Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat (CSAS)

Research Document 2018/035

National Capital Region

Guidelines for Providing Interim-Year Updates and Science Advice for Multi-year Assessments

Krohn, M.M.[1], Chaput, G.[2], Duplisea, D.E.[3], Duprey, N.M.T.[4], Edwards, A.M.[5], Healey, B.P.[6], Howland, K.L.[7], Lester, B.[1], Morgan, M.J.[6], and Tallman, R.F.[7]

[1] Fisheries and Oceans Canada, Ecosystems and Oceans Science,
200 Kent Street, Ottawa (ON) K1A 0E6
[2] Fisheries and Oceans Canada, Gulf Fisheries Centre,
343 avenue Université, P.O. Box 5030, Moncton (NB) E1C 9B6
[3] Fisheries and Oceans Canada, Maurice Lamontagne Institute,
850 Route de la Mer, Mont-Joli, (QC) G5H 3Z4
[4] Fisheries and Oceans Canada, Regional Headquarters,
200-401 Burrard St, Vancouver (BC) V6C 3S4
[5] Fisheries and Oceans Canada, Pacific Biological Station,
3190 Hammond Bay Road, Nanaimo (BC) V9T 6N7
[6] Fisheries and Oceans Canada, Science Branch,
PO Box 5667, St. John's (NL) AC 5X1
[7] Fisheries and Oceans Canada, Freshwater Institute,
501 University Crescent, Winnipeg (MB) R3T 2N6

February 2019

Canada

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

ISSN 1919-5044

Correct citation for this publication:

Krohn, M.M., Chaput, G., Duplisea, D.E., Duprey, N.M.T., Edwards, A.M., Healey, B.P., Howland, K.L., Lester, B., Morgan, M.J., and Tallman, R.F. 2019. Guidelines for Providing Interim-Year Updates and Science Advice for Multi-year Assessments. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/035. v + 40 p.

Aussi disponible en français :

Krohn, M.M., Chaput, G., Duplisea, D.E., Duprey, N.M.T., Edwards, A.M., Healey, B.P., Howland, K.L., Lester, B., Morgan, M.J., et Tallman, R.F. 2019. Lignes directrices sur la prestation de mises à jour et d'avis scientifiques intermédiaires pour les évaluations pluriannuelles. Secr. can. de consult. sci. du MPO. Doc. de rech. 2018/035. v + 45 p.

TABLE OF CONTENTS

ABSTRACT

Fisheries and Oceans Canada (DFO) is broadening the application of the multi-year approach to management of fisheries. Early experience with this broader implementation of multi-year assessments has highlighted the need for clear guidelines on when and what kind of advice is required for the interim years between full stock assessments. This document describes a number of important elements in the development of the framework for providing interim year updates for stocks managed on multi-year assessment cycles. The elements of the document were developed to support the development of guidelines and best practices for providing science advice during interim-years for multi-year assessments and the document was reviewed at a DFO Canadian Science Advisory Secretariat (CSAS) National Peer Review meeting March 10-12, 2015. Advice from this national peer review meeting has been published in DFO (2016a) and proceedings of the meeting are available in DFO (2016b).

1. INTRODUCTION

1.1 OBJECTIVES OF THE MULTI-YEAR ASSESSMENT AND MANAGEMENT APPROACH OF AQUATIC RESOURCES IN CANADA

Fisheries and Oceans Canada (DFO) is broadening the application of the multi-year approach to fisheries management to all fisheries for which it is deemed an appropriate way to provide stability and predictability for harvesters, and where it can be effectively applied to reduce the frequency of peer-reviewed stock assessments and subsequent fisheries advisory processes.

The multi-year approach to management consists of two components:

- the provision of science advice through a peer-reviewed stock assessment at a prescribed interval which may be complemented by interim-year stock updates, and
- the development of multi-year management measures, including harvest levels informed by science advice.

According to the multi-year assessment cycle, most stocks will have full assessments every two to five years, with annual interim-year updates in between.

The Canadian Science Advisory Secretariat (CSAS) has developed “Operational Guidelines for Stock Status Updates for Multi-Year Stock Assessments” to provide nationally consistent guidance for Stock Status Updates in support of the interim reporting of multi-year stock assessments (see annex 2). The guidance in this document builds on the CSAS document as well as on the internal draft document “Multi-year Approach to Fisheries Management - Internal Operational Guidelines” (DFO 2013a).

While science peer-reviewed stock assessments are now mostly conducted on a multi-year cycle, annual monitoring continues and science provides updates in the interim years on the status of the stock based on identified indicators. The default is to establish a set harvest level that will remain unchanged in the interim years providing the monitoring results indicate that the stock status performs as predicted. Alternatively, varying harvest levels (for output control fisheries) or exploitation rate levels (for input control fisheries) could be established for the interim years between years in which stock assessments occur. In such cases, the management measures would include harvest decision rules for the interim years that outline what management measures, if any, will be implemented based on the science reporting on stock status. The exact timing and nature of the updates for the interim years should be determined by Science and Management sectors and are expected to vary from fishery to fishery.

Stock-specific indicators and thresholds for signaling unexpected changes in status in the interim years should be identified during the stock assessment process. Necessary actions will be taken if the indicators fall outside predetermined thresholds during interim years. These actions will be determined on a case-by-case basis and could lead to:

- full stock assessment sooner than indicated in the multi-year assessment schedule, or
- an adjustment of management measures.

1.2 OBJECTIVES AND STRUCTURE OF THE GUIDELINES DOCUMENT

DFO’s early experience with the broader implementation of multi-year assessments has highlighted the need for clear guidelines on the provision of advice for the interim years between full stock assessments.

This document was prepared in support of a peer review meeting convened to review existing approaches for multi-year assessments and advice during interim years and produce guidelines or best practices to be used in future multi-year stock assessments and interim-year stock updates. It is a complement to the published Science Advisory Report from the meeting (DFO 2016a).

Objectives of the current guidance are two-fold:

- The default is that assessments will include advice for the entire multi-year period. Guidance is provided on how to set conditions that would trigger new advice for exceptional circumstances, i.e. what are recommended interim-year indicators and how to determine if the stock is sufficiently outside the bounds of expectation to warrant an early assessment and possibly changes to the interim-year management plan?
- To provide guidance on what approaches exist to provide science advice that allows managers to adjust management measures (e.g. the total allowable catch) in interim years based on changes in the index/indices. The default is to establish a set harvest level at the beginning of the management cycle that will remain unchanged in the interim years, providing the monitoring results indicate that the stock status performs as predicted and remains healthy. However, for some fisheries there may be an interest in adjusting the Total Alowable Ctach (TAC) according to annual changes in the index.

The document covers how to develop the interim-year plan at the assessment meeting so that the process is clear to science and management for triggering new advice, and if requested, for providing the science advice for calculating the adjusted removal rate based on an updated index and agreed harvest control rules.

The guidance provided here for developing interim-year advice aims to be relevant and useable by both science practitioners in producing stock assessments and by clients (i.e. fisheries managers) in planning and engaging resource users on multi-year fishing plans. The guidance here is focused on the process required, as opposed to the scientific methodologies applied.

The guidance was developed based on departmental experience in undertaking stock assessments. Further, various approaches within and external to DFO were reviewed and in some cases new approaches are suggested. This document aims to provide consistency to clients of DFO Science while striking a balance between clear guidance and considerations that leave room for flexibility given the range of stocks and fisheries managed by the Department.

1.2.1 Document structure

The guidance includes a description of where we are now in terms of how advice is provided for interim years (section 2). Section 2 is based on a questionnaire completed by regional assessment leads that included questions about how the individual stocks are assessed, how they are managed and how advice is provided for interim years.

Section 3 is where the main guidance for setting triggers and indicators needed for advice for interim years is included:

- Section 3.1 describes examples of fisheries for which interim-year advice has been provided for specific assessment types and types of management regimes;
- Section 3.2 includes a description of characteristics of indicators to be used in interim-year updates;
- Section 3.3 covers roles and responsibilities associated with interim-year science advice;

- Section 3.4 covers how to define triggers that would prompt an assessment earlier than the pre-agreed assessment cycle, and
- Section 3.5 covers guidance for adjusting harvest advice and/or management plans according to the change in status indicators (with defined harvest control rules).
- Considerations for determining the frequency of interim-year updates are presented in Section 3.6.

Section 4 lays out how the science advice for interim years should be communicated within the context of the assessment and in the interim-year updates.

Section 5 provides considerations for the development of ToR's for multi-year assessments that take into account the need for advice for and in interim years. Included is a checklist of objectives to include in the ToR's for both the full stock assessments and the stock updates.

Finally Appendix 1 provides a description of information requested for the inventory of current species assessments and schedules in Canada.

1.3 DEFINITION OF TERMS

- Indicator: proxies or metrics of stock status.
- Trigger value: Pre-defined thresholds of an indicator which if crossed would signal a change in stock status that may warrant an assessment ahead of schedule.
- Multi-year assessment: Multi-year assessment is an assessment that occurs at a set frequency, i.e. is not annual.
- Single year assessments used for multiple years: Assessments that are done for one year and but are used for multiple years until another full assessment is conducted. These may be assessments conducted before the multi-year management and multi-year assessments were implemented or assessments provided for one year without specific recognition of the multi-year context.
- Re-assessment: A re-assessment may be triggered when the indicator(s) cross the pre-defined trigger values. A re-assessment is a full assessment earlier than was planned according to the multi-year cycle.
- Multi-year advice: Multi-year advice is the advice provided at a multi-year assessment that applies until the next scheduled assessment in addition to any additional advice provided during the interim.
- Interim-year advice: Interim-year advice can refer to any advice provided for years between full assessments of the stock. This can refer to either science advice provided at the multi-year assessment process or in the context of an interim-year update.
- Interim-year update: An interim-year update is the special response science advisory process that is carried out between full assessments. Interim-year updates may be produced annually or at less frequent intervals within the multi-year assessment cycle. They are scheduled during the full assessment processes, but additional updates could be requested due to exceptional circumstances.
- Annual advice used for multiple years: In some cases, advice may have been provided before the multi-year management and multi-year assessment were implemented that was intended for one year but was used over multiple years. Also, in some cases, the advice is

provided for one year without specific recognition of the multi-year context, i.e. that there will be no new advice before then end of the multi-year cycle.

- Harvest control rule: Harvest control rules are rules that the Department has adopted in consultation with industry on how to set harvest levels in relation to stock indicators. The rules could be applied only at the beginning of a multi-year management cycle based on a full multi-year assessment of stock status (to apply throughout the cycle until the next assessment) or could be applied to stock indicators made available through an interim-year update.

2. OVERVIEW OF CURRENT MULTI-YEAR ASSESSMENTS AND THE TYPE OF ADVICE BEING PROVIDED: WHERE WE ARE NOW

2.1 INVENTORY OF APPROACHES FOR CURRENT ASSESSMENTS

As a first step in the development of guidance for multi-year assessments and updates, an inventory of the current state of assessments within the multi-year approach was compiled as was reported in spring of 2015. The inventory was generated based on inputs from science experts in all DFO regions. The information requested by species / stock assessed in each region included input to the following broad categories:

1. Base descriptions of species and stock units,
2. Assessment frequency and management regime,
3. Precautionary Approach (PA) Framework,
4. Multiyear advice and management structure, and
5. Communication of advice or status.

Details of the questionnaire structure are presented in Appendix 1.

The inventory was also used to identify informative examples of current approaches being used within the different regions of DFO.

2.2 RESULTS OF INVENTORY

Nationally, information on 126 fish species and/or stocks was provided based on the questionnaire. Most of these stocks are assessed on a 3-5 year cycle (Fig. 1). Although it is difficult to say how rigid these cycles are, or how well they truly represent the cycles (frequencies) occurring in practice as several fisheries had shorter cycles specified than the time period since the last assessment (e.g. Yellowtail Flounder of the Gulf of St. Lawrence is on a 3 to 5 year assessment frequency but has been assessed less frequently). Overall, more than 80% of the fisheries being assessed have 2 or more years where no assessment takes place, indicating a large amount of the Department's assessment work may require interim advice.

