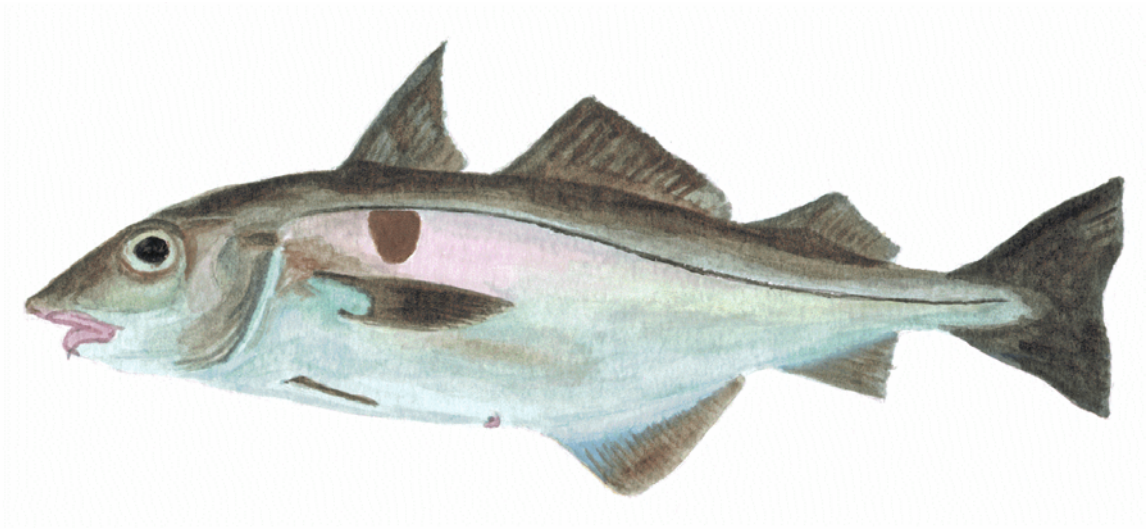
Groundfish Peer Review

February 3-8, 2003
New England Conference Center
Durham, New Hampshire

Review Report

by

Robin Cook



Contents

Background

1. A National Marine Fisheries Science (NMFS) report of March 2002 (Final report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish) provides updated estimates of biological reference points (BRPs) that are proposed for use in the management of New England groundfish. The BRPs are based on new data that have been accumulated in recent years and new analytical methods. They are also based on revised criteria for defining B_{MSY}, in particular the choice of F40% as a basis for setting B_{MSY} proxies as opposed to F20% used previously. A recent Groundfish Assessment Review Meeting (GARM) updated assessments of 21 New England stocks and used the proposed reference points to evaluate stock status.

2. These assessments, and some of the methods for estimating Bmsy, use NMFS trawl surveys. A recent problem has been identified with the trawl warps on the RV *Albatross* leading to concerns about the validity of assessments and some of the calculated reference points.

3. The purpose of the review meeting was to consider the problems with the surveys, review the methodology used in the calculation of reference points and review the methodology used for stock projections. The latter was primarily concerned with the use of projection methods where they are used to calculate $F_{rebuild}$, the F required to rebuild the stock in ten years if the current biomass falls below the 'overfished' biomass threshold.

Review Activities

Documents

4. Approximately one week before the meeting, the main documents for the review became available from the NMFS website. Further material was provided on CD on the first day of the meeting. During the public session of the review additional material was circulated, some from NMFS scientists but most from other participants. A full list of material available is given in Appendix 3.

Preparation and conduct of the meeting

5. I reviewed the documents received before the meeting prior to arrival in the USA. I arrived in Durham NH on 1st February and continued reviewing material at the New England Conference Center on the 2nd.

6. The Groundfish Peer Review meeting began on the 3rd and followed the agenda given in Appendix 2. An independent facilitator ensured presentations were kept to time, and managed interventions from the floor conducted the meeting. At the close of the public session, participants were asked to submit questions and comments to the

panel for its consideration in the preparation of the reviews (Appendix 4). This material was taken into account in the preparation of the consultant's report, though it was not possible to address all the concerns raised. In Appendix 4, the sections of this report dealing with the issues raised are identified by paragraph number.

7. Following the public session, which ended on the 4th February, the consultant worked in a private, executive session with the other three reviewers and the chair of the review team to discuss the panel's findings and begin the preparation of the review report.

8. The consultant departed the USA on the evening of the 8th February and arrived back in the UK on the 9th. A draft report of the consultant's review was sent to the chair of the review panel on the 11th February in order that he might begin preparation of the summary report. A final draft report was completed on the 14th February and transmitted to the Center for Independent Experts (CIE).

Summary of findings

Trawl survey issues and influence on management advice

9. The NMFS trawl surveys conducted in the RV *Albatross* and RV *Delaware* are an important source of data used in the stock assessment of groundfish in the New England fishery. The data are used in two principal ways:
   - As direct estimates of relative stock biomass and relative fishing mortality
   - As relative abundance estimates to 'tune' catch at age analysis from which total biomass and fishing mortality are derived.

10. This means that the surveys are an essential element of the process that feeds into management advice. Clearly if there are problems with the survey estimates there may be serious implications for the management of the stocks. The problem will likely be greatest for those stocks for which the biological reference points are calculated directly from survey data.

11. Following concerns expressed by the fishing industry about the survey protocols, it was discovered that the trawl warps on the RV *Albatross* had been incorrectly marked with the result that, for a number of cruises between 2000-2002, the standard survey gear would have been fished with unequal lengths of wire out on each side of the gear. This occurrence may have affected the efficiency of the gear, which failure could contribute to both bias and noise in the survey estimates compared with previous years. While much concern has been focussed on the trawl warp problem, fishing industry participants at the Groundfish Peer Review (GPR) were critical of many other aspects of the survey protocol. These criticisms included:

    - Dissatisfaction with the survey gear
    - Concerns about the rigging of the net

- Lack of quality control in operating the net in a standard fashion
- Inappropriate towing speed for the gear

12. These criticisms are elaborated in the Report of the Workshop on Trawl Warp Effects on Fishing Gear Performance (NEFSC 2002 doc 02-15). If valid, these concerns affect not only the recent cruises where the warp offset problem is known but call into question the whole of the time series of abundance indices on all surveys. Inevitably, this potentially undermines the basis of many of the BRP calculations and the ability to judge the status of many stocks.

13. For convenience, it is perhaps worth separating the warp offset problem known to exist for some recent surveys from the more general criticisms relating to the overall quality of the whole survey time series. The former has been the subject of a number of studies to determine the nature of the effect and extensive documentation of these was provided at the GPR. The general criticisms relating to quality are more difficult to evaluate at this review without much more information. Nevertheless, issues are raised which need to be considered.

14. The warp offset issue has been analysed and studied intensively in recent months, being the subject of both desk studies and at-sea experiments. The GARM concluded on the basis of studies then completed that 'there is no indication of a systematic reduction in trawl survey fish catch efficiency due to the trawl warp effects'. The analyses presented to the GPR by both Northeast Fishery Science Center (NEFSC) staff and industry scientific consultants were generally unable to detect or quantify any warp offset effect, hence the GARM conclusion appears to be more or less correct. This does not mean that no effect occurred but that the natural variability of the data is such that no effect is detectable.

