

REPORT OF THE NMFS NATIONAL STANDARD 1 GUIDELINES WORKING GROUP

*Pamela M. Mace (Chair), Steven X. Cadrin, Roy E. Crabtree, George H. Darcy,
John H. Dunnigan, Alvin Z. Katekaru, Alec D. MacCall, Mariam E. McCall,
Richard D. Methot, and Grant G. Thompson,
with assistance from Mark R. Millikin*

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Introduction

The National Standard 1 Working Group (NS1WG) was formed in April 2003 with Terms of Reference to develop recommendations as to:

- (i) whether the NS1 guidelines should be revised at all;
- (ii) if revisions are desired, what parts of the NS1 guidelines should have priority for revision, and why;
- (iii) suggested revisions consistent with the objectives that they be technically sound, increase comprehensiveness (i.e., provide guidance for a broader range of situations), add specificity (i.e., provide more guidance on how to handle particular situations), improve clarity (i.e., are easier for non scientists to understand), and recognize scientific and biological constraints.

The Terms of Reference also suggested which parts of the current NS1 guidelines the group should focus on, but did not limit the scope of the review.

The recommendations provided in this report reflect ideas exchanged during numerous teleconferences between NS1WG members, along with input from (i) public comments received in response to an Advanced Notice of Proposed Rulemaking published in the Federal Register on 14 February 2003; (ii) a NMFS-wide workshop held in Kansas City, MO on 7-9 May 2003, (iii) a Science Board meeting held in St. Thomas, VI on 26-29 May 2003, (iv) a meeting with Front Office staff held in Silver Spring, MD on 3 July 2003, (v) a Leadership Council meeting held in Providence, RI on 19-21 August 2003, and (vi) a video-conference held with Headquarters and the Regions and Science Centers on 10 September 2003. Comments from MAFAC were also received and taken into account. At all points in this process, proposed recommendations were evaluated for their ability to clarify, simplify, or amplify sections of the current National Standard 1 (NS1) guidelines, as necessary, in accordance with item (iii) in the above Terms of Reference.

The most substantive recommended changes in terms of their influence on fishery management practices are to strengthen the requirements for quickly ending overfishing, but at the same time to simplify and,

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within limits, to increase the flexibility of rebuilding time horizons. However, increased flexibility for rebuilding time horizons cannot be used to justify continued overfishing. The rationale behind this overarching recommendation is that reducing fishing mortality is within human control, whereas the rate at which rebuilding takes place is not fully within our control – it also depends on a stock’s life history characteristics and the environmental conditions pertaining during the period of rebuilding. More importantly, elimination of overfishing is a *precursor* to permanent rebuilding of overfished stocks.

For similar reasons, the recommendations also increase the emphasis on controlling fishing mortality and reduce, but do not eliminate, the emphasis on minimum stock size thresholds. In a well-managed fishery in which overfishing is a rare occurrence, it is unlikely that a stock or assemblage will become so depleted that it requires radical changes in management measures to rebuild to a level consistent with producing the maximum sustainable yield (MSY). Therefore, keeping fishing mortality below the overfishing threshold is a “first line of defense” against a stock or assemblage becoming depleted. The minimum stock size threshold is a “second line of defense” for a stock or assemblage that has either not been managed so as to prevent overfishing, or has become depleted for other reasons, or a combination of these. In well-managed fisheries, the minimum stock size threshold should rarely need to be invoked.

The body of the text consists of issues considered, Problem Statements pertaining to the issues, and Recommended Solutions. Where needed, additional explanation is provided in square brackets. Alternative solutions discussed and analyzed by the NS1WG and others are included in Appendix 1, along with a brief rationale explaining why they were not incorporated into the Recommended Solutions.

Recommendations

OVERALL

The NS1WG believes that there is a sufficient need for clarification, simplification, or amplification of various aspects of the current version of the NS1 guidelines to warrant revision. However, the NS1WG also believes that the basic tenets represented in the current NS1 guidelines reflect well the intent of the Magnuson-Stevens Act (MSA), as amended by the Sustainable Fisheries Act of 1996, particularly in terms of ensuring an appropriate balance between maximizing fishery yields and minimizing the risk of stock collapse. Therefore, a major overhaul of the current NS1 guidelines is not required. While the NS1WG does acknowledge that further technical guidance is needed on several issues, it does not believe that the NS1 guidelines are the place to provide such details, and recommends the creation of a different forum for this purpose.

Further, if revisions to the NS1 guidelines proceed, they should include a "grandfather clause" that allows (but does not require) NMFS and the Councils to retain any rebuilding plans they have already adopted if such plans have been approved. With respect to rebuilding plans, the new guidelines should be mandatory for stocks and assemblages for which rebuilding plans have not been submitted within a six month period after a Final Rule is published in the Federal Register. At the same time, implementation of modifications to the NS1 guidelines other than those pertaining to rebuilding plans would also become mandatory, but

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NMFS and the Councils will be allowed three years to complete the necessary plan amendments.

The NS1WG recommends that the NS1 guidelines themselves should be modified in the following specific areas only.

