

# Lesson Learned from the North Pacific Albacore Tuna MSE



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NOAA SWFSC and University of California Santa Cruz  
IATTC Tropical Tunas MSE Workshop, December 9 2022

# Why do a Management Strategy Evaluation for NPALB?

Because fishery managers wanted to:

- Evaluate candidate target reference points
- Associated harvest strategies
- And the MSE process is a good way to do so



From the NC13 reports...

71. NC13 recommends that the Commission adopt the attached revision to the title of previously adopted precautionary management framework for North Pacific albacore (**Attachment H**), so that it may be recognized as a harvest strategy. In addition, NC13 recommends that the Commission direct the Secretariat to make this harvest strategy available, as a stand-alone harvest strategy document, on a web page dedicated to this and other harvest strategies, including interim harvest strategies, agreed to by the Commission.

**Attachment H** (Interim Harvest Strategy for NPALB Fishery)

#### **4. Future work**

This framework may be periodically reviewed and revised. To support such revisions, **NC endorses the ongoing development and implementation of an MSE for the stock and fishery**, which would yield new information that would enhance the robustness of this framework.

NPALB:

(B) Implement the Interim Harvest Strategy, including: (1) monitor if LRP is breached; (2) **continue to work to establish TRP and other elements of harvest strategies, if appropriate based on MSE**; (3) recommend any changes to CMM 2005-03.

# Goal of North Pacific Albacore MSE

Examine performance of alternative harvest strategies and associated reference points for North Pacific albacore given uncertainty relative to the set of management objectives agreed-upon with stakeholders



# Key steps in developing an MSE

1. **Select management objectives**
2. Translate management objectives into quantitative performance metrics
3. Select uncertainties
4. Develop and condition operating models
5. **Identify candidate management strategies**
6. Simulation of the application of the management strategy
7. Present results
8. **Select a management strategy**

**Managers and stakeholders**

**Scientists**

# Key steps in developing an MSE

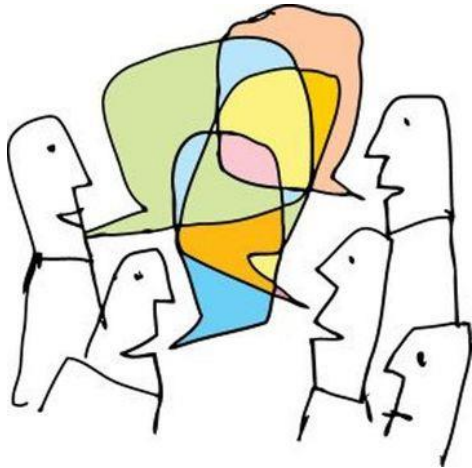
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# Iterative feedback

Management Objectives



Management Strategies

- Management objectives and management strategies agreed upon after 3 workshops
- New performance metrics and management strategies proposed after first set of results
- Continuous refinement of result summaries

Performance Metrics



Simulation Results



# Brief History of the ISC NPALB MSE

## 1<sup>st</sup> ISC MSE WS (16-17 April 2015) Yokohama, JAPAN

- ✓ **71 participants**
- ✓ **Purpose:** to review the objectives, benefits, and requirements to implement an MSE, as well as recent progress made by tuna RFMOs towards adopting and implementing the MSE process

\* ISC-ALBWG chair (Holmes, J.) gave a presentation on MSE for NPALB at the 11<sup>th</sup> Regular Session of the NC (31 Aug – 3 Sep 2015)



## 2<sup>nd</sup> ISC MSE WS (24-25 May 2016) Yokohama, JAPAN

- ✓ **24 participants**
- ✓ **Purpose:** to develop management objectives and performance indicators for those objectives based on input from managers stakeholders and scientists

\* Report on outcomes for the NPALB (attachment 5 of **ISC ALB WG Report: Annex8/ISC16 Plenary**)  
\* NC member's Response to: MSE Template: Information and Instructions (**WCPFC-NC12-2016/WP-01**)

## 3<sup>rd</sup> ISC MSE WS (17-19 Oct 2017) Vancouver, CANADA

- ✓ **23 participants**
- ✓ **Purpose:** (1) to review management objectives and performance metrics, (2) to identify acceptable level of risk for each objective to be used in evaluating performance of management strategies, (3) to develop a preliminary set of candidate reference points and harvest control rules for testing

All inputs to start initial set of runs,  
including how to allocate harvest  
between fleets