15. With the involvement of the fishing industry, an experiment was conducted on the RV *Albatross* to compare an 'optimum' net to a 'worst case scenario' (WCS) net. Comparisons were also made to a fishing vessel towing a commercial gear. The WCS net was configured to include a number of 'faults' such as warp offset, gear damage, door problems, and rigging abnormalities. As all of these effects are included in the 'treatment' it is not possible to attribute any differences between the optimum net and the WCS net to any particular characteristic. For the majority of species no effect could be detected, but unfortunately it is possible that the multiple 'faults' may compensate each other masking any single effect. **If the various survey gear protocol issues remain controversial, then an experiment specifically designed to detect these effects will need to be undertaken.** Interestingly, for a small number of species (skates, herring and scallops), an effect was detected. This indicates that effects were detectable from the experiment and gives support to the conclusions in a number of analyses that the effect of the warp offset problem is not large.

16. As might be expected, clear differences emerged between the survey gear and the commercial gear. This relates both to the size of the catch, its species composition and the variance of the mean catch per tow. Drawing any useful conclusions from

these differences is extremely difficult. It is important to appreciate that because a commercial gear catches more of a particular species, it does not follow that an assessment based on such an index implies a larger stock. The NMFS survey indices are used as a measure of population change not absolute abundance. Hence the absolute efficiency of the survey is not crucial, and the fact the commercial gears take higher catches of certain species need not be of any significance in tracking population change.

17. The difference in species composition shows that the gears sample species with different efficiency. This does matter if comparisons are made between the relative abundance of different species sampled in the same year, but it need not be of any significance when tracking relative abundance of individual species over time.

18. The NMFS analysis of the experiment (Fogarty, 2003) and the industry supported analysis (Starr, 2003) both show lower sample variances for the commercial gear compared to the survey gear. As the two gears differ in design and mesh size, they will sample different populations, which means it is not possible to draw any conclusions from this difference. **However, it is desirable for any survey gear to perform as consistently as possible, and if there are lessons to be learned from the performance of the commercial gear in reducing sampling variability they should be investigated.**

19. It seems likely that the warp offset problem has not resulted in a major 'shock' to the time series of abundance indices for the main species taken in the survey. However, the concerns expressed by the industry encompass the more general question as to whether the survey samples with sufficient precision to track true population change. This question is of particular significance for those stocks where status is determined from survey indices alone. Where the sampling efficiency of a species is very low, or the population being sampled is small, there is a danger that the precision of any abundance estimate is not sufficient to make meaningful judgements about stock trends, particularly over short time scales. **It would be useful for an analysis to be conducted that evaluated the ability of the survey to detect population signal, above the inherent noise in the survey, for those assessments most dependent on survey indices of abundance.**

20. I was concerned that some of the stakeholder criticism of the NMFS surveys arose from a misconception about the fundamentally different objectives of commercial fishing and scientific surveys. This situation is quite common but does not provide a reason for rejecting the surveys as measures of abundance or a basis for modifying survey design. The very long, coherent time series from the research vessel surveys is of incalculable value and a fundamental change of design risks undermining a valuable data set. While there may be some reasons to reconsider the survey design in the light of recent experience, this needs to be done with considerable care. **If there is a move to redesign the NMFS surveys with the involvement of stakeholders, I strongly recommend that independent scientists with knowledge of survey design are included to ensure that scientific standards are not compromised.**

21. Terms of Reference 1D seeks comment on the precision of assessments in relation to the trawl survey. This question is a very big one, and it is beyond the scope of this review to deal with the issue in its entirety. Sensitivity analyses conducted on assessments assuming bias in the survey indicate that the determination of stock status is not changed by any likely effect of trawl warp offset. However, it should be noted that the difference between B_{2001} and F_{2001} and the respective reference points is usually quite large, so this result is not surprising. **Perhaps what is more important is the distance between current estimates of B and F and the reference points, since this will determine the strength of any management response. This issue does not appear to have been considered and should be investigated.**

22. A particular concern is the question of the extent to which estimation error in the current F and B trigger the wrong management response. This problem is one not confined to the warp offset issue, but relates more generally as to how assessment error should be taken into account when making judgements about management action. **It does appear that estimation error can trigger a stock rebuilding response even when there is no need to do so. Given the potential economic impact of this, some thought should be given to how assessment error should be handled within the management process.**

23. The issue of the sufficiency in the incorporation of uncertainty in relation to management advice is hard to address since this has a lot to do with the crafting of advice and the demands of managers. At face value, the management framework arising from the interpretation of the law demands far more precision and knowledge of the stocks than is deliverable. To some degree, therefore, the question could be turned around to ask whether the management system is adequately tailored to the degree of uncertainty inherent in our current knowledge. This question is of particular relevance to the estimation of B_{MSY} and its proxies, which present particular challenges resulting from incomplete knowledge. It is also worth reflecting on the fact that biomass is the quantity least under the control of managers because transient population change is influenced more by recruitment than mortality. Hence, it is questionable whether a rebuilding strategy should be so heavily predicated on a biomass target determined with substantial uncertainty and on a quantity over which managers have so little direct control.

<u>Biological reference points</u>

24. The present US management framework is predicated on the concept of maximum sustainable yield. In its purest form, this theory requires knowledge of the stock recruitment relationship. For many fish stocks recruitment is highly variable, and with the relatively few observations of stock and recruitment for most stocks, this variability makes determination of the relationship highly uncertain. An additional problem is that in many cases the stock size observations have been made only during a period of high exploitation rates when biomass is likely to have been restricted to

the lower left hand end of any relationship. In this circumstance, even if there is adequate data to fit a stock recruit curve (albeit over a restricted biomass range), the biomass and recruitment values associated with MSY probably lie outside the range of observations. Hence any calculation of MSY conditioned on such an s-r relationship effectively condemns the analyst to extrapolation beyond the range of the data with consequent loss of credibility. These difficulties lie at the heart of the 'Report' (Final Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish). Solving them requires a realistic interpretation of MSY in the light of incomplete data and knowledge.

25. In order to address the s-r problem, the NEFSC has invested considerable effort in the selection models to fit existing data for as many stocks as possible. The models are essentially variants on the Beverton-Holt and Ricker type. Model selection was based partly on statistical diagnostics and partly on the credibility of MSY related values in relation to other values such as Fmax and the range of observed landings. Overall, the basis for the model selection seems sensible given the data available. As alluded to above however, the problem is that the estimated values for B_{MSY} are generally higher than the largest biomass observed historically. This means there is little information in the stock-recruit data that inform the calculation of MSY. This applies also to the use of F40% to estimate B_{MSY} where it has been used in conjunction with modelled recruitment. As a result, the estimates of both B_{MSY} and F_{MSY} are subject to very considerable uncertainty.

