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Specification of Precautionary Approach Reference Points and Harvest Control Rules in Domestically Managed and Assessed Key Harvested Stocks In Canada

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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.

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ABSTRACT

Canada's *Fisheries Act* was revised in 2019 to include new Fish Stocks provisions. Updated science guidelines to support the Sustainable Fisheries Framework policies, in particular the *Fishery Decision-Making Framework Incorporating the Precautionary Approach* (PA Policy), and legal and regulatory requirements are also under development. To inform the development of science guidelines, we reviewed the technical specifications of reference points and harvest control rules for a subset of key harvested stocks, focusing primarily on those domestically managed and subject to the PA Policy.

The adoption of default guidance values of the limit reference point (LRP) and upper stock reference (USR) provided in the PA Policy (0.4 and 0.8 B_{MSY}) is not required, but these values appear to have been widely embraced (43% and 65% of cases, respectively). The USR by definition serves a number of functions, including an operational control point (trigger for management action) to control the risk of approaching the LRP, Healthy-Cautious zone boundary, and target. Science guidelines can provide support for identifying alternative USRs by noting proxies for B_{MSY} (enabling use of proxies for 0.8 B_{MSY}) and by addressing various functions attributed to the USR separately.

Removal References (RRs), like USRs, may serve multiple purposes across the stocks in this review. We found that RR values are consistent with indicating whether harvests are at "approved [target] levels" in a wide range of stocks, and sometimes with limits to be either avoided or with which to characterize acceptable stock status in terms of overfishing on the fishing mortality (F)-axis of the PA Policy. Science guidelines could provide support for identifying RRs by highlighting F_{MSY} proxies and characterization of stock states on the F-axis.

Four broad types of harvest control rules (HCRs) appear to be implemented in Canada: feedback status-based rules, mixed feedback/feed-forward risk-based rules, "constant" rules with no operational control points and feedforward-only objective-based "rules." The provisional HCR suggested in the PA Policy guidance is not often used although three-part rules with control points at the LRP and USR are common (38% of HCRs). Rules varied widely, although the vast majority are targeted toward informing quantitative output controls (catch limits).

To support the new provisions, the development of updated science guidelines should aim to support easier identification of PA components and more consistent use of terminology for key aspects of the PA Policy, including reference points, operational control points for HCRs, and measurable objectives. The HCR types and other measures will vary widely for fisheries that represent a spectrum of data and assessment model availability for key harvested stocks. As science support may be requested for developing and evaluating a wide range of HCRs, science guidelines will need to address both prospective and retrospective evaluation for an array of possible rules that reflect input and output controls and interact with other management measures.

INTRODUCTION

A fishery decision-making framework incorporating the precautionary approach ("PA Policy", DFO 2009) is one of the policies included in Canada's Sustainable Fisheries Framework (DFO 2019a). The PA Policy describes a general decision-making framework for implementing harvest strategies that incorporate the precautionary approach (PA) for key harvested fish stocks (and other stocks, when warranted) under the purview of Fisheries and Oceans Canada (DFO; Figure 1). The policy identifies the primary components of the PA framework as follows:

1. Reference points and stock status zones (Healthy, Cautious and Critical);
2. Harvest strategy and harvest decision rules; and
3. The need to take into account uncertainty and risk when developing reference points and developing and implementing decision rules.

Various reference points and harvest decision rules (also often called harvest control rules or HCRs; see glossary in Appendix A) have been developed and implemented for a wide range of stocks across Canada since the PA Policy was published in 2009. These stock-specific PA framework components are tracked and reported by DFO via two avenues: the *Canadian Environmental Sustainability Indicators* program (Environment and Climate Change Canada [ECCC] 2020a), and, in a more detailed fashion, the *Sustainability Survey for Fisheries* (hereafter the "Sustainability Survey" or "Survey"). Derived data reported by the Survey have been posted on the Departmental website since 2015 (DFO 2019b), and are also reported in reviews conducted by non-governmental organizations (e.g., Stauffer et al. 2019).

The Survey was originally conceived of as a "checklist" or Report Card for fisheries that could:

> "assist in reviewing and measuring the biological and management aspects of resource stewardship and fisheries sustainability including the level of information available to make decisions, the status of the stock, the effectiveness of management measures, and progress toward implementing the PA, ecosystem considerations and other management measures. … the checklist will cover three general subjects: knowledge available, objectives and reference points, and implementation. For example under "knowledge available," there will be questions about whether there are estimates of abundance and estimates of annual exploitation or harvest rates for the stock. Under "objectives and reference points," someone could be asked to report on limit and target reference points that may have been established for the stock. Under "fisheries management – objectives and reference points," someone may be asked to report on the existence of formal harvest rules consistent with the precautionary approach." (Stringer et al. 2009).

Results were reported for 177 stocks in the year 2018. While the Survey does not address all stocks managed by DFO, the stocks that are covered are those deemed culturally, economically and/or environmentally important.

PURPOSE OF THIS REVIEW

The 2019 revisions to the *Fisheries Act* (R.S.C., 1985, c. F-14) include new Fish Stocks provisions that introduce legal requirements to implement measures to maintain major fish stocks at or above the level necessary to promote sustainability, or above the limit reference point (LRP). For stocks at or below their LRP, there is a requirement to implement measures intended to rebuild fish stocks. These provisions will only apply to "*major fish stocks*" prescribed under regulation. Forthcoming DFO guidance will specify the required contents, process steps, and roles and responsibilities of different DFO sectors in the development and implementation

of rebuilding plans. Recognizing that there remains an ongoing requirement to implement PA Policy intent for all key harvested stocks and fisheries in Canada since 2009, and that this policy is the main lens through which the new provisions will be interpreted, updated science guidelines to support these policies and requirements are also under development.

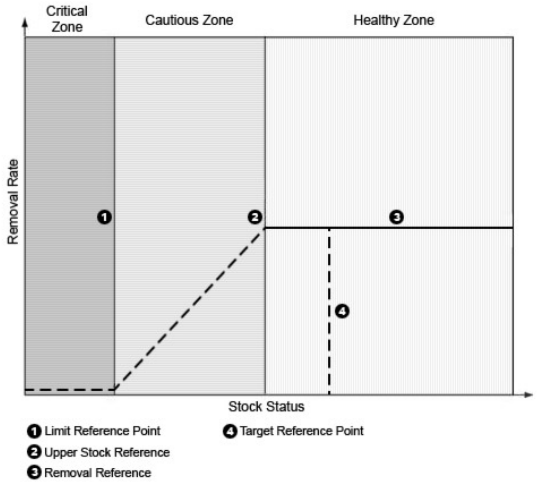

Figure 1: Schematic representation of Canada's national Precautionary Approach Framework illustrating four types of reference points (limit reference point, upper stock reference, removal reference, target reference point) and three stock status zones (Critical, Cautious and Healthy). The framework further classifies fishery status as either "at or below" or "exceeds" the removal reference. Other key components of the PA Policy include a harvest strategy with harvest decision rules (harvest control rules), and the need to take into account uncertainty and risk, as well as an expectation to evaluate harvest strategies (DFO 2009).

To support the development of updated science guidelines, this review characterized the current state of reference points and HCRs in terms of their technical specifications. There have been limited broad-scale examinations of the ways in which the PA Policy has been interpreted for stocks in Canada, and none in light of the recently revised *Fisheries Act*. Thus, this review was a needed step in understanding the challenges to the development of stock-specific PA frameworks for two reasons. First, the review serves as a gap analysis so that science guidelines can be focused on promoting consistent interpretation of PA Policy elements in future science advice. Given the wide diversity of stocks and management approaches represented in Canadian fisheries. Second, it provides an opportunity to expand on existing technical guidance in implementing the PA Policy (DFO 2016), after over a decade of experience since the PA Policy was introduced in 2009.

METHODS

The PA Policy provides guidance for both default[1] and provisional[2] values for certain PA elements where stock-specific PA components are not available. In this review, reference points for a large subset of the 177 stocks reported in the 2018 Sustainability Survey were

[1] 'Default' is understood to be in the sense of a pre-selected, non-mandatory option when no more specific reference point is chosen.

[2] 'Provisional' is understood to be in the sense of serving for the time being, with the possibility of change later on.

examined and classified by type, and updated where necessary to reflect new values since the Survey was conducted. These reference points include the LRP, upper stock reference or USR, and the removal reference or RR. For example, we considered whether the PA Policy default status-based reference point values 0.4 B_{MSY} and 0.8 B_{MSY} were adopted for the LRP and USR, respectively, or whether a limit fishing mortality rate (RR) such as F_{MSY} was identified (where B represents biomass and F fishing mortality, respectively). We recorded the application of other theoretical and empirical proxies for MSY-based reference points, or alternatives. The form of the RR was examined to evaluate whether, and how, its value changed with stock status (i.e., if it was segmented as depicted in the PA Policy diagram, Figure 1).

Information available for each stock was further examined to determine whether and how reference points were used in the design of the HCR, if one was identified and/or implemented. We addressed the following questions for HCRs in relation to reference points:

- If a RR and HCR are both present, is the RR employed as a limit fishing mortality distinct from the target fishing mortality(ies) specified by the HCR, or does it also serve as a target fishing mortality? Both interpretations have been flagged as possible (DFO 2016).
- If a HCR is specified, are operational control points (OCPs) set to the values of reference points such as the LRP or USR?

Science advice or management measures are aggregated in nature for some stocks that consist of multiple sub-units. Where necessary this review separated reference points and/or HCRs by the stock subunit, if they were identified. When available, we also recorded information for both reference points and HCRs that had been developed but not implemented; however, in the tallies below, only reference points and HCRs that are recorded as present/implemented (as noted in the Sustainability Survey) are included. The results are presented in Appendices B and C by stock and/or subunit, where appropriate.

We limited our review to key harvested stocks in Canada reported by the 2018 Sustainability Survey (DFO 2019b). Consequently, the 2018 iteration of the Survey served as the primary source of information about PA Policy components available for each stock. Science Advisory Reports, Science Responses, Research Documents and Integrated Fisheries Management Plans published by DFO were also reviewed to supplement information available about each stock (Appendix D). Of 177 stocks on the Survey, we further restricted the review to those stocks where stock assessments and science advice are regularly provided through the Canadian Science Advisory Secretariat (CSAS) and for which domestic harvest strategies are designed primarily under the specifics of the PA Policy (140 of 177 key harvested stocks). We therefore did not review Pacific and Atlantic salmonids (18 key harvested stocks) that are also managed under either the Wild Salmon Policy (DFO 2005a) or the Wild Atlantic Salmon Conservation Policy (newly revised, DFO 2018b), although these are considered compatible with the intent of the national policy, and for which advice may be issued by alternative means. Similarly, we also excluded stocks managed under transboundary arrangements, or in other international contexts such as Regional Fisheries Management Organizations (19 key harvested stocks). This choice was made because the specific details of science advice or PA framework components for these salmonid or international stocks are often developed to meet requirements of analogous harvest policies, either in Canada or those of other jurisdictions. However, reference points and HCRs for such stocks remain important in the development of Canadian guidelines and may form the subject of future reviews in relation to the intent of the PA Policy.

REFERENCE POINT TERMINOLOGY

In our review, we classified reference points (LRP, USR, RR) according to the following types:

- **Dynamic pool**: a reference point derived from yield-per-recruit or spawning-biomass-per-recruit models, e.g., biomass, fishing mortality or harvest rates associated with $F_{0.1}$, F_{max}, $F_{40\%}$, F_{low}, F_{med}, F_{high} (Gabriel and Mace 1999, Restrepo et al. 1998).
- **Empirical**: particular values of a directly measurable quantity, such as catch, catch rate, length structure, survey index, spatial distribution or sex ratio (Sainsbury 2008), often selected to represent a historical time period of relevance.
- **Historical**: model-based biomass, fishing mortality, or harvest rate associated with a particular point in time chosen to represent either a limit (e.g., a point of reproductive impairment, or the lowest point from which a stock was observed to recover), or a target (e.g., biomass or harvest rates associated with a productive time period for the fishery).
- **MSY-based (Production)**: a reference point associated with maximum sustainable yield (MSY, B_{MSY}, F_{MSY}; Gabriel and Mace 1999).
- **Stock-recruit**: a reference point derived from a stock-recruitment relationship (Gabriel and Mace 1999).
- **Unfished biomass** or carrying capacity, and proportions thereof (K, B_0).
- **Other**: any other type; for example, $F = M$.

We noted those cases that applied proportions consistent with the default reference points in the PA Policy (i.e., 0.4 for LRP and 0.8 for USR), whether to B_{MSY} directly, or to proxies, versus those employing other methods considered more appropriate for the specific stock.

Removal references, to a greater extent than LRPs and USRs, were interpreted quite broadly among stocks and were more challenging to classify (terms used are presented in **bold** below). This review focused on RRs that were reported as being in place for the stock in the 2018 Sustainability Survey.

- In addition to the above categories, we noted whether RRs were expressed as **fishing mortality rates (*F*), harvest rates** (sometimes termed *U* or exploitation rate), **effort**, or **catches** (weight or number of individuals), and whether more than one RR segment had been identified. These could be, but were not always, in the form of a HCR.
- We assumed RRs functioned as ***limits***, and counted them as such, unless the RR was described as possible or actual management ***targets*** (e.g., a harvest rate specified as an output in an associated HCR, an established management measure such as a quota, or as a quota that met a management objective). We note that targets may be set to limits, which means that in several cases, RRs may represent situations where targets have been set to equal limits, even though they could only be confirmed as targets.
- RRs were described as **PBR outputs** when the RR was equated with outputs of Potential Biological Removal HCRs, **HCR outputs** when the RR was equated with complex or more qualitative output variables of certain HCRs, and as **outputs meeting HCR objectives** for stocks with "objective-based" HCRs (see next section).
- In several cases, **management measures** were presented as RRs, including TACs, effort levels, quotas, moratoria, allocation schemes, and various other types of controls available for the fishery.

If multiple RR segments that varied with stock status were identified for a stock, in addition to the above descriptors, we noted whether the segments were configured with **different *F* values**, the **same *F* values**, **catch limits** or **other harvest rates (*U*)**, and if the specifications of the HCR matched the RR configuration. Alternatives to the RR (e.g., a single value of F_{MSY}

invariant to stock status) were occasionally noted to be available for a stock, even if not reported as such in the Survey; these alternatives were recorded where found.

HARVEST CONTROL RULE TERMINOLOGY

In general, HCRs are typically explained as pre-agreed-upon plans for how management measures will adjust in relation to information about the stock status, in the form of functions, formulas or mathematical expressions (Kronlund et al. 2014, Lynch et al. 2018, MF 2008, Rademeyer et al. 2007, Restrepo et al. 1998).

A variety of HCR types have been identified (Deroba and Bence 2008, Punt 2010), with some examples shown below (Figure 2). It should be noted that HCRs expressed in removals (catch) can have non-intuitive or undesirable consequences for the corresponding removal rates. For example, fishing mortality may increase with declining stock size if constant catches are maintained (Figure 2b, e, f). In general, the positive feedback on removal rates created in constant catch rules can amplify risks of breaching limits to stocks in stochastic environments (Punt 2010), although intervals of constant catch limits may be desirable for other reasons (Deroba and Bence 2008).

Hoggarth et al. (2006) distinguished between *constant* and *feedback* harvest strategies. Constant strategies feature control variables that are held constant (e.g., harvest rate, minimum escapement, or catch are invariant to changes in stock status). Conversely, feedback strategies respond by adjusting control variables in accordance with changes in the stock or the fishery. For example, a threshold harvest control rule reduces the target harvest rate at some status level as estimated stock status declines (Figure 2d). It should be noted, however, that the terminology can seem counter-intuitive as feedback effects can occur in constant strategies. For example, a constant harvest rate strategy varies catch in response to stock status, thus introducing negative feedback effects on catch with the intent to harvest the same proportion of the vulnerable stock. On the other hand, destabilizing feedback effects occur on the harvest rate in constant catch strategies as stock status changes (i.e., as the stock declines positive feedback can occur that amplifies the harvest rate, possibly leading to stock decline; as the stock increases positive feedback can amplify the reduction in harvest rate, possibly leading to under-harvest).

As formulas, HCRs can be *model-based* where a stock assessment model-derived estimate of some parameter, such as biomass, B, is input to the HCR to generate a removal rate and subsequently a recommended catch limit. Alternatively, an HCR can be *model-free*, where some (relative) index, such as survey swept-area biomass, or egg density, etc., is used directly as input to the HCR equation to generate recommended catches (Apostolaki and Hillary 2009). Note that in the latter case the index may be smoothed or standardized by a statistical method.

In Canada's PA Policy, the following nested terms are used:

- PA framework,
- Harvest strategy, and
- Harvest decision rules (or HCRs).

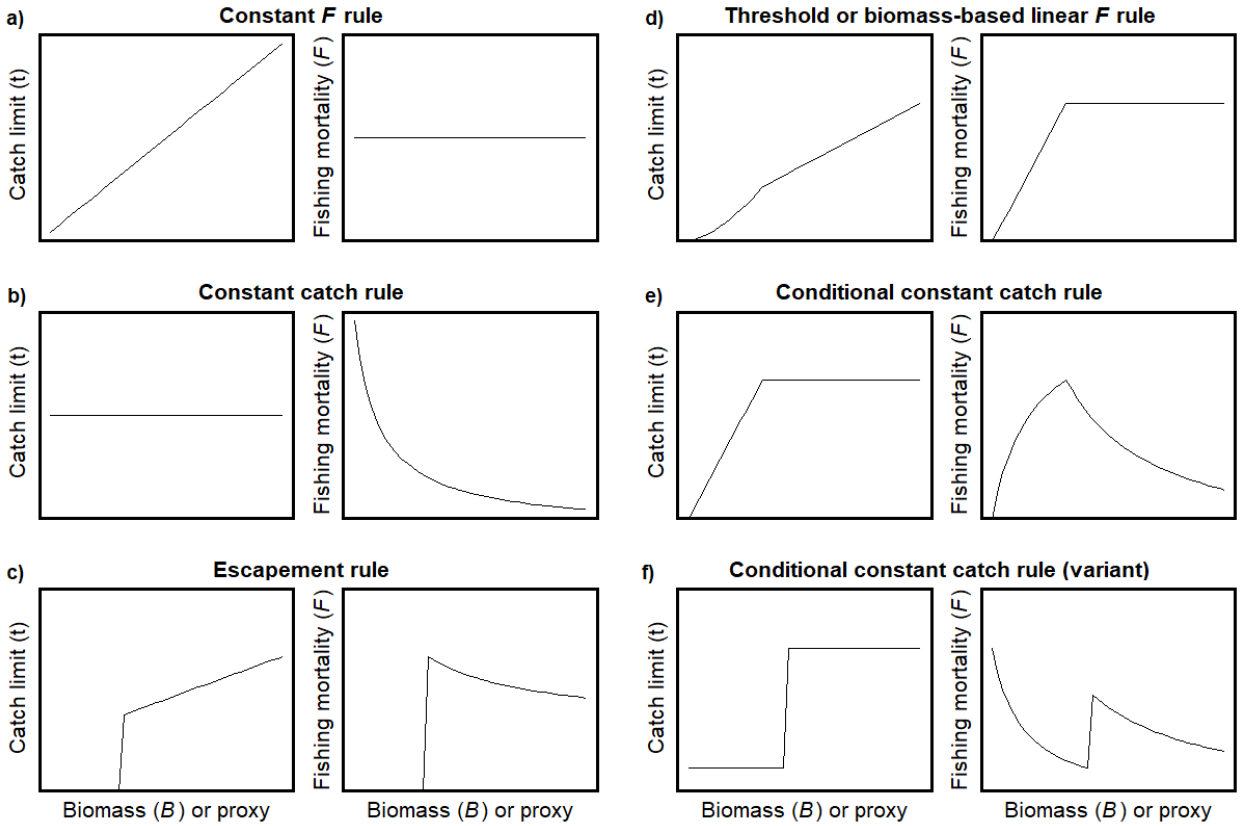

Figure 2: Some basic types of harvest control rules (HCRs) in black lines, showing the same type of rule in terms of removals (i.e., catch limits, for example, in tonnes) and in removal rates (e.g., fishing mortality or F) in relation to biomass (B, which may be in tonnes or another unit) or a proxy such as a survey index. Example HCR types and names are derived from Deroba and Bence (2008) and Punt (2010). A) Constant F rule, which translates into linearly decreasing catch limits with stock decline. B) Constant Catch rule, which translates into increasing instantaneous fishing mortality rates as stocks decline. C) Escapement rule, where catch limits scale linearly with stocks above a certain threshold. D) A threshold or biomass-based linear F rule, where stocks are harvested at constant fishing mortalities until a threshold is reached, below which fishing mortality linearly decreases. This is similar to the provisional HCR in Canada's PA Policy. E) Conditional constant catch rule, which applies a constant catch limit to stocks above a certain threshold, and linear declines in catch limits thereafter. F) A variant of a conditional constant catch rule, which applies two catch limits, one above and one below a threshold.

Harvest strategies (inclusive of objectives, or what is to be achieved) and *HCRs* (a means of achieving the objectives) are contained within PA frameworks. The latter are identified as "essential components" of harvest strategies along with other management measures (DFO 2009). As described above, PA frameworks also contain reference points (embedded in objectives) as well as requirements to consider uncertainty and specify risk tolerance (DFO 2009). While HCRs are generally quantitatively expressed (Kronlund et al. 2014), harvest strategies can outline multiple types of tactics including those that may not be directly related to rule outputs (e.g., area and seasonal closures, gear modifications, size limits, etc.).

The algorithms by which information about a stock is translated into measures by means of HCRs have been developed in several ways in Canadian practice. In general, HCRs are feedback rules that respond to changes in stock status or associated indices and can be adjusted to take into account different types of risks corresponding to various management

objectives. In the context of the PA Policy, HCRs have been described as taking one of two general forms based on what is emphasized (Kronlund et al. 2014, DFO 2016):

- **Status-based feedback rules** that relate stock status to a recommended removal rate or other output. The provisional HCR provided in the PA Policy is of this type, producing a specific, three-segment removal rate (F_p) as a function of B, declining from F_{MSY} (DFO 2009). The operational control points for the PA Policy provisional HCR correspond to the default LRP and USR that are used to delineate status zones Critical, Cautious and Healthy. The OCPs that determine where the removal rate changes are not required to coincide with the estimates of the default LRP and USR as in the provisional HCR (DFO 2016). Indeed, the provisional HCR may not provide the desired management outcomes relative to conservation, socio-economic and cultural objectives. HCRs with other, or fewer, OCPs may perform better.
- **Acceptable risk-based feed-forward/feedback rules,** where acceptable probabilities of future *stock decline* vary with current stock status as well as stock trends in the recent past. Acceptable strategic approaches to setting harvest rates, and associated risks of acceptable declines, are outlined for this rule according to three zones in Table 1 of the PA Policy (DFO 2009; Table 1), although the changing risk tolerances for preventable decline are continuous with stock status (Kronlund et al. 2014). Strategic approaches and risk tolerances in Table 1 become more restrictive as stock status declines, indicating that there is a feedback component to this rule as well. It has been previously noted that this rule may be implemented in a more qualitative fashion (DFO 2016).

Feedback rules are those that respond to *what* has happened in response to an output from the rule. They compare an outcome (e.g., current estimated stock status) relative to a reference state, and then adjust subsequent rule outputs in response to that outcome. In this way, they provide a link between current stock states and future management actions. The adjustment either reduces deviations from the reference state (negative feedback), or amplifies them (positive feedback). Negative feedback tends to reduce the effects of perturbations, leading to stability and promoting an equilibrium. Positive feedback tends to produce instability, oscillation or chaotic behavior, and thus should be avoided.

Feed-forward rules, on the other hand, are those that operate based on what is *expected* to happen (i.e., they respond to predicted outcomes). Feed-forward rules are characteristic of the "traditional" approach to fisheries management in that they assume that the population and fishery dynamics are known, or can at least be predicted reasonably well, and that they are assessed frequently enough to detect changing stock dynamics. Corrective adjustments to management measures are thus made with updated assessments that provide new projections (Kell et al. 2016).

