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Northwest Atlantic Fisheries Organization

Report of the NAFO Joint Commission–Scientific Council Precautionary Approach Framework Workshop

15–16 August 2022
Halifax, Nova Scotia

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1. Opening by co-Chairs, Fernando González-Costas (European Union), Ray Walsh (Canada) and Steve Cadrin (NAFO Precautionary Approach Framework Working Group co-Chair)

The workshop was opened by the co-Chairs Fernando González-Costas (European Union), Ray Walsh (Canada) and Steve Cadrin (co-Chair of the NAFO Precautionary Approach Framework Working Group, PA-WG) at 09:00 hours (UTC/GMT -3 hours in Halifax, Nova Scotia) on Monday, 15 August 2022.

The co-Chairs welcomed participants attending in person and virtually. This included representatives from Canada, European Union, Iceland, Japan, Norway, Ukraine, United Kingdom, United States of America, as well as the NAFO Scientific Council (SC) Chair and invited experts on Precautionary Approach Framework on Fisheries Management (Annex 1).

2. Appointment of Rapporteurs

The NAFO Secretariat (Ricardo Federizon, Senior Fisheries Management Coordinator and Tom Blasdale, Scientific Council Coordinator) were appointed co-Rapporteurs of this meeting.

3. Adoption of the Agenda

The provisional agenda as previously circulated in NAFO 22-184 was adopted (Annex 2).

4. Summary of Precautionary Approach Framework Working Group Recommendations

The PA-WG Co-Chair, Steve Cadrin, presented a summary of the work of the NAFO Precautionary Approach Framework Working Group (PA-WG) to date. Complete account of this work can be found in the following SCRs: Achieving NAFO Convention Objectives with a Precautionary Approach Framework (SCR Doc. 22/02) Report of the NAFO Precautionary Approach Framework Working Group (SCS Doc. 22/15).

5. Discussion Session on PA structure

The following is a summary of discussions occurring in the workshop based around a discussion document that was circulated prior to the meeting, which posed a series of questions to facilitate discussion by participants.

Limit Reference Points:

> *Do we agree with the proposed definitions of the F_{lim}, options for B_{lim}, and risk tolerance for exceeding limits?*

PA limit references are for conservation purposes. They mark the extreme boundaries or exploitation and stock size. The main objective is to avoid recruitment overfishing and high risk of recruitment failure. and usually indicate that drastic measures may need to be taken.

One of the problems with the current NAFO PA framework definition of F_{lim}= F_{msy} is that F_{lim} it is not directly associated with B_{lim}. F_{lim} should mark an extreme boundary that should not be exceeded, and this boundary does not correlate to F_{msy}. F_{msy} should be considered as the limit for optimal exploitation and not that the limit that should definitively should not be exceeded. There may be situations where fishing levels may be set above

F_{msy} (e.g. in situations where B is much higher than B_{msy} or where fishing level may be over F_{msy} for short period but would be below F_{msy} on average.

Other options used for F_{lim} are more related to B_{lim}, for example within ICES where F_{lim} is set at F_{msy} or F_{p05}, whichever is the smaller. F_{p05} is defined as the equilibrium F value that offers 5% probability of being below B_{lim}. In ICES, F_{msy} is currently used as a target but there is movement towards changing to a lower level for F_{target}.

On the other hand, many of the frameworks analyzed by the PA WG use F_{lim}= F_{msy} and some countries may have a legal obligation to use F_{msy} as a limit. The majority of the workshop participants agree with the current use of F_{msy} as F_{lim}. This definition of F_{lim} is more in line with the majority of the PA frameworks analyzed.

If F_{msy} is defined as a limit, the probability of exceeding this limit should be <50%, values of 30-40% were based on a review of risk tolerance for F> F_{msy} in other PA frameworks.

Most workshop participants agreed with the current definition of B_{lim} as the level which avoids recruitment overfishing. The following method of estimating B_{lim} was suggested: Reference point derived from the stock recruitment relationship would be the default. Where there is insufficient basis to use the stock recruit relationship, the lowest level from which the stock has recovered can be considered, and if that isn't possible a proxy, e.g., a percentage of B_0 or a percentage of B_{msy} can be considered. The latter options (B_0 and B_{msy}) seem more complicated as they require deciding what percentage to use.