1. Stocks, Fisheries and Species Assemblages

Problem Statement: The current authorization of the MSA clearly allows “overfishing” and “overfished” to be specified on the basis of fisheries, where a “fishery” is defined, *inter alia*, as “one or more stocks of fish which can be treated as a unit for purposes of conservation and management and which are identified on the basis of geographical, scientific, technical, recreational, and economic characteristics”. However, for the most part, NMFS and the Councils have specified maximum fishing mortality thresholds (MFMTs), minimum stock size thresholds (MSSTs), and rebuilding plans on a stock-by-stock basis. NMFS also generally uses stocks as the unit for reporting on the status of U.S. fisheries in the congressionally-mandated annual Report to Congress and the Councils on the status of fisheries within each Council’s geographical area of authority. By far the majority of these “stocks” are of unknown status (658 of 932, or 70.6%, in 2002), and this tends to be the main statistic quoted back to NMFS and the Councils by our critics. This fuels the belief that one of the agency’s highest priorities should be to move as many species as possible from “unknown” to “known” status. Yet, with a few exceptions, improving the quality, frequency, or timeliness of stock assessments for key target species (and other species heavily impacted by fishing), which are often of “known” status, is likely to be a higher priority both within and outside the agency. Even with a substantial increase in the agency’s budget, a goal of ultimately having 932 separate stock assessments and 932 different sets of management measures is probably unrealistic, unworkable, and not the best use of public funds (especially since the true number of fish and invertebrate stocks captured in U.S. fisheries is probably closer to 3,000+ rather than 932). On the other hand, situations where a limited degree of overfishing may be tolerated for some stocks for the sake of achieving optimum yield (OY) for other stocks need to be strictly controlled. This is achieved through application of a mixed stock exception, which requires that several rigorous conditions be satisfied.

Recommended Solution: The NS1WG recommends that the NS1 Guidelines be clarified and simplified to allow each FMP to classify stocks into two categories: (i) “core” stocks (which may include key target species, historically-important species that may now be relatively rare, important by-catch species, and highly vulnerable species) that will be assessed and managed based on individual MFMTs, MSSTs and OYs, and (ii) stock “assemblages” that will be assessed and managed based on either aggregate MFMTs, MSSTs and OYs, or stock-specific measures for one or more indicator stocks.

Ideally, “core” and “assemblage” stocks will be defined as part of an overall fishery ecosystem plan. Species that are or have been key target species, important bycatch species, or highly vulnerable species cannot be managed as part of an assemblage simply as a means of avoiding the MSA requirement to end overfishing. “Core” and “assemblage” categorizations should be reviewed periodically and modified as appropriate.

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For core stocks, a mixed stock exception similar to that in the current NS1 guidelines may be applied, provided analyses are conducted to demonstrate that three conditions are satisfied: (i) this action will result in long-term net benefits to the Nation, (ii) the same benefits cannot be achieved by other actions that would not result in overfishing, and (iii) the stock must have at least a 50% chance of being above its MSST under prevailing environmental conditions. (The latter condition would substitute for, and be more specific than, the current NS1 guidelines condition which states that a species or evolutionarily significant unit should never be subjected to a fishing mortality rate so high that it requires protection under the Endangered Species Act, ESA; the first two conditions are similar to those in the current NS1 guidelines).

For assemblages, the available quantitative or qualitative evidence should be examined periodically to ensure that no individual stock becomes severely depleted, as may be indicated by, for example, a substantial reduction in the proportional representation of the stock in the total assemblage biomass or the total assemblage landings.

2. Fishing Mortality Thresholds

Problem Statement: It has been seven years since passage of the Sustainable Fisheries Act of 1996, yet there are still several major fisheries where overfishing persists. While it would be unreasonable to expect that all previously-depleted stocks should be rebuilt by now, it is quite reasonable to expect that overfishing should have ended by now in almost all cases, except those where a mixed stock exception or some other exception has explicitly been made and justified, or cases where overfishing has only recently been identified. To date, rebuilding plans have often included a “phasing-in” period to gradually bring fishing mortality rates below the MFMT in order to ease the short-term burden on fishing communities. However, in the medium and long term, it is better for both fish stocks and fishing communities if fishing mortality is somewhat below the MFMT, because this results in high average yields at less risk to the stock. Therefore, with very few exceptions, efforts to eliminate cases of protracted overfishing should be intensified. Strengthening the requirement to eliminate overfishing is in conformance with National Standard 1 of the MSA which states, “Conservation and management measures shall *prevent* overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry”.

Recommended Solution: The NS1WG recommends that the definition of MFMT should remain as it is in the current NS1 guidelines but, where appropriate, requirements for maintaining or reducing fishing mortality below the MFMT should be strengthened; i.e., there should be a lower tolerance for overfishing. Other than cases where a mixed stock exception or some other exception has explicitly been made and justified, or cases where overfishing has only recently been identified, overfishing should be eliminated as soon as possible in order to promote stock rebuilding and, in particular, to prevent further stock depletion. Phase-in periods for reducing fishing mortality down to the level of the MFMT should only be permitted if the following two conditions are met: (i) the maximum permissible rebuilding time is no greater than it would have been without the phase-in period, and (ii) fishing mortality levels must, at the least, be reduced by a substantial (e.g., measurable) amount each year. Progress toward eliminating overfishing should not await approval of a formal rebuilding plan.

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3. Stock Size Thresholds

Problem Statement: The requirement for minimum stock size thresholds (MSSTs) is one of the most contentious parts of the NS1 guidelines. There are several contradictory reasons for the controversy. On the one hand, some have perceived the introduction of a minimum stock size criterion as a mechanism for imposing unduly restrictive management measures on the fishing industry. However, others have perceived it as signaling that rebuilding plans may not be required until stocks have become severely depleted. In addition, the current definition of the MSST ($\frac{1}{2} B_{MSY}$ or the minimum stock size at which rebuilding to B_{MSY} would be expected within 10 years while fishing at the MFMT level, whichever is greater) is perceived by some as being too complex, and by others as being unnecessarily restrictive since fishing is supposed to be restricted to the OY level which should be below the MFMT. Therefore, there is a need to (i) simplify the requirements for specifying and calculating MSST, and (ii) emphasize its role as a secondary, rather than a primary, consideration relative to the need to bring fishing mortality under control.