We therefore approached our review of HCR specification by considering these two general categories of rules in the analysis below. HCRs were described:

- As constant, feedback, and/or feed-forward in strategy;
- As model-based and/or model-free in formulation;
- Via input and output variables;
- Via the number of OCPs for input variables; and
- By the management measures they could inform (e.g., qualitative and quantitative input and output controls; Morison 2004, Table 2).

Table 1: A reproduction of Table 1 of the PA Policy (DFO 2009), corresponding to risk-based management actions that vary with stock status.

	Stock Status		
	Critical	**Cautious**	**Healthy**
General Approach	Conservation considerations prevail. Management actions cannot be inconsistent with secure recovery	Socio-economic and conservation considerations should be balanced in a manner that reflects location in zone and trajectory	Socio-economic considerations prevail. Conservation measures consistent with sustainable use apply.
Harvest Rate Strategy	Harvest rate (taking into account all sources of removals) kept to an absolute minimum.	Harvest rate (taking into account all sources of removals) should progressively decrease from the established maximum and should promote stock rebuilding to the Healthy Zone	Harvest rate (taking into account all sources of removals) not to exceed established maximum.
Recent Stock Trajectory	Management actions must promote stock growth. Removals from all sources must be kept to the lowest possible level until the stock has cleared the Critical Zone. A rebuilding plan must be in place with the aim of having a high probability of the stock growing out of the Critical zone within a reasonable timeframe. This plan must be associated with appropriate monitoring and assessment of the condition of the stock to confirm the success of rebuilding. The plan must also include additional restrictions on catches, and a provision that application of the measures is mandatory if the evaluation fails to find clear evidence that rebuilding is occurring.	**Increasing** Management actions should promote stock growth to the Healthy Zone within a reasonable time frame. Risk tolerance for preventable decline – low to moderate (if high in zone) **Stable** Management actions must encourage stock growth in the short term. Risk tolerance for preventable decline – low to moderate (if high in zone) **Declining** Management actions must arrest declines in the short term or immediately if low in the zone. Risk tolerance for preventable decline – very low / low. Development of a rebuilding plan is ready to come into effect if the stock declines further and reaches the critical zone.	**Increasing** Management actions should be tolerant of normal stock fluctuations. Risk tolerance for preventable decline – high **Declining** Management actions should react to a declining trend that approaches the cautious boundary. Risk tolerance for preventable decline – moderate (if low in zone) to neutral

Table 2: Examples of input and output controls that may be used in fisheries management, classified as either qualitative or quantitative. Reproduced from Morison 2004.

	Qualitative Controls	Quantitative Controls
Input Controls	Closed seasons Closed areas Types of gear Mesh sizes	Number of licenses Number of pots Number of rods/hooks Length of nets
Output Controls	Protected Species Size limits Sex limits Maturity Stages	Numbers of fish Weight of fish

Distinguishing among HCR types in this way allowed an examination of whether, and how, different HCR configurations outlined in stock-specific PA frameworks integrated reference points (LRP, USR) as OCPs and whether limits (RRs) were included as targets in the HCR.

ANALYSIS

AGGREGATE STOCKS

Some of the key harvested stocks on the Sustainability Survey are comprised of multiple subunits, which can be distinguished spatially. Examples of spatial subunits are separate beds for benthic invertebrates, or different rivers for diadromous species. Subunits can also be separated by spawning behaviour such as a spring- or fall-spawning herring, or they may represent different species such as the redfish complex of the genus *Sebastes* which are not distinguished in historical catch data. Such stocks can be termed *aggregate stocks*. Sixteen of the 140 domestically managed and assessed stocks from the 2018 Sustainability Survey were comprised of multiple subunits (i.e., they are aggregates), for at least some of which reference points or HCRs have been implemented (n = 54 subunits in all). We chose to disaggregate such stocks into subunits where possible for this analysis to facilitate accounting for individual PA components by subunit. As a result, a total of 178 key harvested stocks and/or their subunits are examined here.

REFERENCE POINTS

Limit Reference Points

Limit Reference Points were implemented for 102 of the stocks or subunits. A little under half of these cases (n = 44, or 43%) used the default PA Policy guidance of employing 0.4 of either B_{MSY} or a suitable proxy to establish the LRP (grey rows in Table 3). A full list of LRPs reviewed here is presented in Appendix B. Where information was available, each LRP is accompanied by the most recent estimate of the reference point, and the year for which that estimate applies (the last year of data availability).

Apart from the stocks that adopted an LRP of 0.4 B_{MSY} (n = 24), empirical (n = 39) and historical (n = 18) LRPs were also commonly employed, whether intended to represent a proxy for B_{MSY} or some other value. Examples of empirical proxies for B_{MSY} used to set LRPs included average landings (Lobster – Areas 19-20-21) or survey indices (Witch Flounder – 3Ps) over productive periods in the past. In some cases, alternative proportions were taken of a B_{MSY} proxy (e.g., 0.3 of the survey index from a reference period; Northern Shrimp, SFAs 4, 5 and 6). Other empirical bases for LRPs included survey indices at low periods of abundance from which stock recovery

was observed (Unit 1&2 Redfish), which can be considered proxies for historical LRPs such as $B_{recover}$ (used for Haddock – 4X5Y and Herring – 4T, among others).

Table 3: Types of Limit Reference Points (LRPs) established for a subset of Canada's key harvested stocks or their subunits. Grey rows correspond to LRPs matching the default policy guidance of 0.4 B_{MSY}.

Category (LRP Type)	Number of Stocks or Subunits
0.4 of B_{MSY}	24
0.4 of a dynamic pool proxy	1
0.4 of an empirical proxy	17
0.4 of a historical proxy	1
0.4 of another proxy	1
Subtotal	**44**
Other (empirical)	22
Other (historical)	17
Other (stock-recruit)	4
Other (unfished biomass)	9
Fraction of USR	3
Other	3
Subtotal	**58**
TOTAL	**102**

The Sustainability Survey further classifies stocks according to broad life history, functional or taxonomic categories. Of these, LRPs based on B_{MSY} were favoured for most groundfish (n = 17, 52%) and for Arctic salmonids (n = 4, 100%), whereas historical LRPs were favoured for marine mammals (n = 3, 100%) and empirical LRPs were employed for most crustacean stocks (n = 27, 87%) (Table 4).

Table 4: Types of Limit Reference Points (LRPs) established for a subset of Canada's key harvested stocks or their subunits, grouped by stock type (taxonomic group and/or life history). Grey shading added for contrast.

Category (LRP Type)	Crustacean	Groundfish	Marine Mammal	Mollusc	Other	Small Pelagic	Salmonid
B_{MSY}	1	17	--	2	--	--	4
Dynamic Pool	--	--	--	--	--	1	--
Empirical	27	6	--	4	2	--	--
Historical	--	5	3	5	--	5	--
Stock-recruit	--	4	--	--	--	--	--
Unfished biomass	3	--	--	--	--	6	--
Fraction of USR	--	1	--	--	2	--	--
Other	--	--	--	4	--	--	--
TOTAL	**31**	**33**	**3**	**15**	**4**	**11**	**4**

Upper Stock References

Upper Stock References were implemented for 86 stocks or their subunits. Over half (n = 56, 65%) used the default PA Policy guidance of employing a proportion of 0.8 of B_{MSY} or proxy to establish the USR (grey rows in Table 5). A full list of USRs reviewed here is presented in Appendix B categorized by type.

As for LRPs, apart from MSY-based USRs (n = 24 stocks), empirical USRs (n = 35 stocks) were common. Examples of empirical proxies for B_{MSY} used to set USRs included average landings (Lobster – Southern Gulf (LFA 23, 24, 25, 26A, 26B)) or survey indices ("Prawn Trap" or Spot Prawn) over productive periods. Other examples of USRs included Green Sea Urchins (empirical: 0.9 legal-sized urchins per square meter) and Herring in 4R (lowest observed biomass that produced good recruitment). USRs were set according to a rationale of "twice the LRP" for six stocks or subunits including Atlantic Cod – 4X5Y and Sea Scallop – SFA 29W.

Table 5: Types of Upper Stock References (USRs) established for a subset of Canada's key harvested stocks or their subunits. Information in grey rows is highlighted in the main body of the text.

Category (USR Type)	Number of Stocks or Subunits
0.8 of B_{MSY}	23
0.8 of a dynamic pool proxy	1
0.8 of an empirical proxy	29
0.8 of a historical proxy	2
0.8 of another proxy	1
Subtotal	**56**
Other (B_{MSY})	1
Other (dynamic pool)	2
Other (empirical)	6
Other (historical)	6
Other (stock-recruit)	1
Other (unfished biomass)	3
Multiple of LRP	6
Other	5
Subtotal	**30**
TOTAL	**86**

As for LRPs, USRs based on B_{MSY} were favoured for most groundfish (n = 16, 62%) and for Arctic salmonids (n = 4, 100%), whereas historical USRs were favoured for marine mammals (n = 3, 100%), and empirical USRs were employed for most crustacean stocks (n = 27, 87%) (Table 6).

Table 6: Types of Upper Stock References (USRs) established for a subset of Canada's key harvested stocks or their subunits, grouped by stock type (taxonomic group and/or life history). Grey shading added for contrast.

Category (USR Type)	Crustacean	Groundfish	Marine Mammal	Mollusc	Other	Small Pelagic	Salmonid
B_{MSY}	1	16	--	2	--	1	4
Dynamic Pool	--	--	--	--	--	3	--
Empirical	27	3	--	3	2	--	--
Historical	--	2	3	1	--	2	--
Stock-recruit	--	1	--	--	--	--	--
Unfished biomass	--	--	--	--	--	--	--
Multiple of LRP	--	3	--	3	--	--	--
Other	3	1	--	5	--	--	--
TOTAL	**31**	**26**	**3**	**14**	**2**	**6**	**4**

Removal References

The Sustainability Survey tracks various attributes of RRs. These include the RR segment presence/absence, and its value, in the Healthy, Cautious, and Critical zones, and RRs for stocks assigned a status of Uncertain. RRs were identified, at least in part, in the Survey for 104 stocks or subunits. The most common RR segment implemented was that of the Healthy zone (n = 71), followed by RRs for the Critical zone (n = 58), Cautious zone (n = 43), and Uncertain stock states (n = 25).

For stocks and subunits with at least one reported RR segment (n = 104), RRs based on values associated with or derived from maximum sustainable yield (F_{MSY}, U_{MSY}, MSY) or on dynamic pool bases ($F_{0.1}$, etc.) that are proxies for F_{MSY} were the most likely to be described or inferred as primarily limits (i.e., below which targets are set or to be breached with some acceptable probability (n = 22 of 25 cases; Table 7). Most RRs, however, were described as potential or implemented targets (i.e., equated with actual or potential removal rates or management measures that are, or could be, approved and implemented). This included RRs equated to HCRs, or to current measures (n = 80, 77%). It was not generally clear how many of these would also be identified as limits (i.e., representing scenarios where targets are set to limits), or if they are intended to represent targets alone. This might be the case where the RR is equated to the F_{ref} (reference value of F) employed in a HCR, or to the maximum target rate of a range possible in the HCR, for example.

Table 7: Types of Removal References (RRs) established for a subset of Canada's key harvested stocks or their subunits. The RR was considered equated to harvest control rule (HCR) outputs, or as target values in the HCR, when the same information or the same harvest rate was provided for both RR and HCR. The RR was considered equated to the use of management measures when information on tactical actions (quotas, size limits, allocations, etc.) was provided. Grey rows are used to highlight RR types that appear to be used as limits. F_{MSY} = fishing mortality at maximum sustainable yield. MSY = maximum sustainable yield. PBR = potential biological removals. U_{MSY} = harvest rate at maximum sustainable yield. [1]Other types of HCR outputs mean catch limits corresponding to objective-based rules, or those outputs of more complex status-based or risk-based HCRs where mixed F or catch limits, along with other outputs such as objectives, guidance, etc., are produced from the rule for a given stock indicator.

Category (RR Type)	n	RRs as limits (limits in HCRs)	RRs as targets (targets in HCRs)
F_{MSY}/U_{MSY}	11	9 (8)	2 (2)
MSY	8	8 (2)	--
Dynamic pool (*F/U*)	6	5	1 (1)
Other *F/U* or harvest rate	29	--	29 (28)
PBR	12	--	12 (12)
Other catch limits	2	--	2 (2)
Other types of HCR outputs[1]	15	--	15 (13)
Management measures	19	--	19
Uncertain or Complex	2	--	--
TOTAL	**104**	**22**	**80**

The most common type of non-MSY or dynamic pool RR was in the form of a harvest rate (n = 29), most of which were equivalent to target rates in the associated HCR for that stock (established as targets either through past fishery experiences, simulation testing, or some other basis). This formulation was followed closely in frequency by RRs as other types of HCR *outputs*, including Potential Biological Removals (PBRs; altogether n = 27), or in general RRs equated to other approved management measures such as TACs, quotas, allocation schemes, effort, size limits, etc. (n = 19). A full list of RRs reviewed here is presented in Appendix B with their types identified.

Among stock types, RRs based on values associated with or derived from maximum sustainable yield (F_{MSY}, U_{MSY}, MSY), or on dynamic pool bases ($F_{0.1}$, etc.) that are proxies for F_{MSY} were the most likely to be in place for groundfish (n = 15, 52%) and for small pelagic (n = 5, 50%) stocks (Table 8).

Table 8: Types of Removal References (RRs) established for a subset of Canada's key harvested stocks or their subunits, grouped by stock type (taxonomic group and/or life history). Grey shading added for contrast. The RR was considered equated to harvest control rule (HCR) outputs, or as target values in the HCR, when the same information or the same harvest rate was provided for both RR and HCR. The RR was considered equated to the use of management measures when information on tactical actions (quotas, size limits, allocations, etc.) was provided. F_{MSY} = fishing mortality at maximum sustainable yield. MSY = maximum sustainable yield. PBR = potential biological removals. U_{MSY} = harvest rate at maximum sustainable yield. [1]Other types of HCR outputs mean catch limits corresponding to objective-based rules, or those outputs of more complex status-based or risk-based HCRs where mixed F or catch limits, along with other outputs such as objectives, guidance, etc., are produced from the rule for a given stock indicator.

Category (RR Type)	Crustacean	Groundfish	Marine Mammal	Mollusc	Other	Small Pelagic	Salmonid
F_{MSY}/U_{MSY}		9	--	--	--	--	1
MSY	1	5	--	1	2	--	--
Dynamic pool (*F/U*)	--	1	--	--	--	5	--
Other *F/U* or harvest rate	10	3	--	10	1	5	--
PBR	--	--	12	--	--	--	--
Other catch limits	--	2	--	--	--	--	--
Other types of HCR outputs[1]	9	3	3	--	--	--	--
Management measures	9	6	--	1	--	--	3
Uncertain or Complex	--	--	--	2	--	--	--
TOTAL	**29**	**29**	**15**	**14**	**3**	**10**	**4**

Fifty-eight stocks or subunits were identified as having two or more RR segments implemented, whether segments were continuous or discontinuous. In almost all cases (n = 55, or 95%) this corresponded to RRs equated with target harvest rates, catches, fishing mortality or other outputs from HCRs, or other approved management measures, in the Survey (grey rows in Table 9).

Table 9: Basis on which multiple segments of Removal References (RRs) were established for a subset of Canada's key harvested stocks or their subunits. Other management measures included TACs, quotas, allocation, size limits for stocks with no HCRs, or catch limits apart from what are specified in the HCR. Grey rows are used to highlight RR types that appear to represent targets.

RR Segment Basis	Number of Stocks or Subunits
HCR outputs	47
Other management measures	8
Different *F* levels	2
Uncertain or Complex	1

HARVEST CONTROL RULES

As of the 2018 Sustainability Survey, HCRs were reported as implemented for 89 stocks or their subunits. Fourteen of these described management measures, where a link between these measures and a rule for the stock was not clear. Another seven stocks reported the use of decision tables, which may be synonymous with "objective-based" feed-forward "rules" discussed below, but this was also not clear. As a result, 68 HCRs were examined in more detail (Table 10).

HCRs could be assigned to one of four strategies:

1. ***Constant rules,*** meaning rules that have no control points, including constant rate rules, such as those for Atlantic Halibut – 3NOPs3VWX+5, Sea Cucumber, and Pacific Oyster; and Potential Biological Removals, as used for data-poor marine mammals such as Narwhal and Bowhead stocks;
2. ***Status-based rules*** (Kronlund et al. 2014), feedback rules with at least one control point that adjust outputs in accordance with some indicator of stock status, such as those for Cod 4RS-3Pn, Dogfish (Inside and Outside), and Gulf Shrimp;
3. ***Risk-based rules***, Kronlund et al. 2014), mixed feedback and feed-forward rules, all with at least two control points (at the LRP and USR), which restrict harvest rates and provided increasingly risk-averse short-term management objectives with respect to future stock decline (growth) as stock status declines, such as those for Haddock – 4X5Y, Northern Shrimp – SFAs 4-6, and Surfclam (Banquereau and Grand Bank); and
4. ***Objective-based "rules",*** entirely feed-forward management approaches that occur where a (presumed constant) management objective or set of objectives is applied to projections of stock status (e.g., in relation to reference levels) in order to select catch limits, such as reported for Beluga – Northern Quebec (Nunavik) and Green Sea Urchin.

Categories of HCRs were nearly evenly split between model-free (i.e., did not require an assessment model to generate an estimate of stock status relative to OCPs in the rule; n = 33) and model-based (n = 30) in formulation. A further five risk-based HCRs appeared to be primarily model-free but might be able to use additional model-based inputs in the form of projections to quantitatively address HCR outputs for management objectives related to stock decline or growth.

Status-based rules were the most common (n = 32), followed by risk-based rules (n = 18). All risk-based rules and more than half of status-based rules employed the LRP and/or USR as OCPs for adjusting outputs from the rule. Other OCPs (instead of, or in addition to, OCPs at the LRP/USR) were common in status-based rules and were also found in a third of risk-based rules.

*Table 10: An examination of harvest control rules (HCRs) implemented for a subset of Canada's key harvested stocks or their subunits. Grey shading added for contrast. OCP = operational control point. LRP = limit reference point. PBR = Potential Biological Removals. USR = upper stock reference. *5 model-free risk-based HCRs may have model-based components for some outputs related to objectives and risk tolerances for stock growth or decline. Quant. = quantitative. Qual. = qualitative. Input/output control classification was performed as per Morison (2004).*

HCR by Strategy	n	Model-based	OCPs: LRP, USR, Other	Quant. Output controls	Quant. Input controls	Qual. Output controls	Qual. Input controls	Other Outputs
Constant (including PBR)	16	--	--	16	--	--	--	--
Status-based (feedback)	32	15	25, 19, 17	26	3	2	1	5
Risk-based (mixed feed-forward and feedback)	18	13*	18, 18, 6	16	--	--	--	18
Objective-based (feed-forward)	2	2	--	2	--	--	--	--
TOTAL	**68**	**30**	**43, 37, 23**	**60**	**3**	**2**	**1**	**23**

Most HCRs (n = 60 of 68) provided outputs that related to quantitative output controls. These include harvest rates, fishing mortality rates, or catch limit recommendations that relate to types of output control measures such as quotas, total allowable catches (TACs) or numbers of individuals removed (see Table 2 for other examples of such controls). A few status-based rules provided outputs related to quantitative input controls (effort level), qualitative output controls (size limits) and qualitative input controls (area closures), primarily with respect to crustacean stocks (Table 11). Risk-based and some status-based rules also had other types of outputs, including guidance for management measures, partially or fully-specified measurable objectives with respect to stock decline and/or exceeding fishing mortality limits and targets, and recommendations to seek science advice.

Table 11: An examination of harvest control rules (HCRs) and the types of management controls they inform, reported as implemented for a subset of Canada's key harvested stocks or their subunits in 2018, grouped by stock type (taxonomic group and/or life history). Grey shading added for contrast. PBR = Potential Biological Removals. Quant. = quantitative. Qual. = qualitative. Input/output control classification was performed as per Morison (2004).

HCR or Management Control Type	Crustacean	Groundfish	Marine Mammal	Mollusc	Other	Small Pelagic	Salmonid
Constant rule (including PBR)	--	1	9	2	1	--	3
Status-based rule	15	5	--	6	--	6	--
Risk-based rule	5	4	--	8	--	--	1
Objective-based rule	--	--	--	--	2	--	--
TOTAL	**20**	**10**	**9**	**16**	**3**	**6**	**4**
Quant. Output controls	15	8	9	15	3	6	4
Quant. Input controls	2	--	--	1	--	--	--
Qual. Output controls	2	--	--	--	--	--	--
Qual. Input controls	1	--	--	--	--	--	--
Other outputs	10	4	--	8	--	--	1

The provisional HCR in the PA Policy is given by:

- When the stock is in the “Healthy Zone” : $F_p < F_{MSY}$
- When the stock is in the “Cautious Zone” : $F_p < F_{MSY}$ x ((Biomass – 40% B_{MSY}) / (80% B_{MSY} − 40% B_{MSY})), and
- When the stock is in the “Critical Zone” : $F_p = 0$

The provisional HCR configuration was used in its entirety as a RR for the Dogfish-Inside, Dogfish-Outside, and Lingcod-Outside stocks; and a similar rule with a non-F_{MSY} basis was used as both RR and HCR for the Shrimp Trawl and Sea Scallop – Inshore SFA 28 (Bay of Fundy) stocks. Although the provisional rule itself was not widely used, segmented (“hockey-stick”)-like HCRs generally resembling the provisional rule in shape were common (Appendix C). For example, 12 risk-based and 14 status-based rules (n = 26, 38% of all HCRs) took a “three-part” shape, where OCPs were only positioned at the LRP and USR.

SUMMARY

LIMIT AND UPPER STOCK REFERENCE POINTS

The PA Policy guidance provides default values of 0.4 and 0.8 B_{MSY} for the LRP and USR respectively. The PA Policy indicates these values are considered best practice in Canada when stock-specific values are not available:

> "*In cases where insufficient stock-specific information is available, these reference points may be considered as the best available guidance for management and for assessing the stock in relation to sustainability. Actual reference points for a stock may use other metrics and be set lower or higher than these references but should be demonstrably appropriate for the stock and be consistent with the intent of the PA. For example, the LRP must be consistent with a point below which serious harm is occurring to the stock. Stocks that are not managed on the basis of biomass and/or harvest rate controls should adapt the concepts in the reference points and harvest rules below to their particular circumstance, while respecting the basic tenets of the PA as set out in the general framework*." (DFO 2009)

If B_{MSY} cannot be estimated, the PA Policy provides provisional proxies including B at $F_{0.1}$, the average biomass or index of biomass over a productive period, or 50% of the maximum historical biomass. However, it is important to note that neither 0.4 or 0.8 of B_{MSY} nor a proxy for B_{MSY} is required. As quoted above, "*concepts*" inherent in the reference points and harvest control rules provided in the PA Policy can be adapted as required to meet the needs of each stock or fishery scenario in a way that still meets policy "*tenets*" (i.e., intent).

The default values of the LRP and USR (0.4 and 0.8 B_{MSY}) appear to have been widely applied in practice, in 43% and 65%, respectively, of the cases examined here. Our review should not, however, be taken to infer that there is insufficient information available to set other types of reference points for stocks that adopted the default reference point configurations. We did not consider whether an alternative basis for reference points was examined and then deemed inappropriate for each stock or subunit at the time the LRP and/or USR was established.

Beyond the common adoption of default values for reference points, this review showed that a number of alternative formulations have been employed for a broad range of stocks, particularly empirical reference points. However, it was not always easy to discern whether the basis of these reference points was intended to represent a proxy for B_{MSY}, nor the year in which that particular reference point estimate was generated. This is an important consideration since the value of reference points may vary with the accrual of new data and can be very sensitive to model assumptions where a model is used. Thus, the estimates of the same reference point at two points in time may potentially be quite different despite being based on say, B_{MSY}, due to a change in model assumptions that occurred between assessments.

