A fishery decision-making framework incorporating the Precautionary Approach

Introduction

This paper describes a general fishery decision-making framework[1] for implementing a harvest strategy that incorporates the Precautionary Approach (PA). The framework applies where decisions on harvest strategies or harvest rates for a stock must be taken on an annual basis or other time frame to determine Total Allowable Catch or other measures to control harvests. The framework applies to key harvested stocks managed by Fisheries and Oceans Canada; that is, those stocks that are the specific and intended targets of a fishery, whether in a commercial, recreational or subsistence fishery. In applying the framework, all removals of these stocks from all types of fishing must be taken into account. While application of this framework to key harvested stocks is the minimum requirement, it may be applied more broadly to other stocks where necessary and as circumstances warrant.

This decision framework is one part of an overall Sustainable Fisheries Framework for Canadian fisheries, which includes a number of other policies and initiatives, completed or being developed, such as a Forage Species policy and a Sensitive Benthic Areas policy that together will provide a more rigorous and comprehensive approach to managing Canada's fisheries, factoring in ecosystem considerations and precaution. The Sustainable Fisheries Framework applies, and all the policies pursuant to it apply, to fishery decisions on a stock by stock basis. This paper begins with background on the PA in Canadian fisheries then describes the elements of the decision framework and considerations for applying it in a fishery.

The Precautionary Approach in Canadian Fisheries

In resource management, the PA is, in general, about being cautious when scientific information is uncertain, unreliable or inadequate and not using the absence of adequate scientific information as a reason to postpone or fail to take action to avoid serious harm to the resource.

The United Nations *Agreement on Straddling and Highly Migratory Fish Stocks* (UNFA)[2], which came into force in 2001, commits Canada to use the PA in managing straddling stocks as well as, in effect, domestic stocks. In 2003, the Privy Council Office,

[1] This decision framework is guided by the legal and policy framework designed to deliver the management of Canada's fisheries and oceans resources, including the *Fisheries Act*, the *Oceans* Act, and the *Species at Risk Act*.

[2] United Nations, Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Related to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. Sixth Session, New York, 24 July – 4 August 1995, Article 6 and Annex II.

on behalf of the Government of Canada published a framework applicable to all federal government departments that set out guiding principles for the application of precaution to decision making about risks of serious or irreversible harm where there is a lack of full scientific certainty.[3]

In 2004, the Atlantic Fisheries Policy Review (AFPR) led by DFO called for a comprehensive risk management framework for decision-making, which incorporated the PA and included the following elements:

- reference points linked to stock and ecosystem indicators;
- objectives for desirable resource and fishery outcomes; and
- resource use strategies to scale resource use to its condition in a manner that avoids undesirable outcomes

One of the main drivers for the AFPR recommendation on conservation was the stock declines that have occurred in recent decades in some groundfish fisheries.

In June 2005, DFO adopted the Wild Salmon Policy for Pacific salmon[4], which incorporates a precautionary approach to decision-making. In May 2006, DFO Science released a paper outlining the minimal requirements, from a science perspective, for a harvest strategy to be compliant with the Precautionary Approach.[5] SAR 2006-23 informs the basic elements of this framework

Components of the General Decision Framework [6]

The following are the primary components of the generalized framework:

1. Reference points and stock status zones (Healthy, Cautious and Critical). Table 1 illustrates the three stock status zones and includes generalized criteria for management actions for key harvested stocks.

2. Harvest strategy and harvest decision rules

3. The need to take into account uncertainty and risk when developing reference points and developing and implementing decision rules.