Recommended Solution: The NS1WG recommends that an MSST or proxy should continue to be required, either at the level of individual stocks for core stocks, or at the level of assemblages or indicators species for assemblage stocks, with limited exceptions (see below). A stock or assemblage that falls below the MSST shall be deemed to be overfished and require a rebuilding plan.

The NS1WG further recommends that quantification of MSST should continue to take account of the fact that fish stocks fluctuate naturally, even if fished at a constant rate. Therefore, it would not make sense to set the MSST at or above B_{MSY} because a stock fished at or somewhat below the MFMT could frequently flip between a state of being overfished (therefore requiring development of a rebuilding plan) and one of being rebuilt. Based on simulations of fish stocks with a variety of combinations of life history characteristics fished at or near F_{MSY} , the NS1WG determined that stocks for which overfishing did not occur would rarely fall below $\frac{1}{2} B_{MSY}$ except when they have very high natural mortality (meaning that there are few age classes in the population), or very high recruitment variability, or are prone to runs of unusually low recruitments. Based on empirical evidence, it appears that stocks are typically able to rebound from $\frac{1}{2} B_{MSY}$ to B_{MSY} with little difficulty so long as fishing mortality is suitably constrained. In other words, it is unlikely that depensatory effects (reduced per capita growth rates at low levels of abundance) are of consequence at population sizes near or above $\frac{1}{2} B_{MSY}$.

Therefore, the NS1WG recommends that the NS1 guidelines be simplified to define the default MSST to be $\frac{1}{2} B_{MSY}$. In rare cases, it may be possible to justify MSST levels below $\frac{1}{2} B_{MSY}$ (e.g., for stocks with high natural fluctuations that result in biomass frequently falling below B_{MSY} even when overfishing does not occur; in this case, it may be reasonable to set the MSST near the lower end of some appropriate range (e.g., the lower 95% confidence interval) of the natural fluctuations that would result if the stock or assemblage was not subjected to overfishing. On the other hand, the MSST could be set higher than $\frac{1}{2} B_{MSY}$ for stocks that are rarely expected to fall below some biomass level appreciably higher than $\frac{1}{2} B_{MSY}$.

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For short-lived stocks with high annual fluctuations in productivity and abundance, it is permissible to define MSST relative to stock abundance over a multi-year period (as is currently done for Pacific salmon).

It is also permissible to use proxies for MSST, as stated in the current NS1 guidelines, particularly in data-poor situations. The NS1WG recommends that the current NS1 guidelines language about proxies should be retained (with the future possibility of further technical guidance provided in a different forum).

An MSST or proxy should always be specified, if possible, with the following exceptions. First, if an OY control rule is implemented that results in fishing mortalities at least as conservative as would have been the case if an MSST had been used, then explicit use of an MSST is not required. However, even in these circumstances, use of an explicit MSST is encouraged, at least as a “second line of defense”. Second, if the Secretary determines that existing data are grossly inadequate or insufficient for providing a defensible, albeit approximate, estimate of MSST or a reasonable proxy thereof, specification of such is not required. In such cases, it may be necessary to rely on qualitative evidence that the stock or assemblage is, or is not, sufficiently depleted as to require rebuilding. However, such cases should be rare, particularly for core stocks, and explicit justification should always be provided whenever an MSST or proxy is not specified. This sub-issue is addressed further under 5.

4. Rebuilding Time Horizons

Problem Statement: The definition of the maximum rebuilding time horizon in the current NS1 guidelines contains an inherent discontinuity. Define T_{\min} to be the minimum rebuilding time based on the number of years it takes to achieve a 50% probability that biomass will equal or exceed B_{MSY} at least once when $F = 0$. Define T_{\max} to be the maximum permissible rebuilding time. Using these terms, the current NS1 guidelines state that T_{\max} may not exceed 10 years if T_{\min} is less than 10 years, and T_{\max} may not exceed T_{\min} plus one generation time if T_{\min} is greater than or equal to 10 years. The problem is that this results in a discontinuity in rebuilding times such that, for example, T_{\max} equals 10 years when T_{\min} equals 9 years, but T_{\max} can be considerably greater than 10 years when T_{\min} is only one year longer.

Recommended Solution: The NS1WG recommends that if $T_{\min} + \text{one generation time}$ exceed 10 years, then $T_{\max} = T_{\min} + \text{one generation time}$; otherwise T_{\max} can be up to 10 years.

[The NS1WG and others put considerable effort into evaluating the efficacy of alternative rebuilding time horizons. Numerous alternative approaches were considered (see Appendix 1), but this approach was chosen because it is consistent with the provisions of the MSA, results in the least change to the existing definition and its justification, yet it does remove the discontinuity and will result in more flexible rebuilding time horizons in some cases. Other reasons for favoring this approach are discussed in Appendix 1].