Default values were used much more frequently for the USR than for the LRP. This may be because there is a relatively simpler function for the LRP in the PA Policy. The LRP defines a threshold below which *serious harm* may be incurred (DFO 2009, Shelton and Rice 2002). Similar reference points that define states of reproductive impairment are employed worldwide (Sainsbury 2008), allowing for a broader understanding of alternatives that can still meet PA Policy intent such as $B_{recover}$. The USR, on the other hand, is assigned multiple simultaneous, and in some cases incompatible, functions from a technical perspective (DFO 2016). The primary specified function of the USR is as an OCP for management measures, set to adjust the risk of approaching the LRP while accounting for socio-economic considerations in HCRs. In this way it is similar to indicators used in a "control" function for management (Rice and Rivard 2007). However, it is also indicated to be a target reference point in lieu of a separately

identified target, a Healthy-Cautious zone boundary (an "audit"-like function; Rice and Rivard 2007), and an inflection point of another reference point, the RR (DFO 2009).

There are international analogs for all these functions, although such analogs rarely serve more than one or two roles simultaneously. Target reference points are as fundamental as limits in implementing the precautionary approach internationally (FAO 1996). A value of 0.8 B_{MSY} is used by the Food and Agriculture Organization as a component of a sustainability indicator (14.4.1) to report stock states acceptably near a target of B_{MSY} (Ye 2011). "Cautious"-like zones can be used in some jurisdictions to report stock states unacceptably close to limits (ICES 2019, NAFO 2004, Rice 2009). Some states have designed default HCRs in harvest policies with OCPs for adjusting target harvest rates on stocks that deviate too far from target reference points like B_{MSY} (ICES 2019, MF 2011, Restrepo et al. 1998) or too closely to biomass limits (ICES 2019), and which can also include inflection points for fishing mortality limit reference points (Restrepo et al. 1998). However, the numerous coupled functions of the USR (and a lack of clarity as to the underlying assumptions; Rice 2009) will limit the ability of science guidelines to provide technical support for identifying suitable alternatives to the default USR value that still meet PA Policy intent and also satisfy different value-based management objectives acceptably. However, science guidelines could address what considerations could be taken into account when providing advice for a given USR function, and address possible proxies for B_{MSY}.

REMOVAL REFERENCE POINTS

The PA Policy states that RRs must be less than or equal to removal rates associated with MSY (F_{MSY}, U_{MSY}), and that "the adjustment of the [RR below the USR] does not have to follow a linear relationship as shown in the diagram but a progressive reduction in removals is required" (DFO 2009). In addition, RRs do not need to be expressed in the same units of the HCR. This is required to accommodate stocks managed using input controls, output controls or a mixture of control types. If F_{MSY} cannot be reliably estimated, as noted for B_{MSY} above, possible proxies are given that include dynamic pool reference points (e.g., $F_{0.1}$), and the average fishing mortality or index that did not lead to stock decline over a productive period, or $F = M$.

The guidance for RRs (and HCRs) has been implemented in several different ways, revealing multiple and possibly conflicting roles for the RR. This diversity is at least in part because, as noted by DFO (2016), the PA Policy guidance for establishing the RR can be interpreted in three ways:

- **RR as a limit**, in keeping with international agreements: "…the maximum acceptable removal rate for the stock…", and "…to comply with the [United Nations Fish Stocks Agreement],… must be less than or equal to the removal rate associated with maximum sustainable yield," (DFO 2009), taking into account that the UNFSA (UN 1995) establishes F_{MSY} as a minimum standard limit reference point (Shelton & Sinclair 2008);
- **RR as target**, which means the RR (e.g., F_{MSY}) may be regularly exceeded as a consequence; because fishery status on the F axis of the PA framework is binned into either "at or below" versus "exceeds" the RR (DFO 2009), suggesting that harvest rates at the RR are as acceptable as those below it;
- **RR as a HCR**, because the provisional HCR in the Policy uses the two terms nearly interchangeably; "Provisional harvest rule: In absence of a pre-agreed harvest rule developed in the context of the precautionary approach, a provisional removal reference or fishing mortality (say F_p) could be used to guide management and to assess harvest in relation to sustainability" (DFO 2009). The practice of equating the RR (reference point) with the HCR (management measure) also has the potential consequence of limiting the ability of

fisheries scientists and managers to design the management procedure, inclusive of HCRs, to achieve an acceptable trade-off of management outcomes.

The provisional HCR formula provided in the PA Policy has been used less often than defaults for USRs and LRPs, and then generally as a RR. Guidance has long been needed for alternative methods to modify the value of the RR below the USR apart from a linear ramp (DFO 2005b), as similarly segmented reference points, such as the "MSY control rule" found in the United States are often established by the application of a default configuration, imposing B_{MSY} as a target and only adjusting for natural mortality (e.g., Restrepo et al. 1998). DFO (2016) proposed that the diagonal component of the RR was perhaps best interpreted as a HCR, and similarly the review here shows that the RR is primarily understood as a target, rather than as a limiting fishing mortality rate (as developed; Shelton and Sinclair 2008). It is also by this interpretation (RR as target and/or as HCR) that multiple segments of the RR have been established in almost all cases reviewed here. As a result, it can be more difficult to discern the basis of some RRs. It is not always clear whether the value of the RR is intended to represent or be derived from a proxy for F_{MSY}, or some lower value. This is true whether the RR is expressed as F, U, catch, etc. F_{MSY} would be the international standard reference point for determining stock states consistent with "overfishing" (Froese and Proelss 2012).

Some RRs may represent scenarios where targets have been set to limits (i.e., where the RR is intended to serve both roles, such as where the RR is set to the F_{ref} or the maximum target level within a range); however, these are not always readily differentiated from those where the RR is intended to reflect only targets. More generally, the information provided for RRs is consistent with reporting whether harvests are at "approved levels" in a wide range of stocks, and sometimes with limits to be avoided. The latter usage was more common when RRs overall, or RR segments in the Healthy zone, are expressed as either F_{MSY} or F_{MSY} proxies (i.e., more closely adherent to the basic technical specifications provided in the PA Policy). This finding suggests that science guidelines may provide support by focusing on such reference points, both to facilitate characterization of stock states and to enable identification of suitable RRs.

HARVEST CONTROL RULES

The types of HCRs previously identified by Kronlund et al. (2014) in the PA Policy represent two broad but not exclusive categories of rules that have been developed for key harvested stocks across Canada. These comprise feedback (***status-based***) rules similar to the provisional HCR in the PA Policy, and mixed feedback/feed-forward (***risk-based***) rules that are more closely linked to the intent of risk tolerance guidance captured in Table 1 of the PA Policy (DFO 2009). Various permutations of these two broad categories of rules have been developed and implemented for a variety of fish stocks. This review showed that at least two other categories of rules (***constant rules***, including PBRs, and feed-forward only ***objective-based "rules"***) are also used for several key harvested stocks in Canada. In addition, while three-part rules (*sensu* Rice 2009) were common, they remained the minority (38%) of all HCRs in this analysis.

Risk-based rules were the most complex in structure, producing typically multiple outputs for any given stock status, and in some cases may require inputs derived from both empirical assessments and stock assessment model projections. Such rules are uncommon internationally and their complexity may make scientific support of their development or evaluation more technically challenging than for other rules (Kronlund et al. 2014). Status-based rules, on the other hand, have been developed for the widest range of possible management measures including both qualitative and quantitative input and output controls.

Types of HCRs were almost equally divided between model-based and model-free formulations, reflecting the wide range of bases for reference points that have been developed across

Canada. Not all HCRs use the LRP and the USR as OCPs (nor are they required to do so), and this choice varied by rule type; risk-based rules always relied on the LRP and USR as OCPs, while status-based rules were more flexible in the choice of OCPs and were more likely than other rules to set alternative types of OCPs. Constant rate and objective-based rules, by their nature, did not adjust the way HCR outputs were generated at OCPs related to stock status.

RECOMMENDATIONS

Our analysis suggests that science guidelines could help support easier identification of PA components and more standardized use and understanding of technical terminology used in both stock assessments and the design and evaluation of harvest strategies, inclusive of HCRs. In the future, periodic reviews of the technical aspects of PA policy implementation would help to ensure that science guidelines continue to serve science needs in practice. The efficiency of the review process would be greatly improved if the derived data were archived in a database designed to capture the evolution of PA Policy frameworks over time.

Several areas were identified that may benefit from additional technical clarification in science guidelines intended to support implementation of the PA Policy. These areas are described below.

Guidance for Supporting Reference Points

Recognizing that best practices for establishing reference points continue to evolve, science guidelines for reference points should not be prescriptive with respect to specific methodologies, although it could recognize and adopt broad categories such as the classification schemes already available in the literature (e.g., Gabriel and Mace 1999, Sainsbury 2008). Adoption of a common classification scheme would allow greater consistency in description of reference points in assessments, advisory documents, and public reporting.

Science guidelines should instead support PA Policy implementation by clearly reflecting PA Policy intent for limit and target reference points as basic components of Canada's precautionary approach, expressed as biomass, fishing mortality or effort (especially B_{MSY}, F_{MSY} or proxies), and providing a general standard to assist with providing the basis for the choice of reference points, reporting estimates of reference points and assigning stock status relative to reference points in science advice. In addition, describing the conditions under which reference points can change should be incorporated as science guidelines evolve.

Guidance for Supporting Harvest Control Rules

Harvest control rules vary widely in the strategy they support and their formulation for key harvested stocks across Canada where they have been implemented. Science support may be requested for the development and/or evaluation of HCRs tailored for the needs of specific fisheries. Science guidelines should thus outline broad categories HCR types and how they may be codified for both retrospective (past) and prospective (future) evaluation. Such evaluation may vary given data collection and assessment methods, measurable objectives, and the range of the possible input and output controls that HCRs may govern (Morison 2004). The role of OCPs should be clearly defined as points for management action that are separate functions from (but can be set equal to) reference points.

Guidance to distinguish components of measurable objectives from the tactics used to meet the objectives may assist clarifying PA framework implementation for stocks managed with risk-based or objective-based HCRs, for example. Given the range of possible management measures that can be included in HCRs, guidelines should address HCR scenarios including input controls such as spatial closures, and more rarely used quantitative input controls such as

effort. Science guidance should further discuss options available for supporting HCR development and evaluation across the data continuum (poor to rich), reflecting the widespread use and likely continued need for both model-based and model-free formulations in the future.

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APPENDIX A: GLOSSARY

Terminology here adopted or adapted from DAWR (2018), MF (2011), NOAA (2018).

***B_0*: Virgin biomass, unfished biomass**. This is the theoretical **carrying capacity** of the **recruited** or **vulnerable** or **spawning biomass** of a fish **stock**. In some cases, it refers to the average **biomass** of the **stock** in the years before fishing started. More generally, it is the average over recent years of the biomass that theoretically would have occurred if the stock had never been fished. B_0 is often estimated from stock assessment modelling and various percentages of it (e.g. 40% B_0 or $0.4B_0$) are used as **biological reference points (BRPs)** to assess the relative status of a **stock**.

Biological Reference Point (BRP): A benchmark against which the **biomass** or abundance of the **stock,** or the **fishing mortality rate** (or **exploitation rate**), can be measured in order to determine **stock status**. These reference points can be **targets**, **thresholds** or **limits** depending on their intended use.

Biomass: Biomass refers to the size of the **stock** in units of weight. Often, biomass refers to only one part of the **stock** (e.g., **spawning biomass, vulnerable biomass** or **recruited biomass**, the latter two of which are essentially equivalent).

***B_{MSY}*:** The average **stock biomass** that results from taking an average catch of **MSY** under various types of harvest strategies. Often expressed in terms of spawning **biomass**, but may also be expressed as **recruited** or **vulnerable biomass.**

***B_{REF}*:** A reference average biomass usually treated as a management target.

Carrying capacity: The average **stock** size expected in the absence of **fishing**. Even without fishing the **stock** size varies through time in response to stochastic environmental conditions.

Catch (*C*): The total weight (or sometimes number) of fish caught by fishing operations including both retained (landed) and released fish (sometimes called discards).

CPUE: Catch per unit effort is the quantity of fish caught with one standard unit of fishing effort; e.g., the number of fish taken per 1000 hooks per day or the weight of fish taken per hour of trawling. CPUE is often assumed to be a relative **abundance index**, i.e., proportional to the portion of the stock biomass (or numbers) vulnerable to the gear.

Exploitation rate (*U*): The *proportion* of the **recruited** or **vulnerable biomass** that is caught during a certain period, usually a fishing year. Note $U=1-e^{-F}$.

***F*:** The **fishing intensity** or **fishing mortality rate** is that part of the total mortality rate applying to a fish **stock** that is caused by fishing. Usually expressed as an instantaneous rate.

***$F_{0.1}$*:** The **fishing mortality rate** at which the increase in **equilibrium yield per recruit** in weight per unit of effort is 10% of the **yield per recruit** produced by the first unit of effort on the unexploited **stock** (i.e., the slope of the **yield per recruit** curve for the *F0.1* rate is only 1/10th of the slope of the **yield per recruit** curve at its origin).

$F_{40\%B0}$: The **fishing mortality rate** associated with a biomass of 40% ***B_0*** at **equilibrium** or on average. Also appears as $F_{40\%}$.

$F_{40\%SPR}$: The **fishing mortality rate** associated with a spawning potential ratio (**SPR**) of 40% B_0 at equilibrium or on average.

Feed-forward: the modification or control of a process, such as **exploitation rate**, using its anticipated results or effects. May occur in the form of a **Harvest Control Rule.**

Feedback: the modification or control of a process, such as **exploitation rate**, by its results or effects. See **Harvest Control Rule.**

Fishing intensity: A general term that encompasses the related concepts of **fishing mortality** and **exploitation rate**.

Fishing mortality (*F*): That part of the total mortality rate applying to a fish **stock** that is caused by fishing. **Natural mortality (*M*)** is the other component **of total mortality (*Z*).** Usually expressed as instantaneous rates as opposed to annual **exploitation rates**. Note F=-ln(1-U).

F_{MAX}**:** The **fishing mortality rate** that maximizes **equilibrium yield per recruit**. F_{MAX} is a **fishing mortality** level that defines **growth overfishing**. In general, F_{MAX} is different from F_{MSY} (the **fishing mortality** that maximizes **sustainable yield**), and is always greater than or equal to F_{MSY}, depending on the **stock-recruitment relationship**.

F_{MEY}**:** The fishing mortality corresponding to the maximum (**sustainable**) economic yield. Not often used in Canada.

F_{MSY}**:** The **fishing mortality rate** that, if applied constantly, would result in an average catch corresponding to the **Maximum Sustainable Yield** (**MSY**) and an average biomass corresponding to B_{MSY}. Usually expressed as an instantaneous rate.

F_{REF}**:** The **fishing mortality** that is associated with an average biomass of B_{REF}.

Harvest Control Rule (HCR): A pre-determined plan that adjusts fishing activity according to the biological and economic conditions of the **stock** and/or fishery (as defined by **indicators** from monitoring or assessment). Also called **Harvest Decision Rules**, HCRs can be **feedback, feed-forward**, or constant in nature. HCRs are a key **tactical** element of a **harvest strategy**.

Harvest Decision Rule: See **Harvest Control Rule**.

Harvest rate: see **exploitation rate.**

Harvest Strategy: For the purpose of the PA Framework, a **harvest strategy** specifies **target** and **limit reference points,** a statement of risk**,** and management actions (**tactics**) associated with achieving the **targets** and avoiding the **limits**. More generally, a **harvest strategy** is a decision framework designed to pursue defined biological, ecological, social and/or economic **objectives** for fish **stocks** in a given fishery. Key elements include: **objectives**, **performance measures**, reference points, acceptable levels of risk, a monitoring strategy, an assessment and **harvest control rules**. Also called a management strategy.

Index: Same as an **abundance index**.

Indicator: A measurement that provides information on the state of some item of interest; e.g., a single **stock**, or more broadly, major fish stocks worldwide. **Stock status** indicators may include estimates of **biomass**, **fishing mortality** or **exploitation rate**, or suitable **proxies** for these. See **metric, performance measure** and **abundance index**.

Limit: a **biomass** or **fishing mortality reference point** that should be avoided with high probability.

Limit Reference Point: the name of the **biomass limit** in Canadian **harvest strategies** that also often serves as an **operational control point**.

***M*:** The (instantaneous) **natural mortality rate** is that part of the total mortality rate applying to a fish **stock** that is caused by predation and other natural events.

Management Procedure (MP): an algorithm for managing a fishery, consisting of a combination of data collection, assessment method, and harvest control rule. Different MPs may

be evaluated based on their performance relative to measurable objectives as part of a Management Strategy Evaluation.

Management Strategy: See **harvest strategy.**

Metric: An alternative term for **indicator**, and sometimes used in the evaluation of management procedures (see also **performance measure**).

MEY: maximum economic yield, the catch or effort level for a fishery that allows net economic returns to be maximized. In this context, "maximized" equates to the largest positive difference between total revenue and total cost of fishing.

Model: A set of equations that represents the population dynamics of a fish stock (and associated fisheries), a hypothesis about the population dynamics of a fish stock (and associated fisheries).

MSY: Maximum sustainable yield is the largest long-term average catch or yield that can be taken from a **stock** under prevailing ecological and environmental conditions, and the current selectivity patterns exhibited by the fishery.

MSY reference points: MSY references points include B_{MSY}, F_{MSY} and **MSY** itself; analytical and conceptual **proxies** for each of these quantities may be calculated.

Natural mortality (rate) or *M*: That part of the total mortality rate applying to a fish **stock** that is caused by predation and other natural events. Usually expressed as an instantaneous rate.

Objective: Measurable objectives consist of a specified **target** or **limit,** a period of time, and a desired probability or acceptable risk level. Sometimes described as SMART: specific, measurable, achievable, relevant and time-bound.

Operational control point: a value of an **indicator** or other input variable that acts as a trigger for a change in management actions, as for example in a **Harvest Control Rule**.

Overexploitation: A situation where observed **exploitation** (or **fishing mortality**) rates are higher than **target levels**. Another term for **overfishing**.

Overfishing: A situation where observed **fishing mortality** (or **exploitation**) rates are higher than **target** or **threshold** levels. Internationally, overfishing is commonly defined to represent $F > F_{MSY}$.

Performance Measure: A measure that provides information on management procedure performance relative to an **objective**, often expressed as an **indicator** in relation to a **reference point**. Sometimes called a performance **metric**.

Potential Biological Removals: a **harvest control rule** used for many marine mammal stocks with a wide range of life histories and data poverty levels.

Projection or forecast: Predictions about trends in stock size and fishery dynamics in the future. Projections are made to address "what-if" questions of relevance to management. Short-term (1–5 years) projections are typically used in support of decision-making. Longer term projections become much more uncertain in terms of absolute quantities, because the results are strongly dependent on **recruitment,** which is very difficult to predict. For this reason, long-term projections are more useful for evaluating overall management strategies than for making short-term decisions.

Proxy: A surrogate for another value, such as B_{MSY}, F_{MSY} or **MSY,** that has been demonstrated to approximate one of these metrics through theoretical or empirical studies.

Recruitment: The addition of new individuals to the fished component of a **stock**. This is determined by the size and age at which fish are first caught.

Recruitment-overfished: A situation in which the rate of fishing is, or has been, such that annual **recruitment** to the exploitable **stock** has become significantly reduced. The situation is characterized by a greatly reduced **spawning stock**, a decreasing proportion of older fish in the catch, and generally very low recruitment year after year. If prolonged, exploitation rates associated with recruitment-overfishing can lead to stock collapse, particularly under unfavourable environmental conditions.

Removal Reference: the name of the **fishing mortality limit** in Canadian **harvest strategies**.

Reference Point: A benchmark against which the biomass or abundance of the **stock** or the **fishing mortality rate** (or **exploitation rate**) can be measured in order to determine its **status**. These reference points can be **targets**, **thresholds** or **limits** depending on their intended use.

Spawning stock biomass (SSB): The total weight of sexually mature fish in the **stock**. This quantity depends on the abundance of **year classes**, the **exploitation** pattern, the rate of growth, both fishing and **natural mortality rates**, the onset of sexual maturity, and environmental conditions. Same as **mature biomass**. Often refers to females only.

Spawning (biomass) Per Recruit (SBR): The expected lifetime contribution to the **spawning biomass** for the average recruit to the fishery.

Spawning Potential Ratio (SPR). The ratio of spawning biomass per recruit at some fishing mortality rate divided by the spawning biomass per recruit at the unfished state, i.e., F=0. For a given exploitation pattern, rate of growth, maturity schedule and **natural mortality**, an **equilibrium** value of SPR can be calculated for any level of fishing mortality. SPR decreases monotonically with increasing fishing mortality.

Stock: The term has different meanings. It may be defined with reference to units for the purpose of fisheries management. On the other hand, a biological stock is a population of a given species that forms a reproductive unit and spawns little if at all with other units. However, there are many uncertainties in defining spatial and temporal geographical boundaries for such biological units that are compatible with established data collection systems. For this reason, the term “stock” is often synonymous with an assessment / management unit, even if there is migration or mixing of some components of the assessment/management unit between areas.

Stock assessment: The analysis of available data to determine stock status, usually through application of statistical and mathematical tools to relevant data in order to obtain a quantitative understanding of the **status** of the **stock** relative to defined management benchmarks or **reference points.**

Stock-recruitment relationship: An equation describing how the expected number of recruits to a stock varies as the **spawning biomass** changes. The most frequently used stock-recruitment relationship is the asymptotic Beverton-Holt equation, in which the expected number of recruits changes very slowly at high levels of spawning biomass.

Stock status: Refers to a determination made, on the basis of **stock assessment** results, about the current condition of the **stock**. Stock status is often expressed relative to management benchmarks and **biological reference points** such as B_{MSY} or B_0 or F_{MSY} or $F_{\%SPR}$. For example, the current biomass may be said to be above or below B_{MSY} or to be at some percentage of B_0. Similarly, fishing mortality may be above or below F_{MSY} or $F_{\%SPR}$.

Strategy: a plan of actions designed to achieve a major or overall goal or aim. Strategies inform the selection of **tactics** used to achieve measurable **objectives** in support of the overall plan goal.

TAC: Total Allowable Catch is the sum of the catches from all sources.

Tactic: the specific measures or actions taken to achieve a particular **objective**, as part of a **strategy.**

Target: Generally, a **biomass**, **fishing mortality** or **exploitation rate** level or **reference point** that management actions are designed to achieve with a specified level of probability, usually 50% or "on average."

Threshold: Generally, a **biomass**, **fishing mortality** or **exploitation rate** level or **reference point** that management actions are designed to achieve with a specified level of probability (usually >50%). Thresholds may also be used for reporting **stock status**. A **limit** is a type of threshold.U_{MSY}**:** The **exploitation rate** associated with the maximum sustainable yield. Usually expressed as an annual proportion.

Upper Stock Reference: the name of the **biomass threshold, target** and/or **operational control point** in Canadian **harvest strategies**.

Yield: Catch expressed in terms of weight.

Yield per Recruit (YPR): The expected lifetime **yield** for the average recruit. For a given **exploitation pattern**, rate of growth, and **natural mortality**, an **equilibrium** value of YPR can be calculated for each level of **fishing mortality**. YPR analyses may play an important role in advice for management, particularly as they relate to minimum size controls.

