U.S./Canada Pacific Hake/Whiting Treaty Joint Management Committee (JMC) Meeting – Record of Discussion

July 31 – August 1 2018, Chateau Victoria Hotel & Suites, 740 Burdett Ave, Victoria BC

PARTICIPANTS

Name	Advisory Body	Organization
Paul Ryall	JMC Canada Chair	DFO
Frank Lockhart	JMC U.S. Chair	NOAA
Barron Carswell	JMC Canada	Province of British Columbia
Phil Anderson	JMC U.S.	Pacific Fishery Management Council
Bruce Turris	JMC Canada	Groundfish Conservation Research Society
Dan Waldeck	JMC U.S.	Pacific Whiting Conservation Cooperative
Theresa Williams	JMC Canada	Fisher Bay Seafoods Ltd.
Steve Joner	JMC U.S.	Pacific Coast Treaty Indian Tribes
Michelle McClure	U.S. SRG Chair	NOAA
Ian Taylor	U.S. JTC Co-chair	NOAA
Kristin Marshall	NWFSC	NOAA
Nis Jacobsen	NWFSC	NOAA (Post-Doctoral Fellow)
Kelli Johnson	NOAA Science	NOAA
Kaitlyn		Oregon State University – M.Sc. Student
Aaron Berger	U.S. JTC	NOAA
Joe Bersch	U.S. AP Co-chair	Phoenix Processor Limited Partnership
Shannon Mann	Canada AP	Groundfish Trawl Committee, Mariner Seafoods Ltd.
Mike Okoniewski	U.S. AP	Pacific Coast Seafood
Lori Steele	U.S. AP	Westcoast Seafood Processors Association
Rob Kronlund	DFO Science	DFO
Mike Turner	Ministry of Agriculture	Province of British Columbia
Rob Tadey	DFO – GMU	DFO
Gwyn Mason	DFO – GMU	DFO

WELCOME AND INTRODUCTIONS – Paul Ryall, JMC Canada Co-Chair

Paul Ryall welcomed participants, led introductions and reviewed the agenda.

Staffing updates:

- Kelli Johnson will be fulfilling Ian Taylor's role as JTC Co-Chair
- Jim Hastie will be fulfilling Michelle McClure's role as SRG Chair

2018/2019 MEETING SCHEDULE/APPROVAL – Paul Ryall, JMC Canada Co-Chair

Deadlines and upcoming meeting schedules for JTC, SRG, and JMC were discussed and agreed upon.

The 2018/2019 Meeting Schedule is as follows:

- **October 30, 2018:** MSE Working Group teleconference
    - JMC members request ability to listen in to teleconference

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EVENT	DATE(S)	LOCATION
JTC Meeting	December 11 or 12, 2018	Seattle area
Stock Assessment Draft	Feb 6, 2019	Available on Whiting Treaty website
JMC Draft Assessment Briefing Teleconference	Feb 8, 2019	Teleconference 9am –11am
SRG Meeting	Feb 18-22, 2019	Vancouver area
SRG Report	Feb 27, 2019	Available on Whiting Treaty website
JMC Meeting RE: 2019 TAC	March 4-5, 2019	Vancouver area

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FISHERY UPDATE – Joe Bersch, U.S. AP Co-chair, and Shannon Mann, Canada AP

Joe Bersch and Shannon Mann gave brief updates on the current fishery for the U.S. and Canada, respectively.

U.S.A *(PacFin data – July 30, 2018)*

- The fishery seems to be healthy this year with good CPUE, with the following breakdown of sector catch:
    - Mothership sector at ~44% of TAC (fishing to resume mid-September)
    - Catcher-processers at ~42% of TAC (fishing to resume mid-September)
    - Shore-side vessels at~ ~42% of TAC (fishery ongoing)
    - Tribal sector harvested ~ 2167 mt (Harvest is limited by processing within the sector)
- Challenges in bycatch avoidance of rockfish, POP and Widow, were reported, including having difficulties retaining hake without encountering rockfish. Reports of high bycatch of rockfish were reported early in the season north of the Columbia river. It appears that there is a geographic spread of both inshore and offshore rockfish species to Northward and Southward.
- The fishery is encountering high numbers of juvenile sablefish. It has been reported that there are high numbers of sablefish (2 yr age class) at both the Canada/U.S. border, and in the Bering sea. Freezer vessels haven't been able to fish as successfully due to the inability to avoid juvenile sablefish.
    - Q/A – Sablefish Avoidance protocols: Co-ops have adopted rules for bycatch avoidance, including mandatory reporting, moving out of areas highly populated by juvenile sablefish, as well as a mandatory immediate notification requirement of bycatch events of a certain threshold/magnitude. The mothership sector put a sablefish protocol in place, including closure areas and advisory areas.
    - Q/A – Hard vs. soft cap for sablefish bycatch: There is a soft cap for sablefish for Mothership and Catcher-processor combined. Shoreside has individual quota holdings for sablefish.
- Vessels have had to move and find alternative fishing grounds in order to minimize bycatch.
- Hake are in excellent condition.