26. From a management standpoint, the implications of the uncertainty in F and B are not the same. In the case of F_{MSY}, whatever its value, common sense may be used to judge whether it is obtainable since it is entirely driven by human intervention. The main principle behind the choice of F_{MSY} is to achieve a fishery that is productive and implies a low risk to the resource. It is possible to choose an F value that approximates to F_{MSY} without recourse to stock-recruitment data as the F40% proxy does. Hence, unless the calculated F_{MSY} is obviously different from SPR related F reference points, there is less need for concern about uncertainty.

27. Unfortunately, for biomass estimates, uncertainty has much more unpleasant side effects. In the present situation, where the B_{MSY} estimates are beyond the range of observations, there is the possibility that not only is the target B_{MSY} not where you think it is, but that it may simply be unobtainable. The latter takes on additional significance where the target is used to derive $F_{rebuild}$. Clearly, if B_{MSY} is not adequately estimated, then the associated $F_{rebuild}$ will be inappropriate. A crucial question is therefore 'what are the costs of being wrong?' **If the current B_{MSY} reference points are to be adopted, I would recommend that an analysis is done to evaluate the potential costs of adopting an erroneous value**.

28. If there is substantial uncertainty in the calculated values of $B_{MSY,}$ it is legitimate to ask what can be reasonably inferred from the analysis. It seems likely, given the history of exploitation of many of the stocks concerned, that the calculated values give a reasonable indication of the direction of travel from current biomass in order to

get closer to MSY. A pragmatic interpretation of an operationally useful determination of B_{MSY} would therefore be to set it at a value closer to the range of the actual observations. If, for example, B_{MSY} is estimated to lie beyond the range of the data, the B_{MSY} proxy might be set provisionally as the largest observed value in the historical time series or some conventionally chosen percentage above the largest value. If, after a number of years, more data has been obtained, the B_{MSY} proxy can be re-evaluated.

29. In the light of the discussion above, the question of the choice of Beverton-Holt or Ricker curves is somewhat redundant, since while the choice of curve has a very substantial impact on the calculation of B_{MSY}, neither can be supported by the data in the region of predicted MSY.

30. During the meeting, analyses of two cod stocks were presented by a fishing industry consultant (Butterworth et al). These analyses used a 'stock production' model to simultaneously reconstruct the population history and estimate MSY reference points. The analyses were not intended as definitive proposals for the reference points but to provide an alternative perspective on their calculation. While important differences about the error structure of the data are made in these analyses, the underlying population dynamics model and data used are essentially the same as the NMFS assessments. If configured similarly, one might reasonably expect the two approaches to yield similar results. If the approaches don't show similarity, this failure may be an indication that the data do not contain sufficient information to estimate the parameters of the population model well. It would be worth investigating the stock-production and ADAPT based approaches to better understand differences between them. However, at present, there are no obvious reasons to choose one method over the other.

31. In presenting the stock production analysis, some emphasis was placed on the relevance of natural mortality (M) in the assessment and the calculation of MSY reference points. MSY can be sensitive to the choice of M, but great care is required in altering M in assessments where no real information exists on its magnitude. The stock production modelling framework used by the consultant is capable of estimating M from the data, but the fact that it is estimable does not make its estimation reliable. Most datasets do not contain sufficient information to estimate M reliably, and its estimation is frequently confounded with estimates of survey catchability, or is biased by missing catch (such as discards) in the data. It is often better to fix M externally rather than attempt to estimate it. Overall I was not convinced that investigating the role of M in the calculation of MSY was a high priority since the main problem with the reference points was the extrapolation of biomass values beyond the range of the data. Addressing that issue would obviate the need to be overly concerned with M.

32. One important characteristic to appreciate is that it is undesirable to estimate reference points using one model, but to use another model in the stock assessment to judge stock status. Changing assessment methodology tends to change the scale on

which biomass is measured, and this change can lead to inconsistency in management advice. It is, therefore, of some importance to choose an assessment and reference point methodology that are internally consistent. If NMFS were to change from an ADAPT based approach to a stock production approach, great care would be needed to ensure the consistency of process within the SAW.

33. As well as more conventional age based assessment methods, the report introduces a novel approach to the use of survey indices for stocks where VPA is not available. The method is innovative, elegant and shows promise. Interestingly, in implementing this method more flexible judgements have been made about the choice of B_{MSY} proxies. For example, for Gulf of Maine haddock, the Bmsy proxy is based on stable indices observed in the early 1960s. While *ad hoc*, this does seem a sensible choice but it raises the obvious question about Georges Bank haddock. Given that these two populations show similar stock dynamics (page 85 of the Report), a Bmsy chosen on the same basis for Georges Bank haddock would be approximately 150000-175000t rather than the 250000t estimated using the recruitment data.

34. While I found the survey index analytical method attractive, my main concern relates to validation. A number of necessary but arbitrary choices are made in the model specification and since the approach is new, it is highly desirable to demonstrate that implementation would actually drive the stock in the direction desired. This demonstration could be done through a simulation study. **I recommend that a simulation study be undertaken to validate the survey index method in a management context and to investigate its sensitivity to *ad hoc* assumptions.**

35. One attractive feature of the survey method is that it is rooted in the empirical data and does not make external assumptions about stock and recruitment. The survey method is one that could be applied to all stocks, even those based on VPA. If done, this method would provide a consistent framework across most of the stocks and avoid the weakness of the methods that made assumptions about stock and recruitment.

36. The change in the overfishing threshold from F20% to F 40% appears to be related to a change of emphasis from a limit reference point (F20%) to a target reference point (F40%), which change is primarily one in management framework rather than a scientifically driven change. F20% is generally regarded as a proxy for deriving a minimum spawning biomass. It is therefore more relevant to defining recruitment over-fishing. F40% may be regarded as a value to derive B_{MSY} and is therefore more consistent with identifying a target. Thus F20% defines a region where you don't want to be while F40% defines a region where you do want to be. From a purely scientific point of view, taking only biological risk into account, it is more important to be above a limit than at a target, and this view should be used to inform the strength of management response to these reference points.

37. F50% has been used as a basis for selecting reference points for Acadian redfish. The biology of this species is such that it is prudent to base reference points on a lower

fishing mortality rate than more productive stocks. Relative to many gadoids, redfish are usually unproductive having slow growth rates and inherently low rates of increase. Hence, the more conservative choice of reference value is appropriate.

38. At a practical level, given the history of the New England stocks, much more is known about the region of undesirable stock size than the region of desirable (and actually attainable) stock sizes. This knowledge gap presents both scientists and managers with considerable challenges if the law requires that stocks be rebuilt to a B_{MSY} target within a specified time frame. The current state of knowledge means that it is easier to know the direction in which stock biomass should be driven rather than the distance of travel to B_{MSY}. Where B_{MSY} estimates are extrapolations well beyond the range of the data, it is not possible to judge whether the targets are overly conservative, but there clearly is a danger that they are. **In the above circumstance, the proposal by the working group in the Report (page ix) to adopt an adaptive approach to biomass management seems eminently sensible, and I would recommend that it is followed.** Provided the target F is achieved, biomass levels should evolve naturally to a state of B_{MSY}.

