INTERNATIONAL PACIFIC HALIBUT COMMISSION

An update of the MSE Program of Work for 2026-2028

Agenda item: 4.1.3
IPHC-2026-SRB029-07
(A. Hicks & I. Stewart)

2026 MSE Program of Work (High Priority)

IPHC-2026-AM102-R, para. 56: The Commission **NOTED** that the 2026 MSE and HSP Program of Work will include the following high priority topics:

a) Update and recondition the MSE Operating Model in accordance with the schedule defined in the Harvest Strategy Policy;

b) Evaluate a range of SPR values to determine if the optimal reference coastwide fishing intensity is different than the current reference fishing intensity (F43%) defined in the HSP;

c) Investigate productivity regimes to determine how the Pacific halibut population and fisheries respond to different productivity regimes, if the optimal reference fishing intensity differs across productivity regimes, and how productivity regimes may be incorporated into a Management Procedure;

d) Further develop the Depleted concept and identify a limit reference point below which recovery of the Pacific halibut population would be uncertain.

2026 MSE Program of Work (Low Priority)

IPHC-2026-AM102-R, para. 57. The Commission NOTED that the 2026 MSE and HSP Program of Work will include the following low priority topics, which may not be completed before AM103:

a) Improve the estimation model used in the MSE framework;

b) Evaluate potential management actions to invoke when approaching a depleted limit reference point;

c) Evaluate additional elements of Management Procedures which may include
   a) a triennial assessment frequency,
   b) constraints and smoothers on the interannual change in the TCEY, and
   c) empirical rules to determine the reference TCEY in years without a stock assessment;

d) Determine reference points using the updated MSE Operating Model (e.g. FMSY and MSY);

e) Develop guidance documents for the Harvest Strategy Policy (e.g. specifications of a rebuilding plan).

SRB028 Recommendations and Requests

IPHC-2026-SRB028-R, para 27 (SRB028–Rec.01): *The SRB **NOTED** that a single control rule based on relative biomass is unlikely to reach the ramp (descending limb) where reduction in F are triggered. Therefore, the SRB **RECOMMENDED** investigating HCRs based on absolute biomass.*

IPHC-2026-SRB028-R, para 23 (SRB028–Req.05): *The SRB **REQUESTED** that the Secretariat investigate, via the MSE, control rules based on changes to the risk of overfishing (often referred to as p*, see Shertzer et al. 2008).*

IPHC-2026-SRB028-R, para 25 (SRB028–Req.06): ***RECALLING** that at SRB026, the SRB made the following recommendation,*

> *IPHC-2025-SRB026-R, SRB026–Rec.07 (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."*

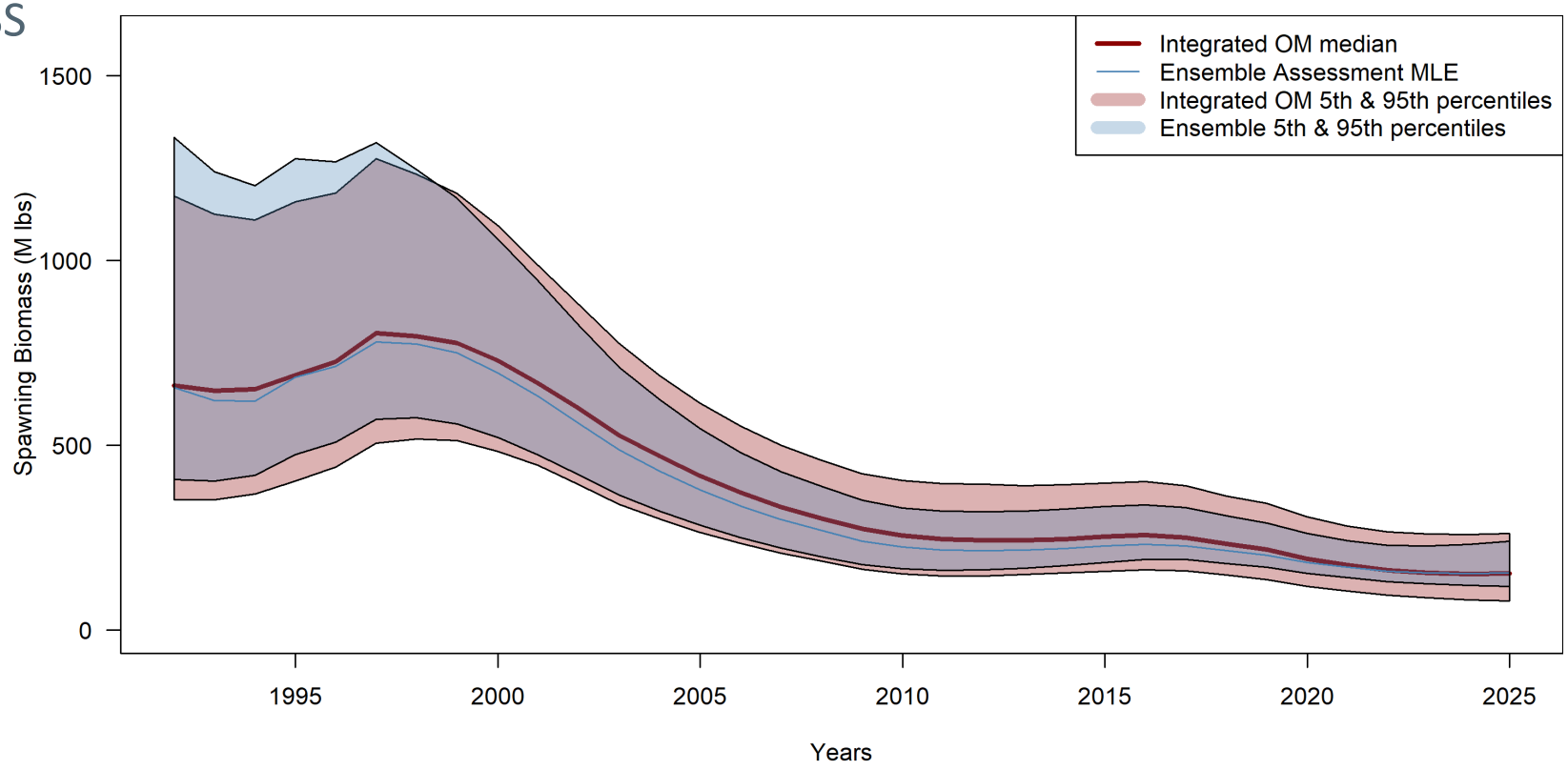
*and **NOTING** the update provided by the Secretariat at SRB028, the SRB **REQUESTED** an analysis of projecting recruitment via projections in environmental drivers (Pacific Decadal Oscillation) in addition to autocorrelated recruitment, which tends to rapidly revert to the mean.*

Outline

- Condition the Operating Model
- Setting up projections
  - Weight-at-age projections
  - Recruitment projections
  - MSE projections
- Simulating Management Procedures
  - Range of SPR values
  - Alternative control rules
- Productivity Regimes
- Depleted concept

Condition the Operating Model

- Four models in an ensemble inspired by the stock assessment models
  - Conditioned to
    - Spawning biomass estimates from the stock assessment
    - Stock distribution from FISS
    - Age compositions from FISS



