MSE Program of Work for MSAB related activities 2018-22

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PURPOSE

To update the five year MSE Program of Work and timeline from 2018-22.

INTRODUCTION

This Program of Work is a description of activities related to the Management Strategy Advisory Board (MSAB) that IPHC Secretariat staff will engage in for the next five years. It describes each of the priority tasks, lists some of the resources needed for each task, and provides a timeline for each task. However, this Program of Work is flexible and may be changed throughout this period with the guidance of the MSAB, Science Review Board (SRB) members, and the Commission. The order of the tasks in this Program of Work plan represents the sequential development of each task, and many subsequent tasks are dependent on the previous tasks. A set of working definitions are provided in Appendix A.

MANAGEMENT STRATEGY EVALUATION (MSE)

Management Strategy Evaluation (MSE) is a process to evaluate alternative management strategies. This process involves the following

1. defining fishery goals and objectives with the involvement of stakeholders and managers,
2. identifying management procedures to evaluate,
3. simulating a halibut population with those management procedures,
4. evaluating and presenting the results in a way that examines trade-offs,
5. applying a chosen management procedure, and
6. repeating this process in the future in case of changes in objectives, assumptions, or expectations.

Figure 1 shows these different components and that the process is not necessarily a sequential process, but there may be movement back and forth between components as learning progresses. The involvement of stakeholders and managers in every component of the process is extremely important to guide the MSE and evaluate the outcomes.

BACKGROUND

Many important tasks have been completed or started and much of the work proposed will use past accomplishments to further the Management Strategy Evaluation (MSE) process. The past accomplishments include:

1. Familiarization with the MSE process.
2. Defining goals for the halibut fishery and management.
3. Developing objectives from those goals.
4. Development of an interactive tool (the Shiny application).
5. Discussions about coast-wide (single-area) and spatial (multiple-area) models.

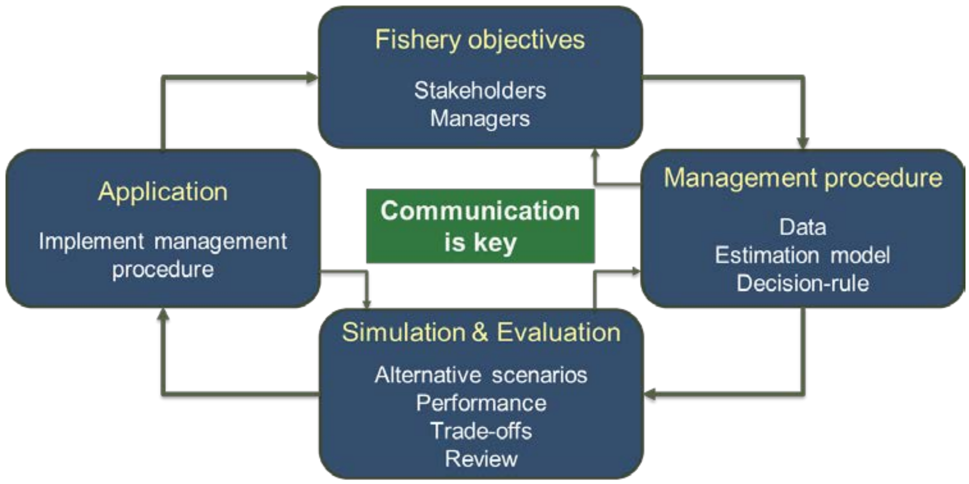

Figure 1: A depiction of the Management Strategy Evaluation (MSE) process showing the iterative nature of the process with the possibility of moving either direction between most components.

The tasks described in this work plan expand upon the work that has already been done since the MSAB was formed. Management Strategy Evaluation is a process that can develop over many years with many iterations. It is also a process that needs monitoring and adjustments to make sure that management procedures are performing adequately. Therefore, the MSE work for Pacific halibut fisheries will be ongoing as new objectives are addressed, more complex models are built, and results are updated. This time will include continued consultation with stakeholders and managers via the MSAB meetings, defining and refining goals and objectives, developing and coding models, running simulations, reporting results, and making decisions. Along the way, there will be useful outcomes that may be used to improve existing management, and will influence recommendations for future work.

Overall, the plan is to use what has already been learned to continue making progress on the investigation of management strategies.