Another alternative that was discussed was a definition of B_{lim} which described recruitment overfishing and $B_{limsoft}$ that is more like a buffer to avoid B_{lim}. If $B_{limsoft}$ is implemented, the allowable risk of being below $B_{limsoft}$ should be higher than the allowable risk of being below B_{lim}, establishing a region in which management actions can be taken before the stock goes below B_{lim}.

When there is a probability distribution, there is no need for a B_{buf}, but instead $B_{limsoft}$ can be used with a higher acceptable risk level. $B_{limsoft}$ could also be used to incorporate ecosystem information when this becomes available. The difference between $B_{limsoft}$ and B_{buf} is related to stocks where there is error distribution and so if the $B_{limsoft}$ were implemented there would be no need for using the B_{buf}. Participants concluded that it is important that the new framework be as simple and easy to communicate as possible and that other simpler tools (harvest control rule (HCR), buffers, etc.) can be used to avoid approaching B_{lim} than $B_{limsoft}$.

The allowable risk of being below B_{lim} should be very low. The current NAFO PA framework notes that 'very low' might be defined as 5-10% but the actual value is not prescribed but should be specified by mangers. The same or similar level of risk is used in most of the analysed frameworks.

The need to not only specify a risk level but also to take into account other factors such as biomass trends was discussed in the workshop. One of the problems with using trends is that trends can be unpredictable at low stock levels and may not be the same next year and when used again in the context of MSE, it becomes too complex.

The possibility of establishing a risk range was also discussed. If this were established, it would complicate the work of the SC to produce the advice as different advice would have to be formulated for each level of risk.

Buffer Reference Points:

> *If we believe they are necessary, it would be convenient to look at possible estimation methods to establish their values.*

One of the main problems with the current NAFO PA framework is that reference point buffers were never implemented. The reason they weren't implemented is because they are only necessary in stocks where it is not possible to estimate risk unlike the majority of the NAFO stocks where this is possible. Another reason B_{buf} isn't used is because many stocks do not have any limit reference point established.

One of the advantages of having the buffer would be that it is possible to manage stocks to a level above B_{lim}, rather than just above B_{lim}. There is value in having a "middle zone" where action may be taken (not necessarily a recovery plan). Buffers also could be very useful for defining and implementing HCRs.

Uncertainty can be accounted for either buffers or by using probability distribution. Where we don't have estimates of uncertainty there are useful proxies that can be used to establish a buffer to account for uncertainty.

F_{buf} is often a way to set F_{target}, so the implementation of both would not be required; one or the other can be implemented.

F_{target} Reference Point:

> *A possible F_{target} in the healthy zone is the level F_{buf} or the F that has a certain risk of being greater than $F_{lim} = F_{msy}$.*

Regarding the question if the F_{target} should be defined as a fraction of F_{msy} or in terms of risk of going beyond F_{lim}, it was suggested that if defined as a % of F_{msy} it should be 80-85%. In ICES, the fraction of F_{msy} is a level that gives a fraction of the yield at F_{msy}.

One other possibility is to use a value somewhat lower than F_{msy}, e.g. $F_{0.1}$ because in many cases, yield per recruit (YPR) with a flat-top curve makes very difficult to estimate F_{msy}. $F_{0.1}$ value proved to be much more stable to noise in the data than the F_{msy} estimate.

Both may be required; a fraction of F_{msy} or a definition based on risk of going beyond F_{lim}, depending on whether there are deterministic or stochastic estimates. Also, there is no guarantee that 80-85% of F_{msy} will give the risk of being > F_{msy} below 30-40% so both may be required. A pragmatic way to do it may be to use the risk where we have an assessment that allows it, but where this is not possible use the fraction.

The key principles of the ICES F_{eco} (a reference point based on ecosystem state) are the desire to transfer ecosystem information into the F_{target}. To do this, there is a need to evaluate a "safe range" in which to change the F_{target}, and rather than transferring absolute F_{target} values from another applied model a multiplier to the target F. F_{eco} is not as good as including factors directly in the assessment model, it is a fallback for factors that cannot be included directly. F_{eco} would meet the Convention requirement to consider the ecosystem objectives.

If the absence of ecosystem information, a default set at a sensible level would be used that could be further improved and additional information can be added later.