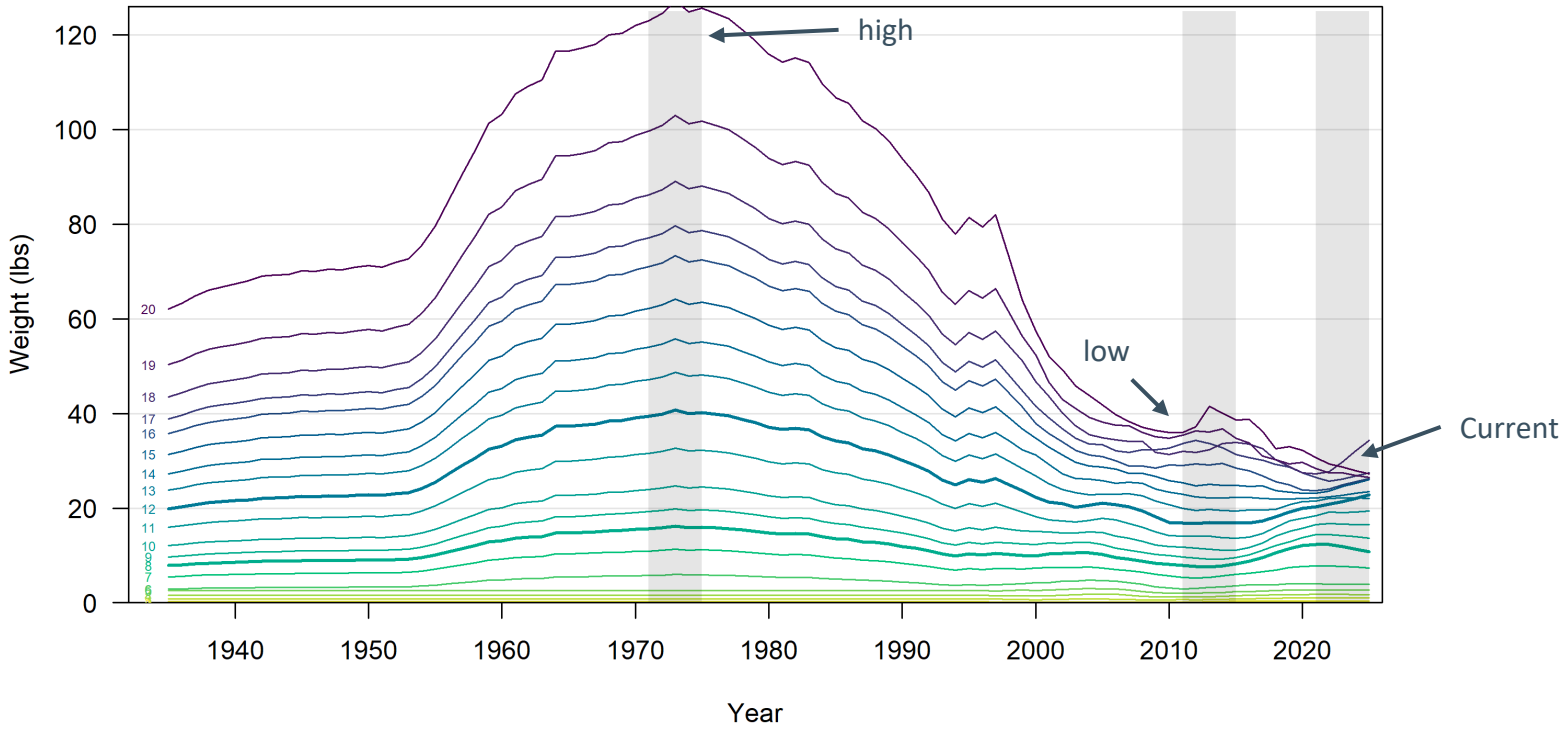
See IPHC-2026-SRB028-08 Rev_1 for details

Projections

- Next step was to set up projections
  - Project variable weight-at-age
  - Project PDO regimes
    - Affects average recruitment, movement rates, and recruitment distribution
  - Project variable selectivity
    - Tied to weight-at-age, as has been done before

Historical weight-at-age

- Weight-at-age is a major driver in spawning biomass and TCEY
- Historically weight-at-age has slowly varied over a wide range
- Weight-at-age regimes defined by three different 5-year periods



The random effects model

- Random effects model using RTMB
- Each age/year is a deviation from an overall mean weight-at-age (mu)

$$W_{a,y} = e^{\ln(\mu_a)+\varepsilon_{a,y}}$$

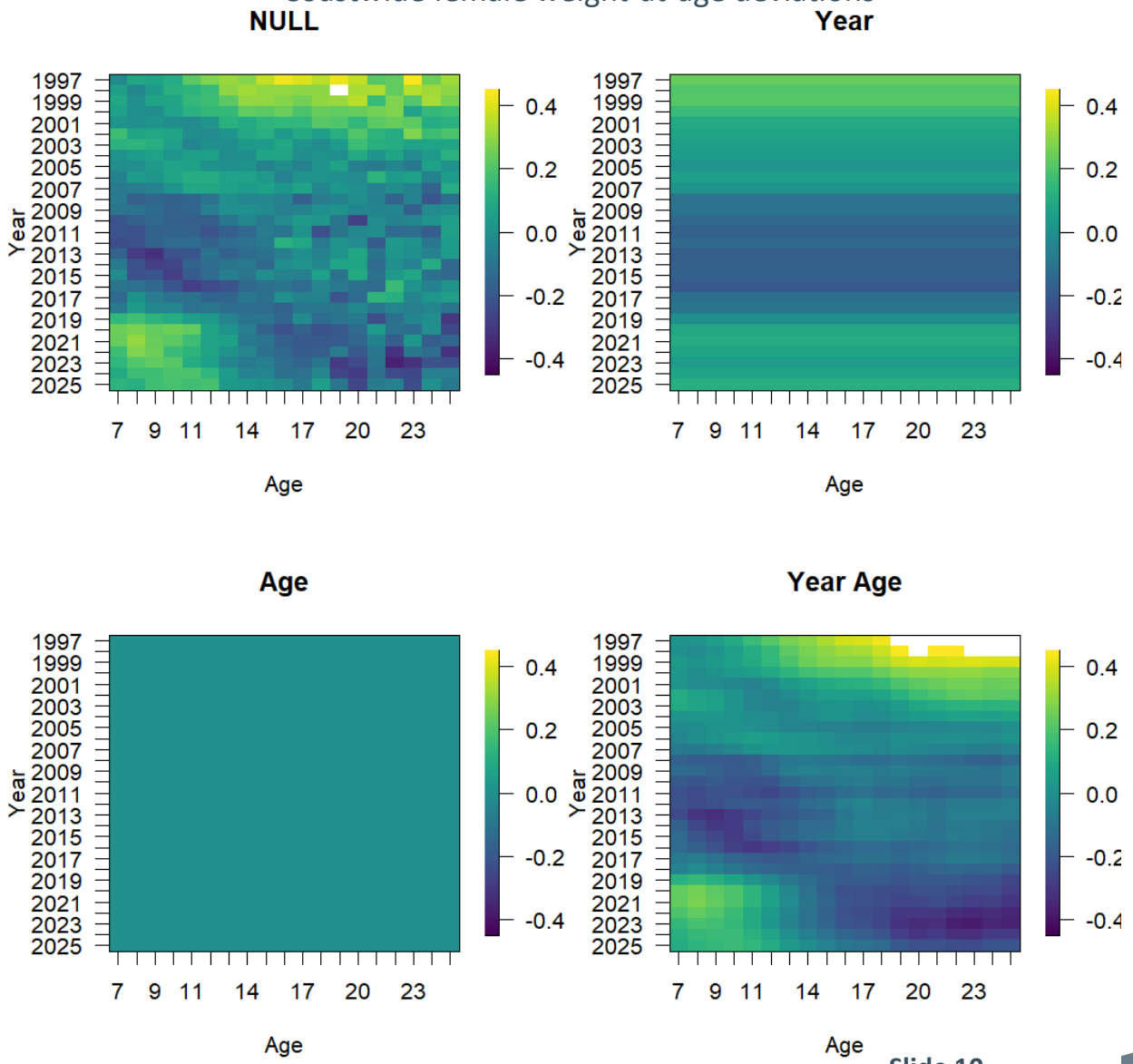
- The year and age effects follow an AR(1) process
  - Year effect determines correlation across time
  - Age effect determines how the deviation changes moving to next age
  - (A cohort effect would specifically parameterize the change for a cohort)
    - year/age diagonal
- Need to specify observation error