\* Report on outcomes for the NPALB (**attachment 3 of ISC ALB WG Report: Annex4/ISC18 Plenary**)  
\* Report of NPALB WG WS (**Annex13/ISCC18 Plenary**)

# Brief History of the ISC NPALB MSE



4<sup>th</sup> ISC MSE WS (5-7 Mar 2019)  
Yokohama, JAPAN

- ✓ 25 participants
- ✓ **Purpose:** to examine results of the initial round of the NPALB MSE; provide feedback on future improvements to the MSE; and develop recommendations for the WCPFC NC and IATTC

\* Report on 1st round of NPALB MSE (Annex 12/ISC19 Plenary)

\* Report of NPALB MSE WS (Attachment 5 in ALBWG WS report: Annex 6/ ISC19 Plenary)

\* Report on NPALB MSE (will be presented and reviewed at ISC21 Plenary)

5<sup>th</sup> ISC MSE WS (22-25 Mar 2021)  
Web Meeting

- ✓ ALBWG improved the MSE based on feedback from 4<sup>th</sup> MSE WS
- ✓ COVID-19 travel restrictions resulted in web meetings by country or region
- ✓ **Purpose:** (1) to help managers and stakeholders understand MSE results, and (2) to provide feedback to the ALBWG on improvements to presentation of MSE results

2021

IATTC SAC meeting

WCPFC-SC

ISC21 Plenary

WCPFC-NC

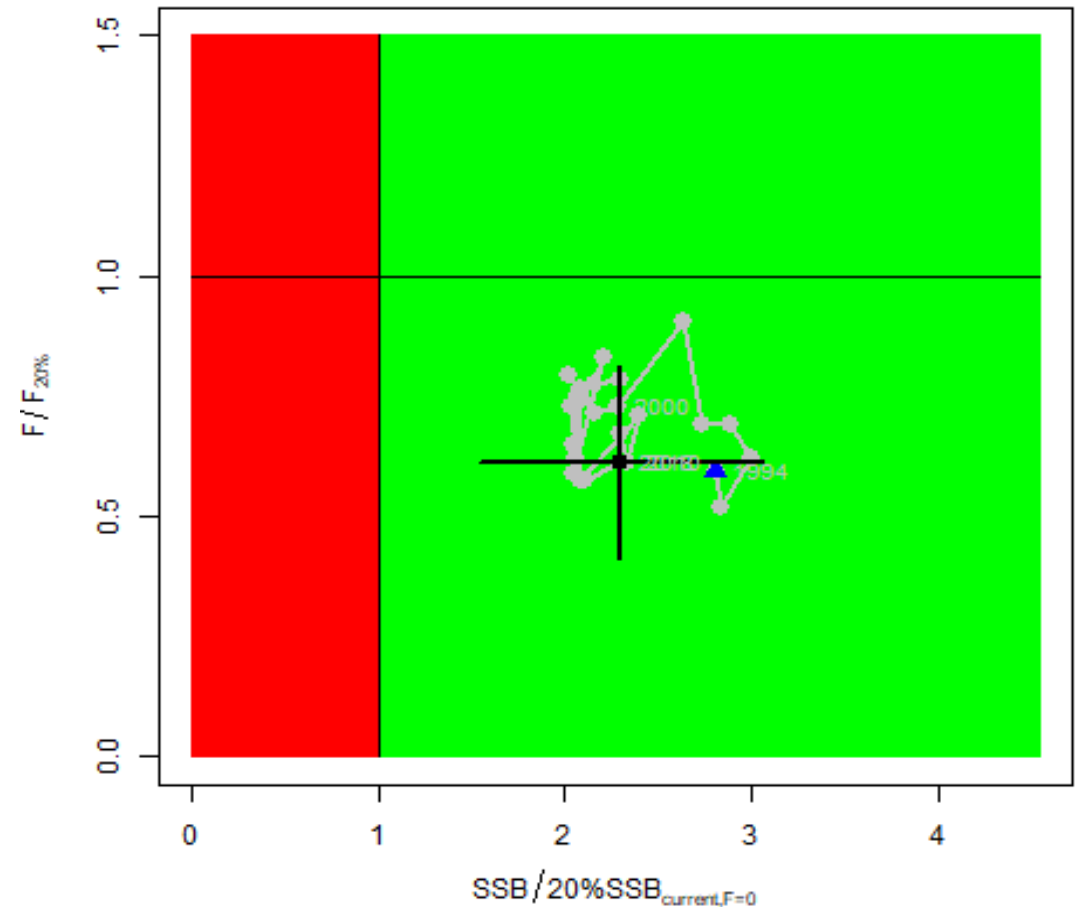
2022  
Adoption of  
objectives, reference  
points

