INTERNATIONAL PACIFIC HALIBUT COMMISSION

MSE & HSP update

Agenda item: 4.1.3
IPHC-2025-SRB027-08
(A. Hicks & I. Stewart)

Outline

- An Investigation of Autocorrelation in Recruitment
- Definitions of Overfished and Depleted
- Definition of Overfishing
- Update on Process to adopt a Harvest Strategy Policy

Recruitment

IPHC-2025-SRB026-R, para 24. The SRB **RECOMMENDED** that recruitment projections in the stock assessment and Management Strategy Evaluation (MSE) incorporate a random-walk starting from the most recent reliable recruitment estimate to constrain expected short-term recruitment around recent estimates rather than immediately reverting to the stock-recruitment relationship.

- Investigated autocorrelation in estimated recruitment deviations
- Compared simulations with and without autocorrelated recruitment deviations

Investigation of autocorrelation

- Used estimated recruitment deviations from each model in the ensemble
  - 'Main' period of estimates strongly informed by data

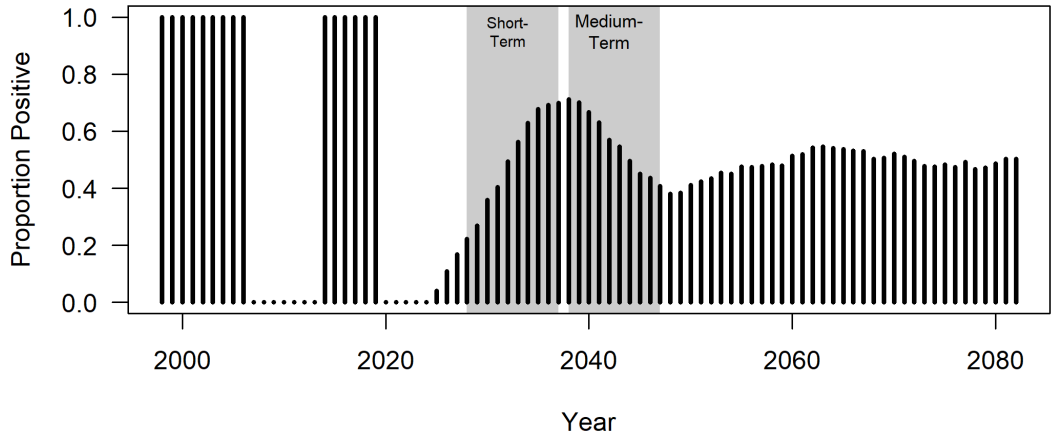
$$R'_0 = R_0 \times e^{I_y \delta}$$

PDO relationship

$$R_y = f(B^{sp}_{F,y} | R'_0, B^{sp}_0, h) \times e^{(\varepsilon_y - \frac{\sigma_R^2}{2})}$$

Recruitment deviation

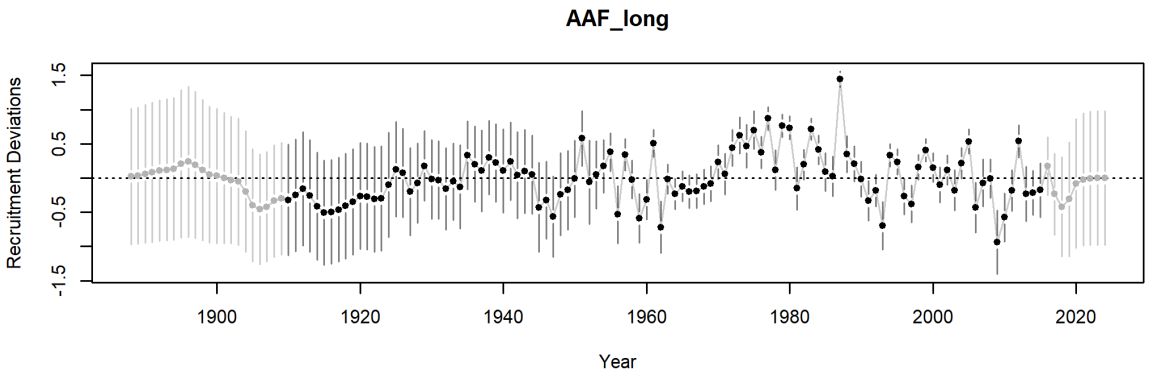
- Some persistence of current conditions is maintained by modelling average recruitment as a function of PDO