***Z*:** Total mortality rate. The sum of **natural (*M*)** and **fishing mortality (*F*) rates**.

APPENDIX B: REFERENCE POINT AND HCR SPECIFICATION DETAILS

Reference points were categorized by type, and whether the default proportion of 0.4/0.8 of B_{MSY} or a proxy was applied for LRPs and USRs. Reference points were described as

- **MSY-based** (production),
- **Dynamic Pool,** including $F_{0.1}$, $F_{40\%,}$ etc.
- **Stock-Recruit**,
- **Historical**, like $B_{recover}$; generally from a model estimate
- **Empirical**, or data-based, which are often based on past values of either fisheries-independent or -dependent data indices
- **Unfished biomass** (B_0)
- **Other** (e.g., $F = M$)

RRs were primarily classified by the Healthy Zone segment value (if multiple segments were present), and were further described as:

- **MSY**, when that estimate is given
- **PBR outputs**, when the stock is managed with a PBR or one is available
- **HCR outputs,** when the RR is equated with that and the HCR output cannot be expressed as a single *F*, *U*, etc.
- **Management measures**, when an RR is given as a TAC, quota, moratorium, effort level, size limit, etc., and these are not related to a HCR. The implication is that the RR is similar to approved levels. This is also used for decision tables, even though those might actually be objective-based rules.
- **Output meeting HCR objective,** when the RR is identified with management measures that would meet an objective-based HCR
- **(limit/target in HCR)** is added when a *F*, *U* or other value is produced from a HCR

RR segments, if present, were classed as

- Different/Same *F* values/Other *U*/Empirical Rate (according to HCR) if the values matched HCR outputs
- Management measures, when an RR is given as a TAC, quota, moratorium, effort level, size limit, etc., and these are not related to a HCR (or the HCR is given as “Management measures”)
- Different catch limit (not in HCR), for some objective-based HCRs or for stocks without HCRs
- HCR output, if the RR cannot be expressed as a *F*, *U*, or other quantitative value from the HCR (including PBRs, risk-based rules, etc.)

Table 12: Details of the basis of limit reference points (LRPs), Upper Stock References (USRs), and Removal References (RR) for the analyses of the subset of key harvested stocks and subunits examined here. Rows corresponding to subunits are in grey. HCR = harvest control rule. OCP = operational control point in HCR, a point at which management measures (HCR outputs) change in response to an input variable like stock status. Dates of estimates for reference points are given to reflect the most recent model-based estimate, or the most recent point at which an empirical value was either established or reiterated.

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
American Lobster - LFA 3-14c	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
American Plaice - Southern Gulf of St. Lawrence (4T)	2015 estimate: 33,770 t of trawlable biomass, 19.5 kg/tow or 139,135 t (SSB that produced 50% of maximum recruitment at age 4 years)	Stock-recruit	No	n/a	TAC/Quota (moratorium)	Mgmt measures (targets)	n/a	No	n/a	n/a	n/a
Arctic Char - Cambridge Bay	2010 estimate: 207 t (0.4 B_{msp})	0.4 B_{MSY}	2010 estimate: 414 t (0.8 B_{msp})	0.8 B_{MSY}	2013 estimate: F_{msp} = 0.1805	F_{MSY} (limit)	n/a	Mgmt measures	n/a	n/a	n/a
Arctic Char - Cumberland Sound	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	n/a	See subunits	n/a	n/a	n/a
Ijaruvung Lake (Commercial)	2015 estimate: 11,769 kg (0.4 B_{MSY})	0.4 B_{MSY}	2015 estimate: 23,538 kg (0.8 B_{MSY})	0.8 B_{MSY}	TACs/quotas, but MSY is available 1,683 kg (2015 estimate)	Mgmt measures (targets)	n/a	Constant rate rule	No	No	No
Iqalujjuaq Fiord (Commercial)	2014 estimate: 15,699 kg (0.4 B_{MSY})	0.4 B_{MSY}	2014 estimate: 31,398 kg (0.8 B_{MSY})	0.8 B_{MSY}	TACs/quotas, but MSY is available (2,626 kg, 2014 estimate)	Mgmt measures (targets)	n/a	Constant rate rule	No	No	No

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Irvine Inlet (Commercial)	2014 estimate: 20,066 kg (0.4 B_{MSY})	0.4 B_{MSY}	2014 estimate 40,132 kg (0.8 B_{MSY})	0.8 B_{MSY}	TACs/quotas, but MSY is available (2,733 kg, 2014 estimate)	Mgmt measures (targets)	n/a	Constant rate rule	No	No	No
Atlantic Canada Dogfish - 4VWNX - 5	$SSB_{threshold}$ from US assessment: 79,644 t (50% of USR; 2018)	Fraction of USR	SSB_{target} from US assessment: 159,288 t (a proxy for adult female biomass at MSY; basis unclear; 2018)	Unclear/ complex	F for SSN_{MSY} = 0.072; specific to adult females. It is not clear that this is still applicable to the stock. The US overfishing limit is available.	F_{MSY} (target in HCR)	n/a	Risk-based rule	Yes	Yes	No
Atlantic Cod - 4X5Y	2018 estimate: 22,193 t (sb50/90)	Stock-recruit	48,000 t (2*old LRP)	Multiple of LRP	F = 0.2 in the Healthy Zone, which according to the IFMP was determined in the 1980's to approximate $F_{0.1}$. The F_{ref} for the Critical Zone is 0.1. No F_{ref} was proposed at the 2018 framework.	Dynamic Pool (F) (target in HCR)	Different F values (according to HCR)	Developed - risk based	Yes	Yes	No
Atlantic Halibut - 3NOPs4VWX +5	2013 estimate: 2,600 t (min SSB from 1982-2013 that produced 50% of max recruitment)	Stock-recruit	2013 estimate: 6,668 t (highest SSB in time series to 2013)	Historical	F = 0.14, based on $F = M$	Other F (target in HCR)	Same F values (according to HCR)	Constant rate rule	No	No	No
Atlantic Halibut - 4RST	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Atlantic Walrus - Baffin Bay (High Arctic)	No	n/a	No	n/a	PBR	PBR output	n/a	Developed - PBR	No	No	No
Atlantic Walrus - Foxe Basin (Central Arctic)	No	n/a	No	n/a	PBR	PBR output	n/a	Developed - PBR	No	No	No
Atlantic Walrus - Hudson Bay-Davis Strait (Central Arctic)	No	n/a	No	n/a	Developed - PBR	Not set; PBR output	n/a	Developed - PBR	No	No	No
Atlantic Walrus - Penny Strait-Lancaster Sound (High Arctic)	No	n/a	No	n/a	PBR	PBR output	n/a	Developed - PBR	No	No	No
Atlantic Walrus - South and East Hudson Bay	No	n/a	No	n/a	Developed - PBR	Not set; PBR output	n/a	Developed - PBR	No	No	No
Atlantic Walrus - West Jones Sound (High Arctic)	No	n/a	No	n/a	PBR	PBR output	n/a	Developed - PBR	No	No	No
Beluga - Cumberland Sound	No	n/a	No	n/a	PBR	PBR output	n/a	PBR-based	No	No	No

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Beluga - Northern Quebec (Nunavik)	Two options developed for Eastern Hudson Bay Subunit: 24% of K (carrying capacity) or 30% of the largest stock size observed	Not set; Unclear/ complex	Two options developed for Eastern Hudson Bay Subunit: 48% of K (carrying capacity) or 70% of the largest stock size observed	Not set; Unclear/ complex	Management objective	Output meeting HCR objective (target)	n/a	Objective-based rule	No	No	No
Bocaccio Rockfish	2019 estimate: 3,785 t; ref. case (0.4 B_{MSY})	0.4 B_{MSY}	2019 estimate: 7,570 t (0.8 B_{MSY})	0.8 B_{MSY}	75 mt in Critical, 981 t (MSY) in Healthy Zone (F_{MSY} is available)	MSY (limit)	Mgmt measures	Decision tables	n/a	n/a	n/a
Bowhead - Eastern Canada - West Greenland (ECWG)	No	n/a	No	n/a	PBR	PBR output	n/a	PBR-based	No	No	No
Canary Rockfish	2009 estimate: 1,113 t; model run 11-u (0.4 B_{MSY})	0.4 B_{MSY}	2009 estimate: 2,225 t; model run 11-u (0.8 B_{MSY})	0.8 B_{MSY}	MSY = 981 t (2009 estimate; U_{MSY} is available)	MSY (limit)	n/a	Decision tables	n/a	n/a	n/a
Capelin - 4RST	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Capelin - SA2+3KLPs	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Cod - 4RS-3Pn	116,000 t (avg SSB of two S-R models; 2018 value)	Stock-recruit	188,000 t (dividing SR clouds; mean SSB for the years 1975, 1976 and 1977; 2018 value)	Stock-recruit	RR equated to HCR (mixed F, TAC provided for various stock levels below the LRP). (F_{MSY} is available)	HCR output (target)	n/a	Status-based rule	No	No	Yes

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Cod - Atlantic (3Ps)	2019 estimate: 66,000 t (SSB in 1994, $B_{recover}$)	Historical	2019 estimate: 132,000 t (2*LRP)	Multiple of LRP	No	n/a	n/a	Developed – Risk-based	Yes	Yes	No
Cod - Northern (2J3KL)	2018 estimate: 829,000 t (Average SSB from 1980s)	Historical	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Cod - Southern Gulf of St. Lawrence (4TVn)	80,000 t fixed in 2003 ($B_{recover}$)	Historical	No	n/a	Moratorium; TAC/Quota	Mgmt measures (targets)	n/a	No	n/a	n/a	n/a
Common Clam	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Dogfish - Inside	No	n/a	No	n/a	Provisional RR/HCR from PA Policy	F_{MSY} (limit in HCR)	Different F values (according to HCR)	Status-based rule	Yes	Yes	No
Dogfish - Outside	No	n/a	No	n/a	Provisional RR/HCR from PA Policy	F_{MSY} (limit in HCR)	Different F values (according to HCR)	Status-based rule	Yes	Yes	No
Dungeness Crab	Not set but proposed as 20% of maximum recruitment from the S-R model	Not set; Stock-recruit	Not set but proposed as 50% of maximum recruitment from the S-R model	Not set; Stock-recruit	No	n/a	n/a	No	n/a	n/a	n/a
Eel (Large)	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Elvers	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Eulachon - Fraser River	Not set but proposed as 382 t	Not set; Unclear/ complex	No	n/a	Not set, but 112 t (MSY) is developed	Not set; MSY	n/a	No	n/a	n/a	n/a
Euphausiids	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Gaspereau	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See sub-units	See sub-units	See subunits
Alewife	4.87 t/km^2 of nursery habitat. Represents 10% of B_0, varies from river to river. Median estimate, 2006 meta-analysis.	Unfished biomass	7.23 t/km^2 of nursery habitat. Represents SSB_{MSY}. Varies from river to river. Median estimate, 2006 meta-analysis.	B_{MSY}	35% target, 53% limit exploitation to all alewife populations (U corresponding to F_{max}, 2003 estimate)	Dynamic Pool (U) (limit)	n/a	No	n/a	n/a	n/a
Blueback Herring	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Geoduck	40% estimated original (estimated unfished) biomass at sub-bed scale, biomass from 1st survey plus landings pre-1989	Empirical	Not set but proposed as 50% of unfished biomass per bed.	Not set; Empirical	0% in Critical zone, and in Healthy Zone, 1.2 to 1.8% target harvest rates for various regions, simulation-tested.	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	No	Yes
Green Sea Urchin	See subunits	See subunits	See subunits	See subunits	Median MSY estimate	See subunits	See subunits	See subunits	See sub-units	See sub-units	See subunits

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Northeast Vancouver Island	0.45 legal-sized Green Sea Urchins/m^2	Fraction of USR	0.9 legal-sized Green Sea Urchins/m^2; density from which stock can increase without changing harvest	Empirical	310.2 t (2018 estimate); 0 t in Critical Zone	MSY (limit)	Different catch limit (not in HCR)	Objective-based rule	No	No	No
Southeast Vancouver Island	0.45 legal-sized Green Sea Urchins/m_2	Fraction of USR	0.9 legal-sized Green Sea Urchins/m^2; density from which stock can increase without changing harvest	Empirical	95 t (2018 estimate) ; 0 t in Critical Zone	MSY (limit)	Different catch limit (not in HCR)	Objective-based rule	No	No	No
Greenland Halibut - 4RST	2018 estimate: 10,000 t (B_{rec} proxy; geometric mean of index from 1990-1994)	Empirical	Not set but proposed as 50,500 t, 80% of the geometric mean of the indicator for 2004-2012, a proxy for B_{MSY}	Not set; 0.8 Empirical	No	n/a	n/a	No	n/a	n/a	n/a
Greenland Halibut - Cumberland Sound	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Grey Seal	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See sub-units	See sub-units	See subunits

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Sable Island and Southwest Nova Scotia	2016 estimate: 114,090 seals (N_{30} - 30% of maximum estimated or inferred population)	Historical	2016 estimate: 266,210 seals (N_{70} - 70% of maximum estimated or inferred population)	Historical	Possible TAC/Quota in Healthy Zone; 0 seals in Critical Zone	Output meeting HCR objective (target)	Different catch limit (not in HCR)	Developed – objective-based	Yes	No	No
Gulf of St. Lawrence	2016 estimate: 13,230 seals (N_{30} - 30% of maximum estimated or inferred population)	Historical	2016 estimate: 30,870 seals (N_{70} - 70% of maximum estimated or inferred population)	Historical	Possible TAC/Quota in Healthy Zone; 0 seals in Critical Zone	Output meeting HCR objective (target)	Different catch limit (not in HCR)	Developed – objective-based	Yes	No	No
Gulf Shrimp	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See sub-units	See sub-units	See subunits
Northern Shrimp SFA 10 (Sept-Iles)	0.53 indicator units (proxy for B_{rec}), average between two lowest years 1980s-1990s	Empirical	1.33 indicator units (0.8 of average from 1996-2002 period, a B_{MSY} proxy)	0.8 Empirical Proxy	Harvest rates in HCR (based on index reference period 1990-2010)	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	No
Northern Shrimp SFA 12 (Estuary)	0.65 indicator units (proxy for B_{rec}), average between two lowest years 1980s-1990s	Empirical	1.12 indicator units (0.8 of average from 1996-2002 period, a B_{MSY} proxy)	0.8 Empirical	Harvest rates in HCR (based on index reference period 1990-2010)	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	No
Northern Shrimp SFA 8 (Esquiman)	0.45 indicator units (proxy for B_{rec}), average between two lowest years 1980s-1990s	Empirical	1.34 indicator units (0.8 of average from 1996-2002 period, a B_{MSY} proxy)	0.8 Empirical	Harvest rates in HCR (based on index reference period 1990-2010)	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	No

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Northern Shrimp SFA 9 (Anticosti)	0.6 indicator units (proxy for B_{rec}), average between two lowest years 1980s-1990s	Empirical	1.18 indicator units (0.8 of average from 1996-2002 period, a B_{MSY} proxy)	0.8 Empirical	Harvest rates in HCR (based on index reference period 1990-2010)	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	No
Haddock - 4X5Y	2019 estimate: 19,700 t (B_{rec}, SSB, age 4+)	Historical	40,000 t SSB (age 4+) - generally higher production and approximately double LRP, established 2017	Multiple of LRP	F_{lim} = 0.25, F_{targ} = 0.15 in Healthy Zone; F_{lim} = 0.15 in Cautious Zone, derived from F_{median}	F_{MSY} (limit in HCR)	Different *F* values (according to HCR)	Risk-based rule	Yes	Yes	No
Harp Seal - Northwest Atlantic	2019 estimate: 2,300,000 seals (N_{30}, 30% of N_{max})	Historical	2019 estimate: 5,300,000 seals (N_{70}, 70% of N_{max})	Historical	Possible TAC/Quota; 0 seals in Critical Zone)	Output meeting HCR objective (target)	Different catch limit (not in HCR)	Developed – objective-based	Yes	No	No
Herring - 2J3lKLPs	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Herring - 4R	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	No	n/a	n/a	n/a
Herring - 4R Fall	47,953 t (20% of maximum observed historical SSB back to 1965)	Historical	61,074 t (Lowest observed historical SSB that produced good recruitment, time series back to 1970)	Historical	Healthy $F_{0.1}$ = 0.22, Critical F_{high}= 0.19 Unclear if applied.	Dynamic Pool *(F)* (limit)	Different *F* values	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Herring 4R Spring	37,384 t (20% of maximum observed historical SSB back to 1965)	Historical	57,468 t (Lowest observed historical SSB that produced good recruitment, time series back to 1970)	Historical	Healthy $F_{0.1}$ = 0.16, Critical F_{med} = 0.03. Unclear if applied.	Dynamic Pool *(F)* (limit)	Different *F* values	No	n/a	n/a	n/a
Herring - 4S	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Herring - 4T (Fall Spawner)	2019 estimate: 52,825 t ($B_{recover}$, SSB from 1980-1983)	Historical	2019 estimate: 335,345 t (60% maximum SSB in high mortality period, 2002-2019)	Dynamic Pool	Healthy $F_{0.1}$ = 0.32	Dynamic Pool *(F)* (limit)	Mgmt measures	No	n/a	n/a	n/a
Herring - 4T (Spring Spawner)	2019 estimate: 47,250 t ($B_{recover}$, SSB from 1980-1983)	Historical	2019 estimate: 132,546 t (B at $F_{0.1}$), rescaled as was LRP	Dynamic Pool	Healthy $F_{0.1}$ = 0.35	Dynamic Pool *(F)* (limit)	n/a	No	n/a	n/a	n/a
Herring - 4VWX	See subunits	See subunits	See subunits	See subunits	No	n/a	n/a	Risk-based rule	Yes	Yes	No
SW Nova Scotia/Bay of Fundy	2018 estimate: 317,846 t (average acoustic survey biomass 2005-2010)	Historical	632,626 t proposed (combined acoustic biomass)	Not set; Multiple of LRP	No	n/a	n/a	No	n/a	n/a	n/a
Offshore Scotian Shelf Banks	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Coastal Nova Scotia	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Herring - Central Coast (Pacific)	2018 estimate: 15,864 t (0.3 SB_0)	Unfished biomass	Not yet set, multiple options developed including 0.6 SB_0	Not set; Multiple of LRP	20% harvest rate from former HCR, simulation-tested.	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	No	Yes
Herring - Haida Gwaii (Pacific)	2018 estimate: 6,778 t (0.3 SB_0)	Unfished biomass	Not yet set, multiple options developed including 0.6 SB_0	Not set; Multiple of LRP	20% harvest rate from HCR, simulation-tested.	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	No	Yes
Herring - Prince Rupert District (Pacific)	2018 estimate: 17,740 t (0.3 SB_0)	Unfished biomass	Not yet set, multiple options developed including 0.6 SB_0	Not set; Multiple of LRP	20% harvest rate from HCR, simulation-tested.	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	No	Yes
Herring - Strait of Georgia (Pacific)	2018 estimate: 40,884 t (0.3 SB_0)	Unfished biomass	Not yet set, multiple options developed including 0.6 SB_0	Not set; Multiple of LRP	20% harvest rate from HCR, simulation-tested.	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	No	Yes
Herring – WCVI (Pacific)	2018 estimate: 14,290 t (0.3 SB_0)	Unfished biomass	Not yet set, multiple options developed including 0.6 SB_0	Not set; Multiple of LRP	20% harvest rate from HCR, simulation-tested.	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	No	Yes
Icelandic Scallop - 16EF-18A	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Intertidal Clams - Central Coast-Heiltsuk Manila	No	n/a	No	n/a	TAC and size limits	Mgmt measures (targets)	n/a	Status-based rule	No	No	No

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Intertidal Clams - Depuration	30 legal clams/m^2	Empirical	130 legal clams/m^2	Empirical	Harvest rates from HCR	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	Yes
Intertidal Clams - North Coast Haida Gwaii Razor	255 t (0.4 B_{MSY})	0.4 B_{MSY}	510 t (0.8 B_{MSY})	0.8 B_{MSY}	Harvest rates from HCR	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	No
Intertidal Clams - South Coast-Vancouver Island	No	n/a	No	n/a	No	n/a	n/a	Mgmt measures	n/a	n/a	n/a
Lake Trout - Great Slave Lake	No	n/a	No	n/a	No	n/a	n/a	Mgmt measures	n/a	n/a	n/a
Lake Whitefish - Great Slave Lake	No	n/a	No	n/a	No	n/a	n/a	Mgmt measures	n/a	n/a	n/a
Lingcod - Outside	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See sub-units	See sub-units	No
Southwest VI (Area 3C)	2010 estimate: 10,087 t (0.4 B_{MSY})	0.4 B_{MSY}	2010 estimate: 20,174 t (0.8 B_{MSY})	0.8 B_{MSY}	Uses provisional RR based on F_{MSY}	F_{MSY} (limit in HCR)	Different *F* values (according to HCR)	Developed - status based	Yes	Yes	No
Northwest VI (Area 3D)	2010 estimate: 8,827 t (0.4 B_{MSY})	0.4 B_{MSY}	2010 estimate: 17,654 t (0.8 B_{MSY})	0.8 B_{MSY}	Uses provisional RR based on F_{MSY}	F_{MSY} (limit in HCR)	Different *F* values (according to HCR)	Developed - status based	Yes	Yes	No

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Queen Charlotte Sound (Areas 5AB)	2010 estimate: 8,823 t (0.4 B_{MSY})	0.4 B_{MSY}	2010 estimate: 17,646 t (0.8 B_{MSY})	0.8 B_{MSY}	Uses provisional RR based on F_{MSY}	F_{MSY} (limit in HCR)	Different F values (according to HCR)	Developed - status based	Yes	Yes	No
Hecate Strait & west coast Haida Gwaii (Areas 5CDE)	2010 estimate: 5,463 t (0.4 B_{MSY})	0.4 B_{MSY}	2010 estimate: 10,926 t (0.8 B_{MSY})	0.8 B_{MSY}	Uses provisional RR based on F_{MSY}	F_{MSY} (limit in HCR)	Different F values (according to HCR)	Developed - status based	Yes	Yes	No
Lobster - 17	No	n/a	No	n/a	Effort control	Mgmt measures (targets)	n/a	No	n/a	n/a	n/a
Lobster - Areas 19-20-21 (Gaspé)	325 t landings (40% of average landings 1985-2009)	0.4 Empirical	650 t landings (80% of average landings 1985-2009)	0.8 Empirical	Effort control	HCR output (targets)	HCR output	Status-based rule	Yes	Yes	Yes
Lobster - Inshore LFA 27-33	See subunits	See subunits	See subunits	See subunits	No (later set)	n/a	n/a	No	n/a	n/a	n/a
LFA 27	0.14 kg/TH (40% of median combined catch rate data from 1990–2016)	0.4 Empirical	0.27 kg/TH (80% of median combined catch rate data from 1990–2016)	0.8 Empirical	0.84 (75th quantile of the posterior distribution of the maximum modeled Continuous Change in Ratio, [CCIR] exploitation rate)	Later set; Other Rate (limit)	No	No	n/a	n/a	n/a
LFA 28	0.12 kg/TH (40% of median combined catch rate data from 1990–2016)	0.4 Empirical	0.25 kg/TH (80% of median combined catch rate data from 1990–2016)	0.8 Empirical	No	n/a	n/a	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
LFA 29	0.11 kg/TH (40% of median combined catch rate data from 1990–2016)	0.4 Empirical	0.22 kg/TH (80% of median combined catch rate data from 1990–2016)	0.8 Empirical	0.94 (75th quantile of the posterior distribution of the maximum modeled Continuous Change in Ratio, [CCIR] exploitation rate)	Later set; Other Rate (limit)	No	No	n/a	n/a	n/a
LFA 30	0.28 kg/TH (40% of median combined catch rate data from 1990–2016)	0.4 Empirical	0.56 kg/TH (80% of median combined catch rate data from 1990–2016)	0.8 Empirical	0.77 (75th quantile of the posterior distribution of the maximum modeled Continuous Change in Ratio, [CCIR] exploitation rate)	Later set; Other Rate (limit)	No	No	n/a	n/a	n/a
LFA 31A	0.16 kg/TH (40% of median combined catch rate data from 1990–2016)	0.4 Empirical	0.31 kg/TH (80% of median combined catch rate data from 1990–2016)	0.8 Empirical	0.89 (75th quantile of the posterior distribution of the maximum modeled Continuous Change in Ratio, [CCIR] exploitation rate)	Later set; Other Rate (limit)	No	No	n/a	n/a	n/a
LFA 31B	0.16 kg/TH (40% of median combined catch rate data from 1990–2016)	0.4 Empirical	0.32 kg/TH (80% of median combined catch rate data from 1990–2016)	0.8 Empirical	0.82 (75th quantile of the posterior distribution of the maximum modeled Continuous Change in Ratio, [CCIR] exploitation rate)	Later set; Other Rate (limit)	No	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
LFA 32	0.14 kg/TH (40% of median combined catch rate data from 1990–2016)	0.4 Empirical	0.29 kg/TH (80% of median combined catch rate data from 1990–2016)	0.8 Empirical	0.84 (75th quantile of the posterior distribution of the maximum modeled Continuous Change in Ratio, [CCIR] exploitation rate)	Later set; Other Rate (limit)	No	No	n/a	n/a	n/a
LFA 33	0.14 kg/TH (40% of median combined catch rate data from 1990–2016)	0.4 Empirical	0.28 kg/TH (80% of median combined catch rate data from 1990–2016)	0.8 Empirical	0.81 (75th quantile of the posterior distribution of the maximum modeled Continuous Change in Ratio, [CCIR] exploitation rate)	Later set; Other Rate (limit)	No	No	n/a	n/a	n/a
Lobster - Inshore LFA 34	4,433 t (40% of the median landings for 1985-2009, other indicators may be developed)	0.4 Empirical	8,867 t (80% of the median landings for 1985-2009, Other indicators may be developed; 0.62 kg/trap haul, and 490 lobsters/km^2 in the trawl survey)	0.8 Empirical	No	n/a	n/a	No	n/a	n/a	n/a
Lobster - Inshore LFA 35-38	788 t (40% of the median landings for 1985-2009, other indicators may be developed)	0.4 Empirical	1,575 t (80% of the median landings for 1985-2009, other indicators may be developed)	0.8 Empirical	No	n/a	n/a	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Lobster - Offshore LFA 41	The median of the five lowest nonzero biomasses in the time series for four survey indicators of biomass.	Empirical	40% of the median of the higher productivity period (i.e. 2000-2015) for four indexes.	Empirical	No	n/a	n/a	Status-based rule	Yes	Yes	No
Lobster - Southern Gulf (LFA 23, 24, 25, 26A, 26B)	6,899 t landings (40% average landings 1974-2009, proxy for B_{MSY})	0.4 Empirical	13,798 t landings (80% landings in 1974-2009, proxy for B_{MSY})	0.8 Empirical	Refers to the HCR for details.	HCR output (target)	HCR output	Status-based rule	Yes	Yes	Yes
Lobster - Zone 22 (MI)	875 t landings (40% landings from 1985-2009, proxy for B_{MSY})	0.4 Empirical	1,750 t landings (80% landings from 1985-2009, proxy for B_{MSY})	0.8 Empirical	Effort control	HCR output (target)	HCR output	Status-based rule	Yes	Yes	Yes
Longspine Thornyhead	No	n/a	No	n/a	TACs and allocations	Mgmt measures (targets)	n/a	Developed – objective-based	n/a	n/a	n/a
Mackerel - Atlantic (NAFO 3-4)	2018 estimate: 46,114 t (40% B at $F_{40\%}$)	0.4 Dynamic Pool	2018 estimate: 92,228 t (80% B at $F_{40\%}$)	0.8 Dynamic Pool	No ($F_{40\%}$ is available)	n/a	n/a	Developed - status based	No	No	Yes
Narwhal - (EHA BB) Admiralty Inlet	No	n/a	No	n/a	PBR	PBR output	n/a	PBR-based	No	No	No
Narwhal - East Baffin	No	n/a	No	n/a	PBR	PBR output	n/a	PBR-based	No	No	No
Narwhal - Eclipse Sound	No	n/a	No	n/a	PBR	PBR output	n/a	PBR-based	No	No	No