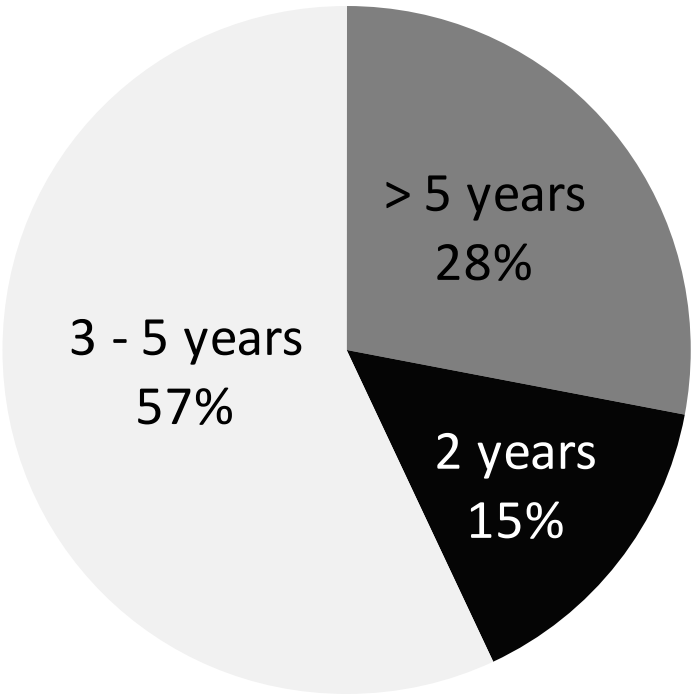

Figure 1. Frequency of assessment of the 126 fishery stocks reported from six DFO regions for which multi-year advice is provided.

Data on the assessment type was also collected (Figure 2). The most common type of assessments used are those based on indices using fishery dependent and independent data, however there were a relatively similar number of assessments using age-structured population models and indices based on fishery independent data only . Of the 121 fisheries reporting Management Regimes, 78% (94) were output controlled (TAC or similar measure), compared to 22% (27) which were Input controlled (effort controlled) fisheries.

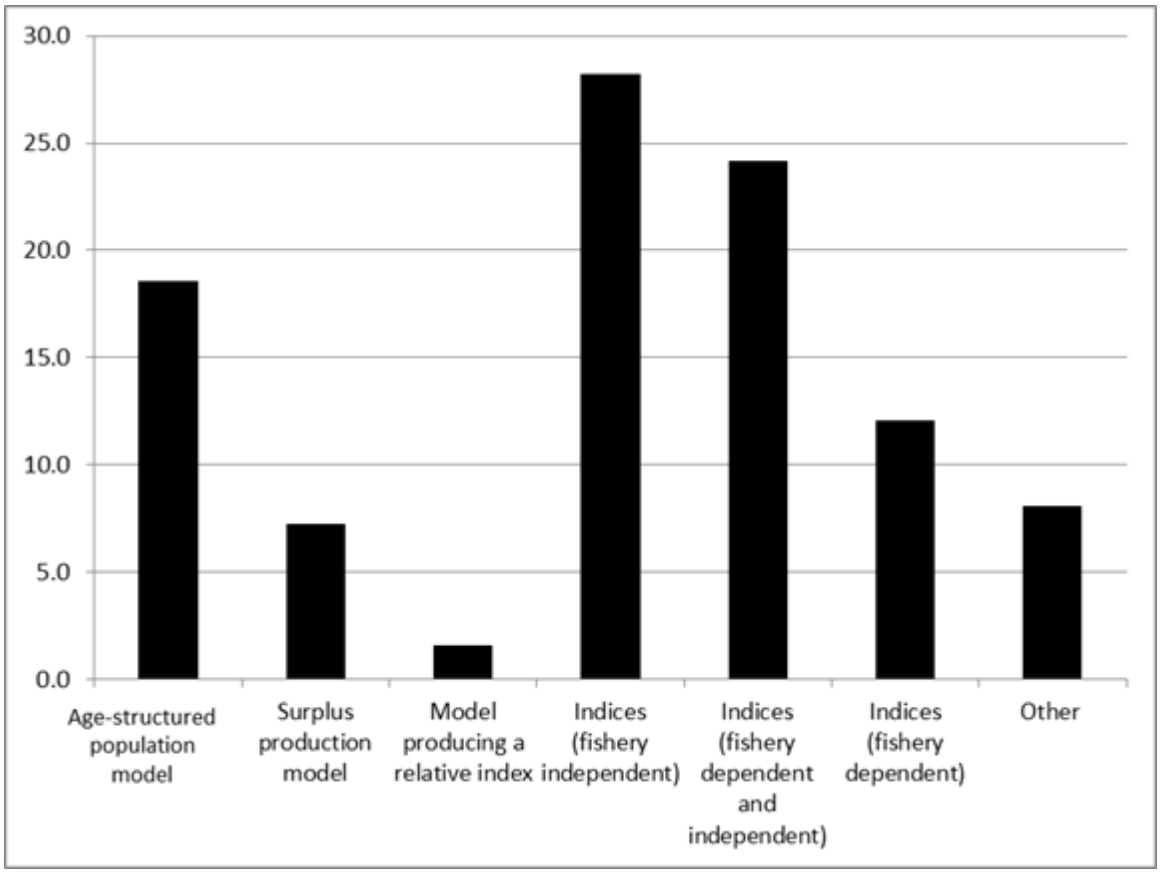

Figure 2. Percentage of fish stocks by type of assessment model, from the 126 multi-year assessed stocks, based n information provided in the questionnaires. Full questionnaire results can be found in the Appendix 1.

No indicators had been developed or identified for 99 of the 113 stocks as of the time of the survey in spring 2015, while 14 stocks had identified indicators that could be used to determine if new advice may be warranted, e.g. if there was unexpected change in the stock level. No answer was provided for 21 stocks.

Eleven had defined trigger values that would be used to initiate a full stock re-assessment if required, eighteen had pre-defined conditions that provide a mechanism to adjust management measures according to a change in an index for the stock, and nine reported having pre-defined trigger values that would result in additional advice on removals.

2.3 IDENTIFIED GAPS IN CURRENT PRACTICES FOR PROVIDING ADVICE FOR INTERIM YEARS

Following analysis of the questionnaire, key gaps were identified to help develop the guidance:

- Few species/stocks have defined rules for deciding if a re-assessment is advised earlier than the pre-agreed assessment cycle.
- Fewer stocks have harvest decision rules to adjust annual management relative to changes in stock status in the intervening years (although this is not necessarily a gap depending on the fishery.) There can be pressure to change the management measures (e.g. TAC) in interim years based on changes in a stock index, but there are usually no projections or advice in interim years upon which to base a change in removal levels. The principle of

multi-year management is that such adhoc changes based on annual changes in the index would be avoided, so the plan must be clearly laid out at both the assessment and in the management plan. For many fisheries it is not seen as advantageous to "follow the noise" so a clear plan must be put forward to avoid pressure to do so.

- For stocks for which there is a high level of external involvement in assessments, there may be particular considerations for interim years, for example for Western Scotian Shelf Pollock (DFO 2015a) in Maritimes region for which industry developed the assessment model. In such cases an arrangement will have to be made for who is responsible for any modelling work required for the interim-year update.

There is a need for a clear process for how advice is produced for interim years to give some consistency among fisheries.

While it is clear that the provision of multi-year advice and multi-year management requires input from both management and science, the roles and responsibilities of science and management have not been clearly articulated.

For most stocks, a plan for what will be done in interim years is not clearly laid out at the assessment or in the management plan. Late development of Terms of Reference (ToR) will not allow for all the upfront work that will be required. Thought needs to be put into it to include the goals of both Science Branch and Ecosystem and Fisheries Management sector (EFM). This work should be included in working papers to be reviewed at the assessment.

2.4 OTHER JURISDICTIONS

Other jurisdictions have moved or are in the process of moving to multi-annual assessments. There are various motivations behind multi-annual assessments related to species biology, data availability, stock status, management regime and to reduce workload. Most jurisdictions have developed formal or informal means of considering new monitoring information in interim years. A brief summary of the nature of the process and or considerations in selected different jurisdictions is offered here to place DFO guidelines developed here in an international context.

2.4.1 International Council for the Exploration of the Sea (ICES) stocks

Currently all stocks with full analytical assessments are assessed and advice is provided annually, although a move to multiyear advice is currently being discussed. The primary motivation for this is to reduce workload. Stocks without an analytical assessment as the basis for advice usually have less frequent assessments and advice is provided for a 2-year period.

Circumstances when there is no interim-year update include:

- biennial advice was already provided at the last assessment;
- only landings data are available and changes in landings were negligible;
- the previous year's advice was for lowest possible landings or zero catch advice and there has been no change in the perception of the stock state;
- the precautionary approach buffer (a decrease in removals by 20% when it is likely that F > Fmsy or when exploitation rate is unknown) has been applied for the previous two years, without an interim update. Exceptions may be for short-lived species and stocks with benchmarks or methodology revisions; and
- the Depletion Corrected Average Catch (DCAC) method was applied (this method uses approximations of stock depletion over the catch time series to estimate MSY and is used when only landings data are available).

Circumstances when advice will be updated in the interim-years include:

- The PA buffer has not been applied;
- There are doubts about the method applied and a more appropriate method can be put forward; and
- Benchmark meeting has been held since the assessment thus previous advice may no longer be valid.

Generally in ICES, for stocks that have multi-annual assessments, the process is to review the new stock information in the interim year and produce a stock advice sheet which is reduced in scope from a full assessment advice sheet. If the new information provides no reason to modify the advice, then the advice from the last assessment is restated. The advice for the interim year is based on the same method that is applied in the assessment (which for multi-year stocks are usually not analytical models) and provided at the assessment for multiple years (usually two years) (ICES 2014).

2.4.2 Northwest Atlantic Fisheries Organisation (NAFO) stocks

NAFO Scientific Council began providing multi-year fisheries management advice using a multi-year assessment cycle at its 1999 Annual Meeting. This was preceded by extensive Scientific Council (SC) discussion on revising its working procedures due to issues with both schedules and workload (NAFO 1998). At that time, concern was raised over difficulties experienced in trying to complete and document all requests for advice from the NAFO Fisheries Commission (FC) during the SC meeting. Initially, six stock assessments, corresponding to six stocks that were in a depleted state, were placed on two-year cycles. It was recognized that given the poor status of each stock, it was unlikely that the advice to managers ("No Directed Fishing") would require revision within two years. Over time, additional stocks under NAFO purview were moved to a multi-year assessment, and at present only one stock (Northern Shrimp in Divs. 3LNO) is scheduled to be assessed annually.

When the multi-year assessments and advice were first introduced, SC proposed the approach that annual monitoring would continue, and "should a significant change be observed in stock status (e.g. from surveys), the Scientific Council will evaluate this change and provide the appropriate advice." (NAFO 1998). In practice, this eliminated extensive annual reviews of data and/or model results for stocks in interim years. This approach was subsequently endorsed and adopted by the Fisheries Commission (FC), and is the current working procedure within SC. The observations based on new data available during interim years are formally reported in an 'Interim Monitoring Report', and if no significant changes have occurred and the previously issued advice remains valid, then the advice is simply re-iterated annually. Noteworthy is that the term 'significant change' above has not been explicitly defined hence there are no pre-defined triggers that would lead to a re-assessment of a given stock. Each case is evaluated independently.

NAFO stocks on the NAFO multi-year schedule are assessed on either a two- or three-year cycle. In general, three-year cycles are utilized for resources that have exhibited some period of stability (whether at depleted or healthy levels). There have been some instances where stocks on the multi-year schedule have had full stock assessments conducted earlier than scheduled, both due to requests from FC or on the advice of SC.

During the 2014 Annual Meeting, SC decided to amend its working procedures (NAFO 2014) in order to further expedite the time required to review and document the Interim Monitoring Reports (IMR). For each IMR, the stock lead drafts the report, after which it is reviewed by an appointed reviewer as well as the chair of the assessment committee. To ensure consistency of

review and to provide guidance to the stock leads and designated reviewers, a checklist is completed for each IMR. Jointly completed by the stock lead and designated reviewer, it also serves as a means to raise any concerns the assessment committee chair should consider during final review.

