Joint Canada–U.S.A. Scientific Review Group Report for 2025

Virtual Meeting
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INTRODUCTION

Under the authority of the Agreement Between The Government of The United States of America and The Government of Canada on Pacific Hake/Whiting (hereafter referred to as "the Treaty"), the Scientific Review Group (SRG) met online, February 10-13, 2025 to review the draft stock assessment document prepared by the Canada/U.S.A. Joint Technical Committee (JTC), planning for the coastwide acoustic survey to be conducted by both nations in 2025, including the integrated survey within the U.S.A., acoustic trawl survey research, and other research and advancements. The SRG based its terms of reference on the language of the Treaty and on the Pacific Fishery Management Council's Stock Assessment and Review (STAR) terms of reference, which the Joint Management Committee (JMC) approved as the formal Terms of Reference for the SRG. The SRG is composed of two US, two Canadian, two independent members designated by the JMC, based on recommendations from the Advisory Panel (AP), and two industry advisors from the AP. Only one independent member was appointed and under contract at the time of this meeting.

The SRG provides independent peer review of the JTC's work. The SRG is charged with:

1. Reviewing the stock assessment data and methods and survey methodologies used by the JTC;

2. Providing annually, by March 1 unless otherwise specified by the Joint Management Committee, a written technical report of the stock assessment and its scientific advice on annual potential yield; and

3. Performing other duties and functions as directed by the Joint Management Committee.

The SRG meeting convened on Monday, February 10, 2025. Owen Hamel (SRG co-chair) welcomed attendees and after a round of introductions reviewed the SRG Terms of Reference and the proposed agenda (Attachment 1). The co-chairs then assigned reporting duties to each SRG member. It was noted that the SRG was expected to submit its report to the JMC by February 27, 2025, and that it would be posted to the website by February 28, 2025. Meeting participants represented the AP, JMC, JTC, Acoustics Team, MSE Technical Team, and stakeholders (Attachment 2). **Text highlighted in bold throughout this report represents requests from the SRG for more information, analysis, or guidance.**

MAJOR CONCLUSIONS

The following points summarize the main findings of the SRG with respect to the 2025 stock assessment, acoustic survey, management strategy evaluation, and research.

1. The structure of the 2025 assessment model is similar to that of the 2024 model. All runs in the 2025 model use a Bayesian sampler applied via the MCMC No-U-Turn Sampler (NUTS) to estimate parameter uncertainty, including the base-case model, bridging, sensitivity and retrospective analyses. The uncertainty measures in this assessment are based only on the data, structure, and processes included in the base model. Thus, uncertainty in current stock status and projections is likely underestimated.

2. Additional data for the 2025 assessment include fishery catch, age-composition data, and weight-at-age data for 2024, and minor changes to pre-2024 data.

3. Model-based estimates of both weight-at-age and maturity on an annual basis continued to be used for this assessment. Weight-at-age is based upon a model with fixed effects for sex, random effects for year and cohort, and a smoothed effect for age, in contrast to the empirical method used previously. The fecundity-at-age curve varies across years based on temperature information (at 130 m).

4. During the SRG meeting, the JTC and SRG agreed that the age-1 index time series would be removed in the final base model for 2025.

5. The base-case model estimates that median female spawning biomass at the beginning of 2025 is 1.223 million metric tonnes (Mt), with a 95% credible interval from 0.521 to 3.028 Mt. This estimate represents a spawning biomass that is 67% of the unfished equilibrium level (B_0), but is highly uncertain with a wide 95% credible interval of 29% to 157%. There is a 1.9% joint probability that the stock is both below $B_{40\%}$ (40% of B_0) at the beginning of 2025 and above a level of fishing intensity equivalent to the default harvest rate of $F_{40\%}$ in 2024.

6. Total age 2+ biomass (males and females) at the beginning of 2025 is estimated to be 2.573 Mt, with a 95% credible interval of 1.120 to 6.302 Mt. The 2025 assessment provides a positive picture of the stock but the SRG still has concerns about the status of the stock. Most importantly, the survey biomass estimate in 2023 was the third lowest in the time series, and catch utilizations were at record lows in both countries in 2024. The current estimate of the spawning biomass at the beginning of 2024 is a bit lower than that estimated for 2025, at 1.189 Mt. The SRG continues to note that the proportion of fish in Canadian waters remains at an all-time low with only 2.4% of survey biomass in Canadian waters in 2023 (Figure 1) and catch attainment relative to the Canadian TAC being only 14.4% in 2023 and an all-time low of 2.7% in 2025. The southern orientation of biomass in both 2023 and 2024 also affected the observed biomass off Washington and Oregon, resulting in an estimated biomass distribution to the south of other years, with catch attainment relative to TAC being low in the US in 2023 (52.1%) and at a record low in 2024 (40.7%). Long-term trends in acoustic survey biomass show lower proportions of hake migrating into Canadian waters.

7. The addition of the 2024 data did not change the pattern of recruitment estimates prior to 2023. When the 2023 year class was estimated with that data, however, it was estimated as above average due to the observations of age-1 hake in the 2024 fishery. Recruitment for 2023 was fixed as coming off of the spawner-recruit curve for the base model. The removal of the age-1 index had a much larger impact, resulting in somewhat lower estimates of the size of recent large recruitment events. The estimate of 2020 recruitment in last year's assessment was above average (median of 4.748 billion fish; 95% interval 2.063-12.728 billion fish). The estimate of 2020 recruitment in the current assessment is a median of 3.402 billion fish (95% interval 1.595-9.144). The 2021 year-class was estimated to be 10.187 billion fish in the 2024 assessment. The 2025 assessment resulted in a lower median estimate for the 2021 year class of 7.055 billion fish (95% interval of 2.890 to 19.307). The median estimate of 2014 recruitment decreased by 636 million fish (7.7%) and the median estimate of 2016 recruitment decreased by 641 million fish (11.4%). The 2014 and 2021 year-class size estimates in particular remain well above average at 7.6 and 7.1 billion fish respectively (sixth and seventh highest in the time series), while 2016 and 2020 are also estimated to be above average.

