Joint U.S.-Canada Scientific Review Group Report for 2019

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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 in Vancouver, British Columbia, February 19-21, 2019 to review the draft stock assessment document prepared by the Canada/US Joint Technical Committee (JTC), progress on an MSE focused on Pacific Hake/Whiting, and the planning and design of the acoustic survey to be conducted by both nations in 2019. 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, and two independent members designated by the JMC, based on recommendations from the Advisory Panel (AP). The JMC also appointed two industry advisors from the AP to assist the SRG in its deliberations.

The Scientific Review Group provides independent peer review of the Joint Technical Committee's work. The SRG is charged with:

1. Reviewing the stock assessment data and methods and survey methodologies used by the Joint Technical Committee;

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 at 09:00 Tuesday, February 19, 2019. Jim Hastie (SRG co-chair) welcomed attendees and after a round of introductions reviewed the agenda (Attachment 1) and SRG Terms of Reference and then assigned reporting duties. It was noted that the SRG was expected to submit its report to the JMC by February 27, 2019. Meeting participants represented the AP, JMC, JTC, Survey Team, MSE Technical Team, and stakeholders (Attachment 2). **Text highlighted in bold through this report is a request from the SRG for more information or analysis.**

The SRG notes that the JTCs ability to conduct the 2019 stock assessment and respond to SRG recommendations from 2018 was curtailed by the U.S. government shutdown and furlough of its employees for 35 days between December 22, 2018 and January 25, 2019. This period is critical for the Pacific Hake/Whiting stock assessment as it coincides with the assembly and review of all data inputs (catch, age compositions) and running of the stock assessment model.

Conclusions

The following points summarize the main findings of the SRG with respect to the 2019 stock assessment and acoustic survey research.

1. The structure of the 2019 assessment model is similar to the 2018 model, with the incorporation of time-varying fecundity. Pre-2018 fishery catch, fishery age composition and weight-at-age data were updated, and 2018 fishery catch and age data and weight-at-age data

were added to the model. The uncertainty measures in this assessment include only the structure and processes included in the model. Thus, uncertainty in current stock status and projections is likely underestimated.

2. Assessment model results are sensitive to the variance parameter assumed for recruitment deviations (σ_R, sigmaR; a parameter that is not directly observable) and the variance parameter assumed for fishery selectivity (Φ, Phi = 1.40). While the spawning biomass trajectories across values of sigmaR were very close to one another, the corresponding estimates of R_0 and unfished biomass led to widely different estimates of stock status (relative spawning biomass). This adds considerable uncertainty to the assessment.

3. The SRG considers the 2019 assessment report and appendices to present the best available scientific information on Pacific Hake/Whiting. Time-varying fecundity was implemented in this model using the annual matrix of weights-at-age data for the 1975-2018 period. A bridging analysis showed that adding time-varying fecundity resulted in a large increase in late 1970s biomass due to the higher weight-at-age of older fish in that time period, but little change in the biomass trajectory after the 1970s. The average weights-at-age vector applied over all years (1975-2018) was used in estimating fecundity prior to 1975 for several reasons including the paucity of weight-at-age data from the early period of the fishery, uncertainty about the reliability of the ageing method (surface reads of otoliths) used in the early period, and regression analysis that showed very slight trends in weights-at-age through time. The SRG agrees with these choices and appreciates the thoughtful response of the JTC to the request for this analysis in the 2018 SRG report.

4. The assessment estimates that the 2010 year class is the second highest in the time series (after that for 1980). The 2014 year class is likely larger than average, but smaller than the 2010 year class. While age-1 fish from 2017 comprised a higher than normal proportion of fishery catch and the 2016 year class is estimated to be above average, the strengths of these year-classes remains highly uncertain. The SRG anticipates that the 2019 summer acoustic survey will provide more certainty regarding 2016 and 2017 cohort strength.

5. Multiple cohorts support the fishery at this time. The 2010, 2014, and 2016 cohorts are predicted to comprise 15%, 35%, and 21%, respectively, of the stock biomass at the start of 2019.

6. The base-case model estimates that median female spawning biomass at the beginning of 2019 is 1.312 million tonnes (Mt), with a 95% credibility interval of 0.471 to 3.601 Mt. This estimate represents a spawning biomass that is 64.1% of the unfished level, with a 95% credibility interval of 26.3% to 156.7%. The joint probability that the stock is both the stock is below $B_{40\%}$ at the beginning of 2019 and above the target relative fishing intensity (a measure of the relative magnitude of fishing often expressed as a percentage) of $F_{40\%}$ in 2018 is estimated to be 10.3%.