5. Rebuilding Targets

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Problem Statement: Under the current NS1 guidelines, once a stock or assemblage has been declared to be overfished (i.e., below its MSST), it must be rebuilt back to at least B_{MSY} before being declared to be fully rebuilt and no longer requiring a rebuilding plan. The reason for requiring rebuilding all the way to B_{MSY} , rather than just to the MSST level, is that a stock or assemblage that has been depleted to this extent is likely to have a distorted age distribution, and therefore both the age distribution and the biomass need to be rebuilt in order to meet the MSA mandate of “rebuilding to a level consistent with producing the MSY”. While the NS1WG believes that this argument makes sense, it also recognizes the difficulties inherent in estimating the B_{MSY} target in certain situations. In particular, alternative approaches may be needed when the Secretary determines that biomass-based reference points cannot currently be reliably estimated due, for example, to a lack of appropriate biomass-related data, because B_{MSY} is probably beyond the range of quantified observations, or because an environmental regime shift has occurred.

Recommended Solution: The NS1WG recommends that when the Secretary determines that there are inadequate data to estimate biomass-based reference points reliably, it should be permissible to use appropriate fishing mortality proxies in certain situations. For example, when there are inadequate data to estimate MSST and/or a B_{MSY} rebuilding target reliably, but the available quantitative or qualitative evidence suggests that a stock or assemblage is sufficiently depleted that it requires rebuilding, then it should be permissible to set a rebuilding fishing mortality at or below the MFMT that will result in a very low probability of the stock or assemblage declining further, and to evaluate rebuilding performance every two years as required by the MSA. In these circumstances, it may be reasonable to declare a stock or assemblage to be rebuilt if the realized running average fishing mortality has been below the MFMT for at least two generation times, provided there is no other strong evidence that biomass is still depleted. It would also be reasonable to expect that data on the stock or assemblage would accumulate during the two generation period, and this could ultimately be used to estimate the biomass-based reference points, and to re-evaluate the appropriateness of the MFMT. In this sense, the biomass rebuilding target is, in effect, an emergent property of the rebuilding plan.

However, in order to invoke this approach, National Standard 2 (“best scientific information available”) must be brought to bear on the issue of the adequacy of the data for estimating biomass-based reference points. Here, scientific peer review has an obvious role to play. Additional provisions should apply for invoking a regime shift argument to apply the approach. A regime shift can only be inferred when there is a scientific basis to do so (e.g., changes in climatic indices that operate on decadal time scales, or persistence changes in a species’ survival ratios). The distinction that needs to be made is between fluctuations that are within the range of natural variability normally encountered in a generation time of the fish stock, versus quasi-permanent or cyclical changes. In addition, the possibility that a switch to a low productivity regime may ultimately be followed by a switch a high productivity regime, and vice versa, needs to be acknowledged and accounted for. Other provisions in the current NS1 guidelines related to regime shifts will continue to apply; for example, thresholds are to be calculated with respect to prevailing environmental conditions and, in the event of a regime shift, such thresholds must be respecified.

6. Revision of Rebuilding Plans

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Problem Statement: The current NS1 guidelines provide a template for the initial formulation of rebuilding plans, but do not include guidance on procedures to follow when rebuilding plans require revision after initiation. In addition, the MSA requires that progress towards ending overfishing and rebuilding affected fish stocks be evaluated for adequacy at least every two years, but does not define “adequate progress”. The following example illustrates the type of paradox that can result when there is no guidance on revision of rebuilding plans after initiation. Consider a case where an initial rebuilding plan was based on a stock assessment that estimated T_{\max} to be 30 years, but in the first five years of the plan rebuilding occurred substantially faster than anticipated and a new assessment indicates that T_{\max} is now 10 years; however, in order to rebuild in 10 years, fishing mortality must be substantially reduced.

There are two different, but related, situations to address. The first is the situation where rebuilding has occurred substantially faster or slower than expected, and the second is the situation where estimates of assessment variables, such as the rebuilding target, are substantially modified based on a new or revised stock assessment.

Recommended Solution: The NS1WG noted that, by definition, fishing mortality targets should be achieved on average and therefore recommends that rebuilding plans should not be adjusted in response to each minor stock assessment update. However, if rebuilding plans are to be adjusted, then it may be permissible in some circumstances to modify either the sequence of rebuilding fishing mortalities, or the time horizon, but not both. Rebuilding must continue until the biomass target is met.

The following two paragraphs apply for situations where rebuilding has occurred substantially faster or slower than expected (but estimates of stock assessment parameters and variables have not been substantially modified based on a new or revised stock assessment).

- If rebuilding proves to have occurred substantially faster than initially projected, the former¹ sequence of rebuilding fishing mortalities should be retained until the stock or assemblage is rebuilt.
- If rebuilding proves to have occurred substantially slower than initially projected, even though the former¹ rebuilding fishing mortalities have **not** been exceeded, it is permissible to either retain the former¹ rebuilding time horizon and reduce the former¹ sequence of rebuilding fishing mortalities to meet it, or to keep the former¹ sequence of rebuilding fishing mortalities and lengthen the time horizon accordingly. If the former¹ rebuilding fishing mortalities have been exceeded, the former¹ rebuilding time horizon must be maintained, and future fishing mortalities must be reduced to the extent necessary to compensate for previous overruns.

The following two paragraphs apply for situations where estimates of stock assessment parameters and variables, such as the rebuilding target, have been substantially modified based on a new or revised stock assessment. The text is identical to that of the previous block, except for allowing

¹Here, “former” refers to something that was previously approved through the usual FMP process

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greater flexibility in the case of new estimates that would permit substantial increases in rebuilding fishing mortalities.

