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Attention: Paul Ryall and Canadian JMC

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Regarding: Revising the Hake assessment to separate fishing fleets

Background

Catch sharing and accessibility are a key concern being addressed by the MSE process for Pacific Hake. On the Canadian side, there is concern about the distribution of fishing intensity over age-classes of Hake since higher fishing intensity on young fish could mean lower total migration of older fish into Canadian waters (according to the prevailing understanding of Hake migrations, REF). Estimates of fishery age-selectivity derived from stock assessment models provide the most direct way to determine how fishing intensity is distributed over a fish stock. Most contemporary stock assessments estimate fleet-specific age-selectivity when multiple fleets harvest the same stock since fishing fleets often differ in where, when, and how they fish, as well as the sampling protocols that affect data quality. The Pacific Hake stock assessment pools catch-at-age over several, quite different, fisheries operating in both the USA and Canada despite substantial variety in fishing gear, location, size-selectivity, and sampling quality. It is, therefore, not surprising that time-varying age-selectivity of the combined fleet continues to be an issue in the assessment. For example, the assessment requires a non-parametric, time-varying age-selectivity because the emergent patterns does not conform to any standard selectivity form (see inset Figure 29).

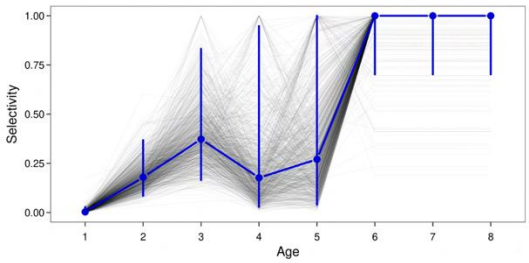


Figure 29. Estimated selectivities for the acoustic survey age-2+ biomass index (top, with selectivity of zero for age-1 fish) and fishery (bottom – shown for 2023 only, age-1 and older) from a subsample of 1,000 draws from the posterior distribution for the base model.

The odd feature of the current Hake age-selectivity relationship is the apparent ability of the combined fleet to fish age-4 about half as much as age-3 and two-thirds that of age-5. Further, there is a 4-fold increase in selectivity between ages 5 and 6 despite a difference in body weight of 0.04 kg (~10%).

An alternative explanation is that the estimated selectivity pattern represents a mixture of two distinct selectivity patterns, such as one from the USA (Figure 29, left peak) and one from Canada (Figure 29, age-4+). Differences in total catch between the countries would affect the relative weight of each selectivity to the overall pattern observed for the combined data and thus, the need to use a time-varying non-parametric form.

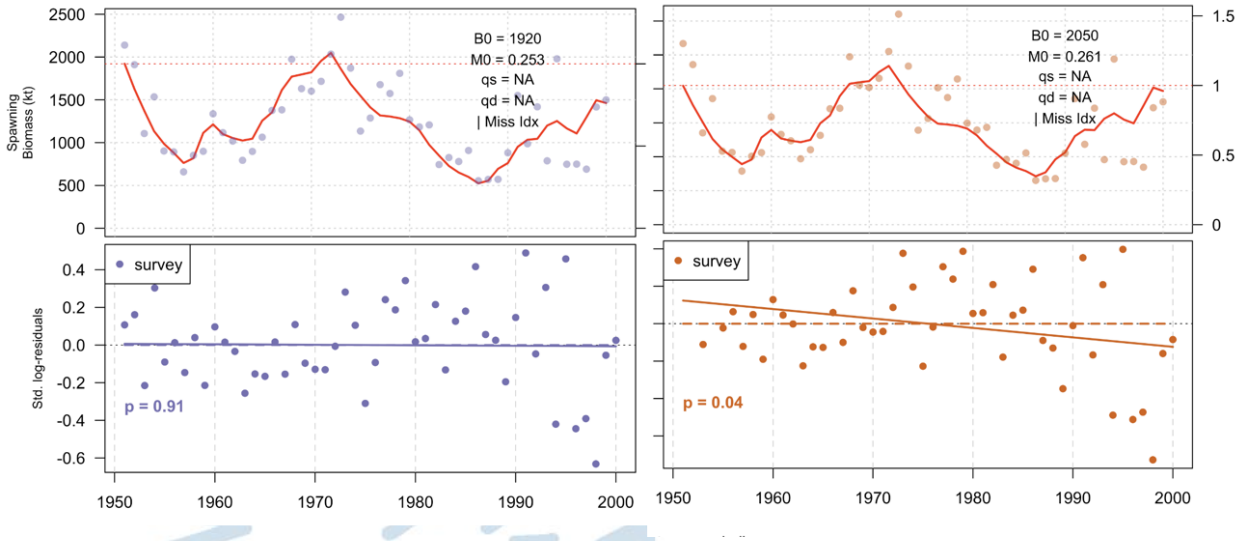
A simulation experiment to demonstrate the potential impacts of combining catch-at-age over fleets

Age-/size-selectivity is critical to the reliability and robustness of stock assessment models, including the one for Pacific Hake since it strongly influences estimates of recruitment, fishing intensity, and the distribution of fishing mortality over the population age composition. We performed a simple simulation experiment of a hake-like stock assessment by generating catch-at-age data from two fisheries and one survey with properties like those estimated for Pacific hake. A standard age-structured stock assessment model was then fit with either (i) pooled catch-at-age data into a single combined fleet or (ii) catch-at-age data fit separately for a two-fleet model configuration (i.e., matching the true simulation two-fleet setup). We recognize that the Pacific Hake assessment is more complex than this, but the point here is to demonstrate that (i) selectivity in Figure 29 could indeed be an artefact of data pooling and (ii) there could be serious consequences of continuing under the current single combined fleet assessment model for

Pacific Hake.