$$\hat{W}_{a,y} = W_{a,y} + e^{\tau_{a,y}}$$

Results of the random effects model

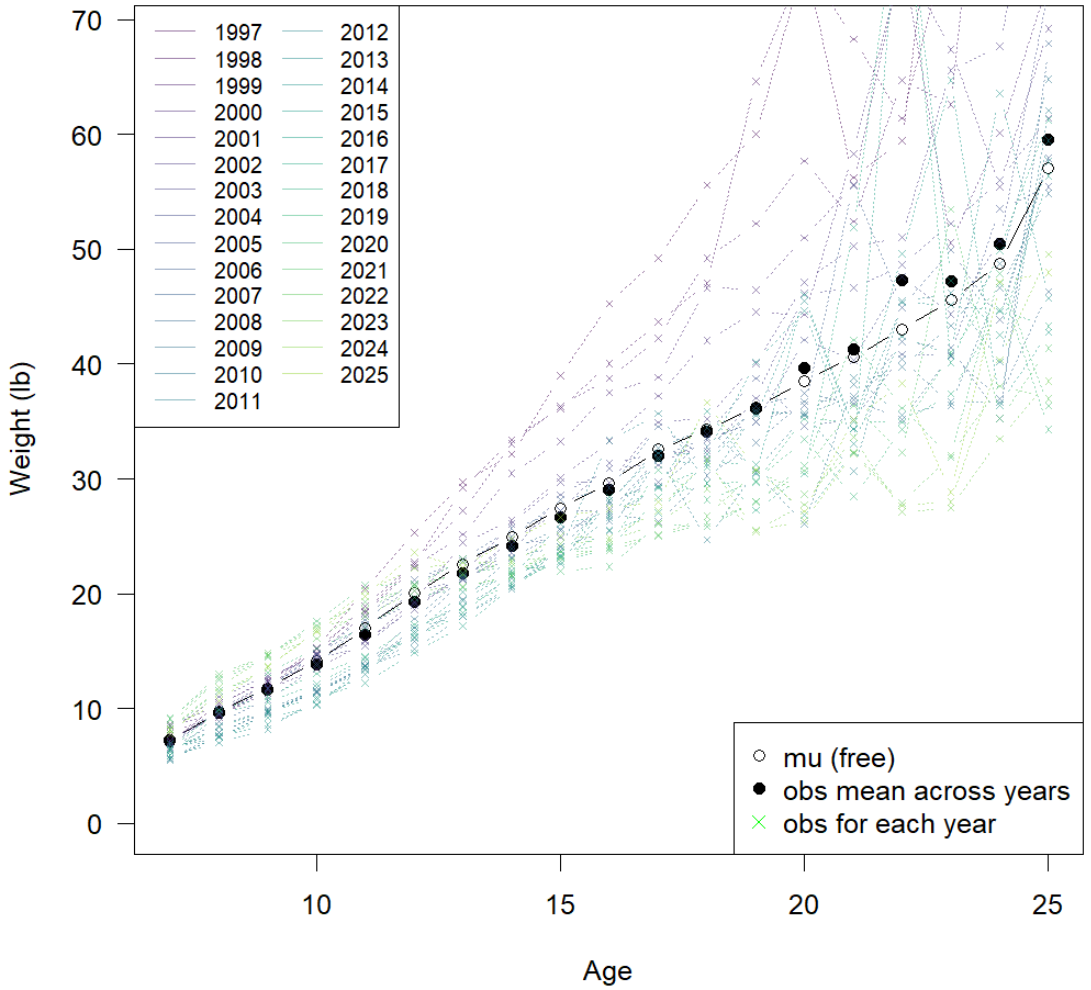
- Random effects model with year and age effects using RTMB
  - Tried cohort effects, but these models did not seem correct (future work)
- The combination of year and age explains cohort trends

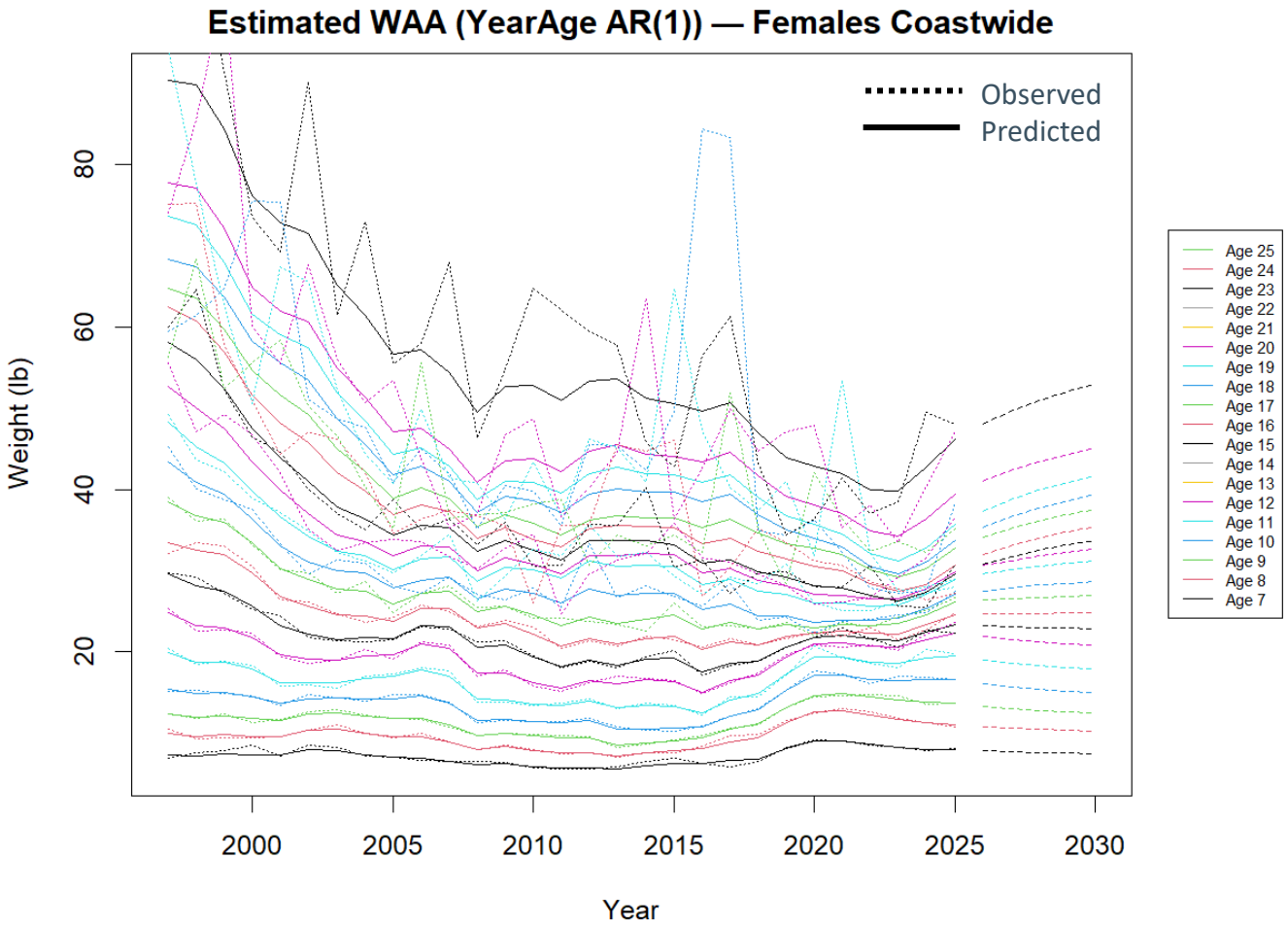
Coastwide female weight-at-age deviations



Model outputs

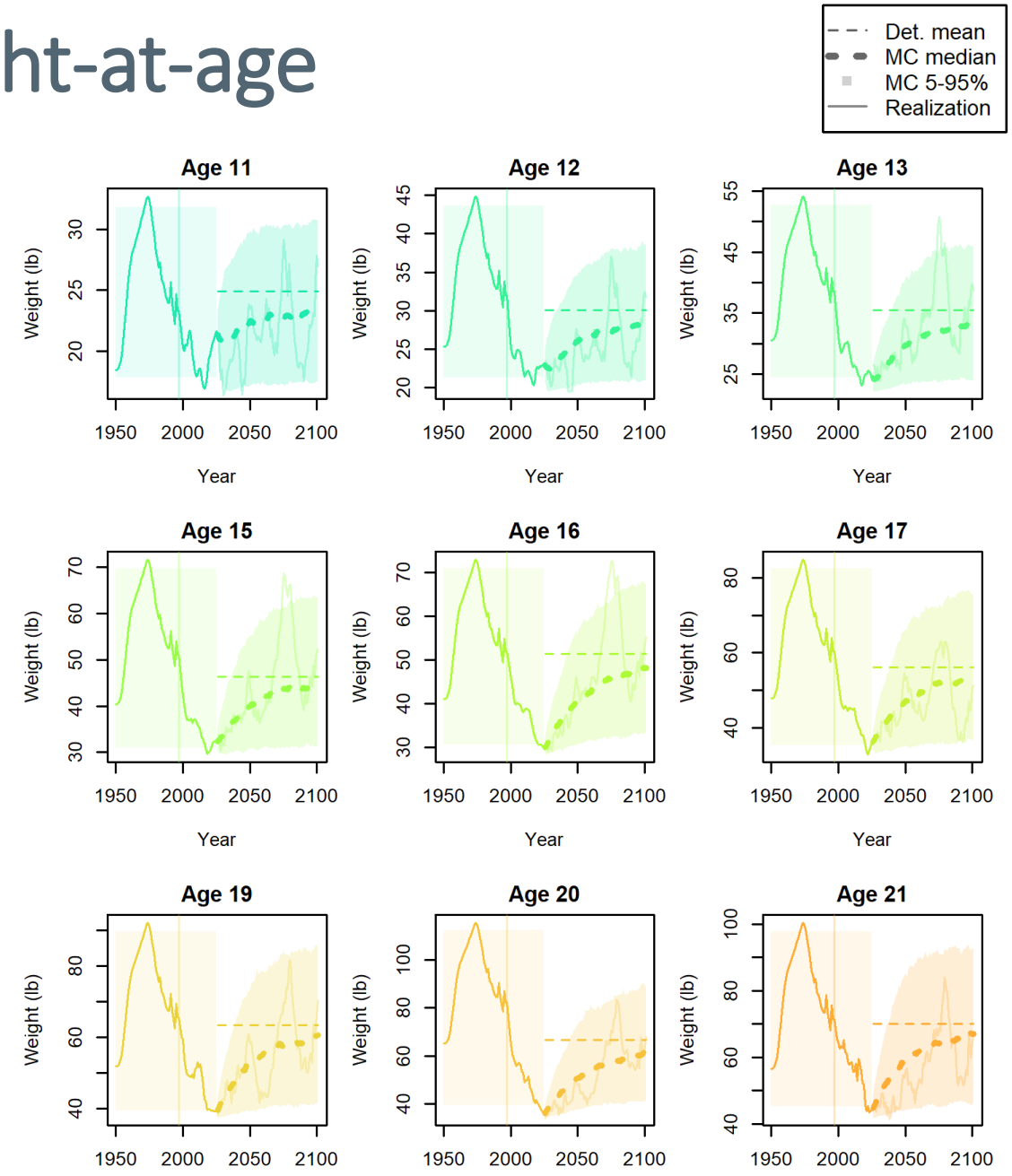
Female coastwide (1997-2025)