Potential problems for F_{eco} implementation were discussed, among which it was commented that when a quantitative assessment is available, productivity is already factored into this through the data (growth, recruitment, mortality, etc.) used in the model. Given that we also have the 2TCI concept in terms of ecosystem productivity, there are doubts whether the implementation of the F_{eco} at the single stock assessment level would overwhelm the ecosystem information in the final results. Beyond that, the F_{eco} and ecosystem consideration concepts and their implications should be more clearly understood before implementation by managers.

Biomass Target Reference Point:

> *The framework needs a target reference point for biomass? The SC PA WG does not have a clear opinion on whether it is necessary to establish an explicit B_{target}. If needed the B_{target} value should be related with F_{target}.*

It was commented that B_{target} would probably not need to be implemented in the new PA framework and that there is no clear need for management measures associated with this reference point, but on the other hand

there should be a target associated with F_{target}. The 1995 United Nations Fish Stocks Agreement also recognizes the need of B_{target}. In general, B_{target} is most relevant for rebuilding plans and status determination. The UN Stock Agreement has a requirement to rebuild stocks to a level that could be equivalent to B_{target}.

If the NAFO objective is to have B> B_{msy} more often than not, it makes sense to have it as a target against which it can be monitored. B_{msy} will be most useful as a performance statistic to monitor whether Convention objectives are being met and could also be useful in a Management Strategy Evaluation (MSE) but should not necessarily be part of the framework. B_{msy} and F_{msy} could be seen as guideposts in the framework for reference rather than as management points that trigger actions. This serves the function of communicating.

One possible way to define the B_{target} is to set it as a function of the biomass given by the F_{target}, e.g. if 80% F_{msy} is our F_{target}, the associated target biomass will be somewhat > B_{msy}. Alternatively, F_{target} could be defined as a function of B_{target} but F is a ratio and B is an absolute number and models are much better at estimating ratios than numbers.

Biomass Trigger Reference Point:

> *It is desirable to have a biomass operational control point ($B_{trigger}$) between B_{lim} and the target below which fishing pressure is reduced.*

The participants are of the opinion that it is necessary to establish biomass reference points in the new framework that delimit the recovery zone from the danger zones and the safety zone. WKLIFE has found in simulations that if there is no "biomass safeguard" there is a loss of yield. There are two possibilities for setting these benchmarks: setting them based on degree of proximity to B_{lim} or based on whether it is too far from our "target" reference point; to stay away from B_{lim} or to stay close to B_{target}.

Having a trigger is necessary for a harvest control rule unless fishing is at a very low F level. The trigger is a protection against a run of bad recruitment. A trigger with a sharp cut off can lead to highly fluctuating catches.

B_{buf}/$B_{limsoft}$ is a trigger on the lower end. Having $B_{trigger}$ as a point closer to B_{msy} is a tool to communicate to managers. A second inflection point allows fishing pressure to be slowly reduced before we reach B_{buf} /$B_{limsoft}$.

Having a fixed fraction of B_{msy} may not necessarily protect us from going below B_{lim}.

Biomass $B_{limsoft}$ Reference Point:

There are several reasons for implementing this soft limit reference point. It has the advantage that the risk of falling below it could be higher and more stable.

As previously commented, there are two possibilities for setting these intermediate biomass reference points: setting them based on whether we are too close to B_{lim} or based on whether we are too far from our "target" reference point ---to stay away from B_{lim} or to stay close to B_{target}. During the workshop, different options on this point were discussed, one is to have two intermediate reference points; $B_{limsoft}$/B_{buf} that provides a safeguard against going below B_{lim}, and $B_{trigger}$ closer to B_{msy}. The other view is to have only one biomass reference point for simplicity, and a possible candidate for this biomass reference point that serves both purposes could be B_{isr} established in the 3LNO American plaice recovery plan. The proposed value for B_{isr} is equivalent to twice B_{lim}.

If the option is to have a buffer to avoid going below B_{lim}, it will need to be set at a level that will give us some time to take action before we hit B_{lim}. i.e., not too close to B_{lim}. The reference point (B_{isr}) was proposed to delineate this zone in the American plaice 3LNO recovery plan.

From the point of view of industry-related participants, B_{buf} is important for two reasons: to avoid reaching B_{lim} levels and to get more performance. If there is a choice between the two, the preferred option would be stability,

as they prefer the B_{buf} level not to be just above B_{lim}, where management measures would be much more restrictive. They would prefer the B_{buf} level to be halfway between B_{lim} and B_{msy}.