8. A large proportion of age-1 Pacific hake were observed in the 2024 fishery, leading to the estimate of the 2023 recruitment being well above average, although uncertain, when the 2023 recruitment was estimated in the model. This fishery data was the only source of information for the size of the 2023 cohort, and given the unusual performance of the fisheries compared to previous years, there was concern that this could be misleading. Therefore, the 2023 and later (as there is no way in Stock Synthesis to fix 2023 and not the later) recruitments were fixed at average given spawning biomass in the base model and thus for projections. This assumption underrepresents the uncertainty in the projections. Since 2010, this stock has been supported by multiple above-average cohorts simultaneously. In 2025, as in 2024, it is estimated to comprise mostly of the 2020 and 2021 cohorts, representing 20% and 55% of the age 2+ stock biomass, respectively, at the start of 2025.

9. The decision tables presented for the base-case model report the expected effects of various catch levels on stock biomass and fishing intensity and reflect a substantial amount of the joint uncertainty related to equilibrium assumptions that influences the calculation of unfished biomass. Application of the default harvest policy corresponds to a catch of 560,742 t in 2025 and 463,364 t in 2026. Applying the default harvest policy ($FSPR_{40\%}$ — calculated using average selectivity over the last 5 years) in 2025 and 2026 results in a 59% probability that the stock will be below $B_{40\%}$ at the beginning of 2027. The probability that fishing intensity is greater than $F_{40\%}$ in 2025 and 2026 when harvesting at these levels is 42 and 44%, respectively.

10. The SRG considers the 2025 assessment report and appendices to represent the best available scientific information on Pacific Hake. The SRG appreciates the thoughtful responses of the JTC to its requests for analyses in the 2024 SRG report, and during the 2025 SRG meeting.

11. Due to planned mid-life vessel refits, reducing vessel availability, NOAA is planning

an integrated West Coast pelagic survey for 2025 and future years, which will combine the NWFSC Pacific Hake Ecosystem and Acoustic Trawl Survey and the SWFSC California Current Ecosystem Survey, or Coastal Pelagic Species survey. The SRG appreciates the information presented at a December 2024 meeting and at the 2025 SRG meeting, and the efforts of the survey team to support the joint management of the Pacific Hake/Whiting stock in a comparable manner to the current hake acoustic/trawl survey, including biological sampling and eDNA collection that can be used for hake and its prey species.

12. The SRG regards dynamic reference points as a promising innovation for assessing stock status and recommends that the JTC and the MSE Team continue this research.

13. The SRG received updates on research on eDNA, including indices derived from eDNA information; on risk tables; on FT-NIRS ageing approach; on the distribution of Pacific hake, and on alternative approaches to modeling fishery selectivity. **The SRG believes that results of this research, and that on environmental influences on Pacific Hake dynamics and distribution presented in previous years, may improve stock assessment projections and be useful in refining the MSE operating model and in examining potential impacts of global climate change on Pacific Hake.**

14. **The SRG recommends as a high priority the continued analysis of catch distribution, biomass distribution and predictors based on age, environmental covariates, and stock size that can explain and forecast the latitudinal distribution of Pacific Hake between Canada and the United States**

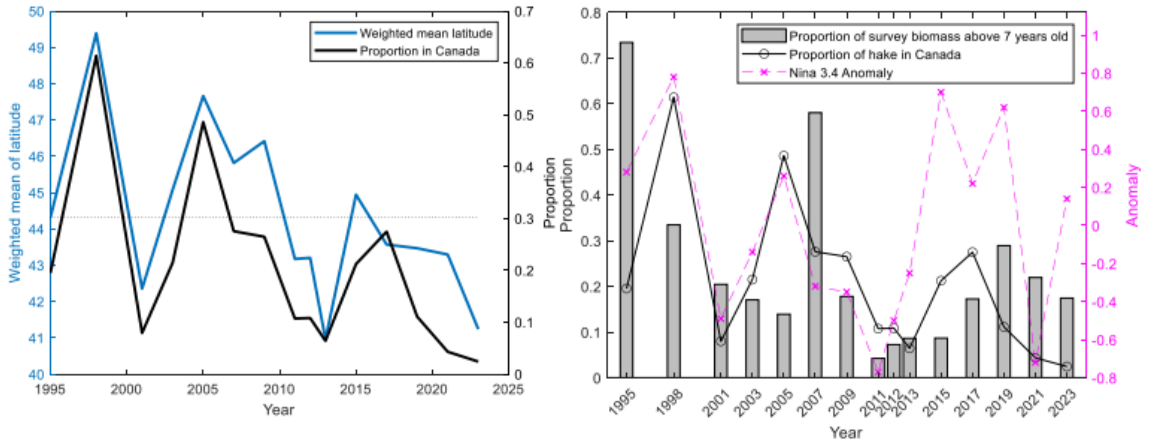

Figure 1: Comparisons of Hake acoustic survey findings over time showing the latitudinal shift in Hake biomass. The left panel shows the weighted mean latitude (blue) of Hake biomass observations over the survey region compared to the estimated proportion of Hake survey biomass within Canada (black). The right panel shows the same estimates of the proportion of Hake survey biomass within Canada (black lines, open circles) compared to the estimated proportion of Hake survey biomass above 7 years old (bars) and the La Nina 3.4 Anomaly environmental index time series (pink dashed lines, crosses).