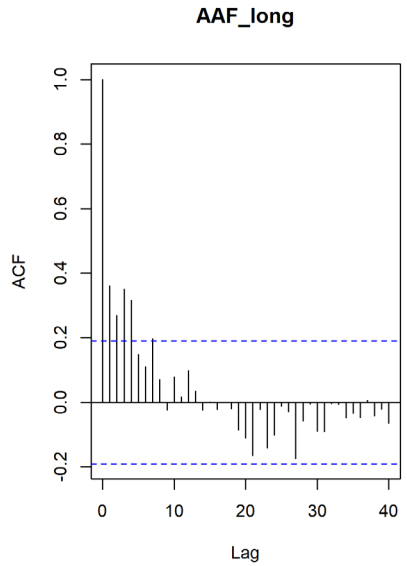


Recruitment deviations

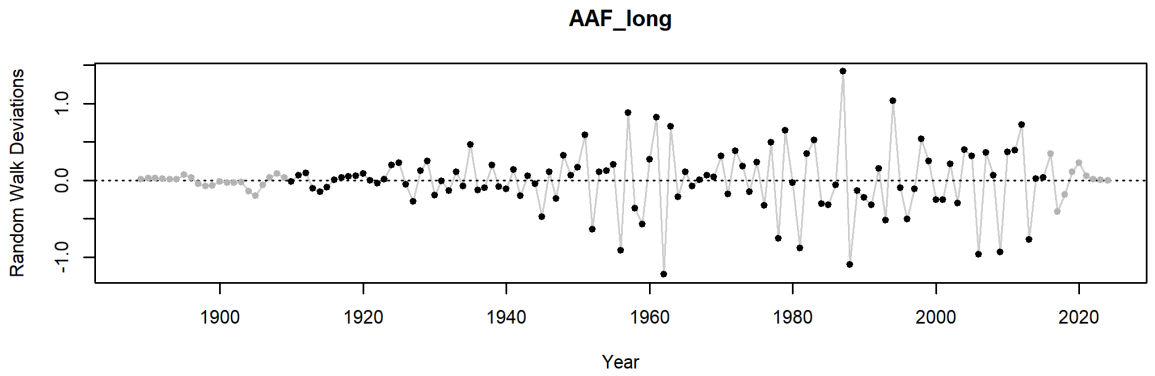
Other results in document
IPHC-2025-SRB027-08