Different reasons have been mentioned why it might be convenient to have two reference points (soft and buffer). If we only have one inflection point, experience shows that this can result in going below B_{lim}. The point of the $B_{limsoft}$ is to have a softer lower point which we want to stay away from but is less disastrous.

Management of fishing mortality based on a Harvest Control Rule:

> *Any PA must define the appropriate reduction in fishing pressure to correct the biomass decline. Many of the HCRs analyzed have a segmented shape, with the inflection point at the $B_{trigger}$.*

From a management perspective it would be preferable for the HCR to be conceptual rather than prescriptive. There could be other factors and information, e.g., the trajectory of the stock or a coming good year class that could make support a decision outside the HCR. It's impossible to have a framework that can cover all possibilities so important to have the HCR as a default with the expectation the managers can deviate from it where appropriate.

Prescribed management actions can be either formulaic or descriptive, as the present PA. The current framework does have prescriptive management actions, but they are not formulaic. It will be very difficult to simulation test and monitor the performance of a non-prescriptive formulaic rule. The generic testing simulations should take account of environmental variation by having this reflected in realistic OMs. If there is a recovery zone and a danger zone established, there is a need to have different management actions in the two zones in order to test them. The assumption is that reductions be faster in the danger zone.

Management of fishing mortality (Recovery Plans):

> *Are rebuilding plans needed in the framework?*

If a recovery plan is needed, it does not mean that the framework is not working well. The other option is that some aspect of the recovery can be built into the HCR and the framework so that it does not reach the point of having to discus and implement a recovery plan, which would take time and effort. Having management measures built into the recovery zone that perform the role of a recovery plan removes the need for the development and implementation of a recovery plan.

From a manager's perspective, if the purpose of the recovery zone is to rebuild the stock, then we would have management measures in place to address low biomass. Implementation of a rebuilding plan takes time and effort for which we have limited resources and other stocks consider.

Because the behavior of stocks at low levels is unpredictable, it is unwise to set timelines as they are never met given the dependence on variable productivity and we should therefore not have prescribed timelines.

Some of the possible HCRs seen in the workshop are in themselves recovery plans and could be tested as other HCRs. In practice the behavior of collapsed stocks is very hard to predict or simulate. The ability to complete realistic simulation testing for recovery plans is always a question.

Escapement strategy for highly variable stocks:

> *The choices to make are; what risk to accept, and what the is limit we wish to remain above. Typically this will be B_{lim}, since the aim often is to avoid recruitment overfishing, but other considerations can also be used.*

This strategy could be used for stocks with episodic recruitment or short-lived stocks. Trying to keep these stocks at stable, equilibrium levels is clearly unrealistic. In stocks like these, the best approach is to make the

best use of the biomass or recruitment that is there, but then restrict fishing to make sure there is enough biomass left to produce future recruitments.

Redfish are important stocks in NAFO. As well as having highly variable recruitments, they also have very variable survey results due to variable catchability. One approach suggested was "inventory management".

There are clear differences between the management of the small pelagics and redfish. In the small pelagics an escapement strategy makes sense but means managing in a risky area when the stock nears B_{lim}. There will be an ICES workshop on small pelagics later this year which will do some simulations on these types of stocks. For long lived species like redfish, the strategy is in principle an escapement strategy but because the fish are long lived, the effect of variable recruitment gets smoothed over the years.

NAFO is now in the process of MSE for 3LN redfish and this could be a good point to test management strategies for this stock. The results would be expected to apply to the other redfish stocks.

6. PA Framework Conclusions

Based on the above discussion, the workshop agreed the following main conclusions (numbering does not imply priority):

1. B_{lim} should represent seriously impaired productivity (e.g., the point of impaired recruitment), derived from stock-recruitment information if possible or proxies (e.g., 30-40% B_{msy}, $B_{recover}$; depending on available information).

    a. Management should be based on very low risk of $B < B_{lim}$ (e.g., 5-10% risk, defined by managers).

    b. Recent and projected stock trajectory (and other information like age structure, environmental conditions, etc.) should be considered for determining appropriate management actions to achieve low risk of $B < B_{lim}$.