– If estimates of assessment parameters and variables, such as the rebuilding target, change in such a way as to allow substantial increases in the former¹ sequence of rebuilding fishing mortalities in order to rebuild within the former¹ time horizon, it is permissible to either retain the former¹ rebuilding time horizon and increase the former¹ sequence of rebuilding fishing mortalities to meet it, or to keep the former¹ sequence of rebuilding fishing mortalities and either retain the time horizon or shorten it accordingly.

– If estimates of assessment parameters and variables, such as the rebuilding target, change in such a way as to require substantial reductions in the former¹ sequence of rebuilding fishing mortalities in order to rebuild within the former¹ time horizon, even though the former¹ sequence of rebuilding fishing mortalities have **not** been exceeded, it is permissible to either retain the former¹ rebuilding time horizon and reduce the former¹ sequence of rebuilding fishing mortalities to meet it, or to keep the former¹ sequence of rebuilding fishing mortalities (provided these are no greater than any new estimate of MFMT) and lengthen the time horizon accordingly (provided this is no greater than any new estimate of T_{max}). If the former¹ rebuilding fishing mortalities have been exceeded, the former¹ rebuilding time horizon must be maintained, and future fishing mortalities must be reduced to the extent necessary to compensate for previous overruns.

Note that “keeping the former¹ sequence of rebuilding fishing mortalities” when the former¹ rebuilding time horizon may be lengthened means that the average of the sequence of fishing mortalities, excluding any period of phasing-in of fishing mortality reductions, should be applied until the stock or assemblage is rebuilt.

7. OY Control Rules

Problem Statement: While most FMPs have defined threshold or limit reference points based on MSY control rules, few have specified OY control rules, or “target control rules”. However, it could be argued that the need for an OY control rule is at least as implicit in the language of the MSA as the need for an MSY control rule. Furthermore, if both an MSY control rule and an OY control rule were required, we would have the tools necessary to determine compliance with the MSA’s requirement that OY be no greater than MSY.

Recommended Solution: The NS1WG recommends that the requirement to develop target OY control rules, in addition to threshold or limit control rules, be strengthened; i.e., change “may” to “must”. Targets should be achieved on average; e.g., with 50% probability. OY control rules must satisfy the condition that they are less than the MSY control rule over their entire range.

8. Terminology

First Problem Statement: The NS1 guidelines use the term “threshold” to indicate a property of control rules that is usually defined as a “limit” in much of the published scientific literature and in other fisheries forums, including international fisheries organizations. To be in conformance with common usage, “limit” should be used to denote a reference level that should be avoided with high

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probability and "threshold", if used at all, should denote a "red flag" or "warning zone". In addition, use of the phrase "minimum stock size threshold" implies that biomass thresholds (limits) are to be applied at the level of individual stocks, whereas the NS1WG has recommended that they may be applied at the level of species assemblages, where appropriate.

Recommended Solution: The NS1WG recommends that the term "minimum stock size threshold" (MSST) should be replaced with the term "biomass limit" (B_{lim}), and the term "maximum fishing mortality threshold" (MFMT) should be replaced with the term "fishing mortality limit" (F_{lim}). The NS1 guidelines should require limits to be defined in most cases, and could outline the utility of also having thresholds, but would not require them. The NS1 guidelines should also recognize that biomass is not the only metric that can be used to express the size of a stock or assemblage, and therefore other appropriate metrics, such as numbers or egg production, can be used in place of biomass.

Second Problem Statement: The word "overfished" is used in both the MSA and the NS1 guidelines to denote a stock or assemblage in need of rebuilding. However, stocks and assemblages can become depleted for reasons other than overfishing. The current terminology places an unfair onus on the fishing industry, the Councils and NMFS to classify all depleted stocks or assemblages as "overfished". In addition, stocks or assemblages that have been substantially reduced in size need to be rebuilt if possible, regardless of the cause of depletion. Continued use of the term "overfished" in inappropriate situations or in situations where both overfishing and environmental factors have contributed to stock decline has led to proposals (e.g., proposed legislation for reauthorization of the MSA) requiring NMFS and the Councils to differentiate between depletion caused by overfishing and depletion caused by other factors. Such a requirement is virtually impossible to satisfy from a scientific viewpoint, and is potentially counter-productive.

Recommended Solution: The NS1WG recommends that the word "overfished" be replaced with "depleted" in most, if not all, places within the NS1 guidelines. "Depleted" needs to be defined explicitly to avoid confusion with the definition used in the Marine Mammal Protection Act. Factors that can cause depletion will be listed and will include overfishing, environmental changes, pollution, and habitat destruction. Factors that result in permanent changes in stock productivity (e.g., irreversible habitat destruction) may require recalculation of limits and rebuilding targets relevant to prevailing conditions, as is required for a regime shift.

9. Technical Issues

Problem Statement: There are many complex technical issues associated with the application of the NS1 guidelines. These include:

- methods for estimating MSY-based reference points;
- biological reference points for assemblages;
- acceptable procedures for special situations; e.g. "annual crop" species such as squids and some shrimps;
- how to address data-poor situations;
- stock size projection methods; and
- standardization of statistics (e.g., arithmetic means, geometric means, medians and probabilities)

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used to formulate and evaluate rebuilding plans. Guidance on some of these items could be incorporated into the NS1 guidelines, but inclusion of guidance on all items would result in the guidelines becoming too cumbersome and convoluted, particularly if the objective is to provide guidance that can be applied to each and every existing fishery.