MAIN TASKS FOR THE NEXT 1-2 YEARS

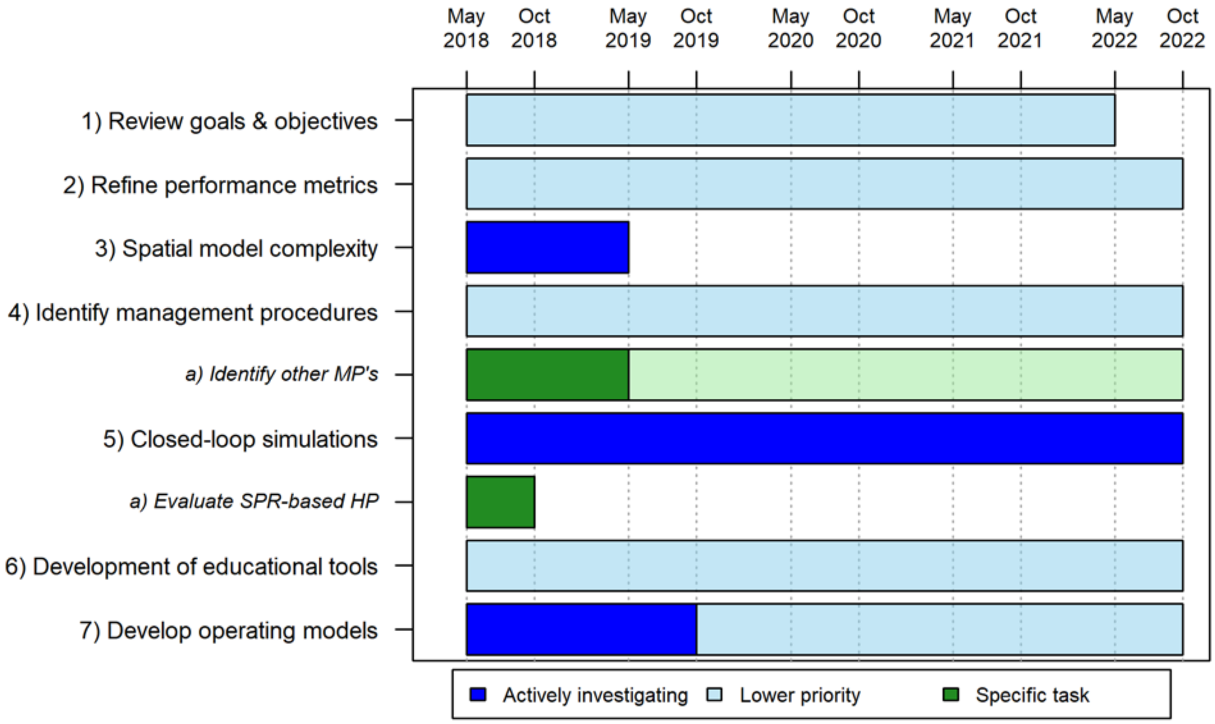

Figure 2: Gantt chart for the two-year work plan. Tasks are listed as rows. Dark blue indicates when the major portion of the main tasks work will be done. Light blue indicates when preliminary or continuing work on the main tasks will be done. Dark green indicates when the work on specific sub-topics will be done and light green shows when continuing work will be done. The end of the dark color shows when those results will be presented.

Task 1. VERIFY THAT GOALS ARE STILL RELEVANT AND FURTHER DEFINE OBJECTIVES

Timeline: Ongoing

Deliverables: A list of goals important to the management of the halibut fishery, and a set of measureable objectives associated with those goals.

Relevance: Relevant goals and measureable objectives are essential to the MSE process. They are necessary to determine what types of models are needed and how to evaluate the management strategies.

Resources: Time to review past meetings, MSAB members to confirm and verify intent of goals, MSAB members to assist with the development of measureable objectives.

Relation to other tasks: Defining goals and objectives is critical to developing useful performance metrics (Task 1), determining applicable management procedures (Task 4), and identifying the complexity needed in the operating model (Task 3 and Task 7).

Description: A very important part of the MSE process is to define goals (aspirational and realistic) and turn those into measureable objectives. The first step is to define a set of goals that are important to stakeholders and managers, which has been done at past MSAB meetings. It is important to verify that these aspirations are still of interest to all MSAB members, and to determine if additional goals should be added to the list. Currently, there are five overarching goals.

1. Biological sustainability
2. Fishery (all directed fisheries) sustainability and stability
3. Assurance of access – minimize probability of fishery closures
4. Minimize bycatch mortality
5. Serve consumer needs

And a possible sixth goal would be to preserve biocomplexity. Document IPHC-2017-MSAB10-08[1] describes these in more detail.

Measurable objectives can then be defined from these goals. Measurable objectives are objectives that have

1. an *outcome* (a specific and measurable description of what is desired),
2. a *time frame* (over what period of time is this outcome desired, which can be how far in the future and/or over a period of years), and
3. a *probability* (the tolerance for failure).