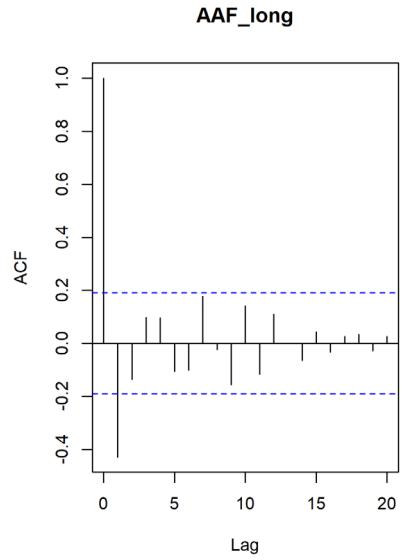
Deviation





Random Walk





ARIMA Models

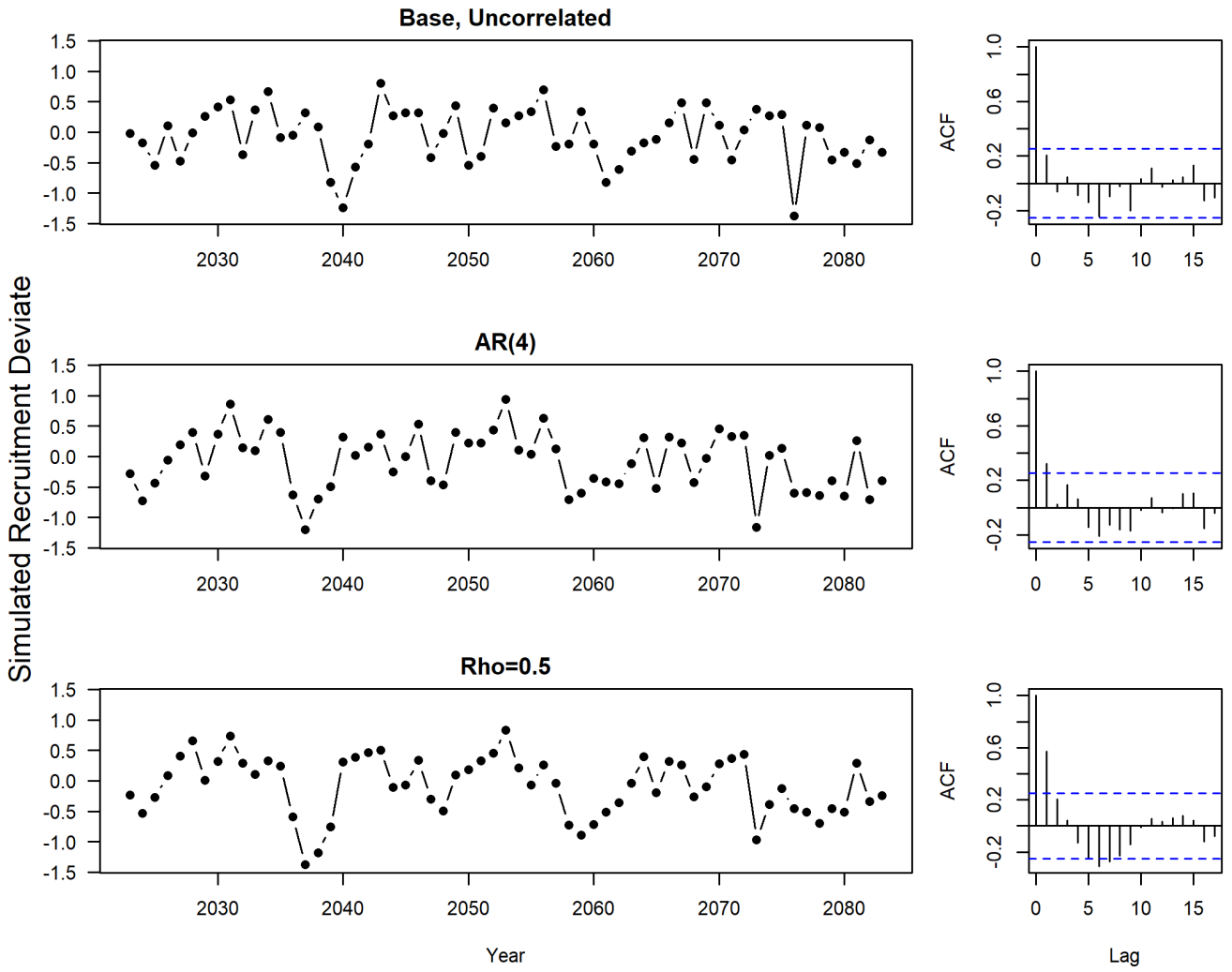
Recent Years

Model Type		AAF_long	CW_long		AAF_short	CW_short	AAF_long	CW_long
	Years	1910–2015	1925–2015		1992–2016	1992–2016	1992–2016	1992–2016
NULL	(0,0,0)	98.68	94.71		**35.81**	**69.07**	**24.11**	**22.06**
AR(1)	(1,0,0)	85.81	76.81		**36.22**	**70.87**	**25.95**	**23.95**
	(2,0,0)	85.04	75.88		**38.21**	**72.01**	**25.23**	**22.00**
	(3,0,0)	**80.17**	**70.24**		40.19	73.79	27.16	**23.97**
	(4,0,0)	**80.10**	**67.65**		41.80	74.46	29.05	25.54
Random Walk	(0,1,0)	121.70	101.78		43.67	84.11	36.61	35.01

- Longer time-series shows a significant AR(3) or AR(4)
- Recent years did not show a significant ability to predict
- No support for the random walk

MSE simulations with autocorrelation

- Modelled recruitment deviations with autocorrelation
- Three sets of simulations
  - Uncorrelated
  - AR(4):
    - $\varepsilon_t = -0.02 + 0.23\varepsilon_{t-1} + 0.07\varepsilon_{t-2} + 0.21\varepsilon_{t-3} + 0.14\varepsilon_{t-4} + \tau_t$
  - ρ=0.5 in $\varepsilon_t = \rho\varepsilon_{t-1} + \sqrt{1-\rho^2}\tau_t$



MSE Simulation Results

SPR=43%

Recruitment Deviates	Uncorrelated	AR(4)	$\rho = 0.5$
P(RSB<20%)	<0.001	<0.001	<0.001
P(RSB<36%)	0.24	0.28	0.28
Median TCEY	53.8	51.8	51.6
AAV	10.8%	11.9%	12.0%

- Results are slightly different with autocorrelation
- Do not know if it would result in choosing a different MP

Recruitment Projections Conclusions

- Slight evidence of autocorrelation in estimated deviates
  - Appearance of autocorrelation may be a result of ageing error and uncertainty

- Three-year stock assessment projections not affected by how recruitment is projected
- Short-term and long-term MSE performance metrics are slightly affected
  - Unlikely to result in choosing a different MP given that current default MP is a trade-off between yield and variability in yield, and that relationship is unlikely to change with how recruitment is projected