7. Total exploitable stock biomass (age 2+, males and females) at the beginning of 2019 is estimated to be 3.232 Mt, with a 95% credibility interval of 1.166 Mt to 9,695 Mt.

8. The decision and risk 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 influencing the calculation of unfished biomass, B_0. The base-case model forecasts that median catches of 587,419 t in

2019 and 556,709 t in 2020 could be achievable when fishing at the $F_{40\%}$ reference point level, with an equal probability of being above or below the reference point. Applying the default harvest control rule yields an allowable catch of 725,593 t for 2019.

9. The acoustic survey is planned for summer 2019. The design of the survey is based on recent survey designs, with adjustments to address reduced ship time available in both Canada and the United States and the potential for an El Niño event and increased northward movement of Pacific Hake/Whiting. Transect spacing is expected to be 10 nmi from Point Conception (34.5°N) to the north end of Vancouver Island (50.5°N) and 20 nmi spacing north of Vancouver Island to Dixon Entrance (54.5°N). The current plan includes skipping every 8th transect in US waters due to the reduction in ship time for the survey. Survey adjustments will be implemented if Canadian industry and the AFSC Bottom Trawl Survey detect a shift in northern hake extent. **The SRG concurs with this design approach for the 2019 survey**.
10. The SRG noted that five Saildrones were able to cover the full spatial extent of the regular acoustic/trawl survey during testing in 2018 in about 100 days. The results of those trials highlighted several logistical issues that need to be addressed to ensure comparability with the current acoustic/trawl survey. The SRG also notes that trawl sampling to collect species composition and biological data used to interpret the acoustic backscatter data is one of the most important unresolved problems of a Saildrone survey. **The SRG recommends taking advantage of the opportunity to deploy and evaluate the performance of Saildrones in conjunction with the regular acoustic/trawl survey scheduled for the summer of 2019.**
11. The SRG reviewed preliminary results of the development process for Pacific Hake/Whiting management strategy evaluation (MSE) and is encouraged by the progress that has occurred on this important tool for strategic advice. This review highlighted the need for further work on the MSE model, including the performance indicators and validation of the estimation model to ensure that it more closely matches the stock assessment model. **The SRG continues to support ongoing MSE development and progress.**
12. The SRG reviewed initial output from the FATE project on environmental drivers of age-specific Pacific Hake/Whiting distribution and abundance. These results show strong positive spatial correlations between abundance and temperature at 100m depths in areas north of Vancouver Island and strong negative spatial correlations off Oregon and northern California, but there were age-specific differences in movements that contributed to this pattern. For example, there were no significant correlations related to age-2 fish across the entire spatial domain. **The SRG supports the continuation of this work and anticipates that results of the FATE project will be useful both in refining the MSE operating model and in examining potential impacts of global climate change scenarios on the Pacific Hake/Whiting stock.**
13. The SRG appreciates the efforts of the JTC to produce a high quality stock assessment and advice, despite the shutdown and furlough of NOAA employees in January 2019.

2019 Stock Assessment

Overview

The 2019 assessment uses the same basic model structure as used in assessments 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. Age-specific selectivity for ages 1 to 6 is estimated for the fishery and ages 2 to 6 for the survey, with constrained annual variation allowed in fishery selection up to age 6. The base model uses a matrix of empirical (observed) weights-at-age to calculate fecundity, catches and total biomass and continues the approach, first applied in the 2018 assessment, of using Dirichlet multinomial distributions to estimate the weighting of the age-composition data. The model also uses the same input value used in the 2018 assessment model for the parameter ($\Phi = 1.40$) that controls the year-to-year variation in fishery selection parameters. A Bayesian approach is used for parameter estimation, with informative priors specified for natural mortality and spawner-recruit steepness. Changes from the 2018 assessment include updates to historical fishery catch, age-composition, and weight-at-age data, the addition of 2018 values for these inputs, and the use of time-varying fecundity (calculated as maturity-at-age × annual weight-at-age) for the 1975-2018 model period. Tables requested in the 2018 report (annual numbers of fish underlying each annual age-composition observation, estimates of total age-2+ biomass, changes in model structure and parameterization implemented since 2011) were added by JTC and are a standard part of the assessment.

