Panel Summary Report
of the
Groundfish Assessment Review Meeting
(GARM III)

Part 3. Biological Reference Points

By
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Including Presentation Highlights for each Working Paper written by the lead Assessment Scientists

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SUMMARY

The Biological Reference Points which will be used in the assessments and rebuilding plans of 19 New England groundfish stocks being considered in the 2008 Groundfish Review Assessment Meetings (GARM) were reviewed at the Northeast Fisheries Science Center in Woods Hole, Massachusetts during 28 April – 2 May 2008. The review considered the influence of retrospective patterns in parameter estimates (e.g. fishing mortality, biomass, and/or recruitment) from assessment models on the computation of biological reference points and on the specification of initial conditions for forecasting. It also considered recent and historical trends in the productivity of each stock, including trends in pertinent environmental variables that might be related to the trends in those biological parameters relevant to the biological reference points. In relation to the latter, the review considered the overall production potential of the fishery based on food chain processes and commented on aggregate single stock yield projections in relation to overall ecosystem production. The majority of the review focused on updating or redefining the fishing mortality and biomass threshold reference points or proxies for each of the 19 stocks.

This was the third meeting of a four part process, the first being on data inputs (29 October – 2 November 2007), and the second on assessment models (25 – 29 February 2008). These three meetings will inform the review of the assessments to be undertaken during 4 – 8 August 2008. The GARM process has been designed so that each review can inform subsequent ones.

The body of this report consists of the recommendations of a six member review panel in response to the meeting's terms of reference. The report also includes a synopsis of each of the working papers presented at the meeting along with the associated discussion, during which suggestions and recommendations were made to address identified issues. The Panel considered these in drafting this report.

Overall, the meeting generally fulfilled its terms of reference and represents an important contribution to the GARM III process.

INTRODUCTION

This document is the summary report of the review Panel (herein termed the 'Panel') of the Groundfish Assessment Review Meeting (GARM) on biological reference points (BRPs). The GARM is a regional scientific peer review process developed in 2002 to provide assessments for the stocks managed under the Northeast Multispecies Fishery Management Plan (Multispecies FMP). The first two GARMs took place in October 2002 (NEFSC, 2002a) and August 2005 (NEFSC, 2005) respectively. This GARM III is the most comprehensive to date, intended to provide peer reviewed assessments on 19 groundfish stocks managed by the New England Fisheries Management Council (NEFMC).

The four meetings of GARM III include:

- Data Inputs (29 Oct – 2 Nov 2007)
- Assessment Methodology (25 – 29 Feb 2008)
- Biological Reference Points (28 April – 2 May 2008)
- Assessments (4 – 8 August 2008)

The first three meetings are to establish the analytical formulations of the assessments to be used in the last meeting. The first meeting (NEFSC, 2007) focused on the data inputs (e.g. catch, sampling, surveys, etc) to be used in the assessments. The second meeting considered the assessment approaches to be applied to the datasets of each stock discussed at the first meeting. The third meeting, which is the focus of this report, focused on the fishing mortality and biomass biological reference points (BRPs) to be used in the assessments and rebuilding plans of the 19 GARM III stocks (see Terms of Reference, appendix 1). The meeting also considered the influence of retrospective patterns in parameter estimates from the assessment models on the computation of the BRPs and on the specification of initial conditions for forecasting. It considered recent and historical trends in the productivity of each stock, including trends in pertinent environmental variables that might be related to the trends in those biological parameters relevant to the biological reference points. In relation to the latter, the review considered the overall production potential of the fishery based on food chain processes, estimated the aggregate yield from the ecosystem and commented on aggregate single stock yield projections in relation to overall ecosystem production.

After introductions (see meeting participants, appendix 2) on Monday morning, the meeting started (see agenda, appendix 3) with an overview of the methods and estimates of the current BRPs. Stochastic simulation in rebuilding projections and the consequences of these for BRPs was then discussed. This was followed by consideration of the working papers to address terms of reference 2 (trends in stock productivity). Much of the Monday afternoon was devoted to consideration of the working papers for Terms of Reference 3 (ecosystem approaches) with the day ending with discussion on two working papers on specific aspects of Terms of Reference 4. On Tuesday morning, working papers on terms of reference 1 (influence of retrospective patterns) were first considered with the rest of the meeting until Thursday afternoon devoted to terms of reference 4 (BRPs by stock). No working papers were explicitly devoted to addressing Terms of Reference 5 (forecasting models). On Friday, the Panel held a closed session on the contents of its report. The GARM review Panel consisted of Mike Bell, Vivian Haist, Stuart Reeves, Stratis Gavaris, Grant Thompson and the chair, Robert O'Boyle. The first three reviewers were assigned to the review by the national Center of Independent Experts (see statement of work for these CIE reviewers in appendix 4) while the last three were invited by the Northeast Fisheries Science Center (NEFSC). All were invited based upon their extensive expertise and experience with the issues considered by the meeting.

The presentation highlights of each working paper (appendix 5) and the ensuing discussion as recorded by assigned rapporteurs are provided in appendix 6. These were important reference material to the Panel in drafting its report.

The focus of the meeting's review was the BRPs for each of the 19 groundfish stocks. No attempt was made to review the status of the 19 stocks, which are the terms of reference of the August GARM, although the results from models to assess status are used in models to derive BRPs. The meeting often considered a range of models and made recommendations that could result in changes to the BRPs to be considered at the August GARM review. The review focused its attention on fishing mortality and biomass MSY reference points and their proxies.

PANEL RESPONSE ON TERMS OF REFERENCE

ToR 1. Influence of retrospective patterns on the computation of BRPs and on specification of initial conditions for forecasting

Retrospective patterns in assessment results may be caused by an unrecorded change in catches, a change in natural mortality, a change in the abundance index catchability (q) and/or a change in fishery selectivity. To properly account for a retrospective pattern, it is necessary to know the cause. The Panel recommends that plausible hypotheses about the cause of a retrospective be investigated and an adjustment to account for the retrospective should be made if possible. There may be cases however, where an acceptable adjustment cannot be made, leaving assessment results that display retrospective patterns of a magnitude that is consequential.