Canada *(Updated July 31, 2018)*

- Approximately 34% TAC has been caught thus far. Fishing has been reported as steady, and up from previous years. According to a July 26th IHAC report, ~62% of catch was from offshore, 38% JV. 2017 as a record year, and so far 2018 is on track to be as good as, if not better than, last year.
- A new freezer trawler is due to start fishing soon (Within approximately one week), called the Viking Alliance

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- Fish are reported to be well-sized, in the 400-600g range, being caught in traditional areas (South, Northwest coast) at traditional depths.
- The fishery is reporting high levels of juvenile sablefish. Avoidance protocols have been put in place to mitigate the issue.

HAKE MSE PROGRESS UPDATE – Kristin Marshall, NWFSC

Kristin Marshall was introduced and recapped the Management Strategy Evaluation process and progress to date.

Reminder: MSE is a process

- An MSE simulates the entire management process: data collection, assessment, application of harvest control rules (HCRs) and the effect of removals on abundance, distribution and productivity.
- During the development and testing process, communication from all sides (industry, management, scientific, etc.) is key
- Testing the management procedures first in a virtual world, before considering implementing them in reality is part of due diligence
- The MSE is not meant to inform tactical decision-making

Workplan – thru December 2019

- Plan and Design 1 (completed): Since March 2018, the project team and MSE working group have been established, and goals for the first iteration of the MSE were determined:
    - Evaluate the performance of current Hake management procedures under alternative hypotheses about current and future environmental conditions
    - Better understand the effects of hake distribution and movement on both countries' ability to catch fish
    - Better understand how fishing in each country affects the availability of fish to the other country in future years
- Plan and Design 2 (ongoing):Identify environmental scenarios, identify other types of scenarios, develop operating and estimation models
- Implementation of MSE simulation (ongoing): Develop the computer code for closed loop simulation, parameterize operating models, simulate each management strategy with each operating model and summarize and interpret performance metrics, develop communication tools for simulation results
- Timeline of presenting simulation results:
    - JMC Summer meeting 2018 (current meeting): present 1st iteration, with a single non-conditioned model
    - February/March 2019: present 2nd iteration, with at least one conditioned model
    - August 2019: present 3rd iteration, with multiple conditioned models
    - December 2019: Technical documentation of results

MSE Working Group Progress

- Representatives from the JMC, AP, JTC and MSE project team make up the MSE Working group. So far, 3 working group calls have occurred over the past 5 months; with a more formal review at SRG and JMC meetings.
- The three calls covered the following three topics (discussed in more detail below): Management objectives and performance indicators, operating model structure and Fisheries and the Environment (FATE) Hake hypothesis, and scenarios for uncertainty
- CALL 1: Management objectives and performance indicators:
    - The purpose of this call was to develop goals, sub-goals, objectives and performance metrics of the MSE; as well as determine tentative timelines and probabilities for each goal.
        - Goal 1: Manage the Pacific hake resource in a precautionary and sustainable manor
        - Goal 2: Ensure both parties can receive their intended benefits under the treaty

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- CALL 2: Generating hypotheses for MSE operating models and FATE Hake project
    - The purpose of this call was to 1) generate hypotheses about what influences the distribution of hake within and among years to inform the FATE Hake project, and 2) to generate ideas about alternative operating model structures for the MSE
    - Comment: More focus is required regarding gear differences between countries and between fleets. This will have significant impacts on the population, especially during years of lower abundance.
    - Q/A – implementation of fleets in model: Need to determine how to increase the resolution in the model, then figure out how to allocate catch in respect to the fleets. It is possible to break it down by fleet type.
    - Q/A – mechanism by which fish are caught: What plays a bigger role - horse power, mesh size? Is it based on overall fleet type or does specific gear have a significant influence? It is likely not a large issue; in terms of explaining selectivity between countries or between fleets within a country – the bigger picture will be more telling. Kristin noted that caution should be taken regarding the complexities that are desired for the MSE – it may not be possible to explore all complexities with the data

