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Northwest Atlantic Fisheries Organization

Report of the Scientific Council Meeting

27 July 2022
By Webex

NAFO
Halifax, Nova Scotia, Canada
2022

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REPORT OF SCIENTIFIC COUNCIL MEETING
27 July 2022

Chair: Karen Dwyer Rapporteur: Tom Blasdale

I. PLENARY SESSIONS

1. Opening of the meeting

The Scientific Council met by Webex, during 27 July 2022. The purpose of this meeting was to finalize development of a working paper to be presented to the NAFO Precautionary Approach workshop, 15-16 August 2022 and to discuss the agenda for the workshop.

Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), the European Union, the United Kingdom, and the United States of America. The Scientific Council Coordinator, and other members of the Secretariat were in attendance. A full participants list is presented in Appendix III.

The Council was called to order at 08:00 on 27 July 2022. The Scientific Council Coordinator was appointed the rapporteur.

2. Review and finalization of the Precautionary Approach working paper.

Scientific Council reviewed and finalized the working paper drafted by the Precautionary Approach Working Group (PA-WG). The final draft of this working paper, which will be presented to the Precautionary Approach workshop (15-16 August 2022) and WG-RBMS (17-19 August 2022), is attached to this report as Appendix II.

3. Planning for the Precautionary Approach workshop, 15-16 August 2022.

The co-Chair of PA-WG, Fernando González-Costas, presented the provisional agenda and program for the Precautionary Approach workshop as approved by Scientific Council in June 2022 (see Appendix II). Scientific Council reviewed the agenda and discussed meeting logistics.

4. Adjournment

The meeting was adjourned at 10:45 on 27 July 2022.

APPENDIX I. SUMMARY OF THE CONCLUSIONS

1. Introduction

The objective of this working document is to summarize the main conclusions and recommendations made by the PA WG in the revision of the current NAFO PA Framework. These recommendations and conclusions are detailed in SCR 22/02 (Achieving NAFO Convention Objectives with a Precautionary Approach Framework) and SCS 22/15 (Report of the NAFO Precautionary Approach Working Group (PA-WG)19 May 2022). This working document also presents alternative PA frameworks that reflect the main recommendations and conclusions of the PA-WG as well as the main decisions needed during the PA Revision Workshop (15-16 August 2022). If the workshop can decide which option is the most appropriate and acceptable for all stakeholders, the revised framework can be performance tested for NAFO stocks.

2. PA framework

The basic principles behind PA frameworks are similar in all regions around the world where they are applied, with a range of limit and target reference points (RPs) being used to monitor and manage fishing and fish stocks. Limit reference points are defined as the lower limit of acceptable stock size (B_{lim}) and the upper limit of fishing pressure (F_{lim}). B_{lim} is typically set at a level where the biological productivity of the stock would be impaired, while F_{lim} is often related to F_{msy}.

In addition to the limits, a fishing pressure target (F_{target}) is sometimes defined, typically below F_{msy}, and some regions also define a biomass target, typically set at the level which gives maximum sustainable yield (B_{msy}). These target RPs effectively serve to articulate the trade-off between the objectives of maximizing fishery yield while minimizing risk to the stock, while stock status relative to these RPs can be an informative indicator as to whether these objectives are being met. It should also be noted that the use of B_{msy} as target, but F_{msy} playing a not fully clarified dual role of being a target and a limit is often a cause of confusion and debate.

PA frameworks typically make a distinction between stock status (desirable/intermediate/undesirable) and current fishing pressure (overfishing/not overfishing). This distinction is particularly relevant because it informs on the likely role of fishing in driving stock status, and consequently, on the ability of fisheries management measures to affect stock status. This is especially important given that the combination of sustainable fishing pressures (e.g. $< F_{msy}$), and rapidly changing marine ecosystems implies that in many cases fishing may not be the main driver of stock status, and where fisheries management measures would only be able to moderate, but not necessarily change, stock trajectories.

Overall, since PAs are generally guided by similar principles and objectives, many of their most apparent differences (e.g., the use of F_{msy} as limit or target) may be mitigated by additional specific operational decisions made for implementation (e.g. consideration of uncertainties, tolerable risks, and use of buffers), which could make many of these differences more superficial than substantive in reality, however, this has yet to be tested. However, all PAs include a combination of features that stems from evidence-based arguments and pragmatic decisions, so there are many choices to be made beyond the basic principles and these decisions are key to the degree of success in the implementation.

The mapping objectives, review of structural aspects of PAs, and considerations of uncertainty and risk provide the basis for, proposing an updated architecture for the NAFO PA, while laying out some of the key decisions that are needed to fully flesh an updated framework. The PA WG-RBMS workshop is intended to provide guidance on these aspects, so that a complete candidate PA framework can be put together and tested.

a) B_{lim}

Typically, B_{lim} is defined as the level where the biological productivity of the stock is considered seriously impaired. This level is often estimated with rules of thumb using relationships between stock level and recruitment, and when these analyses are not possible, proxies are used. These proxies typically involve a fraction of B_{msy} or B_0 (or their proxies), or the lowest level of the stock from where sustained recovery has been observed ($B_{recover}$).