Recommended Solution: The NS1WG recommends that selected metrics or methods should be standardized across Regions, but that the NS1 guidelines not unduly constrain flexibility in applying alternative models, probability distributions, and other relevant methodologies. The NS1WG suggests that three methodological considerations should be standardized and incorporated in the NS1 guidelines: (i) B_{MSY} should be the long-term median (which may not be equal to the average) spawning biomass that is expected when fishing according to the MSY control rule; (ii) rebuilding control rules should have at least a 50% probability that biomass will achieve the B_{MSY} level on or before T_{max} ; and (iii) stock productivity parameters used to calculate rates of rebuilding must be consistent with the rates used to calculate B_{MSY} , or an explicit accounting of environmental effects on productivity must be included in the rebuilding calculations. Regarding item (ii), the NS1WG recognizes that some Regions have used rebuilding criteria that are more conservative than this. However, the language “at least a 50% probability” means that more conservative rules are not precluded. Whatever the approach used, stocks or assemblages must continue under a rebuilding plan until they are rebuilt in practice, not just in theory. Also, use of (ii), and even some more conservative rules, could result in some stocks or assemblages being declared “fully-rebuilt” prematurely. However, this is not considered to be a major concern because stocks or assemblages prematurely declared to be rebuilt must continue to satisfy the constraint that fishing mortality does not exceed the MFMT.

To address other technical issues, the NS1WG recommends formation of a permanent Scientific Working Group to produce recommendations on individual concerns as they arise. This group might have a somewhat fluid membership and should meet at least twice per year, if required. Resulting recommendations should be provided to all Regions in written form.

10. International Fisheries

Problem Statement: Several MSA and NS1 guidelines requirements (particularly responsibility for determining overfished status, the need for rebuilding plans, and the process for implementation of rebuilding plans), are difficult to apply in international fisheries for straddling stocks, and for highly migratory species (HMS) such as tuna, swordfish, marlins and sharks. The greatest difficulties arise in cases where (i) there is no responsible international management authority, and (ii) the U.S. catches only a small portion of a stock or assemblage.

Recommended Solution: The NS1WG recommends that the NS1 guidelines be amplified with respect to international HMS and straddling stocks in which the U.S. has an interest. Principles to be incorporated are: (i) to generally rely on international organizations in which the U.S. participates to determine the status of HMS stocks or assemblages under their purview, including specification of status determination criteria and the process to apply them; (ii) if the international organization in which the U.S. is a participant does not have a process for developing a formal plan to rebuild a

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specific overfished HMS stock or assemblage, to use the MSA process for development of a rebuilding plan by a regional fishery management council or NMFS to be promoted in the international organization or arrangement; and (iii) to develop appropriate domestic fishery regulations to implement internationally agreed upon measures or appropriate U.S. fishery measures consistent with a rebuilding plan giving due consideration to the position of the U.S. domestic fleet relative to other participants in the fishery.

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APPENDIX I. Non-Preferred Alternative Solutions

Introduction

Under each of the issues identified in the main body of the text, several alternative approaches were examined. In particular, the status quo alternative (“Status quo; no change to the NS1 guidelines”) was always discussed at length. Other alternatives were either rejected as being inferior to the Recommended Solution, unwieldy or unworkable, or not precluded by the Recommended Solution. Many of the alternatives considered were ultimately revised and folded into the Recommended Solutions, and therefore are not repeated here. Thus, some of the alternatives listed below only apply to specific parts of the Recommended Solutions. These lists of alternatives are presented to illustrate the diversity of options explored by the NS1WG.

A brief rationale for rejecting particular alternatives is included in square brackets after each alternative.

1. Stocks, Fisheries and Species Assemblages

Alternative 1: Status quo; no change to the NS1 guidelines. [Not recommended because the MSA clearly allows overfishing and overfished to be specified on the basis of individual stocks or on the basis of “fisheries”. The current NS1 guidelines need to be clarified to reflect this.]

Alternative 2: Establish an MFMT for multispecies assemblages. MFMT can be greater than the MSY control rule for minor components of the assemblage as long as it does not drive any stock in the assemblage below its stock-specific MSST. [– This approach is not precluded by the Recommended Solution].

Alternative 3: Manage all multispecies fisheries as assemblages with overall MFMTs and MSSTs, or MFMTs and MSSTs based on one or more indicator stocks, but not individual MFMTs and MSSTs except that individual stocks must satisfy the current requirements in the NS1 guidelines (e.g., to not become subject to listing under ESA). [Not recommended because this alternative could result in important target species remaining in an overfished state indefinitely, an action that would likely compromise long-term net benefits to the Nation. If such an action did actually result in increased long-term benefits to the Nation, it would be covered by the mixed species exception contained in the Recommended Solution].

Alternative 4: Manage to the weakest stock in an assemblage. [Not recommended because this alternative would also compromise long-term net benefits to the Nation; however, it is recognized that weak stocks require special consideration and this is included in the Recommended Solution].

Alternative 5: Manage to the economically or biologically most important stock in an assemblage. [Not recommended because this alternative would likely lead to numerous stocks becoming overfished and is likely to compromise long-term net benefits to the Nation].

Alternative 6: Increase the flexibility of the current "mixed stock exception" in the guidelines. [The NS1WG was unable to determine how to accomplish this objective without compromising the long-term viability of ecologically important stocks and assemblages].

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Alternative 7: Decrease the flexibility of the current "mixed stock exception" in the guidelines. [This has already been accomplished in the Recommended Solution by replacing the current NS1 guidelines requirement that a stock not become eligible for an ESA listing with a higher standard].