- CALL 3: Prioritizing scenarios of uncertainty for the MSE
    - The purpose of this call was to prioritize types of current and future uncertainty to explore and to identify candidate management strategies.
    - Discussions took place regarding elements of the management strategy ('things we can manage') and how they may affect the operating model ('things we can't manage')
    - The working group explored how to parameterize different movement regimes and how the effect of future environments may affect movement rates.
    - Other scenarios were raised for consideration, including recruitment scenarios and growth scenarios.

MSE OPERATING MODEL OVERVIEW – Nis Jacobsen, NWFSC

Nis Jacobsen, a post-doctoral fellow with NWFSC, was introduced and discussed the progress and results of the first iteration of the MSE, with a single non-conditioned model

Overview

- The Pacific Hake MSE can compare performance metrics and trade-offs between operating models, estimation models and harvest control rules.
- A cyclical model can be used to make predictions several years into the future:
    - Operating model (movement, recruitment, mortality) → Data generation (catch, survey, age compositions) → Estimation Model (fishing mortality, stock status, reference points) → Harvest control rules (TAC)
- The estimation model (EM) is the same as the maximum likelihood model in the official stock assessment and currently runs 50 years in 0.3 seconds.
- The operating model (OM) is an age-based model. Currently the time scale is set to 4 seasons per year.
    - Spatial parameters include fish movement, fisheries, spawning and selectivity (differs in each season)
    - This produces data similar to the data available from the fishery
    - The OM is written in a flexible framework to allow for the exploration of different scenarios and OM configurations.
- As of now, the computer code has been created for a flexible OM (can be altered), the OM has been partially conditioned and closed-loop simulations have been conducted.

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Operating Model

- OM parameters were set to mimic realistic conditions as closely as possible, using historical catch as input.
- *Movement* was modelled as a fraction of an age group that moves out of an area, where area is currently implemented as 2 boxes (north/south) (software is flexible). Older individuals have a higher probability of moving than younger individuals; most spawners move south in the last season of the year to spawn (move in season 4 (December) to spawn in season 1 of the next year (January).
    - Q/A – are seasons based on calendar year or on management yet? The seasons are based on the calendar year, approximately 3 months per 'season'
- *Spawning* is coded as a Beverton Holt relationship with annual recruitment deviations, and occurs in the beginning of season 1. The stock-recruitment relationship is area specific (depends on the spawners in each area), deviations are the same for all areas. Recruits (age 0-1) do not move between boxes.
- The catch in *fisheries* is divided by areas according to the treaty and the OM calculates fishing mortality in each area depending on the catch distribution per season. Catches occur predominately in seasons 2 and 3.
- OM conditioning data used in the initial plots that were presented included catch-at-age data from Canada/US, survey spatial estimates and total catch records from Canada/US. Other data being gathered includes data from the FATE Hake project, expert opinion and other literature sources.
- The estimation model (EM) takes ~0.3 seconds to run and the OM takes ~0.5 seconds to run. One realization 50 years into the future (51 stock assessments) takes ~40 seconds. One realization with Hessian calculated requires ~ 4 minutes.
    - Q/A – Is there a loss of resolution with an increase in simulation speed? No, resolution is not affected. The simulation is run using MLA (multinomial analysis) rather than MCMC.

Operating Model Output Examples

- Using the first iteration of the MSE, it is possible to recreate the JTC *stock assessment SSB model*; the curve is very similar throughout the time series.
- *Survey biomass* estimates (occur ever 2nd year from 1995 onwards) were able to be reproduced with a relatively similar pattern. However, it should be noted that the survey's confidence intervals are quite large, and the OM predicts a slightly higher biomass across times. This could be due to the OM 'survey' occurring earlier in the year than the actual survey.
- The simulated *average age in the survey* from the OM was similar to that of the assessment and of observations.
- The *average age in catch* was similar among both countries combined between observations and simulations. The average catch age in catch in the US was similar between observations and simulations, while the average age in catch in Canada is higher in the observation than in the OM. The example assumes that movement is the same in all years, but movement may be more unpredictable in reality. The OM also assumes equal (gear) selectivity between the two countries.
- The *biomass distribution in the survey* had a relatively similar pattern between observations and the OM for the US, while the OM predicts more biomass in Canada than what has been seen in the survey.