2.4.3 New Zealand

All New Zealand information is based on personal communications with Marie-Julie Roux, National Institute of Water and Atmospheric Research, New Zealand, and Paul Starr, Trophia Limited, New Zealand. I. In New Zealand, multi-year assessments are generally the rule. For offshore fisheries, most species tend to be assessed every three years, and for inshore and deep water fisheries the process is ad hoc. Most inshore stocks are not assessed due to time and data constraints. One approach is calculating a standardised CPUE (catch per unit effort) series and gauging it against empirical target levels based on the same series. There are no official triggers in place that would trigger new advice or a new assessment.

The only active management strategy evaluation in New Zealand is for Red Rock Lobster (*Jasus edwardsii*; e.g. Starr et al. 2014). This requires a new CPUE index each year which still involves significant effort as there are eight stocks.

There is no formal guidance in New Zealand regarding how to provide advice for interim years for multi-year assessments.

2.4.4 Australia

In Australia, an emerging challenge is the relatively high cost of harvest strategies that are based on quantitative stock assessments, which has resulted in a greater emphasis on multi-year total allowable catches (TACs; Smith et al. 2014). Although multi-year TACs increase certainty for stakeholders, it has been recognized that they should lead to lower average TACs to account for the greater risk associated with having less frequent assessments and consequently less frequent adjustments of TACs (Smith et al. 2014). Furthermore, multi-year TACs (and how they are implemented) have not been subjected to formal management strategy evaluation.

2.4.5 International Commission for the Conservation of Atlantic Tunas (ICCAT) stocks

The Standing Committee on Research and Statistics (SCRS) of ICCAT provides biological information on the stocks that are fished pursuant to the ICCAT Convention. The SCRS carries out stock assessments and advises the Commission on the need for specific conservation and management measures.

It is up to the Commission to schedule the assessments but as yet it has not formally adopted a protocol. Nevertheless, the ICCAT SCRS has recommended several times to fix a minimum of a three-to-four year period between assessments, in particular the Bluefin Species Group (see ICCAT 2010). For stocks other than Bluefin, this recommendation is often followed, but in the case of Bluefin, the Commission has been requesting assessments every two years.

In addition, the SCRS evaluated Bluefin Tuna as part of a Management Strategy Evaluation (MSE; see Kell et al. 2003). According to this evaluation, the choice of reference points was more important to stock performance than was assessment frequency.

While full stock assessments are scheduled to take place at various intervals (between 2-6 years between assessments), regular monitoring and updates to the previous assessment are

completed annually by the SCRS incorporating any new data that comes available including updated catches.

2.4.6 United States National Oceanic and Atmospheric Administration (NOAA)

Major assessments are called benchmark assessments and are generally conducted every 2-6 years, although some stocks may not be reassessed for 10 years or more. A benchmark assessment introduces new methods or data types and may involve a thorough investigation of all aspects of the assessment. Update assessments, which occur between benchmark assessments, involve adding recent data to previously approved assessments, and are reviewed under an expedited process. Updates use a previously reviewed modeling approach and data types. Minimal review is required (Methot 2015).

The decision about whether to have a benchmark assessment, an update, or neither in any given year is made through a prioritization exercise in the context of all stocks.

Target update periods are set for each stock, and are expected to typically be 1-3 years, but could be up to 10 years. The priority for updating an assessment depends upon the degree to which it is overdue relative to its target frequency. For stocks that are equally overdue, priority is be given to those that are on rebuilding plans, are at risk of overfishing, have new information indicating a drift from the previous forecast, and to stocks with higher fishery importance.

Planning an update based on data that indicate a change in stock abundance is not encouraged because of the risk of "tracking the noise" in the index causing excessive fluctuations in management advice. If there is a "noisy" signal, the recommendation is to reduce the frequency of assessment updates to design the assessment approach to better smooth out data fluctuations and provide more stable management advice. It is recognized that it may be possible to make a quick evaluation of new information as it becomes available, and adjust the stock's priority for assessment based upon how closely the new data match expectations from forecasts from the previous assessment. However, NOAA recommends that such early assessments should be avoided because they are disruptive to the planning process and compromise capacity to conduct planned assessments.

Criteria considered in planning benchmark assessments include:

- New data/information is available and a benchmark assessment is needed to fully investigate the assessment performance with this new information;
- The previous assessment identified a shortcoming that is not feasible to investigate with available methods and data; and
- Several updates have been conducted and a review of selected aspects of the assessment is reasonable.

3. GUIDANCE ON PROVIDING ADVICE FOR INTERIM YEARS BETWEEN ASSESSMENTS

As indicated in Section 1, the application of the multi-year approach to fisheries management requires the identification and tracking of stock status indicators in the interim years for the purpose of:

- determining if there has been a change in status which would signal that a re-assessment of the stock and possibly a revision of the management advice prior to the scheduled assessment cycle may be warranted, and

- adjusting the annual fishing plan in the interim years based on the state of the indicator linked to a defined harvest decision rule, where required.

A re-assessment of the stock earlier than the scheduled assessment cycle may be warranted for a number of reasons associated with a change in the indicator(s) state(s) in the interim years, such as:

- an unexpected change in the status of the stock (up or down);
- a change in status of stock to an undesired condition (for. example from cautious zone to the critical zone of the PA);
- a change in the state of the indicator that exceeds the variation associated with the observation uncertainty of the indicator; or
- lack or limited recovery on a stock for which a fishery has been restricted to bycatch and there are no regular updates.

As a first priority, the indicators must be identified which are (or can be) monitored in the interim years and which can be used for tracking the status of the resource. Once the indicator(s) are defined, a conceptual model must be formulated that provides a measure of the amount of interim-year change of the indicator that would trigger a reassessment).

3.1 EXAMPLES FOR PROVIDING INTERIM-YEAR ADVICE AND ASSESSMENT TRIGGERS FOR SPECIFIC ASSESSMENT TYPES AND MANAGEMENT REGIMES

All DFO regions already have many stocks on multi-year assessment schedules. Some have recently moved from annual assessments to multi-year assessments as the department implements the multi-year policy described in the introduction. Annual monitoring continues (where there was already annual monitoring) and advice is provided for many (but not all) stocks in interim years in various ways, most often as formal Science Responses although some interim-advice is provided informally.

The way advice is provided in interim years depends on the assessment type and management regime. Examples of the kinds of interim-year advice that are provided are included below, broken down by assessment type and management regime. The intention is that these current practices could be used to inform guidelines and future practices. The examples include a description of what is done currently in providing interim-year advice, and also what has been successful and what has been less successful.

3.1.1 Input control fisheries

An input control fishery is one where the fishery is regulated by effort, i.e., the catch is not the factor which is directly regulated but it is indirectly regulated through controls on the amount and nature of the fishing effort.

For example, effort could be controlled through the number of licences, length of the fishing season, spatial closure/openings, days at sea/days at port, number of traps/nets/hooks, mesh size, and fish size. Some fisheries in Canada, such as some American lobster stocks, are purely input control fisheries, but, some combination of input/effort controls are usually employed in catch control fisheries as well. Canadian fisheries regulated by input control alone are the exception. A special section has been devoted to them because input control is generally the main basis for control for new fisheries. New fisheries on non-traditional species in both southern and Arctic waters are emerging with increasing frequency in Canada and input controls can be expected to be considered more frequently in the future.

Scallop (Magdalen Islands)

This fishery does not have a trigger to initiate an early assessment in the interim years, but has advice for the interim years that is provided at the assessment to adjust harvest effort in the interim years. This stock is assessed every three years (DFO 2013b) and has an annual fishery independent CPUE index conducted by DFO. A harvest control rule has been developed which relates catch rates to “healthy” CPUE levels. The control measure is the number of fishing days at sea and this is adjusted annually on the basis of the annual fishery-independent CPUE index level. The interim-year information is communicated informally (through an information sheet).

3.1.2 Trend based assessments

Most assessments for stocks in Canada do not use an analytical population model as the basis of their assessment but instead use a temporal trend as a proxy for stock state or stock health. Commonly, this trend would be a fishery independent survey catch rate index. The index may also be based on a fishery dependent index, such as CPUE (catch per unit effort) or simply total catches.

3.1.2.1 Fishery independent survey index based assessments

In a survey-based assessment, a survey index trend from a DFO survey, industry-based survey or other survey could be used. Ups and downs in the trend(s) are assumed to reflect real fluctuations in abundance.

Great Slave Lake Inconnu

There is a formal CSAS reviewed precautionary approach framework for Great Slave Lake Inconnu, *Stenodus leucichthys* (VanGerwen-Toyne et al. 2013; Day et al. 2013). As this fishery co-exists with a much larger Lake Whitefish fishery, *Coregonus clupeaformis*, fishery conservation measures for Great Salve Lake Inconnu have been to close small areas of the lake to fishing rather than to set a quota for Inconnu. Great Slave Lake Inconnu are now caught as bycatch only in the Lake Whitefish commercial fishery. When the index falls into the critical zone, fisheries management may request a science review of the existing information before making a decision, i.e., the trigger to consider a new assessment is for the stock to fall into the critical zone.

The removal reference rate for the upper stock status was set at 40,000 kg of Inconnu from the west basin because it was the annual mean harvest of Area IE (where Buffalo River Inconnu are most vulnerable) prior to the abrupt stock decline. The assessment is based on a gillnet survey index of abundance and on information from log books. The survey index is the proxy for abundance (number of mature females for a standardized gillnet effort) and the reference points are based on the survey time series (DFO 2013c).

While there are no formal trigger values for an assessment, a significant change in the survey index would trigger a request for new advice. Also, if the total harvest substantially exceeded the TAC (roughly greater than 20% change) coupled with other information (e.g. Community report, Traditional Knowledge) that indicated a concurrent change in abundance, an assessment would be triggered.

The fishery is managed through TAC on the target fishery, Lake Whitefish, and through closed areas and timing of harvest. The goal of the closures is to minimize the number of Inconnu harvested while not significantly hindering the Lake Whitefish commercial fishery. Were an assessment to be triggered, the new advice would be based on the same control mechanisms, i.e., a TAC for directed Whitefish fishery and duration and geographical extent of closed areas.

While there is no inconnu TAC, the harvested bycatch is monitored and is used as a performance indicator for the management measures applied.

4RST Greenland halibut

This stock is assessed every two years by tracking indices from the DFO annual multispecies survey, sentinel indices, total catches and fishery CPUE. The DFO survey index is considered a good index of the population and carries the most weight in terms of assessing the stock. A multi-year TAC (for 2 years) is given for the fishery.

The stock was assessed in winter 2013 (DFO 2013d). The summer 2013 DFO survey showed a decline in the abundance of the stock to below the long term average and the index from the sentinel mobile survey was near the lowest in its 18 year history. There were also signs of weak incoming year-classes. These drops were concerning to both science and fisheries management, and fisheries management asked for additional advice on removals for the 2014 fishing season (DFO 2013e). There were no pre-set levels established at the assessment to trigger a re-assessment, and there was some lack of clarity in how to proceed in response to a negative signal from several indices. Interim advice was developed through three special science response processes (DFO 2013e; DFO 2014a; DFO 2014e). Status quo TAC was continued for the interim year. This example demonstrates well the need to establish triggers at the assessment.

Shrimp Gulf of St Lawrence

This stock has four management units assessed separately every two years with separate advice provided for each, even though they do not represent closed biological stocks. All management units are assessed at the same time. An index from the DFO annual summer survey since 1990 and the commercial CPUE index are used as a combined index to assess the stock. The commercial CPUE is considered to be a reliable indicator of abundance. The fishery is conducted by relatively large vessels, with strong obligatory reporting protocols exploiting relatively stable and healthy stocks which provide little incentive to misreport. Both indices are given equal weight in the assessment.

Possible harvest control rules (HCR) were tested against a number of performance criteria and harvest control rules were then identified for all stocks based on multi-stakeholder consultative process in 2012.

The harvest is adjusted annually (i.e. in the interim years as well as assessment years) on the basis of the HCR (DFO 2012a, 2013f). For each stock, the main stock status indicator represents the mean of the four indices, those of the males and females obtained from summer commercial fishery and the DFO research survey. The HCR is applied to this combined/main stock status indicator. The HCRs have been applied twice since they were evaluated.