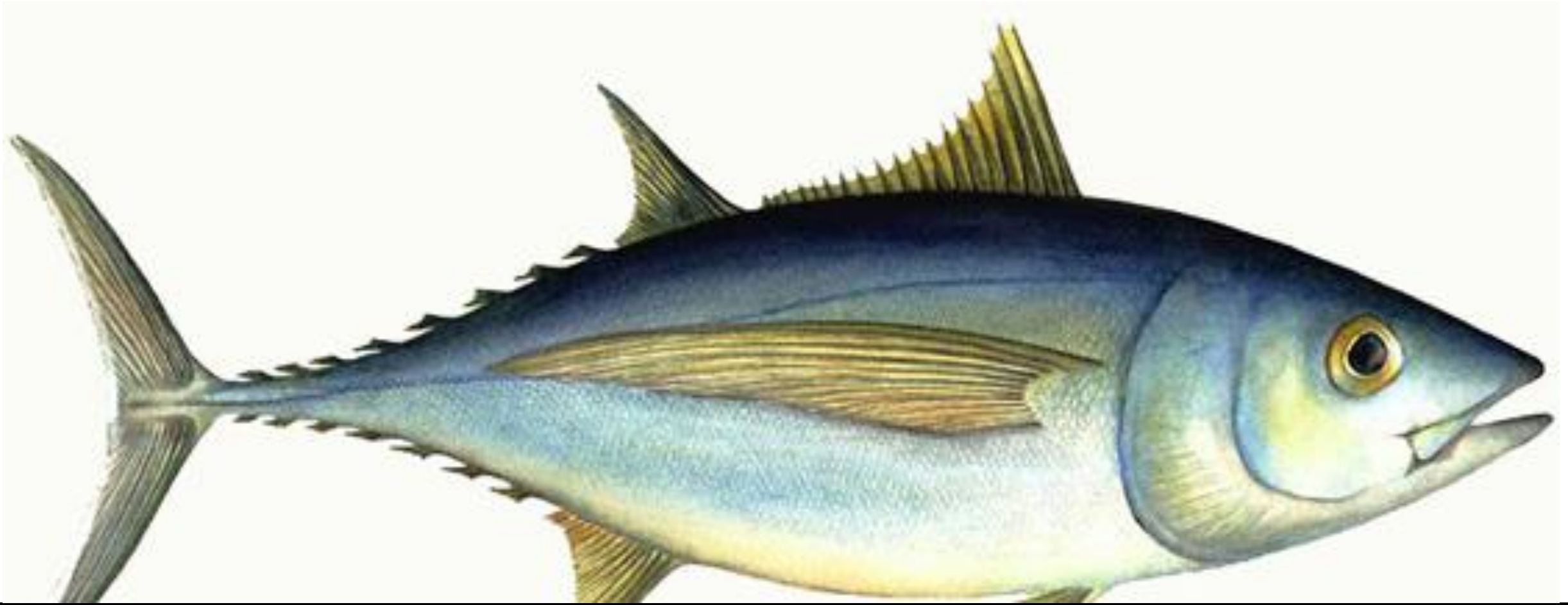


# Current Stock Status of North Pacific Albacore

Last assessment was in 2020

- 2018 female SSB at about 46% of dynamic unfished female SSB
- $F_{2015-2017}$  at about  $F_{50\%}$





# Management Objectives and Performance Metrics

# Management Objectives

Management Objective	Label	Performance Indicator
Maintain SSB above the limit reference point (LRP)	Odds SSB > LRP	Probability that SSB in any given year of the MSE forward simulation is above the LRP
	Odds SSB > 20%SSB0_d	Probability that SSB in any given year of the MSE forward simulation is above 20% of the dynamic unfished SSB – currently adopted by WCPFC
	Odds SSB > 7.7%SSB0_d	Probability that SSB in any given year of the MSE forward simulation is above 7.7% of the dynamic unfished SSB
	Odds SSB > equilibrium 7.7%SSB0	Probability that SSB in any given year of the MSE forward simulation is above 7.7% of the equilibrium unfished SSB – interim IATTC LRP for tropical tunas
Maintain depletion of total biomass around historical average depletion	Odds depletion > historical	Probability that depletion in any given year of the MSE forward simulation is above minimum historical (2006-2015) depletion

