Proceedings of the national peer review of science guidelines to support development of rebuilding plans for Canadian fish stocks

Meeting dates: January 14-16, 2020
Location: Montreal, Quebec

Chairperson: Joanne Morgan
Editor: Brittany Beauchamp

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Correct citation for this publication:

DFO. 2021. Proceedings of the national peer review of science guidelines to support development of rebuilding plans for Canadian fish stocks; January 14-16, 2020. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2021/022.

Aussi disponible en français :

MPO. 2021. Compte rendu de l'examen national par les pairs des lignes directrices scientifiques à l'appui de l'élaboration des plans de rétablissement des stocks de poissons canadiens; du 14 au 16 janvier 2020. Secr. can. de consult. sci. du MPO. Compte rendu 2021/022.

TABLE OF CONTENTS

SUMMARY

These proceedings summarize the relevant discussions and key conclusions that resulted from the Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS) national peer review meeting on science guidelines to support development of rebuilding plans for Canadian fish stocks. This meeting was held January 14-16, 2020 in Montreal, Quebec. This meeting was attended by representatives from DFO Ecosystems and Oceans Science, Fisheries and Harbour Management, and Strategic Policy sectors, Fisheries New Zealand, and academia.

Under Canada's recently modernized *Fisheries Act*, the Minister of DFOis required to develop and implement rebuilding plans for major stocks listed in regulation that decline to or below their limit reference point, taking into account the biology of the fish and the environmental conditions affecting the stock. In addition, DFO is developing a regulation that will set out the necessary contents of rebuilding plans required under the *Act*. Science advice was requested to support development of rebuilding plans to meet the legal requirements of the legislation and the regulation, the policy requirements of the Fishery Decision-Making Framework Incorporating the Precautionary Approach, and the Guidance for the Development of Rebuilding Plans under the Precautionary Approach. The main objectives of the meeting were to review existing guidance and policies, in Canada and internationally, related to science components of rebuilding plans and to produce science advice to support development of guidelines to assist the Science Sector in developing science advice on elements of rebuilding plans. These guidelines will help clarify the role of the Science Sector to support development of rebuilding plans and will help ensure that science advice is delivered more consistently and efficiently.

The conclusions and advice resulting from this meeting are provided in a Science Advisory Report which is available on the CSAS website. Supporting Research Documents reviewed and discussed at the meeting will also be made available on the CSAS website.

OVERVIEW OF LEGAL AND POLICY REQUIREMENTS FOR REBUILDING

Presenter: Amy Lebeau

Summary

The Fish Stocks provisions (FSP) were introduced as part of the amendments to the *Fisheries Act* in June 2019 (sections 6.1-6.3). They strengthen DFO's fisheries management framework by establishing binding obligations on DFO to manage prescribed major fish stocks at levels necessary to promote their sustainability, taking into account the biology of the stock and the environmental conditions affecting the stock. If a prescribed stock declines to or below its Limit Reference Point (LRP), a rebuilding plan must be developed and implemented. These FSPs are based on DFO's 2009 Precautionary Approach (PA) Policy, and thus the policy provides guidance on how to meet the new obligations. Further guidance is also in development.

To support the implementation of the FSP, DFO is developing regulations to (a) prescribe the first "batch" of major stocks subject to the FSP, and (b) set out the required contents and timelines to develop rebuilding plans. The required contents are based on DFO's 2013 Rebuilding Guidance. In addition, the proposed regulations would require plans to be completed within 24-months of the stock declining to its LRP (with an optional extension of up to 12 additional months). The Rebuilding Guidance is under revision to align its contents with the new legislation and proposed regulation, as well as to make it more "user-friendly".

Discussion

A participant asked about how the timing to develop a rebuilding plan would vary between those stocks on "batch 1" that are already below the LRP compared to stocks that decline to or below the LRP after they are prescribed. It was clarified that if a stock is prescribed by regulations and it is at or below its LRP, once the regulations come into effect, the proposed 24 month timeline would start. If a stock that is already prescribed declines to or below its LRP, the proposed 24 month timeline would start after the day on which the Minister first had knowledge that the stock had declined to or below its LRP. Policy guidance is expected to be developed that will help guide when the provision to extend the time to develop a rebuilding plan would apply.

NATIONAL OPERATIONAL GUIDELINES FOR SCIENCE

Presenter: Julie Marentette

Summary

The presentation provided an overview on National Operational Guidelines for Science that are being developed to support implementation of the Fish Stocks Provisions. The Science Sector has developed an implementation plan which includes plans for establishment of a National Fisheries Science Working Group (NFSWG), development of National Operational Guidelines, new survey and monitoring activities, a Grants and Contributions Program, as well as staffing to support these activities. The NFSWG is responsible for issue identification, priority setting, resource allocation and work planning to allow the Science Sector to support the Department in meeting the requirements of the new Fish Stocks Provisions.