NAFO 4T snow crab

The main index for the T crab is a fishery independent bottom trawl survey. Because of the uniformity of bottom type in this region and few untrawlable areas, this is considered a good index of abundance for crab in this management zone. Although the stock is assessed using a survey index, one-year projections are carried out using current abundances for a given year-class. Management of the southern Gulf of St. Lawrence snow crab fishery is based on establishment of annual quotas and provides an example of how to provide stock advice for interim years. Reference points and harvest decision rules compliant with the PA have been defined (DFO 2012b, 2014c). The stock is currently assessed annually but for 2016, a multi-annual assessment was planned to begin. A system for interim-year monitoring of the index was established, where if the survey biomass in interim years is outside the 95% confidence interval

of the projection, then a new assessment would be triggered. As part of the assessment or in the interim year of the 2-year assessment cycle, the agreed harvest decision rule would be applied to the estimate of the exploitable biomass from the survey to calculate the exploitation rate and the associated TAC. This proposed approach for applying a harvest decision rule in an interim year has yet to be applied for this species/stock. The fishery independent bottom trawl survey is funded using a Section 10 collaborative agreement with the industry and as of 2017, the multi-year assessments have not been instituted as per the request from the industry.

3.1.2.2 Catch-based trend assessments

A catch-based trend index may be a fishery dependent catch per unit of effort or possibly just total catch. Catch in a commercial fishery is not simply a function of fish abundance but also reflects market conditions, operating costs and regulatory measures. The use of catch to track fish abundance requires a full comprehension of the key factors affecting catch.

Dolly Varden

Anadromous northern Dolly Varden char are harvested through a rights-based subsistence fishery by Inuvialuit, Gwich'in in the western Canadian Arctic (Howland et al. 2012). The species is mainly fished for subsistence using gillnets in marine coastal feeding locations of the Beaufort Sea during the summer months and in tributaries during the fall upstream migration to spawning/overwintering locations. Northern form Dolly Varden was assessed as "Special Concern" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2010) and there is an Integrated Fisheries Management Plan (IFMP) completed for all anadromous Northern Dolly Varden stocks in Canada (DFO 2010).

Northern Dolly Varden fisheries are co-managed through adaptive community-based fishing plans. Community needs, community/harvester's observations, and scientific data are taken into consideration in recommending annual voluntary harvest levels (Howland et al. 2012). Scientific assessments are based mainly on population abundance estimates obtained through mark-recapture studies (for details see Howland et al. 2012). Since implementation of the IFMP, a set of harvest control rules (HCR), formalized in the IFMP, is to maintain the catch below 5% of the most current population abundance estimate for the fishable component of a given stock (DFO 2010). Given the variance around abundance estimates, additional indicators of stock abundance are also taken into consideration for setting voluntary harvest levels. These include mortality estimates based on catch curve analysis, size and age structure of populations (to provide an indication of juvenile recruitment and presence of older/larger individuals), sex ratios, proportion of spawners, estimates of maximum sustainable yield based on statistical catch at age and surplus production models, and local harvester observations. Efforts are being made to move towards formalizing the use of multiple indicators through application of a traffic light approach (Caddy 2002; Howland et al. 2012).

Formal DFO Canadian Science Regional Advisory Processes (RAPs) and renewal of the IFMP with stock assessment advice and overarching guidelines for management are conducted on a 5-year cycle. Interim advice is provided annually by DFO Science and used to set voluntary quotas which are determined by community-led fisheries working groups in each land claim settlement region.

If the catch exceeds the set level it could trigger a re-evaluation of stock status, however a formal re-evaluation would typically only be undertaken at the request of client groups (fish management or land claim management boards) if there were concerns regarding stock status. If a new assessment was triggered before the planned multi-year schedule, this would likely reset the schedule. If a re-assessment were triggered, science advice would be provided in

accordance with HCRs outlined in the IFMP. Given that this is a subsistence fishery DFO would only intervene in the case of a clear conservation issue.

The current assessment approach and HCR appear to be effective and work well in the context of co-management. The annual provision of interim advice and setting of voluntary quotas is a particularly effective approach given that abundance levels can be quite variable in some populations. Use of this approach has led to recovery and current stability in populations that were previously depressed through a combination of overharvest and possible environmental effects.

3.1.2.3 Assessments that include environmental indices

In some cases, indicators used in the assessment and/or for interim-year monitoring may reflect an aspect of stock productivity in future years (as opposed to an indicator directly estimating stock abundance).

Harp Seal

March ice cover and ice thickness in the Northeastern Gulf of St Lawrence play a role in the pupping success rate of harp seals. In years when ice conditions are very bad for pupping, it can lead to an almost complete failure of the year class to recruit beyond the nursing stage. These years then can signal a change in hunting advice for upcoming years.

Harp seal is assessed using an age-based population model that incorporates annual estimates of removals, ice-related mortality of young, age-specific pregnancy rates, and periodic estimates of pup production obtained from aerial surveys during whelping season. These surveys are done every four to five years and are followed by a full assessment a year later. While surveys and full assessments are done periodically, reproductive rates, catches and ice mortality are monitored annually.

Since 2003, ice mortality has been incorporated into the population model formally and is based upon ice anomalies.

Science advice is based upon forward projections using assumptions about mortality, reproductive rates and catches (DFO 2014d). Each assumption is provided with a degree of uncertainty. Assumptions are made in different ways; one approach is to use the range of values seen the previous ten years while another is to incorporate density-dependent relationships.

The agreement for interim years is that if there are any major changes in any of these assumptions a new assessment would be triggered. The level of change is not defined but a new assessment would be triggered if there were multiple years (>3 years) of poor ice resulting in high pup mortality or continued low reproductive rates that could result in an over harvest that impacts the population in the long term.

Multi-year quota setting is taken into account in the advice by providing the probability that the population remains above the reference level over the long-term (15 years, based on life history characteristics).

Eastern Scotian Shelf Shrimp

Advice on the status of the Eastern Scotian Shelf Shrimp stock is requested annually by management and industry to help determine a Total Allowable Catch (TAC) that is consistent with the IFMP. Science advice for the management of the stock is provided as a fully peer-reviewed stock assessment at an inclusive Regional Advisory Process meeting on a biennial basis (DFO 2015b). In interim years, science advice is provided as a stock status update and published as a Science Response (e.g. DFO 2014e).

There is a complete analysis of all the indicators every year, i.e. whether it be a full assessment or an interim year. The summary “ecosystem” characteristic incorporates three temperature indicators as well as predator abundance and trends in cold water conspecifics. All indicators are provided for the assessment and in interim years the SSR only address individual indicators that might be particularly relevant to the provision of advice in that year.

Each ecosystem indicator is assigned a color for every year there is data according to its percentile value in the series (i.e., >0.66 percentile = green or healthy; 0.66-0.33 percentile = yellow or cautious; and <0.33 percentile = red or critical). Indicators have been grouped into stock characteristics of Abundance, Production, Fishing Effects, and Ecosystem. Note that indicators are not weighted in terms of their importance, and the summary for each characteristic is determined as a simple average of individual indicators.

3.1.3 Analytical model-based assessment (without feedback simulation)

For many fish stocks in Canada, scientific advice to managers is derived using an analytical model. Using an analytical model allows the definition of productivity-based reference points such as Bmsy and Fmsy, and allows for the reconstruction of historical population size and projections of future population size under a range of catch scenarios. These models can explicitly account for uncertainty, allowing for a risk-based framework for advice that clearly shows the trade-off between safe harvest levels and uncertainty, i.e. as uncertainty increases, harvest levels must decrease if risk is to remain the same. At the assessment, projections of the expected values of the indicators in interim years can be made over a range of catch levels. Interim-year updates could compare the actual indicator to what was expected based on projections and if these were to differ by a pre-identified margin, then a new assessment would/could be triggered.

West Greenland Atlantic Salmon

In 2007, ICES developed a framework (FrameWork of Indicators; FWI) to be used in interim years to determine if there is an expectation that the multi-year management advice for the Greenland Atlantic salmon fishery is likely to change before the next assessment (ICES 2007). A significant change in science advice to management would be signaled by an unforeseen increase in stock abundance to a level that would allow a fishery where no catch had been previously advised, or an unforeseen decrease in stock abundance when catch options had been chosen. The finalized Framework (FWI) was accepted by NASCO (North Atlantic Salmon Conservation Organization) in June 2007 and was applied in 2008 to the West Greenland fisheries to determine if a re-assessment was advised (it was not). In 2009, the FWI was updated for application for the 2010 to 2011 fisheries, updated again in 2012 and applied for the 2013 and 2014 fisheries. At every assessment that begins the cycle of forecasting and catch advice for the three year management cycle, ICES updates the FWI in support of the multi-year catch advice and the potential approval of multi-year regulatory measures (ICES 2015).

The FWI consists of indicators (estimates of returns or return rates to individual rivers) from forty Atlantic salmon stocks from the eastern US to Newfoundland. The indicators are compiled and compared to threshold values. Updated conclusions based on the combined indicators can be:

- No significant change identified by the indicators, or
- Reassess.

If no significant change has been identified by the indicators, then the multi-year catch advice for the year of interest could be retained. If a significant change is signaled by the indicators, the response is to reassess. The framework is designed to capture both fishing and non-fishing scenarios:

- Multi-year advice provides no catch options greater than zero but indicators are suggesting that the management objectives may be met (conclusion: Reassess),
- Multi-year advice provides catch options greater than zero but the indicators suggest the management objectives may not be met (conclusion: Reassess).

It is anticipated that the data for the indicator variables to populate the framework would be available in January of the year of interest. Figure 3 illustrates the timeline of the implementation of the FWI. The first step in the framework evaluation is to enter the catch advice option (i.e. tonnes of catch) for the West Greenland fishery. This feature provides a two way evaluation of whether a change in management advice may be expected and a reassessment would be required. The second step is to enter the current values of the indicators identified in the framework. The spreadsheet evaluation update automatically generates the conclusion. While the framework was developed by ICES, the annual analysis of the status of the indicators and associated analysis is completed by a sub-committee established by the Regional Fisheries Management Organisation, NASCO. It is critical that the framework results be communicated to ICES in early February to allow sufficient time for the ICES Working Group to provide catch advice by June for a fishery that begins in August.

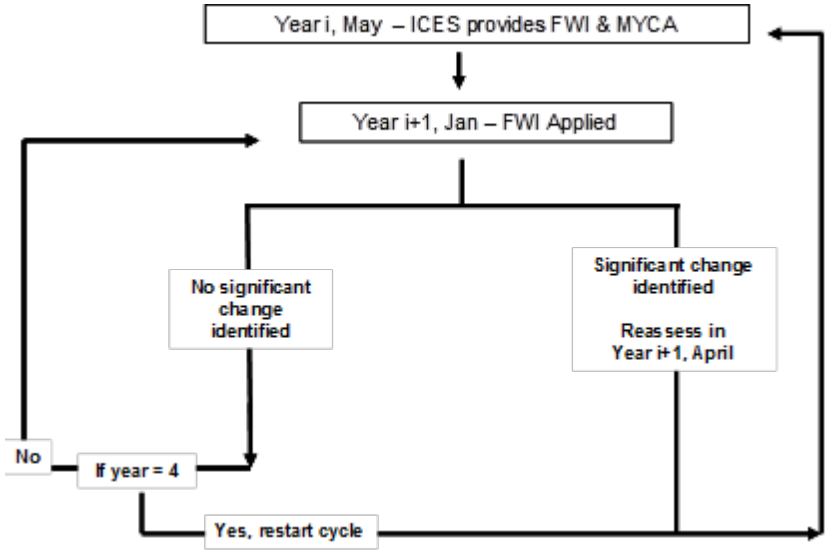

Figure 3. Suggested timeline for implementation of the FrameWork of Indicators (FWI) for the Atlantic salmon fishery at Greenland.

In Year i, ICES provides multi-year catch advice (MYCA) and an updated FWI which re-evaluates the updated datasets. In January of Year i+1 the FWI is applied and one of two options is automatically identified. If no significant change is detected, no re-assessment is necessary and the cycle continues to Year i+2. If no significant change is detected in Year i+2, the cycle continues to Year i+3. If a significant change is detected in any year, then reassessment is recommended and ICES would also provide an updated FWI the following May.

