INTERNATIONAL PACIFIC HALIBUT COMMISSION

Development of the 2026 stock assessment

Agenda item: 4.1.2
IPHC-2026-SRB028-07
(I. Stewart & A. Hicks)

Outline

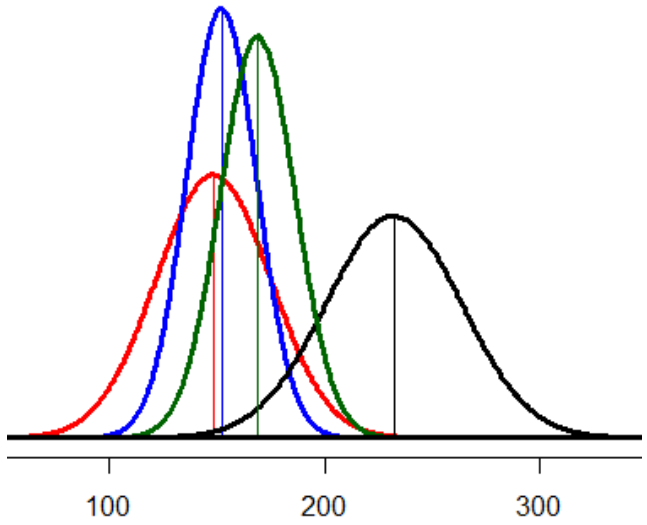
- Stock assessment process
- Time-series and software updates
- SRB requests
  - State-space model development
  - Decision table evaluation (receiver operating characteristic curves)
- Other topics

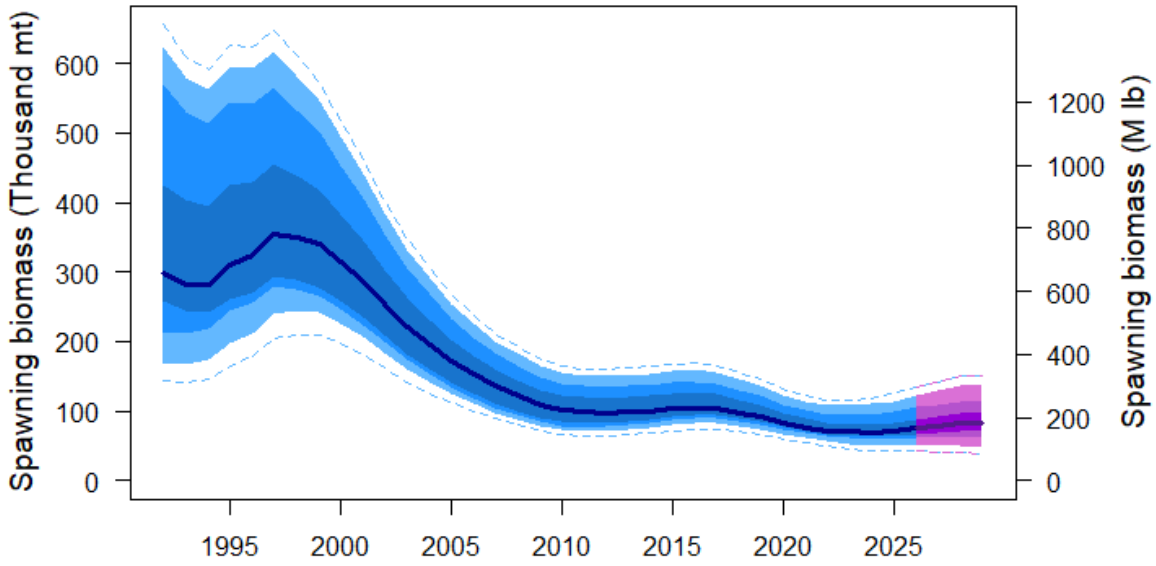
Stock assessment and review process

- Full stock assessments – every ~3 years
  - 2015, 2019, 2022, 2025
  - Includes re-evaluation of all data sources, model structure, etc.
- Updated stock assessments in intervening years
  - **2026**
  - Only minor/necessary changes as data sets and methods evolve

The stock assessment ensemble

- 4 models:
  - Long and short time-series
  - Aggregated and separated data by Region
- Each responds differently to new data and represents a different hypothesis about how the population dynamics and observations are best represented
- Results are equally weighted and integrated into a single probability distribution





Time-series update

- Extend all four models by 1 year (to include 2026)
- 2026 projected mortality based on adopted mortality limits
- No change to the parameter estimates or previous results
- Allows direct comparison of each incremental change from the final 2025 stock assessment to the final 2026 stock assessment (bridging analysis)