A National Operational Guidelines Task Force was launched with the end goal of developing National Operational Science Guidelines for Canada. This group met in winter 2019 to examine implications of legal language of the Fish Stocks Provisions from the perspective of fisheries science, to identify gaps between current practice and FSP requirements and to begin developing a recommended roadmap of activities that will be required to produce National

Operational Guidelines. One of the immediate advice needs identified was advice for rebuilding guidelines. The current advisory meeting is the first formal science advisory process to support development of National Operational Guidelines for the Science Sector.

Discussion

There was concern raised about the need to develop concrete guidelines while things are evolving quickly and the risk of the product not being up to date. The expectation is that guidelines will get reviewed periodically and will need to be updated over time. The current recommendations for guidelines are based on proposed regulations which are not yet in effect. The guidelines may also need to be updated based on clarification of legal understanding of the obligations.

The importance of developing guidance that is useful and adaptable was highlighted, noting the difficult balance between being prescriptive and wanting to allow for flexibility while also not being too vague. It will also be important for the guidance to be appropriate for the wide range of stocks managed in Canada, including the full spectrum of data availability and quality. This will be a challenge for this meeting.

FISHERIES NEW ZEALAND HARVEST STRATEGY STANDARD AND APPROACH TO REBUILDING

Presenter: Pamela Mace (external reviewer)

Pamela Mace is a Principal Science Advisor with Fisheries New Zealand. An overview of New Zealand's experience with harvest strategies and rebuilding plans was presented. Topics included an overview of New Zealand's Harvest Strategy Standard (HSS), stock rebuilding requirements, current status of stocks, how HSS and rebuilding programs have worked in practice, and some thoughts about rebuilding plans and related issues.

Discussion

A question was asked about trade-offs between species. The presenter indicated that this is an issue in New Zealand, similarly to other countries. When setting quotas for multi-stock complexes, interactions are taken into account but there is not a formal way of dealing with it. A participant commented that the International Council for the Exploration of the Sea (ICES) provides mixed fisheries advice but that this is difficult for managers to use because there are no objectives about how to make trade-offs. It is recognized that this is a very difficult problem.

A participant asked about how often the New Zealand guidelines are used. There are very few academics working on fisheries in New Zealand so it is mainly government looking at guidelines and those interested in Marine Stewardship Council certification. They have received a lot of feedback and questions and so far the HSS has stood the test of time. However, the operational guidelines need to be updated.

The presenter was asked to comment on the consultation process for the HSS. The consultation process took about five years with over 10 workshops.

SCIENCE ADVICE ON CORRELATES OF FISHERIES REBUILDING

Presenter: Jeffrey Hutchings (external reviewer)

Jeffrey Hutchings is a Professor of Biology at Dalhousie University. Science considerations for fisheries rebuilding were presented. Topics included the need to take into account the biology of

the fish and environmental conditions affecting the stock, magnitude of stock depletion and impacts to recovery, Allee effects, and regime shifts.

The presentation drew attention to the need for meaningful, external review at science advisory meetings to increase the probability that stock assessment model outputs are scientifically defensible. The presentation discussed Allee effects (or depensation), making the point that Allee effects represent a pattern, not the causal mechanism(s) responsible for the pattern. (The pattern is a decline in per capita population growth rate, r, with declining population size.) The presentation highlighted the utility in considering Allee-effect thresholds within the context of biomass limit reference points (B_{lim}). The presentation discussed the growing evidence for Allee effects in marine fishes, such as Atlantic cod and Atlantic herring (e.g., Perälä and Kuparinen 2017; Neuenhoff et al. 2019). It also stressed the point that a key reason for slow rebuilding in depleted fish stocks is the fact that small populations are more vulnerable to unpredictable, stochastic changes in the environment than large populations (Neubauer et al. 2013; Hutchings and Kuparinen 2017). There is evidence in multiple marine fish stocks, for example, that the variance in r, as reflected by recruits per spawner, increases as stock sizes get smaller. Thus, the greater the magnitude of population decline, the slower and increasingly uncertain the recovery. The presentation also pointed out that analyses of Allee effects that depend solely on stock-recruit relationships are misleading because the latter does not account for changes in natural mortality (*M)* during adult stages. In a discussion of regime shifts on Atlantic cod (Perälä et al. 2020), the presentation drew attention to recent work indicating that fishing mortality appears to be of fundamental, over-arching importance in sensitizing cod to regime shifts, and that the consequences of regime shifts on fishes such as cod are magnified when they coincide with other regime shifts and when populations are small.