2025 STOCK ASSESSMENT

The 2025 assessment continues with the same model structure used since 2014. The model begins in 1966, and catches are modeled as being taken by a single coast-wide fleet. The model is informed by catch and age-composition observations from the fishery, an age 2+ biomass index from the acoustic/trawl survey, and observations of survey age-composition from trawl samples taken during the survey. An age-1 survey index was not used in the 2025 base model, unlike in base models in assessments in 2022-2024. Age-specific selectivity for ages 1–6 is estimated for the fishery and ages 2–6 for the survey, with constrained annual variation allowed in fishery selection up to age 6. In 2025, the JTC continued using model-based approaches for developing the input matrix of weights-at-age, and time-varying maturity ogives to better inform time-varying fecundity.

A Bayesian approach is used for parameter estimation, with informative priors specified for natural mortality and spawner-recruit steepness. Changes in data from the 2024 assessment include the addition of 2024 fishery catch, age-composition, and weight-at-age data, minor updates to pre-2024 fishery data, and removal of the age 1 relative index. Kriged results of age 2+ biomass and age compositions from the acoustic trawl survey were used in the base model for the 2025 assessment. Due to an unusually high proportion of age-1 Pacific hake observed in the 2024 fishery and poor fishery performance in 2024, the base model fixed the recruitment deviation in 2023 at zero since the 2024 observations of age-1 Pacific hake in the fishery data are the only source of information for the strength of this cohort. The base model also fixed recruitment deviations from 2024 onward at zero (thus taking the recruitment from the SR-curve) because fixing the 2023 recruitment deviations at zero within the Stock Synthesis platform resulted in fixing all subsequent recruitment deviations at zero as well. This is not typical practice, despite the lack of information to inform these future recruitments, as fixing these does not allow the model to account for the high uncertainty in these future recruitments.

The 2025 assessment included the standard suite of sensitivity analyses requested by the SRG: alternative priors and parameterizations for natural mortality, alternative assumptions for steepness, alternative values for σ_R (a parameter limiting recruitment variability), the addition of the age-1 acoustic survey index, downweighting of fishery age-composition data, alternative standard deviations for time-varying selectivity (Φ); as well as others: age-specific deviations in natural mortality (M) inputted as fixed values (derived from CEATTLE), a different assumption to predict annual maturity-at-age, and the addition of a relative index derived from environmental DNA collected during the acoustic surveys in 2019, 2021, and 2023.

SRG Recommendations and Conclusions for the Stock Assessment

The SRG thanks the JTC for its detailed responses to its 2024 recommendations and has several additional recommendations for future iterations of the Pacific Hake stock

assessment. The recommendations below are shown in order of priority.

1. The SRG is concerned about the low proportion of fish in Canada in recent years and especially in 2024, and the record low proportion of the quota caught in both the US and Canada in 2024. **The SRG recommends a thorough analysis of catch and biomass distribution for Canada and US that examines latitudinal shifts over time, and seeks to explain poor fishery performance in recent years. The SRG recommends developing a limited set of standardized descriptive spatial distribution metrics (such as center of gravity) to support future year discussions.**
2. **The SRG recommends continuing sensitivities for steepness, natural mortality, σ_R, including the age-1 index, alternative standard deviations for time-varying selectivity, and down-weighting fishery age-composition data.**
3. **The SRG recommends that the JTC continue exploring alternative ways of estimating natural mortality to update the current approach in the model, and particularly consider options which have age-based natural mortality, and may be external to SS3.**
4. The SRG noted that alternative structures of the assessment model have not been comprehensively examined since 2011. **The SRG recommends examining alternative structural assumptions for the stock assessment. More complex structural assumptions may utilize the data more thoroughly, explain different trends across areas and/or fleets, and estimate stock status more accurately, but simpler models may be more appropriate for determination of the TAC. The MSE can be used to determine best performing assessment models for management**. Priority avenues of examinations include multiple fleets (e.g., fleets-as-areas) and alternative parametric and time-varying (or time-invariant) selectivity patterns.
5. The SRG welcomed the development of a new eDNA index of abundance. **The SRG recommends considering including this index for inclusion in the assessment as a second index of abundance for Pacific hake, also estimating additional variance for the index given the small nominal CV values**. The SRG acknowledges that it is not truly independent given samples were taken close in space and time to the acoustic backscatter used in the hydroacoustic survey biomass index.
6. The age-1 index was removed at the request of the SRG given that the index appeared to have a large influence on recent year classes, in particular the 2018 and 2022 recruitment deviations. Influences may stem from the likelihood function used to fit the data, as well as an under-representation of uncertainty. **The SRG recommends that the JTC continue investigating how to include the age-1 index in the stock assessment in this or future assessment frameworks, but notes that the selectivity/catchability of the gear is expected to change depending on the AWT or MFT gear used in the survey.**
7. **The SRG encourages the JTC to consider alternative methods to determine the maximum input sample size for the age compositions** (e.g. Stewart and Hamel 2014, Hulson et al. 2023).

The SRG appreciates the dedication and teamwork displayed by the JTC in producing

the best available scientific information and advice on the Pacific Hake stock.

ACOUSTIC SURVEY

In preparation for implementing the 2025 Integrated West Coast Pelagics Survey, the 2024 at-sea summer research program focussed on 2 goals: (1) assessing net selectivity of the Aleutian Wing Trawl (AWT), and (2) evaluating the new multi-function trawl (MFT) for hake. AWT net selectivity study was implemented on the Shimada, July 5-25, using the NOAA-AWT. The new NOAA-MFT was tested (August 1-5), and a paired trawl study was implemented (August 10-18) to compare the NOAA-MFT (Shimada) with the DFO AWT (on the Franklin).