Scenarios to Explore and Future Work

- Some scenarios to be explored are:
    - How do movement parameters influence the population and the fishery?
    - What if spawning and movement are affected by climate change in the future?
    - What happens when selectivity is different between Canada and the US?
- Upcoming work includes the implementation of scenarios into the OM, complete OM conditioning, troubleshoot any bugs in the code, and review the performance metrics of the initial conditioned OM
- Once the OM has been conditioned, the technical team will explore a spatial assessment model that would estimate movement rates, as well as implementing selectivity differences between Canada/US. Recruitment scenarios and changes in growth and mortality will also be explored.

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Questions and Discussion

- Can you elaborate on the data limitations with the OM?
    - The age compositions between some sectors in the catch only exist for about 10 years. In terms of the spatial survey abundances, there are about 10 data points from 1999 onwards. There is not much available in terms of spawning data or movement data between seasons. In order to fill these 'gaps', we have to make some assumptions and run sensitivity analyses.

- How would predicting movement in the future improve if there is limited data in terms of movement, but the model makes projections in terms of how the population is moving between seasons?
    - Will the model be able to help with this? The model only 'knows' what is put into it in terms of parameters. Assumptions will be added manually and tested. The technical team will get feedback on these – can the assumptions be made more robust? Does the assumption hold up?

- When comparing the model output vs. observed data, how will the model be tweaked in the future?
    - Feedback will be gathered from meetings like this, from expert opinion, etc. The FATE Hake project is working on short term movement (between seasons), so when that's able to be added, it will be. A request could be made to DFO for early life history stages of hake in Canadian waters. As modellers, you can point out and prioritize the unknowns, and can estimate the degree to which the fishery is affected by these unknowns.
    - It was pointed out that because the spawning biomass data spans a number of years, it is possible to determine anomalies and then retroactively determine climate/fishing conditions during those years. It may provide an indicator of movement/spawning patterns.
    - The model predicts catches predominantly in seasons 2 and 3. It was pointed out that when the fishing season is going well in Canada, fishing can occur well into November and December (season 4). Freezer trawlers finish fishing in October/November and leave the fishing grounds. However, this doesn't mean that certain age classes aren't present. Young age classes have been reported in bottom trawls in December.

- How is the closed loop being conducted?
    - Data from the assessment model is being used and the simulation is being generated based on geographic distribution of the fish. As of now, neither a 'no fishing' or a 'perfect world' scenario has explored, but it will be in the future. Discussions are in progress regarding how uncertainty is identified and handled within the model.

- Comment: The issue with movement will remain ever-present. It was suggested to approach from another direction – when management procedures begin to fail to meet the objectives, and then build the case where this may be able to be mitigated in the future using output from the MSE.

- What is the biggest worry at this point in terms of conditioning and implementing the model?
    - It is concerning that the movement parameters could cause some issues. Currently there are 20 movement parameters – each age class has a movement parameter in each season of each year. We are trying to build a very complex model that doesn't have a lot of data to determine the accuracy of the model.
    - Recruitment deviations are quite high – there is likely something that isn't well understood about the stock's behaviour (interspecific competition, etc.)
        - It was mentioned that historically recruitment wasn't as unpredictable until around 1999/2000 and 2010. Is there a way to find out more about these time periods that may have caused a shift in recruitment? Weather patterns, other major differences, etc.

    - The movement for the 3-5 year age classes is sporadic, they can move southward. Usually the 6-10 year age classes don't really move. Is it possible to make batches for age classes (i.e. a batch with a cut-off of age 3, then another at age 5, etc.)?

- Comment: When work began on the MSE OM, originally a model that didn't include seasonality was being considered – only yearly time steps were included. This would have been simpler but it would have over-simplified processes. Adding a seasonal element allows for more realism at the cost of extra complexity. A 'sweet spot' needs to be found where one can adequately draw from data, find other sources, etc.

- Comment: The goal of the 2nd iteration of the MSE is to have a fully conditioned OM to present output at the spring 2019 meeting, and the modelling team is on track with this goal.