The 2019 base model implements time-varying selectivity in response to explorations during the 2018 SRG review showing that the model results and corresponding estimates of stock status (e.g., relative spawning biomass) are strongly affected by the choice of weights-at-age used in estimating fecundity. A matrix of empirical annual mean weights-at-age are used for the 1975 to 2018 period. A vector of mean weights-at-age averaged over all years with data (1975-2018) is used to estimate time-varying fecundity for years without observations (pre-1975, forecasts), and unfished spawning biomass (B_0). The 2019 assessment document includes a series of sensitivity analyses that explore the consequences of different approaches for estimating time-varying fecundity for years without weight-at-age data. **The SRG concurs with the approach in the 2019 base model of using the long-term averages.**

The 2019 assessment included the suite of sensitivity analyses that the SRG has requested as a standard package: alternative standard deviations of the priors for natural mortality, alternative values for steepness, alternative values for σ_R (a parameter limiting recruitment variability), and inclusion of the experimental age-1 acoustic survey index. Additional sensitivity runs were conducted to illustrate the sensitivity of the 2019 assessment results to the following:

- the method used for age-composition data weighting;
- alternative weight-at-age and fecundity assumptions;
- alternative flexibility in time-varying selectivity (Φ); and
- alternative parameterization of time-varying selectivity.

The SRG greatly appreciates the efforts of the JTC to complete the 2019 assessment under very challenging circumstances; i.e., the greatly reduced time available.

SRG Recommendations and Conclusions for the Hake Stock Assessment

The SRG has several recommendations for future iterations of the hake stock assessment. Some of these requests are repeated from the 2018 SRG report, because the JTC did not have sufficient time to address them.

1. The SRG notes the high sensitivity of the model to the variance parameter assumed for recruitment deviations (σ_R, a parameter that is not directly observable). While the spawning biomass trajectories across values of σ_R were very close to one another, the corresponding estimates of R_0 led to widely different estimates of stock status (relative spawning biomass). The JTC presented evidence that supported the value used in the assessment. **The SRG encourages the JTC to explore methods for parameterizing recruitment and/or estimating sigmaR that would reduce model sensitivity to the value of this constraint**.
2. The SRG notes that when setting values for other parameters that cannot be estimated directly with confidence, the choice of values should be made using methods that are objective, repeatable, and depend on fits to the observed data rather than on the model's subsequent estimates of biomass or recruitment. One clear example is setting the parameter controlling time-varying fishery selectivity (ϕ), with a goal of establishing repeatable steps for setting ϕ each year. This year the JTC presented a semi-parametric method of characterizing the flexibility in selectivity, but this method did not resolve the sensitivity of results to the choice of ϕ. **The SRG recommends that the JTC provide a review of how time-varying selectivity is parameterized and estimated in other assessments.**
3. The histological analysis of ovaries for maturity presented in 2018 showed a distinct difference in the percent of Hake that are mature at age 2 and age 3 between areas, with a greater proportion mature south of Point Conception (34.5°N). These data show that there may be two populations of hake, north and south of this boundary. The SRG also notes that ovaries collected in Canada were not used to update the maturity ogive. Hake found in Canada are generally older, and including samples of these fish in the maturity analysis should improve the accuracy of the maturity ogive. The JTC noted that work began late in 2018 to address this recommendation. **The SRG strongly supports the ongoing genetic analyses to determine whether there are genetic differences among the two southern regions and other regions. In addition, the SRG notes that Canadian samples should be included in the maturity analysis.**
4. The issue of data weighting remains a significant technical challenge for stock assessments that integrate information of different forms (e.g., biomass indices and age compositions) from different sources (e.g., different fishing sectors). A potential issue related to data weighting that should be explored in the next assessment is the JTC's approach to deriving the initial set of data weightings associated with the fishery and survey age-composition observations. The annual number of at-sea hauls and shore-based trips from which fish ages were incorporated into the age-composition series are summed to provide initial sample sizes. If there are changes in the number of fish associated with each sample unit (haul or trip) over time, then a corresponding change in the information content of an age-composition sample would be expected. The approach taken to deriving the initial data weights could account for changes in the number of fish per sampling unit. Alternatively, the Dirichlet multinomial parameter that accounts for variability in the age-composition observations could include a time-varying component to account for changes in the number of fish per sampling unit. **The SRG notes that the JTC included information in the 2019 assessment on the annual numbers of fish underlying each annual age-composition observation, but were unable to complete an analysis, as requested in the 2018 SRG report, on the effect of potential changes in sampling protocols that could influence the input sample sizes. The SRG reiterates its request for this analysis.**