Software update

- Stock synthesis version 3.30.23.1 to 3.30.24.02
- No change to any of the features used in the Pacific halibut stock assessment
- No change to parameter estimates or model results

SRB requests and recommendations

SRB026 (para. 26):

*"The SRB **RECOMMENDED** that a candidate state space assessment model (e.g. WHAM) be developed for Pacific halibut and presented by SRB032, tentatively scheduled for June 2028. Progress toward this modelling framework may also be presented at interim SRB meetings."*

Assessment platforms

- Potential addition/replacement of models in the current ensemble for 2028
- Specific features important to the Pacific halibut assessment
  - Time-varying processes (random effects): selectivity, catchability, …
  - Sex-specific dynamics
  - Multiple ageing error matrices (surface, break & bake, AI)
  - Environmental covariates to the S-R function
  - Prior distribution on M

Assessment platforms

- Generalized and widely used platform vs. customized but local code
  - Ease of transfer among authors
  - Review transparency
  - Standardized diagnostics
  - Comparison of currently existing generalized platforms (Table 1):

Model	Reference	Sex-specific dynamics	Multiple aging error matrices	Environmental covariates to S-R function	Time varying selectivity	Prior distribution for M	Used for assessments informing management
SAM	Nielsen and Berg 2014	No	No	Yes	Yes	Yes	Yes
WHAM	Stock and Miller 2021	No	No	Yes	Yes	No	Yes
FIMS	None	No	No	No	No	Yes	No
SPoRC	Cheng et al. 2026	Yes	No	No	Yes	Yes	No
CEATTLE	Adams et al. 2022	Yes	Yes	Yes	Yes	Yes	Yes

Assessment platforms

- Currently testing implementation of a Pacific halibut model in WHAM and CEATTLE
- Potential to add features to existing open-source code if needed
- Development of multiple modelling platforms is moving quickly and additional alternatives for the IPHC may emerge in the very near future

SRB requests and recommendations

SRB027 (para. 16):

*"The SRB **RECOMMENDED** that the analysis of projection performance be expanded to include plotting receiver operating characteristic (ROC) curves and evaluating the area under the curve (AUC) to understand the predictive performance of probabilistic advice from the stock assessment projections. This approach is commonly used as a threshold-independent metric of performance in applications such as species distribution modelling."*

The decision history

	What we think happened			What we projected at the time
Decision year	**SB**	**Percent change**		**Probability of stock decline**
2013	216.5	1.8%		84%
2014	220.4	3.0%		67%
2015	227.1	1.9%		30%
2016	231.4	-1.3%		29%
2017	228.3	-6.0%		71%
2018	214.7	-5.8%		93%
2019	202.2	-9.6%		84%
2020	182.9	-7.4%		95%
2021	169.4	-6.0%		65%
2022	159.2	-2.9%		59%
2023	154.7	-1.0%		38%
2024	153.2	1.3%		40%
2025	155.1	7.0%		25%
2026	166.0	??		14%

Receiver-operating characteristic analysis

- Generally used to compare and evaluate testing or detection methods
  - True positive vs. false positive rates

- We compare the frequency of projections of spawning biomass with differing levels of certainty to the estimated trends:

		Spawning biomass projection	
		Declining	Not declining
Actual SB trend	Declining	P_t	N_f
	Not Declining	P_f	N_t

Receiver-operating characteristic analysis

- Proportion of years with true positive projections of declining spawning biomass:

$$\boldsymbol{Proportion\ true\ positive} = \frac{\boldsymbol{P_t}}{\left(\boldsymbol{P_t} + \boldsymbol{N_f}\right)}$$

- Proportion of years with true positive projections of declining spawning biomass:

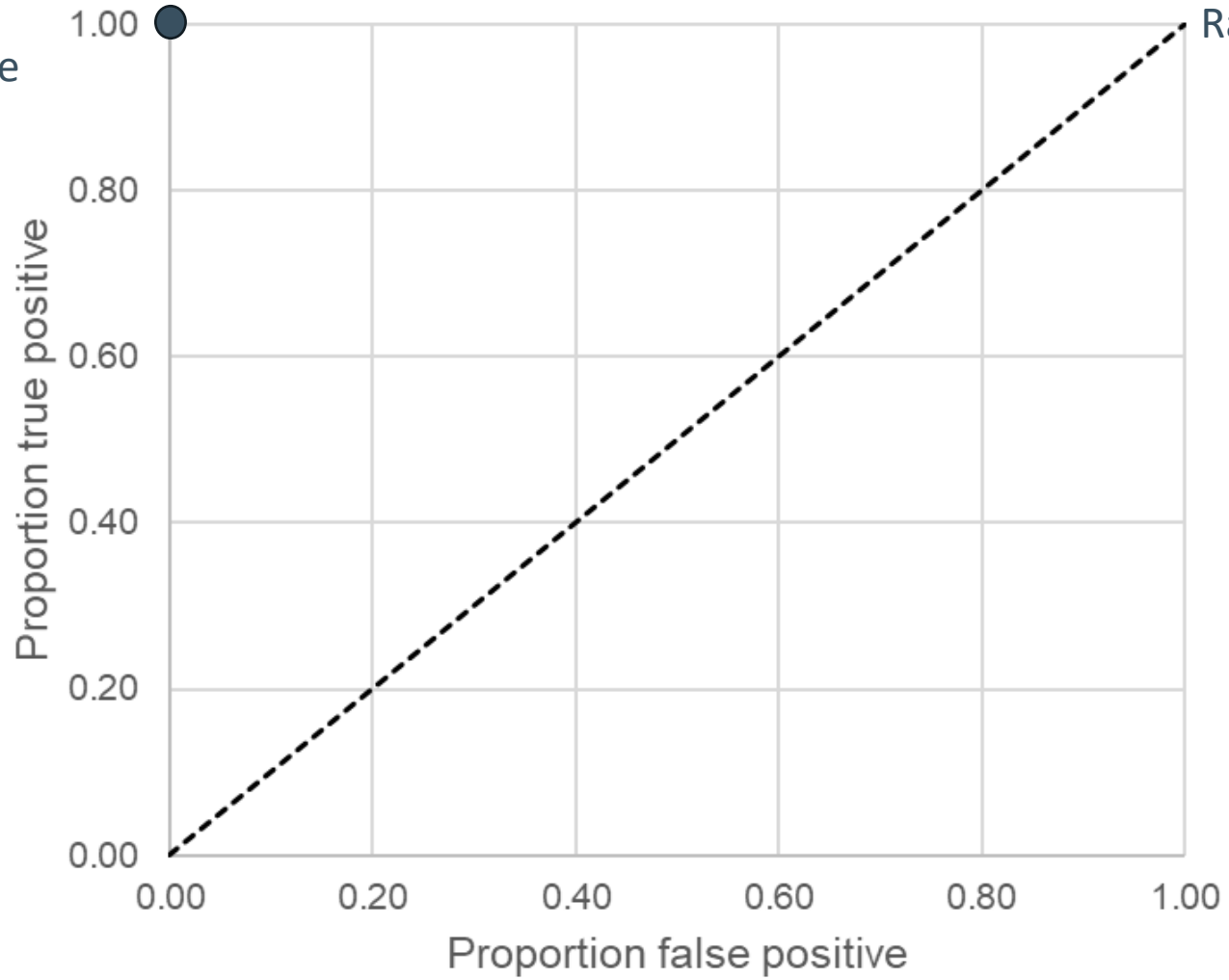
$$\boldsymbol{Proportion\ false\ positive} = \frac{\boldsymbol{P_f}}{\left(\boldsymbol{P_f} + \boldsymbol{N_t}\right)}$$

Application to Pacific halibut

- Consider incremental estimated values of the probability of SB decline (5-95%) as alternative ‘testing’ methods
- Apply to different levels of estimated SB decline:
  - Any decline
  - >1%
  - >2%
  - >3%