JMC Co-chair Paul Ryall encouraged members to review what has been discussed regarding the MSE and its progress. Look at the objectives to make sure that the group is satisfied with the priorities going forward. He wanted to ensure that members are satisfied with the JMC's direction to the technical team.

INITIAL SUMMARY OF RETROSPECTIVE PERFORMANCE METRICS - Ian Taylor, NOAA

Ian began the second day of the meeting by presenting the performance metrics applied to 1966-2018 dynamics. Performance metrics are a key component of the MSE process – they determine how well alternative management procedures achieve the goals. A method that can be used to understand the context of MSE results is to apply the same performance metrics to the historical stock and fishery.

Performance Metrics Related to Hake Resource

- The percentage of years that the coastwide spawning biomass was above B_{10} was 100% for all years.
    - 100% for all years
- The percentage of years that the coastwide spawning biomass was above B_{40}
    - 83% for the entire history of the fishery
    - In recent years (2009-2018) has been at 69%.
    - A recent call was made to ensure that the spawning biomass is above B_{40} 75% of the time.
- The percentage of instances that the coastwide spawning biomass is < B_{40} and remains there for 3 or more consecutive years
    - The median estimate of relative spawning biomass was < 40% from 2007-2011 (5 consecutive years)
    - Q/A - how is this calculated? Can these periods overlap? If SSB dips below 40% one year, track it 3 years later. If SSB is below B_{40} two consecutive years, then these 3-year periods would overlap.

Performance Metrics Related to the Fishery

- Percent of years that Canadian/US TAC exceeds the exploitable biomass in Canada/US
    - The country-specific exploitable biomass is not currently estimated.
    - Q/A – what counts as exploitable? Typically in a model, it means the product of the available resource and the selectivity of each age/size
- Percent of years that coastwide TAC < 180k tons
    - * Historical TAC values are not easily accessible, so the numbers presented were relying on catch. If a table of TAC values from early years exists (prior to 2008), it would be useful.
    - In the full history of the fishery, catch* was < 180 k in 15/52 years
    - In recent years (2009-2018), catch* was never < 180k. (TAC was just above this value in 2009)
- Percent of years that catch > 375k tons
    - In the full history of the fishery, catch was > 375k 2% of the time
    - In recent years (2009-2018), catch was > 375k 11% of the time

- Percent of years that catch > 500k tons
    - The fishery has not yet exceeded 500k tons
- Average annual variability in catch
    - In the full history of the fishery, the average annual variability in catch is 24%
    - In recent years, the average annual variability in catch is 30%, more volatile than in previous years.
    - This metric was used in the first round of the MSE, and the results were presented as absolute values.

Summary
The stock is estimated to have never fallen below 10% of B_0. As catches have increased over time, the probability of being over B_{40} has declined and variability in catch has increased.

Questions and Discussion

- Comment: Caution should be exercised when exploring the idea of stabilizing hake, as many fisheries co-exist. Balancing hake may create unbalance in other facets.

- Comment: It is prudent to apply a multi-attribute idea of decision making. A hierarchy of goals/metrics should exist, and it may be dependent on legislation. It's unlikely that all objectives will have equal weight, so it was suggested to have the group work towards establishing a hierarchy so that weight can be placed on each objective.

- Comment: This is the cornerstone of how one goes about managing the hake fishery. Two extremes exist, from maximizing catch to prioritizing conservation. The ideal balance of those extremes is largely in the eye of the beholder. A commonality should be agreed upon by the group in terms of which objectives should be more heavily weighed (see hierarchy comment above) in order to effectively make management decisions in the long-term. It is important for Canada and the US to come to an agreement in how to balance achieving hake stability while maximizing catch.

- Comment(s): The balancing act of conservation vs. catch maximization is contentious in the industry. Members expressed concern over the MSE directing management decisions that will negatively affect business. It is very difficult to minimize variability in catch when the effects of biological conditions on the stock aren't well understood or predicted.
    - The group was reassured that the MSE is a tool that can be used to explore potential scenarios with differing parameters and how these scenarios would affect both countries. Hopefully, using this as a tool will guide the group towards an agreeable scenario.
    - The MSE can be used to explore the extreme scenarios mentioned above. For example, what is the potential impact to the resource over the next 20 years if the TAC is maximized for the next 5 years. The group can see the potential effects and shape decisions based on that.
    - It is important to remember that we need to examine the results of various scenarios from the MSE before any conclusions or decisions can be discussed.
- Comment: A useful exercise will be to conduct hindcasting of scenarios with data that already exists. Then there may be an idea of what outcomes could have been possible that are based on real numbers.