When fractions of B_{msy} or B_0 proxies are used, the specific fraction that defines B_{lim} is somewhat arbitrary. For example, the current NAFO PA considers in practice a default of 30% B_{msy} as a B_{lim}proxy. Other jurisdictions use higher default percentages (e.g. 40% B_{msy} in Canada, 50% B_{msy} in New Zealand and Australia), and some consistency in these practices would be beneficial.

It is also relevant to consider that ecological functionality of the stock (i.e. its functional role in the ecosystem) is likely to be impaired before the biological productivity of the stock becomes seriously impaired. One way of including this ecological consideration would be to define a B_{lim}eco level above B_{lim}, which could be initially set in a pragmatic way (e.g. using default values based on proxies/fractions of B_{lim}, B_{msy} or B_0 informed by general ecological knowledge), and later on refined by taking into account ecological analyses aimed at estimating a stock-specific B_{lim}eco.

b) Acceptable risk of falling below B_{lim}

Any fishing pressure (even zero) will result in some non-zero chance of a stock falling below B_{lim} due to natural variability in recruitment and potentially assessment errors. It is therefore important to define the acceptable risk of falling below B_{lim}. In the NAFO context this has been set as a default range of risks, which the managers can deviate from if they so choose. Having a default (and especially having a single default risk tolerance level, rather than a range) has major benefits in those cases where managers have little desire to revisit this issue for a particular stock, but still allows managers to deviate from it if they so wish. The alternative is the ICES-style fixed risk tolerance, which provides a clear cut definition of which risk level is deemed acceptable, but it may not make sense for all stocks given their inherent different variabilities.

Choices to be made during the PA workshop:

- A range of default risk levels (eg. 5%-10%) plus manager discretion to deviate from it.
- A single default risk level (e.g. 10%) plus manager discretion to deviate from it.
- What should the default value(s) be?

One of the problems with considering very small risks (<10%) of falling below B_{lim} is that the estimation of the tails of a probability distribution is often difficult, and values can vary substantially with small changes in the data. Other problem is that we might want a conservative fixed risk tolerance, but it might not be achievable for all stocks.

A possible solution is to replace the actual B_{buf} with a soft B_{lim} (B_{lim}soft), higher than B_{lim}, for which a higher risk tolerance could be chosen to define an acceptable risk. The estimation of such higher probability would be expected to be more stable to small changes in data.

This B_{lim}soft option would also be consistent with the implementation of the B_{lim}eco concept identified above. Having distinct B_{lim} proper and B_{lim}soft also provides a performance indicator and/or an early control point for decision making before the stock reaches a critical state.

c) F_{msy} and F_{target}

Within the current NAFO framework, F_{msy} has been effectively operationalized in practice as a limit RP, and it has been used in simulations to define the upper limit on acceptable fishing pressure. This is consistent with the mapping objectives exercise which identified keeping stocks above B_{msy} more often than not, and keeping yields near MSY in the long term as objectives consistent with the NAFO Convention.

F_{target} is the desired fishing level in the healthy zone. This desired level of fishing pressure also provides an avenue for incorporating ecosystem considerations. If variability in stock productivity is related to ecological and/or environmental factors, F_{target} can be constructed to respond to these drivers, increasing F_{target} when conditions are favorable and decreasing it when they are not. This is the basic premise behind ICES F_{eco}, but other alternative approaches using a similar conceptual premise can also be explored. A key point here is that an adaptable F_{target} within the PA framework can provide a connection point with other elements of the NAFO Roadmap to EAF.

Choices to be made during the PA workshop:

- How should F_{target} be defined (e.g. $\%F_{msy}$, $F_{0.1}$, $F_{40\%spr}$, The F level with a low probability to be above F_{lim})?
- Should F_{target} be recognized as a fishing pressure level that could be adapted to ecosystem conditions?
- What should the risk of being above F_{lim} be?

d) B_{msy}

Fishery management can only indirectly influence biomass levels, in the sense that fishing pressure combines with other ecosystem drivers to impact stock biomass. Both the biomass level and the actual level of B_{msy} will vary over time. Therefore, it is not possible to control the biomass to be exactly at B_{msy}. In considering this, the question about if a target reference point for biomass is actually needed, and if so, how should it be used arises. It may be that we only need to define the region around B_{msy} where we want to be. If a target biomass is to be set, it has to be linked to F_{target} to avoid confusions.