39. The desire to move all 19 stocks to B_{MSY} values calculated on a single species basis does raise questions about the ability to reach such targets simultaneously. All the calculations assume fixed schedules of growth, maturity and natural mortality which may well be adequate when interpolating, but which may not suffice when extrapolating outside the range of observations as has been done for a number of stocks in this exercise. Given the complexity of biological interactions, and the ecosystem in which the stocks exist, it is not possible to evaluate from any current modelling exercise whether the desired targets are attainable in practice. Experience of modelling the North Sea multispecies system, which bears some similarities to the New England system, suggests that single species MSYs are not good indicators of mutlispecies MSY. Thus, there are some grounds for scepticism about the reality of the proposed targets. As has been argued above, simply on the basis of extrapolations beyond the data, caution is needed in the choice of B_{MSY} target.

<u>Stock rebuilding and related projections</u>

40. The stock projection methodology used is designed to answer the question "what constant *fishing mortality* is required to rebuild the stock to B_{MSY} with 50% probability". It is very important to understand that this is not the same question as "what *management action* is required to rebuild the stock to B_{MSY} with 50% probability?" To answer the latter question, it is necessary to model stock assessment error and management implementation error; these features are not built into the projection methodology. The NMFS calculations therefore indicate the F required, provided that it can actually be achieved regardless of assessment and implementation error. If these two sources of error are truly random, then their effect is probably on

the width of the envelope of uncertainty and will tend to have a small effect on the 50% probability chosen. Unfortunately, the errors are almost certain to have a tendency to be in one direction (e.g. to over estimate stock size and under-estimate the effectiveness of management action). This tendency would mean that the projections run the risk of being overly optimistic.

41. In my opinion, although the projection methodology does have limitations with respect to assessment and implementation error, it is probably good enough for the purpose of estimating a conventional value for $F_{rebuild}$. Attempting to model implementation error involves too many assumptions about processes that are largely unknown, since management of the stocks concerned does not follow a defined management procedure. Thus, the calculation of $F_{rebuild}$ should be seen as a conventional calculation based on an agreed recipe, rather than one that attempts to capture all the elements of reality.

42. There are three technical aspects of the method that are worth comment. First, the randomization of the starting values of stock size for the projection appears to consider estimation error only. It is common for assessments to show bias and if they do, then the $F_{rebuild}$ will be affected. One way of dealing with this bias would be to examine the retrospective pattern of the assessment and try to include any non-random behaviour into the process. Second, natural mortality, M, is assumed to vary randomly and independently. Since M is dominated by predation, it might reasonably be expected that it showed autocorrelation because predator populations will change only gradually over time. Since the management plan is to increase predator populations, there may be merit in considering simulations that take into account autocorrelation in M. Such effects could be large over periods of a decade. Finally, the stock recruit model used in the projections was the same as the one used to estimate the reference points. It is, of course, desirable to use the same model for consistency. However, the s-r model was chosen partly on criteria for the purpose of estimating MSY that involves the right hand end of the curve. Rebuilding projections use more of the left hand limb of the relationship, and it is important that the choice of model is consistent with the dynamics of the stock at lower stock sizes. **I would recommend that the s-r models used in projections are validated against historical observations of stock dynamics.**

43. During the meeting, a fishing industry consultant suggested alternate rebuilding strategies in which F reductions were phased over the ten-year rebuilding period. There is no scientific reason why such an approach could not be adopted, but the choice of strategy would have to be a management decision, not a scientific one. In general, if the strategy is to stage the F reductions so that the initial reduction in F is small, then the prevailing risk to the stock will tend to be higher than a strategy where all the 'pain' was taken at the outset of the rebuilding period.

44. All of the analyses discussed at the review were strictly based on single species assumptions. There is an implication that such analyses, especially those identifying F_{target} or $F_{rebuild}$ will require single species management. In a mixed fishery, this is not

possible because a mixture of species is taken in differing quantities by different fleets. Thus, while it is possible to calculate target Fs by stock, these may not be achievable simultaneously because the activity of fleets places constraints on management. It is important to quantify as far as possible the limitations on achieving multiple targets in a mixed fishery. This quantification could be done by modelling Fs by fleet to evaluate the technical interactions between them, and hence identify the constraints to achieving multiple targets. **I would recommend that an evaluation of technical interactions in the mixed fishery be undertaken to investigate the consistency of multiple MSY targets.**

Observations on the review process

45. The meeting itself was well organised both for the formal participants and members of the public. The meeting facilities were excellent, and the facilitator conducted the meeting very effectively. The presentations were well prepared and to the point, making the job of review very much easier. Interventions by the audience were dealt with effectively, and apart from occasional limits of time everyone had a chance to make his or her point. The tenor of the meeting was constructive throughout.

46. The main limitation from my perspective was the short time available for preparation, especially as the volume of documentation was very large. It would have been better to have about two weeks to review the documents before the meeting began.

47. The meeting appears to have been arranged at relatively short notice, and it was not entirely clear to the reviewers exactly what their roles were until well into the meeting. I got the impression that the same was true for the facilitator and other participants. It was also not entirely clear who the 'customer' was for the results of the review. I do not think this lack of clarity adversely affected the outcome, but more information would have helped. The haste in the preparation of the meeting was also reflected in the Terms of Reference, which are a little ambiguous in certain areas and were interpreted differently by the various interest groups at the meeting.

Recommendations

The following recommendations are drawn from the discussion above. Numbers in parentheses refer to the relevant paragraph in the main body of the report.

1. **If the various survey gear protocol issues remain controversial, then I recommend that an experiment specifically designed to detect these effects should be undertaken. [15]**

2. **It is desirable for any survey gear to perform as consistently as possible, and if there are lessons to be learned from the performance of the commercial gear in reducing sampling variability, I recommend that they should be investigated. [18]**

3. **It would be useful for an analysis to be conducted that evaluated the ability of the survey to detect population signal above the inherent noise in the survey for those assessments most dependent on survey indices of abundance. [19]**

4. **If there is a move to redesign the NMFS surveys with the involvement of stakeholders, I strongly recommend that independent scientists with a knowledge of survey design are included to ensure that scientific standards are not compromised.[20]**

5. **It does appear that estimation error can trigger a stock rebuilding response even when there is no need to do so. Given the potential economic impact of this, I recommend that consideration be given as to how assessment error should be handled within the management process.[21,22]**

6. **If the current B_{MSY} reference points are to be adopted, I would recommend that an analysis be done to evaluate the potential costs of adopting an erroneous value.[27]**

7. **I recommend that a simulation study be undertaken to validate the survey index method in a management context and to investigate its sensitivity to *ad hoc* assumptions.[34]**

8. **I recommend that the proposal by the working group in the Report (page ix) to adopt an adaptive approach to biomass management be followed because it seems eminently sensible in the light of uncertainty. [38]**

9. **I recommend that the s-r models used in projections are validated against historical observations of stock dynamics.[42]**

10. **I recommend that an evaluation of technical interactions in the mixed fishery is undertaken to investigate the consistency of multiple MSY targets.[44]**

Appendix 1: Statement of Work and Terms of Reference

Consulting Agreement between the University of Miami and Dr Robin Cook

January 7, 2003

Introduction

This document presents terms of reference for peer review of the stock assessment and population dynamics science supporting the New England Fishery Management Council's (NEFMC's) Northeast Multispecies Fishery Management Plan (FMP). Specifically, the review will focus on three major terms of reference:

- Effects on the accuracy and present usefulness of trawl survey data due to uneven trawl warps and other recently-discovered gear-related trawl survey problems. These evaluations will be based on gear testing cruises and related workshops conducted during autumn 2002 as well as any other information available to the reviewers.