Projecting weight-at-age

- The model fitting used data from 1997-2025 and ages 7 to 25
  - Individual observations to calculate observation uncertainty
- Need to project over the entire range of observed mean weight-at-age
  - Much higher in the 1970s and 1980s



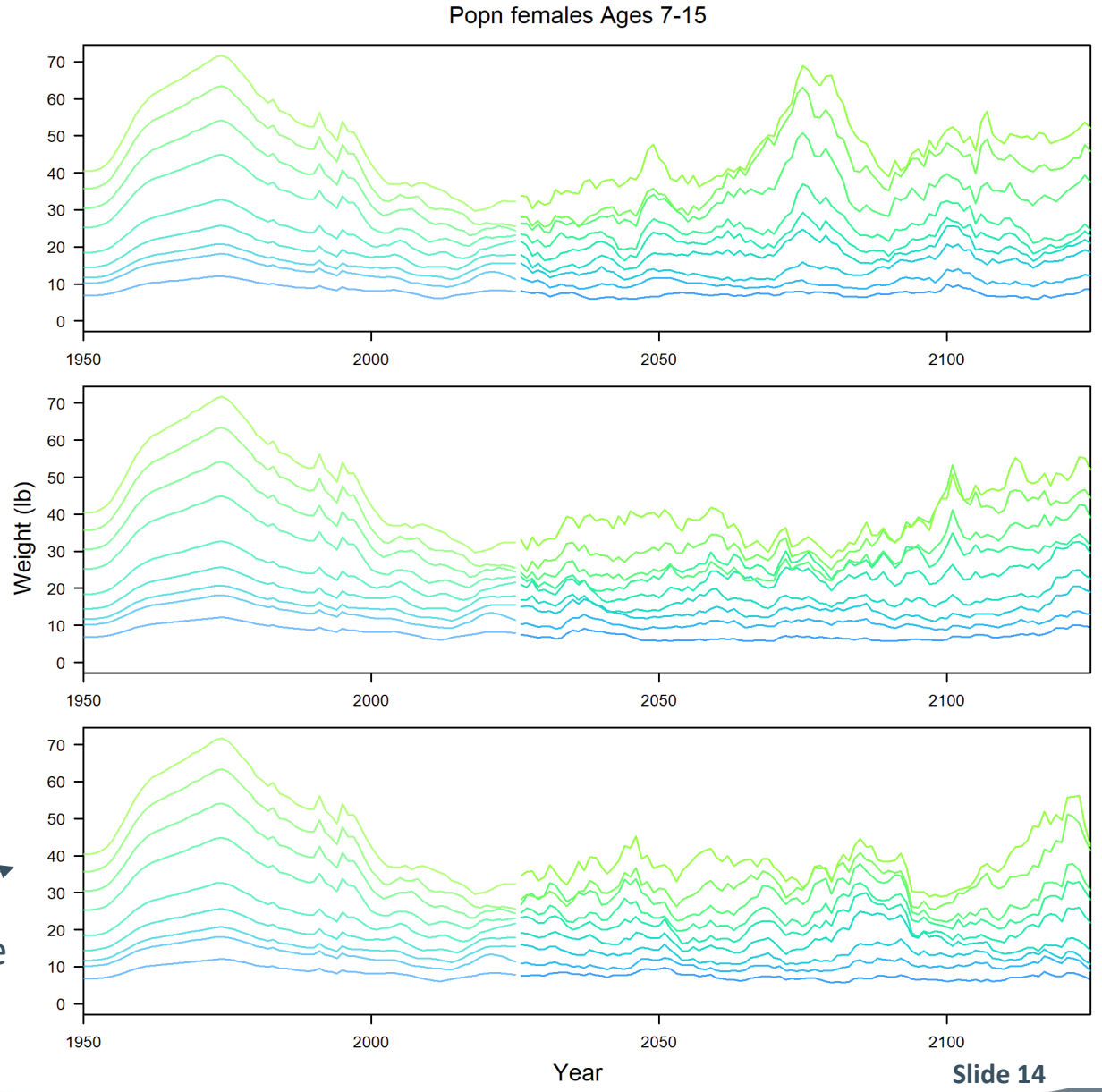
Assumptions for projections

Tuned parameters to meet range observed (1950-2025)

- Age effect as estimated
- mu = median(mean wt-at-age from 1950-2025)
  - Light smoothing over age
- Year correlation = 0.98
  - Increased near-term persistence
- Process error 3X model estimate
- Range: 5% below minimum and at maximum observed mean weight-at-age
- Same deviations across areas and fleets
- Ages 1-30

Projecting weight-at-age

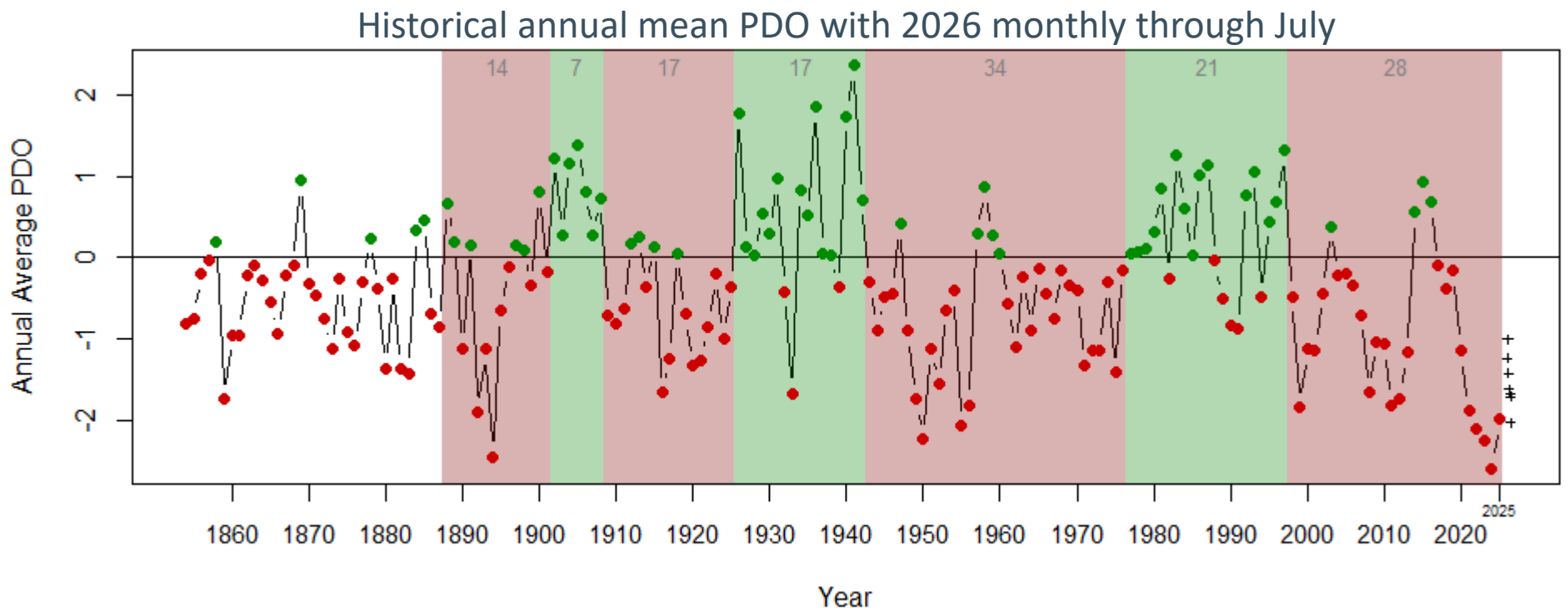
- Weight-at-age is an important sources of variability in stock size
- Goal is to capture slow changes in weight-at-age within the range observed historically
- New method to project weight-at-age also provides insights into some of the factors influencing weight-at-age