5. A recent advance in Bayesian analysis (the no U-turn sampler, NUTS) raises the possibility that the assessment model could reach convergence much more quickly than is now possible. Many 2019 sensitivity runs were limited to maximum likelihood estimates (MLE) values, rather than Markov Chain Monte Carlo (MCMC) values, to save computing time, minutes versus 2.5 days per run, respectively. **The SRG recommends that the JTC continue to explore NUTS and similar options, as using MCMC for all runs would provide better comparability between the base assessment model and sensitivity runs.**
6. Delays in entry and validation of catches reported on paper tickets in Washington and entry into the PACFIN database was identified as a potential issue. This concern has most often applied to tribal catches. The preferred process is that all data are available from managed regional databases in time for JTC data extraction, which usually occurs early in January. **The SRG recommends that the JTC continue to set a deadline for the extraction of catch data and be transparent about the sources of data used in the assessment in the event that data have to be obtained directly from the sources.**

Management Strategy Evaluation (MSE) and Supporting Analyses

Overview

The SRG received a paper and briefings on preliminary work conducted on the management strategy evaluation (MSE) of Pacific Hake/Whiting, aimed at questions that cannot be addressed within the current stock assessment framework. The work has been conducted under a new MSE coordinator and postdoctoral scholar based at the NWFSC.

The MSE under development consists of an operating model of "reality" that is structurally different and more complex than the assessment model, and thus can be used to test how well the assessment and harvest control rule (HCR) perform when the assessment differs from the underlying reality. The operating model includes four seasons and two areas (Canada and the US), with movement between areas depending on the age of fish and season. Spawning is assumed to occur in season one, fishing primarily in seasons two and three, movement into Canada in seasons one to three, and movement back into the US (for spawning) in season four. Younger ages (0-2 yrs.) remain in the US, while older individuals have a greater probability of moving north, allowing the model to mimic the observed age structure in the catches of each country. The operating model is coded in R. The estimation model in the MSE is written in Template Model Builder (TMB) and is intended to mimic the structure of the current stock assessment model. It should be noted that the assessment model is implemented in Stock Synthesis, which is written in a different language. Since Stock Synthesis is a general-purpose model, much of its code is not used in the Pacific Hake/Whiting assessment (e.g., predictions of lengths and weight are not needed, since the assessment model uses empirical weights at age); thus, the TMB code is much shorter (600 lines of code vs. 30,000) and runs 15 times faster. This acceleration of model execution is critical in running MSE simulations. The MSE estimation model, while mimicking general trends in the assessment model, is not yet able to duplicate the assessment model estimates. In addition, due to time constraints, the MSE assessment model does not include Bayesian estimation, which is important because maximum likelihood estimation typically results in slightly different estimates from Bayesian estimates.

The MSE is set up to evaluate whether the current management system can meet the objectives of the JMC: minimize the risk of the stock's being depleted (below $0.4B_0$), minimize the risk of the stock's being below $0.1B_0$, avoid fishery closures, obtain a high average coast wide catch, and maintain enough fish in both countries to catch their respective TACs.

One intent of the MSE process is to evaluate the performance of harvest control rules (HCRs) when fish movement between countries is nonzero. A preliminary analysis shown to the SRG examined three HCRs under medium levels of movement:

(i) catches based on the 40-10 rule encoded in the Hake Treaty ("default HCR");
(ii) catches lower than the 40-10 rule at higher biomasses, similar to past JMC recommendations ("JMC catch buffer"); and
(iii) catches reflecting actual past catches, which have been lower than JMC recommendations at high biomass levels ("realized catch buffer").

Three additional movement scenarios were examined with catches at the realized catch buffer: low movement rates, high movement rates, and medium movement rates, but with movement happening at younger ages.

In the preliminary results, the default HCR yielded much higher catches in some years than the other two HCRs tested, but also resulted in more variable catches, more years of fishery closures, lower median catches, and a higher risk of depletion than the JMC catch buffer or the realized catch buffer scenarios. In addition, the median biomass under the default HCR is well below 40% of B_0 during the simulated future, averaging between 20 and 25% of B_0, but is higher when using the other two HCRs.