An example of defining a measureable objective may be to take the goal "assurance of access – minimize probability of fishery closures, and define the measureable objective as the predicted spawning biomass from the assessment is less than 20% of unfished equilibrium spawning biomass (*outcome*) over a ten-year period far in the future (*time frame* incorporating both components) no more than 5% of the time (*probability*).

These measurable objectives are then used to evaluate alternative management strategies, and can be used to develop the specifics of a MSE simulation framework. For example, what spatial resolution is needed to evaluate the objectives (e.g., coast-wide single area vs. spatial operating model). The development of measureable objectives may be iterative, in that they may be revised as the MSE evolves and more is understood about the relative performance of various management procedures.

Task 2. DEVELOP PERFORMANCE METRICS TO EVALUATE OBJECTIVES

Timeline: Ongoing

Deliverables: A list of performance metrics that would be informative to stakeholders, managers, and scientists to effectively evaluate the performance of different management strategies and the trade-offs between them.

[1] www.iphc.info/MSAB

Relevance: The performance metrics are the key to evaluating management strategies and communicating outcomes to stakeholders. Determining important metrics and finding ways to present them effectively will help with the interpretation of the MSE results.

Resources: Time to review past meetings, MSAB members to confirm and verify current metrics, MSAB members to assist with the development of various performance metrics.

Relation to other tasks: Performance metrics are the key to presenting results from the management strategy evaluations and will be used in the outcomes from Task 5 (Closed-loop simulation programming).

Description: Measurable objectives guide the development of the simulation framework for a MSE, and performance metrics are needed to gauge the performance of a management strategy relative to those objectives. For example, a measurable objective may be to keep the average catch above a specific amount (the *outcome*), in the long-term over a 10-year period (the *time frame*), at least 95% of the time (the *probability*). The performance metric, framed as a risk, could then be the probability that the average catch was less than that level in this time period (average here refers to the average over the 10-year period and the probability accounts for the many replicated simulations). Another example is that a potential aspirational goal would be to have stability in yield, which could be translated to a measurable objective as keeping the annual change in catch to less than 10% (*outcome*) over a 10-year period (*time frame*) at least 90% of the time (*probability*). The performance metric may then be, again framed as a risk, the average number of years that the absolute change in catch exceeded 10% over that 10-year period (the average number of years refers to average over simulations and is used because many replicate simulations would be done).

Other performance metrics may not be directly associated with measureable objectives, but related to aspirational goals. These could be the average catch and the average annual variability in catch, and they do not have a probability associated with them. They do, however, provide a comparison between management procedures, but can be more ambiguous in interpretation (e.g., compare an average catch of 101 tons to 100 tons, as opposed to a defined probability threshold for achieving a particular catch). If the goal is to maximize average catch or minimize average annual variability, then these performance statistics could be used to measure achievement of those goals (or to examine the trade-offs between them), but it is more difficult to gauge the performance of a metric like average catch in light of uncertainty. An important component of performance metrics is the *distribution of outcomes* under different scenarios; some scenarios may confer much greater sensitivity of results than others and the understanding of this sensitivity is critical to the evaluation of the management procedures that are tested. This is also a key element in understanding the uncertainty associated with results.

Determining important and useful metrics, as well as how to present them, is key to communicating outcomes, interpreting MSE results, evaluating trade-offs, and making decisions on management procedures. Many performance metrics have already been defined, and this task will refine those, identify new metrics, and develop ways to present them. For example, Table 1 and Figure 3 show results from a MSE for Pacific hake (Hicks et al 2016). The probabilities and other details are apparent in Table 1, while the trade-offs are easily seen in Figure 3. Additionally, performance metrics can be related to past performance, such as the observed average catch over the last 2 decades, and advice will be solicited to determine if there is a historical period for comparison.

Table 1: A table presenting performance metrics (rows) and management scenarios (columns) for a MSE on Pacific hake (from Hicks et al 2016).

	Long-term (2033-2042)				
	Perfect	F_{40}	F_{40}:0-500	F_{40}:0-375	F_{40}:180-375
Conservation					
Median average relative spawning biomass	26%	39%	42%	45%	35%
$Pr(B < B_{10\%})$	2%	6%	5%	5%	19%
$Pr(B_{10\%} \leq B \leq B_{40\%})$	77%	48%	47%	44%	41%
$Pr(B > B_{40\%})$	21%	45%	49%	51%	41%
Yield					
Median average catch	242	199	203	216	233
Median AAV	32%	52%	41%	34%	19%
Pr(catch = 0)	1%	13%	12%	10%	0%
Pr(catch < 180)	44%	52%	50%	44%	21%
Pr(180 ≤ catch ≤ 375)	31%	27%	25%	56%	79%
Pr(catch > 375)	25%	21%	26%	0%	0%