[3] Canada Privy Council Office, 2003. A Framework for the Application of Precaution in Science-based Decision-Making about Risk

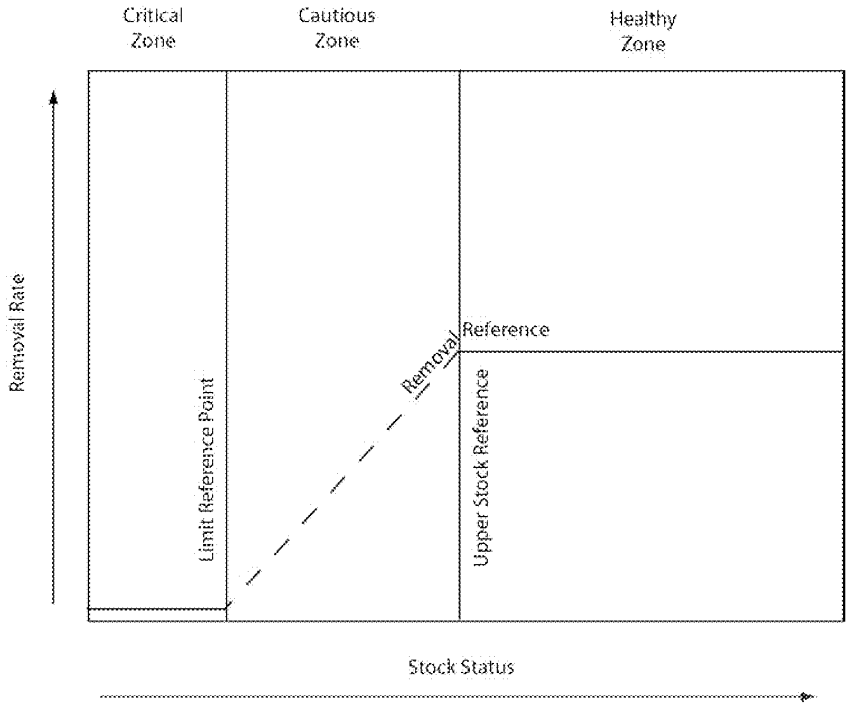
[4] For the purposes of applying the PA to decisions regarding the management of Pacific salmon stocks, Canada's Policy for Conservation of Wild Pacific Salmon applies.

[5] DFO 2006. A Harvest Strategy Compliant with the Precautionary Approach. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/023.

[6] This decision framework is consistent with the 1995 FAO Code of Conduct for Responsible Fisheries and the 1996 FAO Technical Guidelines for Responsible Fisheries: Precautionary Approach to Capture Fisheries and Species Introductions.

Reference Points and Stock Status Zones

The stock status zones are created by defining the Limit Reference Point (LRP) at the Critical:Cautious zone boundary, and an Upper Stock Reference Point (USR) at the Cautious:Healthy zone boundary and the Removal Reference for each of the three zones. The three-zoned diagram below shows these different elements.

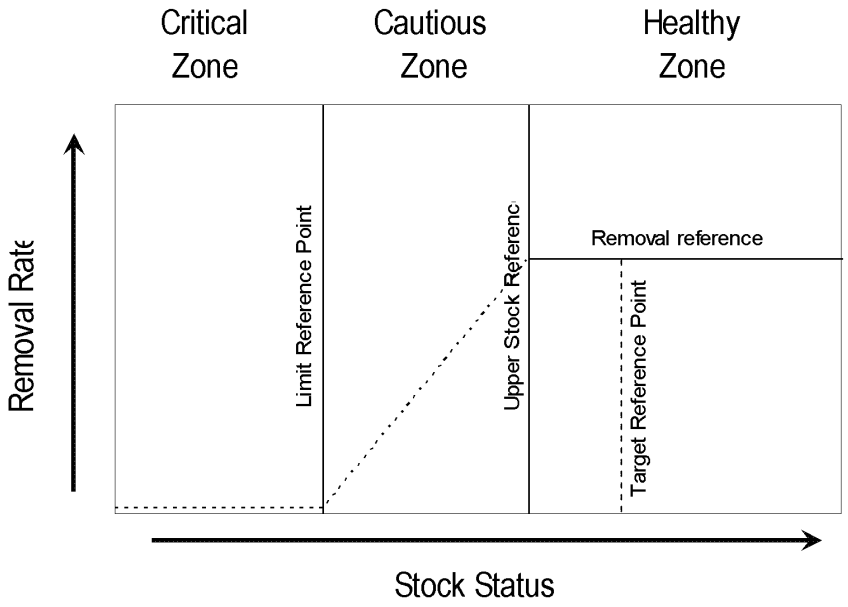


The LRP represents the stock status below which serious harm is occurring to the stock. At this stock status level, there may also be resultant impacts to the ecosystem, associated species and a long-term loss of fishing opportunities. Several approaches for calculating the LRP are in use and may be refined over time. The units describing stock status will vary depending on the nature of the resource (groundfish, shellfish, salmonids or marine mammals). The LRP is based on biological criteria and established by Science through a peer reviewed process.