Both the SRG and the MSE Technical Team note that these preliminary results are promising, but further work is needed to resolve issues identified during the SRG meeting before the MSE can be used with confidence to support management decision-making. Incorporation of the results from the FATE project predicting hake movements from environmental and climate drivers may also improve the MSE in the future. **The SRG strongly supports the MSE process, which is valuable for strategically advancing Pacific Hake/Whiting stock assessment science and management, and looks forward to seeing more definitive results at the 2020 meeting.**

Research into Environmental and Demographic Influences on Hake Distribution

Research being conducted by a post-doctoral scholar at the Northwest Fisheries Science Center was reviewed by the SRG. This work includes analysis of associations between water temperature and the distribution of Pacific Hake/Whiting by age during the seasonal period covered by the U.S. and Canadian summer acoustic/trawl surveys. An intended outcome of this research is to help inform parameterization of the two-area MSE operating model, which includes fish movement between U.S. and Canadian waters.

Data for this research were drawn from the minimum common range of the 12 surveys conducted from 1995 to 2017. Survey temperature readings at 100m depths were examined as explanatory variables of both overall and age- (or age-group-) specific abundance, using a Bayesian additive model.

Pooling data across years and age-classes, positive temperature anomalies (at 100m depths) were associated with statistically-significantly higher biomass estimates north of Vancouver Island, and lower biomass estimates from lower Vancouver Island south to northern Oregon. From that point southward, areas with higher and lower biomass associations were observed, but these associations were not statistically significant.

The analysis also investigated the effects of positive temperature anomalies on areal abundance estimates for three groups: fish of age 2, ages 3 and 4, and those greater than 4 years of age. Warmer-than-average water temperature (at 100m) was associated with somewhat higher northern abundance and lower southern abundance of age-2 fish, but these relationships were not statistically significant. For age 3-4 fish, above-average water temperatures were associated with statistically significant, higher-than-average abundance from upper Vancouver Island, north, and below-average abundance from lower Vancouver Island south to Cape Blanco (42.8°N). Above-average abundance was observed south of there, but with limited statistical significance.

Abundance anomalies for fish older than 4 years exhibited a similar pattern, but with the alternating patterns of above- and below-average abundance shifted northward. While a similar (though somewhat less robust) region of higher abundance was observed north of Vancouver Island, the area of negative abundance anomalies extended only as far south as the Columbia River, and significant positive abundance anomalies characterized nearly the entire survey area from Newport south to Pt. Arena.

Recommendations for the MSE and supporting analyses

1. **The SRG recommends that operating model scenarios include those accounting for the effect of climate change on hake distribution and movement**, to test the robustness of current and future management procedures to climate change.
2. The SRG commends the MSE Working Group (AP, JMC, and MSE Technical Team) for the planned coordination between the survey team, the FATE project, and the MSE project to ensure that priority data are collected and results used to inform the operating model.
3. The SRG encourages continued research on the FATE project, particularly factors influencing the positive deviations of 5+ fish off California, since this is expected to directly inform movements modeled in the MSE. The SRG also notes that estimates of euphausiid distribution will go into the FATE model to see whether predictions of Pacific Hake/Whiting movement and abundance are improved.
4. The SRG emphasizes the following topics (not in rank order) for examination with the MSE:
    i. Climate change and its impact on hake distribution, movements, and fisheries in each country.
    ii. Modeling the spatial distribution and movements of fish of different ages to ensure that sufficient quantities of fish are present in each country to allow TACs to be taken.
    iii. Testing the usefulness of results generated from incorporating the age-one index obtained from the acoustic/trawl survey as a sensitivity run or part of the base run, as done in the 2016 MSE evaluation.

iv. Testing the impact of Saildrone surveys (described below) on performance metrics, for example comparing scenarios with no Saildrone survey; Saildrone surveys alternating with acoustic/trawl surveys; and sequences of two years of Saildrone surveys followed by one year of acoustic/trawl survey. The MSE should assume Saildrone surveys provide a relative index that will not be comparable to the acoustic survey, that Saildrone surveys may result in systematic bias in assigning acoustic backscatter to the correct species, and that biomass of other species recorded in the Saildrone surveys may systematically increase or decline over time.