Albacore tuna

Albacore Tuna in the North Pacific Ocean undergoes a full international assessment every three years, with DFO participation through ICCAT. This includes review of the data and the model (e.g. Albacore Working Group 2014). Management is effort-based (rather than catch-based), and the assessment produces recommendations of advice. In the interim years the model is not run but scientists meet and look at the data relative to the recent years of model output and

decide whether the recommendations need to be updated; usually it is decided recommendations do not need to be updated (J. Holmes, DFO, pers. comm.). No formal trigger values are set.

3.1.4 Analytical model based assessment with feedback simulation

Full feedback simulation approach (management strategy evaluation; MSE) has been applied to very few stocks in Canada. In theory these approaches have accounted for the full plausible uncertainty in assessment and should be able to run essentially on autopilot. Potentially, however, it could arise that an MSE would no longer be considered valid within the initially proposed period if there are unforeseen or implausible events such that a new process would have to be considered before the next assessment.

Scotian Shelf/Southern Grand Banks Atlantic Halibut

At the Scotian Shelf/Southern Grand Banks Atlantic Halibut Framework assessment in November 2014, triggers were chosen for identifying the conditions under which an early assessment would be required before the next scheduled five year assessment (DFO 2015c). The trigger was set as below average recruitment in three years since the assessment (not necessarily three consecutive years).

A range of harvest control rules, specifically a range of constant TACs as well as a range of F's were tested for performance, including probability of growth over 45 years. From these options, a specific harvest control rule would be chosen by Resource Management based on the science advice from the assessment and the results of advisory meetings with industry. This harvest control rule is applied to a running three year average of the Halibut index during interim years based on a five step calculation provided in the science advisory report (SAR).

Western Scotian Shelf Pollock

An MSE approach was adopted for Western Pollock to address the challenges with the traditional Virtual Population Analysis VPA based assessments that had a tendency to give highly variable results and made it difficult for business planning from an industry perspective (DFO 2011).

In interim years, catch limits for Western Component Pollock for the upcoming fishing year are calculated using an HCR linked to a management procedure (MP) model which was chosen to satisfy three medium term objectives, and either increases or decreases catch limits based on results from ongoing monitoring, i.e. from the DFO summer Research Vessel (RV) survey. A three-year running geometric mean of the summer (RV) Survey Biomass Index is used as the indicator (DFO 2015a).

There are exceptional circumstance protocols in place to cover situations that fall outside the range for which the MP model was simulation tested. Triggers for an exceptional circumstance include:

- When the Survey Index Ratio falls below 0.2 or is beyond the 90% probability level from model predictions;
- When the RV survey biomass index is < 6.0 kg/tow for two consecutive years; and
- RV survey age-specific indices are monitored for changes in age structure which could also trigger an exceptional circumstance (i.e. when extremely compressed/expanded).

When exceptional circumstances are detected, three courses of action are possible depending on the circumstance observed:

- Review the information, but maintain the Management Procedure as the management mechanism; additional research/monitoring may be recommended to determine if the signal detected warrants moving to step 2;
- Advance the review period, and potentially revise the Management Procedure, but implement the Management Procedure outputs; and
- Set a catch limit that departs from the Management Procedure, and revise the Management Procedure.

Otherwise, the process is designed to operate on auto-pilot for a period of up to five years. The MSE currently in place for this stock is up for review in 2016/2017.

Science advice is provided annually through a Science Response (DFO 2015a).

In terms of measuring success, based on survey results, Western Component Pollock abundance has been declining since 2010 with low incoming recruitment. Stock rebuilding has not progressed as much as expected/hoped when MSE was first implemented in 2011.

Sablefish

A management strategy evaluation (MSE) has been implemented in the Pacific Region for Sablefish (*Anoplopoma fimbria*). A catch-age model was used as the operating model in the full multi-year assessment to pick the management procedure that meets pre-agreed objectives (DFO 2014f).

In the interim years, landings and a survey index are used in a surplus production model to give a recommended catch. The surplus production was tested during the MSE, and is less complex than the catch-age model so can be run in interim years. There are pre-defined conditions that would adjust the recommended catch in the interim years, using an HCR. Production model outputs are translated into retained catch using a PA-compliant harvest control rule that sets the removal rate that is reduced linearly from UMSY (harvest rate at maximum sustainable yield), when the estimated stock is above 0.6BMSY and to zero when the estimated stock size is less than 0.4BMSY

The MSE accounts for the possibility of very low or very high abundances, and so there is no trigger for reassessment. The interim-year advice is provided as a Science Response.

The main drawback of this approach is the large amount of work required for the original MSE, which is scheduled for updates every five years.

Greenland Halibut NAFO

Greenland Halibut is assessed in NAFO using an age-structured population model. The TAC is set using an HCR that has been tested by an MSE management strategy evaluation (NAFO 2011).

Advice on the TAC and whether or not there are exceptional circumstances is provided each year (NAFO 2015). The TAC advice is given through the application of an HCR. The assessment is not updated each year. Exceptional circumstances should trigger a new assessment and/or re-evaluation of the HCR. Exceptional circumstances have been explicitly defined for primary and secondary indicators but not what to do if it is found they are occurring.

The “primary indicators” are catch and survey biomass index. The observed values are compared to the simulated distributions from both Statistical Catch at Age (SCAA)-based operating models and Extended Survivors Analysis (XSA)-based operating models. If the observed values are outside of the 90% confidence interval (i.e. outside the 5th and 95th

percentiles) from the simulations presented to MSE working group in 2010, then the NAFO Scientific Council advises the Fisheries Council that exceptional circumstances are occurring.

When exceptional circumstances are occurring there are five secondary indicators which should be considered:

1. Data Gaps in the survey series used in the HCR;
2. Biological Parameters;
3. Recruitment;
4. Fishing Mortality; and
5. Exploitable Biomass.

There is no HCR for exceptional circumstances. While it is not stated, the assumption is that a new management strategy evaluation would need to be initiated. The approach is considered to be successful.

3.1.5 Fisheries with sporadic data updates

There are numerous small scale freshwater and aboriginal fisheries in Canada for which there is no routine stock monitoring or management plan in place. Most of these fisheries are not commercial but are subsistence fisheries, and data comes from them sporadically or on an opportunistic basis. Because such fisheries do not have regular assessments, interim years cannot be defined specifically in this context. Examples include Arctic Charr (DFO 2013g) and a number of arctic marine mammals (DFO 2015d). An assessment or update of advice may be triggered by a request from stakeholders, or by opportunistic sampling.

3.2 CONSIDERATIONS FOR DEFINING INDICATORS TO BE USED IN INTERIM YEARS

In the interim years between the prescribed stock assessment cycle, science monitoring is expected to continue and science is expected to provide updates on the status of the stocks based on defined indicators. The indicators to be used in the interim-year updates should be proposed, peer reviewed, and described in the advice during the full stock assessment process.

The most useful indicators are those which are proportional to abundance (of the exploited component in the fishery) and can be associated directly with or used as proxies for the stock status zones of the Precautionary Approach. The indicators can be of varied types; as simple as landings in effort control fisheries, to catch rate indices (fishery dependent or fishery independent), to modelled indices of abundance. In some particular cases, indicators which may not be proportional to abundance but which may affect stock productivity or fishery performance could be used as a basis for generating interim-year advice.

The following are considerations for choosing indicators to be used in interim years:

- The indicators must be based on observations / data which would be collected in the interim years for which an update is expected.
    - May not qualify as indicators are surveys conducted every 2nd or 3rd year or infrequently such as for marine mammals as they would not necessarily be available for all interim years.
- The data must be collected and the processing time for the data appropriate for providing the interim-year update sufficiently early to prepare and conduct a full assessment if a re-assessment is recommended before the next fishing period.

- Examples of indicators that may not be appropriate: lobster landings are not a good interim-year indicator when purchase slips entry has a backlog of more than one year; age-based indices that require ageing services and long processing times, etc.

- It should be demonstrated that the indicators are directly associated with or can serve as a proxy / proxies for the status of the exploited component of the stock.
  - Indicators that are not likely appropriate: recruitment rate without consideration of compensatory stock and recruitment dynamics, fishery-dependent CPUE indices that are affected by market or management constraints such as individual trip limits.
- The indicators should be characterized by sufficiently small annual variation due to observation error to allow the detection of the signal associated with variations in stock status.
  - Examples of indicators that may be insufficient: catch rates of Atlantic herring in the research vessel bottom trawl surveys; catch rates of species whose spatial or seasonal distribution is sparsely encompassed in multi-species surveys such as rainbow smelt, winter flounder, and most nearshore coastal species.
- Options for handling indicators with large inter-annual variations due to observation uncertainty may include using smoothing values over several years (moving average values).

The projected or anticipated values of the indicators for the interim years following the assessment may be derived from a range of models of varying complexity from a simple average of previous year states, random walk models, trend forecasting, to full projections from a quantitative assessment model. See Shelton et al. 2007 for descriptions and analyses of projection models and approaches.

Some stocks are assessed using proxy indicators for productivity or abundance. These indicators are not a direct measure of the productivity or abundance of the stock but which are strongly related to them. For example, such an indicator could be an environmental signal that is related to recruitment of a stock. Examples of these kinds of indicators could be the morpho-edaphic index (mean depth of lake and phosphorus content) used as a measure of fish production in Canadian lakes, abundance of key prey (i.e. it may be easier to assess the prey than the target species) or lower trophic levels. Alternatively, an indicator may relate to a life history characteristic of a stock, such as maturity, condition factor, shell condition, or age-structure of the population. We should also recognize that there is a rapidly advancing capability in remote sensing where environmental signals (e.g. ice cover, ice-out time, temperature, Chl-a) can be collected in near real time from remote areas. Assessments for some data poor stocks may be increasingly based on these kinds of data. Indicators monitored during the interim would also come from these same data streams.

3.3 ROLES AND RESPONSIBILITIES FOR TRIGGERING AN EARLY ASSESSMENT

The decision to trigger a re-assessment, i.e. an assessment earlier than was planned according to the multi-year cycle, is an internal DFO process. The two players are Science and Resource Management.

The setting of indicators and associated trigger values should be included in the objectives portion of the Terms of Reference (ToRs) for full multi-year assessments. These ToRs are agreed upon and approved by both Science and Management.Science should lead on the setting of indicators and triggers at the assessment. This exercise should be done in

consultation with fisheries management and any industry members participating in the peer review.

These defined indicators and triggers would be presented by Science at the consultations with stakeholders at the management advisory process following the assessment.

When an indicator does cross a trigger value in an interim year, management may decide not to request a re-assessment and may decide to adjust the fishing plan based on the interim indicator state applied to a harvest decision rule. When a trigger value is crossed, Science may decide there is a need for a new assessment even if it is not requested by management.

When possible, pre-agreed decisions on science and management actions in response to the changes in indicator states should be made.

3.4 GUIDANCE FOR SETTING TRIGGERS THAT WOULD PROMPT AN ASSESSMENT EARLIER THAN THE PRE-AGREED ASSESSMENT CYCLE

Trigger values or thresholds that would signal an unexpected change in status and that would provide advice on whether a re-assessment is warranted should be defined at the full multi-year assessment, i.e. at the beginning of the multi-year assessment cycle. The trigger values should be developed considering a number of factors including the recent status of the resource, the current management plan, and the magnitude and direction of change of the indicator.

3.4.1 Framing changes in interim indicators in the appropriate risk context

All the guidance points below are essentially risk evaluations; if risks to the long term productivity of the stock are minimal according to the observed interim-year updates, then it is unlikely that actions need to be taken. The current state of a stock relative to a previous state or its precautionary approach zone status places the information in a certain risk context. For example, a stock which is in the critical zone for which the assessment projected an increase, but the interim-year index/indices have decreased, should be considered to be at elevated risk and an immediate strong management response may be desirable because of conservation concerns.