Under this framework, the USR can perform two functions. First, in accordance with SAR 2006-023 the USR is the stock level threshold below which removals must be progressively reduced in order to avoid reaching the LRP. For this reason, under this framework, the USR, at minimum, must be set at an appropriate distance above the LRP to provide sufficient opportunity for the management system to recognize a declining stock status and sufficient time for management actions to have effect. Secondly, the USR can be a target reference point (TRP) determined by productivity objectives for the

stock, broader biological considerations[7] and social and economic objectives for the fishery.[8] A TRP is a required element under UNFA and in the FAO guidance on the application of the PA, as well as ecocertification standards based on it, such those of the Marine Stewardship Council and may also be desireable in other situations.

In practice, the threshold point below which removals must be reduced to avoid serious harm (USR) can be different than the TRP. However, it is essential that while socio-economic factors may influence the location of the USR, these factors must not diminish its minimum function in guiding management of the risk of approaching the LRP. In either case, the USR would be developed by fishery managers informed by consultations with the fishery and other interests, with advice and input from Science. As an illustration, the diagram below shows the TRP as distinct from the USR.



For many stocks, setting the LRP and USR, as well as a TRP, in biomass terms is suitable, but other units (such as escapement for salmon, or yield for effort controlled fisheries) may be used to indicate stock status where appropriate. In data deficient cases, priority should go to monitoring the stock and establishing data time series to support the identification of an LRP. When developing reference points efforts should be made to take into consideration the range of factors which may affect the productivity of the stock including changes in ocean conditions, where information is available.

[7] For example, taking into account the importance of a prey species when determining appropriate abundance targets.

[8] Long term resource objectives can help to guide decisions and the design of harvest decision rules as well as serve as the basis for future reviews of decision-making, harvest rule and fishery performance. Guidelines will be developed for identifying long term resource and fishery objectives.

The Removal reference is the maximum acceptable removal rate for the stock. It is normally expressed in terms of fishing mortality (F) or harvest rate. It could be described in ways other than F or harvest rate but it always must be described in terms of fishery-related pressure that affects the overall stock. The Removal reference includes all mortality from all types of fishing. To comply with the UNFA, the Removal reference must be less than or equal to the removal rate associated with maximum sustainable yield. Both the previous diagrams illustrate how the Removal reference would be adjusted depending on the stock's abundance and its location in the three stock status zones. In the Cautious zone, the adjustment of the Removal reference does not have to follow a linear relationship as shown in the diagram but a progressive reduction in removals is required.

Reference points will usually be determined using standard biomass and harvest metrics. However, for a number of stocks, such measurements are not available. In these cases, precautionary management actions should be based on the estimates of productive potential and harvest that are the most appropriate for the stock of concern and data available, with the objective of avoiding serious harm to reproductive capacity of the stock. Annex 1a elaborates on the cases where other indicators are used as reference points for a particular stock or fishery. Such actions aiming at conserving reproductive capacity could include the use of minimum harvest sizes (above size at first maturity), gear restrictions, and/or temporal or local closures. In these cases, reference points could be based on empirical measurements of reproductive potential (e.g. minimum egg per recruit for lobster).

Harvest Rate Strategy and Harvest Decision Rules

A harvest rate strategy is the approach taken to manage the harvest of a stock and is a necessary element of any fishery plan. In order to implement the PA in a fishery, pre-agreed harvest decision rules and management actions for each zone, are essential components of a harvest rate strategy.