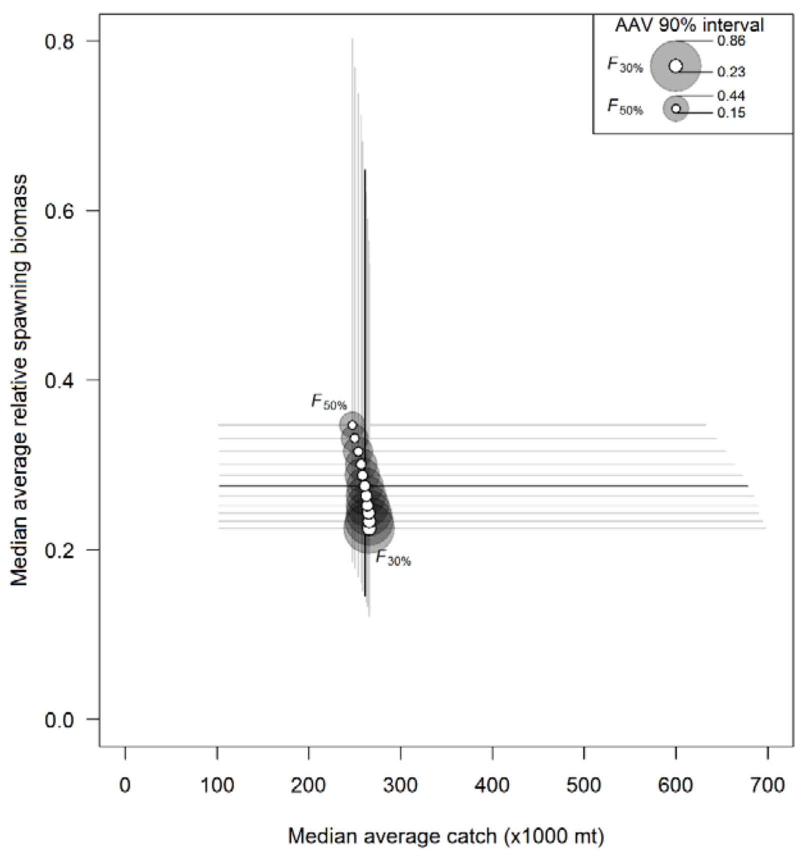

Figure 3: A figure showing the trade-offs between catch (x-axis), conservation (y-axis), and stability in catch (circle size). Quantiles representing 5% and 95% are shown as lines and shaded areas of the circles.

Task 3. Identify the strengths and weaknesses of single-area and multiple-area models from a MSE perspective

Timeline: Now through 2018

Deliverables: Describe what is needed to develop single-area and multiple-area operating models for use in closed-loop simulations, the resources needed to do so, and how much time it may take. Provide a table showing what measureable objectives a coast-wide or a spatial operating model would address. Present the strength and weaknesses of the coast-wide and spatial operating models in relation to each measurable objective.

Relevance: Identifying the strengths and weaknesses of these two models will help to determine what questions can only be answered by a multi-area model and what can be accomplished with a single-area model.

Resources: Time, a set of measurable objectives

Relation to other tasks: The spatial complexity with be determined from and related to the goals and objectives (Task 1) and feed into the closed-loop simulation programming (Task 5). What is learned from the spatial model and complexity task will be directly used in the further development of operating models (Task 7).

Description: The complexity of an operating model (simulating the population) is an important factor to consider in a MSE. A more complex operating model may be able to answer more specific questions, but is also more challenging to parameterize such that it represents reality, is more difficult to code, and typically increases the run time of the simulations. Due to these challenges, it may not always be optimal to simply try to create a complex operating model, especially if a less complex operating will answer many of the questions being asked. Therefore, it is useful to identify the strengths and weaknesses of simple and complex models from the perspective of being able to address the goals and objectives of the MSE when deciding on the complexity of the operating model.

The goals defined for the management of a fishery and the measurable objectives defined from these goals often have an operational component. These operational components can guide the development of the operating model. For example, an aspirational goal may be to have a sustainable fishery and a measureable objective may be to keep the long-term biomass above 20% of B_0 at least 95% of the time over a 10-year period. This goal and objective could be addressed with a coast-wide, single-area operating model since that defines the overall fishery. On the other hand, a different aspirational goal may be to maintain viable fishing opportunities across communities, and a measurable objective could be to keep average catch in each management area above a historical average at least 90% of the time over a 5-year period. The aspirational goal is vague in its guidance of the complexity of an operating model, but addressing the objective would require a model with spatial complexity (multiple areas) that at least includes each management area (or some type of apportionment approach in addition to the coast-wide, single-area operating model).