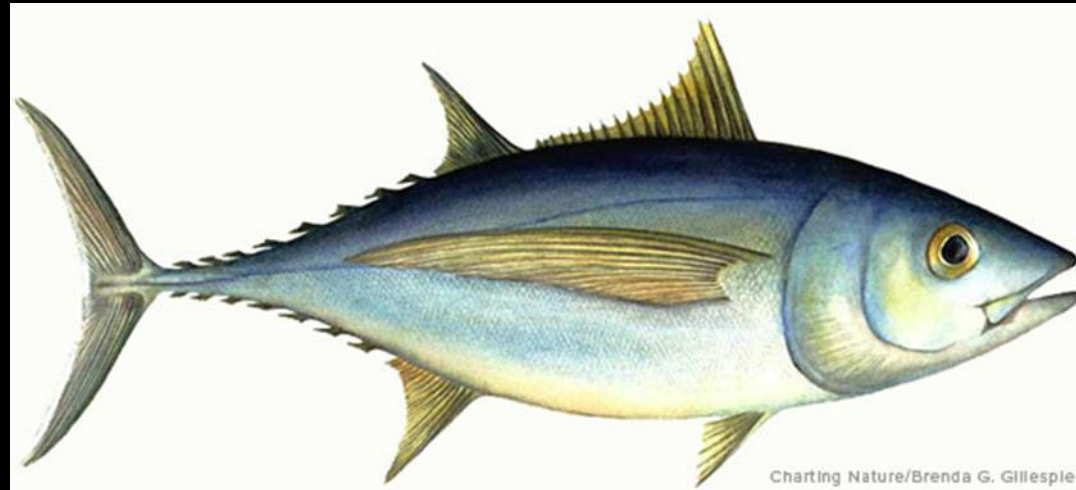
Management Objective	Label	Performance Indicator
Maintain catches above average historical catch	Odds catch > historical	Probability that catch in any given year of the MSE forward simulation is above average historical (1981-2010) catch
	Odds medium term catch > historical	Probability that catch averaged over years 7-13 of the MSE forward simulation is above average historical (1981-2010) catch
	Odds long term catch > historical	Probability that catch averaged over years 20-30 of the MSE forward simulation is above average historical (1981-2010) catch
Change in total allowable catch between years should be relatively gradual	Catch Stability	Probability that a decrease in TAC is <30% between consecutive assessment periods (once every 3 years), excluding years where TAC=0.
	Odds of no management change	Probability of $SSB > SSB_{\text{threshold}}$
Maintain fishing intensity (F) at the target value with reasonable variability	$F_{\text{TARGET}}/F$	$F_{\text{TARGET}}/F$

# Adopted Management Objectives

Management Objective MSE	Adopted Management Objective
<p>Maintain SSB above the limit reference point (LRP)</p>	<p>Maintain SSB above the limit reference point (LRP), with a probability of at least 80% over the next 10 years.</p> <p>Adopted LRP is 14%SSB<sub>0</sub></p>
<p>Maintain depletion of total biomass around historical average depletion</p>	<p>Maintain depletion of total biomass around historical (2006-2015) average depletion over the next 10 years.</p>
<p>Maintain fishing intensity (F) at the target value with reasonable variability</p>	<p>Maintain fishing intensity (F) at or below the target reference point with a probability of at least 50% over the next 10 years.</p> <p>Adopted TRP is F<sub>45</sub></p>
<p>Change in total allowable catch between years should be relatively gradual</p>	<p>To the extent practicable, management changes (e.g., catch and/or effort) should be relatively gradual between years.</p>