Table 1 provides generalized management actions to apply this decision framework to the management of key harvested stocks. Actual harvest decision rules should be more precise and provide details on the harvest rates and possibly other management procedures that are required in each zone or steps within a zone. The pre-agreed harvest decision rules and management actions should vary in relation to the reference points, and be designed to achieve the desired outcome by affecting the removal rate. The removal rate should take into account total removals from all fisheries. They should be expressed in terms appropriate for the management system (e.g. effort controls for an effort based management system) and do not need to be expressed in the same units as the LRP, USR or Removal reference.

Specific values for individual stock harvest strategies are to be provided through science assessments. The development of decision rules is a Management responsibility and Science's role is to provide advice in support of their development. The harvest rate strategy, along with its associated harvest rules, would take the form of a table and/or

graph that should be appended to the decision-making framework for each stock. Annex 2a shows a general example of a harvest rate strategy for a fictional stock.

This framework provides guidance on developing reference points and harvest decision rules for key harvested targets stocks. However, the application of the harvest decision rules in a fishery may need to be tempered to limit effects on other stocks. Management actions related to other ecosystem elements may also be considered when using the decision-making framework based on available information.

Uncertainty and Risk

An important aspect of this decision framework is the treatment of uncertainty and risk when estimating stock status, reference points and in making and implementing management decisions.[9]

Both scientific uncertainty and uncertainty related to the implementation of a management approach must be explicitly considered and the management decisions taken must be tempered when necessary to give effect to the PA. Uncertainty should be incorporated in the calculation of stock status and biological reference points. It is desirable that scientific uncertainty be quantified to the extent possible and used to assess the probability of achieving a target or of a stock falling to a certain level under a specific management approach.

The appropriate risk to consider when using this framework is the probability of and the severity of the impact from management actions on stock productivity. In the framework, the management of this risk is expressed by the identification and position of reference points, the changing severity of management actions that are chosen as stock status changes and the tolerance for stock declines.

To illustrate, in the Healthy zone, where economic considerations may prevail, stock reductions resulting from management actions with a low probability of the stock falling to the Critical zone are tolerated because of their reduced impact on the integrity of the stock. In the Critical zone, conservation concerns are paramount and there is no tolerance for preventable declines. Decision rules developed for a fishery should reflect these general principles.

Management decisions should be explicit about the risk of decline associated with a management action by deciding on a risk tolerance for a particular management decision (Annex 2b contains a draft table of risk tolerance designations). As an illustration, if a stock's abundance is in the Cautious zone, near the Critical zone, it may be decided that there is a low tolerance for a risk of the abundance declining from its current level.

[9] For the purposes of this paper uncertainty is defined as incomplete knowledge about the state of nature and risk is defined as the probability of an outcome multiplied by the level of impact of the outcome. In the framework, the probability component of risk is managed by establishing increasingly stringent management actions and lower tolerances for preventable decline as the stock moves from the Healthy zone, through the Cautious zone towards the Critical zone. The impact component is managed through the use of reference points, which are discussed in the paper.

According to the table, a low tolerance for risk is where the risk of a stock's decline from its current level is estimated to be between 5% and 25%. Management actions would then aim to be consistent with this level of risk tolerance.

Defining growth criteria

When a stock is in the critical zone, management actions must promote stock growth and removals by all human sources must be kept to the lowest possible level. However, the development of harvest decision rules should also include defining growth criteria for the stock when it is in the Cautious zone. These criteria are recommended as an element of a fully adapted stock-specific decision framework. They are a primary tool for the establishment, with industry input, of an agreed growth trajectory for a stock toward recovery or other targets that are to be achieved within a specified period and with a high probability.

Optional Elements of the Framework

Stock trajectory

When the stock is in the Cautious or Healthy zone, management actions could be differentially considered on the basis of both stock status (e.g. abundance) and trajectory or rate of change in status, within the bounds of the removal rate strategy appropriate for the status zone. For example, management actions might appropriately vary if a stock is in the Cautious zone but clearly improving in status (e.g. growth in abundance), as opposed to declining sharply (e.g. decrease in abundance) through the same status zone. Flexibility in management measures is limited in the critical zone given that when the stock has reached this zone, priority must be to keep all sources of mortality at the lowest possible level to get the stock out of the critical zone within a reasonable timeframe, according to the rebuilding plan. Table 1 provides criteria for developing management actions in the Cautious and Healthy zones, based on trajectory of the stock.

