

Appendix 1.

Centre for Independent Experts University of Miami

Independent Experts Report of the Groundfish Assessment Review Meeting Woods Hole 8 – 11 October 2002

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Executive summary

The Groundfish Assessment Review Meeting (GARM) took place in Woods Hole on the 8 – 11 October 2002. The meeting peer reviewed stock assessments for 20 Northeast USA groundfish species.

The GARM meeting was competently chaired, organised, and supported by NEFSC staff. All of its terms of reference were addressed within the limited time available. Assessment co-ordinators were prepared for the meeting and presentations of data and model results were well structured. The ability, attitude, and team-work demonstrated by the meeting participants was of a comparable, high standard to the better quality assessment meetings that I have attended within the International Commission for the Exploration of the Sea (ICES), Canada, and the North Atlantic Fisheries Organisation (NAFO).

The procedures adopted for the assessment reviews follow similar protocols and standards to those used within ICES and NAFO. Each assessment was reviewed in detail, and suggestions and criticism were readily accepted and incorporated into the assessment models or taken forward within research recommendations.

The meeting was the most optimistic assessment meeting that I have attended. For the majority of stocks, fishing mortality has gradually been reduced and in response spawning stock biomass (SSB) is rebuilding.

Unfortunately, the trawl offset issue clouded what would otherwise have been a relatively straightforward assessment review. The attitude of the NEFSC staff to the data analysis required for resolving this issue was open-minded and thorough. The conclusion that there were limited or no effects of the offset on survey catch rates was robust to the type of analysis and the data sets used. Sensitivity tests of the assessments revealed that even if a substantial warp effect had not been detected by the statistical analysis, the conclusions that the stocks are currently being over-fished would not change.

Conduct of the meeting

Review

The meeting presentations and discussions were open and balanced, and sufficient time was allowed for each issue. It is unfortunate that the invitation to attend was not taken up by the fishing industry; this would have provided a useful opportunity for the industry to contribute to the process and add its experience on the state of the stocks.

The GARM meeting was well chaired and organised by Dr. Steve Murawski who, given the limited time available for the review of 20 stocks, kept the meeting on track and discussions relevant.

The GARM had high-quality background support from the NEFSC staff, prior to and during the meeting. Without this support, the meeting would have been considerably more difficult. The Web site and LAN set up for the meeting allowed rapid dissemination of information and results and both were extremely successful.

At the meeting, the assessment co-ordinators were well prepared. Suggestions and criticism were readily accepted and most of the additional work required by the GARM was completed during the evenings, after the meetings, in time for review the next day. The ability, attitude, and team-work demonstrated by the meeting participants was of a comparable, high, standard to the better quality assessment meetings that I have attended within ICES, Canada, and at NAFO.

The NEFSC Modelling Group provided invaluable support to the meeting on the issue of the trawl warp offset. The extraction and statistical analysis of the data used in the resolution of this issue required a substantial amount of effort by that group in a very short time period. Their input was much appreciated by the GARM and the external reviewers.

Recommendations

I have two minor criticisms that apply to the review procedure and logistics.

- I could have achieved more if I had earlier notice that the meeting was to take place. Reading of the papers and supporting documentation was carried out at short notice and more time to assimilate and link together the information would have been a distinct advantage.
- Although some of the important background documents were available on the Web site, many were not. Electronic versions of all the major texts referred to in the report should be accessible. This issue was raised during the meeting and will be addressed for the current report.

Data

Review

During recent years, there has been an increased pressure on the fishery to reduce fishing mortality. In general, this has led to high-grading and dumping when trip limits are exceeded. In some fisheries, the reduction in commercial landings has also led to the recreational fishery becoming a major proportion of the catch.

Data on the number of samples for length and age were presented at the meeting for each stock. The stock co-ordinators were aware that the level of sampling has been very low, and that this has created problems in the collation of assessment data sets. In recent years, the situation has improved as the level of sampling of the commercial catch has increased.

Recommendations

- The level of sampling of the commercial landings has increased in recent years and is described within the assessment texts as currently being "adequate". The magnitude of the error resulting from sampling should be enumerated annually.
- Calculations for the levels of random error associated with sampling for length and age distributions are routinely submitted to ICES Working Groups as part of a report on the quality and sources of the data being used for the assessment. This should be a routine part of the preparation of assessment data for the stocks examined by the GARM.
- In many cases, catch data are prorated from logbook information. If not currently available (there was no obvious reference in the stock assessment texts), a study of the levels of uncertainty that this raising procedure introduces to the catch data should be considered.
- The intensity of sampling of the discards and recreational landings does not appear to have been increased in line with their magnitude; consequently, increasing levels of uncertainty are associated with the assessment results.
- The retrospective patterns shown by the majority of the assessments, over-estimation of SSB, and under-estimation of F could be a direct result of under-estimation of discard mortality.

The Review and Updating of Stock Assessments

Review

All of the assessment Terms of Reference for the GARM were covered. Assessment models were fitted to the updated survey and catch data and stock status determined for each of the stocks. The fitting procedures, model diagnostics, and results were discussed in detail, and the conclusions drawn about the stock dynamics are consistent with the model estimates and associated uncertainties.

Assessment co-ordinators were well prepared and organised. The presentations of data and model results were well structured. The procedures adopted for the assessment reviews follow similar protocols and standards to those used within ICES and NAFO. Each assessment was reviewed in detail and suggestions and criticism were readily accepted and incorporated into the assessment models or taken forward within research recommendations.