Discussion

A participant questioned if a soft operational control point above the LRP is needed. While our ability to create new elements of the PA Policy is limited, this concept could be taken into account when discussing risk tolerances.

CONSIDERATIONS FOR THE DESIGN OF REBUILDING STRATEGIES FOR CANADIAN FISH STOCKS

Presenters: Allen. R. Kronlund, Julie Marentette, Melissa Olmstead

Summary

Rebuilding plans are required by law under the new Fish Stocks provisions of the revised *Fisheries Act* for major fish stocks prescribed under regulations that have declined to, or below, their limit reference point. The provisions state that the biology of the fish and environmental conditions facing the stock will be taken into consideration in the design of rebuilding strategies. Rebuilding strategies inform the development of rebuilding plans and should be regarded as integral to overall management (harvest) strategies. Science activities focus on the development and evaluation of management strategies in response to stated objectives, including rebuilding.

Viewing a rebuilding strategy as separate from the overall management strategy can lead to the deferral of actions intended to prevent stock decline. Failure to plan rebuilding measures before they are needed can create hard-to-resolve conflicts with measures intended to provide opportunities for resource use. Increased likelihood that rebuilding is achieved depends on planning the transition from rebuilding to target outcomes within a management strategy.

Like many other jurisdictions, Canada advocates management by reference points. Our review of international fisheries agreements highlights key elements that produced Canadian fisheries policy related to the Precautionary Approach. Interpretation of policy must distinguish between

objectives that embed biological reference points related to abundance or fishing mortality, and the management measures intended to provide acceptable stock and fishery outcomes. As management by reference points can be challenging when there is data- or model-poverty, rebuilding strategies for such stocks should prioritize increasing information needed to adapt the rebuilding plan while preserving policy intent to avoid or correct undesirable stock states.

We review obligations for recovery strategies under the *Species at Risk Act* and an eco-certification standard to evaluate where common information demands exist that could lead to efficiencies in providing advice. Existing Canadian rebuilding plans are reviewed to identify information needed to support rebuilding considerations in light of proposed regulations to support the Fish Stocks provisions.

We discuss components of rebuilding strategies needed to meet proposed regulations. These include determining when rebuilding is needed, identifying the rebuilt state, and specifying a time period over which to implement a rebuilding plan. One science role is consistent communication of the plausible range of stock scenarios during the lifespan of the plan to inform expectations of decision-makers and resource users. Plan success can be enhanced by allowing for adaptation during the rebuilding period as new data, updated analyses, and revised objectives are considered.

We suggest principles for developing national science guidelines for rebuilding fish stocks. Guidelines are intended to clarify expectations for, and to encourage, consistent science practices. We advocate a structured decision-making approach to developing feasible rebuilding strategies, identifying possible scenarios and eliciting objectives from resource users and decision-makers. The process can be used for data-poor contexts and maps directly into quantitative approaches such as management strategy evaluation. Finally, we provide a recommended list of elements for rebuilding strategies that should be reflected in science guidelines.

Discussion

There was discussion about the statement that rebuilding strategies should be regarded as integral to overall management strategies. It was questioned whether it was possible and if it made sense to integrate the two. Participants indicated that harvest decision rules should be about maintaining stocks at healthy levels and ensuring they don't fall below limit reference points. But, if they do, you need to deviate from the harvest decision rules and have a separate rebuilding plan.

A participant raised the point that incentives should be created to make sure you do not go below the LRP. It is quite a bit of work to develop and implement a rebuilding plan and this should be avoided if possible. As you approach the LRP you should act quickly to make management changes to avoid reaching the LRP and having to develop a rebuilding plan.

It was recognized that although under the *Fisheries Act* a rebuilding plan is not required until a stock is at or below the LRP and that there is a proposed two years to develop the plan, it is best to start development of the plan early (i.e., before a stock is at the LRP, consistent with PA Policy recommendations). The point was made that there are advantages for the stock of implementing rebuilding measures so even if a stock increases to above the LRP shortly after a rebuilding plan is implemented that effort would not be wasted. While it is understood that a stock that switches back and forth between being above and below the LRP can be frustrating, rebuilding measures would be expected to be advantageous for the stock. If a stock is near the LRP, whether a bit below it or a bit above it, this is concerning and action should be taken. Overall, there was consensus that to support sustainable fish stocks there is a need to take action before a stock reaches the LRP.

Time-varying reference points were discussed and the general conclusion was that you should be very careful about implementing time-varying reference points in a fishery management system but that additional research and advice related to this topic is needed.