Considerations for the Application of the Decision Framework

Tailoring the generalized three-zoned decision framework for an individual stock and applying it involves a number of steps, as outlined in this paper, from the determination by science of reference points and stock status in relation to these points, to the development by fisheries management, in collaboration with fishery interests, of a harvest rate strategy including pre-agreed decision rules for each zone of the framework.

For stocks that are currently not in a healthy situation, the identification of reference points and pre-agreed decision rules will contribute to the identification of conditions that correspond to a healthy situation and the necessary measures to reach such conditions. For stocks presently in a healthy situation, reference points and decision rules will contribute to the identification of conditions to avoid for a given stock or fishery and will guide decisions made in advance about the relevant measures necessary to maintain the stock in a good situation, or the necessary adjustments that will be required if the condition of the stock changes.

The scientific information available may vary substantially from one stock to another. Accordingly, different approaches must be used for calculating LRPs and defining harvest rules that take into account the information currently available for a given stock. Annex 1b contains reference points and harvest decision rules that may be considered as the best available guidance to assess the stock in relation to sustainability and to guide conservation, in the absence of existing stock or fishery specific precautionary reference points and harvest decision rules.

The best metric available to identify the conditions where serious harm could occur should always be chosen. For example, the metric used could be based on spawning biomass or on a particular sex ratio for a given species that may increase the risk of impaired productivity. Similarly, a set of indices, concerning various aspects of a stock or fishery, could inform about risks to productivity.

In general, as long as a time series as possible should be used in establishing reference points for a stock. Many stocks will show substantial variation in productivity over a long time series, and this variation should be taken into account when setting the reference points. Scientifically sound ways have been established for dealing with the special cases when this variation appears to be structured as periods of consistently high or low productivity. These cases need to be evaluated individually, but as a general rule the only circumstances when reference points should be estimated using only information from a period of low productivity is when there is no expectation that the conditions consistent with higher productivity will ever recur naturally or be achievable through management.

Whenever appropriate, management decisions and actions will take into account socio-economic factors as well as biological. When a stock is in the Healthy zone, socio-economic considerations may prevail; in the Cautious zone, socio-economic and biological factors will be balanced to reflect the stock trajectory and location in the zone; and in the Critical zone, biological considerations will prevail.

Producing a workable decision framework for a fishery will require the participation of fishery interests in all aspects of the process to develop the framework.

The various components of the framework for a fishery (i.e. the reference points, removal references and decision rules) should be explicit enough to allow assessment or evaluation of the performance of the framework. Such an assessment or evaluation should be considered on a regular basis and it would normally take place after there is sufficient experience with the framework to conduct a proper evaluation of its performance (a period of 6 -10 years might provide enough time to gain appropriate experience with the framework). However, the availability of any new information that could have a significant impact on the application of the framework could justify an earlier evaluation of the framework and adjustments to it, if necessary.

Finally, the framework for a fishery and its components, as described in this document, should be considered as risk assessment tools that need to be reviewed periodically and that may be refined over time.

Stocks in the Critical Zone, Rebuilding Plans and Management Strategies

In the critical zone, management actions must promote stock growth and removals from all sources must be kept to the lowest possible level until the stock has cleared this zone. There should be no tolerance for preventable decline. When a stock has reached 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 is referenced in Table 1). This plan must be associated with an 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.

The development of a rebuilding plan should be initiated enough in advance to ensure the plan is ready to come into effect at the boundary of the Critical and Cautious zones if a stock has declined and reached the LRP. Developing a rebuilding plan may take considerable time and this should be taken into account in deciding when to initiate the process. In some cases, a plan could be initiated when the stock declined past the mid-point of the Cautious zone. If a stock is already in the critical zone, a rebuilding plan must be developed and implemented on a priority basis.