The age-based models that were applied to assess the recent stock dynamics are standard methods that are routinely used within other fisheries management institutions, and the review protocol adopted by the meeting was appropriate for those methods. The index based assessment methodology approach to the estimation stock status and reference points, that is being developed at the NEFSC, is more advanced than methods applied at other North Atlantic research and management organisations.

The potential influence of the trawl warp offset on model estimates was examined and discussed at all stages of the assessment process. Within each stock, the sensitivity of the assessments to the trawl warp issue was thoroughly explored in a consistent approach to the problem. The approach was discussed and developed prior to the meeting, which was a useful time saver.

Recommendations

- Single calibration series assessments were used by the GARM to examine the agreement between stock estimates derived from independent survey series. Caution is needed when applying this approach, in that the series should cover the whole age range and spatial distribution of the exploited fraction of the stock used in the assessment model. Discussions within the GARM showed that this issue was being addressed in the current approach and in the research recommendations.
- In only a limited number of cases were alternative model structures used to examine the robustness of the results to model structural uncertainty (e.g. VPA vs. ASPIC). Recent studies have shown that this uncertainty can be as significant as random errors about the assumed model. Given the uncertainty introduced to the assessment by the low levels of sampling in recent years, I would recommend a comparison with models that allow for uncertainty in the catch at age data.
- It was surprising that age based stock assessments were not being carried out for Gulf of Maine haddock and pollock. Ageing of these species is relatively straightforward. It should therefore be possible to construct age-based assessments even if only for recent short periods of time. Such models could be used to

evaluate growth over-fishing reference points for comparison with the index based analyses presented at the GARM.

- The level of mortality estimated for the Yellowtail stocks is very high for a flatfish species. This is especially the case for the Cape Cod stock, which is increasing under severe fishing pressure. A co-operative tagging study, carried out with the fishing industry, could provide valuable information on growth rates, ageing and stock identity. This information could help resolve this apparent anomaly.
- The bootstrap procedures used to derive confidence limits for F and SSB do not include all of the uncertainty in the assessment process. They are model conditioned and do not include errors in the catch data or retrospective bias. They are therefore under-estimates of the uncertainty in F and SSB. This problem is not unique to the GARM/Working Group models. It is a research area within fisheries science that is currently being actively explored. The GARM was up to date with the most recent thinking on these issues and its advice was given with regard to them.
- Further development of the index based assessment methodology should be encouraged, especially with regard to the estimation of the uncertainty associated with stock and reference point parameters.

Management Advice and Reference Points

Review

The GARM did not update any of the reference points established by the *Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish*. For each stock, the recent dynamic history of the population and the fishery were discussed in detail in relation to the biomass and fishing mortality benchmark reference points. The sensitivity, of the stock status relative to reference point benchmarks, to the trawl warp issue was continually raised within the meeting and addressed using sensitivity analyses. The conclusion that the status of the stocks relative to management reference points is robust to the relatively minor changes in catchability that would have resulted from the trawl warp offset.

Recommendations

- At least two of the stocks for which the GARM provides management advice (pollock and Atlantic halibut) are not "closed" entities but are part of a much larger population complex. The units are not true stocks with negligible immigration and emigration, as required for a full understanding of the population and fishery dynamics. Whilst management of these stocks using reference points derived from the index method provides an indication of the relative exploitation status of the stock sub-unit, the stock dynamics could be controlled by events taking place outside of the management area, e.g. recruitment. As such, spawning stock and recruitment analyses and reference points for these stocks could be highly ambiguous. The GARM was aware of the problem and is monitoring the

situation. It is strongly recommended that the assessment and management of such stocks be addressed in spatial units that equate to the scale of their system dynamics.

- In some texts, B_{msy} is quoted when SSB values have been used for the determination of the reference point. Although the authors are aware of their meaning and glossaries are sometimes provided at the beginning of reports, if the reader is not aware of the potential for error or the text is extracted in isolation, this will lead to confusion and mistakes. It is strongly recommended that a common nomenclature is adopted for the SSB and biomass based reference points. This issue was discussed within the GARM and will be addressed.
- The majority of the stocks examined by the GARM are taken in mixed species fisheries. Changes in effort or TAC directed towards target species will influence the dynamics of other species. It was therefore surprising that the management advice was provided on a single stock basis without discussion of mixed fishery issues. F rebuild resulting in the recovery of one stock within the designated time frame may impose an indirect bycatch or discard mortality, on a second stock, that is too high for it to recover.

The Trawl Warp Issue

Review

The GARM was unanimous in its conclusion that that the magnitude of the trawl warp offset effect on survey catchability is relatively small relative to the natural and sampling variation inherent in all survey time series. Assessment results and the advice as to the state of the stock were shown to be robust to under-estimation bias at the level of the expected effects.

In my opinion, a level-headed and rigorous scientific analysis was applied to the trawl warp offset problem. Although the "gut feeling" of the participants was that there should be little or no effect, this was not allowed to influence the analysis or the interpretation of the results.

Numerous diverse data sets and methodologies were analysed in order to find an indication that the mis-marked trawl warps had had an effect on the catch rates from the surveys. These included trawl monitoring measurements, trawl damage indices, catch rates of species by depth, between and within survey series. In each case, the results of the analysis pointed to the conclusion that a reduction in survey catchability could not be detected during the period when the offset was present. This was not unexpected given the video evidence that the net was still fishing at the expected range of trawl offsets and that such offsets will fall within the natural variation induced by currents, wind and wave action, fishing on slopes, etc.