Three example projections

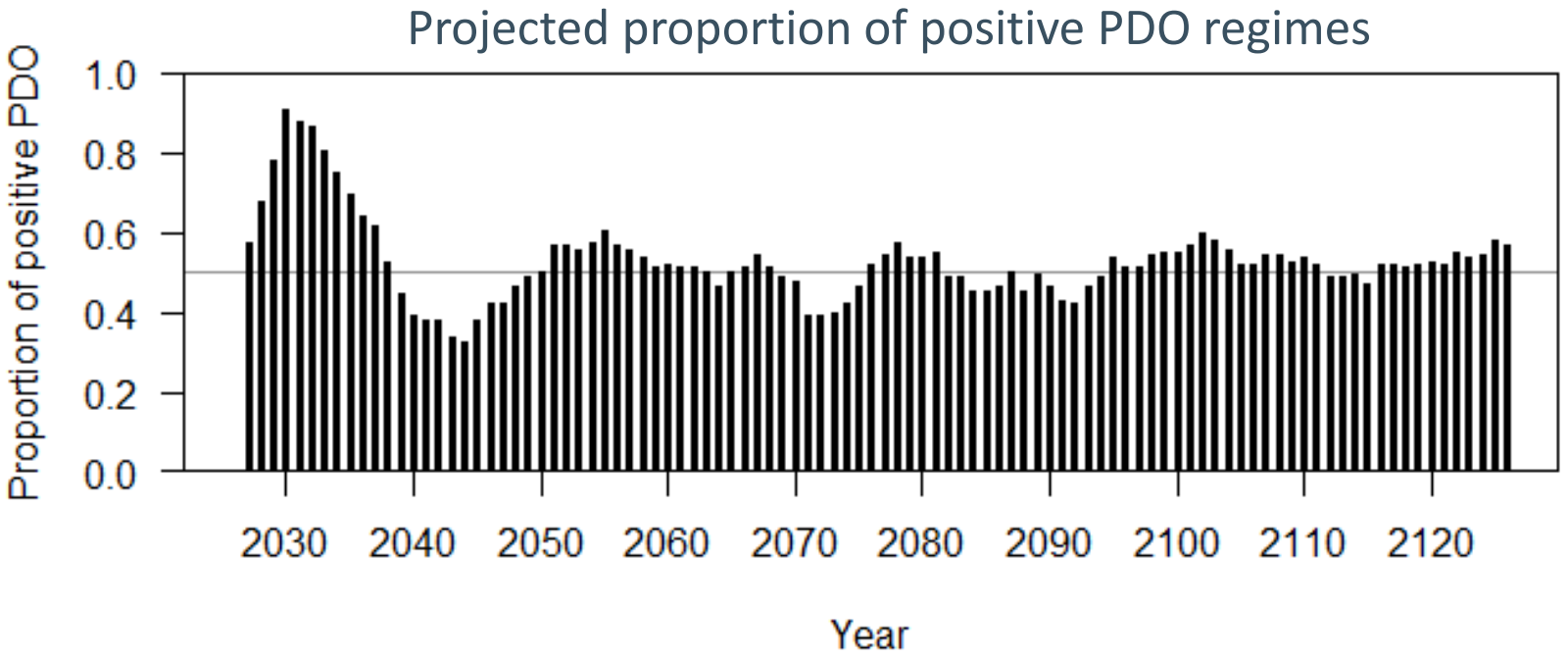
The Operating Model and the PDO

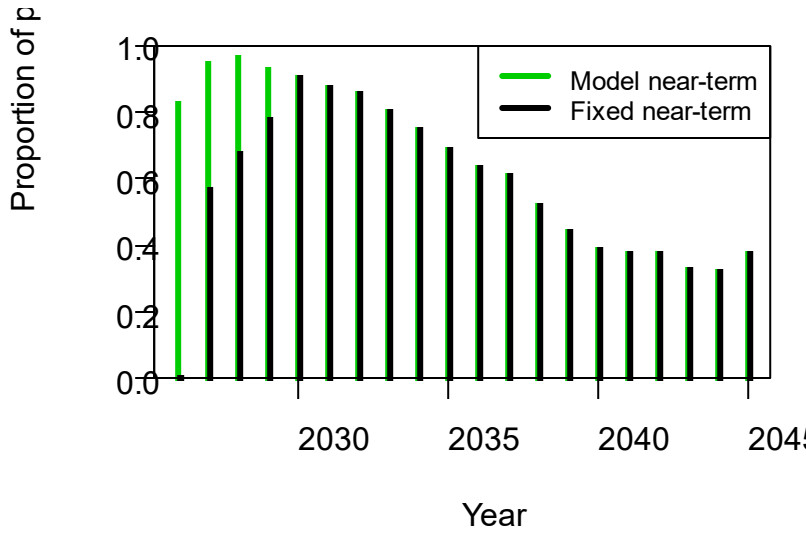
- Positive or negative Pacific Decadal Oscillation (PDO) regimes affect average recruitment, movement, and age-0 distribution
- Negative PDO is associated with a low recruitment regime



Projecting the PDO

- The PDO is projected as positive or negative
- Switches regime randomly but a higher probability of switching the longer the regime has been in place
- A slower switch to a positive regime in the near-term





Alternative methods to project recruitment

Response to SRB028–Req.06

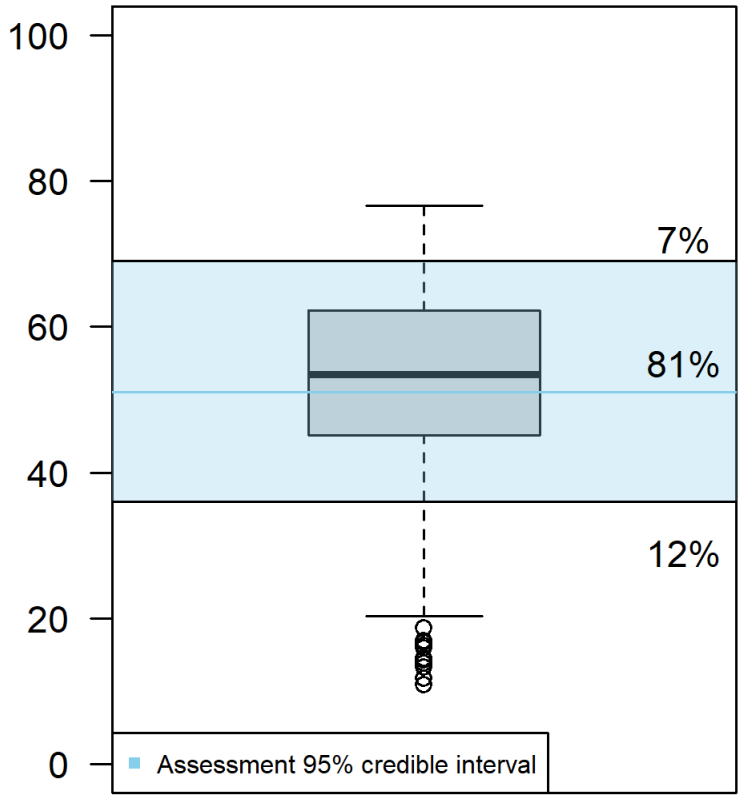
- Projections from climate models
  - PDO represents a combination of processes
  - Makes projecting the PDO beyond one year challenging
  - These projections integrate over low/high regimes while capturing the decadal oscillation
- Autocorrelated recruitment
  - Small amount of autocorrelated recruitment in assessment estimates
    - That is affected by ageing error and other uncertainties
  - Instead, implemented a slower transition out of the recent regime
    - Affects short- and medium-term MSE results