Evaluations focussed on species composition, catch efficiency of hake, and size-selectivity of hake. Preliminary results: (1) catches from the MFT and DFO AWT show greater species composition and more smaller fish due to smaller codend mesh liners, (2) the MFT is more efficient at catching mid-sized hake (as compared to the AWT), and (3) the MFT retains a greater portion of small hake (as compared to the AWT).

Based on initial indicators of MFT performance, the acoustic survey team advocates switching to the MFT for the Summer 2025 survey in the U.S. and Canada (using a NOAA-MFT). Additional trials of the NOAA-MFT will occur on the Franklin in the Strait of Georgia (February 2025) and on the Shimada (March 2025- testing with open codend, including surface trawling).

The 2025 integrated survey will include 81 days for the Shimada from June 11-Sept 13, and 28 days for the Franklin, Aug 18-Sept 14, with daytime acoustics and daytime trawling (both vessels), CPS (Shimada, nighttime), and environmental sampling and eDNA on both vessels. Finally, the 2025 Shimada survey will include 13 days dedicated to comparisons between the NOAA-AWT and MFT to support calibration.

The Survey Team provided an update on the planning currently underway at the Northwest Fisheries Science Center (NWFSC) and the Southwest Fisheries Science Center (SWFSC) to integrate the Pacific Hake and coastal pelagic species (CPS) acoustic surveys for summer 2025. This has international implications given the Hake/Whiting Treaty identifies the acoustic survey as a key component for the management of Pacific Hake.

The combination of daytime trawling for Hake with nighttime trawling for CPS species in 2025 has substantial implications for data collected during the survey. Currently this includes biological samples, oceanographic data, especially subsurface water temperatures and dissolved oxygen from CTD casts, and water samples for eDNA. Ongoing collection of subsurface environmental data is critical for model training and forecast development. **The SRG is concerned that the integrated survey will reduce collections of some of these key data, particularly the eDNA water samples, which are useful in developing a parallel long-term index of hake, their prey, and their predators.** In addition, the eDNA time series offers comprehensive coverage of latitude, distance from shore, and depth that can be used for a wide variety of other research projects on other taxa including krill, fish, and marine mammals. **The SRG strongly encourages continued collection of these data, and efforts to restore the same level of collections as seen in recent surveys.**

The SRG is concerned about the additional time needed for Pacific Hake personnel on the survey south of Point Conception, where biological data show that the hake are different (earlier age at maturity), and any change in survey timing may affect comparability of the survey time series.

SRG Recommendations and Conclusions for the Acoustic Survey

The 2025 Integrated Survey may result in an appreciable change in the estimation of hake biomass compared to previous surveys, with potential downstream effects on management advice. The following recommendations are in order of SRG priority.

1. Recognizing safety concerns when switching trawl doors and nets and additional time to deploy two different nets during the survey, **the SRG recommends that the 2025 Integrated survey be conducted using the single MFT gear type.**
2. Initial results of comparisons between the MFT and AWT gear types suggest different selectivity on age-0 and age-1 hake. The SRG is encouraged to hear the 2025 survey plan includes 13-days for comparisons between MFT and AWT and **recommends continued longer-term comparison of the two nets for future calibration for the age-2+ and age-1 time series.** This may include standard deployment of pocket nets on the MFT gear during the survey.
3. The SRG is encouraged that the 2025 integrated survey includes plans for collection of key environmental data, and eDNA water samples, which are useful in developing a parallel long-term index of hake, their prey, and their predators. The SRG is, nonetheless, concerned with the increased spacing between and reduced number of samples to be collected in 2025. **The SRG recommends that the Integrated Survey be provided with adequate resources to continue the collection of these data.**
4. Given that 2025 will be the first Integrated Survey, **the SRG recommends providing an opportunity well in advance (suggested in December 2025) to discuss the results of the 2025 Integrated Survey**, since the February meeting may be too late for any feedback to be incorporated into analyses**.**
5. Given the information available from the age-1 index in estimating the size of the age-classes entering the fishery, **the SRG recommends that the Survey Team explore estimating the CV of age-1 index values to move away from a fixed 0.5 minimum CV for all years, and continue researching the effects of the MFT net on the index.**
6. **The SRG recommends that the Survey Team continue to document and publish the survey design, methods and operational protocols, including trawl protocols in technical reports for each country and requests that the SRG have the opportunity to review the documents prior to entering the publication process in each agency. The SRG asks that in future years, notifications are provided when draft and final documents are available.**
7. **The SRG requests that the survey team continue to provide regular updates on survey research and planning to all parties (SRG, JTC, JMC),** so that the parties can provide feedback and direction on survey comparisons, proposed methodologies, and direction for next steps.

8. **The SRG requests a written document outlining the results of the 2025 Integrated Survey, available at the same time as the 2026 assessment (~two weeks before the SRG meeting).**
9. **The SRG requests that the age-1 distribution plots include a summary of relevant environmental observations below each year, similar to how the age classes are displayed for the age 2+ distribution plots.**
10. **The SRG requests that the joint Survey Team provide survey age composition and biomass data by country as a routine output.**

Survey-Related Research

The Fisheries Engineering & Acoustic Technologies (FEAT, NWFSC) and Institute of Ocean Sciences at the DFO Pacific Biological Station survey teams (acoustic survey team) provided updates on a number of research topics supporting the ongoing goal to improve survey methods and efficiencies. This includes broad goals to incorporate new technologies and emerging science, to expand ecosystem-level information for stock assessment, to improve the understanding of Pacific hake biology, and to improve the acoustic survey.