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Narwhal - Northern Hudson Bay	No	n/a	No	n/a	PBR	PBR output	n/a	PBR-based	No	No	No
Narwhal - Smith/Jones/ Parry	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	n/a	See subunits	No	No	n/a
Smith Sound	No	n/a	No	n/a	PBR	PBR output	n/a	PBR-based	No	No	No
Jones Sound	No	n/a	No	n/a	PBR	PBR output	n/a	PBR-based	No	No	No
Parry Islands	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Narwhal - Somerset	No	n/a	No	n/a	PBR	PBR output	n/a	PBR-based	No	No	No
North Slope Dolly Varden - Big Fish, Rat, Firth, Babbage, Vittrekwa	No	n/a	No	n/a	Not set, but 5% maximum harvest rate is used in the HCR	Not set; Harvest rate (target in HCR)	n/a	Risk-based rule	Yes	Yes	No
Northern Shrimp - SFA 5	2018 estimate: 15,300 t (30% geometric mean female SSB index, 1996-2001)	Empirical	2018 estimate: 40,900 t (80% geometric mean female SSB index, 1996-2001)	0.8 Empirical	HCR (F_{MSY} cannot be calculated)	HCR output (target)	HCR output	Risk-based rule	Yes	Yes	Yes
Northern Shrimp - SFA 6	2018 estimate: 81,600 t (30% geometric mean female SSB index, 1996-2003)	Empirical	2018 estimate: 218,000 t (80% geometric mean female SSB index, 1996-2003)	0.8 Empirical	HCR (F_{MSY} cannot be calculated)	HCR output (target)	HCR output	Risk-based rule	Yes	Yes	Yes

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Northern Shrimp (Borealis) - Eastern Assessment Zone	2018 estimate: 6,800 t (30% geometric mean female SSB index, 2006-2008)	Empirical	2018 estimate: 18,200 t (80% geometric mean female SSB index, 2006-2008)	0.8 Empirical	HCR (F_{MSY} cannot be calculated)	HCR output (target)	HCR output	Risk-based rule	Yes	Yes	Yes
Northern Shrimp (Borealis) - SFA 4	2018 estimate: 19,100 t (30% geometric mean female SSB index, 2005-2009), 2019 estimate	Empirical	2018 estimate: 51,000 t (80% geometric mean female SSB index, 2005-2009), 2019 estimate	0.8 Empirical	HCR (F_{MSY} cannot be calculated)	HCR output (target)	HCR output	Risk-based rule	Yes	Yes	Yes
Northern Shrimp (Borealis) - WAZ	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Northern Shrimp (Montagui) - SFA 4	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Northern Shrimp (Montagui) - WAZ	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Pacific Ocean Perch - PMFC 3CD-WCVI	2012 estimate: 2,324 t (0.4 B_{MSY})	0.4 B_{MSY}	2012 estimate: 4,647 t (0.8 B_{MSY})	0.8 B_{MSY}	1,048 t (MSY, 2017; U_{MSY} is available)	MSY (limit)	n/a	Developed - decision tables	No	No	No
Pacific Ocean Perch - PMFC 5ABC-QCS	2016 estimate: 9,647 t (0.4 B_{MSY})	0.4 B_{MSY}	2016 estimate: 19,293 t (0.8 B_{MSY})	0.8 B_{MSY}	3,843 t (MSY, 2017; U_{MSY} is available)	MSY (limit)	n/a	Developed - decision tables	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Pacific Ocean Perch - PMFC 5DE-HS/DE/WHG	2012 estimate: 2,921 t (0.4 B_{MSY})	0.4 B_{MSY}	2012 estimate: 5,843 t (0.8 B_{MSY})	0.8 B_{MSY}	1,488 t (MSY, 2017; U_{MSY} is available)	MSY	n/a	Developed - decision tables	No	No	No
Pacific Oyster	No	n/a	No	n/a	Not set, but 10% harvest rate from HCR is developed	Not set; Harvest rate (target HCR)	n/a	Constant rate rule	No	No	No
Pink and Spiny Scallop	No	n/a	No	n/a	Harvest rate from HCR	Harvest rate (target in HCR)	n/a	Constant rate rule	No	No	No
Pollock - 4X5 (Western Component)	0.2 Survey index ratio relative to reference period (1984-1994)	Empirical	No	n/a	No	n/a	n/a	Status-based rule	No	No	Yes
Prawn Trap	1.56 spawner index units (0.4 B_{MSY} proxy)	0.4 Empirical	3.12 spawner index units (0.8 B_{MSY} proxy)	0.8 Empirical	HCR output (subarea opening/closing)	HCR output (target)	HCR output	Status-based rule	No	Yes	Yes
Queen / Snow Crab - CFA 1-12	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	n/a	n/a	n/a
Division 2HJ	Not set, but proposed as lowest of multiple indicators	Not set; Unclear/ complex	Not set, but proposed as multiple indicators	Not set; Unclear/ complex	Not set, but exploitation rates from proposed HCR	Not set, Harvest rate (target in HCR)	Harvest rate (according to HCR)	Developed – Risk-based	Yes	Yes	Yes
Division 3K	Not set, but proposed as lowest of multiple indicators	Not set; Unclear/ complex	Not set, but proposed as multiple indicators	Not set; Unclear/ complex	Not set, but exploitation rates from proposed HCR	Not set, Harvest rate (target in HCR)	Harvest rate (according to HCR)	Developed - bounded	Yes	Yes	Yes

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Division 3L Inshore	Not set, but proposed as lowest of multiple indicators	Not set; Unclear/ complex	Not set, but proposed as multiple indicators	Not set; Unclear/ complex	Not set, but harvest rates from proposed HCR	Not set, Harvest rate (target in HCR)	Harvest rate (according to HCR)	Developed – Risk-based	Yes	Yes	Yes
Division 3LNO Offshore	Not set, but proposed as lowest of multiple indicators	Not set; Unclear/ complex	Not set, but proposed as multiple indicators	Not set; Unclear/ complex	Not set, but harvest rates from proposed HCR	Not set, Harvest rate (target in HCR)	Harvest rate (according to HCR)	Developed – Risk-based	Yes	Yes	Yes
Division 3Ps	Not set, but proposed as lowest of multiple indicators	Not set; Unclear/ complex	Not set, but proposed as multiple indicators	Not set; Unclear/ complex	Not set, but harvest rates from proposed HCR	Not set, Harvest rate (target in HCR)	Harvest rate (according to HCR)	Developed – Risk-based	Yes	Yes	Yes
Division 4R3Pn	No	n/a	No	n/a	Not set, but harvest rates from proposed HCR	Not set, Harvest rate (target in HCR)	Harvest rate (according to HCR)	Developed – Risk-based	Yes	Yes	Yes
Quillback Rockfish - Inside	2010 estimate: 2,190 t (0.4 B_{MSY})	0.4 B_{MSY}	2010 estimate: 4,380 t (0.8 B_{MSY})	0.8 B_{MSY}	TAC/Quota options (F_{MSY} is available)	Mgmt measures (targets)	n/a	Decision tables	No	No	No
Quillback Rockfish - Outside	2010 estimate: 3,723 t (0.4 B_{MSY})	0.4 B_{MSY}	2010 estimate: 7,446 t (0.8 B_{MSY})	0.8 B_{MSY}	TAC/Quota options (F_{MSY} is available)	Mgmt measures (targets)	n/a	Decision tables	No	No	No
Red Sea Urchin	0.3 mature urchins / m^2	Empirical	0.6 mature urchins / m^2 was proposed	Not set; Multiple of LRP	No	n/a	n/a	Decision tables	No	No	No
Redfish - Unit 1	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See sub-units	See sub-units	See subunits
Redfish - Unit 2	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See sub-units	See sub-units	See subunits

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Unit 1+2 *S. mentella*	2019 estimate: 43,000 t (B_{rec} proxy)	Empirical	2019 estimate: 265,000 t (80% of the SSB geometric mean from 1984-1990)	0.8 Empirical	Proposed HCR options, which produce catch limits, simulation-tested	Catch (target in HCR)	Catch (according to HCR)	Developed - status based	No	No	No
Unit 1+2 *S. fasciatus*	2019 estimate: 25,000 t (B_{rec} proxy)	Empirical	2019 estimate: 168,000 t (80% of the SSB geometric mean from 1984-1992)	0.8 Empirical	Proposed HCR options, which produce catch limits, simulation-tested	Catch (target in HCR)	Catch (according to HCR)	Developed - status based	No	No	No
Redfish - Unit 3	29,000 t (40% of mean smoothed survey index of biomass, 1970-2011; 2018 value)	0.4 Empirical	58,000 t (80% of mean smoothed survey index, 1970-2011; 2018 value)	0.8 Empirical	HCR (12 to 3% declining maximum exploitation rates)	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Risk-based rule	Yes	Yes	Yes
Rock Crab - CFA 23, 24, 25, 26A	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Rougheye Rockfish	No	n/a	No	n/a	TAC and Allocation	Mgmt measures (targets)	n/a	Mgmt measures	n/a	n/a	n/a
Sablefish	18,469 t (0.4 B_{MSY})	0.4 B_{MSY}	36,938 t (0.8 B_{MSY})	0.8 B_{MSY}	Harvest rates from HCR (U_{MSY} is available)	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	No	Yes
Sardine - Pacific	No	n/a	No	n/a	No	n/a	n/a	Status-based rule	No	No	Yes
Scallop - Southern Gulf of St. Lawrence (SFA 21a, b, c, 22, 23, 24)	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Sea Cucumber	50% of biomass on 1st survey following phase 1 closure (proxy for B_0)	Empirical	No	n/a	Harvest rates from HCR	Harvest rate (target HCR)	Harvest rate (according to HCR)	Constant rate rule	Yes	No	No
Sea Cucumber - 3Ps	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Sea Scallop - Area 20	0.85 kg/h*m (CPUE)	Empirical	1.5 kg/h*m (CPUE)	Empirical	Stock status indicators (HCR inputs); outputs (effort) are available	Unclear/ complex	Unclear	Status-based rule	Yes	Yes	No
Sea Scallop - Inshore SFA 28 (Bay of Fundy)	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See sub-units	See sub-units	n/a
SPA 1a	480 t (B_{rec})	Historical	1,000 t (*B* of maximum catch), from simulation under range of *U*	Other	HCR (15% to 0% exploitation rate), derived from simulations of maximum catch	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Risk-based rule	Yes	Yes	No
SPA 1b	880 t (B_{rec})	Historical	1,800 t (*B* of maximum catch), from simulation under range of *U*	Other	HCR (15% to 0% exploitation rate), derived from simulations of maximum catch	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Risk-based rule	Yes	Yes	No
SPA 3	600 t (B_{rec})	Historical	1,000 t (*B* of maximum catch), from simulation under range of *U*	Other	HCR (15% to 0% exploitation rate), derived from simulations of maximum catch	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Risk-based rule	Yes	Yes	No

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
SPA 4	530 t (B_{rec})	Historical	750 t (*B* of maximum catch), from simulation under range of *U*	Other	HCR (15% to 0% exploitation rate), derived from simulations of maximum catch	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Risk-based rule	Yes	Yes	No
SPA 5	No	n/a	No	n/a	Separate HCR may not exist for this subunit	Unclear/ complex	Unclear/ complex	Risk-based rule	Yes	Yes	No
SPA 6	6.2 kg/hr	Empirical	9.1 kg/hr	Empirical	No	n/a	n/a	No	n/a	n/a	n/a
Sea Scallop - Inshore SFA 29W	See subunits	See subunits	See subunits	See subunits	No	n/a	n/a	No	n/a	n/a	n/a
Subarea A	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Subarea B	1.12 t/km^2 (0.3 density at maximum catch in high suitability areas, from simulation)	Other	2.24 t/km^2	Multiple of LRP	No	n/a	n/a	No	n/a	n/a	n/a
Subarea C	1.41 t/km^2 (0.3 density at maximum catch in high suitability areas, from simulation)	Other	2.82 t/km^2	Multiple of LRP	No	n/a	n/a	No	n/a	n/a	n/a
Subarea D	1.3 t/km^2 (0.3 density at maximum catch in high suitability areas, from simulation)	Other	2.6 t/km^2	Multiple of LRP	No	n/a	n/a	No	n/a	n/a	n/a
Subarea E	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Sea Scallop - Offshore SFA 26 German, Browns	Not set; 2,730 t proposed for Browns North subunit (30% mean biomass, corresponding to lowest biomass observed, 1991)	Not set; Historical	Not set; 7,281 t proposed for Browns North subunit (80% mean biomass over a productive period from 1991-2010)	Not set; 0.8 Historical	Not set; proposed for Browns North subunit as harvest rate of 0.1 (resulted in no change in biomass)	Not set; Harvest rate developed	n/a	No	n/a	n/a	n/a
Sea Scallop - Offshore SFA 27, Georges	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See subunits	See sub-units	See sub-units	n/a
Georges 'a'	7,137 t (30% mean historical biomass)	Historical	13,284 t (80% of mean historical biomass)	0.8 Historical	Target harvest rate of 0.25 from HCR	Harvest rate (target in HCR)	n/a	Risk-based rule	Yes	Yes	No
Georges 'b'	No	No	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Shrimp - Scotian Shelf (SFA 13-15)	5,459 t (30% of average SSB from 2000-2010; B_{rec} proxy)	Empirical	14,558 t (80% of average SSB from 2000-2010)	0.8 Empirical	20% female exploitation (HZ), 0% (CRZ), roughly equal to proxy for $F = M$ (M = *25-33*%)	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	No
Shrimp Trawl	0.4 B_{MSY} proxy (In avg biomass over 1997 to 2007); note: 36 shrimp management areas	0.4 Empirical	0.8 B_{MSY} proxy (In avg biomass over 1997 to 2007)	0.8 Empirical	35% harvest rate, to 0% through HCR, from simulation testing	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	No
Silver Hake - 4VWX	23,600 t (set in 2012; 0.4 B_{MSY})	0.4 B_{MSY}	47,200 t (set in 2012; 0.8 B_{MSY})	0.8 B_{MSY}	F_{MSY} of 0.32 = F_{lim}; F_{targ} = 0.1 to 0.25 in Healthy, 0.05 to 0.1 in Cautious	F_{MSY} (limit in HCR)	Different F values (according to HCR)	Risk-based rule	Yes	Yes	Yes

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Snow Crab - 12A	No	n/a	No	n/a	No	n/a	n/a	Mgmt measures	n/a	n/a	n/a
Snow Crab - 12B	No	n/a	No	n/a	Mgmt measures	Mgmt measures (targets)	n/a	Mgmt measures	n/a	n/a	n/a
Snow Crab - 12C	No	n/a	No	n/a	Mgmt measures	Mgmt measures (targets)	n/a	Mgmt measures	n/a	n/a	n/a
Snow Crab - 13	No	n/a	No	n/a	Mgmt measures	Mgmt measures (targets)	n/a	Mgmt measures	n/a	n/a	n/a
Snow Crab - 14	No	n/a	No	n/a	Mgmt measures	Mgmt measures (targets)	n/a	Mgmt measures	n/a	n/a	n/a
Snow Crab - 15	No	n/a	No	n/a	Mgmt measures	Mgmt measures (targets)	n/a	Mgmt measures	n/a	n/a	n/a
Snow Crab - 16	No	n/a	No	n/a	Mgmt measures	Mgmt measures (targets)	n/a	Mgmt measures	n/a	n/a	n/a
Snow Crab - 16A	No	n/a	No	n/a	Mgmt measures	Mgmt measures (targets)	n/a	Mgmt measures	n/a	n/a	n/a
Snow Crab - 17	No	n/a	No	n/a	Mgmt measures	Mgmt measures (targets)	n/a	Mgmt measures	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Snow Crab - CFA 12 (12, 18, 25, 26), 12E, 12F, 19	10,000 t (lowest *B* of commercial sized males that produced good recruitment, from survey, set in 2012)	Empirical	41,400 t of commercial sized males (0.8 of B_{MSY} proxy, 50% of maximum biomass in historical period, set in 2012)	0.8 Empirical	Harvest rates from HCR. U_{MSY} empirical proxy (average exploitation rate from same period as USR) = 0.346 is available (2012 estimate).	Harvest rate (target in HCR)	Harvest rate (according to HCR)	Status-based rule	No	No	Yes
Snow Crab - Scotian Shelf (4X)	2018 estimate: 293 t (25% carrying capacity)	Unfished biomass	2018 estimate: 585 t (50% carrying capacity)	Unfished biomass	F_{MSY} = 0.36 (2018 estimate), is limit in IFMP, but *U* from HCR are used, with historical basis.	F_{MSY} (limit in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	No
Snow Crab - Scotian Shelf (ENS-N)	2018 estimate: 1,213 t (25% carrying capacity)	Unfished biomass	2018 estimate: 2,425 t (50% carrying capacity)	Unfished biomass	F_{MSY} = 0.46 (2018 estimate), is limit in IFMP; *U* from HCR are used, with historical basis	F_{MSY} (limit in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	No
Snow Crab - Scotian Shelf (ENS-S)	2018 estimate: 13,925 t (25% carrying capacity)	Unfished biomass	2018 estimate: 27,850 t (50% carrying capacity)	Unfished biomass	F_{MSY} = 0.40 (2018 estimate) is limit in IFMP, but *U* from HCR are used, with historical basis	F_{MSY} (limit in HCR)	Harvest rate (according to HCR)	Status-based rule	Yes	Yes	No
Stimpson's Surfclam	No	n/a	No	n/a	No	n/a	n/a	Status-based rule	No	No	Yes
Striped Bass - Bay of Fundy	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Striped Shrimp (Montagui) – Eastern Assessment Zone	2018 estimate: 2,300 t (30% of biomass index in reference period)	Empirical	2018 estimate: 6,100 t (80% of biomass index in reference period)	0.8 Empirical	HCR (F_{MSY} cannot be calculated)	HCR output (target)	HCR output	Risk-based rule	Yes	Yes	n/a
Surf Clam - Banquereau	2016 estimate: 96,906 t (0.4 B_{MSY})	0.4 B_{MSY}	2016 estimate: 193,812 t (0.8 B_{MSY})	0.8 B_{MSY}	0.5 F_{MSY} (0.45, 2019 estimate)	F_{MSY} (target in HCR)	n/a	Risk-based rule	Yes	Yes	No
Surf Clam - Grand Bank	2009 estimate: 281,226 t (0.4 of B_{ref}, which is B at F = 0.33M)	0.4 Other	2009 estimate: 562,452 t (0.8 of B_{ref}, which is B at F = 0.33 M)	0.8 Other	F = 0.33 M, 0.264 (2012 estimate)	Other F (target in HCR)	n/a	Risk-based rule	Yes	Yes	No
Whelk - 3PS	No	n/a	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
White Hake - 4T	2013 estimate: 12,800 t (0.4 B producing maximum surplus production)	0.4 B_{MSY}	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Winter Flounder - 4RST	2016 estimate: 147,800 t (40% of biomass at reference period, 1973-1994)	0.4 Historical	2016 estimate: 295,700 t (80% of biomass at reference period, 1973-1994)	0.8 Historical	No	n/a	n/a	No	n/a	n/a	n/a
Witch Flounder - 3Ps	40% B_{MSY} based on survey indices 1983-1993, interim proxy	0.4 Empirical	No	n/a	No	n/a	n/a	No	n/a	n/a	n/a
Witch Flounder - 4RST	2016 estimate: 10,480 t (0.4 B_{MSY})	0.4 B_{MSY}	2016 estimate: 20,960 t (0.8 B_{MSY})	0.8 B_{MSY}	Not set but F_{MSY} is available (0.072, 2016 estimate)	Not set; F_{MSY} is developed	n/a	No	n/a	n/a	n/a

Stock	LRP	Type of LRP	USR	Type of USR	RR	Type of RR	RR Segments	HCR	LRP = OCP	USR = OCP	Other OCP
Yelloweye Rockfish - Inside Population	2009 estimate: 1,293 t (0.4 B_{MSY} = 0.2 B_0)	0.4 B_{MSY}	2009 estimate: 2,586 t (0.8 B_{MSY} = 0.4 B_0)	0.8 B_{MSY}	Mgmt measures (TAC in relation to objective); F_{MSY} is available	Output meeting HCR objective (target)	n/a	Decision tables	No	No	n/a
Yelloweye Rockfish - Outside Population	2014 estimate: 4,309 t (0.4 B_{MSY} = 0.2 B_0)	0.4 B_{MSY}	2014 estimate: 8,618 t (0.8 B_{MSY} = 0.4 B_0)	0.8 B_{MSY}	Mgmt measures (TAC in relation to objective); F_{MSY} is available	Output meeting HCR objective (target)	Mgmt measures	Decision tables	No	No	n/a
Yellowmouth Rockfish	2010 estimate: 4,304 t (0.4 B_{MSY})	0.4 B_{MSY}	2010 estimate: 8,608 t (0.8 B_{MSY})	0.8 B_{MSY}	MSY (2,567 t), U_{MSY} is available	MSY (limit)	n/a	Developed - decision tables	No	No	n/a

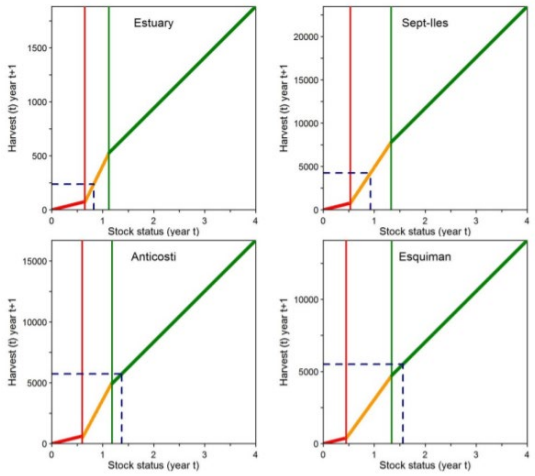
APPENDIX C: HARVEST CONTROL RULE SPECIFICATION DETAILS

This appendix provides a tabulation of harvest control rule (HCR) specifications by stock or stock subunit. The HCRs reported are those described as either implemented, or both implemented and evaluated, in the 2018 Sustainability Survey. The source of the HCR description is cited (e.g., Integrated Fisheries Management Plan (IFMP) or the Sustainability Survey). The inputs and outputs of the HCR are listed and the operational control points (OCPs) described. Complete references to documentation (CSAS Science Response or Research Document, or Integrated Fishery Management Plan) are provided in Appendix C for each stock.

