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Limit reference Flim at Fmsy – a Flimsy point?
On some possible revisions of the NAFO Precautionary Approach framework

by

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Abstract

The NAFO PA framework intends to specify "limit" reference points for stock status and exploitation as those implying "serious harm" to the resource. Limits for biomass comply with this definition. However, in descriptions of the PA framework, the limit for fishing mortality is stated to be the MSY rate (Fmsy), although it is sustainable without serious harm. At the same time, the MSY rate (Fmsy or its proxies e.g. F0.1 and Fmax) is in practice—i.e. for setting TACs—often taken as a target value instead. We suggest a revision of the PA framework to admit target reference points, and setting limit values for mortality that correspond more closely with limit values for biomass.

Introduction

The "Precautionary Approach" in fisheries management entails establishing reference points with which estimates of stock status and exploitation pressure can be compared—the results of the comparison then directing decisions for the management of the fishery. The key stock-status parameter monitored is typically (recruited) stock biomass (*B*), and fishing mortality (*F*) is the corresponding key tactical management parameter. Two sets of reference points may be set: a "target" level, which it is seen as desirable to reach, and a "limit" level, marking an area of "serious harm" which should to be avoided.

The NAFO PA framework (Anon., 2004) only specifies limit reference points. However, while this framework does not explicitly define target reference points, the present management plans for American place in Div 3LNO and cod in Div 3NO do implicitly define B_{msy} as a target reference point for biomass (see appendix).

Limit reference points, marking extreme boundaries for exploitation and stock size, function to protect stocks from recruitment overfishing and from stock sizes associated with a high risk of recruitment failure. In addition, target reference points, marking desired exploitation and stock size, can be considered to be a means of obtaining best long-term management of the stock. We think that the NAFO PA framework would be strengthened if they were formally included. But the explicit limit and implicit target reference points for biomass and fishing mortality presently existing in the NAFO PA and management frameworks are not complementary and they are not treated in a consistent manner in the scientific advice and in management actions.

Background

In a typical stock-production or stock-recruitment relationship (convex upwards for biomass below B_{msy} and non-increasing elsewhere) (Fig.1), fishing mortality and stock biomass inescapably constitute a linked pair of management objectives. Managing consistently at a given fishing mortality will converge (in a stable environment) on a certain corresponding stock biomass. Equally, taking a given stock biomass as a management objective will require the imposition of some corresponding fishing mortality (Fig. 1).

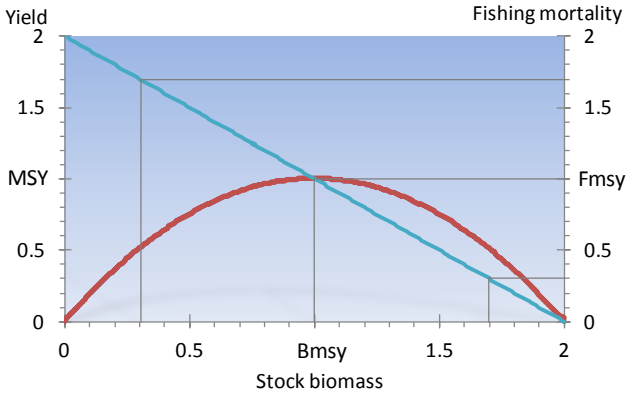

Figure 1. Example dome-shaped stock-recruitment relationship: the production/yield according to the logistic model (*red curve*) and corresponding fishing mortality, F (*blue straight line*). For illustration three corresponding points of stock biomass and fishing mortality are shown. MSY=Maximum Sustainable Yield; B_{msy}=stock biomass at MSY; F_{msy}=fishing mortality corresponding to MSY.

But fishing mortality and stock biomass are not wholly interchangeable as management objectives. Stock dynamics and the effect of fisheries are such that biomass can not be changed in the short term. However much a stock assessment might show that biomass has diverged from a target level, we cannot by fiat restore it, and its target level has to remain a longer-term objective. On the other hand, fishing mortality is within reach, and can—within practical limits—be readily altered in the short term.

If precautionary reference points for both fishing mortality and for biomass are to be defined, it will be logical if the target reference point for biomass converges on the target reference point for fishing mortality—and vice versa—and similarly the limit reference point for biomass should logically correspond to the limit reference point for fishing mortality. In that way specifying fishing pressure relative to *F* reference points will determine evolution and final destination of stock development relative to the associated *B* references.

