DRAFT

IPHC staff work plan for MSAB related activities from May 2016 to May 2018

Introduction

This work plan is a description of activities related to the Management Strategy Advisory Board (MSAB) that IPHC staff will engage in for the next two years starting May 2016. It describes priority tasks and provides a timeline for each task. However, this work plan is flexible and may be changed throughout this period with the guidance of the MSAB and Science Review Board (SRB) members. The order of the tasks in this work plan represent the sequential development of each task, and many subsequent tasks are dependent on the previous tasks.

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 and spatial models.

The new tasks described in this work plan expand upon all of the work that has already been done since the MSAB was formed. Dr. Allan Hicks will be responsible for much of the upcoming work, and comes to the IPHC with experience working with harvest policy and in conducting management strategy evaluations for other fisheries. He has worked with stocks of orange roughy (*Hoplostethus atlanticus*) in New Zealand and observed the development of harvest strategies by the New Zealand Ministry of Fisheries. More recently, he has been the lead for the assessment of Pacific hake (*Merluccius productus*) in U.S. and Canada, and started a MSE for Pacific hake in 2012. Progress on the hake MSE was made in the three years that he worked on it, and stakeholders and managers found the analyses to be useful.

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, we expect that MSE work for Pacific halibut fisheries will take a number of years to set up before specific recommendations are approved. This time will involve consultation with stakeholders and managers, 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. This work plan outlines the priority tasks of the MSE process for the next two years.

Main tasks for the next 1-2 years

1) Become familiar with halibut management, the MSAB and IPHC processes, and past activities 3

2) Verify that goals are still relevant and further define objectives 3

3) Develop useful performance metrics to evaluate objectives 4

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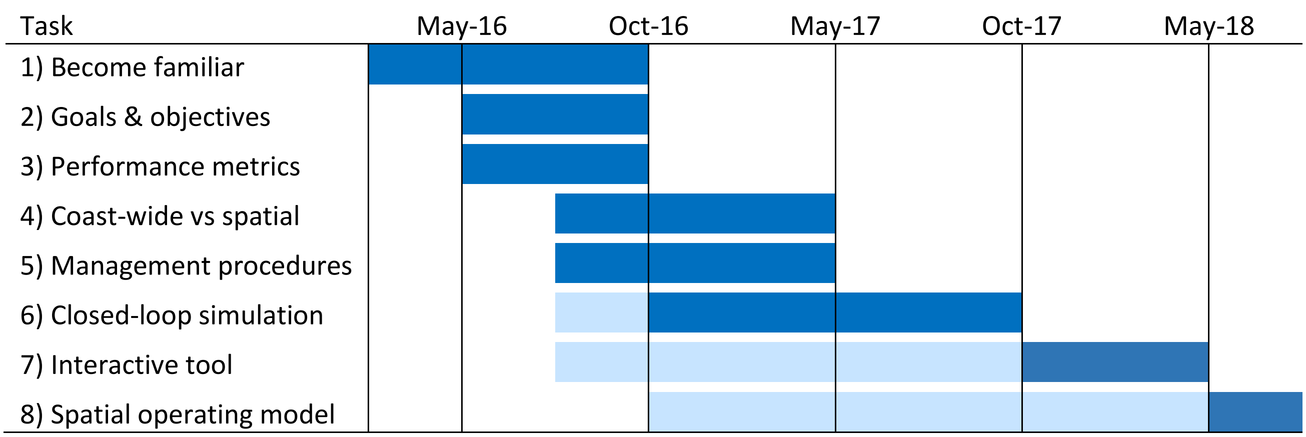
6) Develop a closed-loop simulation framework and computer program to extend the current equilibrium model approach 6

7) Further the development of an interactive tool that will engage stakeholders and facilitate communication 8

8) Develop a spatial operating model 8

Gantt chart for the two-year workplan. Tasks are listed as rows. Dark coloring indicates when the major portion of the work will be done. Light coloring indicates when preliminary work will be done.



Description and timeline of tasks

1) Become familiar with halibut management, the MSAB and IPHC processes, and past activities

Timeline: October 2016, continual learning after then

Deliverables: Further develop a vision and path forward for the MSE. Develop a plan to involve the SRB and MSAB advisory bodies when proposing work and presenting progress.

Relevance: Being familiar with the process and having a smooth workflow will make the process much more efficient.

Description: Dr. Allan Hicks began working at IPHC in early April, and it will be useful to allow time for him to become familiar with the IPHC process, to learn more about the management of halibut, and to review past documents, meetings, and decisions before planning and embarking on new analyses. This will help to build from past experiences and maintain continuity in the MSAB process. Part of that learning experience will be at the May MSAB meeting where Allan can formally meet the MSAB members and discuss his vision of MSE.

When learning more about the IPHC process, Allan would also review how the different advisory bodies are integrated, especially the MSAB and SRB. More specifically, a plan will be developed for how and when proposed work will be approved by each advisory body, and how and when completed work will be reported to each advisory body.

2) Verify that goals are still relevant and further define objectives

Timeline: October 2016, and 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.