Revised advice may be warranted when:

- If a stock is in the critical zone and the interim-year update shows indicators with a significant directional change in stock trajectory from expected positive to observed negative;
- Stock status under status quo fishing that unexpectedly declines from cautious to critical zones;
- For stocks in the cautious zone, unexpected declines in status;
- If stock status under status quo fishing unexpectedly declines from healthy to cautious;

For a stock that remains in the healthy zone, unexpected changes in direction are unlikely to pose a risk to productivity of the stock in the short term.

The triggers may be established based on a specific directional change. For example, if a fishery is currently operating at effort corresponding to the maximum removal rate, an increase in the indicator in the interim year would likely not warrant a re-assessment or changes in fishing plans. On the other hand, for a stock which is under moratorium due to low abundance, and an increase in the indicator in the interim year is pointing to improved status, a re-assessment may be of interest to provide advice on potential fishing opportunities. The setting of the trigger values and deciding whether the trigger is one-tailed or two tailed (i.e. considers change in one

or both directions) should be made in consultation with fisheries management and stakeholders as it is associated with a conservation risk to the resource, risk of lost benefits, as well as risk of triggering early assessments unnecessarily.

Key considerations for setting trigger values based on an interim year indicator will vary among stocks and among types of assessment, i.e. stocks that have an analytical model versus those with based on a survey index. Guidance on setting trigger values is provided below broken down by assessment type.

3.4.2 Stocks where advice is provided based on a feedback simulation (FBS) / management strategy evaluation (MSE)

Stocks where the assessment is based on FBS/MSE should rarely require an early assessment as they typically have tested the performance of the management strategy under a wide range of plausible variations in the interim year indicators. The adopted management strategy should therefore be robust to all plausible changes in the system. Typically for such fisheries catch advice is updated annually by applying the harvest control rule. In some circumstances, however, new information may come forward which casts doubt on the validity of the operating model (OM) which is not unheard of in dealing with natural systems. The interim-year update would be used to determine if the new information invalidates the OM used in the FBS. If the OM is considered to be compromised, then the HCR is no longer robust to the uncertainties in the way determined by the FBS. New advice would be warranted, which, when feasible, would include running a new FBS with a revised OM. Typically MSE processes lay out exceptional circumstances indicating when the advice would no longer be valid, for example if there were a number of years in a row with below average recruitment (see 3.1.4 for examples of exceptional circumstances). In addition to pre-identified exceptional circumstances, new information about the species/stock may invalidate the assumptions of the OM, e.g. if new information indicated that the ageing was wrong.

3.4.3 Stocks assessed with an analytical model

A large number of stocks in DFO have science advice on catch provided by fitting an analytical model. These may be full age-structured models or much simpler biomass dynamic models for which there are annual inputs. While the model may or may not be run each year, these inputs are typically monitored in interim years and if they fall out of prescribed bounds then a full assessment (including rerunning the model) would be triggered.

These models have all or some combination of the following data inputs which are monitored annually: commercial catch, by-catch, catch relative to TAC, survey abundance index, size-at-age, maturity, condition, recruitment. Any of these inputs may be identified as indicators with prescribed trigger values that when crossed would trigger an early assessment.

When selecting the values for the trigger, consideration should be given to the precision of the projected model value (if applicable) and precision of the measured indicator. The anticipated trend of the indicator can also be considered. A trigger value which is too easily breached may result in triggering a full stock re-assessment more often than is required. On the other hand, if the trigger value is too hard to reach, the trigger may not be responsive to true changes in stock status and fail to signal a full stock re-assessment when one may be warranted. The width of the bounds between the upper and lower trigger values will define how often the index crosses the trigger value.

The selected values of the trigger will be case-specific and would be defined at the full stock assessment process, including pre-agreed responses when trigger values are crossed. Values of the trigger could be defined and tested using historical data to quantify how often full stock re-

assessment recommendations would have been signaled in the past under different trigger values.

In interim years, the indicator could be converted so it scales to the projected model output. For example for groundfish, the catchability of the survey index (the q value) could be be applied. If such a comparison would be required, an explanation of how to do so should be included in the SAR (what is the q, and how to use it to estimate a biomass value from the index.) An example of this use of catchability conversion using q in interim years is the Scotian Shelf and Southern Grand Banks Atlantic Halibut framework (DFO 2015c).

Use of confidence intervals

One method to set trigger values is to use a defined confidence interval. If the value of the main indicator is outside the projected range from the last assessment (e.g. 25 - 75% of the confidence interval of the projected index from the model output) then new advice would be warranted. The appropriate range of the confidence interval (trigger values) would be case-specific and would depend on whether the index is smoothed. More variable indices will require wider confidence intervals, i.e., higher and lower trigger values.

Smoothing the indices

To minimize the likelihood of triggering a new assessment because of year-effects in the indicator, smoothing of the index should be considered. A wider range in the trigger values will likely be required if the index is not smoothed. Three to five year windows for smoothing are commonly used. The smoothing window would depend on a number of factors including mean generation time, variability in the index and age at recruitment to the fishery. The shorter the generation time and the more variable the index, the longer the smoothing window should be. Smoothing over a range of time windows could be tested for the index time series to see how often an early assessment is likely to get triggered. In setting the trigger values, careful consideration should be given to whether they are based on smoothed indices and whether the index that will be compared to the expected value at the interim-update is smoothed. This will affect how often an early assessment is triggered. For example, if both the expected value and the trigger value are smoothed values, using a confidence interval of 25-75% would result in triggering an early assessment half the time in any given interim year (50% of the values would be expected to fall inside the range and 50% outside). In most cases this would be considered to be too often as early assessments are expected to be triggered only in exceptional circumstances.

Use of more than one indicator

More than one indicator of abundance may be identified to be used to trigger early assessments. The extra information gained from having more than one indicator can be especially useful in the context of interim-year advice. While it may be difficult to interpret a change in one indicator, a similar change in several indicators can provide a clearer picture that new advice is required.

When there are multiple indices, it must be clearly defined at the full assessment what would trigger an early assessment in terms of which combination of the indices need to be outside the defined ranges (i.e. if any one of the indices is outside of the range, a subset of the indices, or all indices, etc.). The assessment should identify whether the indicators are weighted, i.e., if one of the indices is the main one, the weighting should be clearly identified at that assessment.

Examples of how the use of multiple indices could be used to trigger the need for an early assessment include:

- If the main smoothed index has increased or decreased more than X standard deviations (SD) from the expected value y then revised advice is warranted.
- If two or more of the smoothed indices have increased or decreased more than X SD from the expected value, then revised advice is warranted.

3.4.4 Stocks assessed using an abundance/biomass index trend

Most exploited stocks assessed by DFO use some kind of survey index as a proxy for abundance. Some of these stocks have precautionary approach stock status zones based on these survey indices, including historical mean size, minimum size from which there has been recoveries, etc. It is therefore possible to designate stock status relative to a PA zone for stocks assessed with indices only. Relative fishing mortality indices can also be calculated for some of these stocks and the time series of the relative fishing mortality can be used to define relative fishing mortality reference points.

The guidance above for stocks with an analytical assessment would apply to those with an index, although there would be no need for scaling the index to the modelled biomass series.

For these stocks, while there would not be an expected value based on an analytical model output, there could be an expected value based on recent values or continuation of a recent trend. To establish expected values upon which to base the trigger values, a period based on the recent past could be chosen to best reflect current productivity conditions.

The trigger value would depend on whether the expectation is that the stock is rebuilding. If the stock is rebuilding, a drop in a smoothed index could be used as a trigger for an early assessment and new advice.

3.4.5 Stocks assessed using a catch index

In many cases, a stock abundance indicator is not available but total catch is available. If the catch time series is relatively long, then this may contain a large amount of information about stock productivity, especially if something is known about the effort required to get that catch, as for example if harvesters from a small community undertake relatively stable effort.

For this assessment type, catch would be the indicator used to establish trigger values. The deviance from expected catch that would trigger a new assessment must be established by experts as part of the provision of multi-year advice.

If expected catch (e.g. TAC) was not obtained for reasons related to the fishing industry's harvesters' ability to find fish, then this may warrant a re-assessment and revised advice. If effort has been relatively constant, or there is sufficient knowledge about the change in effort, then it may be possible to base the trigger on a similar method to that described above for the assessments that are based on an abundance index.

If catch or TAC significantly exceeded expectation at the time of the assessment (or time to reach the TAC was shorter than expected), this may warrant a re-assessment and revised advice, particularly if this happens for several years in a row (need to demonstrate that this is continued event/new pattern). More than one year would be required to have enough new information to warrant a new assessment.

3.4.6 Stocks where productivity or abundance is assessed using proxy indicators

For proxy indicators described in section 3.2, triggers for re-assessment and new advice could be developed similarly to how an abundance index for interim years would be used to monitor

and trigger re-assessment for the category of stocks assessed using an abundance trend (section 3.4.4).

3.5 ADJUSTING HARVEST ADVICE AND/OR FISHING PLAN ACCORDING TO THE CHANGE IN STATUS INDICATORS (WITH DEFINED HARVEST CONTROL RULES)

To date in the multi-year management of many stocks, the process has been to establish a set harvest or effort level that remains unchanged in the interim years. In most of these cases, changes to the fishing plan could occur if indicators in the interim years exceed the triggers resulting in a re-assessment with revised catch advice based on the new assessment.

However, in some cases, management measures that include harvest decision rules for the interim years are developed where the harvest level/fishing plan responds to changes in the stock status indicator. Such an approach requires a pre-agreed procedure from the assessment or advisory meeting. The approach could include a constant TAC as a default, but if the indicator reaches a pre-agreed level the TAC would be adjusted based on a defined rule. Alternatively, and perhaps more commonly, an F is applied to the new biomass index. Changes in the TAC in interim years could be capped (e.g. plus or minus 5-15%) and/or could be based on a smoothed index. Depending on the specifics of the stock and fishery, adjusting TAC each year is not necessarily preferable.

Using this approach, there is a defined association between a status indicator and a harvest decision rule which is used to tune the fishing plan to annual variations in the status indicators. Examples of such harvest decision rules are included in section 3.1 and in various reports (DFO 2011; DFO 2013b; DFO 2014c; DFO 2015c).

Under this scenario, in interim years the status indicators would be reviewed to evaluate whether the defined triggers signal that a re-assessment is warranted. If a re-assessment is not warranted, an adjustment to the TAC based on the state of the indicator linked to a harvest decision rule, would occur automatically. As discussed in section 3.0, how managers respond to the results of the analysis of the indicator states in the interim years must be agreed between sectors and the users at the full assessment process.

A generic objective should be added to the terms of reference for stock assessments to describe how the indicators of status are linked to harvest decision rules. This objective would apply at each full assessment process, including those assessments that are undertaken as a result of the indicators surpassing the triggers.

3.6 CONSIDERATIONS FOR DETERMINING THE FREQUENCY OF INTERIM-YEAR UPDATES

It should not be assumed that Science would necessarily provide updates of indicators in every interim year for all species / stocks that have ever been assessed, including those which do not have a defined assessment cycle, as this would represent a significant additional science delivery to current activities. In the interim years between the full stock assessments, monitoring will continue and, according to the schedule defined at the assessment, Science will provide updates on the status of the stock based on peer-reviewed identified indicators. Examples of updates of status indicators have been published in the DFO CSAS Science Response series (DFO 2014g, 2014e, 2014h, 2015a) in some cases representing multiple species in one report (DFO 2014i, 2014j).

Updates in interim years would only be provided for species/stocks that meet the following conditions:

- A schedule for interim-year updates has been agreed at the assessment;

- There is a request for an update even though none was planned for that year.

Additional interim year updates may be warranted if indicators or other information suggests a conservation concern.

A request from management to provide an update of stock status exclusively for communication purposes to the fishing industry without any potential for interim-year interventions in management would not be a sufficient reason for science to provide interim-year updates.

The frequency and number of interim-year updates must be agreed during each full assessment process. These could be based on species characteristics and population dynamics, the defined fishing plans, and the associated potential interim-year management actions for the fishery during the interim years. The multi-year assessment cycle for species/stocks generally ranges from two years to five years. The frequency of updates must be determined on a case-by case basis for each fishery ..