When a harvested stock is in the critical zone below the LRP, long-term sustainable fishery benefits can only be realized by emphasizing considerable restraint through the stock recovery phase. Stocks with very low abundance generally have poor productivity, and therefore, rebuilding is even more challenging. In these circumstances, concerted action is required to ensure stock recovery occurs. While some flexibility may be found in the pace established to reach recovery objectives, it is crucial that rebuilding strategies and rebuilding objectives are identified that are supportive of the PA. In many cases, rebuilding of a stock to more sustainable levels has to be seen in terms of a long time horizon.

Participation of Fishery Interests

To be successful, the utilization of this decision making framework generally and its application to the specific fisheries needs to be done in concert with the fishing participants, to which it is applied, and with engagement of others with an interest, including Provinces, Territories, Aboriginal people, wildlife management boards (as authorized under a land claims agreement), processors and others. If effectively implemented in this way, this approach will facilitate the stable and predictable business environment in the fishery that participants seek, while at the same time contributing to sustainability. In fact, decision rules we are seeking to establish are only likely to hold if they are developed in concert with its participants. This approach will also provide a stable framework for the adoption of an "ocean to plate" approach to fisheries management supportive of long-term planning and engagement. Finally, involving

fishing participants as partners and involving others through engagement facilitates co-management interactions and shared stewardship.

Scope of application

Among other things, the Policy is guided by the principle that the fishery is a common property resource to be managed for the benefit of all Canadians, consistent with conservation objectives, the constitutional protection afforded Aboriginal and treaty rights, and the relative contributions that various uses of the resource make to Canadian society, including socio-economic benefits to communities.

Table 1 - Three zone PA framework with criteria[10] for management actions for key harvested stocks

		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	**Increasing**	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[11]. 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.	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)	Management actions should be tolerant of normal stock fluctuations. Risk tolerance for preventable decline – high
	Stable[11]		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.	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

[10] In this framework, scientific uncertainty about stock status and/or stock trajectory must be explicitly considered when establishing decision rules and management actions. Where due to uncertainty, two or more status/trajectory combinations could be considered on the basis of the scientific advice provided, management actions from the more precautionary combinations should be followed.

[11] "Stable" may be interpreted as 'no consistent trend' to accommodate an appropriate degree of variability while in the Cautious and Healthy Zones only.

[11] A reasonable timeframe would normally represent the time for a cohort to recruit to the spawning biomass and then contribute to rebuilding the productive capacity of the stock. This period will vary among species. For many species, it will correspond to a period of 1.5 – 2 generations but it could be longer for long-lived species.

Annex 1a

The metrics that can be used in relation to the Precautionary framework

In the context of fisheries management, the limit reference point is the stock level below which productivity is sufficiently impaired to cause serious harm. The PA framework would normally be described using units that relate directly to stock productivity. For stocks with age-structured analytical assessments, the most direct measurement of stock productivity is usually spawning biomass or egg production.

However, it is not always appropriate or possible to have as direct an index of productivity and hence of serious harm. There are many situations where spawning biomass is not estimated for a stock and the resource is managed on the basis of other indicators of stock condition such as catch rate indices and size/age profiles in the catch. Where necessary, other metrics can and should be considered for use in defining serious harm and guiding decision-making in relation to stock condition.

The approach of using a suitable proxy for Spawning Stock Biomass (SSB) has originally been mentioned in the science framework released in 2006. However, the use of the concept of "proxies" sometimes creates confusion and somehow the false perception that SSB is the only right indicator to identify the productive capacity of a stock, any alternate indicator being a second best. The estimate of the reproductive/replacement potential must always be based on the best information available and the approach retained must be the most appropriate for the stock of concern and data available.

There are two challenges associated with the choice of the best metric to be used. The first is to consider what index best represents the potential productivity of the stock. The second is to consider what conditions, described using this index, would constitute serious harm to productive potential (or ability to recover from the perturbation, if the concept of "productivity" did not apply for some reason) and to then define the decision-making framework in relation to those conditions. For example, in a case where the LRP cannot be derived from the history of the status of a stock (often because of the proper data were not collected), the state from which a secure recovery has been demonstrated under similar conditions might be the best scientific basis for estimating a limit reference point.