If limit and target reference levels are not corresponding pairs, difficulties will ensue in both the formulation of advice and the taking of management action: going after one target will mean abandoning another; respecting one limit could mean transgressing another.

Present specifications.

Fishing mortality reference points

The NAFO PA framework specifies both that Flim is to be no greater than Fmsy *and* that Flim is to be exceeded 'with low probability'; *a fortiori*, Fmsy will also be exceeded with low probability. Although inconsistent with the 'serious harm' definition of limit reference points this specification has been defended (Anon. 2004a) by referring to UN fisheries agreements:

"Perhaps most importantly, Fmsy as a limit is in conformance with the Precautionary Approach as described in several United Nations agreements (in particular, Annex II of the United Nations Straddling Stocks Agreement)".

This Annex, cited in part below, explicitly uses the word 'limit' in connection with Fmsy as a reference point for mortality and requires that management strategies shall *ensure* that it is not exceeded.

Annex II of the UNFSA: *"The fishing mortality rate which generates maximum sustainable yield should be regarded as a minimum standard for limit reference points. For stocks which are not overfished, fishery management strategies shall ensure that fishing mortality does not exceed that which corresponds to maximum sustainable yield.*

As said above, the NAFO PA framework does not define target reference points. .

Taking Fmsy as a limit implies that it is considered to be associated with serious harm to the resource—which it isn't—and also means that any reference level accepted as a target would have to be much lower. In practice, other standard reference levels for fishing mortality—F0.1 or Fmax, sometimes considered proxies for Fmsy—are now already treated as acceptable target levels rather than as limits to be avoided (e.g. 3M cod).

Stock biomass reference points
A limit reference point for biomass in the NAFO PA framework for stocks managed with a production model is commonly taken as 30% of B_{msy}. For data-poor stocks managed without a quantitative assessment model, the lowest observed biomass may be taken as a limit biomass reference. For some stocks for which a stock-recruitment plot is available, its break-point is taken as B_{lim}. All are fully consistent with the definition as a "serious harm" level.

Target reference points are as mentioned before generally absent from the NAFO PA framework. However, the rebuilding strategy adopted by NAFO for 3LNO American Plaice and 3NO Cod seems to have B_{msy} as a long-term objective for biomass. Annex II of UNFSA also considers that Bmsy 'can serve as a rebuilding target' for overfished stocks.

Inconsistency
Therefore, the present definitions of limit values for biomass do *not* correspond to definitions of limit values for fishing mortality—but specified *targets* for biomass do.

Discussion

We propose two changes to the NAFO PA framework. The first is that target levels should be set in addition to limit levels. In their absence, there is a risk that limit levels, which should be avoided, become *de facto* targets because they are the only definite and specified values on the board, whereas considered target reference points marking desired exploitation and stock size should be the means of obtaining best long-term management of the stock.

Secondly, we propose that the pairs of reference levels should be made consistent: a target level for fishing mortality should in the long term lead to the target level for biomass; and the limit level for biomass should be efficiently avoided by avoiding the limit level for mortality. The present NAFO structure lacks this consistency. For example, a limit level for biomass set at 30% of Bmsy (e.g. for Northern Shrimp in Div. 0A and SA1, Yellowtail Flounder in Divs 3LNO) corresponds in the long term to a mortality of 170% of Fmsy. Instead, the limit level for mortality is set at 100% of Fmsy, and if this is to be 'exceeded with low probability', we should expect biomass to remain rather above Bmsy—or at three to four times what is now considered its limit level (Fig. 1). We regard the defence of this inconsistency by referring to the UN Straddling Stocks Agreement as weak, as it appeals to one part of a text which itself is internally inconsistent (the fishing mortality to achieve MSY, i.e. F_{msy}, is referenced as both a target and a limit – see appendix).

There is reason to suppose that for rationally managed commercial fisheries the economic optimum stock biomass lies above Bmsy. Stock assessments commonly assume that biomass is linearly related to the fishery catch:effort ratio; the corollary is that catch:effort (CPUE) is linearly related to stock, and that therefore fishing becomes more efficient as stock biomass increases. To be consistent with this biomass target, a tactical management target range for mortality should be slightly below Fmsy; or in risk-based advice, a moderately low probability of exceeding Fmsy. Incontrovertibly, the safety margin on fisheries management would also increase with increasing the biomass target.