The need to take action while a stock is declining well before the LRP so that you do not get there and the need for a higher target so that you do not risk going below the LRP in the short to medium term was discussed. While targets are defined by Fisheries Management, it was suggested that default states (e.g., biomass at maximum sustainable yield [B_{MSY}]) could be calculated in addition to a rebuilt state or other targets defined by Fisheries Management. It was suggested that Science could provide an estimate relative to B_{MSY} or its proxy, where this can be estimated. This could be used to inform selection of a target.

A suggestion was made to link the evaluation schedule for rebuilding plans with the multi-year assessment schedule, where applicable.

A participant commented that in many cases there may not be a relationship between rebuilding times and generation times. Generation time does not take into account the extent of stock depletion or environmental conditions.

TECHNICAL, ECOSYSTEM, AND IMPLEMENTATION CONSIDERATIONS FOR REBUILDING

Summary

This working paper was presented by a number of authors and the presentation was split into three main sections: technical considerations, ecosystem considerations, and implementation considerations.

Technical, ecosystem, and implementation considerations were outlined for the Ecosystems and Oceans Science Sector (Science Sector) to support development of rebuilding plans. Recommendations for science guidelines were provided. The information presented was intended to support development of science guidelines for rebuilding plans that meet PA Policy requirements and the legal requirements of the legislation and proposed regulations and that are consistent with the Guidance for the Development of Rebuilding Plans.

TECHNICAL CONSIDERATIONS FOR REBUILDING

Presenters: Mark Simpson, Danny Ings, Elisabeth Van Beveren, Dan Duplisea, Yanjun Wang, Kendra Holt

Summary

Topics in this section included: criteria for determining a LRP has been breached, rebuilding objectives, rebuilding timelines, targets for rebuilding, performance measures, rebuilding procedures, and uncertainty.

Discussion

The comment was made that some other countries have rebuilding targets that use biomass at maximum sustainable yield (B_{MSY}), often because it is in legislation. However, Canada's *Fisheries Act* does not mention B_{MSY}. It was suggested that the Science Sector could provide default information, for example biomass relative to B_{MSY}, as well as relative to other values and/or targets as provided by Fisheries Management. Objectives and targets are determined by Fisheries Management. A concern was raised related to multi-species considerations and that it is likely not possible to have an entire community at B_{MSY} simultaneously. Therefore, if B_{MSY} was

set as the target we would fail based on ecosystem considerations alone. There was general agreement that Science Sector should provide information relative to B_{MSY} when it can be estimated, however this is not meant to imply it is a rebuilding target. Fisheries Management will define the rebuilding target and Science Sector will also provide information relative to that target as well as other values as requested. A participant questioned why we would not use the Upper Stock Reference point (USR) as a default. This was not recommended based on the multiple roles of the USR and how it is defined (i.e., beyond biological considerations and based on broad fishery considerations). However, the Science Sector may still provide information relative to the USR when requested and where feasible. There was consensus that while the Science Sector does not establish the rebuilding target, to be consistent with the intent of the legislation and the PA Policy a rebuilding target should be set at a level that is far enough above the LRP to have a high probability of the stock being above it, taking uncertainties into account. The rebuilding target should also be set far enough above the LRP so that there is a low probability of falling below the LRP in the short to medium term.

Other stock attributes that may be important for rebuilding were discussed. While it is important to rebuild age-structure, spatial distribution, etc. it may be difficult to define measurable objectives for these attributes. It was suggested that these should be examined on a case-by-case basis and that the overall intent should be to create the conditions that would facilitate rebuilding of these attributes. The impacts of environmental conditions on these attributes, and the likelihood that it would be possible to rebuild them, should also be considered.

There was discussion about the use of generation time to set timelines for rebuilding and reiteration that this does not take into account the state of depletion or current environmental conditions. There was consensus that when possible, T_{min} (time to reach the rebuilding target with zero fishing mortality) should be calculated to inform rebuilding times. It is recognized that this will not be possible for all stocks, in particular those that are data-poor, however where possible T_{min} should be calculated.

Recommendations for maximum rebuilding time were discussed. The choice of rebuilding time is a Fisheries Management decision however the meeting discussed what science could recommend, largely guided by a discussion of maximum rebuilding times used in other jurisdictions. General guidance was provided and the comment was made that other factors such as where the target is set would need to be considered. It was agreed that having a discontinuity in the approach was not preferred. While New Zealand uses $2xT_{min}$, based on experience it was suggested that the maximum rebuilding time (T_{max}) should likely not be capped at $2xT_{min}$. It was also noted that in the US, if T_{min} is less than 5 years then T_{max} would be greater than $2xT_{min}$ (i.e., T_{max} would be 10 years). Participants agreed that as a general guideline, a maximum rebuilding time of 2-3 times T_{min} could be considered based on international practice and experience. In all cases, the need to take immediate action to rebuild was stressed. A rationale for the choice of rebuilding time should be provided.