Choices to be made during the PA workshop:

- Is a target reference point for biomass related with B_{msy} needed (e.g. some multiplier of B_{msy} to ensure that biomass will be above B_{msy} more often than not)?
- How do we evaluate whether we are meeting this objective successfully (status as performance indicator)?
- Do we need to estimate status relative to this target to operationalize decision-making?

e) Response to falling stock size

Due to natural variability and/or overfishing stocks can fall below desired stock levels. Any PA must therefore define the appropriate reduction in fishing pressure to correct these declines. In extreme situations it may be necessary to mostly or completely close the fishery (i.e. $F_{target} =0$). Choosing a high biomass level as an operational control point at which to reduce fishing pressure will lead to reducing fishing pressure more often and making small changes in quotas more common, while at the same time allowing for a gentler introduction of the decline in fishing pressure. For example, choosing to have an operational control point to reduce fishing pressure at B_{msy} while also requiring stocks to be at or above B_{msy} 50% of the time implies that the reduction in fishing pressure will occur in half of all years when stocks are meeting the objective to be at a target of B_{msy}.

It is often desirable to have biomass operational control points between B_{lim} and B_{target} below which fishing pressure is reduced. If these points are necessary they can be set relative to the probability of being close to B_{lim} or relative to moving away from B_{target}.

Choices to be made during the PA workshop:

- At what point should fishing pressure be reduced (e.g. B_{msy}, B_{target}, some fraction of B_{msy}, some multiple of B_{lim})? If using fractions/multipliers, what should these be?
- At what point should fishing be closed (e.g. B_{lim}, some B_{lim}soft level above B_{lim} like soft B_{lim})?
- What shape should the reduction in fishing have (e.g. linear, logistic, something else)?

f) Highly variable stocks/escapement strategy

Some stocks show very large natural variability in recruitment or other life history parameters even in the absence of fishing pressure. In these cases, a fixed F_{target} strategy is likely to be suboptimal since it would lead to large loss of yield in good years and high risk of overfishing in poor ones. These stocks are often fished with an escapement strategy where the allowed level of fishing is such so to ensure that the stock biomass will remain above a defined level with a prescribed probability after fishing. The choices then are what risk to accept, and what the limit to remain above is (typically B_{lim}, since the aim often is to avoid recruitment overfishing, but other considerations can also be used).

Choices to be made during the PA workshop:

- What is the biomass to be kept (e.g. B_{lim}, a multiplier of B_{lim}, some B_{lim}soft level?
- What are the criteria to be considered for choosing this biomass level?
- What is the desired risk level?

g) Ecosystem considerations

While the revised PA is intended to be single-species, connection points with the NAFO EAFM Roadmap are expected to be identified and developed to the extent possible. A couple of elements described here provide such connection points.

One is the definition of an ecosystem-informed soft B_{lim} level which allows for including ecosystem functionality considerations, and which flags an erosion of the stock before its biological productivity is seriously impaired. While in practice defining a soft B_{lim} level can be argued based on a non- ecosystem related rationale, and policy defaults may need to be used in many cases, it is expected that as ecosystem information becomes available it will be used in the definition and estimation of this reference point in a more stock-specific fashion.

The second element is the consideration of an adaptable F_{target} that can respond to variations in ecosystem drivers, allowing for more intense fishing when ecosystem conditions are favorable for stock production, and reducing fishing pressure when ecosystem conditions are unfavorable. A non-ecosystem informed F_{target} can be used as baseline while deviations from this baseline are informed by ecosystem conditions.

While full implementation of these ecosystem considerations is beyond the scope of the current work, it is important to consider incorporating this flexibility within the framework so that the PA can be integrated with and informed by other elements of the NAFO EAFM Roadmap.

h) Recovery plans

The current NAFO PA Framework does not include the use of recovery plans among its possible management measures. This could be a very useful tool for improving management of depleted stocks and for achieving rebuilding objectives.

It could be argued that reducing F to zero below B_{lim} represents the ultimate recovery plan, or that the need for recovery plans imply that the PA framework by itself would be insufficient to promote rebuilding. Furthermore, the time required for developing recovery plans could be adding an additional lag to the management response to declining stocks at the precise time when delays in action are particularly undesirable and risky.

However, recovery plans are often touted as necessary, so why is this the case? This question can be examined by considering when triggering a recovery plan could be more effective. Closing a fishery when the stock is below B_{lim} could imply that stock rebuilding in as short a timeframe as possible is the primary and/or sole objective of management at those low stock levels. However, a fishery closure signifies important negative impacts on fishing fleets. If the fishery were to continue at some small level, this would allow the fishing fleet to retain capacity and return to fishing following stock recovery, while reducing the negative impacts on fishers. Since the full negative impacts on fisheries are triggered by the stock falling below B_{lim}, one obvious alternative is to implement recovery plans before the stock reach this level. This would mean that if the stock falls below some level still above B_{lim}, like B_{lim}soft, rebuilding can become a primary but not exclusive objective of management. Reduced F levels can be implemented to prevent the stock from falling below B_{lim} and to prioritize positive stock trajectories, including timelines for recovery. While these are often features of a recovery plan, most of these elements could be hardwired into the PA framework itself, which would avoid the need for an additional and explicit recovery plan.