5. **The SRG requests that development continue on the MSE's estimation model until it can more closely reproduce the estimates of the current assessment model. The SRG requests that further comparisons of the models be presented as part of the MSE report at its 2020 meeting.**

At-Sea Investigations

The SRG received several informative presentations about at-sea research conducted by the acoustic/trawl survey teams in both Canada and the US. Here, we summarize some highlights:

Saildrone feasibility studies: The Saildrone is a proprietary, wind-powered, acoustic-oceanographic vessel operated by Saildrone, Inc., in accordance with clients' requirements. The vessel is about 7 m (23 ft.) long and 5 m (16.5 ft.) tall, with a keel extending about 2.4 m (8 ft.) below the surface. The vessel is solar powered, moves at 2.5-3.0 knots and is capable of carrying various oceanographic instruments, among them two Simrad 38 and 200 kHz transducers and sonar transceivers. The Saildrones were programmed to follow predetermined tracks by day, while at night their acoustic capabilities were not used owing to hake dispersal behaviour and they were allowed to mill about their positions. However, depending on the survey design, Saildrones could be programmed to move to new transects at night to be on station ready to begin surveying the following day. The vessels are monitored by operators at Saildrone, Inc.

Five Saildrones were deployed in a 2018 trial run and acoustically sampled the full spatial extent of the regular acoustic/trawl survey in about 100 days. This result raises the possibility of cost savings, or obtaining more information, or both. However, considerable work remains to develop protocols to ensure comparability of Saildrone observations with the ongoing acoustic/trawl survey and to resolve several other operational and scientific issues. Most importantly, the Saildrone itself has no capability to inform/enhance acoustic backscatter measurements with physical sampling to identify species and age compositions, making its deployment alone less informative than the current survey. Further, as currently configured, Saildrones are restricted to two acoustic frequencies and therefore lack the ability to utilize the full array of acoustic frequencies available above survey vessels. The survey teams hope to deploy and evaluate Saildrones in conjunction with the regular acoustic/trawl survey scheduled for summer, 2019, as a further step towards understanding best uses of Saildrones.

Moored acoustic systems: The SRG was advised of work by DFO to retrieve three moored upward-looking echosounders that had been placed along west coast of Vancouver Island at depths of 300-400 m in Barkley Canyon, Clayquot Canyon and off Brooks Peninsula. These moorings consisted of three frequencies (70, 125, and 200 kHz) looking upward to the surface to provide high-time-resolution views of organisms (from euphausiids through fish) that move over

fixed areas through time. Although analysis of the data is not complete, the SRG was shown striking echograms showing daily vertical migrations of fish and plankton. Such work has the potential to increase our knowledge of organismal migrations and other behavior, as well as abundance. The moored echo sounders were redeployed in the summer of 2018 so a second year of data may be collected and available for analysis sometime in 2019.

EK60 vs EK80 comparison: Both the US and Canada plan to move from Simrad EK60 echosounders to the new EK80 model, the current world standard. The 2019 acoustic/trawl survey will be conducted with the EK60 on the NOAA research vessel, *Bell Shimada*, to provide best comparability with the Canadian chartered vessel, *F/V Nordic Pearl*, which also uses the EK60. In 2020, the new Canadian research vessel, CCGS *Sir John Franklin*, is expected to be in service and equipped with the EK80, and the R/V Bell Shimada will upgrade to the EK80 as well. Comparison of the EK60 and EK80 in 2018 showed data from the two models to be close, but not identical. Thus, slight corrections, possibly depth-dependent, will need to be made to data collected with the EK60 as the EK80 becomes the standard in the acoustic/trawl survey.

Trawl codend liner comparison: Research was conducted in the summer of 2018 to compare US and Canadian cod-end liners. The US (32 mm mesh) and Canadian (7 mm mesh) were trawled in sequential pairs. Because of operational problems, only 6 trawl pairs were taken. Analysis of those data show no significant differences in the size or species composition of animals caught, but differences are difficult to show with such a small sample size. Investigators believe that the smaller mesh of Canadian gear is counteracted by the greater pressure wave it generates, which tends to push smaller organisms out of the main net's larger mesh. These results, though not fully conclusive, do help increase confidence in the trawl data by answering a longstanding question about gear comparability.

Recommendations and Conclusions for At-Sea Investigations

1. Winter cruises, Jan-Feb, were conducted in 2016 and 2017 in part to examine whether a winter survey could efficiently estimate hake biomass as the distribution of hake was thought to be compressed into a smaller area in winter than summer. Further analysis of the 2017 results was not available at the 2019 SRG meeting. **The SRG reiterates its 2018 recommendation that the Survey Team complete the analyses of the winter cruise survey data in anticipation that the results will inform the direction of the winter cruise effort in the future.**
2. The Saildrone represents a promising new technology. **The SRG notes that, because of the Saildrone has no capacity to physically sample species in the water column for identification and age compositions that inform the interpretation of acoustic data, its deployment alone is less informative than the current survey. The SRG recommends that scenarios be examined in which the Saildrone is used nonexclusively to increase sampling while controlling costs to inform considerations of future technology for the survey.** This scenario exercise might be possible, for example, by conducting Saildrone surveys in some years or areas while conducting the existing acoustic/trawl survey in others. The survey team noted that the Saildrone's echo frequencies could be modified to match those of the EK80, by replacing the 200 kHz band with 120 kHz, and that this would be more suitable for surveying Pacific Hake/Whiting.