Table 13: Details of harvest control rules (HCRs), grouped by type (status-based rules, risk-based rules, objective-based rules, and constant harvest rate rules).

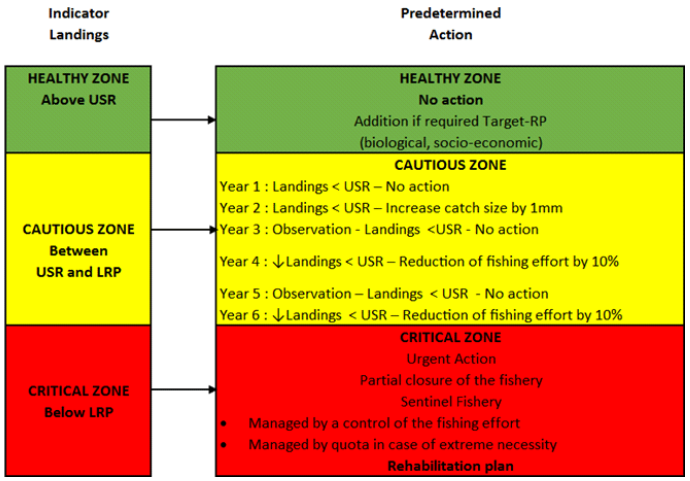
Stocks	Harvest Control Rule
Status-based Rules	
Cod- 4RS-3Pn	**2018 Sustainability Survey:** "SSB <12,000 t Moratorium; 12,000 to <15,000 *F*1 = 0.075 Stewardship fishing / Bycatch; 15,000 to <18,000 F = 0.075 Variable (1,200 <1,500 t); 18,000 <25,000 TAC = 1,500 t; 25,000 <30,000 TAC = 1,800 t ~ F1 = 0.067; 30,000 <40,000 TAC = 3,185 t ~ F1 = 0.101." **Strategy:** Feedback **Formulation**: Model-based **Input variable**: Stock status indicator - Spawning stock biomass (SSB) **Output variable**: Fishing mortality rate (*F*), and catch limit recommendations **Operational control points**: Six, all representing stock states below the LRP **Management measures**: Quantitative output controls (TAC)

Stocks	Harvest Control Rule
Dogfish – Inside Dogfish - Outside	**Res Doc 2011/034:** "These reference points mean that stocks are assessed as in the Healthy zone if current biomass estimates are greater than 0.8·BMSY, in the Cautious zone if current biomass estimates are between 0.8·BMSY and 0.4·BMSY, and in the Critical zone if current biomass estimates are below 0.4·BMSY. Furthermore, when there is no pre-agreed harvest rule developed in the context of the precautionary approach, Annex 1b also provides guidance on a provisional Removal Reference (i.e. harvest rate or fishing mortality, FLIMIT) to apply within each stock status zone: When the stock is in the Healthy zone: FLIMIT < FMSY; When the stock is in the Cautious zone: FLIMIT < FMSY x [(Biomass – 40% BMSY) / (80% BMSY − 40% BMSY)]; When the stock is in the Critical zone: FLIMIT=0." **Strategy:** Feedback **Formulation**: Model-based **Input variable**: Stock status indicator - biomass (*B*) **Output variable**: Fishing mortality rate (*F*) **Operational control points**: LRP, USR (note, these are not set for either stock) **Management measures**: Quantitative output controls (TAC, ITQs)
Geoduck	**IFMP**: "Based on management decision rules, the biomass estimate used for calculating the maximum harvest option on a bed is limited to: 1) the mean biomass estimate, if the bed has been surveyed or 2) the half-way point between the lower 95 and the mean biomass estimates for beds that were not surveyed." Also, "Currently, the Limit Reference Point consists of closing harvest on a bed once current biomass on the bed is below 40% of estimated original biomass. Beds that have been fished heavily in the past, with a reduction of 60% or more of the estimated original biomass, are closed to harvest until they are surveyed and assessed as having recovered above the Limit Reference Point." **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Stock status indicator – mean biomass estimate from survey (*B*'); whether or not bed was surveyed **Output variable**: Catch limit recommendation **Operational control points**: LRP, status of having being surveyed (yes/no) **Management measures**: Quantitative output controls (TAC, ITQs)

Stocks	Harvest Control Rule
Gulf Shrimp	**IFMP**: "The decision rule is based on a stable exploitation rate when the stock is in the healthy zone, equal to the mean rate observed between 1990 and 2010. The harvest rate decreases in the cautious zone and the critical zone, where it is stable at a value four times smaller than that of the healthy zone. The TAC for a given year is based on the main stock status indicator for the previous year and on its position in relation to the stock status classification zones (healthy, cautious and critical). To minimize TAC variations that may arise between two consecutive years, decision rules are completed using a formula that plans the application of a threshold and a cap on TAC changes. No adjustment will be made if the difference between the TAC and the projected harvest of two consecutive years is less than 5%. If the stock is in the healthy zone and the difference between the TAC and the projected harvest is more than 5%, a cap will be applied and the TAC adjustment (positive or negative) will not exceed 15%." **SAR 2018/015:** Figure below.  *Figure 13. Harvest guidelines by fishing area. The projected harvest for 2018 is shown in view of the main stock indicator in 2017.* **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Stock status indicator from previous year (indicator = derived from four indices) **Output variable**: Catch limit recommendation, taking into account caps **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC, IQs, ITQs)

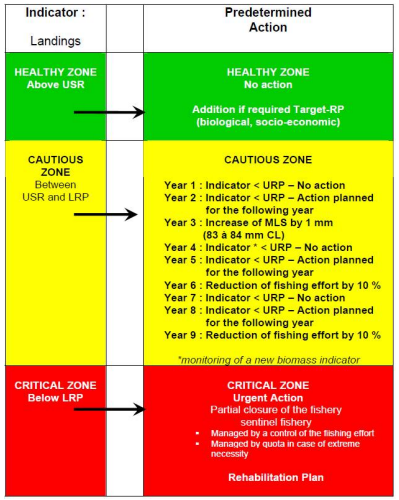
Stocks	Harvest Control Rule
Pacific Herring: CC: Herring - Central Coast (Pacific) HG: Herring - Haida Gwaii (Pacific) PRD: Herring - Prince Rupert District (North Coast / Pacific) SOG: Herring - Strait of Georgia (Pacific) WCVI: Herring – WCVI (Pacific)	**SAR (2019a**): "In 2016, DFO committed to renewing the current management framework to address a range of challenges facing Pacific Herring stocks and fisheries in BC. Renewal of the management framework includes engaging in a management strategy evaluation (MSE) process to evaluate the performance of candidate management procedures against a range of hypotheses about future stock and fishery dynamics…Generally, harvest advice for the major stocks of Pacific Herring has been based on a 1-year forecast of pre-fishery spawning biomass and application of a HCR that is a hybrid of fixed escapement and a target harvest rate." **2018 Sustainability Survey:** "A 20% maximum harvest rate has traditionally been applied when stock above fixed cutoff of 17,600t (evaluated in 1988) and above the LRP with a high probability (using decision tables). Harvest control rules for herring are currently being evaluated using simulation, within a Management Strategy Evaluation process." **Strategy:** Feedback **Formulation**: Model-based **Input variable**: Stock status indicator (biomass) **Output variable**: Harvest rate (varies by stock management area) **Operational control points**: Lower control point at $0.3B_0$ (coincides with LRP) for all stocks. Upper control point varies by stock ($0.5\text{-}0.6B_0$, no adopted USR but SAR (2019a) reports candidate USR=$0.6B_0$ for all stocks), maximum target harvest rate varies by stock management area (<10%-20%) but for 2020 CC, HG, PRD, WCVI closed to commercial catch (U=0) and SOG U=0.2. Formerly: LRP, fixed cut-off of 17,600 t **Management measures**: Quantitative output controls (management area-based TAC, IQs)
Intertidal Clams – Heiltsuk, Manila	**SAR 2010/077**: "Since 2001, fishery managers have used the Magnusson-Stefansson Feedback Gain Model to set in-season thresholds for each of the monitored subareas. The community has continued to complete extensive annual surveys using standard protocols (Gillespie and Kronlund 1999) in each of the subareas and changes in estimated index biomass and the previous year's yield were used to set threshold recommendations for each year." **Strategy:** Feedback **Formulation**: Model-based **Input variable**: Stock status indicator (biomass from one and two years' previous estimates), previous year's catch **Output variable**: Catch limit recommendation **Operational control points**: none **Management measures**: Quantitative output controls (TAC)

Stocks	Harvest Control Rule
Intertidal Clams - Depuration	**Res Doc 2000/122:** **Table 15. Proposed Limit and Threshold Reference Points and associated target harvest rates for beaches in the experimental harvest program.** Reference Point / Type / Harvest Rate < 30 legals/m^2 — Limit — 0.00 (Close for Recovery) < 70 legals/m^2 — Threshold — 0.10 < 130 legals/m^2 — Threshold — 0.20 ≥ 130 legals/m^2 — Threshold — 0.40 **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Stock status indicator (density of legal-sized clams per square meter) **Output variable**: Harvest rate **Operational control points**: LRP, USR and one intermediary point **Management measures**: Quantitative output controls (TAC)
Intertidal Clams – North Coast Haida Gwaii Razor	**2018 Sustainability Survey**: "Jones et al. 2009 identifies a stepped harvest policy as shown below is recommended with a limit reference point at 255t (0.4 Bmsy) and an upper stock reference at 510t (0.8 Bmsy). The policy would be as follows if F0.2 is adopted as the harvest rate: Reference Point Harvest Rate < 255t = 0% 255 -510t = 0% – 22% > 510t = 22%". **Strategy:** Feedback **Formulation**: Model-based **Input variable**: Stock status indicator (biomass) **Output variable**: Harvest rate **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC)

Stocks	Harvest Control Rule
Lobster Area 19-20-21	**IFMP:** "Healthy zone: when the stock is in the healthy zone, no new management measure will be implemented unless the advisory committee decides otherwise. Cautious zone: the decision was made to adopt a six-year approach when the stock is in the cautious zone. Successive and additive conservation methods are used until stocks return to the healthy zone. A first measure (increase the minimum catch size by 1 mm) will be implemented at the end of the second consecutive fishing season below the upper stock reference point (USR). The following year will be an observation year; no specific action will be taken. Afterwards, if stocks show another reduction with respect to the USR, two (2) successive 10% reductions of effort will be carried out over three (3) fishing years, Implementation of a conservation measure may be accelerated if the stock is in the lower range of the cautious zone, close to the limit reference point (LRP). Critical zone: If, in spite of all measures, stocks reach this zone, more stringent measures will be applied to significantly reduce captures. Partial closure of the fishery will be imposed in the most problematic sub-areas." **IMFP**: Figure below.  **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Stock status indicator (index), duration of time in zone **Output variable**: Management measures (size limits, fishing effort), guidance **Operational control points**: LRP, USR, duration of time in zone **Management measures**: Quantitative input controls (effort)

Stocks	Harvest Control Rule
Lobster – Offshore LFA 41	**IFMP**: "If the stock is in the **Cautious Zone**, the OLJCMB will undertake the following: 1. Request that DFO Science, with support from industry and through the use of secondary indicators, identify whether there are factors (environmental, change in fishing strategy, change in data collection) that explain the change in the primary indicators. 2. Evaluate whether the quota flexibility measures (carry forward / back) should continue. 3. Consider undertaking a scientific assessment or science response earlier than would be scheduled in the typical 5-year cycle. 4. Introduce management measures to reduce the removal rate in order to promote stock rebuilding to the healthy zone, if it is confirmed that the decline in the indicators is a real change in stock health. Actions will be established in consultation with industry, will be evaluated annually and will include at least one of the following: a. Size and sex controls (minimum size, window size, maximum size, v-notching); b. Area controls (closed areas); c. Landing controls (quota reduction) • Other actions may also be introduced. • If the stock is in the **Critical Zone**, the OLJCMB will take management actions described above to further reduce the removal rate in accordance with a stock rebuilding plan. Stock rebuilding will follow the guidance outlined by DFO in Guidance for the Development of Rebuilding Plans under the Precautionary Approach Framework: Growing Stocks out of the Critical Zone. • As outlined in the PA Framework, the primary objective of any rebuilding plan is to promote stock growth out of the Critical Zone (i.e. grow the stock beyond the LRP) by ensuring removals from all fishing sources are kept to the lowest possible level until the stock has cleared this zone. There should be no tolerance for preventable decline. This objective remains the same whether the stock is declining, stable or increasing. Actions taken will be established in consultation with industry and will be evaluated annually for effectiveness and adjusted accordingly." **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Stock status indicator (survey indicators) **Output variable**: Guidance for management measures, objectives, requests to science **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC), qualitative output controls (minimum legal size, release of some females), qualitative input controls (area closures)

Stocks	Harvest Control Rule
Lobster – Southern Gulf (LFA 23, 24, 25, 26A, 26B)	**2018 Sustainability Survey**: "Healthy Zone (13,798 t +) = Greater than Upper Stock Reference (USR) : No action required under the Precautionary Approach. Working towards additional Biological Reference Points. Cautious Zone (13,798t- 6,899t) = Between the Upper Stock Reference (USR), and Limit Reference Point (LRP): Year 1: Indicator < USR: Science advice requested on stock status. Consultations will take place with Aboriginal organizations and industry on fishing effort reductions. Year 2: Fishing effort reduction proportional to the landings' decline according to the science advice and further consultations will occur. Request for a stock assessment based on indicators independent from landings. Year 3+: Fishing effort adjustments, if required, based on the stock assessment until the stock is out of the cautious zone. Continue consultations. *Food, Social and Ceremonial fisheries will continue. Critical Zone (< 6,899t) = Below Limit Reference Point (LRP): Minimal removal rates. Closure of commercial fisheries. Consultations will continue with Aboriginal organizations and industry. Development of a rebuilding plan and implementation measures to promote stock recovery and growth." **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Stock status indicator (landings), duration of time in zone **Output variable**: Guidance for management measures and consultation, management objectives, requests to science **Operational control points**: LRP, USR, duration of time in zone **Management measures**: Quantitative input controls (effort)

Stocks	Harvest Control Rule
Lobster – Zone 22 (MI)	**IFMP:** "Healthy zone: when the stock is in the healthy zone, no new management measure will be implemented unless the advisory committee decides otherwise. Cautious zone: the decision was made to adopt an approach that could be scaled up to nine (9) years if the stock is in the cautious zone. Successive and additive conservation methods would be used until stocks return to the healthy zone. A first measure (increase the minimum catch size by 1 mm) will be implemented at the end of the second consecutive fishing season below the upper stock reference point (USR). In year 4, as management measures have changed indicators used to establish reference points, Sciences will need to develop new biomass indicators. The year 5 will be an observation year; no specific action will be taken. If stocks show another reduction with respect to the USR after year 4 and 5, a 10% reduction of effort will be carried out. If indicators are still below the USR 2 years after the implementation of this measure, a second 10% of effort will be carried out. Critical zone: If, in spite of all measures, stocks reach this zone, more stringent measures will be applied to significantly reduce captures. Partial closure of the fishery will be imposed while maintaining a sentinel fishery. A rebuilding plan will need to be put in place that could lead to further reductions in fishing effort and even the introduction of a quota." **IFMP:** Figure below.  **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Stock status indicator (landings), duration of time in zone **Output variable**: Guidance for management measures specific to year, changes to size limits, fishing effort, objectives **Operational control points**: LRP, USR, duration of time in zone **Management measures**: Quantitative input controls (effort)

Stocks	Harvest Control Rule
Pollock – 4X5 (Western component)	**SAR 2011/054:** Figure below.

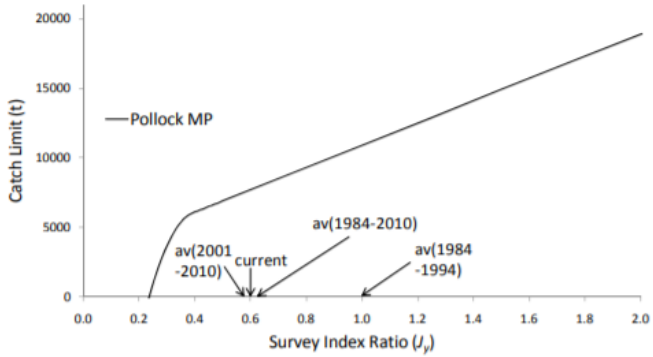


Figure 8: Relationship between the catch limit output by the Pollock Management Procedure and the RV Survey Index Ratio. The arrows indicate values of this ratio at other times or averaged over the periods indicated.

Strategy: Feedback

Formulation: Model-free

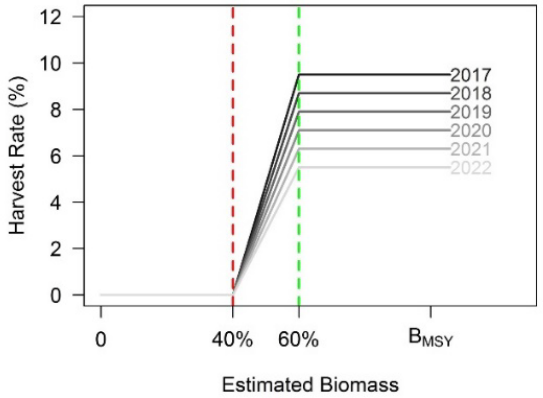
Input variable: Stock status indicator (ratio of survey index to reference period)

Output variable: Catch limit

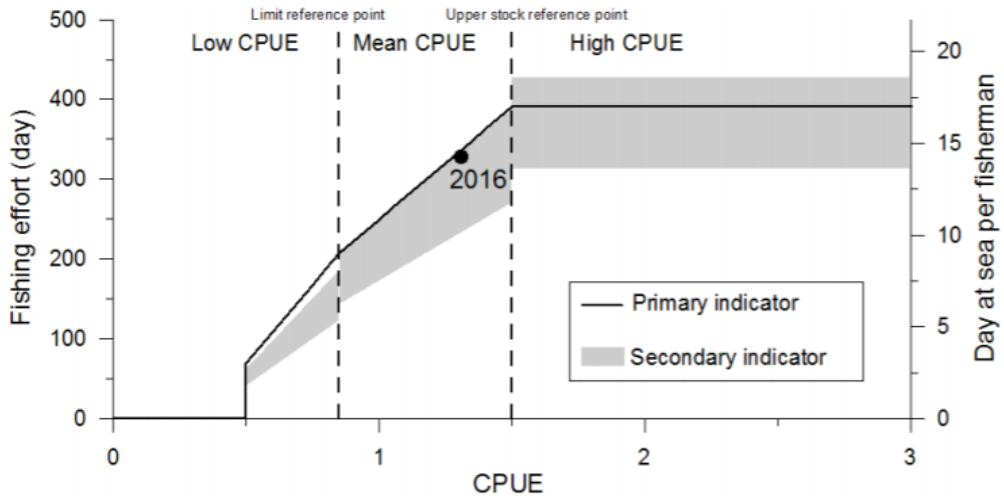
Operational control points: Two (not related to reference points; catch limit reduces to 0 at a point above the LRP of 0.2)

Management measures: Quantitative output controls (TAC, ITQs, Community Quotas)

Stocks	Harvest Control Rule
Prawn Trap	**2018 Sustainability Survey**: "The USR is a dynamic trigger which occurs at the point of first sub-area closure. In the Healthy Zone, all sub-areas are open. On a coast-wide spatial scale, the reduction in exploitation in the Cautious zone is obtained through progressive sub-area closures. A sub-area is closed once the spawner index measure in the sub-area drops to a level at 10% above the LRP. The 10% factor is a subjective buffer to account for SI measure uncertainty. The removal reference is zero. All areas are closed to commercial harvest when the stock is in the Critical Zone." **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Stock status indicator (spawner index units) **Output variable**: Sub-area closure **Operational control points**: USR, 10% buffer above LRP **Management measures**: Qualitative Input control (closures), Quantitative output controls (TAC, ITQs, Community Quotas)

Stocks	Harvest Control Rule
Sablefish	**SR (in press):** "The MP currently used to set annual Sablefish TACs was initially developed in 2011 and revised in two subsequent MSE iterations. Generally, the MP consists of (i) data - landed catch and three biomass indices; (ii) assessment method - a surplus production model with observation and process errors for estimating stock biomass from the biomass indices and landings; (iii) harvest control rule - a 60:40 harvest control rule (HCR) in which the target harvest rate is adjusted from 0% when the estimated biomass is below 40% of B_{MSY} to a maximum value when estimated biomass is above 60% of estimated B_{MSY} ; (iv) a meta rule stating that TAC increases are 0 unless the HCR recommended increase is more than 200 tonnes (TAC decreases are always adopted); and (v) a meta rule adjusting the maximum target fishing mortality rate from 9.5% in 2017 to 5.5% in 2021." Image below (sourced via personal communication):  **Strategy:** Feedback **Formulation**: Model-based **Input variable**: Stock status indicator (estimated biomass) **Output variable**: Harvest rate on legal biomass that is reduced annually to 2022. **Operational control points**: Lower and upper OCPs at 0.4 B_{MSY} (LRP) and 0.6 B_{MSY} estimated from the 1surplus production model in the management procedure. **Management measures**: Quantitative output controls (coastwide TAC, ITQs, FSC)

Stocks	Harvest Control Rule
Sardine - Pacific	**SR 2019/027**: "DFO Fisheries Management adopted a harvest control rule in 2013 that incorporates a July estimate (forecast) of the population's age-1+ biomass, a cutoff value of 150,000 tonnes, and a harvest rate. The cutoff value of 150,000 tonnes is consistent with the cutoff value used in the US harvest guideline. The harvest rate is applied to the difference between the estimated age1+ biomass above the cutoff and the cutoff biomass. As described in the 2013 review (DFO 2013), a range in harvest rates (h) from 3-5% was selected in the calculation of potential harvest allowances." **Strategy:** Feedback **Formulation**: Model-based **Input variable**: Stock status indicator (July forecast of age 1+ biomass) **Output variable**: Harvest rate **Operational control points**: A fixed cut-off of 150,000 t **Management measures**: Quantitative output controls (TAC, ITQs, Individual Quotas)

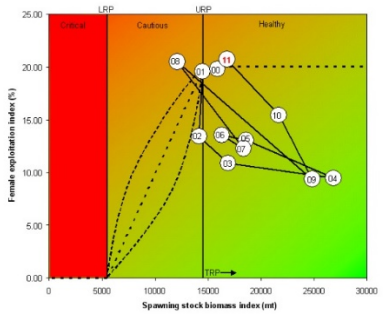
Stocks	Harvest Control Rule
Sea Scallop – Area 20	**SR 2019/020**: "Decision rules have been used to calculate annual fishing effort in Area 20A since 2010. First, the CPUEs of the last two seasons are used to calculate fishing effort. If the final year's CPUE is higher than the previous year's CPUE, the average of the two values is used. Otherwise, only the CPUE of the final year is used. The selected CPUE is inserted into the decision rule chart in Figure 15 to determine whether it is low, average or high. The position of the CPUE on the chart determines the fishing effort for the following year. Second, the most recent research survey abundance results are used to adjust the fishing effort upwards or downwards within the grey area in Figure 15. The maximum fishing effort for the 2016 season would be 329 days at sea in Area 20A." **SAR 2016/027**: Figure below.  *Figure 15. Calculation of fishing effort (days at sea) based on primary (CPUE) and secondary indicators (research survey indices) for Area 20A.* **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Stock status indicator (CPUE), secondary indicators (recent survey abundance trends) **Output variable**: Range of possible fishing effort levels **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC, ITQs)

Stocks	Harvest Control Rule
Shrimp – Scotian Shelf (SFA 13-15)	**IFMP:** "Stock status reference points consistent with DFO's *A fishery decision-making framework incorporating the Precautionary Approach* have been set for SFA 13-15. The size of the stock in relation to these reference points, along with the values and trends of the other indicators, guides the selection of the annual TAC."