This task will also outline what is needed to develop a more complex operating model as well as the data needed to condition that model (make sure that it represents how we believe the population behaves).

The development of a spatial model, the investigation of that model, and its approval for use in a MSE will likely take longer than two years to complete. This is described in Task 7.

Task 4. IDENTIFY REALISTIC MANAGEMENT PROCEDURES OF INTEREST TO EVALUATE WITH A CLOSED-LOOP SIMULATION FRAMEWORK

Timeline: 2018 and then ongoing.

Deliverables: Various management procedures to be tested using closed-loop simulations.

Relevance: Identifying realistic management procedures that are of interest to stakeholders, managers, and scientists will ensure that the results of the MSE are pertinent and useful to managing the Pacific halibut stock.

Resources: Discussions between IPHC staff and MSAB members.

Relation to other tasks: This task will rely on defined goals and objectives (Task 1) and will feed into the closed-loop simulation programming (Task 5).

Description: The purpose of MSE is to evaluate management procedures by examining and comparing the performance and trade-offs of each. A small enough set needs to be determined so that the simulations can be completed in a reasonable amount of time and be easily compared and contrasted. Management procedures can be identified by modifying the current one, consulting with stakeholders, or examining other fisheries. Initially, many may be identified, and then reduced to a manageable size, which can occur through further consultation and investigation with simpler models such as the equilibrium model.

A management procedure contains elements related to data collection, assessment, and harvest rules. Combined with objectives, this make up a management strategy. Some elements of management procedures that have been proposed by the MSAB are:

- **Total mortality**: Direct accounting by area for all sources of mortality in that area, including sub-legals.
- **Size limits**: No size limit, current minimum size limit, 26 inches instead of 32, slot limits.
- **Harvest rules**: 30:20 control rule, reference removal rate 21.5%/16.125%, coast-wide and by area.
- **National shares**: catch limits by areas allocated rather than based on stock distribution.
- **Bycatch mitigation**: Impacts among areas for bycatch in a particular area.

The management procedure that would be evaluated as part of the MSE process would contain all of the necessary elements to set catch levels for the stock. An example management procedure may be

- Coast-wide F_{SPR} with a 30:20 control rule to determine coast-wide total removals
- Coast-wide directed fishery catch levels apportioned to regulatory areas based on proportion of survey biomass
- Size limit of 32 inches
- Status quo recreational, subsistence, and bycatch allocation
- Annual survey to inform the stock assessment
- Status quo fishery data collected
- Annual assessment to determine total catch

The Commission at its 2017 Annual Meeting (AM093) recommended investigating a management approach based-on Spawning Potential Ratio (SPR) to account for all mortality. Spawning Potential Ratio is the long-term equilibrium spawning biomass per recruit with fishing divided by the long-term equilibrium spawning biomass per recruit without fishing. An SPR-based approach is defining a fishing level that results in a specific SPR (reduction in spawning potential) and noted as $F_{SPR=XX\%}$, where XX% is the SPR. This $F_{SPR=XX\%}$ will be treated as an element of a management procedure and evaluated with closed-loop simulation to find a level that best satisfies the defined objectives.

Task 5. Design a closed-loop simulation framework and code a computer program to extend the current equilibrium model approach

Timeline: 2018, and ongoing improvement after that

Deliverables: A design for a computer program that can perform closed-loop simulations for various operating models and management procedures. Once the design and framework are determined, the computer program will be written and tested.

Relevance: A computer program to perform closed-loop simulations is the engine for the MSE. It will perform the simulations and create the output needed to calculate performance metrics. A good design will ensure that the code is useful to address current questions and flexible to accommodate future questions.

Resources: IPHC staff, computer programmer, computing time

Relation to other tasks: This task will incorporate performance metrics (Task 2), spatial model complexity and operating models (Task 3 and Task 7), and management procedures (Task 4).

Description: Prior to 2017, the MSAB used an equilibrium model to introduce the concepts of a MSE. This model was used in a web-based application (the Shiny tool) because it produced results quickly and allowed MSAB members to change a few management options and see equilibrium outcomes related to biomass and yield. Those equilibrium outcomes are long-term averages of quantities that have natural variation (e.g., catches) if the fishery took place for an infinite amount of time.

Understanding the variability of the outcomes, such as yield and spawning biomass, is an important aspect of a MSE, but cannot be assessed with an equilibrium model. The equilibrium model is very useful because it produces results quickly and can be used to see the general patterns of various management strategies. However, this equilibrium model does not include the variability around the long-term equilibrium values, and does not incorporate a closed-loop simulation framework.