There is currently no generally agreed methodological approach that can be used to develop a basis for management advice that accounts for a retrospective pattern in the assessment results. The Panel reviewed analyses that addressed only the latter aspect of terms of reference one (methods for adjusting initial conditions for forecasting when the stock assessment exhibits a retrospective pattern). Two approaches were considered

- adjust the fishing mortality (F) in the quota year by the amount of retrospective seen in the F and
- adjust the initial population to account for the retrospective pattern seen in the population numbers

The latter approach has more merit, is easily implemented and can be applicable for evaluation of rebuilding scenarios, and therefore it was favored by the Panel. While it may be imprudent to adjust for a retrospective pattern without having determined the cause(s), basing management advice on assessment results that display a retrospective pattern implicitly assumes that the terminal estimates are in error whilst the calculated values back in time are correct.

In relation to the determination of stock status, in cases where an acceptable adjustment to the assessment model cannot be made (leaving assessment results that display retrospective patterns of a magnitude that is consequential), the Panel recommends the following practice:

- adopt the default that the terminal estimates are in error whilst the calculated values back in time are correct
- check the age specific retrospective patterns to determine the age range where the magnitude is consequential
- adjust the population numbers for the terminal year of the Virtual Population Analysis (VPA) (initial year of the projection) to account for the retrospective pattern seen in the population numbers
- conduct projections using the adjusted population numbers

The burden of proof is placed on the analyst to demonstrate that an alternative practice performs better. Further, it is suggested that performance against the rebuilding trajectory be checked more frequently for stocks that display a consequential retrospective.

While there were no specific analyses on the influence of retrospective patterns in assessment results for the computation of BRPs, results were presented for several stocks using both models that displayed a retrospective and models that used 'split' survey indices to account for the retrospective. Most of these models used a VPA, but not all. In general, the patterns in the stock - recruitment relationships were not altered greatly by the adjustments made to account for the retrospective pattern.

Thus, in relation to the derivation of BRPs, in cases where an acceptable adjustment to the assessment model cannot be made (leaving assessment results that display retrospective patterns of a magnitude that is consequential), the Panel recommends that corrective measures do not have to be taken for the computation of BRPs.

ToR 2. Trends in Stock Productivity

A majority of the GARM III stocks show appreciable trends in recent growth (length- and weight-at-age) and maturation, with a general trend towards reduced growth and delayed maturation. The relative influence of density-dependent and environmental factors on these life history characteristics has not been assessed; compilation of a number of environmental variables for GARM III will facilitate further work in this area, possibly with a meta-analysis approach to increase statistical power.

For most GARM III stocks, BRPs were calculated using the mean of the most recent five years for weights-at-age, partial recruitment (fishery selectivity), and maturity ogive. Where there were no long-term trends in some of these parameters (most commonly the maturity at age), the whole time series was used. These should provide the best estimates of short to medium term stock productivity, and are therefore appropriate for BRP calculations. For stocks that exhibit strong recent trends (eg. GB haddock weight-at-age) the five year averages may not be appropriate for stock projections or rebuilding scenarios. For those cases, the most recent estimates or forward projection of the trends may provide more accurate estimates of future (short-term) life history parameters.

For the GARM III stocks, the recruitment series used to calculate BRPs were selected to reflect the long-term stock productivity. A number of the stocks exhibit poor recruitment and low spawning stock abundance in recent years, and it is unclear if the reduced recruitment is caused by environmental or stock conditions. If lower recruitment is the result of a shift in environmental conditions which persists, BRPs calculated based on higher average recruitment levels may be unattainable. However, the burden of proof must lie on demonstrating that recent lower average recruitment is related to environmental changes rather than low spawning stock abundance, before adjustments are made to BRPs.

Stock projections and rebuilding scenarios should use the same recruitment assumptions as used in calculating BRPs. However, environmental or depensatory stock-recruitment effects may imply that short-term rebuilding targets are unattainable even with no or little fishing pressure.

ToR 3. Ecosystem Approaches to Gulf of Maine / Georges Bank Fisheries

The Panel noted the following key conclusions from the five working papers presented:

WP3.1 (worldwide cross-system comparison): "Results from this study suggest that on an ecosystem basis, current biomass management targets (B_{MSY}) for GARM, pelagic, and elasmobranch fishes are not unreasonable. The current targets compare favorably with the results of current and historical studies in the region and are also in general agreement with results of many studies for other worldwide ecosystems."

WP 3.2 (energy budget contextualization): "It is unclear if B_{MSY} for all species will be energy limited from a systemic perspective…. We conclude that this method and the results from it, although interesting, remain inconclusive to answer the primary question. That is, although we may have achieved balance of the network, some structural caveats and misunderstandings of this modeling package likely remain on our part."

WP 3.3 (aggregate surplus production estimation): "Overall the results from both surplus production modeling approaches suggest that the expected aggregate yield is lower, the B_{MSY} biomass is lower and the overall fishing mortality rate should be lower for the GARM stocks as a whole than is suggested from the single species results."

WP 3.4 (aggregate and multi-species production simulation): "With respect to the main question at hand — can we have all species at B_{MSY} simultaneously?— these results imply that we may not. Particularly as seen in the differential fishing scenario, it is possible to have all members of a group at or close to their K (and by extension B_{MSY}), but likely not all groups at that level (K or K/2) simultaneously…. Additionally, the aggregate scenarios produce more conservative results than the MS (i.e. multispecies) simulations, implying that there may be some systemic or model structural limitations in the aggregate that are more fully captured than when a more species-specific approach is employed…. The main point of this work is to emphasize the importance of including species interactions…. Often harvest was the lowest source of fish 'loss' compared to species interactions."

WP 3.5 (fishery production potential): "If we take a mean trophic level of the catch of 3.2 and a 30% exploitation rate, then the MSY levels in the partial accounting above comprise 83% of the estimated production potential…. These estimates do not include allowance for landings of species not included in partial accounting above. Nor do they include discard levels for all species. This suggests that the available demand will be exceeded in both cases when these considerations are taken into account…. Despite the drop in primary production required over the last two decades, the concomitant drop in mean trophic level results in an overfished classification in 2005."