In this context, having built-in features of a recovery plan within the PA framework itself can provide the benefits often associated with recovery plans, while ensuring their automatic implementation without delays. This type of implementation would need the definition of an operational point (e.g. B_{lim}soft) which would trigger changes in management actions to prioritize rebuilding within a defined time horizon.

3. Possible PA frameworks

The following figures show the current NAFO PA Framework as well as the different improvement proposals from the simplest to the most complex frameworks. To illustrate these alternative options, data from a hypothetical stock is shown.

Current NAFO PA

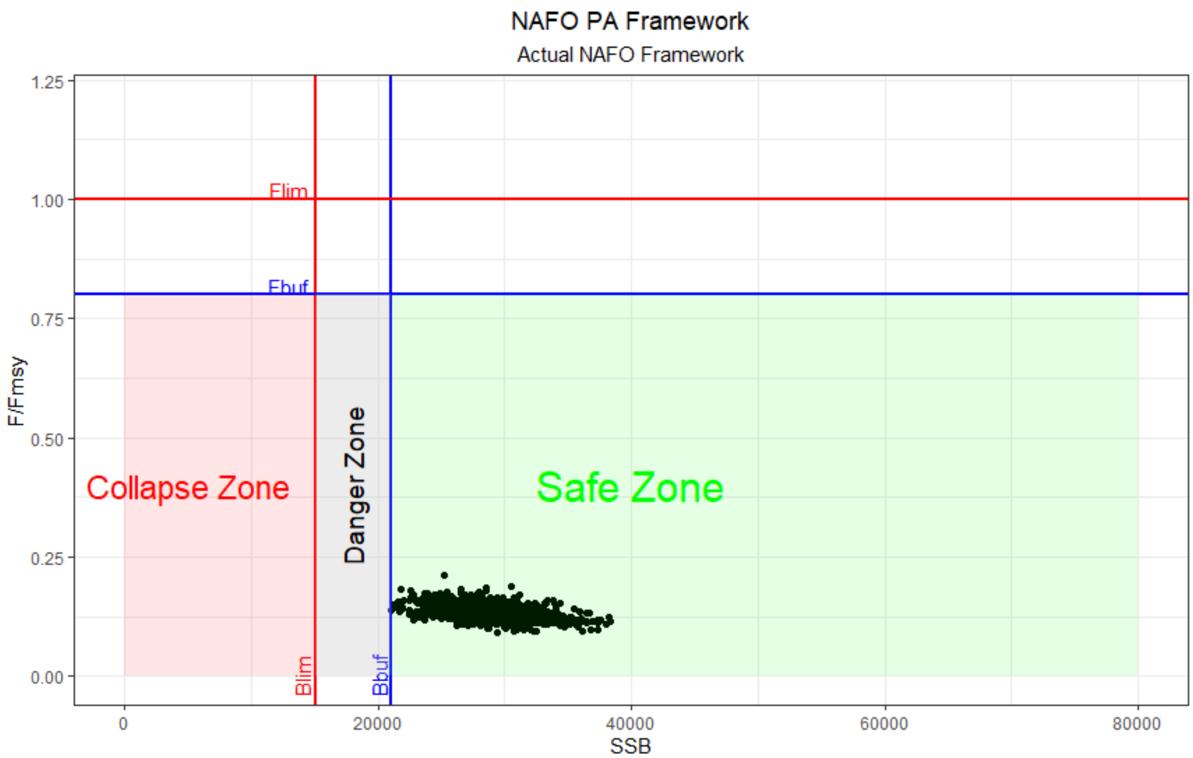

Figure 1. Current NAFO PA Framework. Stock X Blim =15037 (red vertical line), Bbuf=1.4* Blim (blue vertical line), Flim = Fmsy = F30%spr (red horizontal line), Fbuf= 0.8*Flim (blue horizontal line). Black dots correspond to the last year SSB assessment results. Safe Zone (green) =SSB> Bbuf; Danger Zone (grey) = Blim <SSB< Bbuf; Collapse Zone (red) = SSB< Blim.

In the current framework management is solely based on avoiding limits. The lack of clear targets in the framework and how to manage resources in the "safe zone" leads to biomasses to remain within the zone where limits are avoided but which may be far from possible targets, thus losing yields. There is no default harvest control rule (HCR) geared towards reducing fishing pressure in order to increase biomass towards possible target levels.

The current framework states that fisheries should be closed when there is a probability > 10% of being below B_{lim}. Therefore, the level of biomass that has this low probability can be considered as B_{buf} below which the fishery should be closed. One of the problems with this approach is that low levels of risk (<10%) are difficult to accurately estimate since the tails of a distribution can substantially vary with small changes in the data.