A closed-loop evaluation is the process of simulating the population dynamics, with an operating model, as well as the feedback from the management strategy and decision-making process (Figure 4). The operating model consists of concepts that we cannot, or choose not to, control. The management procedure is what we can and choose to control. For example, the operating model will contain the population dynamics and some of the fishery dynamics that are not a part of the management process. The management procedure consists of data gathering, estimation models, and harvest strategies, as well as anything else that informs the decisions affecting the fishery and fish population. Figure 4 attempts to show the annual process of a closed-loop simulation.

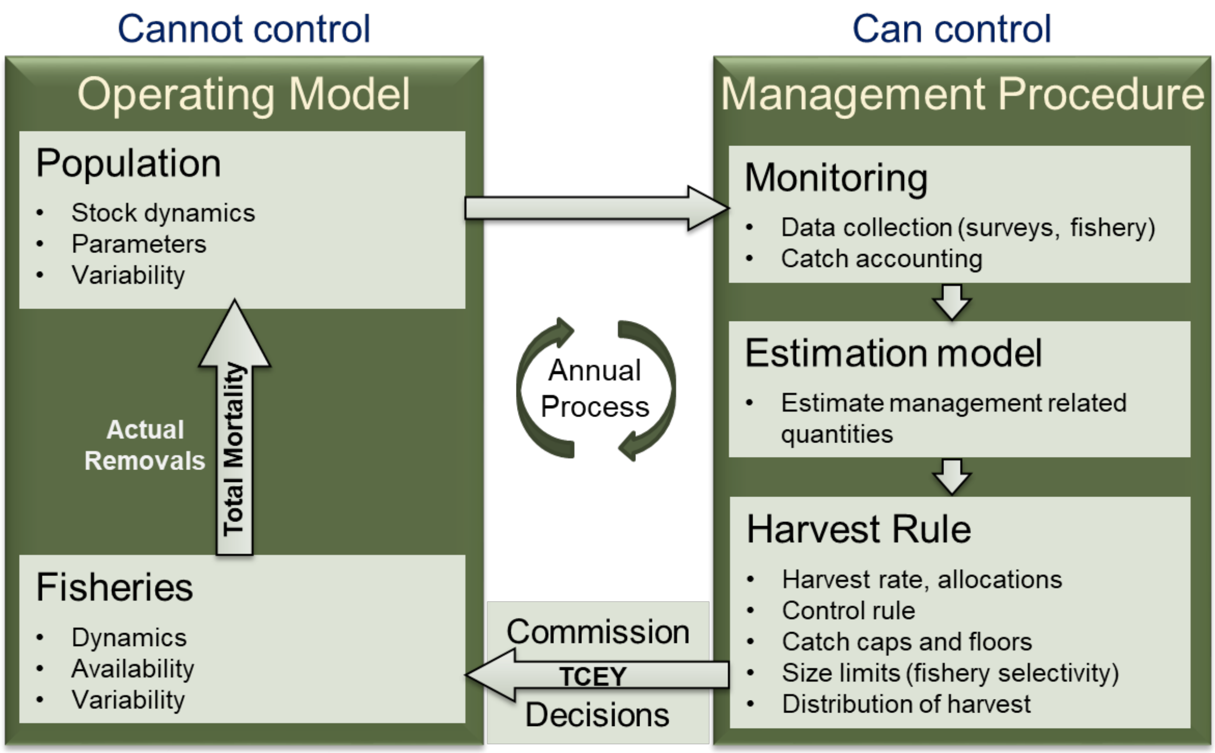

Figure 4: A flow chart of how the annual process is simulated in a closed-loop simulation.

The operating model incorporates variability in the system and additional variability can be added to various parts of the management procedure (e.g., sampling error, assessment uncertainty, and implementation error). This variability is characterized by replicate simulations, resulting in a distribution of outcomes, which can be described with summary statistics (such as the mean) or by probabilities (such as the proportion of time the catch was below a certain level). It is important to note that closed-loop simulations are different than assessment projections because they incorporate hypotheses about the system that may be beyond what is useful for tactical decision making.

The management procedure must be able to be coded in a computer program, although implementation error can be introduced to mimic a real process more closely (e.g., not consistently following the management procedure). The average of a long-term closed-loop simulation with a consistent management procedure should be very similar to the results of an equilibrium model. However, the closed-loop simulation will also provide an insight into the variability of the process.