Simulations

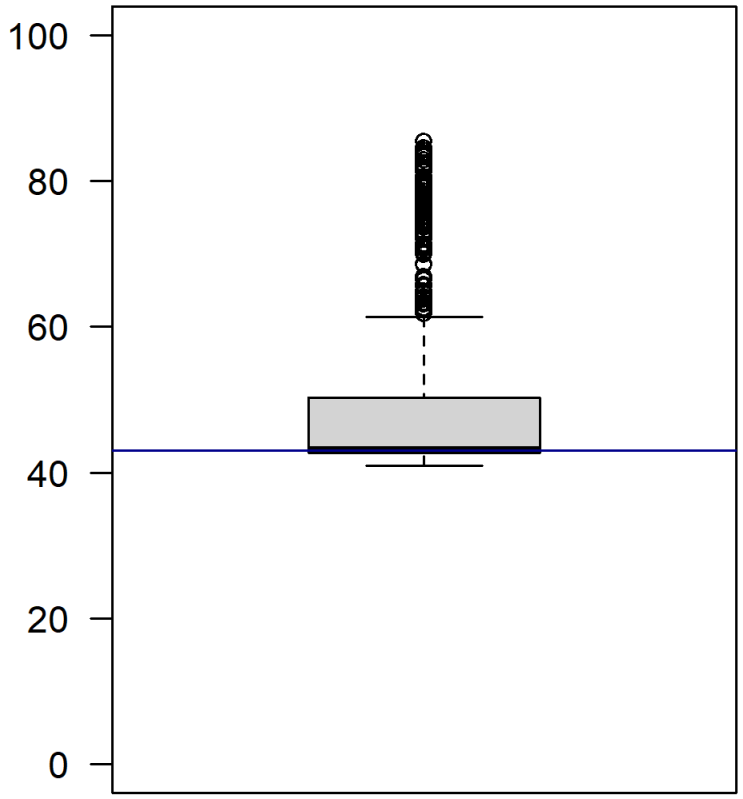
- After a lot of work setting up projections
  - conducted simulations and comparisons to the previous OM and recent expectations
  - Evaluated a range of SPR values

Predictions of SPR

- Fishing mortality is fixed in 2026 at adopted values
  - Assessment estimated that it was associated with an SPR=51%



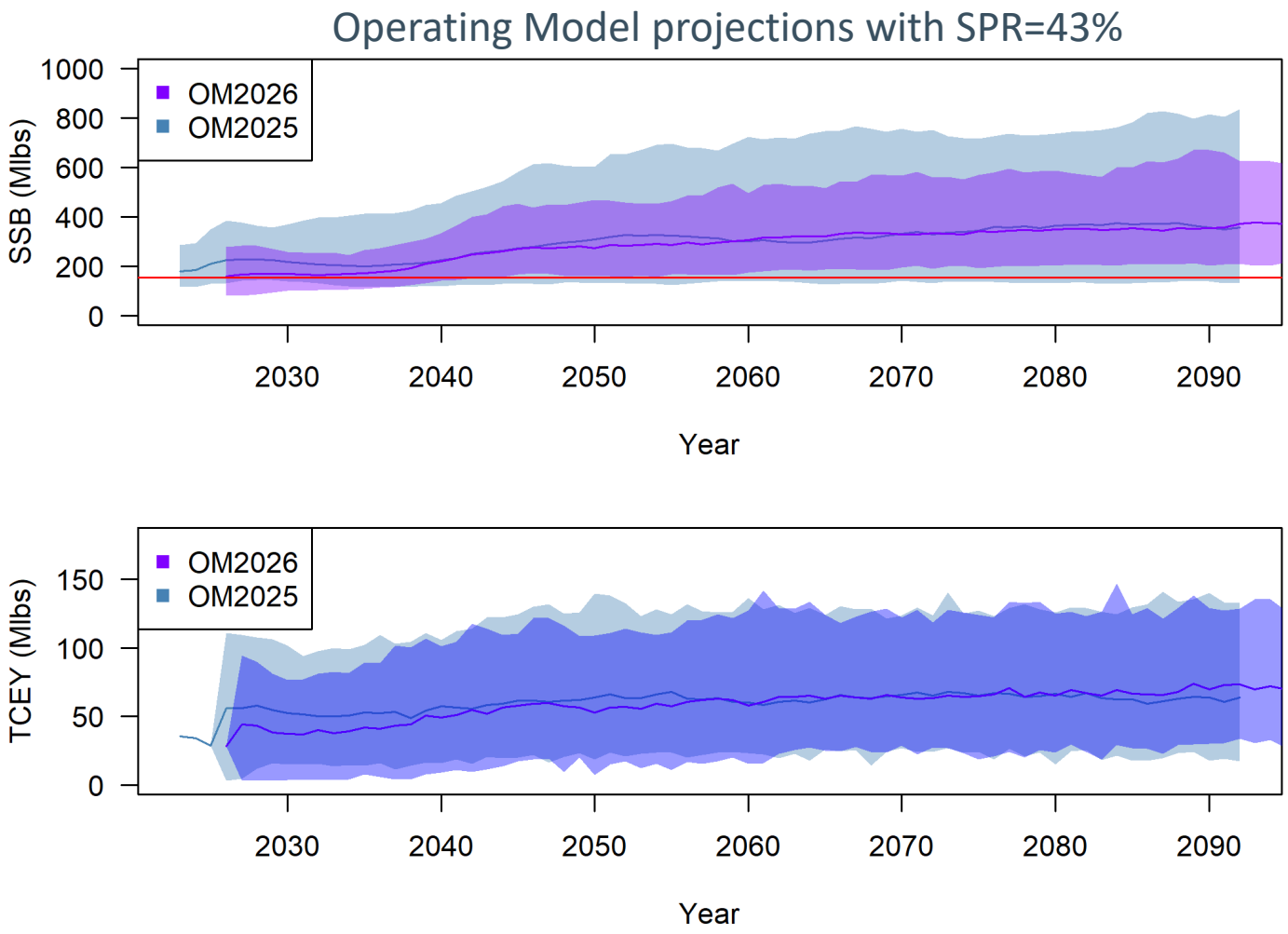
SPR in 2026 with fixed mortality limits



SPR in 2027 with reference 43% and 30:20 CR

Compared to previous OM

- Smaller range of variability in spawning biomass for 2026 OM
- Improvements for 2026 include
  - Incorporate current data and understanding
  - A slower change from recent productivity to average productivity in near-term
  - Improved method to project weight-at-age
  - Optimized code to speed up simulations



2026 MSE results (compared to 2025)

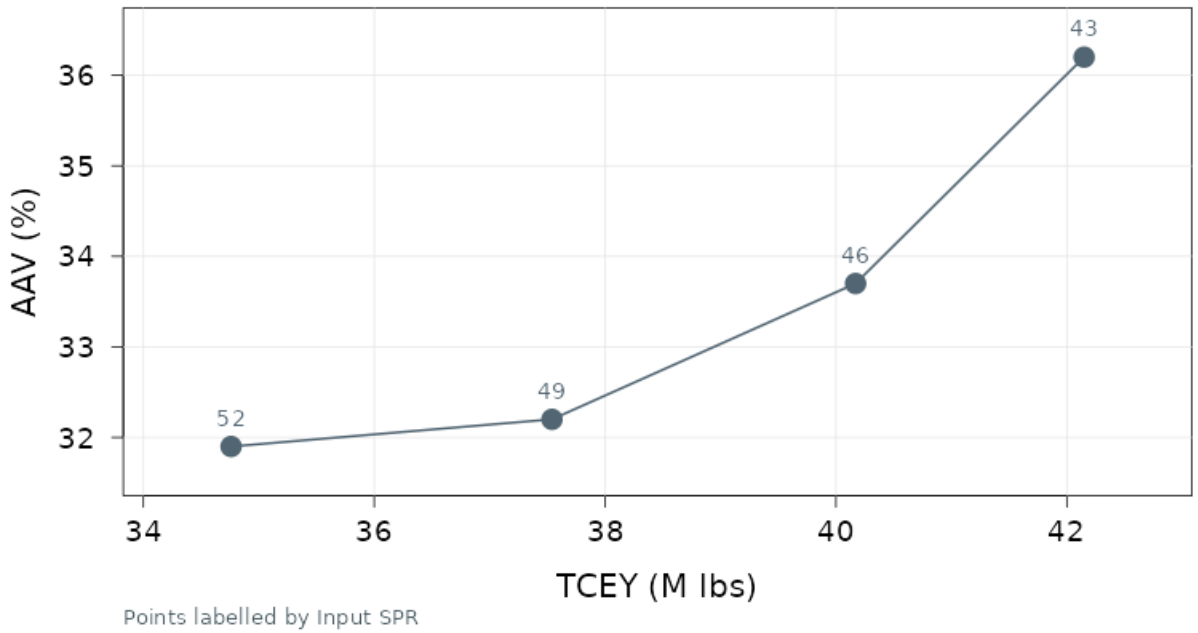
- Higher chance to be below long-term 36% relative spawning biomass
- Slightly lower short-term TCEY
- Higher inter-annual variability (which may be a result of smaller TCEYs)
- Higher chance of being below 2023 spawning biomass in the short-term

		Integrated (low & high) Productivity	
		OM2025	OM2026
	SPR (%)	43	43
Long-term	P(RSB<20%)	<0.001	<0.001
	P(RSB<36%)	0.195	0.263
Short-term	Median TCEY (Mlbs)	52.0	42.2
	AAV	26.3%	36.2%
	P(SB < SB_{2023})	0.350	0.578