B_{lim} is defined as the level where the biological productivity of the stock is considered seriously impaired. This level is often estimated with rules of thumb from relationships between stock level and recruitment, and when these analyses are not possible, proxies and policy defaults are used.

Possible choices about B_{lim}:

- A range of default tolerable risk levels for breaching B_{lim} (eg. 5%-10%) plus manager discretion to move beyond this range.
- A single default risk level for breaching B_{lim} (e.g. 10%), plus manager discretion to change this default value.
- Irrespective of risk level, what should the default value(s) for B_{lim} be?

The PA WG suggests as possible proxy **30-40% of B_{msy} as B_{lim}.** Other possible proxies are percentages of B_0 as well as the lowest level of the stock from where sustained recovery has been observed ($B_{recover}$).

The risk of falling below B_{lim} is fairly similar across many of the frameworks analyzed and **is usually <10%**.

Within the NAFO framework, F_{msy} has been used as an upper limit for an acceptable fishing pressure. This can contribute to achieving the objective of stocks being maintained at or above B_{msy}. The interpretation of F_{lim} is made as the maximum F allowed in the framework and not as the F that would lead to B_{lim} at equilibrium.

Possible choices about F_{lim}:

- F_{lim} equal to F_{msy}?
- F_{lim} related B_{lim}?
- What should the acceptable risk level be?

The PA WG suggestions is that **F_{lim} could be equal to F_{msy}.** Although the NAFO Convention does not specify that this has to be the case, this option does meet all the objectives of the NAFO Convention, and including the operational objective identified during the mapping objectives exercise of keeping stocks above B_{msy} more often than not. The risk of being above F_{lim} should be less than 50% to meet these objectives and the PA WG suggests a **risk range of 30-40%**.

a) NAFO PA with B_{target} and $B_{trigger}$ (B_{tr}).

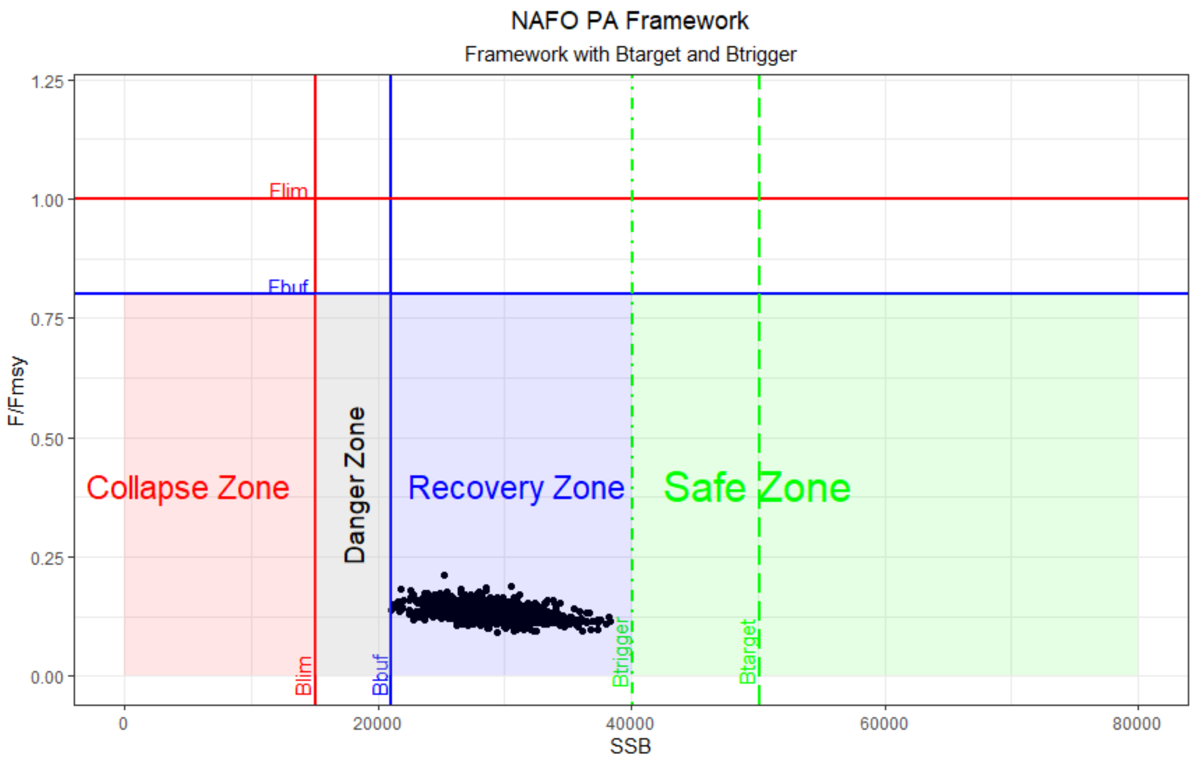

Figure 2. NAFO PA Framework Btarget and Btrigger. Stock X Blim =15037 (red vertical line), Bbuf =1.4* Blim (blue vertical line), Flim = Fmsy = F30%spr (red horizontal line), Fbuf= 0.8*Flim (blue horizontal lime). Btarget = Bmsy estimated through the Bmsy = Blim /0.3 (green vertical segmented line). Btr=0.8*Bmsy (green vertical segmented doted vertical line). Black dots correspond to the last year SSB assessment results. Safe Zone (green) =SSB> Btr; Recovery Zone (blue) = Bbuf <SSB< Btr; Danger Zone (grey) = Blim <SSB< Bbuf; Collapse Zone (red) = SSB< Blim.