Meeting participants agreed that generation time could be used to inform rebuilding plans, in particular for cases where it is not possible to calculate T_{min} and that the method used to calculate generation time should be included. Research on how rebuilding times relate to generation times across jurisdictions was suggested for future work. The point was made that in the PA Policy the 1.5-2 generations refers to getting the stock above the LRP. Therefore, longer rebuilding times may be needed to reach a higher target. A participant commented that maximum rebuilding time is a Fisheries Management choice but that the Science Sector can support that decision by estimating rebuilding times and describing risks.

Probability was discussed and it was agreed that rebuilding objectives should include a defined probability with a rationale for its selection. Participants reiterated that the choice of a probability

(and risk) is a Fisheries Management decision but that science can provide risk-based advice that includes describing probabilities. For qualitative statements about probability/likelihood, participants generally favoured the Intergovernmental Panel on Climate change (IPCC) table of likelihood statements and probabilities over the draft table in DFO's PA Policy because the IPCC table has a basis in the literature. It was agreed that standard and consistent terminology should be used when describing probabilities or likelihoods. Where projections are not possible or in other situations where probabilities cannot be calculated, it was acknowledged that alternative likelihood approaches may be needed such as using the uncertainty estimate around a survey point.

Criteria for when an LRP should be considered breached were discussed, which was largely based on a previously published cross-jurisdictional review of practices. Methods for how to set an LRP were not discussed but this was proposed as a potential topic for future work. Participants discussed challenges with determining criteria for an LRP breach given the many differences in stocks, fisheries, and PA frameworks across the country. Participants agreed that any statement about an LRP breach should provide room to adapt to stock-specific situations. There was general agreement that the LRP should be considered breached when the terminal year stock status indicator is estimated to be at or below the LRP with a greater than 50% probability or under a one year projection with a zero catch scenario. There was some concern about using a 50% probability around the LRP, given this is a point that should be avoided. However, the distinction between the objective of avoiding the LRP and defining a stock as being below the LRP was made.

Participants agreed that performance measures should be linked to objectives and need to be quantifiable. The importance of feedback control in harvest decision rules was also discussed and it was agreed that where possible closed-loop simulation modelling should be used.

The use of stock enhancement in rebuilding plans was discussed. A participant noted the importance about being explicit about enhancement relative to recovery in the context of a rebuilding plan versus the situation where a species is listed under the *Species at Risk Act*.

Projections in the context of rebuilding plans were discussed. There was agreement that where possible projections should be included in advice for rebuilding plans to support decision-making. These projections should include a zero fishing mortality and status quo scenario which can then be used to compare against alternative strategies. The need to include long-term projections, in particular consistent with rebuilding timelines, will be important but concern about the uncertainty around longer-term projections was raised. It will be important to describe assumptions and uncertainties. Projections are very important to support socio-economic analyses. It was suggested that guidelines for doing projections may be something that should be developed in the future. In cases where it is not possible to do projections, it was suggested that part of the plan could include ways to improve data collection to support future analyses.

There was a discussion on characterizing risk and communicating consequences. Overall, it was agreed that specifics on this topic were beyond the scope of the guidelines. There was a suggestion that a toolbox of risk communication products is something that could be developed, outside of this process.

ECOSYSTEM CONSIDERATIONS FOR REBUILDING

Presenters: Jenni McDermid, Hugues Benoit

Summary

Topics in this section included: changing environmental conditions, Allee effects, non-stationary reference points, fish habitat considerations, and mixed-stock fisheries.

Discussion

The challenges of incorporating ecosystem considerations into advice for rebuilding plans, for many stocks, were acknowledged. The need for additional research and work on advancing an ecosystem approach to fisheries management and the on-going work of the Ecosystem Approach to Fisheries Management Working group were highlighted. Participants discussed advice that could be provided in cases where rebuilding prospects are poor, even in the absence of fishing mortality. Suggested text was drafted to be included in the Science Advisory Report. The importance of reducing fishing mortality to increase chances of rebuilding was stressed, even in cases where environmental conditions are unfavourable. The need to plan for what to do (e.g., harvest levels) as the stock increases while being managed under a rebuilding plan was also discussed. Participants discussed the importance of setting LRPs above the Allee threshold and the need to estimate natural mortality whenever possible.

The need to address fish habitat as a potential factor in stock rebuilding was acknowledged to be a complex and multi-sectoral issue. It was suggested that a working group could be developed to address fish habitat considerations for rebuilding plans. Non-stationary reference points were also highlighted as a challenging topic where additional guidance is needed.