Aleutian-Wing Trawl and Multi-Function Trawl net studies

Trawl methodology in the acoustic survey was a large part of the research conducted by the acoustic survey team in 2024. This included running trials of and training crew on the new MFT and comparing AWT and MFT selectivity by sampling Pacific hake with each trawl, sometimes with paired trawls performed by the RV Shimada and CCGS Sir John Franklin. The species composition showed some differences between the two nets with the MFT appearing to catch a wider range of species. Both nets caught Pacific hake in high numbers, but more species in the catch may lead to longer processing times. The MFT was more efficient at catching Pacific hake than the AWT across all sizes, although was more uncertain for small and large lengths. The MFT was more effective at catching (i.e. had higher selectivity for) small fish than the AWT, which can result in higher proportions of age-1 and age-0 Pacific hake in the catch. simulations incorporating target strength relationships with length and assuming different mixtures of age-1 and age-2+ Pacific hake showed a wide range of patterns for the acoustic catchability at length, often with an abrupt change near 30cm fork length. These differences and potential bias necessitate selectivity studies like these if the acoustic survey time-series is to be calibrated to create one single, consistent time-series.

Artificial Intelligence-Machine Learning for Echo Classification

Machine learning algorithms (convolutional neural networks) have been trialed to identify hake aggregations in the acoustic backscatter, with promising results. This technology has the potential to greatly reduce the processing time required to obtain abundance estimates, and to reduce subjectivity in the assignment of hake backscatter. **The SRG strongly supports the continuation and extension of this work.**

eDNA index of abundance

Over the past three acoustic surveys, more than 1800 bottles of water have been sampled annually at night along the survey transects from six depths. This is the largest eDNA sampling effort in the world to date. Analyses of the Pacific Hake DNA concentrations from these samples were conducted using a single-species qPCR primer. Concentrations of eDNA match the longitudinal and depth preferences of Pacific Hake. The underlying data were fitted with a spatiotemporal statistical model, and total concentrations predicted for longitude, latitude, and depth, and then summed up to obtain an index of biomass for hake in 2019, 2021, and 2023. Mean values of this index (in units of thousands of copies of DNA per μl) declined sharply from 308.129 (CV = 0.060) in 2019 to 204.241 (CV = 0.073) in 2021, and declined slightly further in 2023 to 181.817 (CV = 0.061).

Acoustic index of krill from acoustic survey

Estimates of krill biomass from 2007-2023 from the acoustic surveys show a pronounced low in 2015 as well as lower than average values in 2021 and 2023 in all regions. In cold years, krill abundance is high, and is distributed widely along the coast , while in warm years it is concentrated in only two smaller patches (northern California, Vancouver Island).

Echopro to Echopop

The survey team is in the process of converting from using the current EchoPro biomass estimation software package to a new open source package entitled EchoPop. Validation of the conversion will be occurring during the 2025 survey with the goal to complete the transition by the end of 2026.

Hake Fecundity Research

Proposed research to determine Pacific hake fecundity relationships with body size included: 1) develop methods to determine fecundity of Pacific hake, 2) develop a baseline size-dependent fecundity relationship, explore methods to determine a size-dependent spawning frequency relationship. This research would use existing knowledge of oocyte development, existing samples collected during 2016 and 2017 winter surveys, and additional samples from yet to be determined sources. **The SRG supports the continuation of this work for a better understanding of potential maternal effects and to inform fecundity in the stock assessment.**

SRG Recommendations and Conclusions for Survey-Related Research

1. **The SRG strongly encourages the Joint Survey Team to continue research into the development and testing of machine learning tools to inform the classification of Pacific hake in echograms and make the assignment mixes less subjective**.
2. The SRG looks forward to continued research on the multi-function trawl net (MFT) and supports daytime trawling for Pacific hake in the integrated survey protocols. **The SRG recommends that the Joint Survey Team continue to compare the performance and selection properties of the Aleutian wing trawl (AWT) net and**

MFT proposed for the integrated survey in order to calibrate the MFT with past Pacific hake acoustic-trawl surveys.

3. **The SRG encourages the Survey Team to develop selectivity curves for the trawl nets used on past and future surveys and incorporate those selectivities into the age-1 index and age 2+ biomass index estimation process.**
4. The SRG recognizes the Joint Survey Team is understaffed, which has affected the ability of the Survey Team to address high priority SRG requests in a timely fashion. The extra burden placed on the Joint Survey Team by the Integrated Survey planning process is likely to be unsustainable. **The SRG encourages both agencies to commit to funding additional qualified staff to the Joint Survey Team as soon as possible to assist in the completion of survey projects and avoid burnout by current members.**
5. **The SRG encourages the continued collection and integration of US and Canadian oceanographic data (e.g., CTDs, eDNA, etc) so that analyses cover the full distribution of the coastal Pacific hake stock.**
6. **The SRG encourages the continuation of research to better understand intraseasonal shifts in distribution of hake and potential implications for survey biomass estimation (both for the age-1 index and the age 2+ index).**
7. **The SRG requests detailed documentation on the survey biomass index estimation algorithm**, including the kriging method, from the Applied Physics Laboratory at the University of Washington that are currently rewriting the code from Matlab to Python (Echopro to Echopop).
8. **The SRG supports continued research on the distribution and abundance of Pacific hake in survey research years.**
9. **The SRG encourages continued research on hake distribution by depth and changes over time related to environmental observations.**
10. **The SRG recommends continued work on fecundity and functional maturity at size and age, including temporal (annual) and latitudinal variation. Continued collection of ovaries is needed to continue and extend this work.**

OTHER RESEARCH AND TOPICS RELATED TO PACIFIC HAKE

Hake distribution

There are multiple sources of data and methods available to inform an understanding of spatial distribution of Hake stocks over time. These include data from the acoustic survey, groundfish trawl survey, fishery and environmental data. These data can be used as indexes or in more complex forecast and spatial distribution models to index and predict spatial patterns. The SRG heard multiple presentations on many of these varying datasets, approaches and metrics.