3. **The SRG was pleased to see the cod-end comparisons and corresponding data analysis and recommends that additional comparisons be made as possible, to increase confidence in the conclusions.**
4. **The SRG concludes from reports received at the 2019 meeting that comparison studies of EK60 and EK80 echosounders are on schedule and expects that this conversion should go smoothly.**
5. **The SRG looks forward to additional analysis of the data received from the moored echosounders.**
6. **The SRG commends the acoustic survey teams for completing these items and other research that will ensure continuation of a high-quality survey into the future.**

2019 Summer Acoustic Survey

The SRG received a briefing on the 2019 summer acoustic survey, planned for June 13 to September 20. The design of the survey is based on limitations in available ship time in both Canada and the United States, along with the potential for an El Niño event and enhanced northward movement of Pacific Hake/Whiting. The survey will begin at a randomly determined location near Point Conception (34.5°N) and proceed north to Dixon Entrance (54.5°N). Transects in U.S. waters and along Vancouver Island will extend from bottom depths 50 m offshore to 1500 m or 35 nmi offshore (whichever is farther offshore). Transects north of Vancouver Island will cover bottom depths from 50 to 1500 m. Transect spacing will be every 10 nmi from Point Conception (34.5°N) to the northern end of Vancouver Island (50.5°N). Every 8th transect in U.S. waters will be skipped to enable completion of the U.S. portion of the survey in the allotted ship time, resulting in 20 nmi transect spacing at these locations. Transect spacing from the northern end of Vancouver Island (50.5°N) to Dixon Entrance (54.5°N) will be 20 nmi. Canadian industry and the Alaska Fisheries Science Center (Groundfish Bottom Trawl Survey) will provide an "early warning" of northern Pacific Hake/Whiting extent to enable survey adjustments if necessary. The 2019 survey will operate with Simrad EK60 echosounders and is expected to be the last year for this equipment as both countries upgrade to the newer EK80. **The SRG supports and recognizes the efforts of the Survey Team to consult with industry and develop a survey design that is responsive to their concerns and potentially changing ocean conditions, while providing good coverage in support of the stock assessment.**

Recommendations and Conclusions for the 2019 Survey

1. **The SRG would like a better understanding of the guidelines, protocols, and decision rules used in conducting verification trawls and recommends that the Survey Team provide documentation at the next SRG meeting in 2020. The SRG is also interested in characterizing how uncertainty in interpreting acoustic signals affects trawl successes and failures and encourages the Survey Team to consider how this could be accomplished.**
2. The SRG has consistently recommended in previous reports that the Survey Team identify and quantify sources of variability in the survey. **The SRG recommends that the Jolly-Hampton variance estimates be presented as part of the 2019 survey results and expects that the Survey Team will continue to work on better quantifying the survey variance.**

3. **The SRG recommends that the Survey Team provide an age-1 index for inclusion as a sensitivity run or part of the base run, in an appendix to the assessments in order to evaluate the effect of this index on the forecasting ability of the model.**
4. **The SRG reiterates its recommendation that the Survey Team 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.**
5. **The SRG also recommends that the biomass estimation process flowchart reviewed at the 2018 SRG meeting be included in the survey methods and protocol documentation.**
6. **The SRG recommends conducting analysis of commercial catch and fishing effort distribution regularly to ensure that the acoustic/trawl survey is achieving its goal of covering the entire summer range of Pacific Hake/Whiting.**