Table 1: Reference points and harvest strategies for SFA 13-15

Stock Status	Corresponding Biomass	Harvest Strategy (removal reference)
Healthy	Spawning stock biomass is at or above 14,558 t (upper stock reference)	Maximum of 20% of the spawning stock biomass
Cautious	Spawning stock biomass is between 14,558 t and 5,459 t	Gradual decline in the rate of removals
Critical	Spawning stock biomass is at or below 5,459 t (limit reference point)	No removals

IFMP: Figure below.



Strategy: Feedback

Formulation: Model-free

Input variable: Stock status indicator (index), secondary indicators

Output variable: Harvest rate limits (above, and some ranges below USR), other guidance for establishing management measures

Operational control points: LRP, USR

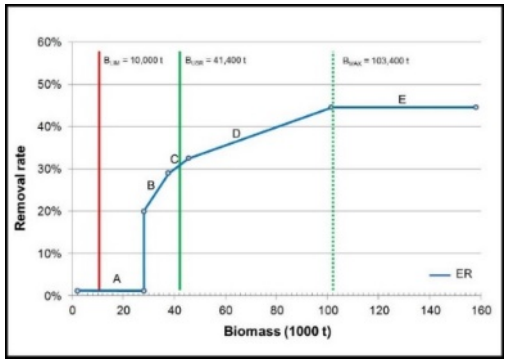
Management measures: Quantitative output controls (TAC, ITQs)

Stocks	Harvest Control Rule
Shrimp Trawl	**SAR 2011/085:** "The PA-compliant HCR used to calculate the annual TAC are as follows (DFO 2009): 1) For shrimp stocks in the Healthy zone, a 35% harvest rate is applied to the estimated biomass; 2) For shrimp stocks in the Cautious zone, a progressive reduction in harvest rate is applied to the estimated biomass where harvest rate = 35%*((Biomass–40% Bmsy)/(80%Bmsy–40%Bmsy)); 3) For shrimp stocks in the Critical zone, a harvest rate of 0% is applied to the estimated biomass." **IFMP:** "When an area is surveyed and sufficient information is obtained to estimate a biomass for a species, but there is not sufficient history to define LRP or USR, a catch ceiling is defined from the survey biomass and a harvest rate of 33%. This harvest rate is derived from a Gulland model at a level of 0.3M." **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Stock status indicator (estimated proxy for biomass) **Output variable**: Harvest rate **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC)

Stocks	Harvest Control Rule
Snow Crab - CFA 12 (12, 18, 25, 26), 12E, 12F, 19	**IFMP**: Table below.

Harvest Decision Rule Application (Letters A through E correspond with the segments illustrated in the figure above)	Minimum Exploitation Rate	Maximum Exploitation Rate
A. If the commercial adult male biomass is at 27,000 t or lower.	0.0%	0.0%
B. If the commercial adult male biomass is between 27,000 t and 36,000 t.	20.0%	29.0%
C. If the commercial adult male biomass is between 36,000 t and 45,540 t.	29.0%	34.6%
D. If the commercial adult male biomass is between 45,540 t and 103,400 t.	34.6%	45.0%
E. If the commercial adult male biomass is above 103,400 t.	45.0%	45.0%

IFMP: Figure below.



Strategy: Feedback

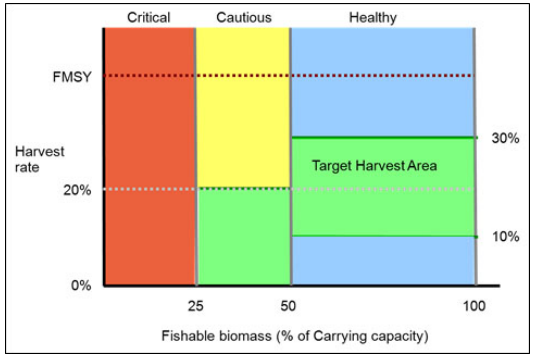
Formulation: Model-free

Input variable: Stock status indicator (estimated biomass from survey)

Output variable: Harvest rate

Operational control points: Five, none aligned with LRP or USR

Management measures: Quantitative output controls (TAC, ITQs), Quantitative input controls (Effort)

Stocks	Harvest Control Rule
Snow Crab – Scotian Shelf (4X) Snow Crab – Scotian Shelf (ENS-N) Snow Crab – Scotian Shelf (ENS-S)	**SAR 2018/046**: "The Target Removal Reference is 20% of the fishable biomass in each area ... Various secondary (population and ecosystem) indicators are taken into consideration for management decisions (Figure 14)" and "Secondary, contextual indicators are used to alter harvest rates between 10 and 30% of fishable biomass (FB; F=0.11 to F=0.36)." … "The Harvest Control Rules are, therefore, as follows: FB > USR : target exploitation rate of 10% - 30% be utilized, based upon contextual information provided by secondary indicators. LSR < FB < USR : target exploitation rate of 0% - 20%, based upon contextual information provided by secondary indicators. FB < LSR : fishery closure until recovery (at a minimum, until FB > LSR)." **IFMP**: Figure below.  a. **Lower Reference Point (LRP**): 25% of Carrying capacity b. **Upper Stock Reference (USR)**: 50% of Carrying capacity c. **Removal Reference (RR):** not to exceed FMSY as stock collapses have been observed with this practice d. **Target removal reference (TRR):** 20% of the fishable biomass (F=0.22), with secondary, contextual indicators altering harvest rates between 10 and 30% of fishable biomass (F=0.11 to F=0.36) where F is defined as the fishing mortality of the legal sized mature male population **Strategy:** Feedback **Formulation**: Model-based **Input variable**: Stock status indicator (biomass), secondary indicators **Output variable**: Harvest rate target range (above the LRP) **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC, ITQs)

Stocks	Harvest Control Rule
Stimpson's Surfclam	**SAR 2018/022:** "According to the guidelines established to recommend quota adjustments in each fishing area, increases should not exceed 6% per 3-year period. A quota cannot be increased unless over 80% of it, on average, has been reached consistently during the assessment period and the CPUE and mean size indicators are above the time series median. In addition, the exploitation rate in the area must be below 3%. According to the existing decision rule, only Area 3A meets all the conditions for a quota increase of 6%." **Strategy:** Feedback **Formulation**: Model-free **Input variable**: Past catches relative to TAC, stock status indicator (CPUE), secondary indicators (mean size indicators, exploitation rate) **Output variable**: Catch limit recommendation **Operational control points**: 80% of quota on average in assessment period, median of time series for CPUE and mean size **Management measures**: Quantitative output controls (TAC, ITQs)
Risk-based Rules	

Stocks	Harvest Control Rule
Atlantic Canada Dogfish – 4VWNX-5 Atlantic Cod – 4X5Y (developed) Haddock – 4X5Y	**IFMP**: "Keep fishing mortality moderate by using the following references and risk tolerances: • The TAC may be set with a neutral (50%) probability of exceeding the fishing mortality target reference (F_{REF}) when it is above the upper stock reference (USR). • The TAC may be set with a low (less than 25%) probability of exceeding the fishing mortality limit reference (F_{LIM}) when the spawning stock biomass (SSB) is above B_{MSY}/ the USR. • The TAC should be set to mitigate declines and, when possible, promote positive change in SSB over a three-year period when it is below the upper stock reference (USR). A harvest strategy of F_{REF} is acceptable when the stock is in the Cautious zone, so long as the first criterion is met; however, it is required that fishing mortality will decline as the stock progresses lower into the Cautious zone. The management response will vary depending on location of the stock within the Cautious zone, whether the stock is increasing or decreasing, whether the trajectory (growth or decline) is projected to continue, and indications of incoming recruitment to the SSB, for example. • When the SSB is below the limit reference point (LRP), the harvest strategy is to be results-driven rather than based on a predetermined harvest rate. Rebuilding to a level above the LRP should be achieved in a reasonable timeframe (1.5 to 2 generations) with a high degree of probability (greater than 75%). The TAC (if appropriate) should be set with a very low (less than 5%) risk of biomass decline." **Strategy:** Feedback, feed-forward **Formulation**: Model-based **Input variable**: Projections relative to target and limit fishing mortality rates and declines, stock status indicator (biomass), recent trends **Output variable**: Management objectives and other guidance for establishing management measures such as TACs **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC)

Stocks	Harvest Control Rule
Herring – 4VWX	**IFMP:** "When the reference point is in the Healthy Zone, the TAC may be set to be tolerant of normal stock fluctuations .Management actions should react to a declining trend that approaches the Health / Cautious Zone boundary. Risk tolerance for preventable decline – moderate (if low in zone) to neutral. “When the reference point is in the Cautions Zone, The management response will vary depending on location of the stock within the Cautious Zone, whether the stock is increasing or decreasing, and indications from secondary indicators. The TAC should be set to mitigate declines and promote positive change in spawning stock biomass (SSB) over a reasonable time frame. It is required that fishing mortality will decline as the stock progresses lower into the Cautious Zone. “When the reference point is below the limit reference point (LRP), the harvest strategy is to be results-driven. Rebuilding to a level above the LRP should be achieved in a reasonable timeframe (6 to 8 years - 1.5 to 2 generations) with a high degree of probability. The TAC should be set with a very low risk of biomass decline." **Strategy:** Feedback, feed-forward **Formulation**: Model-free and model-based components **Input variable**: Projections relative to declines, stock status indicator (survey index), recent trends **Output variable**: Management objectives and other guidance for establishing management measures such as TACs **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC)

Stocks	Harvest Control Rule
North Slope Dolly Varden – Big Fish, Rat, Firth, Babbabe, Vitrekwa	**2018 Sustainability Survey:** **"Healthy**: 5% removal rate, based on the most recent stock size estimate; Voluntary harvest management; Only general legislative requirements and sport fishing limits apply. **"Cautious**: Less than 5% removal rate, based on the most recent stock size estimate; Promote rebuilding of the stock through education and specific management measures; Voluntary harvest management; Only general legislative requirements and sport fishing limits apply; Maintain regular stock assessments to determine population status and trends. **"Critical**: No targeted harvest; Harvest closures in regulations; Promote rebuilding of the stock through education and specific management measures; Maintain regular stock assessments to determine population status and trends. **"Undetermined:** Maintain regular stock assessments to determine population status and trend; Less than 5% removal rate; Promote rebuilding of the stock if required through education and specific management measures; Voluntary harvest management; Only general legislative requirements and sport fishing limits apply. Other management measures that have been implemented to all management categories are as follows: • use of identified fishing gear and fishing methods • 4" or 4.5" mesh nets, • nets no more than 30 meshes deep, • no more than three nets" **Strategy:** Feedback, feed-forward **Formulation**: Model-based **Input variable**: Projections relative to declines, stock status indicator (biomass), recent trends **Output variable**: Harvest rate targets (above USR) and limits (below USR), management objectives and other guidance for establishing management measures, science advice frequency **Operational control points**: LRP, USR (note, not established) **Management measures**: Uncertain - Co-management plans

Stocks	Harvest Control Rule
Northern Shrimp – SFA 5 Northern Shrimp – SFA 6 Northern Shrimp (Borealis) – SFA 4 Northern Shrimp (Borealis) – Eastern Assessment Zone Striped Shrimp (Montagui) – Eastern Assessment Zone	**IFMP:** **"Harvest decision rules (HDRs) SFA 4 – 6, EAZ** "The following provisional rules are to be used when setting TACs. "When SSB is Above the upper stock reference (USR): • Measures should generally promote the SSB remaining above the URP. • The base target exploitation rate will be 15% of exploitable biomass. This rate can increase gradually, particularly as an artifact of a stable TAC strategy applied during a time of declining SSB while in this zone, subject to monitoring/signals that excessive fishing mortality is being exerted on the stock. • The exploitation rate should not exceed FMSY, a level that is yet to be calculated, but is thought to be well above the base target exploitation rate. Changes in the TAC should generally not exceed 15% of the previous TAC, unless the stock is declining precipitously. • Government should not facilitate any increase in industry capacity/infrastructure during any period. "When SSB is between the limit reference point (LRP) and the upper stock reference (USR) (i.e. in the Cautious Zone): • Measures should generally promote the SSB rebuilding towards the URP, subject to natural fluctuations that may be expected to occur in biomass and survey results. • If SSB is in the upper half of the Cautious Zone, the exploitation rate should not exceed 2/3 FMSY, thought to be significantly above 15% of exploitable biomass • If SSB is in the second lowest quadrant of the Cautious Zone, the exploitation rate should not exceed 1/2 FMSY, thought to be above 15% of exploitable biomass • If SSB is in the lowest quadrant of the Cautious Zone, the exploitation rate should not exceed 15% of exploitable biomass • The TAC should not be increased if the SSB is projected to decline or is within a declining trend • Changes in the TAC should generally not exceed 15% of the previous TAC, unless the stock is declining precipitously. "When SSB is Below the limit reference point (LRP): • Measures must explicitly promote an increase in the biomass above the LRP within 6 years of falling below the LRP. • Any fishing mortality must be in the context of a rebuilding plan, and should not exceed 10%." **Strategy:** Feedback, feed-forward **Formulation**: Model-free and potentially model-based components (i.e., for quantitative projections) **Input variable**: Projections relative to declines, stock status indicator (biomass survey index proxy), recent trends **Output variable**: Harvest rate targets (above USR) and limits (above and below USR), management objectives and other guidance for establishing management measures **Operational control points**: LRP, USR, quadrant within Cautious Zone **Management measures**: Quantitative output controls (TAC)

Stocks	Harvest Control Rule
Redfish - Unit 3	**IFMP:** • "The TAC may be set to achieve a maximum 9% exploitation rate, based on the Index, when it is above the upper stock reference (USR). When the stock is above B_{MSY}, a moderate increase in exploitation rate may be considered, not to exceed 12%. • "The TAC should be set to mitigate declines and, when possible, promote positive change in mature biomass over a three-year period when it is below the upper stock reference (USR). The TAC may be set to achieve a maximum 6% exploitation rate, based on the index; however, it is required that the exploitation rate will decline as the stock progresses lower into the Cautious zone. The management response will vary depending on location of the stock within the Cautious zone, whether the stock is increasing or decreasing, whether the trajectory (growth or decline) is projected to continue, and indications of incoming recruitment to the SSB, for example. • When the mature biomass is below the limit reference point (LRP), the harvest strategy is to be results-driven rather than based on a predetermined harvest rate. Rebuilding to a level above the LRP should be achieved in a reasonable timeframe (1.5 to 2 generations) with a high degree of probability. The TAC (if appropriate) should be set with a very low risk of preventable biomass decline and the exploitation rate should not exceed 3% of the Index." **Strategy:** Feedback, feed-forward **Formulation**: Model-based **Input variable**: Projections relative to declines, stock status indicator (biomass), recent trends **Output variable**: Harvest rate limits (above and below USR), management objectives and other guidance for establishing management measures **Operational control points**: LRP, USR, B_{MSY} **Management measures**: Quantitative output controls (TAC, ITQs)

Stocks	Harvest Control Rule
Sea Scallop – Inshore SFA 28 (Bay of Fundy) – 6 subunits, 1a, 1b, 3, 4, 5, 6,	**IFMP**: "The following Harvest Control Rules (HCR) apply to SPA 1A, 1B, 3, and 4/5. HRCs are currently not available for SPA 6. If the scallop stock status is in the Healthy Zone (above the URP) and the biomass trajectory for the following year is positive, can fish at levels up to the Reference Exploitation level (RRP) where there is a neutral probability (50%) of entering the Cautious Zone. Note: If stock is experiencing a large recruitment event, the catch should be set by some other means outside this Harvest Control Rule, ensuring that catches should have a low probability (<25%) of entering the Cautious Zone. If the scallop stock status is in the Cautious Zone then fish at the Reference Exploitation level up to the one that would be derived by the formula (Biomass-LRP)/(URP-LRP)*reference exploitation level where there is a probability (>75%of entering the healthy zone. If the scallop stock status is in the Critical Zone then there will be no fishing." and "The Removal Reference of e=0.15 is currently used along with the LRPs and the USRs for the modeled SPAs (1A, 1B, 3 and 4/5)." **Strategy:** Feedback, feed-forward **Formulation**: Model-based **Input variable**: Projections relative to declines and reference points, stock status indicator (biomass), secondary indicators (recruitment) **Output variable**: Harvest rate limits (above and below USR), management objectives and other guidance for establishing management measures **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC, ITQs)
Sea Scallop – Offshore SFA 27, Georges – 2 subunits (a and b)	**IFMP:** biomass remaining above the USR; the target exploitation rate will be 25% of fully recruited biomass. Above the Upper Stock Reference point there is flexibility in increasing the exploitation rate; and the TAC can be increased despite projected decline in the biomass, provided it is not expected to reduce the fully recruited biomass significantly below the USR. When biomass is between the Lower Reference Point (LRP) and the Upper Stock Reference point (USR): measures should generally promote the rebuilding of biomass towards the Upper Stock Reference Point, subject to natural fluctuations that may be expected to occur in biomass and survey results; and the TAC should not be increased if this can reasonably be expected to result in decline trend in the fully recruited biomass. When biomass is below the Lower Reference Point (LRP): measures must explicitly promote an increase in the biomass; the exploitation rate must be in the context of a rebuilding plan; and if the stock falls below the proxy LRP, research may be undertaken to better determine the true Limit Reference Point for this stock, the level below which reproductive success would be seriously impaired." **Strategy:** Feedback, feed-forward **Formulation**: Model-based **Input variable**: Projections relative to declines and reference points, stock status indicator (biomass), recent trends **Output variable**: Harvest rate target (above USR), management objectives and other guidance for establishing management measures, science advice **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC)

Stocks	Harvest Control Rule
Silver Hake – 4VWX	**IFMP:** "Keep fishing mortality of 4VWX silver hake moderate by using the following references and risk tolerances: • When the biomass is above the upper stock reference (USR), in the Healthy zone, the TAC may be set to an F_{TARGET} =.24. This (F_{TARGET}) is subject to a reduction as low as 0.1 if the stock is in a declining trajectory and is nearing the USR. The determination of the risk tolerance within that range will depend on additional considerations, including but not limited to: indications of incoming recruitment to the fishery; the population age structure; the projected trajectory of the SSB; and market conditions. • When the biomass is between the upper stock reference and the limit reference point, in the Cautious zone, in The TAC should be set to mitigate declines and, when possible, promote positive change in spawning stock biomass (SSB) over a three-year period. It is required that fishing mortality will decline as the stock progresses lower into the Cautious zone. The TAC may be set to a F_{TARGET} = 0.1, subject to a reduction as low as 0.05 if the stock is in a declining trajectory and is nearing the LRP. The management response will vary depending on location of the stock within the Cautious zone, whether the stock is increasing or decreasing, whether the trajectory (growth or decline) is projected to continue, and indications of incoming recruitment to the SSB, for example. • When the biomass is below the limit reference point (LRP), in the Critical zone, the harvest strategy is to be results-driven rather than based on a predetermined harvest rate. Rebuilding to a level above the LRP should be achieved in a reasonable timeframe (1.5 to 2 generations) with a high degree of probability (greater than 75%). The TAC (if appropriate) should be set with a very low (less than 5%) risk of preventable biomass decline." **Strategy:** Feedback, feed-forward **Formulation**: Model-based **Input variable**: Projections relative to declines and reference points, stock status indicator (biomass), recent stock trends **Output variable**: Fishing mortality target range (above the LRP), objectives, other guidance for establishing management measures **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC, ITQs)

Stocks	Harvest Control Rule
Surf Clam – Banquereau Surf Clam – Grand Bank	**IFMP**: "Above the Upper Reference Point (URP): Measures should promote the biomass remaining above the URP. The upper removal reference rate will be F=0.33M (0.0264) for the stock while it is in the healthy zone. This removal reference is applied to the harvestable biomass >75g/m2. Between the Limit Reference Point (LPR) and the Upper Reference Point (URP): Fishing mortality will be reduced. Measures should promote the rebuilding of biomass towards the Upper Reference Point. The TAC should not be increased if this can reasonably be expected to result in declining trend in the biomass. Survey frequency will be reexamined in the context of increased risk to the stock. Below the Limit Reference Point (LRP): Fishing mortality will be reduced to the lowest practicable level If the stock falls below the proxy LRP research may be undertaken to better determine the true Limit Reference Point for this stock, the level below which reproductive success would be seriously impaired." **Strategy:** Feedback, feed-forward **Formulation**: Model-based **Input variable**: Projections relative to declines and reference points, stock status indicator (biomass) **Output variable**: Harvest rate target (above USR), management objectives and other guidance for establishing management measures, science advice (survey frequency) **Operational control points**: LRP, USR **Management measures**: Quantitative output controls (TAC)
Objective-based Rules	
Beluga – Northern Quebec (Nunavik) – Eastern Hudson Bay subunit	**Res Doc 2017/060**: "The current management objective for EHB beluga is referred to as Sustainable Yield (SY), which identifies the catch that maintains a constant population over a period of time. In the case of EHB beluga, it is the catch that has a 50% probability of the population not declining over a period of 10 years." **Strategy:** Feed-forward **Formulation**: Model-based **Input variable**: Projections of stock status **Output variable**: Catch recommendation meeting objective **Operational Control Points**: n/a **Management measures**: Quantitative output controls (TAC)

Stocks	Harvest Control Rule
Green Sea Urchin	**IFMP:** "A table of harvest options is produced for each of the two main harvest areas. The harvest options include the median MSY estimates, a range of reductions from the median MSY estimates, and the probability that the reductions may be greater than or equal to the true MSY (i.e. the risk). For each harvest option, the allocations of quota to each of the PFMAs are also provided based on the proportion that area contributed to aggregate landings from past fishing seasons. The managers decide the risk level from the table, and set the quota limit for the fishery. Quotas assigned during previous years have had a very low probability (low risk) that they were equal to or greater than the true MSY." **Strategy:** Feed-forward **Formulation**: Model-based **Input**: Projections of stock status **Output**: Catch recommendation meeting objective **Operational Control Points**: n/a **Management measures**: Quantitative output controls (TAC, IQs)
Constant Harvest Rate Rules	
Arctic Char - Cumberland Sound	**SAR 2018/021:** Refers to a "target exploitation rate of 5%" for each of the Iqalujjuaq Fiord, Irvine Inlet, and Ijaruvung Lake subunits. **Strategy:** Constant rate **Formulation**: Model-based **Input**: Stock status indicator (estimated biomass) **Output**: Catch limit recommendation **Operational Control Points**: n/a **Management measures**: Quantitative output controls (TAC, ITQs)