The development of a closed-loop simulation framework (see IPHC-2017-MSAB10-09 for more details) has involved coding a program that will incorporate the following:

1. Operating model (OM). The OM is meant to represent reality, including the uncertainty about it. Multiple models making up the OM will allow for structural uncertainty and alternative hypotheses of reality. They will have to be selected, coded, and conditioned. Conditioning an operating model is to tune it such that it is the best representation of reality possible (as indicated by fits to data). Currently, the two coastwide assessment models (short and long) are used as an operating model. In the future, the fleets-as-areas models may be incorporated as well as other individual models yet to be developed.
2. Management Procedure
    a. Data monitoring. This represents the types of data that are collected (e.g., fishery age compositions, survey index), how and how often they are collected, and the processes that generate them.
    b. Estimation model. The method to assess the population can range from simple (e.g., an average of recent survey observations) to complex (e.g., an ensemble of age-structure stock assessment models using multiple sources of data), but its main purpose is to use the simulated data to provide an input for the harvest rule. The current assessment approach (ensemble modelling) is likely too time-consuming for a simulation framework, so simplifications will need to be made. The simplest approach to mimic the assessment process is to add bias and variability to the outcomes of the operating model.
    c. Harvest rule. This is a common focus of a MSE and is the set of procedures that defines how the total removals are determined. Currently, an SPR of 46% defines the fishing intensity which may be modified by a 30:20 control rule. This is not always exactly followed, so introducing implementation error will more closely mimic the current paradigm.

The framework will have to be flexible and compartmentalized to allow changes to be made for each component.

An equilibrium model still has a role in MSE and can be used, as it has been already, to quickly narrow the choices of prospective management procedures. Once the candidate management procedures are narrowed to a plausible number for simulation testing, the closed-loop simulations can be used to further investigate them and characterize the distribution of results.

Task 6. DEVELOP EDUCATIONAL TOOLS THAT WILL ENGAGE STAKEHOLDERS AND FACILITATE COMMUNICATION

Timeline: 2018 and ongoing

Deliverables: Materials, programs (web-based or installed), examples, etc. that will allow users to understand the MSE process through reading or interaction.

Relevance: For a stakeholder driven process to be effective, an understanding of the process and how to interpret results is necessary. These educational tools will facilitate communication and allow users to understand trade-offs between performance metrics given alternative management procedures.

Resources: IPHC staff, computer programmer

Relation to other tasks: Effective understanding and communication is key to interpreting results and fostering communication between science, stakeholders, and management. Therefore, educational tools will be useful for all tasks.

Description: An interactive tool has been developed using the equilibrium model (called the Shiny tool) and has been useful for education and the investigation of some management procedures. This interactive tool will be further developed with additional options added and integrate a closed-loop simulation. Using a closed-loop simulation and introducing variability will necessitate the output to be changed to reflect the uncertainty in the results by reporting performance metrics, and results will be shown using various graphics and tables.

In addition, the development of materials that are useful to MSAB members and their constituents to assist with understanding the MSE process and facilitate communication will be done with the guidance of MSAB members.

Task 7. FURTHER THE DEVELOPMENT OF OPERATING MODELS

Timeline: Ongoing

Deliverables: Individual models to make up operating models that will satisfy the objectives defined by MSAB members will be supplied.

Relevance: Alternative operating models are necessary to examine structural uncertainty and to answer specific management questions.

Resources: IPHC staff, computer programmer, computing time

Relation to other tasks: The further development of operating models will be guided by the analysis of spatial complexity (Task 3) and will be necessary to appropriately evaluate management procedures (Task 4) against goals and objectives (Task 1). These operating models will be used within the closed-loop simulation framework (Task 5).

Description: Management advice for Pacific halibut is currently developed using an ensemble of four different models to account for structural uncertainty. This same concept extends to MSE, and using various operating models with different assumptions can help to properly characterize the overall uncertainty in the management of a fish stock.

Currently, the operating model consists of coastwide models and cannot be used to evaluate area-specific objectives, which can only be answered with a multi-area model. For example, investigating the yield in each IPHC Regulatory Area would require simulating the biomass and fishery in each Area. The spatial complexity of the model depends on the questions being asked, thus before developing an operating model it is useful to determine the extent of the objectives. This will determine the structure of the operating model; for example, whether it needs to be flexible to incorporate different area specifications, or if it can have a fixed set of areas with simple movement between them. Once the level of complexity is decided, the next step is to determine how to best model space, movement, and time. After the design of the model is complete, programming can begin. Finally, the model will need to be conditioned to halibut data before being used in a MSE to ensure that it is a reasonable depiction of reality (or at least what we understand of it), and that we have enough data and knowledge to actually define the complexity of the operating model.