These observations and the discussions at the meeting led the Panel to the conclusions below relevant to Terms of Reference 3.

a. Determine the production potential of the fishery based on food chain processes and estimate the aggregate yield from the ecosystem

The working papers provided a range of estimates of fishery production potential (MSY in kt):

WP (model)	GARM species	Pelagic species	Elasmobranchs	Total
3.1	197	354	18	569
3.3 (group ASPIC)	126	422	59	607
3.3 (aggregated ASPIC)	n/a	n/a	n/a	579
3.3 (multi-species)	110-125	363-445	n/a	473-570
3.5	n/a	n/a	n/a	1,550-1,855

The Panel considers that the working papers represent a commendable effort on the part of NEFSC scientists and that the success of this effort in producing the above estimates is evidence of the utility of the methods used. However, the Panel also agrees with the caveats provided in the working papers and therefore suggests that the above estimates be viewed as preliminary, pending the results of further investigations which the authors have proposed to conduct.

b. Comment on aggregate single stock yield projections in relation to overall ecosystem production, identifying potential inconsistencies between the two approaches

The working papers provide evidence in support of multiple, and occasionally conflicting, hypotheses regarding the relationships between estimates produced by single-species and multi-species or aggregated models. For example, WP3.1 found that estimates of B_{MSY} obtained from single-species models were generally concordant with estimates obtained by cross-system comparisons; whereas WP3.2 found the results to be inconclusive; WP3.3, WP3.4, and WP3.5 found that the ecosystem is unlikely to be able to sustain all stocks at their single-species BMSY levels simultaneously. However, the authors of these working papers generally feel that "the aggregate production model results for GARM species are the elements most immediately applicable for evaluating GARM species reference points from a multispecies/ecosystem perspective". The aggregate production model for the GARM species provided in these working papers results in an aggregate B_{MSY} estimate that is about one-half the value obtained by summing the estimates from species-specific production models, while the aggregate MSY is about two-thirds the value obtained by summing the estimates from species-specific production models. The aggregate F_{MSY} estimate (0.17) is also indicated to be lower than most estimates from single-species models, although the comparability of FMSY values from production models and age-structured models is not clear, due to the effects of partial recruitment (selectivity) and it is based on a biomass rather than a numbers currency.

As with TOR 3a, the Panel considers that the working papers represent a commendable effort on the part of NEFSC scientists and that the success of this effort in producing the above estimates is evidence of the utility of the methods used. Most of the results seem to suggest that current estimates of B_{MSY} are too high. Although the Panel believes that these results are too preliminary to implement at the present time, a precautionary approach would suggest that further research be encouraged and expedited to determine if this finding is correct. The authors have proposed to conduct such research, and the Panel endorses this proposal. In particular, the Panel suggests that future research should involve a formal Management Strategy Evaluation, including consideration of statistical uncertainty. Given that most of the working papers seem to indicate that the sum of single-species B_{MSY} levels cannot be sustained, and given that most of the GARM III stocks are currently somewhat below B_{MSY}, another aspect of the question meriting further investigation concerns the mechanism(s) by which the ecosystem was able to support pre-overexploitation levels of biomass for the GARM III stocks in the first place.

ToR 4. Biological Reference Points by Stock

General Considerations

Overfishing and Overfished Biological Reference Points

For the management of the GARM III stocks, status determination with respect to overfishing and overfished is evaluated using F_{MSY} or its proxy and B_{MSY} or its proxy respectively. If a stock is determined to be overfished, a rebuilding fishing mortality (F) must be specified that achieves a 50% chance or greater that spawning stock biomass (SSB) will exceed B_{MSY} in the prescribed time frame. Fishing at F_{MSY} will not necessarily result in a 50% chance that equilibrium SSB will exceed B_{MSY} if the error distributions for stochastic processes are not symmetric. This observation has led to a perceived inconsistency. This perceived inconsistency was addressed in the working papers by adopting a particular estimator of B_{MSY} based on stochastic long-term projections with the recruitment stream feeding into the projection empirically by resampling from all or a subset of the observed recruitments, or parametrically by putting lognormal error on the predicted recruitment at F_{MSY}. This procedure (herein termed 'stochastic projection') was used for determining the biomass reference points of the 19 GARM III stocks under review. The estimator of B_{MSY} adopted in the working papers was the median long-term SSB obtained when the stock is fished at the deterministic estimate of F_{MSY}. In some cases, the resulting estimates of B_{MSY} were greater than the deterministic estimate of B_{MSY}, by varying amounts, while in others, the resulting estimate of B_{MSY} was less than the deterministic estimate. While addressing the perceived inconsistency, the Panel notes the following complications with the procedure:

- Federal Guidelines for National Standard 1 under the Magnuson-Stevens Fishery Conservation and Management Act (Restrepo et al., 1998) explicitly define F_{MSY} as the constant F that maximizes long-term average (not median) yield and B_{MSY} as the long-term average (not median) stock size when the stock is fished at F_{MSY}. While the Guidelines allow for the use of proxies in cases where information is insufficient to estimate the quantities contained in the definitions directly, the Panel wondered whether changing the biomass BRPs from "average" to "median" might pose a difficulty in terms of compliance, given that estimation of the average does not require any more information than estimation of the median.

- The stochastic projection may place high reliance on the dispersion of an empirical cumulative frequency distribution that is based on few observations. Characterizing dispersion is generally more demanding than characterizing central tendency. For the parametric approach, it is necessary to assume a distributional form for the errors, typically lognormal, and the results are sensitive to the reliability of the estimate of the variance for this distribution. This complicates interpretation of the B_{MSY} proxy and may be contentious.
- When no parametric model of the stock-recruitment relationship is considered suitable for BRP estimation (as was the case for all or nearly all of the GARM III stocks reviewed), mean SSB is straightforward to compute, being simply the product of average recruitment and SSB/R. Moreover, in the case where the recruitment distribution is lognormal, the ratio between stochastic B_{MSY} and deterministic B_{MSY} is straightforward, being exp ($\sigma^2/2$). Computation of median SSB, on the other hand, requires stochastic projection as described in working paper 4.2 (AGEPRO), and there is no simple formula for the ratio between stochastic B_{MSY} and deterministic B_{MSY}.