Rebuilding in the context of mixed-stock fisheries was recognized as another challenging topic. This will involve trade-offs, such as between harvesting productive stocks and overfishing of less productive stocks. The role of the Science Sector was discussed. While decisions about trade-offs are made by Fisheries Management, the Science Sector may be able to support these decisions by, for example, evaluating anticipated stock trajectories or states for a range of scenarios or by evaluating biological impacts of mitigation measures or other management measures.

ECONOMIC ANALYSES TO SUPPORT DEVELOPMENT OF REBUILDING PLANS

Presenter: Stéphanie Lemieux

Summary

Socio-economic analysis for rebuilding plans

Stock rebuilding efforts will often be associated with some socio-economic costs. While short-term socio-economic costs associated with rebuilding measures may be significant, it is important to consider and effectively communicate the long-term socio-economic benefits of healthy stocks and sustainable fisheries. The inclusion of a socio-economic analysis in each rebuilding plan is strongly recommended as it may prove essential in gaining support from fishery participants and others with an interest in the fishery.

The socio-economic analysis is one of the last steps in the development of rebuilding plans. However, the involvement of the Economics Sector at the beginning of the process is essential as the socio-economic analysis relies on information from both the Resource Management and Science Sectors:

Management measures that are required to meet the rebuilding objectives (Resource Management)

Projections of the biological outcomes under the status quo and under the management measures outlined in the rebuilding plan (Science)

The socio-economic analysis will assess the incremental costs and benefits for minimum period of 10 years. A longer time horizon may be warranted particularly when the benefits of rebuilding measures require a longer period of time to materialize.

Source: Preliminary Framework for Integrating Socio-Economic Analysis in the Fish Stocks Provisions Implementation Process, DFO November 2019 (internal draft).

Biological information requirements for the socio-economic analysis

Fisheries and Oceans Canada Economics Sector has communicated the need of biological information for socio-economic analysis at several venues. Specifically, some recommendations that were presented in the species at risk context (at the 2012 Recovery Potential Assessment (RPA) Workshop) could be adapted for rebuilding plans:

Estimate species population and habitat quality forecasts under the status quo and under the management scenario(s) over a three generation period and project the associated outcomes and uncertainties (also breakdown projections in to 5, 10 and 15 year sequential periods). Note that if a harvest scenario can be modeled, the commercial benefits under that scenario can be estimated, albeit with uncertainty.

Identify the significance of habitat for species recovery by modelling further degradation as well as improvements in verifiable terms

Identify interdependencies with other species (predator-prey relationships) and impacts of baseline and management scenarios on other species population dynamics

Identify linkages and importance of the species to ecosystem services such as nutrient cycling, ecosystem resilience, maintaining sediment flows, etc. and impacts of baseline and management scenarios on provisioning services

Furthermore, Shelton et al. 2007, which assesses biological long-term projections in RPAs and their implications for socio-economic analysis, could be of interest in the stock rebuilding context.

Source: Biological Information Requirements of the Socioeconomic Analysis, Recovery Potential Assessment (RPA) Workshop, Discussion Document, Economic Analysis and Statistics, DFO, March 2012 (internal document).

Discussion

The discussion focused on the need for Science, Fisheries Management, and Economics Sectors to work together. There is a need for Sectors to communicate and work together early on in the process. To support economic analyses, projections under the status quo scenario and the alternative(s) being considered are needed where possible. While projections are preferred, it was acknowledged that this is not possible in all cases and that where it is not possible qualitative descriptions can still support economic analyses.

IMPLEMENTATION CONSIDERATIONS FOR REBUILDING PLANS

Presenter: Jaclyn Cleary

Summary

Topics in this section included: defining the role of the Science Sector, requirements for in-progress review, and defining exceptional circumstances.

Discussion

There was concern about the length of time potentially allowed for developing rebuilding plans, as indicated in the draft regulations. Participants indicated the importance of taking action immediately to increase the likelihood of successful rebuilding. Concern about extending the time to develop a rebuilding plan due to the need for additional scientific information was also expressed by some participants. There was general agreement that this should be an exceptional circumstance.

Participants discussed how often rebuilding plan objectives should be re-evaluated. The group agreed that rebuilding plan objectives may be re-evaluated at least every five years or at intervals defined by a multi-year assessment schedule for a stock. This was discussed as a general guideline and a review may be needed sooner under exceptional circumstances or based on the specific context.

GENERAL DISCUSSION

A draft Terms of Reference for Science Advice for rebuilding plans was presented at the meeting. It was decided that this should be further developed and refined and that this will also need additional input from Fisheries Management and others in Science.