Evaluate a range of SPR values

- For SPRs from 43% to 52%
  - Biomass objectives pass
  - TCEY gains are less the 1 Mlbs per 1% SPR
    - gains are slightly greater from 52% to 49% (2.7 Mlbs) than 46% to 43% (2.0 Mlbs)
  - TCEY variability declines most from SPR=43% to SPR=49%

	Integrated (low & high) productivity				
	SPR (%)	52	49	46	43
Long-term	P(RSB<20%)	<0.001	<0.001	<0.001	<0.001
	P(RSB<36%)	0.001	0.015	0.088	0.263
Short-term	Median TCEY	34.8	37.5	40.2	42.2
	AAV	31.9%	32.2%	33.7%	36.2%
	P(SB < SB_{2023})	0.350	0.420	0.498	0.578

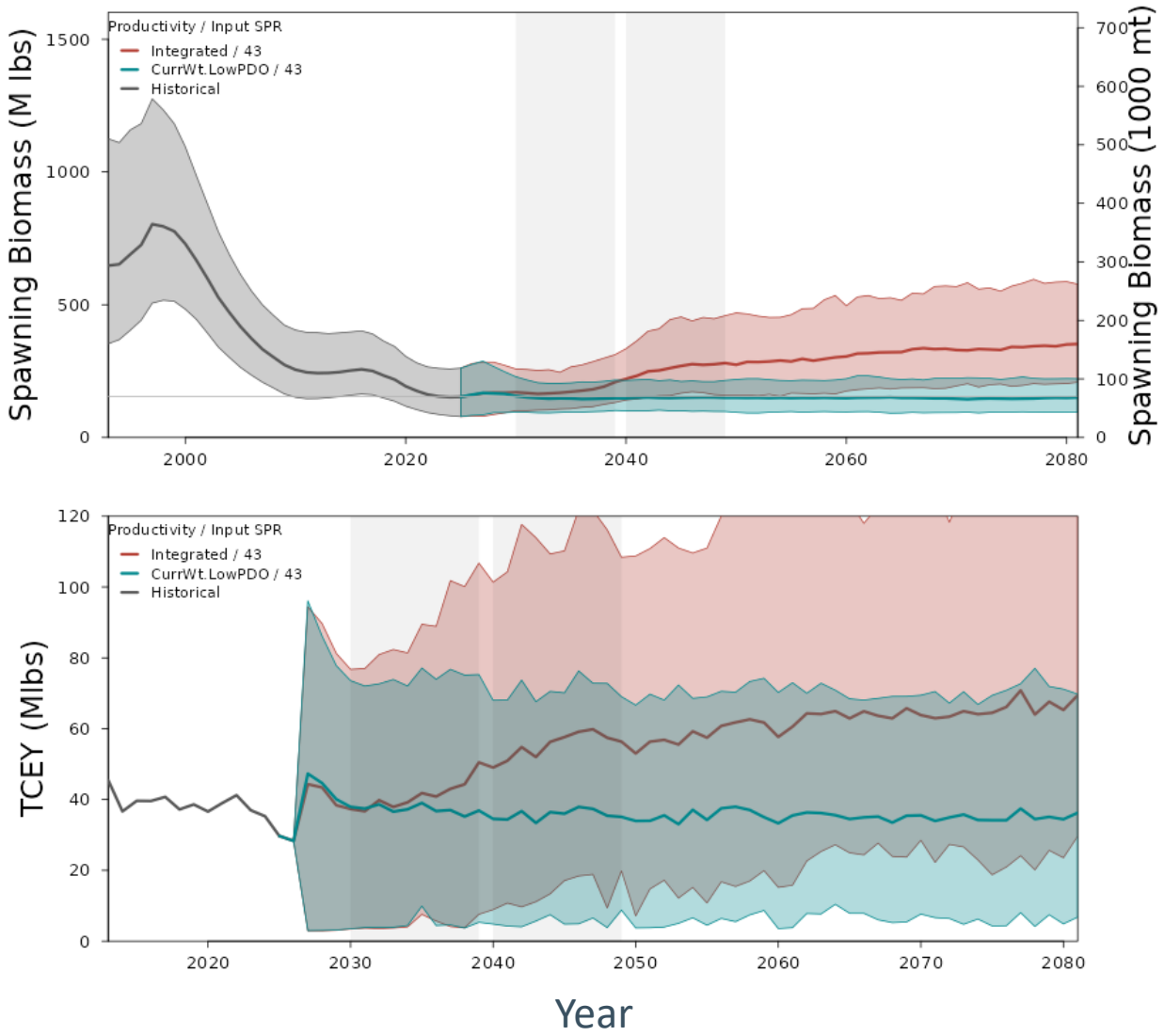


Future MP elements to evaluate

- SPR=40% and 55% (MSAB)
- Triennial assessment frequency with various empirical rules (Commission & MSAB)
- Constraints and smoothers (Commission & MSAB)
- Alternative HCRs (SRB)

Investigate Productivity Regimes

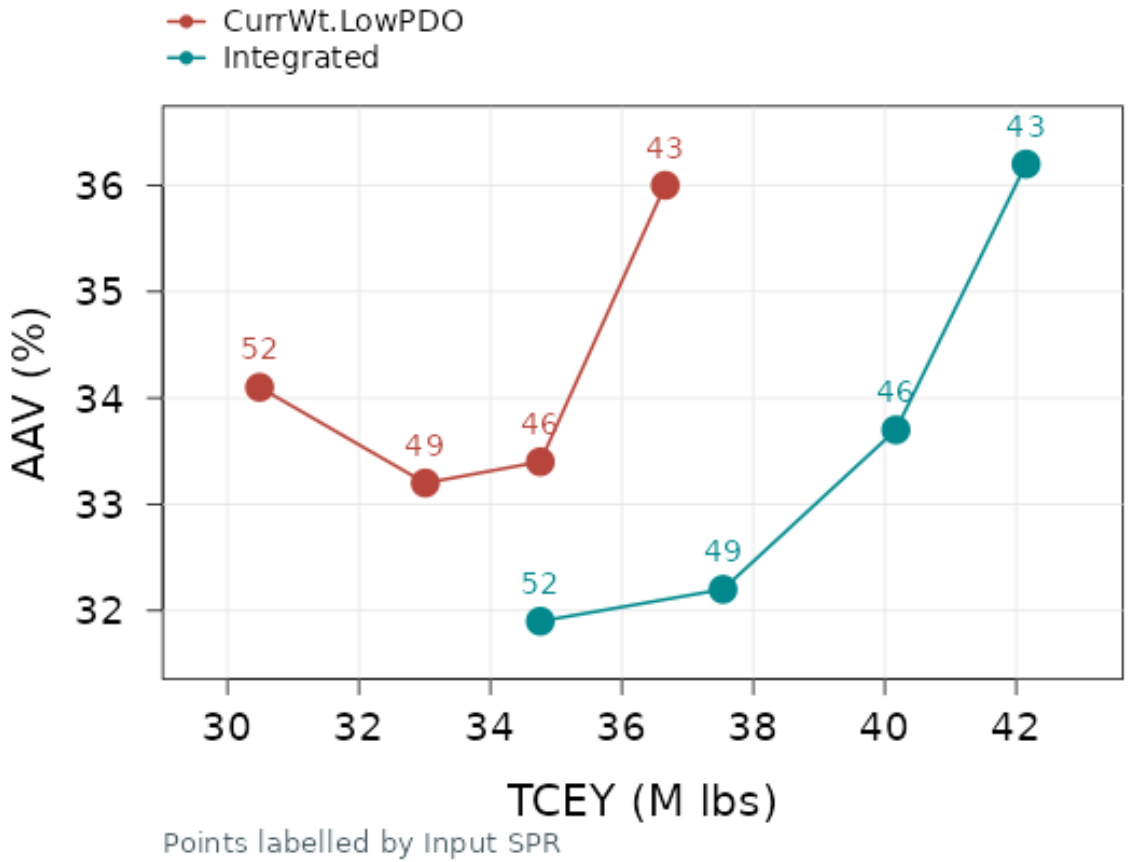
- OM projects a similar biomass and TCEY in the near-term for integrated and current productivity
- Long-term spawning biomass is similar to spawning biomass in 2023
- Current productivity regime shows a much lower SB and TCEY than integrated productivity
  - Therefore, it is important to show projections with different productivity assumptions