The Panel noted that, when no estimate of the stock-recruitment relationship is available and the recruitment distribution is lognormal, simulations indicate that the median SSB is typically very close to, albeit less than, the mean SSB. This suggests that the estimates of B_{MSY} provided herein are, for the most part, likely to be close to the estimates that would have been obtained had the mean been used rather than the median.

The Panel therefore decided to accept the estimates of B_{MSY} provided by the stochastic projections, but suggested that the NEFSC consider the following alternatives when preparing the final assessments:

- Estimate B_{MSY} by the mean rather than the median; and
- In cases where an estimate of the stock-recruitment relationship is available, estimate F_{MSY} by maximizing the long-term average yield rather than the long-term deterministic yield.

The Spawning Stock Biomass – Recruitment Relationship and Estimation of BRPs

The specification of F_{MSY} and B_{MSY} relies on a stock recruitment relationship. In making recommendations for reference points of F_{MSY} or its proxy and B_{MSY} or its proxy, the Panel adopted the following procedure as the default:

- If the recruitment and spawning stock biomass derived from the assessments are informative about a relationship, the Panel recommended use of the stock-recruitment relationship to compute F_{MSY} and B_{MSY} using the parametric projection approach (herein termed the 'parametric' approach)

- If the recruitment and spawning stock biomass derived from the assessments are not informative about a relationship, the Panel recommended use of $F_{40\%MSP}$ as a proxy for F_{MSY} (NEFSC, 2002) and a B_{MSY} proxy computed using the stochastic projection approach (herein termed the 'non-parametric' approach)

The burden of proof was placed on the analyst to demonstrate that an alternative approach to that used by the Panel is more appropriate. Unfortunately, the recruitment and spawning stock biomass derived from most assessments did not display compelling support for any particular functional form of stock recruitment relationship and parameters are generally poorly determined. Therefore, the non-parametric approach was generally adopted. This required inspection of the stock – recruitment relationship to choose the stream of recruitment for the stochastic projection. Specifically, it required a decision on whether or not there was a spawning stock biomass (herein termed 'breakpoint') below which recruitment would be diminished. It also required determination of whether or not exceptionally large year-classes occurred which were unrelated to the size of the spawning stock biomass. In these cases, recruitment may be due to some other, perhaps environmental, process. To choose the recruitment stream for the non-parametric stochastic projections, the Panel initially visually inspected the stock – recruitment relationship to determine the breakpoint SSB and then undertook a more objective scan of the recruitment time series to identify the break point as that which minimized the residual variance after taking mean values either side of this break point ('razor analysis'). The latter resulted in some changes to the breakpoints identified through visual inspection.

On a related note, addressed previously in association with ToR 2, long-term productivity changes stimulated by broader ecosystem changes can influence the relationship between recruitment and spawning stock size. When the Panel considered the recruitment time series to use in the estimation of the BRPs, its choices were more related to data and model estimation issues than potential long-term changes in ecosystem and stock productivity. While the Panel admitted that changes may have occurred, firm evidence was required to suggest that BRPs have changed due to environmental factors rather than fishing impacts. If this could be demonstrated in the future, down- weighting of historical information in the estimation of the BRPs to better reflect productivity conditions both current and in the period of rebuilding would be appropriate.

Overview of Stock-by-Stock Biological Reference Points

The models, data and analytical approaches used to estimate the current BRPs are provided in Table 1. Many of these were developed in reviews held in 1998 (NEFMC, 1998) and 2002 (NEFSC, 2002). Two things become evident in comparison with the models, data and approaches used to update the BRPs at this meeting. First, while some of the stocks originally had BRPs based upon index approaches (e.g. Gulf of Maine haddock), many of these are now based upon age-structured models. This was not possible in all cases (e.g. windowpane and Ocean pout) due to data and/or modeling constraints. Second, the data sets for some of the stocks were extended considerably back in time (1913 for redfish and 1893 for Atlantic halibut). Regarding the model of the stock-recruitment (S-R) relationship, as noted above, the Panel adopted a non-parametric approach for many of the stocks. Only in one case was a parametric approach taken (halibut). The non-parametric derived BRPs were generally based upon a fishing mortality at 40%MSP (except for redfish) which provided spawning stock biomass per recruit (SSB/R) and in turn, with the chosen recruitment time series (indicated for each stock below), provided the biomass target (B_{MSY}) and yield (MSY) reference points. For the index-based stocks, generally the Relative F - Replacement relationship was inspected for statistical significance and if deemed useful, the biomass reference point proxy was based on survey kg/tow for a period of time when the Replacement Ratio was equal or greater than one. The details on the process of identifying BRPs for these data-poor stocks can be found in the respective working papers of the meeting.

Table 2 provides a comparison of the current with the new BRPs developed at this meeting. Note that the biomass reference points are estimated using the stochastic projection approach noted above. On first glance, it will appear that many of the newly estimated biomass reference points are lower and the fishing mortality reference points higher. Unfortunately, one cannot make a direct one-to-one comparison between the old and new BRPs due to changes in weights and partial recruitment at age. If through a combination of low growth rates and management regulations, the fishery has increasingly exploited older individuals, one would expect, based upon yield per recruit considerations that the fishing mortality reference point would increase. The Panel noted that the communication of the GARM III BRPs by the NEFSC to managers and industry will require careful comparison of these with the current BRPs to ensure that the true nature and reasons for the changes are apparent.

Tables 1 and 2 refer only to the fishing mortality and biomass MSY reference points.