The two models provide comparable visual fits to the survey biomass index, although the temporal trend in residuals for the combined fleet model is a potential sign that the model could be mis-specified (Figure 1).

Figure 1. Assessment model fits for a two-fleet (left) vs single combined fleet (right) to simulated data from a two-fleet model.



Despite similar looking fits to the biomass index in Figure 1 (top row), the two models differ substantially in their interpretation of age-selectivity (Figure 2). The two-fleet model correctly identifies the two distinct, smooth age-selectivity relationships, while the combined fleet model, which required a non-parametric form, produces a pattern with similar inconsistencies as the one in Figure 29 (e.g., adjacent ages with widely different selectivity).

Table 1 shows the ultimate effects of pooling catch-at-age data into a single fleet when the true fishery generates catch-at-age from two fleets. In general, the combined fleet model tends to

over-estimate the size of the population via (i) over-estimating unfished recruitment (second row) and (ii) under-estimating the survey catchability (last row). The combined result of this over-estimation is an approximately 90% over-estimation of the current stock depletion; that is, while the true stock is at 50% of unfished in the final year, the combined model estimates it almost twice as high near 90% of unfished.

Figure 2. Estimated age-selectivity from the two-fleet (left) and combined fleet (right) model configurations

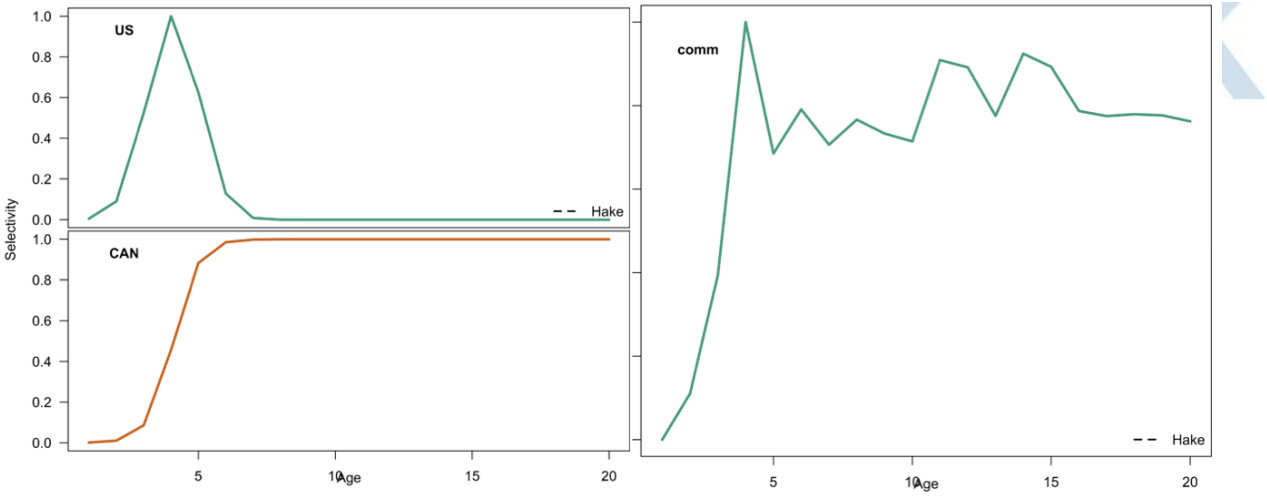


Table 1. Simulation model true values and their corresponding assessment estimates

		Assessment configuration	
Parameter	**True value**	**Two-fleet**	**Combined fleet**
Unfished SSB	1815	1922	2046
Unfished recruitment	1795	2475	2768
Natural mortality	0.23	0.25	0.26
SR steepness	0.78	0.68	0.71
Current depletion	**0.50**	**0.76**	**0.96**
Survey catchability	0.85	0.92	0.72

Conclusion

Catch sharing is a central component of the Pacific Hake treaty and therefore, justifiably, and important process to be considered in the MSE process. The current stock assessment for Pacific Hake suggests the stock is nearly unfished and, therefore, fishing has little apparent impact on the age-composition and abundance, and thus outcomes related to catch sharing. However, such as optimistic assessment could simply reflect the single fleet assumption in the current model despite several quite distinct fleets between and within countries.

It is therefore urgent that the Pacific Hake JTC revise the 2025 stock assessment both for precautionary reasons (i.e., it could be biased) and to expedite the MSE process that is informed by it.