Choosing a high biomass level (B_{target}) as an operational control point at which to reduce fishing pressure will lead to reducing fishing pressure more often and making small changes in quotas more common, while at the same time allowing for a gentle introduction of the decline in fishing pressure than choosing a lower biomass level ($B_{trigger}$).

Choosing to have an operational control point to reduce fishing pressure at B_{msy} while also requiring stocks to be at or above B_{msy} 50% of the time implies that the reduction in fishing pressure will occur in half of all years when stocks are meeting the objective to be at a target of B_{msy}.

Questions about B_{target}:

- target reference point for biomass related with B_{msy} is needed?
- Stock should be at or above B_{msy} some defined fraction of years (e.g. 50%)?

The PA WG does not have a clear opinion on whether or not it is necessary to establish an explicit B_{target} in the new PA framework. **The B_{target} should be directly related to the need for F_{target}. The B_{target} value should be the equilibrium biomass level resulting from applying the F_{target}.**

It is often desirable to have a biomass operational control points ($B_{trigger}$) between B_{lim} and B_{target} below which fishing pressure is reduced. These points can be set relative to the probability of being close to B_{lim} or relative to moving away from B_{target}.

This framework has the advantage over the previous one that the biomass levels of the healthy zone are broader, so greater stability of the TACs with biomasses close to the target is expected. And they have the disadvantage that the decrease in F with biomass in the Recovery Zone is more abrupt.

Questions about $B_{trigger}$:

- Some fraction of B_{msy}? Some multiple of B_{lim}? If using fractions/multipliers then what should they be.
- What level of risk would be acceptable to trigger the reduction of the fishing pressure?
- If we opt for a lower B_{tr} than B_{msy} do we need to define a target or not?

The PA WG suggestion is that B_{tr} could be around 80%B_{msy} with neutral risk.

b) NAFO PA with B_{target}, $B_{trigger}$ and B_{lim}soft.