Table 1. Models, data and approaches used to estimate biological reference points both current and developed at the GARM III 'BRP' review; stock units are as per text and biomass units are in metric tons

A. Current

Species	Stock	Model	Data used	S_R Model	Bmsy or proxy	Fmsy or proxy
Cod	GB	VPA	1978-2000	Parametric	BH SSBmsy	BH Fmsy
Cod	GOM	VPA	1982-2000	Parametric	BH SSBmsy	BH Fmsy
Haddock	GB	VPA	1931-2000	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
Haddock	GOM	AIM	1963-2000	Equilibrium point	Fall RV msy (5100t) Frep (0.23)	Rel F at Rep
Yellowtail Flounder	GB	VPA	1973-2000	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
Yellowtail Flounder	SNE/MA	VPA	1973-2002	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
Yellowtail Flounder	CC/GOM	VPA	1985-2002	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
American Plaice	GB/GOM	VPA	1980-2000	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
Witch Flounder		VPA	1982-2002	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
Winter Flounder	GB	ASPIC	1963-2000	NA	SP Bmsy	SP Fmsy
Winter Flounder	GOM	VPA	1982-2002	Parametric	BH SSBmsy	BH Fmsy
Winter Flounder	SNE/MA	VPA	1982-1998	Parametric	BH SSBmsy	BH Fmsy
Redfish		RED	1952-1999	Non-parametric	SSB/R (F40%MSP) avg R	F 50% MSP
White Hake	GB/GOM	ASPIC & AIM	1964-2000	Equilibrium point	SP Bmsy	Rel F at Rep
Pollock	GB/GOM	AIM	1963-2000	Equilibrium point	Fall RV	Rel F at Rep
Windowpane Flounder	GOM/GB	AIM	1963-2000	Equilibrium point	Fall RV	Rel F
Windowpane Flounder	SNE/MA	AIM	1963-2000	Equilibrium point	Fall RV	Rel F at Rep
Ocean Pout		Index Method	1968-2000	Equilibrium point	Spring RV	Rel F at Rep
Altantic Halibut		None	1893-1997	NA	External: MSY/F0.1	Proxy F 0.1 MSY (300t)

B. GARM III

Species	Stock	Model	Data used	S_R Model	Bmsy or proxy	Fmsy or proxy
Cod	GB	VPA	1978-2006	Non-parametric	SSB/R (40%MSP)	F40%MSP
Cod	GOM	VPA	1982-2006	Non-parametric	SSB/R (40%MSP)	F40%MSP
Haddock	GB	VPA	1931-2006	Non-parametric	SSB/R (40%MSP)	F40%MSP
Haddock	GOM	VPA	1977-2006	Non-parametric	SSB/R (40%MSP	F40%MSP
Yellowtail Flounder	GB	VPA	1973-2006	Non-parametric	SSB/R (40%MSP)	F40%MSP
Yellowtail Flounder	SNE/MA	VPA	1973-2006	Non-parametric	SSB/R (40%MSP)	F40%MSP
Yellowtail Flounder	CC/GOM	VPA	1985-2006	Non-parametric	SSB/R (40%MSP)	F40%MSP
American Plaice	GB/GOM	VPA (2005)	1980-2004	Non-parametric	SSB/R (40%MSP)	F40%MSP
Witch Flounder		VPA	1982-2006	Non-parametric	SSB/R (40%MSP)	F40%MSP
Winter Flounder	GB	VPA	1982-2006	Non-parametric	SSB/R(40%MSP)	F40%MSP
Winter Flounder	GOM	VPA	1982-2006	Non-parametric	SSB/R (40%MSP)	F40%MSP
Winter Flounder	SNE/MA	VPA	1982-2006	Non-parametric	SSB/R (40%MSP)	F40%MSP
Redfish		ASAP	1913-2006	Non-parametric	SSB/R (50%MSP)	F50%MSP
White Hake	GB/GOM	ASAP	1963-2005	Non-parametric	SSB/R (40%MSP)	F40%MSP
Pollock	GB/GOM	AIM	1963-2007	Visual interpretation	External	Rel F at replacement
Windowpane Flounder	GOM/GB	AIM	1975-2007	Visual interpretation	External	Rel F at replacement
Windowpane Flounder	SNE/MA	AIM	1975-2007	Visual interpretation	External	Rel F at replacement
Ocean Pout		Index Method (1998)	1968-2007	Visual interpretation	External	Rel F at replacement
Altantic Halibut		Surplus production	1800-2006	Implied	Internal	F0.1

Table 2. Fishing mortality and biomass biological reference points both current and developed at the GARM III 'BRP' review; stock units are as per text and biomass units are in metric tons; c/i refers to index-based method (catch / index)

A. Current

Species	Stock	Model	Bmsy or proxy	Fmsy or proxy	MSY
Cod	GB	VPA	216,800	0.18	35,200
Cod	GOM	VPA	82,800	0.23	16,600
Haddock	GB	VPA	250,300	0.26	52,900
Haddock	GOM	Landings & Survey	22.17 kg/tow	0.23c/i	5,100
Yellowtail Flounder	GB	VPA	58,800	0.25	12,900
Yellowtail Flounder	SNE/MA	VPA	69,500	0.26	14,200
Yellowtail Flounder	CC/GOM	VPA	12,600	0.17	2,300
American Plaice	GB/GOM	VPA	28,600	0.17	4,900
Witch Flounder		VPA	25,250	0.23	4,375
Winter Flounder	GB	ASPIC	9,400	0.32	3,000
Winter Flounder	GOM	VPA	4,100	0.43	1,500
Winter Flounder	SNE/MA	VPA	30,100	0.32	10,600
Redfish		RED	236,700	0.04	8,200
White Hake	GB/GOM	AIM	14,700	0.29	4,200
Pollock	GB/GOM	AIM	3 kg/tow	5.88 c/i	17,600
Windowpane Flounder	GOM/GB	AIM	0.94 kg/tow	1.11 c/i	1,000
Windowpane Flounder	SNE/MA	AIM	0.92 kg/tow	0.98 c/i	900
Ocean Pout		Index Method	4.9 kg/tow	0.31 c/i	1,500
Altantic Halibut		None	5,400	0.06	300

B. GARM III

Species	Stock	Model	Bmsy or proxy	Fmsy or proxy	MSY
Cod	GB	VPA	143,343	0.25	30,220
Cod	GOM	VPA	71,150	0.23	14,936
Haddock	GB	VPA	164,300	0.34	35,000
Haddock	GOM	VPA	5,995	0.45	1,360
Yellowtail Flounder	GB	VPA	46,000	0.25	10,000
Yellowtail Flounder	SNE/MA	VPA	27,600	0.26	6,300
Yellowtail Flounder	CC/GOM	VPA	8,310	0.24	1,820
American Plaice	GB/GOM	VPA (2005)	20,828	0.18	4,317
Witch Flounder		VPA	10,863	0.22	2,195
Winter Flounder	GB	VPA	15,500	0.25	3,400
Winter Flounder	GOM	VPA	3,557	0.27	854
Winter Flounder	SNE/MA	VPA	37,608	0.26	9,658
Redfish		ASAP	239,309	0.04	8,951
White Hake	GB/GOM	ASAP	56,500	0.21	7,000
Pollock	GB/GOM	AIM	2.00 kg/tow	5.76 c/i	11,516
Windowpane Flounder	GOM/GB	AIM	1.14 kg/tow	0.62 c/i	700
Windowpane Flounder	SNE/MA	AIM	0.33 kg/tow	1.53 c/i	500
Ocean Pout		Index Method (1998)	4.94 kg/tow	0.76 c/i	3,754
Altantic Halibut		Surplus Production	70,000	0.04	2,800