Sensitivity tests applied to the assessments revealed that even if a substantial (x2) effect were to be missed by the statistical data analysis, the conclusions that the stocks are being over-fished would not change.

Recommendations

- Although current statistical analysis have established that the trawl warp offset does not appear to have had a significant impact on the catchability of the survey series, this issue should not be closed after this GARM. It is my understanding that there are a series of experiments that will be conducted by the NEFSC and the fishing industry to examine the problem in more detail. The issue should therefore be placed on the agenda for next year's Working Groups and GARM.
- The detailed data analysis required for the resolution of the trawl warp offset issue has highlighted the importance of comparative towing calibration exercises when planning gear and ship alterations.

Documents reviewed

Historic

Brodziak, J., P. Rago, and R. Conser. 1998. A general approach for making short-term stochastic projections from an age-structured fisheries assessment model. In F. Funk, T. Quinn II, J. Heifetz, J. Ianelli, J. Powers, J. Schweigert, P. Sullivan, and C.-I. Zhang (Eds.), *Proceedings of the International Symposium on Fishery Stock Assessment Models for the 21st Century*. Alaska Sea Grant College Program, Univ. of Alaska, Fairbanks.

Mayo, R.K., E. Thunberg, S.E. Wigley and S.X. Cadrin. 2002. The 2001 Assessment of the Gulf of Maine cod stock. *Northeast Fish. Sci. Cent. Ref. Doc. 02-02*

NEFSC 2002. Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish, . NMFS/NEFSC, Reference Document 02-04, 254p.

NEFSC (Northeast Fisheries Science Center). 2001. Assessment of 19 Northeast Groundfish Stocks through 2000. Northern Demersal and Southern Demersal Working Groups, Northeast Regional Stock Assessment Workshop. *Northeast Fish. Sci. Cent. Ref. Doc. 01-20*, 217p.

O'Brien, L. and N. J. Munroe 2001. Assessment of the Georges Bank cod stock for 2001. *Northeast Fish. Sci. Cent. Ref. Doc 01-10*, 126 p.

Stone, H. H Stock assessment of Georges Bank (5Zjmnh) Yellowtail Flounder for 2002 CSAS Research Document 2002/057

APPENDIX I

GARM Working documents

- A O'Brien L., N. J. Munroe, and L. Col. Georges Bank Cod.
- B Brodziak, J., M. Thompson, R. Brown, and N. Munroe. Georges Bank Haddock.
- C1 Legault, C. Georges Bank Yellowtail Flounder.
- C2 Legault, C. Georges Bank Yellowtail Flounder Sensitivities.
- D Cadrin, S. Southern New England Yellowtail Flounder.
- E Cadrin, S and J King. Cape Cod Yellowtail Flounder.
- F Mayo, R.K. and L. Col. Gulf of Maine Atlantic Cod Stock.
- G Wigley, S. E. Witch Flounder.
- H O'Brien, L., C.Esteves, and L. Col. American Plaice in the Gulf of Maine/Georges Bank Region.
- I Hendrickson, L. Georges Bank Winter Flounder
- J Terceiro, M. Southern New England/Mid-Atlantic Winter Flounder
- K Sosebee, K.A. Georges Bank/Gulf of Maine White Hake.
- L Mayo and L. Col. R.K. The 2002 Status of Pollock, *Pollachius virens* (L.) in NAFO Divisions 4VWX and Subareas 5 and 6.
- M Mayo R.K. and L. Col. The 2002 Status of Acadian Redfish, *Sebastes fasciatus* Storer in the Gulf of Maine-Georges Bank Region.
- N Wigley S. Ocean Pout
- O Hendrickson, L. Windowpane Flounder (Gulf of Maine-Georges Bank)
- P Hendrickson, L. Windowpane Flounder (Southern New England-Mid-Atlantic Bight)
- Q Cadrin, S. Mid Atlantic Yellowtail Flounder.
- R Brodziak, J. and M.Thompson Gulf of Maine Haddock.
- S Brodziak, J. Atlantic Halibut
- T Nitschke, P. Gulf of Maine Winter Flounder

- U Report of the NEFSC Methods Working Group. Evaluation of the potential effects of asymmetric trawl cables on R/V Albatross survey indices from 2000 to 2002.

APPENDIX II

STATEMENT OF WORK

Subcontract between the University of Miami and CEFAS (Dr. Chris Darby)

Groundfish Assessment Review Meeting

The purpose of requesting outside peer reviewers from the Center of Independent Experts (CIE) is to provide input to the Groundfish Assessment Review Meeting (GARM) for northeast USA stocks. The Northeast Multispecies Fishery Management Plan (Multispecies Plan) includes 20 groundfish stocks. The GARM meeting (scheduled for 8-11 October, 2002, in Woods Hole, Massachusetts), will provide scientific review of assessment information and ancillary analyses. The CIE reviewers are requested to provide input on assessment results and forecasts, and to help construct the final report of the meeting.