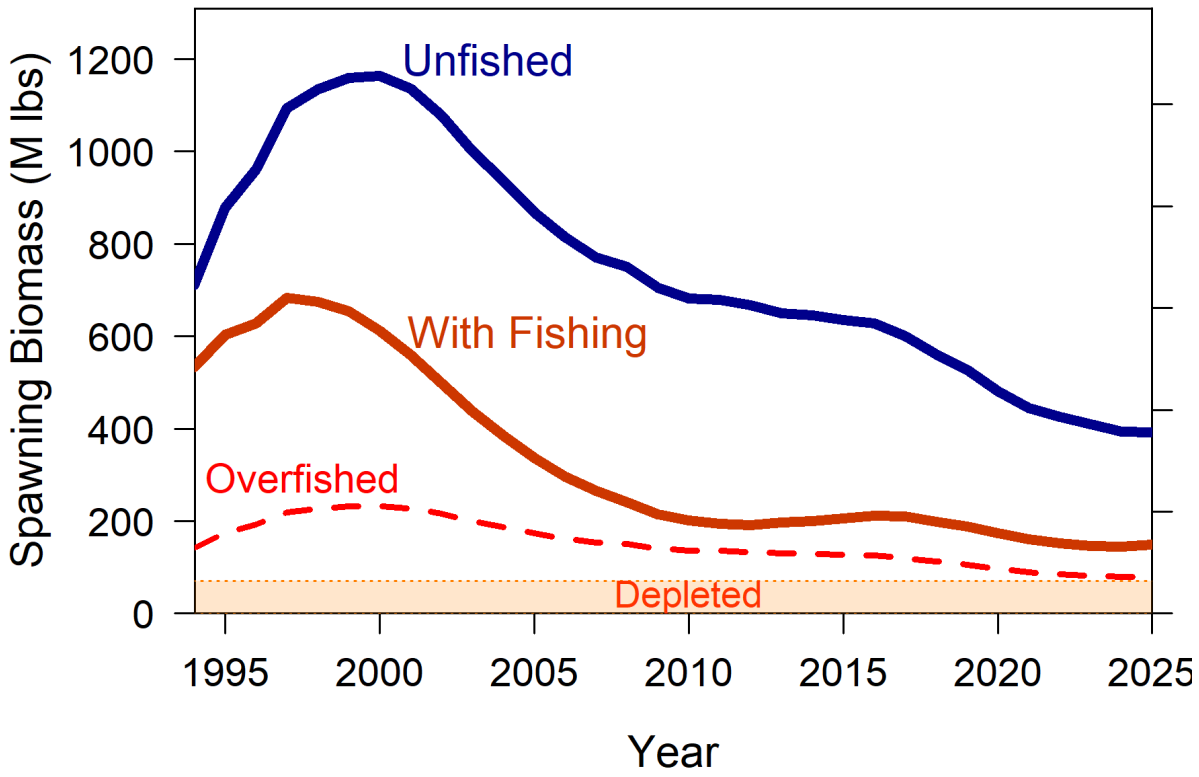
Defining a depleted state

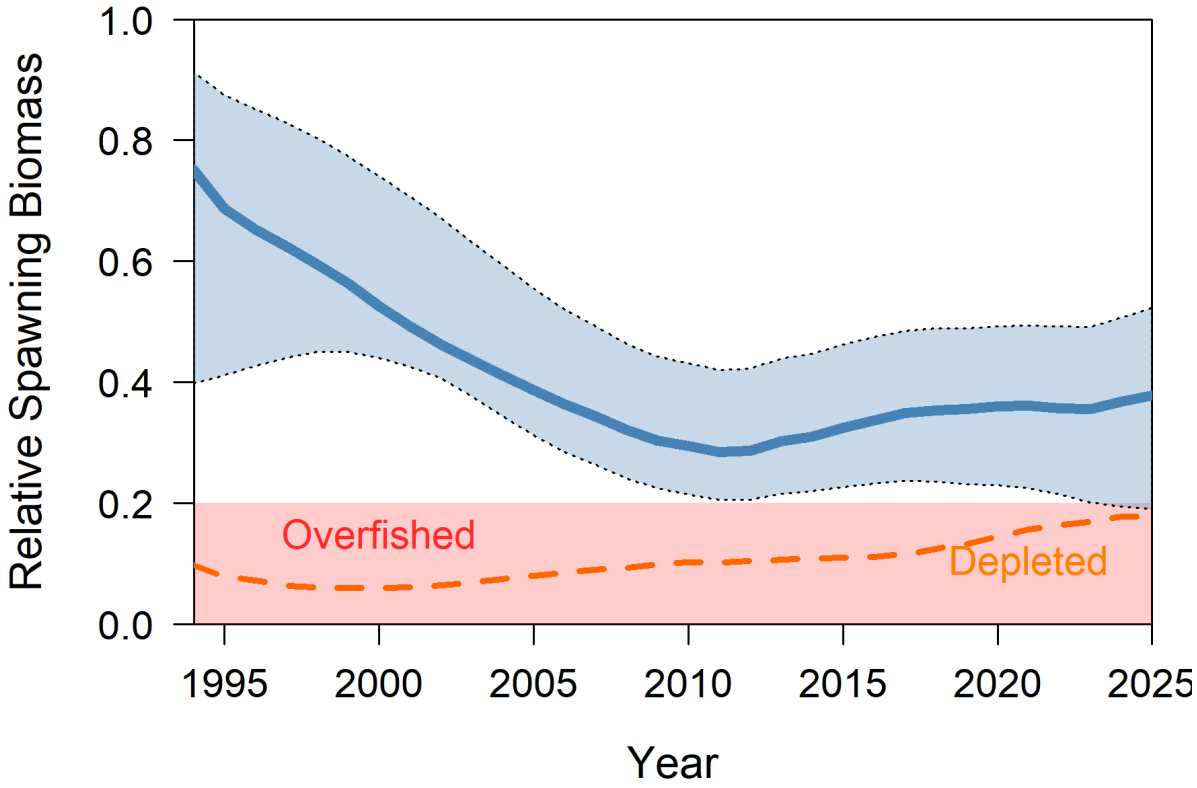
IPHC-2025-SRB026-R, para. 31. The SRB **RECOMMENDED** that the Secretariat/Commission adopt an absolute biomass limit defining "Depleted" to avoid low biomass levels where stock dynamics are poorly understood such that recovery projections would be unreliable

1. Use the lowest spawning biomass observed in the estimated historical time-series
2. Use worst-case scenario simulations to determine at what spawning biomass level the population may not recover

Comparing Overfished and Depleted

- Overfished is a percentage of the dynamic unfished spawning biomass
- Depleted is an absolute constant spawning biomass