Mapping Survey Data - The acoustic survey data can be used to develop bi-annual backscatter and biomass index maps and metrics. Additionally, catch from the American and Canadian groundfish bottom trawl surveys can provide annual biomass index maps and metrics.

Pacific Hake Distribution Forecasts - Forecasts were generated based on ocean temperature outputs from the J-SCOPE model for 43-50°N in 2019-2025. Forecasted distribution was similar during 2020-25, with water temperatures generally at intermediate values, unlike the much higher hake distribution throughout this region in the exceptionally warm waters in 2019.

For 2024, it was predicted that biomass of age-2 Pacific Hake was largely south of 44°N, while age 5-20 Hake were at the US-Canadian border. For regionally aggregated analyses, predicted biomass of age 5-20 in Canada was always far above observed biomass over 2012-2023, and in 2021 and 2023 far above the observed biomass in Canada. Thus the model produces poor predictions for the proportion of hake in Canadian waters when based on temperature alone.

Pacific Fishing Effort Mapping Project - The Pacific Fishing Effort Mapping Project (PacFEM) aims to build an integrated spatial fisheries data system in U.S. waters, including spatial estimates of catch and fishing revenue, while respecting confidentiality. Maps of hake revenue from 2016 to 2023 show a decreasing proportion of revenue off Washington in the At-Sea Processors, especially in 2022 and 2023. This was also visible in the Shoreside Whiting revenue, which was also increasingly concentrated in waters off the Oregon coast.

Climate-Informed Distribution Models - A project under the NOAA Climate, Ecosystems and Fisheries Initiative (CEFI) has begun to develop a coastwide model using survey and fishery data combined with physical, biological and ecological datasets to predict juvenile and adult spatial distributions. The model will be coastwide, 3D, evergreen and able to be updated with new covariates as available. Ages are modelled individually. A preliminary project plan was presented to SRG for feedback. **SRG sees a high value in this project and encourages regular reporting to the JTC/SRG assessment process.**

Hake-Specific Ecosystem Summary

Staff for NOAA NWFSC, along with the JTC, have been working to develop ecosystem risk tables to inform Ecosystem Based Fisheries Management objectives and Hake is being used as a pilot. The intent is to assess and present new ecosystem data not currently used in the system so that it might inform harvest setting. The evaluation rubric synthesizes and categorizes species specific information on ecosystem conditions, assessment data and assessment model on three levels of quality and favorability. The pilot table presented to the SRG for Hake graded ecosystem condition information as neutral and assessment data and model as favorable. The development of these tables is a work in progress.

Hake-centric multispecies assessment model (CEATTLE)

The CEATTLE model aims to estimate age- and time-varying natural mortality based on changes in predators, cannibalism, prey, and temperature. This involves a two-year project by a UW postdoctoral researcher in collaboration with NOAA NWFSC.

The SRG encouraged continued work on this project given the importance of natural mortality in the assessment.

Fisheries Integrated Modeling System (FIMS)

An overview was presented of FIMS, the new stock assessment modeling system being developed by NOAA that will ultimately replace Stock Synthesis. Efforts are being made to develop an assessment of Pacific Hake in FIMS but some of the core methods used in the current assessment are not yet available in FIMS, notably the framework used for age- and time-varying selectivity. The SRG anticipates the ability of the JTC to explore alternative and structurally different population models within FIMS.

Fourier transform near infrared spectroscopy (FT-NIRS)

New NWFSC information was presented in applying FT-NIRS to hake otoliths.. FT-NIRS measures light absorbance signatures of otoliths and models how the infrared spectra relate to age with the goal of implementing this approach to ageing. FT-NIRS is faster and more repeatable than current traditional human age otolith readers. Results of applying the method to 5490 hake otoliths and comparing the resulting age estimates to those from traditional ageing resulted in $r^2 = 0.92$. The approach was consistent, on average, with traditional reads for young ages but tended to produce somewhat lower age estimates for older fish than those from traditional counts. After correcting for bias, 72.3% were estimated to be the same age as from traditional counts, and 92.5% within one year. The latter can be compared to 96.2% for double-blind reads using traditional methods. For large older cohorts like the 2014 cohort, traditional counts were much higher than from FT-NIRS, which tended to spread out age counts into adjacent ages. Therefore, using FT-NIRS would result in differences in cohort estimates unless the assessment implemented new ageing error inputs with even greater adjustments than currently applied for those cohorts.

The SRG considers FT-NIRS a possibly useful tool. Recognizing that NT-FIRS ages are

trained using traditional ages, **the SRG recommends maintaining ageing lab staffing to ensure the continued determination of accurate ages for hake and other species for use as training data for NT-FIRS research.**

The SRG recommends not using NT-FIRS ages in the 2026 stock assessment due to prioritization of incorporating new integrated survey results, but is interested in sensitivities in 2027 that include NT_FIRS ages.

Management Strategy Evaluation (MSE) and Supporting Analyses

The SRG did not receive an update of the Pacific hake Management Strategy Evaluation. However, the SRG supports the MSE work and maintains its recommendations outlined in the 2024 SRG report.

SRG Recommendations for Additional Research

The SRG supports research to improve understanding of linkages between the environment and Pacific Hake distribution and recruitment variability, including ways this information can be used to improve management decisions. Specific recommendations are provided here.