- Estimates of stock biomass and fishing mortality targets and thresholds for the complex of stocks comprising the groundfish resource, and,

- The adequacy of projections of stock rebuilding to achieve the biomass targets, consistent with time frames as mandated under the Sustainable Fisheries Act.

These three focus areas were originally proposed by the staff of the NEFMC. Specific comments appropriate to three terms of reference provide guidance to the review committee recognizing that reviewers are likely to be unfamiliar with the specifics of the Northeast Multispecies FMP and, the provisions of the Sustainable Fisheries Act. Overall, the terms of reference generally concentrate on the adequacy of the science currently available to support fishery management plan development.

For each subject area, a brief objective statement is provided to give an overall context for the terms of reference to the reviewers. Within these subject areas, specific questions are provided with the intent of providing a minimum set of questions to consider in formulating the group's responses. It is envisioned that the reviewers' responses will take the form of detailed reviews of the information and conclusions reached in the various supporting documents and verbal presentations made to the group, along with their own summaries and opinions regarding the adequacy of existing science in supporting fishery management decisions. The reviewers are encouraged to pay particular attention to alternative methods presented by independent experts, if any, in concluding whether the conclusions of the Report, or other approaches, represent the best science available.

1. Trawl survey issues and influence on management advice

Considering the results of the Groundfish Assessment Review Meeting (GARM), subsequent results from experimental trawl comparisons, and other appropriate information, provide an evaluation of the significance of potential differences in trawl survey catchability resulting from recently-discovered survey gear problems on management advice for groundfish stocks managed under the Northeast Multispecies Fishery Management Plan.

In responding, reviewers should consider the following:

A. Are conclusions regarding use of 2000-2002 trawl survey data adequately supported by analyses reported by the GARM? Were analyses sufficient to detect differences in survey catches arising from unequal warps and other survey problems? Did the sensitivity analyses presented in the GARM report adequately bound the range of potential effects inferred from analyses of historical and comparative data? Did the GARM adequately characterize the uncertainties in estimated stock sizes and rebuilding mortality rates potentially arising from unequal warp offsets?

B. Was the design and analysis of data from experimental trawl comparisons adequate to estimate the magnitude of differences resulting from the use of unequal trawl warps and other experimental treatments? Were estimates of the power of these experiments to detect statistical differences in fish catches between treatment and control survey configurations adequately described?

C. Advise on the significance of differences in species composition and relative catch rates resulting from side-by-side tows performed by commercial and government vessels in the recent trawl experiment with respect to model- and index-based estimates of stock size and fishing mortality rates.

D. Comment on the precision of model-based calculations of stock size and fishing mortality rates in relation to variability in trawl survey catches and other sources of information included in assessments. Are the methods used for incorporating uncertainty into management advice sufficient? How should other sources of uncertainty (e.g., model selection, estimates of total removals) be incorporated?

2. Biological reference points

Review the fishing mortality and biomass targets and thresholds established for the 20 groundfish stocks included in the Northeast Multispecies FMP. Consider the adequacy of technical analyses supporting estimates of F_{MSY}, B_{MSY} or their proxies, as provided in the *Report of the Working Group on Re-Estimation of Biological Reference Points for New England Groundfish Stocks* (the "Report"). Comment on

issues related to the simultaneous achievement of B_{MSY} values for the groundfish complex.

In responding, reviewers should consider the following. Of particular note, the NEFMC's Science and Statistical Committee recommended that additional work was needed "…specifically to explore the implications of the uncertainty in the stock recruitment relationship." For this reason, more specific questions are included in order to add clarity to the issues to be addressed by the reviewers.

A. Comment on the technical basis for the estimation of F_{MSY} and B_{MSY}, and choices regarding the use of parametric (Beverton-Holt, Ricker, other candidate models, etc.) and non-parametric stock-recruitment relationships applied to yield per recruit estimates, surplus production models, or proxies for biomass and fishing mortality rate targets and thresholds.

   - Are the Working Group assumptions (growth, maturity ogive, natural mortality, partial recruitment) appropriate for estimating a B_{MSY} proxy, which establishes a minimum biomass threshold and a rebuilding target?

   - Comment with reference to specific species on whether the use of Beverton-Holt type stock-recruitment curves, as opposed to the use of dome-shaped (Ricker type) curves, represent reasonable scientific judgment employing sound methodology and appropriate data sources. Is there a theoretical or practical basis to detect overcompensation (Ricker curve) from the stock-recruitment curve for each groundfish species based on the magnitude of the intrinsic rate of population increase (r) and the carrying capacity (K) parameter estimates from ASPIC production models?

   - Could alternative non-equilibrium production models for groundfish species be examined for estimating F_{MSY} and B_{MSY} thresholds?

B. Comment on the justification for changing the overfishing threshold to $F_{40\%}$ (the proposed proxy for most groundfish stocks) from $F_{20\%}$ that generally defined overfishing before Amendment 9, or from the F_{MSY} estimates in Amendment 9? Are the proposed proxies for F_{MSY} (e.g., $F_{40\%\ MSP}$ for Georges Bank haddock, $F_{50\%\ MSP}$ for Acadian redfish, etc.) more appropriate to achieve MSY, given the groundfish stock dynamics? Are the proposed proxy reference points overly conservative or too liberal for a fishing mortality threshold that complies with the Magnuson-Stevens Act?

   - Reconstruction of the theoretical S-R curve can be done indirectly for each groundfish species by merging results (YPR, SSB/R) from the Thompson-Bell yield-per-recruit model and expected equilibrium yield (mt) from various stock production models. Are the resulting F_{MSY} values similar to the $F_{40\%}$ values (e.g. for haddock) from the Y/R curve? Is $F_{40\%}$ a suitable proxy for F_{MSY} under these conditions?

C. Evaluate evidence for density-dependent regulation of population size (e.g., simultaneous occurrence of various stocks at higher population sizes, predator-prey, and growth rate information) for the groundfish complex. Are potential non-stationary stock dynamic processes (i.e. environmental variations in recruitment

survival) and/or trophic limitations adequately accounted for in estimates of B_{MSY}? Is there evidence that B_{MSY} values estimated for the 20 groundfish stocks cannot be simultaneously achieved?

