin

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