1. The SRG is encouraged by the results of the research into environmental drivers of Pacific Hake recruitment, and **the SRG supports ongoing research to develop predictive relationships of Pacific Hake recruitment that can improve stock assessment forecasts and inform the MSE process.**
2. **The SRG encourages continued ecosystem-related research into the drivers of Pacific Hake distribution and productivity.** This includes the J-SCOPE oceanographic forecasts and the Climate-Informed Distribution Modelling from CEFI which could provide a basis for improved in-year predictions of Pacific Hake distribution and abundance. As well they could support simulation and longer term forecasting for fishery managers and use in the MSE process.
3. **The SRG encourages the development of ecosystem indicator and risk table reporting for Pacific Hake as an important contextual supplement to the stock assessment information for decision-making and looks forward to further reporting at future SRG meetings.**
4. **The SRG encourages continued research into FT-NIRS a possibly useful tool that results in faster readings of otoliths at the expense of higher bias and lower precision. The SRG recommends simulation models comparing assessments with known ages (as an unattainable control) to those with either fewer but more accurate ages (traditional methods) or with a larger number of more biased and less precise ages (from FT-NIRS).**

Other SRG Recommendations

1. The February 2025 SRG Meeting was held fully online. There was general agreement that this was a far less effective meeting than an in-person meeting would have been. In-person meetings allow for free flowing side discussions and one on one conversations more in line with the pursuit of scientific rigour and learning, resulting in the best possible advice and outcomes. **The SRG recommends that future JTC and SRG meetings be prioritized to be held in person.**
2. The SRG has been missing a member for several years due to delays in finalizing appointments before the February meeting. **The SRG continues to recommend that replacement members be appointed, and reappointments be made before summer in each year (ideally as soon as possible after nominations are made at the February/March JMC meeting), to allow for time to start the contract process in summer the year before the meeting occurs.**
3. **The SRG recommends appointing a fifth JTC member, as specified in the Treaty.** It will be important that this fifth JTC member has the skills and time to contribute substantially to the hake assessment and other analyses, especially since there are currently no dedicated staff to support the MSE outside of the JTC.
4. **The SRG recommends maintaining routine communication among all bodies (AP, JMC, SRG, JTC, Joint Survey Team, MSE Working Group, MSE Technical Team) supporting the implementation of the Pacific Hake Agreement, so that members of the SRG are updated about research and analysis priorities and concerns of the management and stakeholder communities.**
5. **The SRG also requests that when the JMC identifies areas on which it would like SRG input, it submits written requests to the SRG co-chairs at least two weeks before the SRG meeting to allow time for the SRG agenda to be adjusted appropriately, and for review by SRG members of any associated background materials.**
6. The SRG appreciates that for several years now, the Survey Team, the JTC, and the MSE Technical Team have presented explicit responses to previous SRG recommendations, and **requests that this approach be continued indefinitely.**
7. **The SRG recommends that the JTC continue to provide electronic copies of the data and model files prior to the review meeting, as this is an efficient way to meet data requests made by the AP and others.**
8. Prior to March 2020, the December JTC/Survey and February SRG meetings would occur in different countries. The last number of years they have both occurred in the U.S. one year and Canada the next. **The SRG recommends returning to splitting hosting duties between countries every year to stabilize annual travel and budget planning.**

ATTACHMENT 1
Joint US-Canada Scientific Review Group for Pacific Whiting

AGENDA
Online Webinar Meeting
February 10-13, 2025

Monday, February 10, 2025

13:00 **Welcome and Introductions**
- Resolve immediate connection/communication problems

13:15 **Review and Approve Meeting Agenda** (Chair)
- Review Terms of Reference for Assessments and Review Meeting
- Meeting report mechanics
- Assignment of reporting duties
- Review of meeting norms and expected behaviours
- Review procedures for resolving communication issues throughout the meeting

13:30 **Fisheries, Data, and Inputs Used in the 2025 Assessment** (JTC & AP Advisors) (*actual 1:45pm*)
- 2024 Fisheries Reports
  - Canadian Waters
  - U.S. Waters
- 2024 Fisheries Catch, Size, and Age Composition Data for Assessment

14:30 **2025 Pacific Hake/Whiting Assessment Modeling** (JTC) (*actual 2:35*)
- Methods, results and discussion
- Model performance and diagnostics: sensitivities and retrospectives
- Forecasts and management implications
- Discussion

15:30 ***Break***

15:45 **2025 Pacific Hake/Whiting Assessment Modeling (cont.)** (JTC)

16:15 **Public Comment**

16:30 **SRG discussion, develop list of requests for JTC, *as needed***

17:00 ***Adjourn for the day***

Tuesday, February 11, 2025

09:00 **2025 Pacific Hake/Whiting Assessment Modeling Cont.**

- Forecasts and management implications

09:30 **Review responses to 2024 SRG Stock Assessment Recommendations** (JTC)
- SRG discussion, develop list of requests for JTC, as needed

10:30 *Break*

10:45 **Risk table approach and ecosystem considerations for interpreting the stock assessment (JTC/Kristin Marshall/Mary Hunsicker)**

12:50 ***Lunch***

13:45 **eDNA research and index development (Ole Shelton)**

14:30 **Landmark Fisheries Memo on Selectivity**

14:55 Other Relevant Hake Research (JTC and Guests)

15:40 ***Break***

15:50 **Public Comment**

16:00 **SRG discussion,** requests for additional information from JTC and Survey Team, as needed

17:00 ***Adjourn for the day***

Wednesday, February 12, 2025

09:00 Discussion of previous day, follow-up questions, review results of assigned tasks

09:10 **Acoustic trawl methodology review** (Survey Team)

- How trawling is used in the survey
- Overview of Summer 2024 research
- Net Comparison Results

10:40 ***Break***

10:50 **Acoustic trawl methodology review** (continued)

- SRG Discussion & Recommendations

11:20 **Review of 2024 SRG Survey Recommendations** (Survey Team)

11:40 **Integrated Survey Design and Planning Updates (Survey Team)**

12:15 **Review of results of requests from Day 2 and associated discussion (JTC)**

13:10 ***Lunch***

14:30 Discussion of results of Day 2 requests (continued; JTC)