Stock-by-Stock Biological Reference Points

Georges Bank (GB) Cod

The current BRPs are based upon a VPA conducted upon the 1978 – 2000 dataset. In the GARM III 'models' review (NEFSC, 2008), it was noted that the data were sufficient for an age-structured model which assumed negligible error in the catch-at-age. A weak retrospective pattern was present.

A range of models on which to base updated BRPs was considered at this review. Given a more pronounced retrospective pattern in the ASAP, the VPA on the 1978 – 2006 dataset (with a mid-1990s split in the times series of all survey tuning indices) was selected as the most appropriate model for BRP estimation.

The revised F_{MSY} (0.25) for Georges Bank cod was based on the fishing mortality (F) that produced 40% of the unfished level of spawning biomass per recruit (herein termed $F_{40\%MSP}$). The yield/SSB per recruit calculations used mean weights, maturities and partial recruitment at age during 2002-2006. There are no obvious recent trends in these parameters. The revised B_{MSY} (143,343 t) was derived using $F_{40\%MSP}$ together with a stochastic projection (AGEPRO) drawing from the cumulative frequency distribution of all recruitments produced by spawning stock biomasses of 50,000 t or greater. This sub-set of the recruitments was used to reflect the higher productivity apparent at larger stock sizes observed earlier in the time series. The 50,000 t breakpoint was confirmed as that which minimized the residual variance after taking mean values either side of it ('razor' analysis). The resulting revised MSY for the stock is 30,220 t.

While the stock assessment on which these reference points are based has not yet been fully reviewed (and it will be updated with recent data in August), it indicates that recent SSB has been at a low level. This is likely to continue to result in low recruitment unless the stock can be rebuilt to a higher and more productive level. The rebuilding deadline for this stock (2026) reflects the recent low productivity of the stock.

Gulf of Maine (GOM) Cod

The current BRPs for Gulf of Maine cod are based upon a VPA using 1982 – 2000 data. The revised BRPs are based on $F_{40\%MSP}$ using the entire recruitment series (1982-2006) from a VPA. The VPA exhibits a weak retrospective pattern with no systematic trends that would cause concern for stock projections or rebuilding scenarios. The revised F_{MSY} and B_{MSY} proxies are 0.23 and 71,150 t respectively. The associated MSY is 14,936 t.

While the Panel considers the new VPA as an adequate basis for the determination of stock status and BRP revision, it noted the need to confirm the partial recruitment on ages five and older as this is particularly influential on the estimation of biological reference points and on stock status determination. An alternative BRP analysis of the Gulf of Maine cod data, using a statistical catch-age model variant (an Age-Structured Production Model - ASPM) and a longer catch series (1893-2006) provided support for the assumption of domed selectivity at age for both the survey and the commercial fishery. Alternatively, when a higher natural mortality rate was assumed (M=0.3), model fits were statistically equivalent for the asymptotically flat and domed survey selectivity assumptions. Both the alternative natural mortality rate and alternative selectivity assumptions will effect BRP calculations and estimates of current status relative to the BRPs.

Tagging analyses were conducted to attempt to distinguish between the domed and flat-top selectivity assumptions. A tagging model that partitioned tagged fish into three length categories and estimated length-specific natural mortality rates, fishing mortality rates, and movement rates was fitted to Atlantic cod tag release-recovery data. Results from this analysis were inconclusive in terms of distinguishing between the two selectivity assumptions because parameters of the tagging model are confounded (e.g. low tag recoveries in a size group can be explained by higher natural mortality rates, fish moving to an area with lower exploitation rates, or lower tag reporting rates). An integrated approach, incorporating the tag release and recovery data with the catch-at-age analysis, may allow resolution of the model selection question. It was noted that the tagging analysis suggests a higher natural mortality rate. Model selection criteria of ASPM model runs accepted larger values of natural mortality with flat – top selectivity. However, the higher natural mortality estimates from the tagging analysis could be aliasing for lower reporting rates or higher tag-induced mortality.

On balance, reiterating the conclusions of NEFSC (2008), the Panel felt a flat-top partial recruitment assumption should be the default unless there is compelling evidence that older fish are not caught by the fishery. Further, a flat-top survey catchability at age is preferred unless there is a plausible explanation for older fish to avoid the survey gear or to have emigrated out of the survey area. The VPA model was fit to a limited range of fishery catch ages and survey ages (ages 2 to 6). For the August 2008 assessment, analyses with data extended to include older ages should be investigated to evaluate their utility to better determine the partial recruitment on older ages. Additionally, VPA explorations should examine a higher natural mortality assumption. Other natural mortality assumptions that could be explored include higher rates for older ages or density dependent mortality such that mortality rates are higher in years (such as recently) with low stock abundance.

Georges Bank (GB) Haddock

The current BRPs are based upon a VPA conducted upon the 1931 – 2000 dataset, which was updated to 2006 for this review. In the GARM III 'models' review (NEFSC, 2008), it was noted that the data were sufficient for an age-structured model which assumed negligible error in the catch-at-age. A weak retrospective pattern was indicated as being present with one of the key concerns being recent changes in haddock size at age (declining). Further, difficulties with using a parametric stock – recruitment relationship (NEFSC, 2002) were noted with exploration of a non-parametric form likely required.

Based upon analyses presented at this meeting, the 1931 – 2006 VPA was considered an adequate basis on which to base BRPs. However, inspection of the stock-recruitment relationship confirmed, as noted by NEFSC (2008), that BRPs should be estimated using a non-parametric approach. Thus the F_{MSY} proxy was established as F40%MSP (0.34), taking into account recent declines in weights at age and partial recruitment. In relation to the latter, the Panel noted that when exceptionally large year – classes have previously moved through this stock (e.g. 1963 and 2003 year-classes), weights at age have declined and subsequently increased. It is thus possible that the current changes in weights at age and partial recruitment are transitory due to the size of the 2003 year-class.