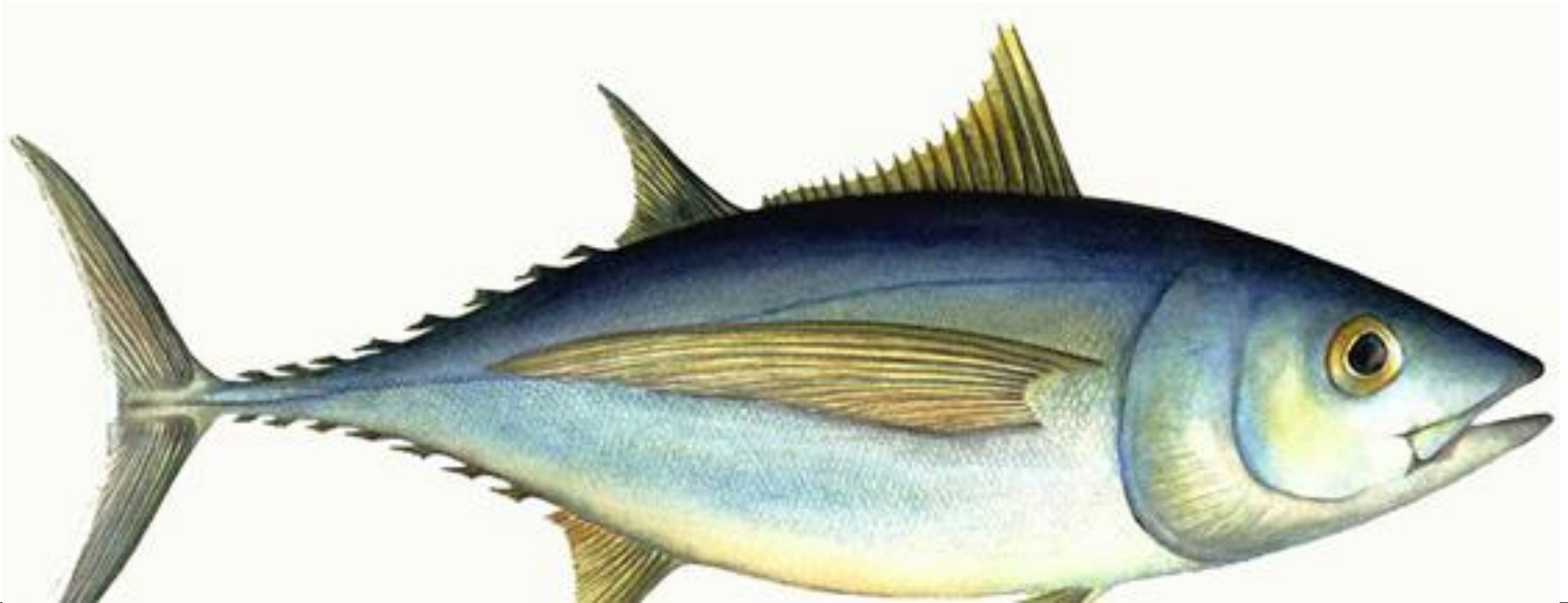
# Target Reference Points (TRPs) for NPALB MSE

- Based on fishing intensity (1-SPR)
- A fishing intensity of F45 would result in approximately 45% of the unfished SSB per recruit (also referred to as spawning potential)
- This is approximately equivalent to an harvest rate of 55%



Charting Nature/Brenda G. Gillespie





Harvest Strategies

# Scope of strategies to be tested was refined over the MSE process

## HCRs Wish List

### MSE WS - October 2017

- Target Reference points (TRP): F30, F40, F50, F0204
- Limit reference points (LRP): 20%, 14%, 7.7% SSBo\_d
- Threshold Reference Points (ThRP): 30%, 20%, 14% SSBo\_d
- Prob(SSB>LRP): 90%, 75%, 50%
- Prob(SSB>ThRP): 75%, 50%
- Fmin = 0, 0.25, 0.5 of F at LRP
- TAC or TAE control
- Threshold, proportional threshold or IATTC tropical tuna rule