Summary bullets were not finalized during the meeting however key science-related elements of rebuilding plans were reviewed and participants agreed on their inclusion in the Science Advisory Report. It was acknowledged that rebuilding is a very large topic and there is still work that needs to be done. It was not possible to cover all science aspects of rebuilding in this meeting but significant progress was made. It was agreed that the draft Science Advisory Report would be distributed to all participants for comments and that an opportunity for an on-line meeting to discuss the comments and suggested changes would be organized if desired by participants.

Given the length of the Research Document on considerations for the design of rebuilding strategies and that some participants indicated they were not able to fully review it before the meeting, additional time to provide comments via e-mail was provided. For the Research Document on technical, ecosystem, and implementation considerations for rebuilding plans a revised version will be distributed to participants for their review. Contributors and/or presenters were asked to submit a short abstract to be included in the proceedings which will also be distributed to participants for review.

REFERENCES CITED

Hutchings, J.A., and A. Kuparinen. 2017. Empirical links between natural mortality and recovery in marine fishes. *Proceedings of the Royal Society B*. 284: 20170693. pmid:2861550

Neubauer, P., Jensen, O.P., Hutchings, J.A. and J.K. Baum. 2013. Resilience and recovery of overexploited marine populations. *Science* 340, 347-349.

Neuenhoff, R.D., Swain, D.P., Cox, S.P., McAllister, M.K., Trites, A.W., Walters, C.J., and M.O. Hammill. 2019. Continued decline of a collapsed population of Atlantic cod (*Gadus morhua* due to predator-driven Allee effects. *Can. J. Fish. Aquat. Sci*. 76: 168-184.

Perälä, T., and A. Kuparinen. 2017. Detection of Allee effects in marine fishes: analytical biases generated by data availability and model selection. *Proceedings of the Royal Society B* 284:

Perälä, T., Olsen, E.M., and J.A. Hutchings. 2020. Disentangling conditions effects of multiple regime shifts on Atlantic cod productivity. *PLoS ONE* 15: e0237414.

Shelton, P.A., Best, B., Cass, A., Cyr, C., Duplisea, D., Gibson, J., Hammill, M., Khwaja, S., Koops, M.A., Martin, K.A., O'Boyle, R., Rice, J.C., Sinclair, A., Smedbol, K., Swain, D.P., Vélez-Espino, L.A., Wood, C.C. 2007. Assessing recovery potential: Long-term projections and their implications for socio-economic analysis. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/045. viii + 38 p.

APPENDIX A. TERMS OF REFERENCE

SCIENCE GUIDELINES TO SUPPORT DEVELOPMENT OF REBUILDING PLANS FOR CANADIAN FISH STOCKS

National Peer Review – National Capital Region

January 14-16, 2020
Montreal, Quebec

Chairperson: Joanne Morgan

Context

Under Canada's recently modernized *Fisheries Act*, the Minister of Fisheries and Oceans Canada (DFO) is required to develop and implement rebuilding plans for major stocks listed in regulation that decline below their limit reference point, taking into account the biology of the fish and the environmental conditions affecting the stock. In addition, DFO is developing a regulation that will set out the necessary contents of rebuilding plans required under the *Act*. Science advice is needed to support development of rebuilding plans to meet the legal requirements of the legislation and the regulation, the policy requirements of the Fishery Decision-Making Framework Incorporating the Precautionary Approach, and the Guidance for the Development of Rebuilding Plans under the Precautionary Approach. DFO Science provides advice required for key elements of rebuilding plans.

Science advice was requested by Resource Management, National Fisheries Policy, and Fish Population Science to establish best practices and guidance in the provision of science advice for rebuilding plans. The aim of this process is to develop a more consistent, standardized, and efficient process and improved science advice tailored to the requirements of rebuilding plans. This advice will support the development of rebuilding plans that are compliant with legal obligations and departmental policies.

Objectives

The objectives of this meeting are to:

- Review existing guidance and policies, in Canada and internationally, related to science components of rebuilding plans.

- Produce a technical guidance document to assist scientist practitioners responsible for developing science advice on elements of rebuilding plans. These guidelines will help clarify the role of the Science Sector to support development of rebuilding plans and will help ensure that science advice is delivered more consistently and efficiently.

Expected Publications

- Science Advisory Report

- Proceedings

- Research Document(s)

Expected Participation

- DFO, Ecosystems and Oceans Science, Fisheries and Harbour Management, and Strategic Policy sectors.

- Academia and/or other invited experts may also be invited.