Conditions that may warrant a more frequent schedule for interim-year updates include:

- Annual updates would be provided for species/stocks with a fishing plan adjusted annually by a harvest control rule linked to the status indicator.
- Species or stocks whose status is in or approaching the critical zone and subjected to directed fishing may benefit from annual tracking of status indicators to ensure that the defined rebuilding objectives can be respected.
- Short-lived species or species for which recruitment is a high proportion of exploitable biomass and shows high annual variability would benefit from annual updates (although such species are likely assessed annually or at most every two years).

Less frequent interim-year updates would be considered for the following conditions:

- Species / stocks that are presently managed on a two-year cycle are unlikely to require an interim-year update in the non-assessment year.
- Species/stocks for which the annual exploitation rate is low (<< M for example) and for which the fishing removals therefore represent a small proportion of the total annual losses.
- Species/stocks which are long-lived, with a large number of age groups / year-classes in the exploited biomass and for which overall annual abundance is not strongly defined by annual variations in recruitment.
- Species / stocks which are in or near the critical zone and for which fishing removals are at the lowest level possible (no directed fishery, losses occur only as low levels of bycatch in other fisheries, i.e. very low fishing mortality).
- Species / stocks which are not under annual TAC management and for which management will not respond in intervening years to variations in status indicators.

4. COMMUNICATION OF ADVICE INCLUDING INTERIM-YEAR UPDATES

Regionally and nationally, DFO has agreed to use the Canadian Science Advisory Secretariat (CSAS) peer review process and advisory report processes to provide Science advice to client sectors. The interim-year updates are considered to be Science advice to clients and the communication of the results of these updates is an important science delivery. CSAS has developed a policy for peer reviewing and communicating the results of interim-year updates of status indicators using the Science Response process. The Science Response process differs from the full peer review process in the scope of the review provided and the requirements for

documentation of the review. For example, reviews of the interim-year updates are likely to be conducted by a small group of departmental experts and typically do not include external (to DFO) participants. Exceptions to this would be if the data for the indicators are provided by non-DFO programs, or specific expertise is required for the review, or an agreement is in place for external participation (such as wildlife management boards).

The CSAS policy provides additional guidelines on the conditions that should apply to interim-year updates, pre-review requirements, and content of the science response update reports. The policy is reproduced in Appendix 2.

Not included in the CSAS policy for interim-year updates is the language to use for communicating the results of the indicator states relative to triggers and the expected actions corresponding to the indicator analysis results. Generic language for communicating the results is recommended and the following are examples of such generic language based on possible conclusions of the indicator analyses.

4.1 IS A RE-ASSESSMENT WARRANTED?

> "Analysis of the indicator(s) for the recent year show the indicator(s) value(s) are within the expected range. A re-assessment is not warranted and the previous advice for the fishery remains appropriate."
>
> "Analysis of the indicator(s) for the recent year show the indicator(s) value(s) are outside the expected range and a re-assessment is warranted. This re-assessment may result in revised catch advice for the fishery." Alternatives:
>
> - the stock status indicator has declined from the cautious zone to the critical zone;
> - other wording based on how the indicators and trigger values are defined during the full assessment peer review.

4.2 REVISED FISHING PLAN

> "Analysis of the indicator(s) for the recent year shows the indicator value(s) are within the expected range and a re-assessment is not warranted. Based on the agreed harvest decision rule, the value of the status indicator for the current year corresponds to an exploitation rate of XX% and a total allowable catch of XXX t (a total effort of XXX days/traps…) for the upcoming fishing year, if requested in ToR.
>
> "Analysis of the indicator(s) for the recent year shows the indicator value(s) are outside the expected range (or alternative wording) and a re-assessment is warranted. This re-assessment may result in revised catch advice for the fishery. Based on the agreed harvest decision rule, the current value of the status indicator for the current year corresponds to an exploitation rate of XX% and a total allowable catch of XXX t (a total effort of XXX days/traps…) for upcoming fishing year. This calculation is provided, although it should be noted the advice no longer applies."

Statements of the type "Science recommends a reduction in TAC or effort" or other prescriptive statements that could be interpreted as fisheries management decisions or related to policy are not to be used.

5. TOR DEVELOPMENT CHECKLIST (FOR ASSESSMENTS AND FOR INTERIM-YEAR STOCK UPDATES)

To ensure that the appropriate analyses and reviews in support of the multi-year assessment and management cycle are conducted, generic objectives should be included in the ToR for full stock assessments and for interim-year updates.

Objectives to include in the ToRs for full assessments, including those assessments that are undertaken as a result of the indicators surpassing the triggers:

- Provide a schedule for providing interim-year updates including the number and timing of the updates, as well as the information to be included within the updates;
- Identify indicators which would be used to characterize stock status in the intervening years of multi-year assessment and management cycle.
- Identify trigger values for the reopening of the advice, i.e. the values of the indicators which would trigger a re-assessment earlier than the scheduled assessment cycle (relative to the indicator value at assessment and/or relative to indicator value from a projection);
- Where appropriate, define how the indicators of status are linked to harvest decision rules;
- Where appropriate, describe what information is required to allow management action in interim years e.g. index and/or other input for harvest control rules (HCR), calculation of HCR, TAC output based on index and HCR etc.

Objectives to include in the ToRs for the interim-year update:

- Update of the main stock status indicator;
- Evaluate whether a re-assessment is warranted based on where the index falls relative to the identified trigger values;
- Where appropriate, provide information required to link the indicators of status to the harvest decision rules or other management action (index or other input for HCR, calculation of HCR, TAC (Total Allowable Catch) output based on index and HCR etc);
- Where appropriate, describe what information is required to allow management action in interim years e.g. index, input for HCR, calculation of HCR, TAC output based on index and HCR).

6. REFERENCES CITED

Albacore Working Group. 2014. Stock assessment of Albacore Tuna in the North Pacific Ocean in 2014. Report of the Albacore Working Group. Annex 10 of Report of the Fourteenth Meeting of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean. Plenary Session, 16-21 July 2014, Taipei, Taiwan.

Caddy, J.F. 2002. Limit reference points, traffic lights, and holistic approaches to fisheries management with minimal stock assessment input. Fish. Res. 56:133-137.

COSEWIC. 2010. COSEWIC assessment and status report on Dolly Varden (northern form) *Salvelinus malma malma* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. 61 p.

Day, A.C., VanGerwen-Toyne, M., and Tallman, R.F. 2013. A risk-based decision-making framework for Buffalo River Inconnu (*Stenodus leucichthys*) that incorporates the Precautionary Approach. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/070. iv +13p.

DFO. 2010. Integrated fisheries management plan for northern Dolly Varden. Canada Department of Fisheries and Oceans.

DFO. 2011. Western Component (4Xopqrs5) Pollock Management Strategy Evaluation. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/054.

DFO. 2012a. Assessment of Shrimp Stocks in the Estuary and Gulf of St. Lawrence in 2011. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/006.

DFO. 2012b. Revised reference points for snow crab to account for the change in estimation area of the southern Gulf of St. Lawrence biological unit. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/002.

DFO. 2013a. Multi-year Approach to Fisheries Management - Internal Operational Guidelines. Unpublished draft.

DFO. 2013b. Stock assessment on scallop of the inshore waters of Quebec in 2012. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/027.

DFO. 2013c. Assessment of Buffalo River Inconnu (*Stenodus leucichthys*) Great Slave Lake, Northwest Territories, 1945-2009. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/045.

DFO. 2013d. Assessment of Greenland Halibut in the Gulf of St. Lawrence (4RST) in 2012. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/039.

DFO 2013e. Update of main indicators of the stock status of Greenland halibut in the Gulf of St. Lawrence (4RST) in 2013. Science Response 2013/025.

DFO 2013f. Update of Stock Status Indicators for Northern Shrimp in the Estuary and Gulf of St. Lawrence. Science Respone 2013/01.

DFO. 2013g. Assessment of Arctic Char (*Salvelinus alpinus*) in the Sylvia Grinnell River, Nunavut, 2009-2011. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/043.

DFO. 2014a. Update of commercial fishing indicators for Greenland Halibut in the Gulf of St. Lawrence in 2013. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/013.

DFO. 2014b. Advice on an acceptable level of Greenland Halibut catches in the Gulf of St. Lawrence for the 2014–2015 fishing season. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/022.

DFO. 2014c. Assessment of candidate harvest decision rules for compliance to the Precautionary Approach framework for the snow crab fishery in the southern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/007.

DFO. 2014d. Status of Northwest Atlantic harp seals, *Pagophilus groenlandicus*. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/011.

DFO. 2014e. Eastern Scotian Shelf Shrimp Stock Status Update for 2013-2014. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/012.

DFO. 2014f. Performance of a revised management procedure for Sablefish in British Columbia. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014 /025.

DFO. 2014g. Update of Stock Status Indicators for Northern Shrimp, *Pandalus borealis*, in Shrimp Fishing Areas 4, 5 and 6. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/021

DFO. 2014h. 2014 Stock Status Update of Lobster (*Homarus americanus*) in the Bay of Fundy (Lobster Fishing Areas 35-38). DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/047.

DFO. 2014i. Maritimes Research Vessel Summer Survey Trends. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/017.

DFO. 2014j. Updated indices of abundance to 2013 for stocks of six groundfish species assessed by DFO Gulf Region. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/028.

DFO. 2015a. Western Component (4Xopqrs5) Pollock Harvest Control Rule Update Report. DFO Can. Sci. Advis. Sec. Sci. Resp. 2015/003.

DFO. 2015b. Assessment of Northern Shrimp on the Eastern Scotian Shelf (SFAs 13-15). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/004.

DFO. 2015c. 2014 Assessment of Atlantic Halibut on the Scotian Shelf and Southern Grand Banks (NAFO Divisions 3NOPs4VWX5Zc). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/012.

DFO. 2015d. Updated abundance estimate and harvest advice for the Eastern Canada-West Greenland bowhead whale population. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/052.

DFO. 2016a. Guidelines for providing interim-year updates and science advice for multi-year assessments. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/020.

DFO. 2016b. Proceedings of the national peer review on Providing science advice to management in the interim years for multi-year stock assessments (Technical Expertise on Stock Assessments); March 10-12, 2015. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2016/032.

Howland, K., Mochnacz, N., Gallagher, C., Tallman, R., Ghamry, H., Roux, M.-J., Sandstrom, S., and Reist, J. 2012. Developing Strategies for Improved Assessment and Ecosystem-Based Management of Canadian Northern Dolly Varden. In: G.H. Kruse, H.I. Browman, K.L. Cochrane, D. Evans, G.S. Jamieson, P.A. Livingston, D. Woodby, and C.I. Zhang (eds.), Global Progress in Ecosystem-Based Fisheries Management. Alaska Sea Grant, University of Alaska Fairbanks. doi:10.4027/gpebfm.2012.09.

ICES. 2007. Study Group on Establishing a Framework of Indicators of Salmon Stock Abundance (SGEFISSA). ICES CM 2007/DFC: 01. 71 pp.

ICES. 2014. General context of ICES Advice. Report of the ICES Advisory Committee 2014. ICES Advice, 2014. pp 13-14.

ICES. 2015. Report of the Working Group on North Atlantic Salmon (WGNAS), 17–26 March, Moncton, Canada. ICES CM 2015/ACOM:09. 56 pp.

ICCAT, 2010. Report of the Standing Committee on Research and Statistics (SCRS). 267 pp.

Kell, L.T., Die, D.J., Restrepo, V.R., Fromentin, J.M., De Zarate, V.O., and Pallares, P. 2003. An evaluation of management strategies for Atlantic tuna stocks. Scientia Marina 67: 353-370.

Northwest Atlantic Fisheries Organization (NAFO), 1998, Annual Report of the Scientific Council. NAFO SCS 98/Part B. 268 pp

Northwest Atlantic Fisheries Organization (NAFO). 2011. Report of the Working Group on Greenland Halibut Management Strategy Evaluation (WGMSE). NAFO/FC Doc. 11/8. 10 p.

Northwest Atlantic Fisheries Organization (NAFO). 2014. Annual Report of the Scientific Council. NAFO SCS Doc. 14/17, Ser. No. N6343. 264 p.

Northwest Atlantic Fisheries Organization (NAFO), 2015. Annual Report of the Scientific Council, NAFO SCS Doc. 15-12 (Revised). Ser. No. N6469. 233 p.