MSE – IDENTIFYING MANAGEMENT STRATEGIES TO TEST – Kristin Marshall, NWFSC

Kristin encouraged discussions regarding what aspects of various management strategies/procedures is the JMC interested in seeing the technical group explore within the MSE. She reminded the group that a management strategy includes the management model (HCRs), the assessment model and the observation model (survey).

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Kristin provided an overview of strategies that had been tested in previous iterations of the MSE, including:

- 'Status quo' HCR
- Catch floors (did not perform well)
- Catch ceilings (performed well)
- Age-1 index

She also presented some proposed management strategies to test with spatial operating models, including:

- Status quo HCR: current F_{SPR} = 40%, with the 40:10 adjustment
- Observation model – acoustic survey frequency (yearly, every 2 years, every 3 years, and above/with/without an age-1 index
- Assessment model: status quo coastwide, coding fleets as 'areas', and conducting a spatial assessment model

Kristin outlined some suggestions and topics that emerged from previous MSE working group discussions, including proposed implementation alternatives:

- Setting the TAC as 100% of what the HCR specifies
- Setting the TAC at 85% of what the HCR specifies, with a 15% carryover
- Having the TAC set at a lower percentage of HCR, reflecting the historical decisions that were made
- Actively targeting certain age classes more heavily than others (e.g. 4 year olds)

The question posed during this discussion was "Are there additional strategies that the JMC would like to see the group explore?"

Discussion

- The chance of a survey occurring annually is slim (resource limited). It is more likely that time between surveys would increase. It would be interesting to test the model with a survey occurring every 3 years.

- Instead of using the HCR as a metric, the model should be run with a parameter that the TAC is never set higher than X and never lower than Y. This was done previously, but without a spatial component being added. It would be useful to see this done using a spatial component. It would be more relatable to see actual values rather than the HCR, which can be perceived as arbitrary.

- There was concern over the degree to which an MSE output would influence management decisions. The group should be able to maintain the ability to make subjective decisions after assessing the model's output.

- There was interest in exploring scenarios where particular age classes are more heavily targeted than others. For example, avoiding 1-2 year olds, actively targeting particular year classes. It may be a fundamental premise or baseline to avoid younger year classes. A combination of scenarios such as these should be explored further.

- More explanation was requested in terms of proposed management strategies for the assessment model. The status quo model (coastwide) is what is currently programmed in the model. Using fleets as 'areas' isn't so much a spatial analysis, but having each fleet more explicitly represented. This has been shown to help with some of the mismatch between a spatial model and a coastwide panmictic model.

- It was noted that the technical group has a lot of tasks to complete, and that the best path forward may be to run the iterative process with the current model and address the scenarios listed above. Then, after the results

are available, revisiting other explorative options (making changes to the assessment model, etc.). Coding and adding in different forms of the assessment model is more of a time sink than running different iterations.

- Caution should also be used in the determination of whether a different OM and an assessment model is a 'bad thing'. Management scenarios should be as simplistic as possible while still meeting management objectives.

MSE NEXT STEPS – MODEL CONDITIONING, MSE WG COMMUNICATION – NWFSC members

Nis Jacobsen informed that the technical group is hoping to have the conditioning of the operating model completed in December 2018. Ian Taylor began a discussion with JMC members regarding the outputs of previous working group calls and coordinating communication for upcoming calls.

Comments regarding MSE WG call #1 – Specifying Objectives and Performance Metrics

- Two of the sub-goals for goal 1 (managing the resource in a sustainable manner) could be considered redundant. The sub-goals of 1) minimizing the risk of the stock dropping below a threshold that impairs recruitment, and 2) if the stock drops below this threshold, minimize the risk that the stock stays below the threshold may want to be revisited.

- In regards to goal 2 (ensuring that both parties can achieve their intended benefits under the treaty), the term 'minimize' in the sub-goal to 'minimize variability in catch' can be contrasting. Some members may view this as minimizing catch to create stability; others may see it as maximizing catch as best as possible.

- The sub-goal mentioned above (minimizing variability in catch) did not have a stated threshold at the time of the WG call. An example of setting a variability threshold could be the variability around the variability. Instead of using an average availability, the technical team could look at the fraction of years that the variability in catch increases/decreases by more than X%.