Stocks	Harvest Control Rule
Atlantic Halibut - 3NOPs4VWX+5	**IFMP**: "The general strategy is to limit TAC fluctuations and optimize catch levels while maintaining the SSB in the Healthy zone for the long-term. A constant *F* strategy is utilized for this stock between framework assessments. Within the constraint of *F* not to exceed *M*, the decision on the appropriate level for *F* is to be determined in the framework assessment year considering the acceptable level of risk for the stock in relation to the results of the long-term simulations. In the interim years, the change in the TAC will be based on the change in the biomass index provided by the rolling 3-year mean of the longline halibut survey, subject to the 15% maximum change. If during the interim period there are three years of the RV survey below its long-term mean, a framework assessment could be triggered." **Strategy:** Constant rate **Formulation**: Model-free **Input**: Stock status indicator (biomass index) **Output**: Catch limit recommendation given cap **Operational Control Points**: n/a **Management measures**: Quantitative output controls (TAC, ITQs)
Beluga – Cumberland Sound Bowhead – Eastern Canada – West Greenland (ECWG) Narwhal – (EHB BB) Admiralty Inlet Narwhal – East Baffin Narwhal – Eclipse Sound Narwhal – Northern Hudson Bay Narwhal – Smith/Jones/Parry Narwhal - Somerset	**Potential Biological Removals** PBR = 0.5 * R_{max} * f * N_{min}, where R_{max} is the maximum rate of population increase (often assumed to be 12% for pinnipeds and 4% for cetaceans), f is a recovery factor between 0.1 and 1.0 (often 0.5), and N_{min} is the estimated population size (20^{th} percentile of the log-normal distribution of the most recent size estimate; Stenson et al. 2014). **Strategy:** Constant rate **Formulation**: Model-free **Input**: Stock status indicator (N_{min}) **Output**: Catch limit recommendation **Operational Control Points**: n/a **Management measures**: Quantitative output controls (TAC, ITQs)

Stocks	Harvest Control Rule
Pacific Oyster	**2018 Sustainability Survey**: "Commercial quotas for each harvest site are established in the IFMP based on estimate of the biomass for that specific beach. DFO uses a precautionary harvest rule of 10% of biomass for that site." **Strategy:** Constant rate **Formulation**: Model-free **Input variable**: Stock status indicator **Output variable**: Catch limit recommendation **Operational Control Points**: n/a **Management measures:** Quantitative output controls (TAC)
Pink and Spiny Scallop	**2018 Sustainability Survey**: "Quotas are set based on the estimate of the total legal size scallop biomass and a recommended harvest rate of 4%. Catch reporting is required for monitoring quotas and, therefore, control exploitation." **Strategy:** Constant rate **Formulation**: Model-free **Input variable**: Stock status indicator **Output variable**: Catch limit recommendation **Operational Control Points**: n/a **Management measures:** Quantitative output controls (TAC)
Sea Cucumber	**IFMP:** "In 2011 the fishery moved to a rotational style fishery in which each quota management area is fished once every three years. Instead of tripling the harvest rate for each quota management area as is done in most rotational style fisheries, managers chose a harvest rate within the range of 3.5 to 10.3 percent recommended in Hand et al 2009 for an annual style fishery. A triennial harvest rate of approximately 10 percent is applied to most quota management areas. This harvest rate is equivalent to a 3.3 percent annual harvest rate and is less than the 4.2 or 6.7 percent harvest rate used previously. The West Coast Vancouver Island licence area and portions of the East Coast of Vancouver Island licence area remain as annual style fisheries and a harvest rate of between 3.3 and 4.2 percent is applied to these areas annually." **Strategy:** Constant rate **Formulation**: Model-free **Input variable**: Stock status indicator **Output variable**: Catch limit recommendation **Operational Control Points**: n/a **Management measures:** Quantitative output controls (TAC)

APPENDIX D: REFERENCES BY STOCK

Table 14: Science advice documents from the Canadian Science Advisory Secretariat and the Fisheries and Oceans Canada website consulted to supplement this review. IFMP = integrated fisheries management plan. Proc = Proceedings. Res Doc = Research Document. SAR = Science Advisory Report. SR = Science Response.

Stock	Science Advice Documents	Reference (IFMP)
American Lobster - LFA 3-14c	SAR 2016/052, Res Doc 2015/057	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/lobster-homard/area-zone-3-14c-eng.html
American Plaice - Southern Gulf of St. Lawrence (4T)	SAR 2016/031, SR 2019/006, Res Doc 2016/057, Res Doc 2012/108, SAR 2012/018	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3pn-eng.html
Arctic Char - Cambridge Bay	SAR 2013/051, SAR 2014/051	http://publications.gc.ca/collections/collection_2016/mpo-dfo/Fs134-22-2015-eng.pdf
Arctic Char - Cumberland Sound	SR 2009/013, SAR 2010/060, SAR 2018/021, SAR 2005/028	n/a
Atlantic Canada Dogfish - 4VWNX - 5	SAR 2014/055, SR 2016/019, Res Doc 2015/065, SAR 2020/001	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-4vwx5-eng.html#toc3.2
Atlantic Cod - 4X5Y	SAR 2019/015	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-4vwx5-eng.html#toc6.2
Atlantic Halibut - 3NOPs4VWX+5	SAR 2015/012, SR 2018/022, Res Doc 2016/001	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-4vwx5-eng.html#app-9
Atlantic Halibut - 4RST	SAR 2019/038	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3pn-eng.html
Atlantic Walrus - Baffin Bay (High Arctic)	SAR 2013/034	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/walrus-atl-morse/walrus-nunavut-morse-eng.html
Atlantic Walrus - Foxe Basin (Central Arctic)	SAR 2013/034, SAR 2016/007	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/walrus-atl-morse/walrus-nunavut-morse-eng.html#app2
Atlantic Walrus - Hudson Bay-Davis Strait (Central Arctic)	SAR 2015/063, Res Doc 2016/036	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/walrus-atl-morse/walrus-nunavut-morse-eng.html#app2
Atlantic Walrus - Penny Strait-Lancaster Sound (High Arctic)	SAR 2013/034	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/walrus-atl-morse/walrus-nunavut-morse-eng.html#app2

Stock	Science Advice Documents	Reference (IFMP)
Atlantic Walrus - South and East Hudson Bay	SAR 2015/063, Res Doc 2016/036	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/walrus-atl-morse/walrus-nunavut-morse-eng.html#app2
Atlantic Walrus - West Jones Sound (High Arctic)	SAR 2013/034	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/walrus-atl-morse/walrus-nunavut-morse-eng.html#app2
Beluga - Cumberland Sound	SAR 2016/037; SAR 2019/024	n/a
Beluga - Northern Quebec (Nunavik)	SAR 2018/008, Res Doc 2017/062	n/a
Bocaccio Rockfish	SAR 2009/040, SAR 2012/059, Res Doc 2012/109	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Bowhead - Eastern Canada - West Greenland (ECWG)	SAR 2015/052	n/a
Canary Rockfish	SAR 2009/041, SR 2009/019, Res Doc 2009/013	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Capelin - 4RST	SAR 2018/037	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/capelin-capelan/index-eng.html
Capelin - SA2+3KLPs	SAR 2019/048	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/capelin-area1-11-zone-capelan/capelin-capelan-2018-eng.html
Cod - 4RS3Pn	SR 2006/001, Res Doc 2011/003, Res Doc 2012/171, SAR 2019/032, Res Doc 2019/075	n/a
Cod - Atlantic (3Ps)	SAR 2019/009	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3p-2016-eng.html
Cod - Northern (2J3KL)	Proc 2010/053, SAR 2018/038, SAR 2019/058, SAR 2019/50	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/2019/groundfish-poisson-fond-2_3klmno-eng.htm
Cod - Southern Gulf of St. Lawrence (4TVn)	SAR 2019/021, Res Doc 2015/080, Res Doc 2019/038	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3pn-eng.html
Common Clam	SAR 2017/024	n/a
Dogfish - Inside	SAR 2010/057, Res Doc 2011/034	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Dogfish - Outside	SAR 2010/057, Res Doc 2011/034	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf

Stock	Science Advice Documents	Reference (IFMP)
Dungeness Crab	SAR 2015/047 and Zhang, Z. and J.S. Dunham. 2013. Construction of biological reference points for management of the Dungeness crab, Cancer magister, fishery in the Fraser River Delta, British Columbia, Canada. Fisheries Researc h. 139: 18-27.	https://waves-vagues.dfo-mpo.gc.ca/Library/40777613.pdf
Eel (Large)	SAR 2013/078 (RPA)	n/a
Elvers	SAR 2013/078 (RPA)	n/a
Eulachon - Fraser River	SAR 2015/002, Res Doc 2011/101, Res Doc 2012/098 (RPAs)	https://waves-vagues.dfo-mpo.gc.ca/Library/40751089.pdf
Euphausiids	Res Doc 2013/032	https://waves-vagues.dfo-mpo.gc.ca/Library/40640899.pdf
Gaspereau	SAR 2007/030, RES DOC 2016/105	n/a
Geoduck	SAR 2011/081, SAR 2017/037, Res Doc 2007/064, Res Doc 2011/121	https://waves-vagues.dfo-mpo.gc.ca/Library/40662469.pdf
Green Sea Urchin	SAR 2009/080, SR 2018/054	https://waves-vagues.dfo-mpo.gc.ca/Library/40706461.pdf
Greenland Halibut - 4RST	SAR 2019/023	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3pn-eng.html
Greenland Halibut - Cumberland Sound	SAR 2008/040, SR 2008/011	n/a
Grey Seal	SAR 2017/045, Res Doc 2017/052	https://www.dfo-mpo.gc.ca/fisheries-peches/seals-phoques/reports-rapports/mgtplan-planges20112015/mgtplan-planges20112015-eng.html
Gulf Shrimp	SAR 2011/062, Res Doc 2012/006, SAR 2018/015, SR 2019/005, Res Doc 2012/101.	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2018-eng.html
Haddock - 4X5Y	Res Doc 2017/026, SAR 2017/006, SR 2018/028	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-4vwx5-eng.html#app-8
Harp Seal - Northwest Atlantic	SAR 2020/020, SAR 2014/011	https://www.dfo-mpo.gc.ca/fisheries-peches/seals-phoques/reports-rapports/mgtplan-planges20112015/mgtplan-planges20112015-eng.html
Herring - 2J3IKLPs	SAR 2019/049	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/herring-hareng/herring-areas-1-11-zones-2-3-hareng-eng.html

Stock	Science Advice Documents	Reference (IFMP)
Herring - 4R (Fall Spawner) / (Spring Spawner)	Res Doc 2010/099, SAR 2018/036	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/herring-hareng/herring-4r3pn-hareng-eng.html
Herring - 4S	SAR 2019/037	n/a
Herring - 4T (Fall Spawner)	SAR 2005/070, SAR 2018/029	n/a
Herring - 4T (Spring Spawner)	SAR 2005/070, SAR 2018/029	n/a
Herring - 4VWX	SAR 2018/052, Res Doc 2012/025	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/herring-hareng/herring-hareng-2013-eng.html
Herring - Central Coast (Pacific)	SAR 2018/002, SAR 2019/001, SR 2019/001, Res Doc 2019/050	https://waves-vagues.dfo-mpo.gc.ca/Library/40762713.pdf
Herring - Haida Gwaii (Pacific)	SAR 2018/002, SAR 2019/001, SR 2019/001, Res Doc 2019/050	https://waves-vagues.dfo-mpo.gc.ca/Library/40762713.pdf
Herring - Prince Rupert District (North Coast / Pacific)	SAR 2018/002, SAR 2019/001, SR 2019/001, Res Doc 2019/050	https://waves-vagues.dfo-mpo.gc.ca/Library/40762713.pdf
Herring - Strait of Georgia (Pacific	SAR 2018/002, SAR 2019/001, SR 2019/001, Res Doc 2019/050	https://waves-vagues.dfo-mpo.gc.ca/Library/40762713.pdf
Herring - WCVI	SAR 2018/002, SAR 2019/001, SR 2019/001, Res Doc 2019/050	https://waves-vagues.dfo-mpo.gc.ca/Library/40762713.pdf
Icelandic Scallop - 16EF-18A	SAR 2016/027	n/a
Intertidal Clams - Central Coast-Heiltsuk Manila	Res Doc 2001/059, Res Doc 2001/089, SAR 2010/007	n/a
Intertidal Clams - Depuration	Res Doc 2005/052, Res Doc 2000/122	https://waves-vagues.dfo-mpo.gc.ca/Library/40757547.pdf
Intertidal Clams - North Coast Haida Gwaii Razor	Res Doc 2001/152, Proc 2009/055	http://www.pac.dfo-mpo.gc.ca/fm-gp/mplans/razorclam-couteaux-ifmp-pgip-sm-eng.pdf
Intertidal Clams - South Coast-Vancouver Island	Res Doc 1997/044	https://waves-vagues.dfo-mpo.gc.ca/Library/40757547.pdf
Lake Trout - Great Slave Lake	No CSAS document.	n/a

Stock	Science Advice Documents	Reference (IFMP)
Lake Whitefish - Great Slave Lake	SAR 2015/042	n/a
Lingcod - Outside	For outside, RES DOC 2011/124, SAR 2011/051 and for inside: RES DOC 2016/013, SAR 2015/014	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Lobster - 17	SAR 2019/059, SAR 2016/044	n/a
Lobster - Areas 19-20-21 (Gaspé)	SAR 2019/060, SAR 2016/043, SR 2013/027	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/lobster-homard/index-eng.html
Lobster - Inshore LFA 27-33	Res Doc 2011/058, SAR 2011/064, SR 2018/030, Res Doc 2020/017, SAR 2020/026	https://dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/maritimes/inshore-lobster-2011-eng.html
Lobster - Inshore LFA 34	SAR 2013/024, SR 2017/038, SR 2018/044	https://dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/maritimes/inshore-lobster-2011-eng.html
Lobster - Inshore LFA 35-38	SAR 2013/023, SR 2017/039, SR 2018/049	https://dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/maritimes/inshore-lobster-2011-eng.html
Lobster - Offshore LFA 41	SAR 2018/004, SR 2019/023	https://dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/lobster-crab-homard/index-eng.html
Lobster - Southern Gulf (LFA 23, 24, 25, 26A, 26B)	SAR 2013/029, Res Doc 2014/036, SR 2014/027, SR 2019/008	http://www.glf.dfo-mpo.gc.ca/Gulf/FAM/IMFP/2014-Lobster-Gulf-Region
Lobster - Zone 22 (MI)	SAR 2016/045, SAR 2019/061	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/lobster-homard/area-zone-22-eng.html
Longspine Thornyhead	Res Doc 2004/059, Res Doc 2005/097	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Mackerel - Atlantic (NAFO 3-4)	SAR 2019/035	n/a
Narwhal - (EHA BB) Admiralty Inlet	SAR 2015/046	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/narwhal-narval/index-eng.html
Narwhal - East Baffin	SAR 2015/046	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/narwhal-narval/index-eng.html
Narwhal - Eclipse Sound	SAR 2015/046	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/narwhal-narval/index-eng.html
Narwhal - Northern Hudson Bay	SAR 2009/082, SAR 2011/073; SAR 2008/035 SR 2010/011 SAR 2009/079 SAR 2009/082 SAR 2011/021 SAR 2011/073 SAR 2012/028 SAR 2012/047 SAR 2015/006	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/narwhal-narval/index-eng.html

Stock	Science Advice Documents	Reference (IFMP)
Narwhal - Smith/Jones/Parry	SAR 2015/046	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/narwhal-narval/index-eng.html
Narwhal - Somerset	SAR 2015/046	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/narwhal-narval/index-eng.html
North Slope Dolly Varden - Big Fish, Rat, Firth, Babbage, Vittrekwa	SAR 2012/065, SAR 2016/055, SAR 2016/058, Res Doc 2018/029.	n/a
Northern Shrimp - SFA 5	SAR 2019/027	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2018-002-eng.html
Northern Shrimp - SFA 6	SAR 2019/027	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2018-002-eng.html
Northern Shrimp (Borealis) - Eastern Assessment Zone	SAR 2019/011	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2018-002-eng.html
Northern Shrimp (Borealis) - SFA 4	SAR 2019/027	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2018-002-eng.html
Northern Shrimp (Borealis) - WAZ	SAR 2019/011	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2018-002-eng.html
Northern Shrimp (Montagui) - SFA 4	SAR 2019/027	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2018-002-eng.html
Northern Shrimp (Montagui) - WAZ	SAR 2019/011	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2018-002-eng.html
Pacific Ocean Perch - PMFC 3CD-WCVI	Res Doc 2013/093, SAR 2013/038, SAR 2017/043	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Pacific Ocean Perch - PMFC 5ABC-QCS	Res Doc 2013/093, SAR 2013/038, SAR 2017/043	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Pacific Ocean Perch - PMFC 5DE-HS/DE/WHG	Res Doc 2013/093, SAR 2013/038, SAR 2017/043	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Pacific Oyster	SAR 2014/029	https://waves-vagues.dfo-mpo.gc.ca/Library/40757493.pdf
Pink and Spiny Scallop	SAR 2010/078, SR 2015/001	https://waves-vagues.dfo-mpo.gc.ca/Library/40779105.pdf

Stock	Science Advice Documents	Reference (IFMP)
Pollock - 4X5 (Western Component)	SAR 2019/018, SAR 2011/054, SAR 2012/035, SR 2018/023, Res Doc 2011/090.	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-4vwx5-eng.html
Prawn Trap	Proc 2008/031, SR 2012/041	https://waves-vagues.dfo-mpo.gc.ca/Library/40780454.pdf
Queen / Snow Crab - CFA 1-12	Res Doc 2018/054, SAR 2019/041	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/index-eng.html
Quillback Rockfish - Inside	SAR 2011/072	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Quillback Rockfish - Outside	SAR 2011/072	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Red Sea Urchin	Res Doc 2013/094, Res Doc 2019/061, SAR 2019/036	https://waves-vagues.dfo-mpo.gc.ca/Library/40797879.pdf
Redfish - Unit 1	SAR 2018/032, SAR 2018/033, SAR 2020/019	https://www.dfo-mpo.gc.ca/fisheries-peches/decisions/fm-2019-gp/atl-25-eng.html http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3p-2016-eng.html
Redfish - Unit 2	SAR 2018/032, SAR 2018/033, SAR 2020/019	https://www.dfo-mpo.gc.ca/fisheries-peches/decisions/fm-2019-gp/atl-25-eng.html http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3p-2016-eng.html
Redfish - Unit 3	SAR 2012/004, SR 2019/014.	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-4vwx5-eng.html
Rock Crab - CFA 23, 24, 25, 26A	Res Doc 2014/032, SAR 2013/030, SR 2019/007	n/a
Rougheye Rockfish	Res Doc 2005/096	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Sablefish	Res Doc 2009/042, Res Doc 2009/043, Res Doc 2011/063, Res Doc 2019/032, SAR 2009/060, SAR 2011/025, SAR2016/015, SAR 2017/017, SR 2014/025	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Sardine - Pacific	SAR 2013/037, SR 2018/041, SR 2019/027	https://waves-vagues.dfo-mpo.gc.ca/Library/40696716.pdf
Scallop - Southern Gulf of St. Lawrence (SFA 21a, b, c, 22, 23, 24)	SAR 2019/006	n/a
Sea Cucumber	SAR 2010/080	https://waves-vagues.dfo-mpo.gc.ca/Library/40720287.pdf

Stock	Science Advice Documents	Reference (IFMP)
Sea Cucumber - 3Ps	SAR 2017/029, SR 2018/010	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/sea_cucumber-holothuries/2019/index-eng.html
Sea Scallop - Area 20	SAR 2016/027, SR 2019/020; Res Doc 2010/068	n/a
Sea Scallop - Inshore SFA 28 (Bay of Fundy)	Res Doc 2012/018, Res Doc 2014/110, SAR 2016/004 SR 2018/003, SAR 2019/039	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/scallop-petoncle/scallop-petoncle2015-toc-eng.html
Sea Scallop - Inshore SFA 29W	Res Doc 2016/107, SAR 2015/035, SR 2018/033, SAR 2019/034	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/scallop-petoncle/scallop-petoncle2015-toc-eng.html
Sea Scallop - Offshore SFA 26 German, Browns	Res Doc 2012/018, SAR 2013/059, SR 2018/036	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/scallop-petoncle/2018/index-eng.html
Sea Scallop - Offshore SFA 27, Georges	SAR 2013/058, SR 2018/037	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/scallop-petoncle/2018/index-eng.html
Shrimp - Scotian Shelf (SFA 13-15)	SR 2018/014, Res Doc 2018/005, SAR 2019/013	https://dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2013-eng.html
Shrimp Trawl	Res Doc 2000/149, Proc 2008/031, SAR 2011/085	https://waves-vagues.dfo-mpo.gc.ca/Library/40779221.pdf
Silver Hake - 4VWX	SAR 2013/018, SR 2018/031	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-4vwx5-eng.html#app-11
Snow Crab - 12A	SAR 2019/047, SAR 2018/047	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/snow-crab-neiges-eng.html
Snow Crab - 12B	SAR 2019/047, SAR 2018/047	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/snow-crab-neiges-eng.html
Snow Crab - 12C	SAR 2019/047, SAR 2018/047	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/snow-crab-neiges-eng.html
Snow Crab - 13	SAR 2019/047, SAR 2018/047	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/snow-crab-neiges-eng.html
Snow Crab - 14	SAR 2019/047, SAR 2018/047	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/snow-crab-neiges-eng.html
Snow Crab - 15	SAR 2019/047, SAR 2018/047	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/snow-crab-neiges-eng.html
Snow Crab - 16	SAR 2019/047, SAR 2018/047	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/snow-crab-neiges-eng.html

Stock	Science Advice Documents	Reference (IFMP)
Snow Crab - 16A	SAR 2019/047, SAR 2018/047	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/snow-crab-neiges-eng.html
Snow Crab - 17	SAR 2019/047, SAR 2018/047	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/snow-crab-neiges-eng.html
Snow Crab - CFA 12 (12, 18, 25, 26), 12E, 12F, 19	Res Doc 2014/083, SAR 2010/014, SAR 2012/002, SAR 2014/007, SAR 2019/010	http://www.glf.dfo-mpo.gc.ca/Gulf/FAM/IMFP/2014-Snow-Crab-Gulf-Region#7
Snow Crab - Scotian Shelf (4X)	SAR 2018/046, Res Doc 2012/024, SAR 2019/053	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/snow-crab-neiges2013-eng.html
Snow Crab - Scotian Shelf (ENS-N)	SAR 2018/046, Res Doc 2012/024, SAR 2019/053	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/snow-crab-neiges2013-eng.html
Snow Crab - Scotian Shelf (ENS-S)	SAR 2018/046, Res Doc 2012/024, SAR 2019/053	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/snow-crab-neiges2013-eng.html
Stimpson's Surfclam	SAR 2018/022	n/a
Striped Bass - Bay of Fundy	SAR 2014/053	n/a
Striped Shrimp (Montagui) – Eastern Assessment Zone	SAR 2019/011	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2018-002-eng.html
Surf Clam - Banquereau	SAR 2017/047, SR 2018/046, SR 2019/041	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/clams-palourdes/clams-palourdes-2014-eng.html#toc6
Surf Clam - Grand Bank	SAR 2010/063, Res Doc 2011/052, Res Doc 2013/007, SR 2018/046, SR 2019/041	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/clams-palourdes/clams-palourdes-2014-eng.html#toc6
Whelk - 3PS	SAR 2013/066	n/a
White Hake - 4T	SAR 2016/034, Res Doc 2016/045 (RPA)	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3pn-eng.html
Winter Flounder - 4RST	SAR 2017/022, Res Doc 2019/026	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3pn-eng.html
Witch Flounder - 3Ps	SAR 2018/011	http://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3p-2016-eng.html
Witch Flounder - 4RST	SAR 2017/036, Res Doc 2018/023	https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3pn-eng.html

Stock	Science Advice Documents	Reference (IFMP)
Yelloweye Rockfish - Inside Population	SAR 2011/084	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Yelloweye Rockfish - Outside Population	SAR 2015/060, Res Doc 2018/001	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf
Yellowmouth Rockfish	SAR 2011/060 (RPA), Res Doc 2012/095	https://waves-vagues.dfo-mpo.gc.ca/Library/40765167.pdf