Area-Under-the-Curve plots

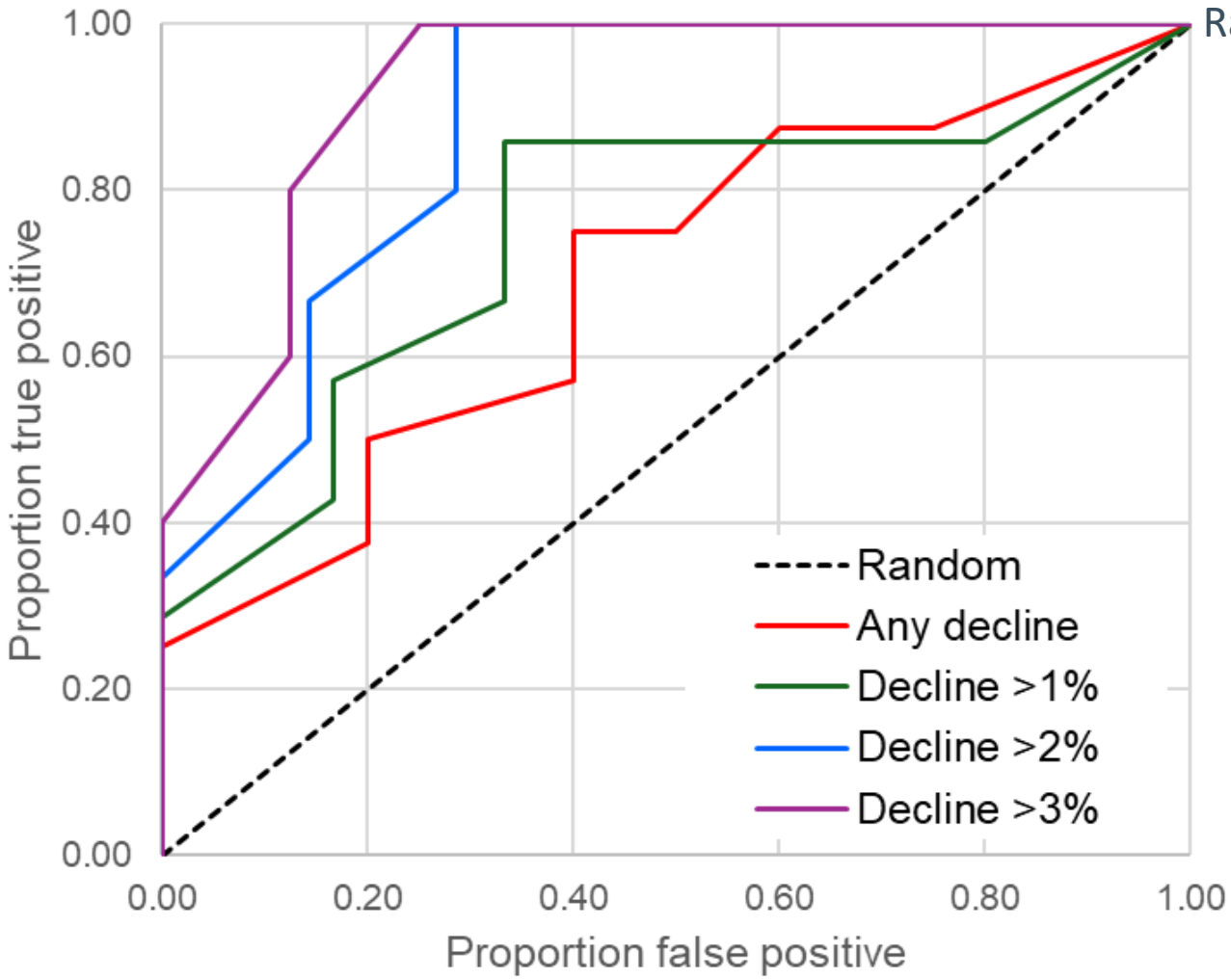
Perfect test performance



Random test performance

Area-Under-the-Curve plots

Lines connect incremental values for probability of projected decline in SB from 5-95%