Taking the time to develop the specifications of an operating model is very important. The development of a multi-area model is ongoing as part of the annual assessment process, which will provide some of the framework for future operating model development. Therefore, a fully developed multi-area model is not likely to be completed in the next two years, but a multi-area model has been developed in Stock Synthesis that may be useful to begin to investigate various hypotheses realted to movement between broad areas. There are many questions that can be answered with a single-area model before transitioning to a multi-area model, and using a single-area model to answer those questions will be much more efficient.

RECOMMENDATION/S

That the MSAB:

1) **NOTE** paper IPHC-2017-MSAB10-11 which updates the five year MSE Program of Work for 2018-22.
2) **CONSIDER** the seven tasks, descriptions, and timeline.
3) **RECOMMEND** additions or deletions to this workplan, or changes to the timeline and priorities.

ADDITIONAL DOCUMENTATION / REFERENCES

IPHC. 2017. Report of the 93rd Session of the IPHC Annual Meeting (AM093). Victoria, British Columbia, Canada, 23-27 January 2017. IPHC-2017-AM093-R, 61 pp.

MSAB. 2017. A discussion on estimating stock distribution and distributing catch for Pacific halibut fisheries. IPHC-2017-MSAB09-09. http://www.iphc.info/msab

APPENDIX A: DRAFT GLOSSARY

It is important to have a set of working definitions, and this is especially true to the Management Strategy Evaluation (MSE) process since it involves many technical terms that may be interpreted or used differently by different people. Below are some definitions that will apply to this work plan. An IPHC glossary is currently being developed and will provide a more thorough set of definitions.

These definitions are a work in progress and will likely be updated after discussions with other scientists implementing MSE on the west coast. For now, these definitions are pertinent to this document.

Closed-loop simulation: The process of simulating dynamics with a feedback loop. For example, simulating the feedback of the annual management process (i.e., setting catch levels) on a fish stock. The simulation framework incorporates an *operating model* and a *management strategy*, and all of the uncertainty that goes along with those.

Control Rule: Defined management actions and reference points that provide an adjustment to the catch beyond the harvest rates. Often, the lower reference point is where catch is zero (limit reference point).

Estimation Model: A single model or multiple models that process data in a simple or complex way to provide outcomes to be considered by the *harvest rule*.

Equilibrium Model: A model that provides the long-term average results for a population given a set of assumptions.

$F_{SPR=XX\%}$: A fishing level that results in a specific SPR (reduction in spawning potential). Also see *Spawning Potential Ratio*.

Harvest Strategy Policy: A set of *management procedures* that define how the fishery is managed (see *Management Strategy*).

Harvest Strategy: The specifics of how catch is determined and adjusted. For example, harvest rates and a *control rule*.

Management Procedure: A set of management measures that define how the procedure for how the fishery is managed as part of a *Management Strategy*. For example, management measures may be a size limit or *control rule*.

Management Strategy: The full set of objectives, *management procedure,* and decision making process that define how the fishery is managed.

Management Strategy Evaluation: A process to evaluate *management strategies* through simulation.

Measurable Objective: An objective that has an associated outcome, time-frame, and risk tolerance, and is typically developed from one of the goals. For example, if the goal is to have a healthy halibut stock, the measureable objective be to keep the population above 20% of unfished biomass (outcome), in the long-term measured over a 10 year period (time-frame), with a probability of 99% (risk tolerance of 1%).

Multi-Area Model: A coastwide model of the halibut population where the dynamics are modeled using more than one area. These areas are not necessarily Regulatory Areas, but assumptions of area-specific dynamics (e.g., migration, recruitment, growth, etc.) are necessary.

Operating Model: A model designed to represent the dynamics of a population and parts of the fisheries for which we cannot control. This is a representation of reality and the uncertainty about that reality.

Performance Metric: A single metric that can be used to evaluate an objective. These can be simply a probability associated with a measurable objective, or can be a measurement associated with an outcome of a measurable objective. For example, the probability that the spawning biomass is less than 20% of unfished biomass, or the average spawning biomass over a 10 year period.

Scenario: A specific set of assumptions for the operating model to determine how the halibut population and fishery are simulated. These assumptions are what we cannot (or choose not to) control and include three broad categories: 1) dynamics that are completely out of our control, such as size-at-age, recruitment patterns, acts of nature, etc., 2) aspects that may be under the control of others, but a management procedure would not apply to (e.g., some fishery dynamics such as where they choose to fish), and 3) management procedures that we choose not to control (e.g., bycatch).

Single-area Model: A coastwide model of the halibut population where the dynamics are modeled as one area (i.e., no migration).

Spawning Potential Ratio (SPR): The long-term equilibrium spawning biomass per recruit with fishing divided by the long-term equilibrium spawning biomass per recruit without fishing. This is a commonly used metric to define the effect of fishing on the spawning potential and used by many agencies to define a target fishing level.