The GARM meeting is a regional process for updating stock assessments using existing models, VPA formulations, and other assessment approaches. Specifically, the GARM will:

- A. Provide updated catch information (landings and discards, where appropriate) for the 20 stocks to be assessed (see list below), catch-at-age data (estimated based on port sampling, where applicable);

Cod	Gulf of Maine Georges Bank
Haddock	Gulf of Maine Georges Bank
Yellowtail flounder	Georges Bank Cape Cod Southern New England Mid-Atlantic
Winter flounder	Gulf of Maine Georges Bank Southern New England
Acadian redfish	
American plaice	
Witch flounder	
Pollock	
Windowpane flounder	Northern Southern
White hake	
Ocean pout	
Atlantic halibut	

- B. Provide updated research vessel survey indices (through spring 2002) for all appropriate survey series, including NMFS spring and autumn series, Canadian series, and state surveys (as appropriate);
- C. Estimate fishing mortality rates (or appropriate proxies) for all 20 stocks (through 2001), and provide estimates of terminal year stock sizes;
- D. Evaluate stock status relative to applicable biological reference points (FMSY and BMSY) as provided in the 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/>);
- E. Provide updated estimates of F-Rebuild (the fishing mortality rate required to rebuild biomasses to BMSY by 2009) for all applicable stocks; and
- F. Comment on the potential sensitivity of assessment results to trawl warp marking discrepancies that occurred in surveys between spring 2000 and spring 2002.

Specific Responsibilities of the CIE Reviewer

The scientific expertise required is in the area of stock assessment and population dynamics.

The CIE reviewer's duties shall occupy no longer than 10 days: Several days prior to the GARM meeting for document review; four days to participate in the GARM meeting; one day following the GARM meeting to review the draft final workshop report; and several days to complete the report to be submitted to the CIE. No consensus opinion between the two CIE reviewers is sought.

Specific tasks and the schedule are itemized below.

1. Prepare for the GARM meeting by reviewing documents posted on the web prior to 8 October 2002.
2. Serve as active participant in the GARM meeting from 8-11 October 2002, providing input, comment, and scientific overview of analyses, and actively participate in drafting the final report and conclusions of the GARM.
3. Review the draft GARM report during the week of 14-18 October 2002, so that the NEFSC can meet the deadline for completion of the final document by 21 October 2002. The review comments should be provided to the Northeast Fisheries Science Center via Dr. Steven Murawski (508-495-2303, smurawsk@whsun1.wh.who.edu) no later than October 18, 2002.
4. No later than October 25, 2002, submit the written report¹ (see Annex I) addressed to the "University of Miami Independent System for Peer Review," and sent to

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.

Dr. David Die, via email to ddie@rsmas.miami.edu, and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu. This report shall include the comments provided under task 3 above.

ANNEX I: REPORT GENERATION AND PROCEDURAL ITEMS

1. The report shall be prefaced with an executive summary of findings and/or recommendations.
2. The main body of the report shall consist of a background, description of review activities, summary of findings, and conclusions/recommendations.
3. The report shall also include as separate appendices the bibliography of materials reviewed for the GARM and a copy of the statement of work.

Review Report on the 2002 Groundfish Assessment Review Meeting (GARM) and its findings and recommendations

By

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Executive Summary

Assessments (through 2001) of the 20 stocks under the Northeast fisheries management plan updated and reviewed by GARM are of consistent high quality, based on models that are suitable for the available data for each stock. The GARM review meeting was competently chaired, and conducted in a spirit of cooperation and teamwork. The assessments, conducted by experienced stock assessment biologists, were subject to a rigorous and very open peer review process that identified the most likely sources of uncertainty and, in some cases, inconsistencies were discovered. In response to requests by GARM, inconsistencies were usually corrected in time for review the next day. Inaccurate information on catch-at-age, resulting from limited spatial and temporal sampling coverage of landings and limited, if any, information on discard was identified as a major source of uncertainty in some age-based assessments. Systematic patterns in the residuals of many VPA model fits (e.g., multiple years in a row with negative or positive residuals) strongly indicates bias in the catch-at-age data, for example resulting from significant discards not accounted for, or from biased catch sampling. The control of fishing mortality through trip limits, which has been implemented for some stocks in recent years, might increase the level of discards and, worse, cause a shift in the time series of catch-at-age that is difficult to correct for in stock assessments.

GARM conducted a rigorous and very thorough evaluation of potential effects of a trawl warp offset recently discovered on the NOAA research vessel *Albatross IV*. The offset, which applied to surveys conducted from winter and spring 2000-2002, and fall 2000 and 2001, could potentially affect recent stock assessments. A suite of studies related to gear configuration, fishing power, and survey indices of abundance and size composition over time strongly suggested that any change in trawling efficiency as a result of the offset was minor. Results from previous controlled fishing power experiments conducted with *Albatross IV* trawling alongside another vessel (*Delaware II*) showed very similar catching efficiencies for *Albatross IV* relative to *Delaware II* before and after the warp offset, thus precluding a major drop in trawl catching efficiency caused by the offset. Analyses of the series of *Albatross IV* survey indices of abundance (and size