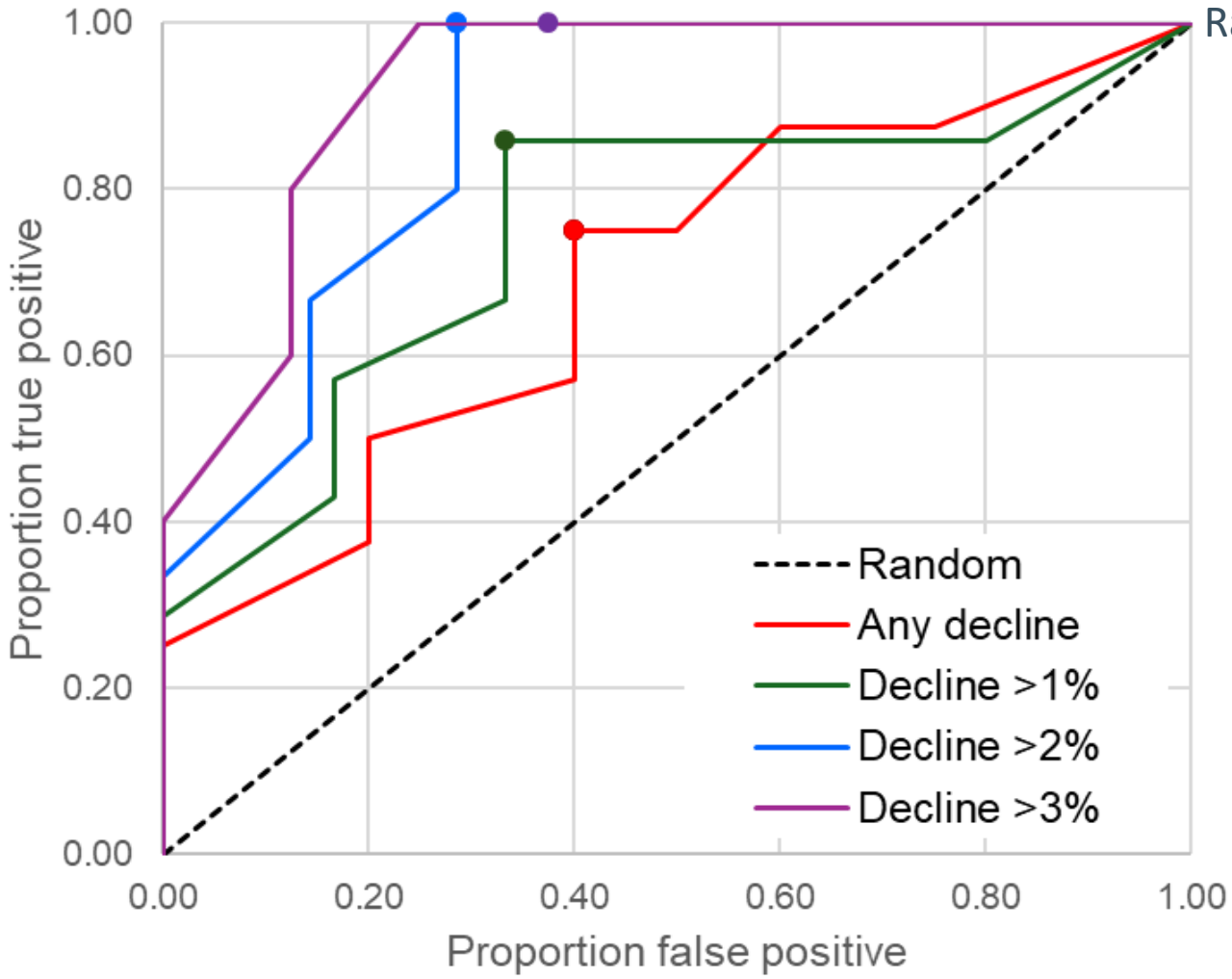


Random test performance

Area-Under-the-Curve plots

Lines connect incremental values for probability of projected decline in SB from 5-95%