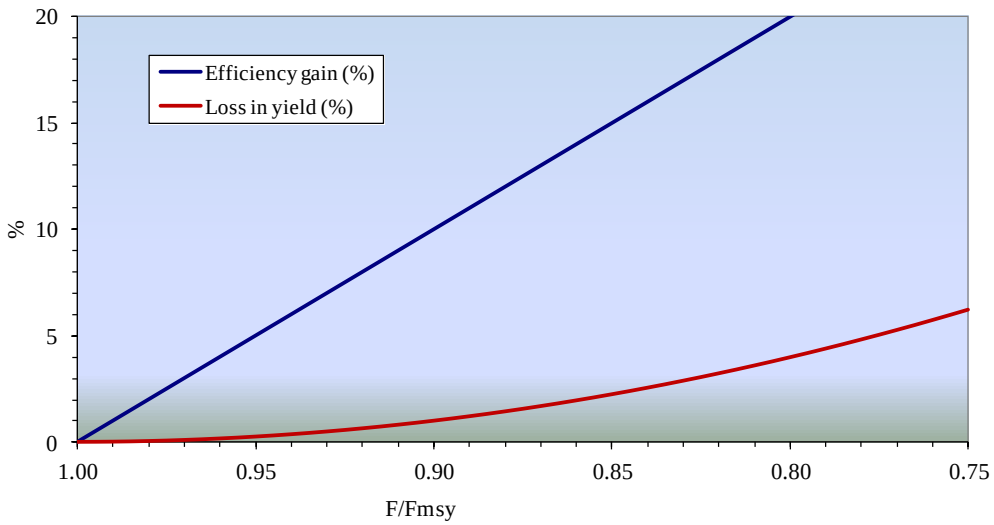

Fig. 2. Effect on fishing efficiency (CPUE) and on loss in yield of reducing fishing mortality (F) from Fmsy.

For a range of fishing mortalities slightly below Fmsy, the reduction in yield from the stock is small, but the gain in the efficiency of the fishery is much greater (Fig. 2). Estimation of economic optimum is outside the scope of this working paper, but it seems likely that there is little to lose by maintaining biomass slightly above Bmsy. These economic considerations were referred to (Anon 2004a):

> *Fishing somewhat below Fmsy results in a relatively small loss in average catch, but a large increase in average biomass (which, in turn, results in a decreased risk to the fish stock, an increase in CPUE, and a decrease in the costs of fishing).*
>
> *Traditional bio-economic models indicate that the fishing mortality associated with maximum economic yield (Fmey) is usually considerably less than Fmsy.*

but should properly relate to the defence of this range of values—'somewhat below Fmsy'—as an optimum-seeking target, not as a last-ditch-defence limit. The text has lost sight of the NAFO definition of limit values as those which indicate 'serious harm to the resource.' Our suggestion remains that mortalities 'somewhat below' Fmsy should be adopted as a target range in the NAFO PA framework.

The adoption, as a target, of a mortality range somewhat below Fmsy has also been recommended in the context of 'ecosystem-based management':

> *Ensuring no major stock is fished harder than the single-species Fmsy has often been recommended as a good first step towards ecosystem-based management (NRC, 1999; Mace, 2001). Ecosystem-based management will likely require even more conservative fishing mortality targets than "traditional" single-species-based management.* (Anon 2004a)

Conclusion

The precautionary reference points in use under the present NAFO interpretation of the precautionary principle do not match up. Target reference points, should be added, and the limit and target levels for biomass and for mortality should constitute consistent pairs.

References

Anon. 2004. NAFO Precautionary Approach Framework. NAFO/FC Doc. 04/18, Serial No. N5069. 5pp

Appendix

Annex 2 of the UNFSA: "The fishing mortality rate which generates maximum sustainable yield should be regarded as a minimum standard for limit reference points. For stocks which are not overfished, fishery management strategies shall ensure that fishing mortality does not exceed that which corresponds to maximum sustainable yield, and that the biomass does not fall below a predefined threshold. For overfished stocks, the biomass which would produce maximum sustainable yield can serve as a rebuilding target."

3LNO American Plaice and 3NO Cod Conservation Plans: "Long-term Objective: The long-term objective of this Conservation Plan and Rebuilding Strategy is to achieve and to maintain the Spawning Stock Biomass (SSB) in the 'safe zone', as defined by the NAFO Precautionary Approach framework, and at or near Bmsy."