composition) alone, or compared to Canadian independent surveys for some species, did not reveal a substantial shift related to drop in fishing power after the warp offset. An additional sensitivity analysis conducted by GARM using hypothetical increases of 10%, 25%, and 100% in survey abundances (corresponding to reductions in catching efficiency well beyond what is supported by available data) would not have sufficient impact on stock assessments to change the determination of status with respect to overfishing (fishing mortality rates) for 19 of the 20 species under the Northeast FMP. American plaice, which had a biomass close to the target of $\frac{1}{2}$ B-MSY in 2001, changed status from ‘overfishing’ to ‘no overfishing’ in the (unlikely) event of a 50% reduction in fishing power caused by the warp offset (corresponding to a 100% upward adjustment of the abundance index). The qualitative status based on the comparison of estimated biomass to the reference ($\frac{1}{2}$ B-MSY) changed for two species (American Plaice and Gulf of Maine haddock) with a hypothetical 10% (or higher) increase in abundance because their estimated biomass were close to the threshold. Clearly, when the point estimate of biomass is close to the threshold, even insignificant changes in catching efficiency (i.e., within the natural variability caused by weather conditions, variations in the vertical distribution of fish, and other factors) could change the qualitative status. Based on these considerations, I believe that it was demonstrated beyond a reasonable doubt that the offset of trawl warps on *Albatross IV* has not invalidated the stock assessments and the determination of fishing status with respect to overfishing.

1. Background

The Northeast Fisheries Science Center (NEFSC) conducts assessments of 20 major groundfish stocks (A-T, Appendix A) under the Northeast Multispecies Fishery Management Plan (FMP). These stock assessments are based on methods that use abundance indices from fisheries independent trawl surveys (conducted since 1963), either directly or indirectly. For stocks where sufficient information is available on catch at age over time (e.g., from port sampling, logbooks and other sources), the assessments are based on VPA (Virtual Population or Cohort Analysis) (A-G) or ADAPT (H). Independent survey indices of abundance (or biomass) are used for the tuning (calibration) of these age-based or integrated models. The assessments of nine stocks (L-T) are based directly on the fisheries independent survey indices of abundance (or biomass) and the estimated population characteristics of the stocks (e.g., size and age distribution), along with information on catch. Due to limitations in basic catch-at-age data, the assessment of two stocks (I, J) was based on a stock production model incorporating covariates (ASPIC), with spring and autumn survey indices of biomass used for tuning; while one stock (K) was assessed by a biomass dynamic model, using survey indices of biomass.

Abundance indices and estimates of population characteristics from fisheries independent surveys provide essential information for the assessments of the groundfish stocks under the Northeast FMP. The NOAA research vessel *Albatross IV* has been used by NEFSC to conduct stratified random surveys for the assessment and monitoring of groundfish stocks since 1963, representing an unparalleled continuous time series for tracking the status and trends of major stocks under the Northeast FMP. The normal operating area for *Albatross IV* is the Gulf of Maine, Georges Bank, and the continental shelf and slope from Southern New England to Cape Hatteras, NC. Concerns have been raised that the reliability of the surveys conducted by *Albatross IV* has been jeopardized in the most recent years because of an un-intended change in the sampling gear configuration in

2000, thus potentially compromising stock assessments for recent years. Measurements of NEFSC survey trawl warps in autumn 2002 suggested that right and left warps (the wires that attach the trawl gear to the vessel) may have been offset by up to several feet on the NOAA Ship *Albatross IV* during surveys conducted from winter 2000 through spring 2002. The offset was caused by biased measurements of the 50 m intervals for one warp, and as a result of these miss-markings, the offset increased proportionally with the length of cable deployed. The fishing industry and other constituents have postulated that the offset may have substantially reduced the trawl catching efficiency because of reduced bottom contact and lesser opening of the trawl. The possibility of the trawl collapsing at greater depths, which would result in zero catches, was also raised. A considerable reduction in trawling efficiency would introduce bias and reduce the reliability of the survey indices of abundance and estimates of population characteristics (e.g., length and age compositions) of groundfish species under the FMP.

These concerns were addressed in the Groundfish Assessment Review Meeting (GARM) from October 8-11, 2002 in Woods Hole, MA. GARM conducted a scientific review of assessment information and ancillary analyses including multiple studies to assess if the warp offset significantly affected trawling efficiency. GARM also assessed the potential implications of warp offset on stock assessment and resulting determination for overfished status (e.g., $<1/2$ BMSY) for the 20 species under the Northeast FMP, based on hypothesized reductions in the catching efficiency of the trawl in a series of sensitivity analyses.

2. Review of the GARM Activities and Findings

Dr. Steve Murawski chaired the GARM meeting, held at the Northeast Fisheries Science Center (NEFSC) in Woods Hole from October 8-11, 2002, in an organized and effective manner. The meeting was conducted in a spirit of cooperation and teamwork. Draft documents of most updated stock assessments were made available for review a few days

before the meeting. During the GARM meeting, the responsible assessment expert presented each stock assessment update, and the panel of experts reviewed it. The group of regional stock assessment scientists (both NMFS and non-NMFS people) and external experts conducted the review. The team of scientists was very diligent in the search for inconsistencies in the methods and results, and everyone was very open to critique from the panel of reviewers.

2.1. Updating of Stock Assessments

Most stock assessments reviewed at the GARM were routine updates of assessments previously reviewed in the SAW or elsewhere. All the assessments specified in the Terms of Reference for the GARM were covered. Estimates of fishing mortality rates (or proxies thereof) and biomasses in 2001, relative to management reference points 2001 fishing mortality (or its proxy), were provided for 19 stocks. For one stock (T), the assessment presented was developed for the first time (by the ASMFC Technical Committee), and has not yet been subject to standard peer review. Accordingly, the details of the analytical stock assessment modeling are not incorporated in the GARM report, pending that “benchmark” review to be conducted at SAW-36 in December 2002.