The B_{MSY} proxy was based upon a stochastic projection (AGEPRO) at F 40%MSP and the expected distribution of recruitment at the biomass proxy. Inspection of the long time series of spawning stock biomass and recruitment indicated that the stock generally experiences moderate but highly variable sized year-classes at SSBs greater than 75,000 t. Below this, the probability of small year – classes appears to increase. Thus, the BRPs are based upon year-class sizes observed at greater than 75,000 t SSB.

The other important feature of recruitment into this stock is the appearance from time to time of exceptionally large year-classes (e.g. 1963 and 2003). These dominate productivity of the resource for a number of years after they enter the fishery. However, they do not appear to be related to the size of the spawning biomass. It is possible that a number of linked environmental factors are responsible for these exceptional year-classes. The Panel noted the 'mixed recruitment' nature of this stock and determined that for the estimation of BRPs, that the 1963 and 2003 year-classes should not be included in the analysis. This assumes a long-term sustained level of stock productivity without the necessity of relying upon the incidence of exceptionally large year-classes. When the latter occur, they can be taken advantage of on a yield per recruit basis.

Thus, the B_{MSY} proxy using recruitment where spawning stock biomass exceeded the 75,000 t breakpoint but excluding the 1963 and 2003 year-classes was 164,300 t with an associated MSY of 35,000 t.

Gulf of Maine (GOM) Haddock

The current BRPs for this stock are based on an index-based (AIM) assessment of the 1963 – 2000 dataset. While the GARM III 'models' review (NEFSC, 2008) considered this approach an adequate basis for revised BRPs, it encouraged efforts to process data sufficient for an age-structured approach. This work was done for this review and new BRPs for the stock are based on a VPA using catch-at-age data for 1977-2006. Unlike the AIM assessment, the VPA takes account of the decreased weight-at-age seen in recent years.

The VPA indicates SSB supported by a few strong cohorts. A strong residual pattern is seen in the fit of a Beverton-Holt stock-recruitment relationship with the resulting parametric F_{MSY} being very high. Therefore, a non-parametric approach to estimating BRPs was adopted. The B_{MSY} proxy (5995 t) was chosen as the median of stochastic projected (AGEPRO) SSB values after 50 years of fishing at $F_{40\%MSP}$ (0.45). Recruitment values were drawn from a sample including estimates hindcast back to 1962 using age one abundance indices from the NEFSC fall survey but excluding the exceptionally strong 1962 year-class and recruitment estimates associated with SSB less than 3,000 t (breakpoint based on 1986-1996 SSBs). The associated MSY is 1,360 t.

The Panel noted that the high value of $F_{40\%MSP}$ is contingent on the partial recruitment pattern in the most recent five years. The gear used by the commercial fishery changed in 2002 from 6 inch diamond mesh (which is still used in the Georges Bank fishery) to 6.5 inch square mesh, which resulted in greater escapement of mature haddock. Haddock taken by the recreational fishery, which accounts for an increased proportion of landings in recent years, are also relatively large. The selectivity change estimated by the VPA and incorporated in the BRP analyses, reflects substantial escapement of mature fish. This implies that the spawning biomass at $F_{40\%MSP}$ is composed of very young fish. It was noted that the current analysis indicates that Gulf of Maine haddock have lower weights at age than the Georges Bank stock. As well, the age at 50% maturity was also lower for Gulf of Maine as compared to Georges Bank haddock.

Comparisons with the Georges Bank haddock stock suggest that current productivity of the Gulf of Maine stock may have changed. Estimates of SSB for the two haddock stocks shows that, since 1988, the Gulf of Maine haddock SSB has been a lower proportion of Georges Bank SSB than during the years prior to 1988. It is also important to note that the perception that the Gulf of Maine stock is currently rebuilt may depend heavily on the contribution of the strong 1998 year-class.

Georges Bank (GB) Yellowtail Flounder

Current BRPs for this stock are based upon a VPA using 1973 – 2000 information. New BRPs for this stock are based on an update of the so-called 'Major Change' VPA (TRAC, 2005). In this assessment, the survey series are split between 1994 and 1995, which results in reduced retrospective patterns in biomass and fishing mortality estimates compared to the base VPA with no split. Except for minor changes to the catch-at-age data (principally discards), the assessment is an update of that applied in 2005. Data for 1973 to 2006 were included in the assessment, and recruitment estimates were hindcast back to 1963 based on regression of VPA estimates on the NEFSC Fall survey index at age one.

Initial exploration of potential BRPs used geometric means of the upper range of hindcast estimates to derive priors for unfished recruitment in fitting Beverton-Holt stock-recruitment curves. Values of F_{MSY} based on these curves were much higher than $F_{40\%MSP}$. Given the extrapolation of the stock-recruitment curve well beyond the range of observed SSB, the Panel preferred to use a non-parametric approach to setting BRPs. Recruitment estimates for SSB greater than 5,000 t (breakpoint), including the hindcast values, were considered representative of productivity at higher stock levels. The B_{MSY} proxy (46,000 t) was chosen as the median of stochastic projected (AGEPRO) SSB values after fishing for 50 years at $F_{40\%MSP}$ of 0.25. The associated MSY is 10,000 t.

The BRPs depend on the hindcast recruitment estimates to provide insight into productivity at higher stock levels than are observed during the time-series of the VPA. It was suggested that inverse variance weighting could be used in the estimation of mean recruitment based on hindcasting. More fundamentally and as time permits, the Panel recommends that the hindcast recruitments be projected forward to assess whether they are consistent with the recorded catches. It would not be possible to fully validate the hindcast estimates, but catch should at least indicate the minimum recruitment levels required to support them. Further, the Panel recommends that the relationship of hindcasted recruitment with SSB be explored to check whether the non-parametric approach to estimating BRPs has fully represented the potential for increased productivity at higher stock levels.