2. Fishing Mortality Thresholds

Alternative 1: Status quo; no change to the NS1 guidelines. [Not recommended because the Recommended Solution will actually result in few substantive changes to the current NS1 guidelines, but it will further strengthen the emphasis on the need to eliminate overfishing].

3. Stock Size Thresholds

Alternative 1: Status quo; no change to the NS1 guidelines. [Not recommended because, at the least, the status quo needs to be changed to Alternative 2].

Alternative 2: Modify the current MSST definition from the greater of "One-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years if the stock or stock complex were exploited at the maximum fishing mortality threshold specified under paragraph ..." to the greater of "One-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years if the stock or stock complex were exploited at the target fishing mortality rate appropriate to that biomass level". [This is unnecessarily complex, particularly when one considers the details of how to conduct the analysis (e.g., the effect of the initial age structure on the result); however, the Recommended Solution would not prevent this approach if it was desired].

Alternative 3: Set MSST equal to B_{MSY} . [Not recommended because, in most cases, this would be unnecessarily conservative and could result in frequent flip-flops between the states of overfished and not overfished (and, therefore, frequent flip-flops in the need for a rebuilding plan)].

Alternative 4: Set MSST equal to $(1-M) B_{MSY}$. [This may also be too conservative; more analysis is needed. However, the Recommended Solution does not preclude this option].

Alternative 5: Disassociate the definition of MSST from B_{MSY} , particularly in cases where MSY-based reference points cannot be estimated or are unreliable; e.g., adopt B_{lim} approaches as per ICES and NAFO. [More analysis is needed to determine the relationship between B_{lim} and B_{MSY} . However, the Recommended Solution does not preclude this option].

Alternative 6: MSST is not required for any fisheries. [Not recommended because experience has clearly demonstrated that an MSST is necessary to ensure a rebuilding response if a stock has become depleted. Even in well-managed fisheries, where overfishing is a rare or non-existent occurrence, there are possibilities of assessment errors or environmental changes that can cause a rapid decrease in the abundance of fish stocks under otherwise good management. Without an MSST to trigger a formal rebuilding program, remedial management has tended to be late and inadequate. Therefore, at the least, an MSST is needed as a "second line of defense" for a stock or assemblage that has either not been managed so as to prevent overfishing, or has become depleted for other reasons, or a combination of these. If MSSTs were not required, it would probably be necessary to

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develop some sort of proxy to use as a trigger for a rebuilding plan].

4. Rebuilding Time Horizons

In the following alternatives, T_{\min} is the minimum rebuilding time, defined as the number of years it takes to achieve a 50% probability that biomass will equal or exceed B_{MSY} at least once when $F = 0$. T_{\max} is the maximum permissible rebuilding time.

Alternative 1: Status quo; no change to the NS1 guidelines. [Not recommended because at the least, it is essential to eliminate the inherent discontinuity in the current NS1 guidelines].

Alternative 2: Emphasize stock biology constraints rather than the MSA's 10-year guideline; set $T_{\max} = 2$ generation times across the board. [See the response following the list of alternatives].

Alternative 3: Emphasize stock biology constraints rather than the MSA's 10-year guideline; set $T_{\max} = 1.5$ generation times across the board. [See the response following the list of alternatives].

Alternative 4: Set $T_{\max} = 2 * T_{\min}$ across the board. [See the response following the list of alternatives].

Alternative 5: Set $T_{\max} = T_{\min} + \rho * \text{generation time}$, where $\rho < 1$. [See the response following the list of alternatives].

Alternative 6: Set T_{\max} = the time it takes to rebuild if fishing at a constant rate of $\frac{1}{2} F_{\text{MSY}}$ across the board. [Not recommended because for severely-depleted stocks where depensatory effects may be important, $\frac{1}{2} F_{\text{MSY}}$ may not be low enough to enable the stock to rebound above the depensatory threshold, below which its long-term viability is jeopardized; also see the response following the list of alternatives].

Alternative 7: If T_{\min} is greater than 10, then $T_{\max} = 10 + 2*(T_{\min}-10)$; i.e., 2 rebuilding years are allowed for each year greater than 10 that it would take to rebuild at $F = 0$. There is no need to invoke generation time, and the discontinuity problem is reduced. [Not recommended because while the discontinuity is not as strong as it is in the current NS1 guidelines, it still exists; also see the response following the list of alternatives].

Alternative 8: T_{\min} is defined based on minimum feasible levels of fishing mortality, rather than $F = 0.0$. [Not recommended because any definition of "minimum feasible levels" would be too subjective. Zero fishing mortality should mean zero fishing mortality. In any case, T_{\min} is only one part of the calculation of T_{\max} . The Recommended Solution will generally result in rebuilding fishing mortalities greater than zero].

Response to Alternatives 2-7: There are many possible variations on Alternatives 2-7, a number of which were discussed by the NS1WG. However, they can all be boiled down to alternatives that contain T_{\min} , and alternatives that are based on selected life history parameter(s), and don't include T_{\min} . Alternatives that contain T_{\min} are problematic because each new stock assessment is likely to result in a new estimate of this quantity due to changes that have accrued in stock size and age distribution since the last assessment, and other factors. However, alternatives not involving T_{\min} are even more problematic because they are not responsive to the degree of depletion that may have occurred, are usually not responsive to current levels of stock productivity, may specify rebuilding time horizons that are biologically impossible, and are not responsive to the MSA language "unless <circumstances> dictate otherwise". The Recommended Solution

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was favored because it (i) is consistent with the MSA, (ii) results in the least change to the existing NS1 guidelines definition and its justification, (iii) removes the discontinuity, (iv) results in time horizons that are responsive to the degree of depletion of a stock, (v) results in time horizons that are responsive to current levels of stock productivity, (vi) results in time horizons that are at least biologically feasible, (vii) allows a certain amount of flexibility to incorporate socio-economic considerations, and (viii) will result in more flexible rebuilding time horizons in several cases. None of the other alternatives satisfy all of these qualities.