Quality of the input data, and the suitability of the VPA model specifications were evaluated through inspection of residual plots. Alternative model structures (e.g., ASPIC) were used in a few cases to examine the robustness of the VPA results. The two primary sources of uncertainty included in the projections (for 2002 and onwards) based on VPA assessments are: (1) the initial estimated stock abundance at age in year 2001, which is driven by the fisheries-independent survey indices used for tuning, and (2) future recruitment to the stock. The tuning minimized the differences between predicted numbers at age from the VPA and the fisheries-independent indices of abundance through parameter adjustments, and has most influence on estimates for recent years. The VPA is a recursive procedure that converges to yield robust estimates of number at age

back in time (under certain assumptions) provided that the input catch statistics are reliable over time.

Inaccuracy in catch-at-age for commercial (and recreational) fisheries resulting from limited spatial and temporal sampling coverage of landings, and limited, if any, information on discard, was recognized by the whole panel as a problem. The non-random residual pattern in the VPA model fits observed for many stocks, with residuals being negative or positive for a series of years, strongly indicates that substantial components of the catch are unaccounted for. The strong retrospective patterns of under-estimation of F also could results from discard unaccounted for. The recent implementation of trip limits to reduce fishing pressure for some stocks is likely to increase discard of target species (e.g., through high-grading), and could introduce significant bias in stock assessments.

2.2. Management Advice and Reference Points

The GARM maintained the reference points established in “The Report of the Working Group on Re-evaluation of Biological Reference Points for New England groundfish”. Sensitivity analyses were conducted to evaluate hypothetical effects of trawl warp offset on the status determination for each stock. Their analyses demonstrated that the determination of the status of stocks, relative to biological reference points set by management, was robust to small (10%), and moderate (25%) changes in the catching efficiency of the trawl used for tracking relative abundance over time. I agree with these findings.

Sampling variability in survey indices of abundance, and the variability in VPA estimates related to uncertainty in catch-at-age, is generally not taken into account in the determination of overfishing status. In my opinion, this introduces a risk, since true abundance could be substantially lower, or higher, than the value used in the determination of overfishing status. Effects of errors in catch-at-age, for example

resulting from poor information about discard, are likely to be of greater importance in the determination of fishing status than the minor change in trawl catching efficiency resulting from the warp offset on *Albatross IV*.

2.3. Trawling performance related to warp offset

The GARM reviewed the results of a series of 10 different studies to evaluate evidence of a reduction in trawl catch efficiency associated with the use of miss-calibrated trawl warps on *Albatross IV*. There were eight affected surveys (winter and spring 2000-2002; and fall 2000 and 2001). These studies covered three broad categories:

- a. Trawl geometry and performance in relation to the warp offsets as function of depth - direct observations of bottom contact and trawl configuration (wing-spread and headrope height measurements), as well as data on rates of gear damage from the *Albatross IV* surveys;
- b. Shifts in the time series of survey indices of abundance and estimated population characteristics (e.g., size distributions) resulting from reduced trawling efficiency;
- c. Fishing power studies - paired trawling conducted by *Albatross IV* alongside the *Delaware II* vessel before and after spring 2000.

I was very impressed by the thorough scientific analysis that had been conducted by NEFSC staff, using all available relevant data, to reveal any shift in trawl catching efficiency caused by the warp offset on *Albatross IV*. The analysts and methods experts, at the request of myself and other GARM members, conducted multiple additional analyses during the meeting. The results did not reveal any significant effects on the catching efficiency of the trawl related to the offset of the warps for depths where groundfish typically occur (warp offset up to about nine feet). In particular, a large number of parallel trawl hauls conducted by *Albatross IV* alongside *Delaware II* before

and after the warp offset showed virtually no change in relative fishing power between the vessels. The analyses were restricted to ten species (including cod, haddock, and yellowtail flounder) that had sufficient sampling coverage for a valid comparison of fishing power between vessels. The almost identical relative catch rates for flatfish before and after the warp offset clearly indicate that the trawl maintained good bottom contact despite the warp offset. In effect, this fishing power study can be considered a controlled experiment (although not intended at the time) to detect effects of the warp offset. The *Delaware II* served as a control because it used a fixed gear and trawling procedure for both time periods (before and after the warp offset on the *Albatross IV* gear). Thus, an appreciable reduction in catching efficiency for *Albatross IV* after the warp offset, as postulated by some, would have resulted in a change in the ratio of mean catches for the two vessels. This did not happen. Any substantial changes in the underlying fish abundance pre and post warp offset, which could be a confounding factor in the evaluation of *Albatross IV* survey indices alone, are essentially accounted for because of the parallel trawling (in space and time) with another vessel.