Comments regarding MSE WG call #3 – Prioritizing Scenarios for the MSE

- A term that comes up often when discussing the MSE is the term "robust". With specificities of movement and recruitment being largely unknown, it's difficult to determine how robust a model can be.

- A question was raised about how the results from the FATE Hake project will fit in to the MSE development and implementation. Kristin explained that within the next several months, a manuscript will be drafted that will detail empirical relationships – this should be available by the end of 2018.

- A key component is understanding how fishing in each country addresses the overall availability of fish. A member asked whether this is addressed. For example, currently Canada has been catching ~50-60% of its TAC. In the future, if Canada catches closer to 100% of its TAC, is it possible for the MSE to predict the implications?
  - This can be addressed when assessing management strategies.

- Paul commented that the technical group now has a comprehensive set of scenarios to move forward on. There may be more input from JMC once the FATE Hake project results are out. Until then, the technical group will begin exploring these scenarios, with the hope of being able to report on results in mid-2019.

MSE Working Group Communication

- The group was asked about its preferences for upcoming communication. It was determined that there will be a teleconference to report on progress-to-date in late October, early November 2018.

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- It was suggested that industry should be more involved during the conditioning of the model process – so a check in in October would be useful. It was asked if it was possible to have a short check in at the December 2018 JRC meeting as well.
    - A summary document of MSE WG meetings should continue to be produced and distributed to the group.

- A JMC member asked when the FATE Hake project would be completed, and if it was possible for a presentation on the results to occur. While a presentation in December or at the SRG meeting in 2019 may not be possible, an update can likely be arranged.

UPDATE ON B_0 ISSUE FROM JTC/SRG – Ian Taylor, NOAA

Ian Taylor introduced the B_0 issue by providing a brief background:

- The average weight-at-age in the 1970s appears to have been greater than the long-term average weight-at-age. Concern was raised by the SRG that the unfished equilibrium spawning biomass (B_0) might be better calculated using an average weight-at-age from the early years, not the long-term average.
- A heat map was presented that displayed the mean weight-at-age of Pacific hake used in the 2018 assessment, with interpolation and extrapolation (Pacific Hake Assessment 2018, Section 8, page 111).
- The SRG recommended that the JTC examine historical weights-at-age data, evaluate approaches for parameterizing fecundity-at-age for years without data and evaluate other methods of deriving biological reference points such as B_0.
- The SRG also questioned the accuracy of samples from the early fishing years and inquired about the potential availability of additional samples.
- From these recommendations, several questions have been explored (in the next section).

Questions Explored

What is the availability of additional samples from the early years of the fishery?

- PacFIN has samples from the 1960s/1970s that were not included in recent stock assessments. However, some of these samples are not from the coastal stock. There was also a noted difference in growth patterns from this era than those collected from 1990 onwards. This shift in growth patterns occurred over a 1 year period.
- The origin and accuracy of these additional samples needs to be explored further.

What is the accuracy of the weights?

- Differences in methods used to weigh fish in the early years of the fishery may contribute to the observed variability. However, upon further investigation, the weight-length relationship is similar across time periods. More fish > 60cm were present in the early years, and these long fish weighed more.

What is the accuracy of the ages?

- Multiple otolith aging methods have been used, including surface reading, thin sectioning and break and burn. It has been documented in 1979 that offshore hake otoliths were aged more easily than those from the Strait of Georgia. An updated comparison would be useful to determine whether this is still the case.
- As to be expected, ageing technologies and methods have changed over time, with NOAA currently using a break and burn approach for fish aged 4 and older that are surface aged. An individual age reader is used to determine if a 0-3 year old needs additional break and burn. Age classes 0-1 are usually surface read only. The DFO approach is similar.

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How best to represent B_0 once the data are better understood?

- Variability in growth (length-and/or weight-at-age) could be driven by a number of factors. The JTC can conduct additional analyses to explore the relative likelihood of different drivers, but only once the data issues have been worked out. The best approach to defining B_0 will likely depend on the source of the variability.

Questions/Comments from JMC

- In the early samples, was seasonality recorded? The date caught was recorded, but up until this point it hasn't been accounted for. The point in the season when they were caught may influence the average size.

- How many samples are in each cell in the heat map? It varies – for the 1999 cohort; there are thousands of samples for each cell. Other cells/years have low sample sizes.