The problem of estimates of T_{\min} changing with each assessment is addressed under Issue 5.

5. *Rebuilding Targets*

Alternative 1: Status quo; no change to the NS1 guidelines. [Not recommended because there have already been several examples where it is obvious that the NS1 guidelines need to be amplified to provide further options and enhance flexibility].

Alternative 2: The only alternatives discussed under the issue of rebuilding targets that were not ultimately folded into the Recommended Solution were (i) the condition for determining an appropriate rebuilding fishing mortality in circumstances where there are inadequate data to reliably estimate biomass-based reference points, and (ii) the metric or mechanism for determining or inferring that a stock is rebuilt in such circumstances. The condition used for setting a rebuilding fishing mortality in the Recommended Solution is that the rebuilding fishing mortality must be at or below the MFMT and must result in a very low probability that the stock or assemblage will decline further (which means that it must have a high probability of increasing over time). This sub-issue is addressed in Alternatives 2a and 2b. The metric used for determining or inferring that a stock is rebuilt is that the running average fishing mortality has been at or below the MFMT for at least two generation times, provided there is no other evidence that biomass may still be depleted. This sub-issue is addressed in Alternative 2c.

Alternative 2a: The rebuilding fishing mortality must result in at least a 95% probability of annual increases in stock size for the foreseeable future (e.g., over the next ten years). [Not recommended because a requirement for stock increases in each and every year might require an unnecessarily restrictive rebuilding fishing mortality due to natural variation in stock size, particularly if it is known that one or more poor years classes will soon recruit to the stock].

Alternative 2b: The rebuilding fishing mortality must be set below some fraction of the MFMT (e.g., below $0.75 \cdot \text{MFMT}$). [Not recommended because it is not possible to specify a fraction of MFMT that will work for every situation].

Alternative 2c: It may be permissible to declare a stock or assemblage to be rebuilt if the realized running average fishing mortality has been less than $0.75 \cdot \text{MFMT}$ for at least two generation times, provided that there is no other evidence that biomass may still be depleted. [Not recommended because the NS1WG determined that adding an arbitrary constant did not make this alternative superior to the Recommended Solution. Although it is possible that fishing mortalities at the beginning of the rebuilding period may need to be much lower than the MFMT, they could potentially be quite close to the MFMT through much of the two

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generation time period].

6. Revision of Rebuilding Plans

Alternative 1: Status quo; no change to the NS1 guidelines; i.e., no amplification of guidance. [Not recommended because the current NS1 guidelines do not address the issue of revision of rebuilding plans after initiation and it is obvious from several recent examples that the guidelines need to be greatly amplified to address this issue].

Alternative 2: Rebuilding plans should be reinvented from scratch every 2-5 years. [Not recommended because such a task would be too onerous, and could keep fisheries in an almost continual state of limbo].

Alternative 3: An alternative to the first bullet point that applies for the situation where rebuilding has occurred substantially faster or slower than expected: If rebuilding proves to have occurred substantially faster than initially projected, it is permissible to either retain the former¹ rebuilding time horizon and increase the former¹ rebuilding fishing mortalities to meet it, or to keep the former¹ rebuilding fishing mortalities and shorten the time horizon accordingly. [Not recommended because rebuilding fishing mortalities should not be increased just because, for example, there has been a run of fortuitously good recruitments. A run of poor recruitments may follow and the rate of rebuilding will fall behind schedule. It is important to remember that rebuilding projections are usually averages or medians of a large number of alternative plausible scenarios, whereas there is only one scenario that actually occurs. If the projection model was “correct” (and the rebuilding fishing mortalities were implemented exactly), it would be expected that the real scenario would fluctuate on either side of the projected average or median trajectory].

7. OY Control Rules

Alternative 1: Status quo; no change to the NS1 guidelines. [Not recommended because few FMPs have specified OY control rules even though the MSA implies that they should do so].

8. Terminology

Alternative 1: Status quo; no change to the NS1 guidelines – however, mention the difference between the NS1 guidelines approach and common usage in other countries and international organizations. [Not recommended because the United States should conform with common usage to avoid confusion and misunderstandings].

Alternative 2: The fishing mortality reference point should be a limit, while the biomass reference point should be a threshold. [Not recommended because the NS1WG has now recommended a potentially less-conservative definition of the MSST than that contained in the current NS1 guidelines. Both should be limits].

9. Technical Issues

Alternative 1: Status quo (all Regions do it differently); no change to the NS1 guidelines. [Not recommended because the NS1WG determined that some degree of standardization is

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required].

Alternative 2: Recommend the formation of another working group to produce an update of Restrepo *et al.* 1998. [Not recommended – this alternative could be reconsidered, but the NS1WG felt that this would be a major task and all of the agency scientists capable of making meaningful contributions are already over-committed with numerous other projects].

10. International Fisheries

Alternative 1: Status quo; no change to the NS1 guidelines; i.e., no clarification of the NS1 guidelines. [Not recommended because the NS1WG believes that clarification and amplification of procedures to follow for straddling stocks and HMS fisheries is required].

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