3. Conclusions and Recommendations

Assessments through 2001 of the 20 stocks under the Northeast fisheries management are of consistently high quality, based on models that are suitable for the available data for each stock. The assessments and updates, conducted by experienced stock assessment biologists, were subject to a rigorous review process. The potential effects of the warp offset on *Albatross IV* in recent years were thoroughly evaluated. Based on all available results, I firmly believe that the warp offset has had minimal effects on the stock assessments conducted in recent years. Because the reduction of trawl catching efficiency resulting from warp offsets appear to be very small in depths where groundfish typically occur (warp offset up to about 9 feet), an intensive and well designed parallel trawling experiment involving *Albatross IV* along with a control vessel (e.g., the *Delaware II* or an industrial fishing vessel) would be required to detect and calibrate such

effects. Such an experiment could also provide additional information on the fishing power in deep waters, with warps offsets up to 18 feet. Although recent trawl experiment studies showed that the net remained open at the maximum offset of 18 feet, the actual fishing power in this case can only be determined from further experimental trawling. It is my understanding that such an experiment is being planned by NEFSC in cooperation with the fishing industry. Depending on the results from such an experiment, additional evaluations of the effects of the warp offset on stock assessments might be warranted.

Age-based assessments (VPA or ADAPT) with appropriate tuning are generally considered to be robust, when assumptions about natural mortality and recruitment are reasonable. However, such age-based assessments are particularly sensitive to inaccurate information on catches at age, for example related limited sampling coverage (spatially and temporally) of landings, and unreported discards. I recommend that the variability in VPA (and ADAPT) assessments caused by sampling variability in estimated landings in number by age be evaluated, for example by applying boot-strapping to port sampling data in connection with the model runs. Also, biased assessments (of unknown magnitude) could occur when multiple survey indices used for tuning of VPA are assigned equal weights, regardless of spatial coverage and precision. Such bias can be severe when some surveys only cover a limited fraction of the distribution area of a species. One way to reduce or eliminate such bias is to combine the respective survey estimates by using a composite estimator with appropriate weighting of each series, before the series is applied in tuning of VPA models. Additional post-stratification might be appropriate when surveys overlap in a sub-area.

I also noted that index based methods for determining fishing status do not incorporate measures of uncertainty in relative fishing mortality rate in the determination of overfished status. Reference points are based on estimated relative F that support replacement of the stock, or a specified growth rate. In the index-based assessments, the relative fishing mortality rate of a species is estimated as the ratio of catch (or harvest for some species) to the relative estimate of abundance from the research trawl surveys. Uncertainty in this ratio estimate is due to sampling variability in the survey indices, as

well as in the estimated total catches. Also, bias would be introduced if the total catches were poorly estimated, for example due to unreliable or no estimates of discard. It is important that the precision and accuracy of the estimated fishing mortality (F) be quantified, so that risk of stock depletion (or of setting too harsh limits on catch size) under current management regimes can be evaluated. The research trawl surveys conducted by NEFSC are probability-based, and thus have the great advantage that precision in the survey estimates of abundance can be quantified. In fact, to my knowledge, the survey series started by NEFSC in 1963 (using *Albatross IV*) was the first example (worldwide) of applying stratified random sampling to trawl surveys. I recommend that NEFSC move towards using a more precautionary approach to determine status relative to reference points, for example based on confidence limits of the abundance estimates. Although the relative standard errors might be fairly large because the estimates are based on moderate sample sizes, it would be more in line with the pre-cautionary approach to take such uncertainty into account. This can be illustrated through an example: If a point estimate of F for a species is just below the overfishing threshold, but with an upper confidence interval that extends well above the threshold, this would clearly indicate that the risk of overfishing occurring is high. By contrast, an estimated F just above the threshold, but with tight confidence limits, suggest a lower risk of severe overfishing than in the former example. The comparison of sampling variability in survey indices of abundance to variability in estimates of catch-at-age can also be useful when planning allocation of resources among fisheries dependent and fisheries in-dependent sampling programs.

4. References

The Report of the Working Group on Re-evaluation of Biological Reference Points for New England groundfish Improving Fish Stock Assessments. National Academy Press, Washington DC, 1998. 177 p.

Improving Fish Stock Assessments. National Academy Press. Washington, DC, 1998. 176 pp.

Improving the Collection, Management, and Use of Marine Fisheries Data, 2000. Ocean Studies Board, National Research Council, 236 pp.

Appendix A

Bibliography of materials reviewed:

- Report of the Groundfish Assessment Review Meeting (GARM) Assessment of 20 Northeast Groundfish Stocks through 2001. (By the Northern Demersal Working Group; Southern Demersal Working Group; Assessment Methods Working Group).

The above report includes updated stock assessments for 20 groundfish species (Documents posted on www.nefsc.noaa.gov/garm):

- A. Georges Bank cod (Loretta O'Brien)
- B. Georges Bank Haddock (Jon Brodziak)
- C. Georges Bank Yellowtail Flounder (Chris Legault/Steve Cadrin)
- D. So. New England Yellowtail Flounder (Steve Cadrin/Chris Legault)
- E. Cape Cod Yellowtail Flounder (Steve Cadrin/Chris Legault)
- F. Gulf of Maine Cod (Ralph Mayo)
- G. Witch Flounder (Sue Wigley)
- H. American Plaice (Loretta O'Brien)
- I. Georges Bank Winter Flounder (Lisa Hendrickson)
- J. So. New England/Mid Atlantic Winter Flounder (Steve C/Mark)
- K. White Hake (Kathy Sosebee)
- L. Pollock (Ralph Mayo)
- M. Acadian Redfish (Ralph Mayo)
- N. Ocean Pout (Sue Wigley)
- O. Gulf of Maine/Georges Bank Windowpane (Lisa Hendrickson)
- P. So. New England/Mid-Atlantic Windowpane (Lisa Hendrickson)
- Q. Mid-Atlantic Yellowtail Flounder (Steve Cadrin/Chris Legault)
- R. Gulf of Maine Haddock (Jon Brodziak)
- S. Atlantic Halibut (Jon Brodziak)
- T. Gulf of Maine Winter Flounder (Paul Nitschke)