Points indicate estimated probability of decline of 50%



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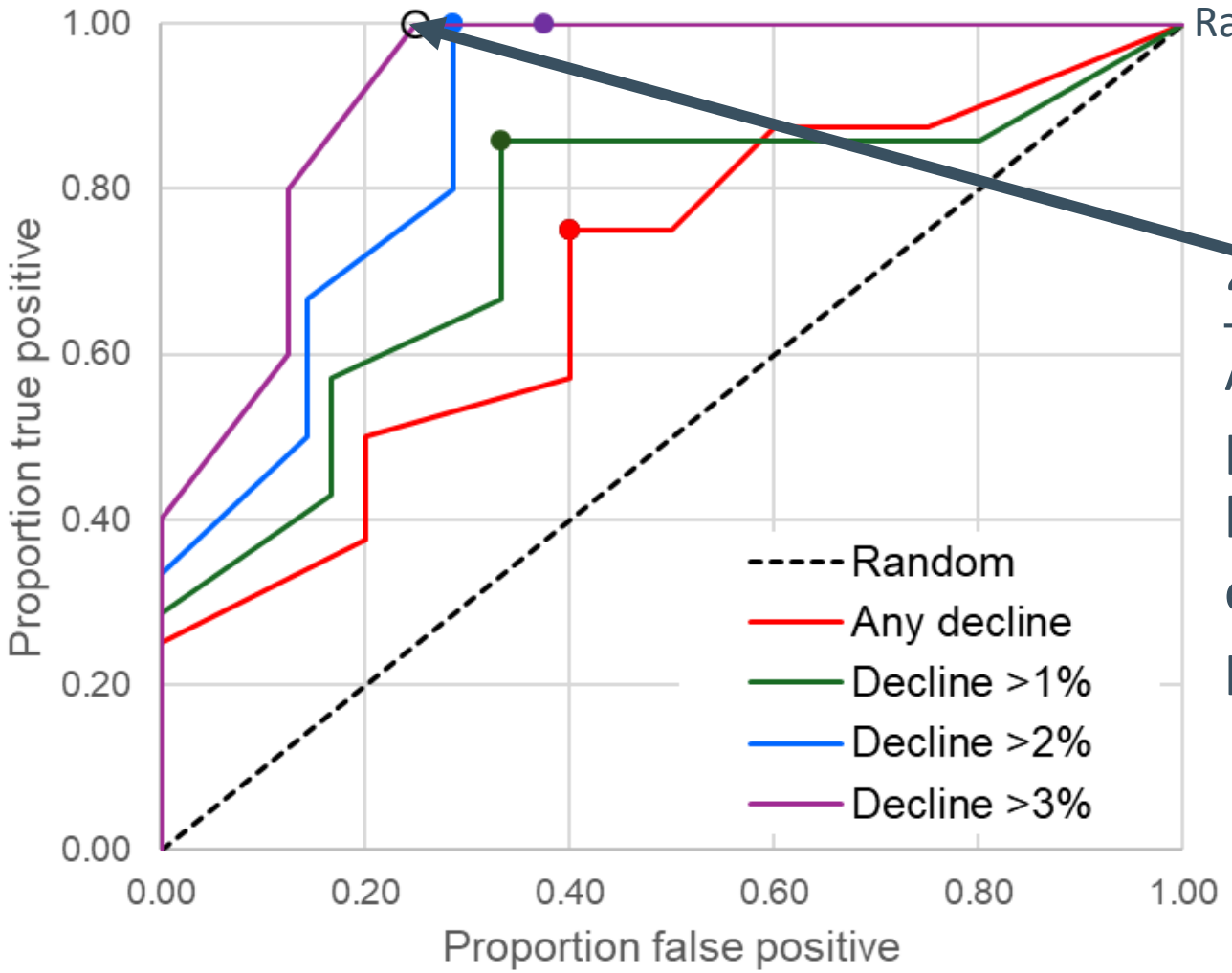

'Best' performing test: A projected 60% probability of decline has a true positive rate of 1.00 and a false positive rate of 0.25

ROC-AUC conclusions

- If we accept that at least a 3% decline in SB in important
  - A high probability (>50%; 50/100) of decline estimated in the annual Harvest Decision table has correctly identified this in all years that it has occurred.
  - The rate at which this has incorrectly been projected is 0.25.
- The decision table provides a reasonably strong ‘test’ to detect upcoming SB decline with a low false positive, especially if the estimate probability of decline is high.
- Sample size is only 13 years and there have been changes in the models and approach over that time

2026 Stock assessment timeline

- September (SRB meeting): Response to June SRB requests
  - No further model changes except as recommended by SRB029
- October: Final 2026 data sets become available
- 1 November: Data sets close for 2026
- Late November: 2026 stock assessment results provided to the Commission

Recommendations

a) **NOTE** paper IPHC-2026-SRB028-07 which provides a response to requests from SRB026 and SRB027, and an update on model development for 2026.

b) **REQUEST** any analyses to support the final 2026 stock assessment.

c) **REQUEST** any further analyses to be provided at future SRB meetings as part of the longer-term stock assessment development.

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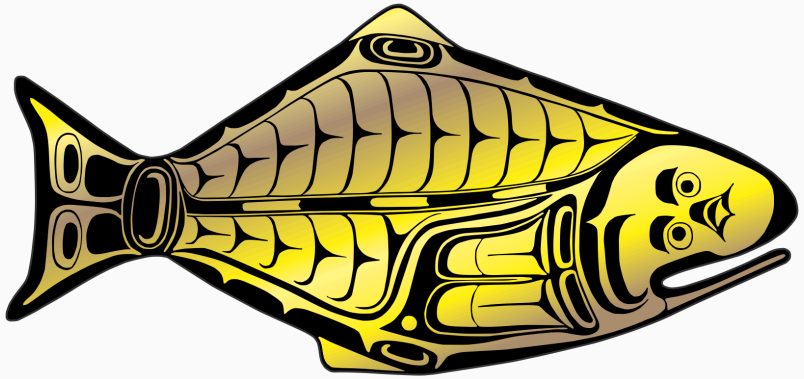

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