APPENDIX B. AGENDA

CANADIAN SCIENCE ADVISORY SECRETARIAT NATIONAL PEER REVIEW MEETING:

Science guidelines to support development of rebuilding plans for Canadian fish stocks

January 14 - 16, 2020

Alt Hotel Montreal, Rose-Fuchsia Room

120 Peel St, Montreal, Quebec, H3C 0L8

Chair: Joanne Morgan

DAY 1: January 14, 2020		
9:00	Introductions Review Agenda CSAS Overview and Procedures	Chair
9:20	Review Terms of Reference	Chair
9:40	Overview of legal and policy requirements for rebuilding	Amy Lebeau
10:00	National Operational Guidelines for Science	Julie Marentette
10:30	BREAK	
10:50	Fisheries New Zealand Harvest Strategy Standard and approach to rebuilding	Pamela Mace
11:30	Science advice on correlates of fisheries rebuilding	Jeffrey Hutchings
12:00	LUNCH	
13:00	Considerations for the design of rebuilding strategies for Canadian fish stocks	Rob Kronlund Julie Marentette Melissa Olmstead
14:30	BREAK	
14:45	Considerations for the design of rebuilding strategies for Canadian fish stocks (continued)	Rob Kronlund Julie Marentette Melissa Olmstead

DAY 1: January 14, 2020		
15:30	Technical Considerations for rebuilding	Authors
17:00	Adjourn	

DAY 2: January 15, 2020		
9:00	Recap of Day 1 Review of agenda	Chair
9:15	Technical Considerations for rebuilding (continued)	Authors
10:30	BREAK	
10:50	Ecosystem Considerations for rebuilding	Authors
12:00	LUNCH	
13:00	Ecosystem Considerations for rebuilding (continued)	Authors
14:10	Economic analyses to support development of rebuilding plans	Stéphanie Lemieux
14:30	BREAK	
14:45	Implementation of rebuilding plans	Authors
17:00	Adjourn	

DAY 3: January 16, 2020		
9:00	Recap of Day 2 Review of agenda	Chair
9:15	Review recommendations for guidelines from the working papers	Chair
10:30	BREAK	
10:50	Science Advisory Report – discussion of contents	Participants

DAY 3: January 16, 2020		
12:00	LUNCH	
13:00	Science Advisory Report – summary bullets	Participants
14:30	BREAK	
14:45	General discussion	Participants
17:00	Adjourn	

Notes:

-This agenda remains fluid and may change as the meeting progresses.

-All presentations will be followed by comments from reviewers and discussion. All participants are expected to participate in the discussions.

APPENDIX C. PARTICIPANTS

Name	Affiliation
Brittany Beauchamp	DFO - Science, National Capital Region
Hugues Benoit	DFO - Science, Quebec Region
Michael Campbell	DFO - Economics and Statistics, Maritimes Region
Jaclyn Cleary	DFO - Science, Pacific Region
Marc Clemens	DFO - Policy, National Capital Region
Dan Duplisea	DFO - Science, Quebec Region
Leigh Edgar	DFO - Fisheries Management, National Capital Region
Jennifer Ford	DFO - Fisheries Management, Maritimes Region
Kendra Holt	DFO - Science, Pacific Region
Jeffrey Hutchings	Dalhousie University
Danny Ings	DFO - Science, Newfoundland and Labrador Region
Roger Kanno	DFO - Fisheries Management, Pacific Region
Martha Krohn	DFO - Science, National Capital Region
Allen R. Kronlund	DFO - Science, National Capital Region
Stéphanie Labbé-Giguère	DFO - Fisheries Management, Quebec Region
Neil Ladell	DFO - Fisheries Management, Pacific Region
Daniel Lapierre	DFO - Fisheries Management, Gulf Region
Amy Lebeau	DFO - Policy, National Capital Region
Stephanie Lemieux	DFO - Economics and Statistics, National Capital Region
Pamela Mace	New Zealand Ministry for Primary Industries
Julie Marentette	DFO - Science, National Capital Region
Cory Matthews	DFO - Science, Central and Arctic Region
Jenni McDermid	DFO - Science, Gulf Region

Name	Affiliation
Joanne Morgan (Chair)	DFO - Science, Newfoundland and Labrador Region
Melissa Olmstead	DFO - Science, National Capital Region
Nicolas Rolland	DFO - Science, Gulf Region
Glen Rowe	DFO - Fisheries Management, Newfoundland and Labrador Region
Mark Simpson	DFO - Science, Newfoundland and Labrador Region
Kent Smedbol	DFO - Science, Maritimes Region
Ross Tallman	DFO - Science, Central and Arctic Region
Elisabeth Van Beveren	DFO - Science, Quebec Region
Yanjun Wang	DFO – Science, Maritimes Region