3. Stock rebuilding and related projections

The Sustainable Fisheries Act requires that various resources be rebuilt to B_{MSY} in no more that 10 years, unless life history attributes of individual stocks dictate a longer rebuilding period (e.g. Georges Bank cod, Acadian redfish). Considering the uncertainty in stock dynamics and the ability to achieve target rebuilding fishing mortality rates for all stocks in the complex simultaneously, comment on stock projection methodology used to advise on management strategies intended to achieve stock rebuilding goals.

In responding, reviewers should consider the following:

A. Evaluate the adequacy of projection methods used to guide the attainment of B_{MSY}, specifically focusing on estimates of uncertainty in starting stock sizes, recruitment, and implementation uncertainty in the attainment of target fishing mortality rates. Comment on potential biases and precision of stock projection methodologies.

B. Are stock projection methodologies sufficient to distinguish the relative merits of various management scenarios?

C. The Magnuson-Stevens Act requires that overfished stocks be rebuilt to a biomass level consistent with producing the maximum sustainable yield from the fishery. Is there a scientific basis for arguing that an intermediate biomass target meets that requirement?

Schedule

The independent peer review is to be completed by March 1, 2003. In order to meet that deadline, the following review format and timeline is proposed.

3-5 February: Public workshop **(including participation of independent reviewers**) on the GARM Report and report of biological reference points during this week.
6-8 February: Independent reviewers meet in executive session to discuss results from the two workshops and supporting documentation.
10-14 February: Independent reviewers prepare their individual reports and submit them to the summarizer.
17-21 February: Summarizer prepares his/her report summarizing findings of individual reports prepared by panel members, which will be made available to the public.

The February 3–5, 2003 public workshop will begin with an introduction followed by a series of presentations summarizing the various documents presented to the panel. Open comment periods will allow for additional scientific input from various members of the public regarding additional analyses and comments. Peer reviewers will interact with agency and independent scientists and members of the public to ask appropriate questions and discuss results.

Specific

The consultant shall be provided with all background material required to prepare for the review, and the consultant shall attend the February 3 – 5, 2003 workshop, the February 6 – 8, 2003 executive session, and to develop an individual, non-consensus report that shall be submitted for final summarization. The report shall also be submitted to the Center for Independent Experts as a review report.

The consultant's duties shall not exceed a maximum total of 14 days: Several days prior to the workshop for document review; the three-day workshop; the three-day executive session; and several days following the meeting to complete the workshop and executive session report. The reports are to be based on the consultant's findings, and no consensus reports shall be accepted.

The consultant's duties include:

1. Reading all background material provided;

2. Participating in the February 3 – 5, 2003 workshop on the Groundfish Assessment and Review Meeting (GARM) Report and report of biological reference points;

3. Participating in the February 6 – 8, 2003 executive session to discuss results from the two workshops and supporting documentation;

4. No later than February 14, 2003, submitting a written, nonconsensus report that is based on the results of the workshops and supporting documentation, the closed door session discussions, and on the terms of reference described in the statement of work. The report should be submitted to the workshop summarizer and to the CIE[1]; the CIE report should be addressed to the "University of Miami Independent System for Peer Review," and sent to Dr. David Sampson via email at David.Sampson@oregonstate.edu, and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu

[1] The written report will undergo an internal CIE review before it is considered final. After completion, the CIE will create a PDF version of the written report that will be submitted to NMFS and the consultant.

Appendix 2: Reviewers and Agenda Groundfish Peer Review (GPR)

Public Meeting – 3-5 February 2003, New England Center, University of New Hampshire, Durham, New Hampshire
http://www.necc.unh.edu/

Independent Peer Reviewers (contracted through the Center for Independent Experts (CIE: University of Miami)

Dr Ewen Bell, Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, England

Dr Robin Cook, FRS Marine Laboratory, Aberdeen, Scotland

Dr Murdoch McAllister, Imperial College, London, England

Dr Robert Mohn, Department of Fisheries and Oceans, Halifax, NS, Canada

Dr Andrew Payne (Chair/summarizer), Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, England

Public Session Moderator

Mr Don Perkins, Gulf of Maine Aquarium

AGENDA - modified during meeting to accommodate participants' availability

Monday, 3 February

0900-1700 Public Session – Topic: **Trawl Survey Issues**

Background Documents:

-Report of the Workshop on Trawl Warp Effects on Gear Performance
http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0215/

- Report of the Groundfish Assessment Review Meeting
http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0216/

- Report of the Trawl Survey Experiment Workshop

available online

- Other contributed documents

Order of the Day:

Introduction of peer reviewers, presentation of terms of reference, and discussion of ground rules (Moderator)

Formal Presentations:

- *An overview of trawl survey issues* – **Russell Brown** (30 minutes)
- *Intervention analyses to detect trawl warp offset problems, sensitivity analyses, scale of potential offset factors*- **Paul Rago** (1 hour)
- *Trawl warp and related experiments*- **Michael Fogarty** (1 hour)
- *An evaluation of Paul Starr's analysis of the fishing gear experiment*- **Doug Butterworth** (20 minutes)
- *Comparison of length composition data from trawl experiments*- **Tom Nies** (30 minutes)

Facilitated discussion regarding presented materials in relation to terms of reference (all)

Tuesday, 4 February

0800-1700 Public Session – Topic: **Biological Reference Points**

Background Documents:

- Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish

http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0204/

- Report of the Overfishing Definition Review Panel:
http://www.nefmc.org/documents/overfishing/

- Report of SAW 36

- Report of the Groundfish Assessment Review Meeting:
http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0216/

- NEFMC Council Meeting Report for July 2002, summarizing Scientific and Statistical Committee review of re-estimated reference points
http://www.nefmc.org
(Go to "News and Motions," then click on "Council Reports")

- Other contributed documents

Order of the Day:

Formal Presentations:

- *Re-Evaluation of biological reference points: goals and objectives*- **Steven Murawski** (1 hour)
- *A Strategy to evaluate alternative stock-recruitment models*- **Christopher Legault** (30 minutes)
- *Evidence for density-dependence in species and ecosystem responses*- **Ralph Mayo** (30 minutes**)**
- *An age-structured production model based assessment and reference point evaluation for the Gulf of Maine cod stock*- **Doug Butterworth** (1 hour)
- *Decision analyses using biological reference points in evaluating groundfish stock status*- **Yong Chen** (30 minutes)
- *Overfishing thresholds (F_{MSY}, B_{MSY}) for New England groundfish from empirically based stock recruitment models*- **Victor Crecco** (30 minutes)
- *A general biological reference point working group model*- **Andy Applegate** (20 minutes)

Facilitated discussion regarding presented materials in relation to terms of reference (all)

Wednesday, 5 February

0800-1700 Public Session – Topic: **Projections of Stock Rebuilding**

Background Documents:

-National Standard Guidelines for Overfishing Definitions: Final Rule
http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=1998_register&docid=fr01my98-23.pdf

- AgePro Users manual:

- GARM Report Revised Projections
http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0216/

- Other Contributed Documents

Order of the Day:

Formal Presentations:

- *NMFS National Standard Guidelines and Stock Rebuilding*- **Pamela Mace** (40 minutes)
- *Projection Methodologies used to evaluate medium-term impacts*- **Jon Brodziak** (40 minutes)
- *A phased rebuidling strategy, using the cod stocks from Gulf of Maine and Georges Bank as examples*- **Doug Butterworth** (30 minutes)
- *Rebuilding strategies for three key stocks*- **Dave Lincoln** (30 minutes)

Facilitated discussion regarding presented materials in relation to terms of reference (all)

Thursday, 5 February – Saturday, 8 February

Executive Session – Invited Peer Reviewers and support staff person (Karena Jolles, New Hampshire Fish and Game Department)

Discuss issues raised at public workshop and in supporting documents. Develop strategy for completing individual reports and how summarizer will convert them to a final document.