Methot Jr., R.D. (editor). 2015. Prioritizing fish stock assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO- 152, 31 p.

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

Smith, A.D.M., Smith, D.C., Haddon, M., Knuckey, I., Sainsbury, K.J., and Sloan, S. 2014. Implementing harvest strategies in Australia: 5 years on. ICES J. Mar. Sci. 71: 195-203.

Starr, P.J., Haist, V., Breen, P.A., Edwards, C.T.T.E. 2014. The 2013 Stock Assessment of Red Rock Lobsters (*Jasus edwardsii*) in CRA 2 and Development of Management Procedures. New Zealand Fisheries Assessment Report 2014/19. 76 pp.

VanGerwen-Toyne, M., Day, A.C., Taptuna, F., Leonard, D., Frame, S., and Tallman, R. 2013. Information in support of Assessment of Buffalo River Inconnu, Stenodus leucichthys, Great Slave Lake, Northwest Territories, 1945-2009. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/069. vii + 80 p.

7. APPENDICES

Appendix 1. Description of information requested for the inventory of current species assessments and schedules in Canada.

Column	Information label	User input	Pull-down options	Description of inputs
Base descriptions of region, species and stock units (columns A to E)				
A	DFO Region	Pull-down	- Pacific - Central & Arctic - Quebec - Gulf - Maritimes - Newfoundland and Labrador - Multiple	Self-explanatory Multiple – refers to situation where several DFO Regions are involved in the assessment and development of advice for the management organization. Applies particularly to international situations (NASCO, NAFO)
B	Species group	Pull-down	- Marine groundfish - Marine pelagic - Freshwater - Diadromous - Invertebrate-crustacean - Invertebrate-shellfish - Invertebrate-benthic - Invertebrate-other	Self-explanatory
C	Species name	User input	na	Species being assessed (do not include stock area)
D	Assessment Unit / Stock 'Name'	User input	na	Specific stock unit or assessment area
E	Scope of assessment and management	Pull-down	- Domestic (Canada) - NAFO - Bilateral (Canada-- US) - NASCO - NPAFC - ICCAT	Indicate for which organization the assessment is being conducted. For international considerations, assessments may be required on an assessment cycle which differs from the domestic schedule. Bilateral (Canada-US) would include TRAC and Pacific Salmon requirements for example

Column	Information label	User input	Pull-down options	Description of inputs
Assessment frequency and management regime (columns F to I)				
F	Frequency of assessments	Pull-down	- 1 year - 2 years - 3-5 years - > 5 years	DFO Science and EFM have developed a schedule that identifies the frequency and starting period for the multi-year assessment cycle. The schedule has not been formalized for all species and regions and some species do not fall easily within the multi-year schedule. For this category, use either the agreed assessment schedule or the frequency of assessment that has occurred.
G	Year of last assessment	Pull-down	- pre-2000 - 2001 to - 2015	Last year for which a full assessment was completed and published in CSAS series. 2015 is included to capture the situation where the species/stock will be assessed in the current fiscal year
H	Category of assessment	Pull-down	- Indices (fishery independent) - Indices (fishery dependent) - Indices (fishery dependent and independent) - Model producing a relative index - Surplus production model - Full abundance model - Other (Provide detail in Comments Section)	This was a question in the original questionnaire and I don't know how it will be used in this exercise. The menu options characterize the type of data and analyses which form the basis of the assessment. Some assessments report only indices which are not used in any subsequent modelling of abundance. Some assessments produce estimates of absolute abundance (full abundance model) using a variety of models (age/size specific or not, surplus production, VPAs or SCAs, mark and recapture, area under the curve, etc).
I	Management Regime	Pull-down	- Output controls (TAC based) - Input controls (effort)	output controls: manage the removals input controls: manage the effort (in terms of seasons, trap limits, licences, area closures) Many marine fish stocks are managed by output controls using TACs whereas important lobster fisheries are managed by input controls. Input controls are also common in many recreational and aboriginal fisheries.

Column	Information label	User input	Pull-down options	Description of inputs
Precautionary Approach Framework (columns J to L)				
J	Is risk-based advice provided?	Pull-down	- Yes - No	As a minimum, a risk based assessment involves statements regarding the probability of a stock being in a specific PA (or equivalent) zone or relative to a pre-agreed reference level. Ideally, if multi-year advice is provided, a similar assessment would be made for each of the multi-year advice years relative to TAC or effort options. Provision of risk-based advice would necessitate that at least a reference value(s) has been defined. If there are no reference levels defined for the stock, it is unlikely that risk-based advice is provided.
K	Reference points defined	Pull-down	- Yes - No	Are PA reference points or alternate reference values for stock status defined and used to assess stocks and provide advice? (For ex. Atlantic salmon conservation definition is not a PA reference point but is used to assess stocks and provide advice).
L	Harvest control rule defined	Pull-down	- Yes - No	A defined rule that relates the exploitation rate (or effort, or catch) to the level of the stock status indicator. When a rule has been agreed, the choice of TAC or effort falls directly from the state of the status indicator (biomass, index of abundance, …)
Multiyear advice and management structure (columns M to T)				
M	Single or multi-year advice provided (number of years)	Pull-down	- 1 - 2 - 3 - 4 - 5 - >5 - no forecast	By default, this would be the number of years between assessments. If there is no forecast or projection model with which to project stock performance relative to management options and no advice is provided, then pick “no forecast”.

Column	Information label	User input	Pull-down options	Description of inputs
N	Category of multi-year management	Pull-down	- fixed TAC over multi-years - variable TACs for multi-year period - annual TAC - no TAC - relative exploitation rate advice - ad hoc adjustment in interim years - Harvest Control Rule used annually - None - Other (Comment Below)	In reference to the previous category, indicate the type of advice provided. By default (as per the guidelines for mutlit-year approach), fixed TAC over multiple years is used. There should be correspondence between previous category and this one (i.e. do not pick 5 in category above and then select annual TAC for this category)
O	Is any interim advice or status indicators provided?	Pull-down	- Yes - No	Yes if: - there are indicators identified that would signal a change in status that may warrant a re-assessment earlier than the scheduled assessment, - indicators and harvest decision rule defined to adjust annual fishing plan based on the indicator status - a pre-agreed management action based on a change in the indicator (not necessarily a harvest control rule).
P	What information is provided to Fisheries Managers in interim years?	Pull-down	- None - Indices (fishery independent - Indices (fishery dependent) - Indices (fishery dependent and independent) - Modelled abundance - Revised TAC based on HCR - Revised Risk Analysis - Other	Choose “None” if previous category is “No” This describes the type of information which would be presented in the interim-year stock status updates. If a Harvest Control Rule is defined, the interim report may include both the status of the stock indicator used in the Harvest Control Rule and the resulting management option specific to the rule. In that case, pick the revised TAC based on HCR category.
Q	Indicators for triggering changes in advice developed	Pull-down	- Yes - No	Indicators and triggers for interim-year actions would be defined in the most recent full assessment
R	Indicator change will trigger a new assessment	Pull-down	- Yes - No	Identified in recent full assessment the extent of the change in the status indices which would trigger a new assessment sooner than indicated in the multi-year implementation schedule

Column	Information label	User input	Pull-down options	Description of inputs
S	Indicator change will adjust the TAC according to the change in index	Pull-down	- Yes - No	Identified in recent full assessment, and in the case of an agreed Harvest Decision Rule, the TAC or other management action will be determined based on the state of the indicator.
T	Indicator change will trigger a special response to provide additional advice on removals	Pull-down	- Yes - No	From the original questionnaire. I don't understand the difference between this and the indicator change triggering a new assessment.
Communication of advice or status (Columns U and W)				
U	How is the interim-year advice or status indicators provided?	Pull-down	- Informal (internal memo) - Science Response Process (update) - Science Response Process (other) - Science Advisory Report - na - Other (specify in comments)	Form of communication used to date to communicate the interim status of the stocks within the multi-year approach - Science Response Process (update) is a category of Science Response within CSAS that is to be used for interim updates of stock status. It differs slightly from the Science Response Process per se in further streamlining the requirements (for example, no ToR required, etc).
V	Most recent year of interim advice or status report	Pull-down	- 2000 - 2001 to 2015	Year in which the most recent stock status update was completed. If no updates have been done, leave blank

Column	Information label	User input	Pull-down options	Description of inputs
W	Additional Comments: Please specify which question (by column A through V) each comment relates to.	User input	na	Add comments that provide further details for the species / stocks such as its COSEWIC status if assessed, where the stock presently resides within the PA, what type of fisheries apply (aboriginal FSC for ex.), etc

Appendix 2. Canadian Science Advisory Secretariat (CSAS) Policy Providing Operational Guidelines for Stock Status Updates for Multi-Year Stock Assessments

1. Guideline Title

Operational Guidelines for Stock Status Updates for Multi-Year Stock Assessments.

2. Effective Date

April 1, 2013

3. Guideline Objective

The objective of this guideline is to provide nationally consistent guidance for Stock Status Updates in support of the interim reporting of multi-year stock assessments.

4. Context

Fisheries and Oceans Canada (DFO) is further expanding the multi-year approach to fisheries stock assessments and management. This is intended to provide stability and predictability for fishers and to reduce the frequency of peer reviewed stock assessment meetings and subsequent fisheries management advisory processes.

There are several components to the multi-year approach:

- peer reviewed assessment, that identifies monitoring indicators and the limits around the indicators to identify when to trigger management measures and/or a reassessment (i.e., to set the method for assessment);
- these peer reviewed assessments are undertaken every 2 to 5+ years, according to the schedule established for each stock or species; and,
- regular monitoring and stock status updates, as appropriate to the stock, to track the status of the stock between full assessments where a multi-year approach has been adopted.

Ideally, a fishery decision-making framework incorporating the Precautionary Approach would be in place. In addition, multi-year management planning must be established to identify harvest levels and management measures for the interim years depending on the science reporting on stock status.

Where the multi-year approach has been adopted, in interim years between peer reviewed assessments monitoring will continue and science will provide regular updates on the status of the stock based on indicators identified in the peer reviewed assessment. Stock Status Updates are to be used to determine if the indicators of stock status are within the bounds expected from the multi-year assessment.

The Stock Status Updates will be published in the Science Response series on the CSAS website with a link to the full stock assessment.

5. General Guidance

Stock Status Updates will be reported to DFO fisheries managers using the Science Response series. The Stock Status Update will report on the indices previously identified in the peer reviewed assessment. The CSAS Policy on the Appropriate Use of the Science Response Process (SRP) will apply. In addition, guidelines for the Stock Status Updates are as follows:

A peer reviewed assessment must be in place to identify the indicators to be monitored.

Stock Status Updates may be undertaken by small groups of departmental scientists (e.g., 2-5) with or without face-to-face meetings to ensure the process for updates are as efficient as

possible. In general, external experts will not participate in updates unless there is specific expertise required or if an agreement is in place requiring such participation (e.g., wildlife management boards for co-managed stocks).

Timing for updates will follow the schedule for multi-year stock assessments as determined by Science and Resource Management. Updates will be posted on the DFO Science Advisory Schedule.

Terms of reference are not required since the details of what will be addressed in the updates will be outlined in a peer reviewed assessment report.

Proceedings are not required for Stock Status Updates.

Stock Status Updates will be approved following the CSAS Policy on Review and Approval of Documents.

Stock Status Updates are intended to be brief documents and will include the following sections:

- Context (mandatory section and title)
- Background (optional)
- Description of Fishery (optional section, title may vary)
- Analysis and Response (mandatory section, title may vary)
- Indicators of Stock Status (mandatory, title may vary)
- Conclusion (mandatory section and title)
- Contributors (mandatory section and title)
- Approved by (mandatory section and title)
- Sources of Information (mandatory, must include the citation for the peer-reviewed Science Advisory Report)

6. Application and Authority

Director, Canadian Science Advisory Secretariat
Oceans and Science Sector
Fisheries and Oceans Canada
200 Kent St.
Ottawa, ON,
Canada K1A 0E6

E-mail: CSAS-SCCS@dfo-mpo.gc.ca
Fax: 613-990-2471