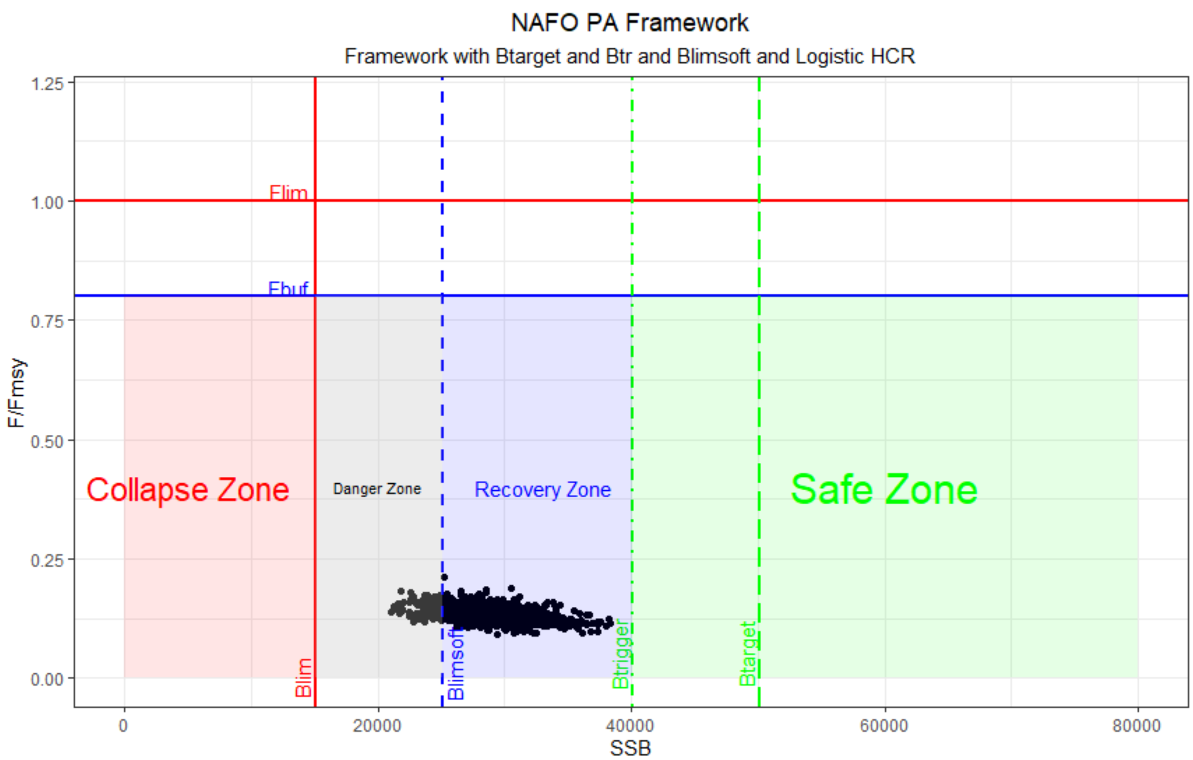

Figure 3. NAFO PA Framework Btarget, Btrigger and Blimsoft. Blim =15037 (red vertical line),, Flim=Fmsy = F30%spr (red horizontal line), Fbuf = 0.8*Flim (blue horizontal lime). Btarget = Bmsy estimated through the 0.3*Blim (green vertical segmented line). Btr=0.8*Bmsy (green vertical segmented doted vertical line). Blimsoft=0.5Bmsy (blue segmented vertical line). Black dots correspond to the last year SSB assessment results. Safe Zone (green) =SSB> Btr; Recovery Zone (blue) = Blimsoft<SSB< Btr; Danger Zone (grey) = Blim<SSB< Blimsoft; Collapse Zone (red) = SSB< Blim.

Here we propose to replace B_{buf} by B_{lim}soft, recognizing that other levels of soft B_{lim} higher than B_{lim} could be chosen. There are several reasons for implementing this soft limit reference point. Within them, ecological reasons, since B_{lim} is associated with a single stock vision while B_{lim}soft could be justified as a level more related to ecosystem functionality. This reference point could have the associated advantage that the risk of falling below this soft B_{lim} could be higher and its estimate less variable.

This reference point could be used as a performance indicator that «we are getting too close to where we don't want to be» and/or as a control point for decision-making. Biomass below B_{lim}soft could trigger more stringent management measures to increase the biomass (e.g. built-in recovery plans), including timelines for rebuilding. If these measures were to be considered, the selection of B_{lim}soft (i.e. the distance between B_{lim} and B_{lim}soft) would need to factor in the time the stock would need to respond to the more stringent management measures without falling below B_{lim}.

Questions about B_{lim}soft:

- Based on what to establish the levels of B_{lim}soft: B_{msy}, B_{lim}, B_0?
- What risk would be acceptable to be below B_{lim}soft?
- If B_{lim}soft is implemented, it would need to implement B_{buf}?

What management measures should be implemented below B_{lim}soft? Recovery plans?

The PA WG suggestion is that **B_{lim} soft could be estimated as around 50%B_{msy} or a multiple of B_{lim} (1.X * B_{lim}) with a 20-30% risk of falling below B_{lim}. If B_{lim}soft is implemented it may not be necessary to have** B_{buf}.

c) NAFO PA with B_{target}, $B_{trigger}$ and B_{lim}soft and HCR.