Commence the report drafting process individually and through debate.

Consult other participants for clarity purposes.

Appendix 3: Documents and Presentations

1. Formal Documentation (received before or at the meeting)

Almeida, F. and L. Jacobson. Working Paper: Species Compositions from the NMFS/Industry Survey Trawl Study Conducted by the R/V *Albatross IV* and F/V *Sea Breeze* 28 October-6 November, 2002. 24 pp.

Almeida, F., and L. Jacobson. Species Size Compositions from the NMFS/Industry Survey Trawl Study Conducted by the R/V *Albatross IV* and F/V *Sea Breeze*, 28 October - 6 November 2002.

Almeida, Frank. Working Paper: Comparison of R/V *Albatross IV* and F/V *Sea Breeze* Catch during the NMFS/Industry Survey Trawl Study. Presence vs. Absence by Species. 9 pp.

Almeida, Frank. Working Paper: Composition of the R/V *Albatross IV* 'Other Catch' Component during the NMFS/Industry Survey Trawl Study Conducted 28 October-6 November, 2002. 5 pp.

Almeida, Frank. Working Paper: Cruise Report of the NMFS/Industry Survey Trawl Study Conducted by the R/V *Albatross IV* and F/V *Sea Breeze*, 28 October-6 November, 2002. 6 pp.

Brodziak, J. K. T. and P. J. Rago. AGEPRO Version 2.02 User's Guide. July 23, 2002. 107 pp.

Brodziak, Jon. Comparison of Average Catch Rates of 20 Species for Optimal andWorst-Case Scenario Net Configurations by Area. January 14-15, 2003.

Butterworth, D S, R A Rademeyer and E´ E Planganyi. An Age-Structured Production Model Based Assessment and Reference Point Evaluation for the Gulf of Maine Cod Stock. 41 pp. (3 pp. Addendum added)

Butterworth, D S, R A Rademeyer, É E Plaganyi. Results for Georges Bank Cod of Age-Structured Production Model Based Assessments Similar to those Conducted for the Gulf of Maine Cod Stock. 22 pp.

Crecco, Victor. Overfishing Thresholds (F_{MSY}, B_{MSY}) for New England Groundfish from Empirically-Based Stock-Recruitment Models. January 26, 2003. 21 pp.

Fogarty, Michael J. Analysis of R/V *Albatross* IV - F/V *Sea Breeze* Trawl Configuration Experiment. 9 pp.

Lovgren, Jim. Observations from the *Albatross IV* correctional cruise. February 5 2003. 4 pp.

National Oceanic and Atmospheric Administration. 50 CFR Part 600 Magnuson Stevens Act Provisions; National Standard Guidelines; Final Rule. May 1, 1998. Federal Register 63(84): 24212-24237.

New England Fishery Management Council. Council Report. July 2002. 6 pp.

New England Fishery Management Council. Correspondence received by Council regarding the trawl gear survey information.

New England Fishery Management Council. Report of the Groundfish Overfishing Definition Committee. November 27, 2000. 12 pp.

Nies, Tom. Working Paper: Analysis of Catch-at-Length Data from the NMFS Industry Survey trawl Study Conducted by the R/V *Albatross IV* and F/V *Sea Breeze*. October 28 - November 6, 2002. 18 pp.

Northeast Fisheries Science Center Reference (NEFSC) Document 02-15. Report of the Workshop on Trawl Warp Effects on Fishing Gear Performance. October 2-3, 2002. 80 pp.

Northeast Fisheries Science Center (NEFSC) Document 02-16. Assessment of 20 Northeast Groundfish Stocks through 2001. A Report of the Groundfish Assessment Review Meeting (GARM) October 8-11, 2002. 511 pp.

Northeast Fisheries Science Center (NEFSC)/Industry Cooperative Survey Gear Study 28 October-6 November, 2002. Source Document: Specifications for Construction of NEFSC Standard #36 Bottom Trawl.

Northeast Fisheries Science Center (NEFSC), National Marine Fisheries Service. Final report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish. March 19, 2002. 232 pp. + 163 pp. of Appendix 7.0.

Northeast Regional Stock Assessment Review Committee (36th SARC). Draft Advisory Report on Stock Status. January 2003. 50 pp.

Overfishing Definition Review Panel. Final report: Evaluation of Existing Overfishing Definitions and Recommendations for New Overfishing Definitions to Comply with the Sustainable Fisheries Act. June 17, 1998. 179 pp.

Restrepo, V.R. et al. Technical guidance on the Use of Precautionary Approaches to implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. 1998. NOAA Technical Memorandum NMFS-F/SPO-31.

Starr, Paul. Memorandum: Analysis of NMFS Trawl Survey Data: R/V *Albatross IV* and F/V *Sea Breeze*. January 10, 2003. 16 pp.

Stauffer, Gary. NOAA Protocols for Groundfish Bottom Trawl Surveys of the Nation's Fishery Resources. December 16, 2002. 81 pp.

2. Presentation or illustrative material (received at the meeting)

Applegate, Andy. Handout: General Biological Reference Point Working Group Model.

Brodziak, Jon. Presentation: (Age-Structured) Projection Methodologies Used to Evaluate Medium-Term Impacts. February 5, 2003.

Brown, Russell W. Presentation: Issues with NOAA Fisheries Bottom Trawl Surveys Conducted.

Butterworth, Doug. Summary of Paul Starr's Analysis Presented to the trawl Experiment Workshop, January 14, 2003.

Butterworth, Rademeyer and Plaganyi. Updated Projections covering phased rebuilding.

Chen, Yong. Presentation: Decision analyses using biological reference points in evaluating groundfish stock status. February 2, 2003.

Correspondence Received by Council Regarding the Trawl Gear Survey Information

Fogarty, Mike. Presentation: Effects of Trawl Warp Offsets and Gear Configuration on Survey Catches.

Goudey, Clifford A. Letter to Paul Howard (NEFMC). Comments on the significance of the warp offset issue and on the utility of the recent R/V *Albatross IV* and F/V *Sea Breeze* comparison cruise in determining the possible sampling errors in recent trawl surveys. January 28, 2003.

Industry Stakeholder Concerns raised by those who participated in the September 25-27 experimental cruise, including a list of questions from fishermen. Handout.

Legault, Christopher M. Presentation: A Strategy to Evaluate Alternative Stock-Recruitment Models.