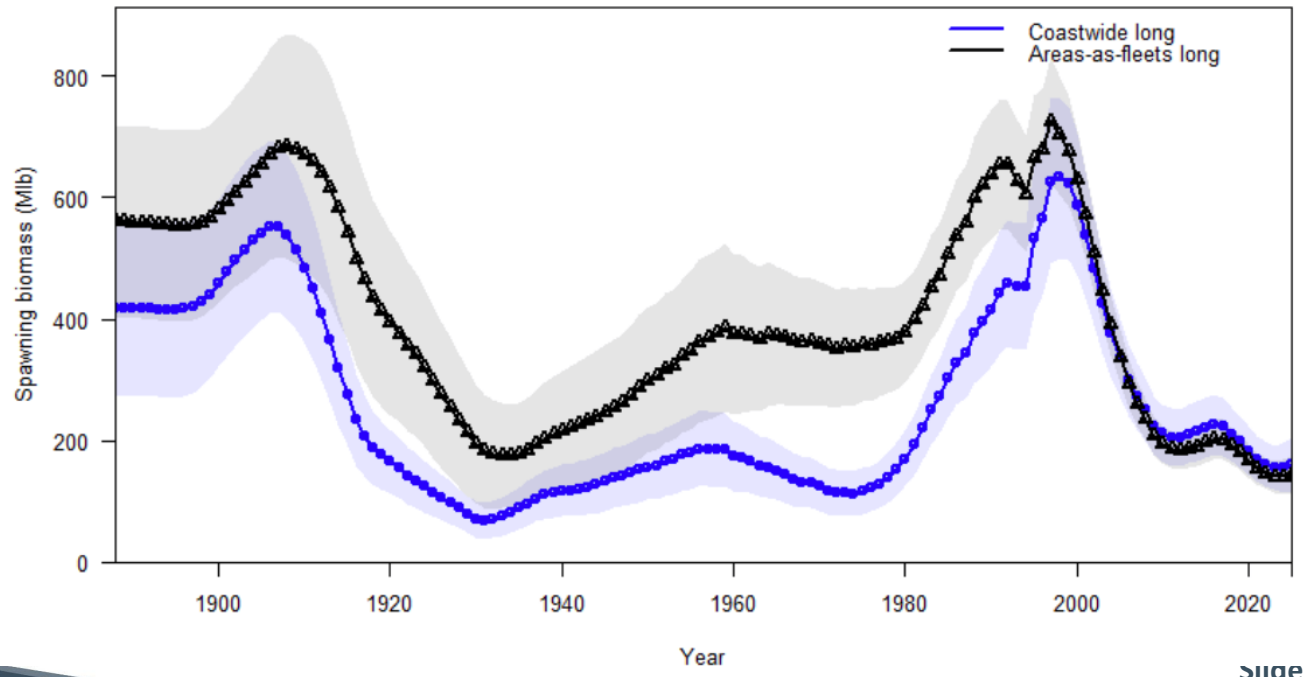


Lowest Observed Spawning Biomass

- This value would scale with updates to the stock assessment
- Estimated SB in 1970s is highly uncertain
- Recent lowest SB occurred in 2024
  - How does the threshold relate to this value?

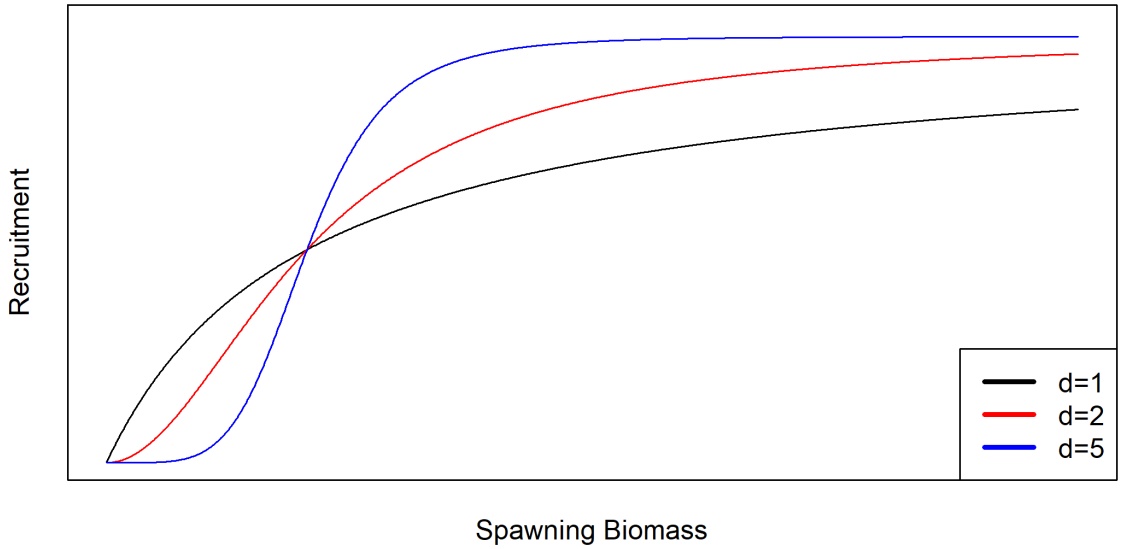
2024 Stock Assessment

Year	SB	SB interval
1992	556	390-1,161
2021	161	131-228
2022	152	122-218
2023	146	112-211
2024	145	103-211
2025	149	97-216