Other SRG Recommendations

1. The SRG remains concerned about a meeting schedule with a short period between the end of the SRG meeting and the start of the JMC meeting. If a serious issue is identified, then there is insufficient time to re-run the assessment, revise the assessment document, and present updated management advice before the JMC meeting. **The SRG recommends maintaining a gap of at least one week between the two meetings to allow time for corrective actions if needed, and for the SRG to complete its work in a more considered manner.**
2. **The SRG recommends maintaining routine communication among all bodies (AP, JMC, SRG, JTC, Survey Team, MSE Working Group, MSE Technical Team) supporting the implementation of the Pacific Hake/Whiting Agreement, so that members of the SRG are updated about research and analysis priorities and concerns of the management and stakeholder communities.**
3. **The SRG also requests that when the JMC identifies areas on which it would like SRG input, it submit written requests to the SRG co-chairs 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 background materials.**
4. The SRG appreciates that for several years now, both the survey team and the JTC have presented explicit responses to previous SRG recommendations. **We request that this approach be continued indefinitely.**
5. **The SRG recommends that the JTC look into the logistics and availability of electronic copies of the data and model files.**

ATTACHMENT 1

Joint US-Canada Scientific Review Group for Pacific Whiting

SFU Harbour Centre
515 West Hastings Street
Vancouver, BC V6B 0B2

February 19-21, 2019

AGENDA

Tuesday, February 19, 2019

09:00 Welcome and Introductions

09:15 Review and Approve Meeting Agenda (Chair)
- Review Terms of Reference for Assessments and Review Meeting
- Meeting report mechanics
- Assignment of reporting duties

09:30 Fisheries, Data, and Inputs Used in the 2019 Assessment (JTC)
2018 Fisheries Catch, Size, and Age Composition Data
- Canadian Waters
- U.S. Waters

10:30 ***Break***

10:45 2019 Pacific Hake Stock Assessment Methods, Results and discussion (JTC), Including incorporated 2018 SRG Stock Assessment Requests

11:45 ***Lunch (on your own)***

13:00 2018 Pacific Hake Assessment: Sensitivities and Retrospectives and discussion (JTC)

13:45 Review other 2018 SRG Stock Assessment Requests (JTC)

14:45 ***Break***

15:00 Management Outcomes of the 2019 Pacific Hake Stock Assessment and discussion (JTC)

15:45 SRG discussion, develop list of requests for JTC, as needed

16:15 Public Comment

16:30 SRG Closed Work Session

17:30 Adjourn for the day

Wednesday, February 20, 2019

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

09:30 Survey-related Research (Survey Team)
- Saildrone
- Overview of 2018 summer research
- Other

10:00 2019 Survey Design (Survey Team)

10:30 Break

10:45 Hake summer distribution and environmental drivers (Mike Malick)

11:45 ***Lunch (on your own)***

13:00 MSE progress update, including responses to 2018 SRG MSE Recommendations (Nis Jacobsen, Ian Taylor, and JTC)

15:00 ***Break***

15:15 SRG Discussion, requests for additional information JTC, Survey Team, and MSE, as needed

16:00 Public Comment

16:30 SRG Closed Work Session

17:30 Adjourn for the day

Thursday, February 21, 2019

09:00 Review of previous day, follow-up questions, etc.

09:30 SRG Closed Work Session

10:30 ***Break***

10:45 SRG Clossed Work Session

11:45 ***Lunch (on your own)***

13:00 Review of Draft SRG Report

14:30 ***Break***

14:45 Review of Draft SRG Report

16:00 Meeting Adjourned

13:00 Meeting Adjourn

ATTACHMENT 2

List of Participants

Name	Affiliation
Aaron Berger	NOAA Fisheries, JTC
Trevor Branch	University of Washington, SRG-Independent Member
Barron Carswell	JMC, Province of BC
Al Carter	AP-USA
Jaclyn Cleary	Fisheries and Oceans Canada, SRG
Andrew M. Edwards	Fisheries and Oceans Canada, JTC
Stephane Gauthier	Fisheries and Oceans Canada
Chris J. Grandin	Fisheries and Oceans Canada, JTC
Jim Hastie	NOAA Fisheries, SRG, Co-chair
John Holmes	Fisheries and Oceans Canada, SRG, Co-chair
Mike Hyde	AP-USA
Nis Jacobsen	NOAA Fisheries
Kelli Johnson	NOAA Fisheries
Shannon Mann	AP Advisor to SRG-Canadian appointee
Mike Okoniewski	AP-USA
Sandy Parker-Stetter	NOAA Fisheries, Survey Team
Michael Prager	NOAA Retired, SRG-Independent Member
Lori Steele	AP Advisor to SRG-USA
David Sampson	Oregon State University, SRG-Independent Member
Rob Tadey	Fisheries and Oceans Canada
Ian Taylor	NOAA Fisheries, JTC
Dan Waldeck	PWCC, JMC-USA