Description: A very important part of the MSE process is to define goals (aspirational) 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. Once a set of aspirational goals are verified, these can be used to define a set of measurable objectives, which are objectives that have an *outcome* (a specific and measurable description of what is desired), a *time frame* (over what period of time is this outcome desired), and a *probability* (the tolerance for failure). These measurable objectives can then be used to develop a MSE simulation framework (e.g., coast-wide 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.

3) Develop useful performance metrics to evaluate objectives

Timeline: October 2016, and ongoing

Deliverables: A list of performance metrics that would be informative to stakeholders, managers, and scientists to effectively judge the performance of different management strategies and the trade-offs between them. This list will likely include metrics derived by both the MSAB and the IPHC staff.

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.

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* and 5% would be the tolerance for failure). The performance metric could then be the probability that the average catch was above 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*, where the tolerance for failure would be a change greater than 10% in 1 out of 10 years). The performance metric may then be 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). An important component of the 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.

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).

4) Identify the strengths and weaknesses of coast-wide and spatial models from a MSE perspective

Timeline: October 2016 with a follow-up in May 2017

Deliverables: Describe what is needed to develop coast-wide and spatial 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 spatial model and what can be accomplished with a coast-wide model.

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 operating model since they define 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 to address the objective would require a model with spatial complexity that at least includes each management area (or some type of apportionment approach in addition to the coast-wide operating model).

The development of a spatial model, the investigation of that model, and its approval for use in a MSE will likely take longer than 2 years to complete. This is described in Task 8.

5) Identify realistic management procedures of interest to evaluate with a closed-loop simulation framework

Timeline: May 2017, and ongoing

Deliverables: A list of management procedures that will be tested using closed-loop simulation.

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.

Description: The purpose of MSE is to evaluate a set of management procedures by examining and comparing the performance and trade-offs of each one. 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. The first step is to accurately characterize what is intended from the current management procedure and what is actually implemented. Then, alternative management procedures can be identified by modifying the current one, consulting with stakeholders, or examining other fisheries. Initially, a large set will 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.

6) Develop a closed-loop simulation framework and computer program to extend the current equilibrium model approach

Timeline: October 2017, and ongoing

Deliverables: A framework for a computer program that can perform closed-loop simulations for various operating models and management procedures. Once that framework is 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.

Description: To date, we have 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 specific quantities 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 model does not include a closed-loop evaluation or the variability around the long-term equilibrium values.

A closed-loop evaluation is the process of simulating the population dynamics, with an operating model, as well as the feedback from the management procedure and decision making process. The management procedure consists of data gathering, estimation models, and harvest rules, as well as anything else that informs the decisions about the fishery. In a simulation, the management procedure and decision making process are concepts that can be coded in a computer program, although implementation error can be introduced to mimic a real process more closely (e.g., not consistently following a harvest policy). 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 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 projections because they incorporate the management procedure instead of simply projecting with a specified catch.

The development of a closed-loop simulation framework will involve coding a program that will incorporate the following:

1. Operating models. These are meant to represent reality, including the uncertainty about it. 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. Current assessment models used in the ensemble approach are good initial candidates for operating models.
2. Management Procedure
    a. Data collection. This represents the types of data that are collected (e.g., fishery age compositions, survey index), 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 (but not as realistic) is to add bias and variability to the outcomes of the operating model.
    c. Harvest rule. The harvest rule is a common focus of an MSE and is the procedure that defines how the quota is determined. The current halibut harvest rule is an aggregate harvest fraction for two areas (16.125% for Areas 3B-4 and 21.5% for Areas 2 and 3A) with a 30:20 biomass based control rule. However, this is not always exactly followed, so introducing implementation error will more closely mimic the current situation.

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.

7) Further the development of an interactive tool that will engage stakeholders and facilitate communication

Timeline: May 2018, and ongoing

Deliverables: A program (web-based or installed) that will allow users to choose various options, and then use the equilibrium model or closed-loop simulation to report outcomes.

Relevance: The interactive tool is a useful tool to facilitate communication and to allow users to see trade-offs between metrics and management procedures.

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 the incorporation of a closed-loop simulation. Using a closed-loop simulation will necessitate the output to be changed to reflect the uncertainty in the results by reporting performance metrics. The results will be shown using various graphics and tables. This will be a useful tool to easily investigate various options.

8) Develop a spatial operating model

Timeline: Beyond May 2018

Deliverables: Initially, the specifications of a spatial operating model that will satisfy the objectives defined by MSAB members will be supplied. Once those are approved, model development will begin. In the end, a program that reads input files and produces simulated output will be provided.

Relevance: A spatial model will be necessary to answer more complex management questions, and it is necessary to make sure that a spatial model is developed that will provide outcomes to answer those questions.

Description: Some questions asked of the Pacific halibut MSE can only be answered with a spatial model. For example, investigating the yield in each regulatory area would require simulating the biomass and fishery in each regulatory area. The spatial complexity of the model depends on the questions being asked, thus before developing a spatial model it is useful to determine the extent of the objectives. This will determine the structure of the spatial model; whether it needs to 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 spatial complexity is decided, it will be determined how to best model space, movement, and time in this model. 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.

Taking the time to develop the specifications of the spatial operating model is very important. This work 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 spatial model is not likely to be completed in the next two years. However, there are many questions that can be answered with a coast-wide model before transitioning to a spatial model. And, using a coast-wide model to answer those questions will be much more efficient.