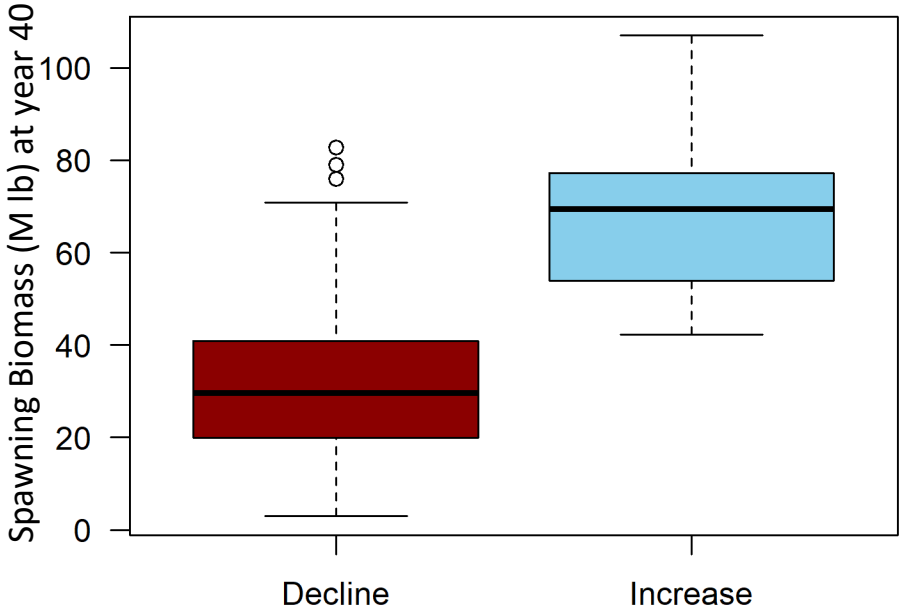


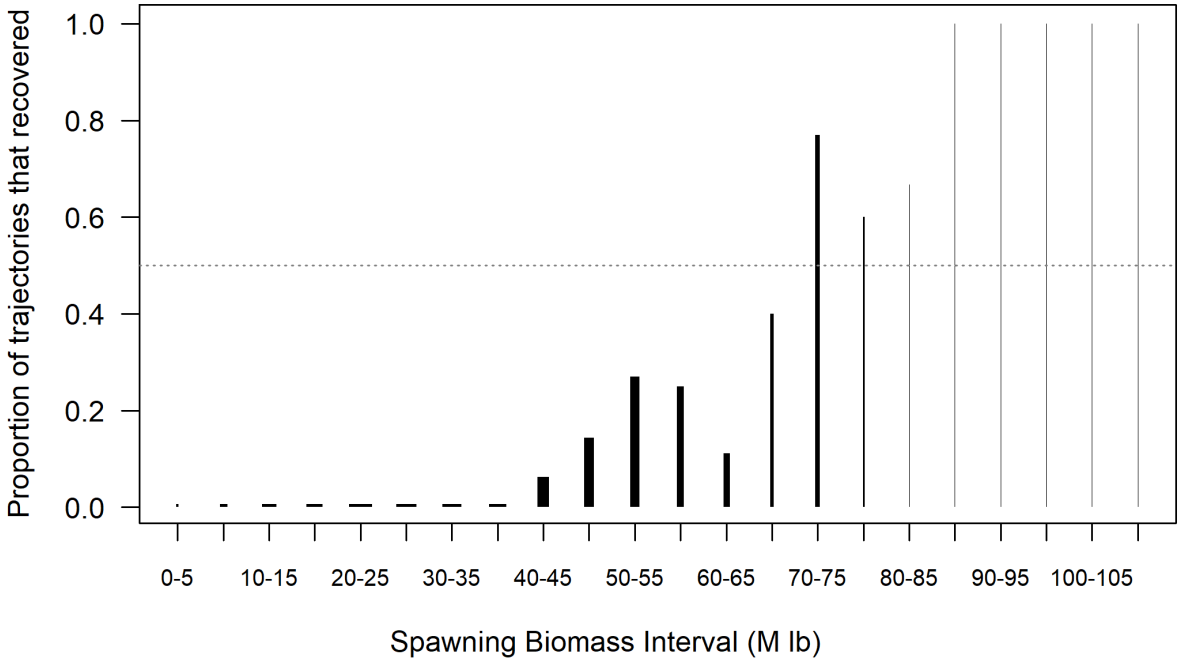
Simulations to Determine Depleted Threshold

- With a worst-case scenario, project at a high fishing rate then stop fishing
  - Low weight-at-age
  - Low average recruitment (i.e. low PDO)
  - Depensation parameter = 5
  - All fishing stops after 40 years, except for 3 million pounds, and simulated another 50 years
- Recovers if SB at end is greater than SB at 40 years



Depleted Threshold from Simulations





Overfishing

IPHC-2025-SRB026-R, **para. 33**. *The SRB **RECOMMENDED** that the Secretariat evaluate via simulation the ability to detect overfishing (based on the proposed definition) under scenarios of reduced assessment performance when defining "Overfishing" based on probabilities of stock status.*

- This simulation have not been completed
- Will need to use a more realistic estimation model

Overfishing

IPHC-2025-SRB026-R, **para. 34**. *The SRB **RECOMMENDED** that the Secretariat consider and justify alternative timelines to the three-year rebuilding period specified in the proposed definition of "overfishing" since a three-year period is probably unrealistic for rebuilding timelines*

- The definition of overfishing was modified to be more consistent with the Harvest Strategy Policy

Overfishing: where the stock is subject to a level of fishing that would move it to an overfished state with a greater than 50% probability within three (3) years at a constant mortality (measured in biomass) or prevent it from rebuilding to a 'not overfished' state within the required timeframe and specifications of a rebuilding plan

Harvest Strategy Policy

- 3 workshops with Commissioners
- Will be considered for adoption at IM101
- Noteworthy improvements
  - Clarified succinct language for objectives
  - Provided definitions of short-term and long-term
  - Added in a description of *Depleted*
    - No threshold provided

Objectives

1. Maintain the long-term coastwide Pacific halibut female relative spawning biomass above a biomass limit reference point where the risk to the stock is regarded as unacceptable ($RSB_{20\%}$) at least 95% of the time;
2. Maintain the long-term coastwide Pacific halibut female relative spawning biomass at or above a threshold reference point that optimises fishing activities($RSB_{36\%}$) at least 50% of the time;
3. Maximize the short-term coastwide yield while minimising annual changes in the short-term coastwide mortality limit, given the constraints above to ensure a sustainable fishery.