## What was feasible given resources

### ISC ALBWG Meeting - March 2018

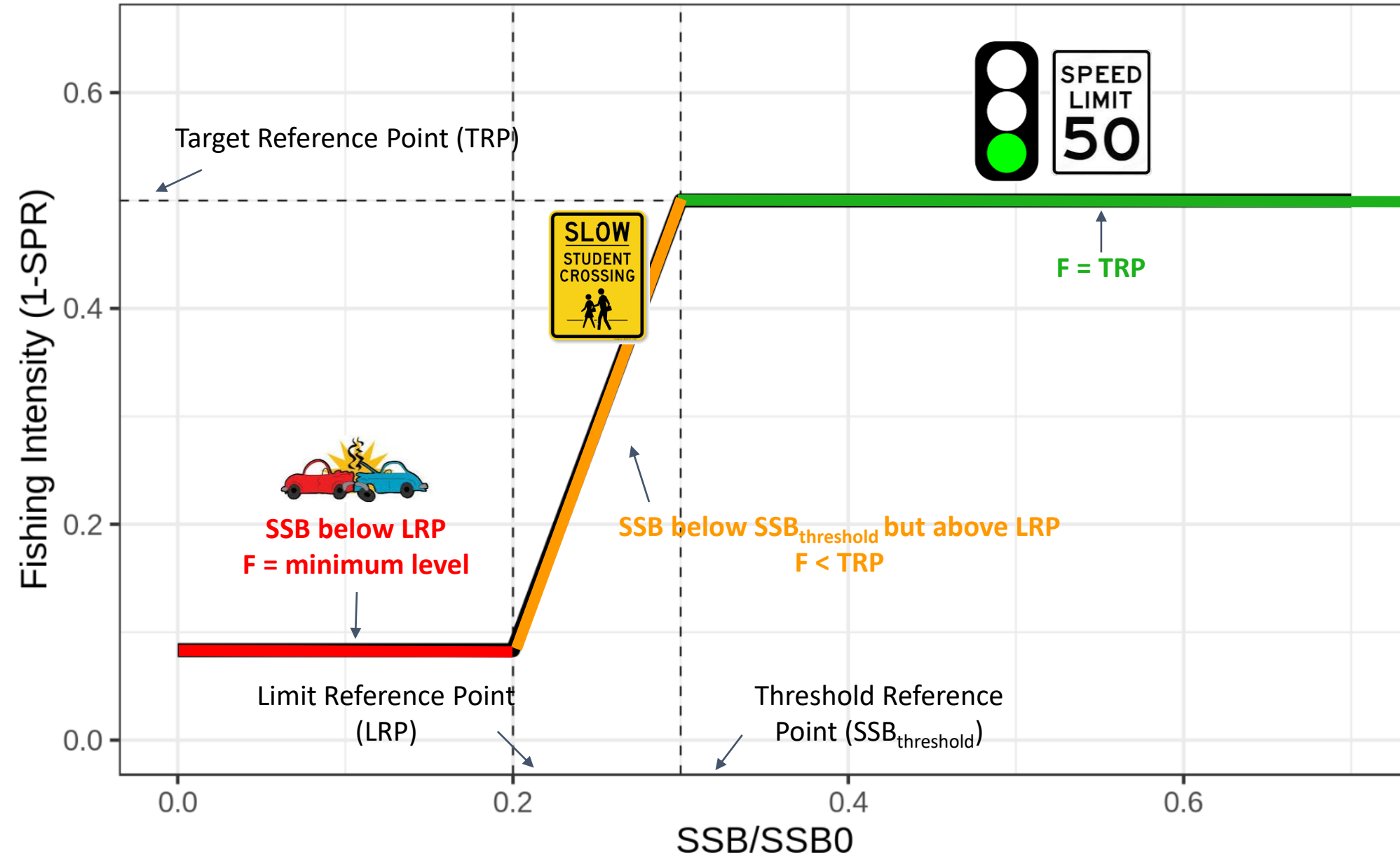
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- Threshold Reference Points (ThRP): 30%, 20%, 14% SSBo\_d
- Prob(SSB>LRP): 50%
- Prob(SSB>ThRP): 50%
- Fmin = 0
- TAC or TAE control
- Threshold, Proportional threshold or IATTC tropical tuna rule