2. Many PA systems have implemented the UN 1995 Straddling Stocks Agreement by defining $F_{lim}=F_{msy}$, recognizing that $F_{lim} = F_{msy}$ is not directly associated with B_{lim} or impaired productivity.

3. Uncertainty and risk need to be addressed in the PA framework, and the framework needs to be implemented with the information available (e.g., buffers require defined limit reference points and estimates of uncertainties or proxies; risk evaluation requires limit reference points and projected uncertainty).

4. F_{target} can be defined using several alternatives: a fraction of F_{msy} (~80-85% F_{msy}), risk of $F > F_{lim}$, a F lower than F_{msy} that that produces nearly MSY (e.g., 90-95%MSY), $F_{40\%MSP}$, or $F_{0.1}$.

    a. Feco as a target needs more development and communication with managers.

5. B_{target} is not needed in the framework, but B_{msy} is necessary as a performance statistic to meet principle b of the NAFO Convention ("*to ensure that fishery resources are maintained at or restored to levels capable of producing maximum sustainable yield*")

6. The PA framework could benefit from an intermediate biomass reference point or multiple biomass reference points that are between B_{lim} and B_{msy} so that management actions can be implemented earlier as the stock approaches B_{lim}.

    a. Intermediate biomass reference points can be derived from uncertainty in the assessment (e.g., B_{buf}), a multiple of B_{lim} (e.g., $B_{isr=2}$,B_{lim} proposed for 3NO cod), a fraction of B_{msy}, or impairment of ecological role.

b. Management action would be based on a probability of falling below the intermediate reference points, and the risk tolerance would be greater for higher biomass reference points.

7. The PA framework requires pre-agreed management actions that are conditional on stock status and fishing status.

    a. As examples, the current NAFO PA framework has pre-agreed management actions:

        i. in the Safe Zone, "select and set fishing mortality from a range of F values that have a low probability of exceeding F_{lim} …";

        ii. in the Overfishing Zone, "*reduce F to below F_{buf}*";

        iii. in the Cautionary Zone, "The closer stock biomass is to B_{lim}, the lower F should be below F_{buf} to ensure that there is a very low probability that biomass will decline below B_{lim} within the foreseeable future";

        iv. in the Danger Zone, "Reduce F to below F_{buf}. The closer stock biomass is to B_{lim}, the lower F should be below F_{buf} to ensure that there is a very low probability that biomass will decline below B_{lim} within the foreseeable future"; and

        v. in the Collapse Zone, "F should be set as close to zero as possible".

    b. Prescribed management actions can be qualitative (e.g., reduce F when B approaches B_{lim}) or applying a functional harvest control rule (target F a function of B)

    c. Performance testing of the PA framework requires formulaic management actions (e.g., a function of stock biomass)

    d. Flexibility will be needed for implementation, because a single HCR is not expected to be appropriate for all NAFO stocks.

8. PA framework should promote rebuilding of depleted stocks.

    a. Stock recovery plans may be needed when the general PA framework is not effective, but they should not be an explicit component of the framework.

9. Flexibility will be needed to implement the PA framework for short-lived stocks or stocks with sporadic recruitment.

    a. An escapement strategy could be based on B_{lim} but might require flexibility in risk tolerance.

    b. Effective management of long-lived stocks with sporadic recruitment needs further development.

10. Participants highlighted the need for a follow-up meeting of manager and scientists to further discuss the concepts considered at the initial workshop. The objective of the meeting would present some additional information that could help inform the development of a proposed revision of the NAFO PA Framework.

7. Adjournment

The meeting was adjourned at 17:00 hours (UTC/GMT -3 hours Time in Halifax, Nova Scotia) on 16 August 2022.

Annex 1. List of Participants

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Annex 2. Provisional Agenda and Timetable

Day 1 – Morning Session (09:00 – 12:00 hours)

- Opening, introductions, and approval of the agenda
- Summary of recommendations
- Key decisions and alternative PA structures to make to update the NAFO PA

Day 1 – Afternoon session (13:00 – 17:00 hours)

- Discussion Session on PA structure and key decision
- Time to Delegations to study the proposals

Day 2 – Morning Session (09:00 – 12:00 hours)

- Revision of decisions and consensus PA structure

Day 2 – Afternoon session (13:00 – 17:00 hours)

- Drafting of summary PA framework conclusions
- Next steps
- Other matters
- Drafting Workshop conclusions and Closing of the workshop