Hierarchical objectives

- Succinct measurable objectives
- General objectives indicate biological or fishery
  - Updated for #3

Long-Term Overarching Objectives Defining Acceptable MPs

1. SUSTAINABILITY

General Objective	Measurable Objective
Keep female spawning biomass above a limit to avoid critical stock sizes	Maintain the long-term coastwide female relative spawning biomass above a biomass limit reference point ($RSB_{20\%}$) at least 95% of the time

2. OPTIMISE FISHING ACTIVITIES AND OPPORTUNITIES

General Objective	Measurable Objective
Maintain spawning biomass at or above a level that supports optimal fishing activities and opportunities	Maintain the long-term coastwide female relative spawning biomass at or above a biomass threshold reference point ($RSB_{36\%}$) 50% or more of the time.

Short-Term Management Objectives Informing a Reference MP

3. OPTIMISE YIELD

General Objective	Measurable Objective
Provide stable fishing opportunities	Maximize the short-term coastwide yield while minimising annual changes in the short-term coastwide mortality limit.

Reference points: Overfished limit & Depleted

- The '*overfished*' limit reference point is defined using a dynamic limit reference point. A dynamic calculation pertains to relative spawning biomass (RSB) being the estimated value relative to the estimated spawning biomass that would have occurred without any fishing given natural variability (e.g. recruitment deviations, changes in size-at-age, etc). This measures the effect of only fishing, rather than the effect of fishing and the environment, thus defining overfished as a concept resulting from fishing where management action would have an effect. Natural variability also affects stock size and results in fluctuations of the absolute spawning biomass. These natural variations, along with fishing, may result in a '*depleted*' stock where reductions in fishing mortality may not lead to recovery without a change in the environmental conditions affecting the stock. The Commission may choose additional precautionary actions whenever needed, including when at, or approaching, a '*depleted*' state.

Process to Adoption of an HSP

- Process leading to adoption
  - Scheduling an MSAB informational session in October
    - MSAB did discuss the draft HSP at MSAB021
  - Adoption at IM101 will define management inputs for the 2025 stock assessment
    - Reference points defined in the HSP will be linked to the decision table (as best as possible)
- Publication
  - Published to IPHC HSP website
    - https://www.iphc.int/research-monitoring/harvest-strategy-policy/
  - Supplementary documentation
    - A document describing elements of a rebuilding plan will be available after adoption and published on HSP website after Commission review
    - Additional “operational” documents will be written with specific details

MSE Program of Work for 2026

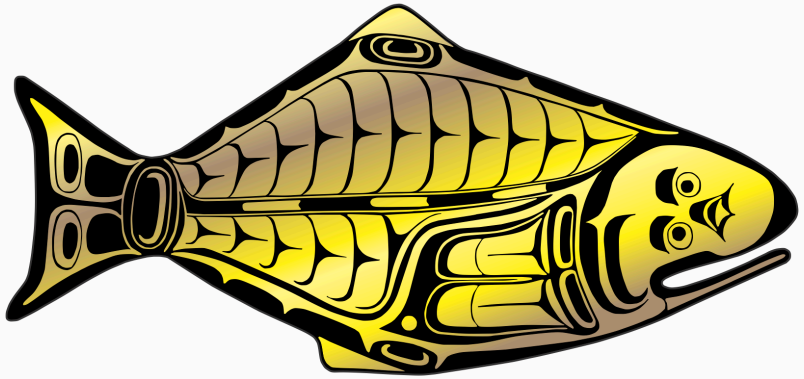
- Recondition Operating Model after completion of full stock assessment
- Compare previous results to updated results
- Work with SRB and Commission to define a depleted threshold
  - Response to approaching or crossing depleted threshold
- Investigate ability to detect overfishing
- Examine productivity scenarios to better understand current conditions

Recommendations

That the SRB:

1. **NOTE** paper IPHC-2025-SRB027-08 which details investigations of autocorrelation in recruitment, definitions of Overfished and Depleted, a definition of Overfishing, and a brief update on the Harvest Strategy Policy.
2. **REQUEST** any topics to add to the 2025-2026 MSE Program of Work.

INTERNATIONAL PACIFIC



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