## What was reasonable given stakeholder feedback on first set of results

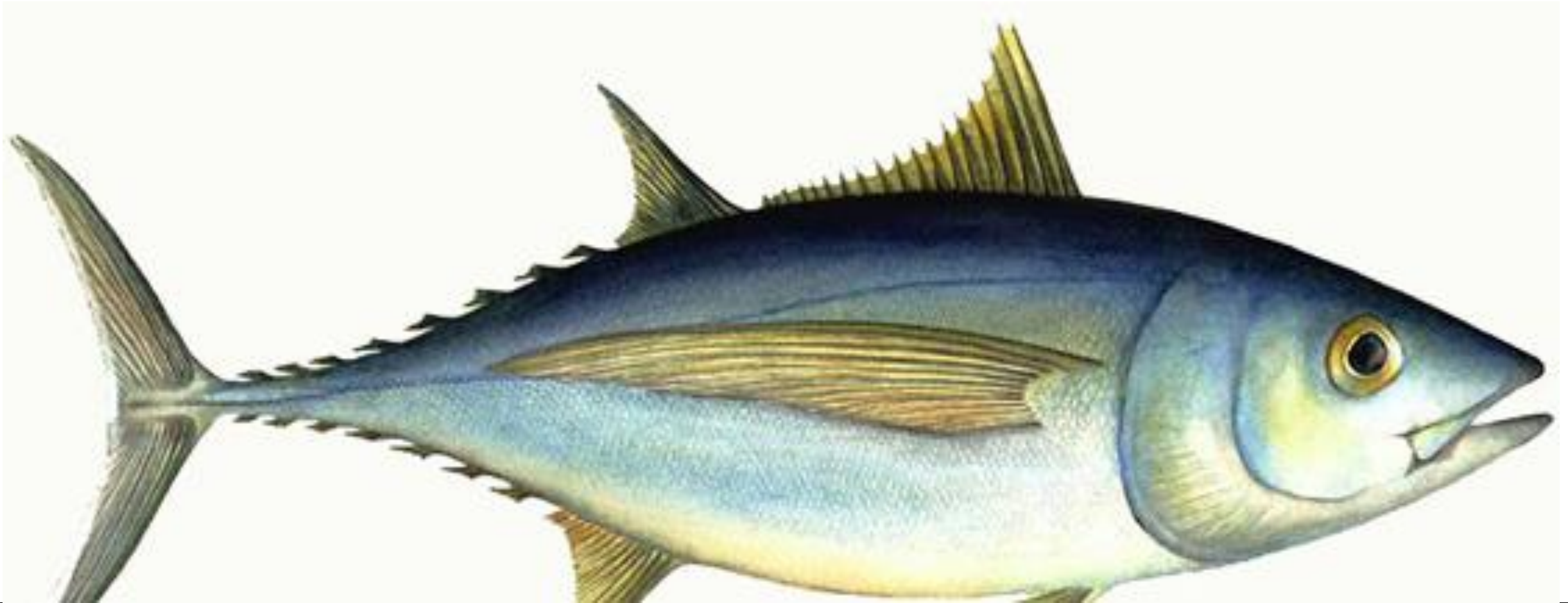
### MSE WS - March 2019

- Target Reference points (TRP): F40, F50, Limit reference points (LRP): 20%, 14%, 7.7% SSBo\_d
- Threshold Reference Points (ThRP): 30%, 20%, 14% SSBo\_d
- Prob(SSB>LRP): 90%, 80%
- Prob(SSB>ThRP): 50%
- Fmin = 0, 0.25, 0.5 of F at LRP
- TAC or **Mixed** or TAE control
- Proportional threshold

# General Harvest Control Rule tested in latest round of NPALB MSE



Adopted reference points:  
TRP = F45  
Threshold = 30% SSB0  
LRP = 14%SSB0



Uncertainties, OM Conditioning, Simulation  
Framework

# Albacore MSE Feedback Loop

Model and process uncertainty

*Management Action*

**OPERATING MODELS**  
"True" Population and fleet dynamics

*Data Generation*

Defines input data to harvest strategy

Implementation error

**MANAGEMENT MODEL**  
Harvest control rule (HCR)

**Every three years ASSESSMENT MODEL + PROJECTION**

*Estimation of stock status*

Observation and assessment error

Defines how stock status estimated – model based



# Select and Prioritize Uncertainties

Which uncertainties are most consequential for Albacore and need to be considered in MSE?

Productivity, Data-related, Non-Stationarity – Punt et al. 2016

## **High priority**

- 1) Recruitment – autocorrelation and various values of steepness
- 2) Natural mortality – various values of M
- 3) Growth – various values of growth parameters

## **Medium priority**

- 1) Age selectivity – time-varying age selectivity
- 2) Recruitment – linked to environmental indices
- 3) Natural mortality – sex-specificity
- 4) Catchability – time varying implementation error

## **Low priority**

- 1) Growth – time-varying growth
- 2) Catchability – time varying catchability of indices
- 3) Size selectivity – time varying selectivity



# Select and Prioritize Uncertainties

Which uncertainties are most consequential for Albacore and need to be considered in MSE?

Process uncertainty, Productivity,  
Observation error – Punt et al.  
2016

## High priority

- 1) Recruitment – autocorrelation and various values of steepness
- 2) Natural mortality – various values of  $M$
- 3) Growth – various values of growth parameters

## Medium priority

- 1) Age selectivity – time-varying age selectivity
- 2) Recruitment – linked to environmental indices
- 3) Natural mortality – sex-specificity
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## Low priority

- 1) Growth – time-varying growth
- 2) Catchability – time varying catchability of indices
- 3) Size selectivity – time varying selectivity

Also robustness set, what if ghost fleet present? Increase in unmanaged, unreported catch

Resources Limitations - need to be pragmatic

Conditioned a total of 27 operating models (full factorial design) but for final set of results only used a reduced reference set that captured range of uncertainty in productivity.