In these cases, there may be added uncertainty about the actual position of the LRP. This uncertainty should be considered (among other factors) when locating the USR. The greater the uncertainty about the degree to which the LRP actually reflects a condition associated with serious harm, the further away the USP should be set from the LRP.

Annex 1b

Guidance to Identify Reference Points and Harvest Rules

The preferred approach is always to have reference points and harvest rules based on the best information available on stock biology and fishery characteristics while taking into account the limitations of the available data. However, in some cases there may be insufficient information on which to base choices of stock-specific precautionary reference points and harvest rules. The following reference points are emerging from review and meta-analyses of experience with a wide variety of fish stocks. They are in line with practices and standards used internationally, such as New Zealand and USA, and consistent with the language found in various international agreements. They are indicative of how the range of each stock status zone should be characterized and, generally, where an LRP and USR should be situated along the spectrum of a stock's potential status. 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 tenants of the PA as set out in the general framework.

Stock Status

In critical zone.
The stock is considered to be in "the critical zone" if the mature biomass, or its index, is less than or equal to 40% of B_{MSY}. In other words: $Biomass \leq 40\% B_{MSY}$.

In cautious zone.
The stock is considered to be in the "cautious zone" if the biomass, or its index, is higher than 40% of B_{MSY} but lower than 80% of B_{MSY}. In other words: $40\% B_{MSY} < Biomass < 80\% B_{MSY}$.

Healthy.
The stock is considered to be "healthy" if the biomass, or its index, is higher than 80% of B_{MSY}. In other words: $Biomass \geq 80\% B_{MSY}$.

Fishery Status

Harvest at or below removal reference. The harvest on this stock is considered to be at or below the removal reference if the harvest rate, or the fishing mortality (F), is lower than the provisional harvest rule given below. In other words: F≤ provisional harvest rule.

Harvest exceeds removal reference. The harvest on this stock is considered to be above the removal reference if the harvest rate, or the fishing mortality (F), is higher than the provisional harvest rule given below. In other words: F > provisional harvest rule.

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. The provisional harvest rule is as follows:

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}))
When the stock is in the "Critical Zone":$F_p = 0$

Note on B_{MSY} and F_{MSY}

In absence of estimates related to the status of the stock and of the fishery at the Maximum Sustainable Yield, options for provisional estimates of B_{MSY} and F_{MSY} are provided below.

Biomass at MSY. In absence of an estimate of B_{MSY} from an explicit model, the provisional estimate of B_{MSY} could be taken as follows (select the first feasible option):

- The biomass corresponding to the biomass per recruit at $F_{0.1}$ multiplied by the average number of recruits; or
- The average biomass (or index of biomass) over a productive period; or
- The biomass corresponding to 50% of the maximum historical biomass.

Fishing mortality at MSY. In absence of an estimate of F_{MSY} from an explicit model, the provisional estimate of F_{MSY} could be taken as follows (select the first feasible option):

- The fishing mortality corresponding to $F_{0.1}$; or
- The average fishing mortality (or an index of fishing mortality) that did not lead to stock decline over a productive period; or
- The fishing mortality equal to natural mortality inferred from life history characteristics of the species.

Annex 2

A) An example of a harvest rate strategy for Stock A:

Stock Status	Corresponding Biomass (or other)	Harvest Rate Strategy
Healthy	Above 250,000 t	Harvest not exceed the rate corresponding to maximum sustainable yield (Fmsy = 0.25).
Cautious	Between 100,000 t and 250,000 t	Harvest rate to be scaled linearly to biomass levels through this range.
Critical	At or below 100,000 t	Harvest rate to be reduced to zero as a result of directed fishing and other removals reduced at a level consistent with growth criteria identified to allow the stock out of the Critical zone within a reasonable timeframe.

B) A draft table defining risk tolerance designations (for use in the decision-making framework)

Risk of decline[1]	Risk category
Less than 5%	Very low
5% - 25%	Low
25% - 50%	Moderate
~50%	Neutral
50%-75%	Moderately High
75%-95%	High
>95%	Very High

[1]Accounts for quantifiable risk only.