15:00 Integrated Survey Design and Planning Updates discussion (Survey Team)

15:15 **Research** (Survey Team)

- **EchoPro/EchoPop** transition
- **HakeML** model overview, testing in the field, current status and next steps
- **Hake Fecundity** proposed research

16:15 **Public Comment**

16:30 **SRG discussion,** requests for additional information from JTC and Survey Team, as needed

17:00 ***Adjourn for the day***

Thursday, February 13, 2025

09:00 **FIMS model (JTC)**

Link to FIMS site:https://noaa-fims.github.io/case-studies/content/pacific-hake.html

09:30 Review of JTC responses to Day 3 requests

10:00 **SRG Discussion & Work Session**

- Stock assessment model finalization and management outcomes (as needed)
- Finalize research needs/priorities for assessment, survey, and MSE

10:45 Break

11:00 **FT-NIRS Ageing research (Jim Hastie)**

12:00 ***Lunch***

13:30 SRG discussion continued of research needs for 2025 and longer-term

- Evaluation of base model and primary sources of uncertainty
- MSE methodology and approaches

14:30 Final SRG discussion, report review, requests for additional information, etc.
Distribution and review status of notes and draft SRG Report

16:00 Public Comment

17:00 SRG ***Meeting Adjourn***

ATTACHMENT 2

Table of Participants, all days

First	Last	Role	Affiliation
Aaron	Berger	JTC	NOAA
Aja	Szumylo	Executive Director	Pacific Whiting Conservation Cooperative
Allan	Hicks	SRG	Independent- fisheries Analysis With Integrity, LLC
Andrew	Edwards	JTC	DFO
Andrew	Shelton	NWFSC- eDNA	NOAA - NWFSC
Brent	Paine	JMC	US JMC- Industry Rep.
Brian	Blake	AP	Ocean Gold Seafoods, Government Affairs
Chantel	Wetzel	JTC	NOAA
Chelsea	Stanley	Survey Team	DFO
Chris	Grandin	JTC	DFO
Chris	Biggs	tracking fisheries oceanography	Washington Dept. Fish & Wildlife
Chris	Cooper	AP	Owner/operator F/V Predator
Cisco	Werner	NMFS Director of Scientific Programs and Chief Science Advisor	NOAA
Colin	Sayre	Treaty Coordinator	NOAA
Corey	Niles	PFMC	Washington Dept. Fish & Wildlife
Craig	Russell	Director- FRAM Division	NOAA- NWFSC
Diana	Baetscher	Research Geneticist, NMFS AFSC	NOAA
Elizabeth	Phillips	Survey Team	NOAA
Emily	Nau		
Eric	Ward	NWFSC, FRAM Division	NOAA
Frank	Lockhart	JMC	NOAA
George	Mukai	GTAC -Canadian Fishing Company	AP
Grant	Dovey	Canadian Groundfish Research and Conservation Society	
Jaclyn	Cleary	SRG	DFO
Jake Burton	Marshall		
Jeff	Lackey	mid-water trawl PFMC Groundfish Advisory Panel	Industry/PFMC
Jim	Hastie	Population Ecology Program Manager	NOAA- NWFSC
John	Pohl	Research Oceanographer, FEAT,	NOAA- NWFSC
Jon	Hare	NEFS	NOAA
Juan	Zwolinski	Acoustic Survey	NOAA- SWFSC
Julia	Clemons	Survey Team	NOAA
Katlyn	Lockhart	PFMC- GMT	ODFW
Kelli	Johnson	JTC	NOAA
Kevin	Stierhoff	Integrated Survey	NOAA
Krista	Nichols		NOAA
Kristen	Koch	Director, SWFSC	NOAA- SWFSC
Kristin	McQuaw	AP	At-Sea MS Cooperative manager
Kristin	Marshall	NWFSC, PEMS	NOAA-NWFSC
Lindsay	Richardson	DFO Trawl Coordinator	DFO
Lisa	Pfeiffer	NWFSC	NOAA

First	Last	Role	Affiliation
Lori	Steele	AP	West Coast Seafood Processors
Maggie	Sommer	SFD- Groundfish Catch Shares Lead	NOAA
Mary	Hunsicker	NWFSC, NOAA (Fisheries and the Environment)	NOAA-NWFSC
Matthew	Koller		NOAA
Melissa	Liotta	NW & SWFSC, NOAA, Integrated Survey Project Coordinator	NOAA
Merrill	Rudd	Data Scientist	Independent- Sea State Inc.
Michael	Myers		
Natalie	Her	Policy Analyst with National, supporting 2025 Treaty Meetings	DFO
Natalie	Rowell		
Owen	Hamel	SRG, Co-chair	NOAA-NWFSC
Owen	Liu	NWFSC- CEFI Decision Support Team	NOAA-NWFSC
Paul	Ryall	JMC	DFO
Raquel	Ruiz Diaz		
Rebecca	Thomas	Survey Team	NOAA-NWFSC
Rebecca	Einhorn		
Sabrina	Beyer	Survey Team	NOAA-NWFSC
Samuel	Johnson	SRG	Landmark Fisheries
Sarah	Nayani	AP	Arctic Storm, Inc
Scott	Dance	reporter	Washington Post
Shannon	Mann	AP	GTAC- Mariner Seafoods
Stéphane	Gauthier	Survey Team	DFO
Stephanie	Johnson	Attorney	NOAA- GC
Steve	Joner	JMC	Makah Tribe
Steve	de Blois	NWFSC	NOAA, NWFSC
Steven	Schut	SRG, Co-chair	DFO
Trevor	Branch	SRG	Independent - University of Washington
Vanessa	Tuttle	At-Sea Hake Observer Program	NOAA
Whitney	Roberts	Marine Policy Analyst	Washington Department of Fish & Wildlife