Details of harvest strategy important

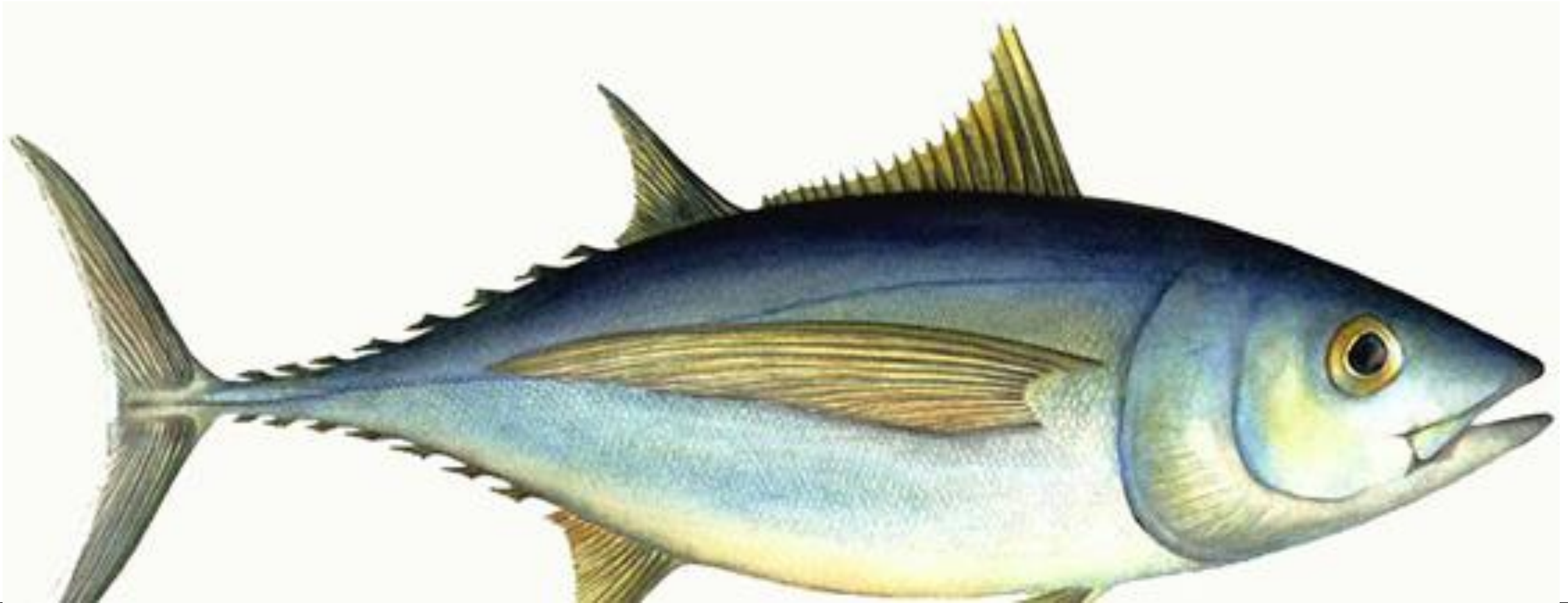
**Within harvest strategy, how to calculate probability of SSB > limit reference point?**

- Use asymptotic uncertainty estimate of terminal year SSB
  - Projection Software

Only after first round of results was presented managers suggested that interested in probability over 10 years, using the projection software

# More Lesson Learned

- Discussion of uncertainties and OM parametrizations decisions and conditioning takes time – start early in the MSE process. It can happen without management input
- Estimation of stock status formulation key decision, trade-off with # of runs
  - Full assessment
  - Simpler/faster assessment
  - Empirical
- Important to be clear with managers on how decisions are/would be made in the real world and what the simplifications/assumptions in the MSE are
  - Albacore – real world effort measure simplified to fishing intensity
  - Albacore – use of projection software
- Have regular interactions with managers and stakeholders. Results from preliminary runs useful even if full set of management strategies to test not yet agreed upon.



Thank you!

Questions? – [desiree.Tommasi@noaa.gov](mailto:desiree.Tommasi@noaa.gov)