Results from the Methods Working Group Report on Examination of Possible Trawl Survey Time- Series Interventions beginning in 2000 were presented in power-point with additional hand-outs. The following issues were covered:

- Description of warp offset problem, and how it relates to fishing depth (Paul Rago)
- Gear Damage Studies (Larry Jacobson)
- Evaluation of Fish Size in Relation to Warp Offsets (Larry Jacobson w/ Anne Richards)
- Warp Experiment Information (Data provided by Lisa Hendrickson)
- Trawl Geometry and Related Issues (Paul Rago/Steve Cadrin)
- Mean/Variance Relationships in Fish Catch (Paul Rago)
- Catch-at-Depth Relationships (Paul Rago /Steve Cadrin)
- Changes in Abundance Indices Pre- and Post Warp Intervention (Steve Cadrin)
- Log Catch Ratios Between Affected and Unaffected Surveys (Larry/Steve)
- VPA Performance (Residuals, Retrospective Patterns) (Chris Legault)
- Evaluation of Fishing Power Experiments, 1980s vs. 2002 (Mike Fogarty/Steve Cadrin)

APPENDIX B: STATEMENT OF WORK

Subcontract between the University of Miami and Versar, Inc. (Dr. Jon Helge Vølstad)

Groundfish Assessment Review Meeting

The purpose of requesting outside peer reviewers from the Center of Independent Experts (CIE) is to provide input to the Groundfish Assessment Review Meeting (GARM) for northeast USA stocks. The Northeast Multispecies Fishery Management Plan (Multispecies Plan) includes 20 groundfish stocks. The GARM meeting (scheduled for 8-11 October, 2002, in Woods Hole, Massachusetts) will provide scientific review of assessment information and ancillary analyses. The CIE reviewers are requested to provide input on assessment results and forecasts, and to help construct the final report of the meeting.

The GARM meeting is a regional process for updating stock assessments using existing models, VPA formulations, and other assessment approaches. Specifically, the GARM will:

- A. Provide updated catch information (landings and discards, where appropriate) for the 20 stocks to be assessed (see list below), catch-at-age data (estimated based on port sampling, where applicable);

Cod	Gulf of Maine Georges Bank
Haddock	Gulf of Maine Georges Bank
Yellowtail flounder	Georges Bank Cape Cod Southern New England Mid-Atlantic
Winter flounder	Gulf of Maine Georges Bank Southern New England
Acadian redfish	
American plaice	
Witch flounder	
Pollock	
Windowpane flounder	Northern Southern
White hake	
Ocean pout	

Atlantic halibut

- B. Provide updated research vessel survey indices (through spring 2002) for all appropriate survey series, including NMFS spring and autumn series, Canadian series, and state surveys (as appropriate);
- C. Estimate fishing mortality rates (or appropriate proxies) for all 20 stocks (through 2001), and provide estimates of terminal year stock sizes;
- D. Evaluate stock status relative to applicable biological reference points (FMSY and BMSY) as provided in the 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/>);
- E. Provide updated estimates of F-Rebuild (the fishing mortality rate required to rebuild biomasses to BMSY by 2009) for all applicable stocks; and
- F. Comment on the potential sensitivity of assessment results to trawl warp-marking discrepancies that occurred in surveys between spring 2000 and spring 2002.

Specific Responsibilities of the CIE Reviewer

The scientific expertise required is in the area of stock assessment and population dynamics.

The CIE reviewer's duties shall occupy no longer than 10 days: Several days prior to the GARM meeting for document review; four days to participate in the GARM meeting; one day following the GARM meeting to review the draft final workshop report; and several days to complete the report to be submitted to the CIE. No consensus opinion between the two CIE reviewers is sought.

Specific tasks and the schedule are itemized below.

1. Prepare for the GARM meeting by reviewing documents posted on the web prior to 8 October 2002. This web site is <http://www.nefsc.noaa.gov/garm/>. The login is "garm"; the password is "kingfish". Additional scientific information will be presented during the GARM meeting.
2. Serve as active participant in the GARM meeting from 8-11 October 2002, providing input, comment, and scientific overview of analyses, and actively participate in drafting the final report and conclusions of the GARM.
3. Review the draft GARM report during the week of 14-18 October 2002, so that the NEFSC can meet the deadline for completion of the final document by 21 October 2002. The review comments should be provided to the Northeast Fisheries Science

Center via Dr. Steven Murawski (508-495-2303, smurawsk@whsun1.wh.who.edu) no later than October 18, 2002.

4. No later than October 25, 2002, submit the written report¹ (see Annex I) addressed to the “University of Miami Independent System for Peer Review,” and sent to Dr. David Die, via email to ddie@rsmas.miami.edu, and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu. This report shall include the comments provided under task 3 above.

Signed _____

Date _____

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.

ANNEX I: REPORT GENERATION AND PROCEDURAL ITEMS

1. The report shall be prefaced with an executive summary of findings and/or recommendations.
2. The main body of the report shall consist of a background, description of review activities, summary of findings, and conclusions/recommendations.
3. The report shall also include as separate appendices the bibliography of materials reviewed for the GARM and a copy of the statement of work.