Lincoln, Dave. Presentation: Rebuilding Strategies vs. Catch.

Mace, Pamela M. Presentation: The implementation of National Standard 1 since the SFA. February 2003.

Mayo, Ralph. Presentation: Ecosystem Implications of Revised Biomass Targets.

Murawski, Steve. Presentation: Age-Specific Catchabilities Estimated for Four Stocks w/ ADAPT.

Murawski, Steve. Presentation: Reference Point Re-Estimation.

O'Malley, James. From Science to Illusion: Mathematics in Fishery Management. In *Pacem in Maribus* XXVI, Halifax, November 29-December 3, 1998.

O'Malley, James D. Letter to Mr Ricks Savage. East Coast Fisheries Federation, Inc. May 16, 2002.

Rago, Paul. Presentation: Intervention Analyses to Detect trawl Warp Offset Problems for NMFS R/V Survey Indices from 2000-2002. February 3, 2003.

Stevenson, Barbara. Handout: Trawl Data for R/V *Albatross IV* and F/V *Sea Breeze*.

Appendix 4: Questions and Comments made to the Panel by Participants

The following questions were posed to the panel at the end the meeting. Figures in parentheses indicate the sections of the main report where these issues are discussed. Not all the questions are answerable and where comments are made in the report, the question may not be dealt with in its entirety.

Doug Butterworth

1. Have ADAPT assessments explored a sufficient set of sensitivities, for example in respect of alternative values of M, and what are the implications for reference point estimates? [31]

2. Comment on the appropriateness of MSY-based management targets given the imprecision of the estimates and difficulties associated in particular with changes over time resulting from new data and changed methodologies. [36-39]

3. Given the ASPM-based reference points for two cod stocks, albeit based on initial analysis, are appreciably different from those based on ADAPT methodology, how important is it that further ASPM-based results be developed to be taken into account in the next set of management decisions for these stocks? [30-32]

4. Given that assessment method, with current data, appear unable to estimate parameters such as stock-recruitment steepness (and hence B_{MSY}) with great precision, what is the potential role of adaptive management towards improving such precision? (Note the relevance of this question in respect of scientific aspects of the TOR 3C.) [38, 43]

5. Is it important for the *Albatross* to survey efficiently (as well as comparably over time) to be able to use associated swept-area estimates of absolute abundance to "ground-truth" estimates provided by population model assessment methods? [15-20]

Geoffrey Smith

1. Given the fact that B_{MSY} values are generally set at one half of the carrying capacity of the stock, is it unreasonable to assume that all 19 stocks of groundfish can be rebuilt to B_{MSY} simultaneously? [39,44]

2. Do rebuilding strategies that allow continued over fishing in the near term pose a greater biological risk than those that reduce fishing mortality rates to levels at or below F_{MSY}? [43]

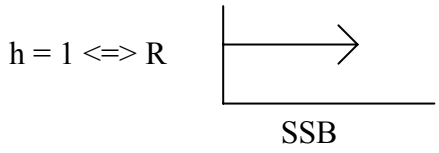
3. Is the question of the National Standard Guidelines requirement to rebuild overfished stocks to B_{MSY} in 10 years or less a scientific question or a legal and/or public policy question?

Priscilla Brooks

1. Fisheries management in the United States is governed by the Sustainable Fisheries Act and National Standards that dictate narrowly the parameters with in which management plans are developed. Pamela Mace's presentation gave you a fairly thorough overview of the law and guidelines. I believe that you must keep in mind the legal reality in which we work and in which your report will be incorporated B_{MSY} and F_{MSY} must be estimated and stocks must be rebuilt within 10 years, except in circumstances in which the natural history of the stock dictates more time. Given these realities, is the NMFS science related to the biological reference points, that is the GARM report, sound? [26-29,36-39]

Jon Brodziak

1. Are the steepness parameters (h) values implied/estimated in the Butterworth production models for GOM cod credible, in the context of Myers et al. (1999. Maximum reproductive rate...CJFAS)?



Ron Smolowitz

1. What is the sensitivity of the trawl survey to towing speed changes over time? [This would require experimental investigation]

Eric Smith

1. Perhaps a useful follow-on question is to ask "Is there justification, given scientific uncertainty in biological reference points and projection methodology, for setting a lower intermediate 10-year rebuilding target that can be adjusted upwards as the stock builds and our estimate of that value becomes more certain?" This better captures the essence of the Council's question/concern from a management standpoint. TOR 3C. [38]

2. Is a Ricker-type S-R curve more (or equally) justified relative to a B-H type curve for cod and haddock? TOR 2A, bullet #2 [25-29]

Phil Ruhle

Please look over NMFS protocol for groundfish surveys, recently developed.

1. The speed issue is of great concern but the gear used is also a problem. In all other surveys gear is well addressed but NEFSC survey net design and age is 40 years. The design has not been used by industry in 20 years.[15-19],

2. Bottom contact on this gear is very lax as is all aspects of handling of this gear; this is shown in NEFSC protocol as compared to other science centers.

Pamela Mace

Note about the Precautionary Approach:

1. See page 11 of Technical Guidance for a statement about how the precautionary approach is appropriate to management decisions, but not to scientific estimation of assessment-related parameters and variables.

Andy Applegate

1. Which other analytical methods can be used to validate the reference point estimates and rebuilding projections given the heavy reliance on less robust and variable recruitment estimates? How do managers use the scientific advice while this effort is made?

2. Are there better methods within the context of the current National Standards to evaluate the performance of the plan and monitor rebuilding of a set of multispecies fisheries?

Tom Nies

Question on Trawl Experiment

1. Was the design of the experiment adequate to determine if errors in the trawl warp cable affected resent survey results? [14-19]

   Points to consider:
   -The control net differed from the design of the survey net used for the past two years (ignoring the issue of warp length). Some differences: different doors, use of swivels on doors, different backstraps, different ground cable rigging.
   -Experimental tows were all conducted either into or with the current. Survey tows are towed in the direction of the next station, without regard to current. The experiment never towed cross-current, and a poorly rigged net may tow differently in a cross-current.
   -If, as suggested by Paul Rago based on Pennington's work, the effective sample size for frequency distributions is closely related to number of tows (as opposed to fish caught), were there enough tows to draw conclusions on catch at length/age?
   -Is the assumption of a covariate relationship between the commercial vessel and *Albatross* catches justified by the analysis? (I have not seen the final paper by Dr. Fogarty).
   -For the covariate analysis, how does the insertion of values for missing Sea Breeze catches affect the results?

Jim O'Malley

1. Is there evidence of any application of the precautionary principle in the assessments or rebuilding targets? [see comment from Pamela Mace above]

2. Is such an application legitimate in science?

David Frulla

1. If one manages towards B_{MSY} for every species in a mixed stock fishery at the same time, can this result in under utilisation of certain species? TOR 3 [39,44]

2. Can differing F reduction strategies accommodate considerations relating to a mixed stock fishery, economic consideration, and uncertainties related to significantly higher new reference points, while achieving the appropriate biomass target over the relevant rebuilding period? TOR 3 [44]