Additional trace plots in MSE-Explorer

Current productivity MSE results

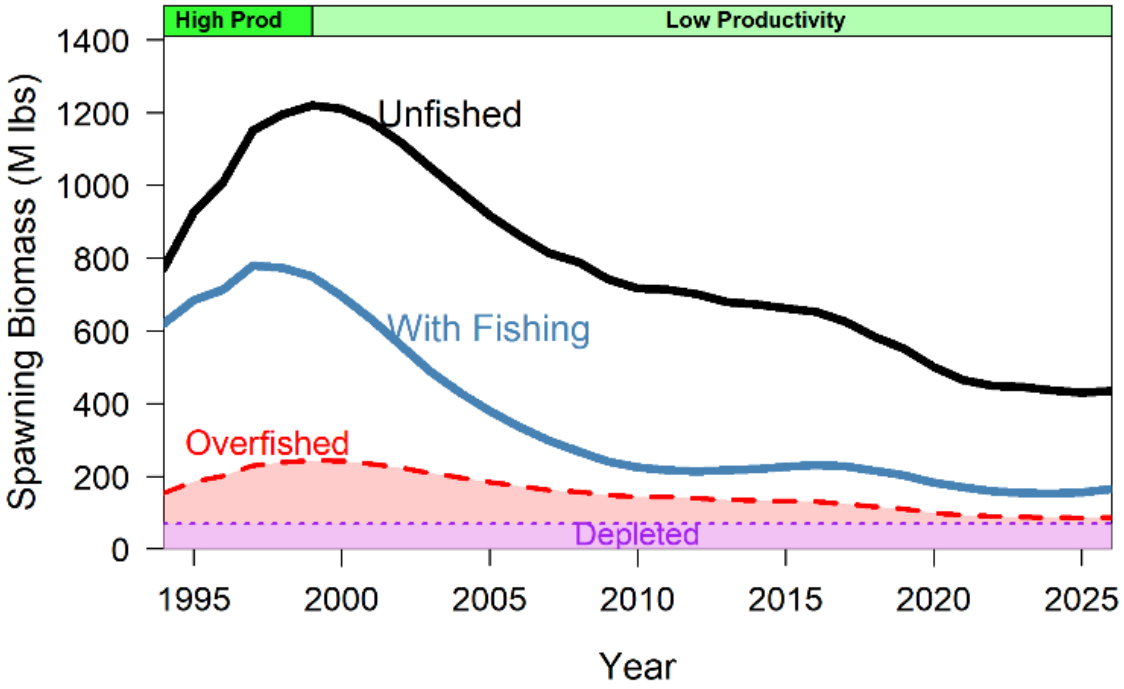
	Integrated (low & high) productivity				
	SPR (%)	52	49	46	43
Long-term	P(RSB<20%)	<0.001	<0.001	<0.001	<0.001
	P(RSB<36%)	0.001	0.015	0.088	0.263
Short-term	Median TCEY	34.8	37.5	40.2	42.2
	AAV	31.9%	32.2%	33.7%	36.2%
	$P(SB < SB_{2023})$	0.350	0.420	0.498	0.578
	Low (current) Productivity				
	SPR (%)	52	49	46	43
Long-term	P(RSB<20%)	<0.001	<0.001	<0.001	<0.001
	P(RSB<36%)	0.081	0.219	0.421	0.629
Short-term	Median TCEY	30.5	33.0	34.8	36.7
	AAV	34.1%	33.2%	33.4%	36.0%
	$P(SB < SB_{2023})$	0.544	0.610	0.666	0.744

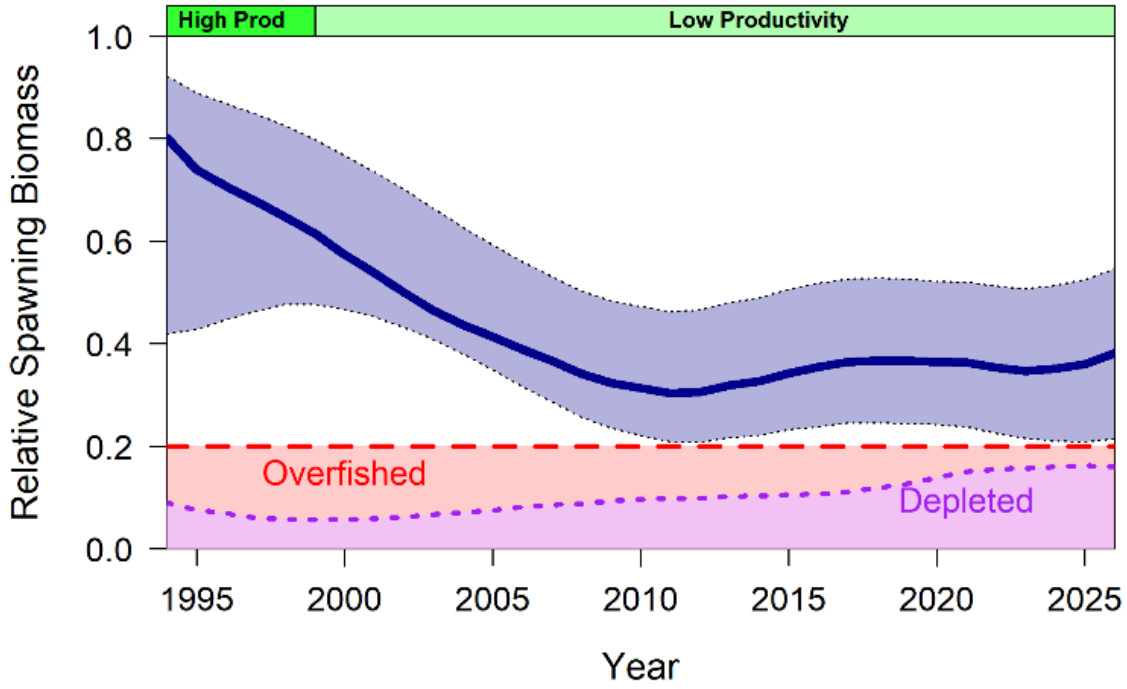


Further develop the depleted concept

The IPHC HSP describes two reference points related to spawning biomass:

- **Overfished**: the female **dynamic spawning biomass** level where the ecological risk to the population and the risk to the health of the fisheries is regarded as unacceptable.
- **Depleted**: the female **absolute spawning biomass** level below which the potential for recovery is uncertain.





Further develop the depleted concept

Three possible approaches to identify an appropriate depleted level

1. Use the lowest spawning biomass observed in the estimated time series from the stock assessment, which is 153 Mlbs in 2024.
   - The estimated spawning biomass in the 1970s may have been at similar levels, but recent levels are estimated to be low with much greater certainty.
2. Use a low spawning biomass level that was associated with a high recruitment event. This could be 215 Mlbs that produced the 2012 year-class.
3. Use simulation (via the MSE framework) to determine an absolute spawning biomass reference point where the potential for recovery is uncertain based on our scientific understanding of biological and reproductive dynamics.
   - This would involve simulating the Pacific halibut population forward at a high fishing rate for many years under a 'worst-case' scenario (e.g. low weight-at-age, low PDO) and then transition to simulating without fishing.

Recommendations

That the SRB:

- **NOTE** paper IPHC-2026-SRB029-07 which provides an update on progress for the MSE Program of Work in 2026 and preliminary results from the updated MSE framework.
- **NOTE** that the MSE operating model (OM) has been reconditioned for 2026 using updated stock assessment inputs and improved weight-at-age and recruitment simulation methods, resulting in a more gradual increase away from current productivity and a narrower range of projected spawning biomass than the 2025 OM.
- **NOTE** that simulations across a range of SPR values and productivity scenarios are underway and a full report is to be provided at IM102.
- **NOTE** that productivity has a large effect on long-term projected outcomes.
- **NOTE** that the Secretariat has identified three candidate approaches for defining an absolute spawning biomass reference point for Depleted and will continue to work with the SRB on this topic.
- **REQUEST** any management procedures and scenarios to evaluate before IM102, including the outstanding recommendation (**SRB028-Rec.01**) and request (**SRB028-Req.05**) from SRB028.
- **REQUEST** any analyses to be provided at SRB030.

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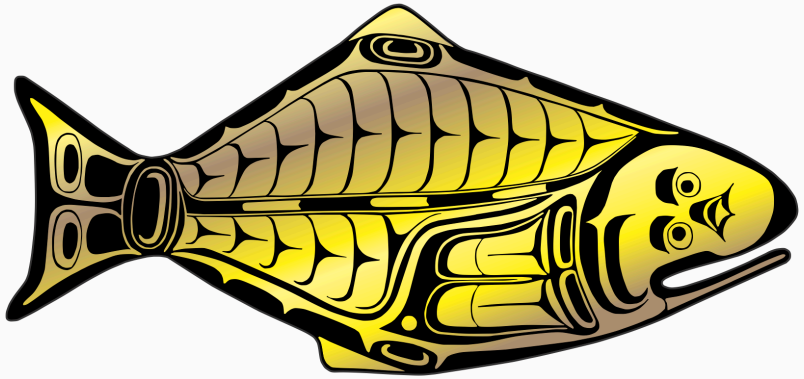

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