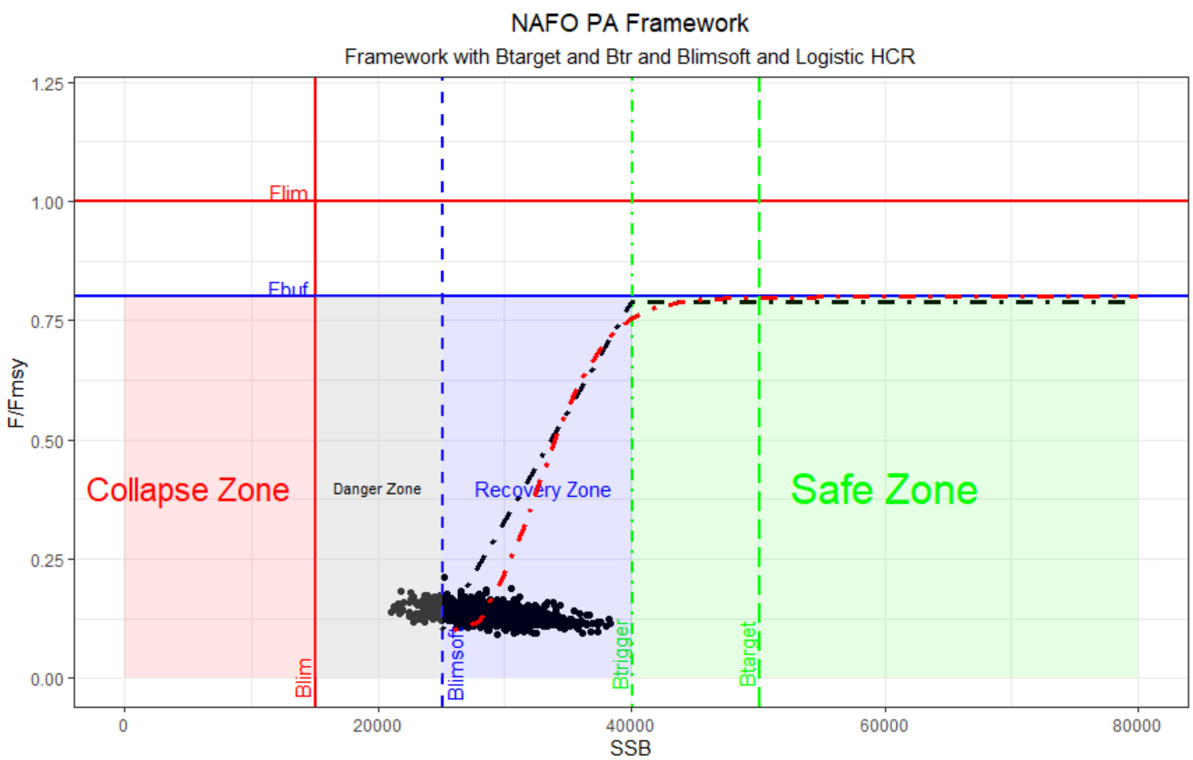

Figure 4. NAFO PA Framework Btarget, Btrigger and Blimsoft. Blim=15037 (red vertical line), Bbuf =1.4*Blim (blue vertical line), Flim=Fmsy= F30%spr (red horizontal line), Fbuf = 0.8*Flim (blue horizontal lime). Btarget = Bmsy estimated through the 0.3*Blim (green vertical segmented line). Btr =0.8*Bmsy (green vertical segmented doted vertical line). Blimsoft=0.5Bmsy (blue segmented vertical line). Black dots correspond to the last year SSB assessment results. Safe Zone (green) =SSB> Btr; Recovery Zone (blue) = Blimsoft<SSB< Btr; Danger Zone (grey) = Blim<SSB< Blimsoft; Collapse Zone (red) = SSB<Blim. Segmented doted black line = Segmented HCR. Segmented doted red line= Logistic HCR.

Within the NAFO framework, F_{msy} in the sense of the absolute maximum has been used as an upper limit on acceptable fishing pressure.

It could be understood that the F_{target} in the healthy zone is the level of F that has a certain risk of being greater than F_{lim} = F_{msy}.

Questions about F_{target}:

- How is F_{target} defined? ($F_{0.1}$? Something else?)
- Risk level of being above F_{lim}?
- Should F_{target} be recognized as a fishing pressure level that could be adapted to ecosystem conditions?

In the analyzed frameworks there are different ways to establish the F_{target} depending on the disponible data and based on different proxies ($F_{0.1}$, $F_{40\%spr}$, F low probability to be > F_{lim}, F produced 95% MSY, etc).

One of the conclusions of the PA WG is **that the F_{target} chosen should meet the Commission's objective of maintaining long-term biomasses above B_{msy} more often than not,** so the risk level of F_{target} being higher than F_{lim} should be less than 50%, **with a recommended risk level between 30-40%.**

The F_{target} value could be informed by ecosystem considerations. F_{eco} or similar approach.

Due to natural variability as well as any potential overfishing, stocks may fall below desired stock levels (Safe Zone). Any PA must therefore define the appropriate reduction in fishing pressure to correct these declines. Choosing a high biomass level as an operational control point at which to reduce fishing pressure will lead to reducing fishing pressure more often and making small changes in quotas more common, while at the same time allowing for a gentler introduction of the decline in fishing pressure than choosing a lower biomass level.

Questions about HCR:

- What shape should the reduction be in the Recovery Zone? Linear? Logistic? Something else?
- At what point should fishing be closed? B_{lim}? Some B_{lim}soft value above B_{lim}?
- If a B_{lim}soft is implemented, what should be the management in the area between B_{lim} and B_{lim}soft.? Rcovery Plans?

Many of the HCRs analyzed have a segmented shape, with the maximum being the F_{target} level in the safe zone and decreasing that F level to zero with the inflection point at the $B_{trigger}$. Management measures at different biomass levels should depend on whether or not new points such as B_{lim}soft greater than B_{lim} are implemented or no.

The PA WG thinks that it would be interesting to study possible forms of HCR other than segmented HCR, such as logistic HCR. The advantage of logistic HCR is that it allows a more gradual decrease of the F from the maximum level (F_{target}) to the minimum level (F=0) and without the sudden changes generated by the hard corners in segmented HCRs. B_{lim}soft and B_{tr} could be candidate values to parameterize a logistic HCR.

APPENDIX II. PROVISIONAL AGENDA NAFO JOINT COMMISSION–SCIENTIFIC COUNCIL PRECAUTIONARY APPROACH FRAMEWORK WORKSHOP15–16 AUGUST HALIFAX, NOVA SCOTIA

Provisional Agenda and Program

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

APPENDIX III. LIST OF PARTICPANTS, 27 JULY 2022

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