The biological basis for the Major Change model is not yet understood. The Panel commented that caution is required in treating converged VPA estimates as an absolute criterion of reality – removal of retrospective pattern does not guarantee that the assessment results are more correct. However, the Major Change model provides the soundest available foundation on which to base management advice. The BRPs for this stock are not dependent on the presence or absence of retrospective pattern, since the estimated stock-recruitment relationship is very similar between the Major Change and the base VPA. Nevertheless, further long-term research is advisable into the basis for retrospective pattern and its removal.

Southern New England –Mid Atlantic (SNE/MA) Yellowtail Flounder

Current BRPs for this stock are based upon a VPA using 1973 – 2002 data. New BRPs for this stock are also based on a VPA. This differs from the previous assessment principally in the change of plus-group definition from age 7+ to age 6+ and in minor changes in the catch-at-age data. Data for 1973 - 2006 were included in the assessment, and recruitment estimates were hindcast back to 1963 based on the relationship between VPA estimates and NEFSC Fall survey indices at age one.

The parametric stock-recruitment relationship based on the VPA results is very uncertain and highly influential on the BRP estimates. BRPs were thus based upon a non-parametric approach using VPA recruitment estimates for SSB greater than 5,000 t (breakpoint). The B_{MSY} proxy (27,600 t) was chosen as the median of the stochastic projected (AGEPRO) SSB values after fishing for 50 years at $F_{40\%MSP}$ (0.26). Hindcast estimates were not included in the recruitment sample for projection. They extended well above the range of 'observed' recruitments and may not be representative of current stock productivity. The associated MSY is 6,300 t.

The Southern New England – Mid-Atlantic yellowtail flounder stock is at the southern end of the range for the species, where it may be more subject to environmental changes affecting productivity and other biological characteristics. Given the sustained low level of recruitment experienced by the stock since the early 1990s, it may not be possible to rebuild to the predicted B_{MSY} level under current conditions.

Cape Cod – Gulf of Maine (CC/GOM) Yellowtail Flounder

The Cape Cod – Gulf of Maine yellowtail flounder stock is the smallest of the three GARM stocks of this species. Current BRPs are based upon a VPA using 1985 – 2002 data. New BRPs for this stock are also based on a VPA. This differs from the previous assessment principally in the change of plus-group definition from age 5+ to age 6+, in minor changes in the catch-at-age data and in the addition of two new survey series from the Maine-New Hampshire inshore survey. Data for 1985 - 2006 were included in the assessment, and recruitment estimates were hindcast back to 1977 based on the relationship between VPA estimates and NEFSC Fall survey indices at age one. This approach was consistent with that used for Georges Bank yellowtail. Sampling limitations (related to inshore strata) prevented extending the hindcasting series back to 1963.

As with the other yellowtail stocks, the parametric stock-recruitment relationship based on the VPA results is very uncertain and highly influential on the BRP estimates. Parametric estimates of F_{MSY} based on a Beverton-Holt stock – recruitment relationship are very high. The Panel preferred $F_{40\%MSP}$ as a proxy for F_{MSY}. The revised BRPs are based on a non-parametric approach, using the full time series of recruitment estimates, including the hindcasted values. Reduced recruitment at low SSB were not evident from a stock-recruitment relationship, and the hindcasted recruitments were all within the range of values estimated by the VPA. The B_{MSY} proxy (8,310 t) was chosen as the median of the stochastic projected (AGEPRO) SSB values after fishing for 50 years at $F_{40\%MSP}$ (0.24). The associated MSY is 1,820 t.

Unlike Georges Bank yellowtail flounder, the hindcast recruitment estimates were within the range of 'observed' values and hence did not provide a perspective on stock productivity at SSB levels higher than those estimated for the VPA time period. In this sense, the hindcast estimates were less informative for derivation of BRPs. Nevertheless, as recommended for the Georges Bank stock, it would be worthwhile to assess as time permits, whether the hindcast recruitments are consistent with the recorded catches.

Georges Bank – Gulf of Maine (GB/GOM) American Plaice

The last assessment for the plaice stock was undertaken in 2005 on the 1980 – 2004 dataset. Due to data availability issues, this analysis could not be updated in time for this review. In lieu of this, an updated F_{MSY} proxy ($F_{40\%MSP}$) of 0.18 was derived using partial recruitment estimates from the 2005 VPA and weights at age from NMFS spring surveys averaged over

2003-2007. Since 2002, there have been increases in fishery mesh sizes which are likely to change the partial recruitment and thus the BRPs.

Recruitment from the full time series of the VPA was used along with the F_{MSY} proxy in a stochastic projection (AGEPRO) to provide an updated B_{MSY} proxy of 20,828 t and an MSY of 4,317 t.

These BRPs should be considered provisional as the assessment and thus BRPs will be updated at the August GARM III review.

Witch Flounder

The current BRPs for the witch flounder stock were derived from the results of a VPA for 1982 – 2002 using a non-parametric approach for the stock – recruitment relationship. The BRPs derived at this review were also based upon a VPA using the 1982 – 2006 dataset and modified to address a retrospective pattern as noted at the GARM III ‘ models’ review. The latter could not comment on the nature of the retrospective pattern other than point out that it could be due to potential sources indicated elsewhere in its report (NEFSC, 2008). The NEFSC undertook explorations of the source of the retrospective but could not identify a specific cause. It was noted that a number of management measures came into effect in the mid-1990s that could be implicated. Notwithstanding this, as has been done for a number of other GARM III stocks, the survey time series was split for the VPA calibration which appeared to largely address the retrospective pattern, caused by an as yet unknown process. This is a discussion for the August GARM III review as the modification is influential on the determination of stock status and the rebuilding schedule, but not the derivation of BRPs.

The non-parametric approach to determination of BRPs was continued at this review due to the observed negative relationship between recruitment and spawning stock biomass.

Thus the B_{MSY} proxy of 10,863 t for this stock was derived using a F_{MSY} proxy of F 40% MSP (0.22) and the recruitment from the full VPA time series (1982-2006) in a stochastic projection (AGEPRO). The resulting MSY is 2,195 t.

Georges Bank (GB) Winter Flounder

Current BRPs for the Georges Bank winter flounder stock are based upon a surplus production model (ASPIC) using 1963 – 2000 data. The GARM III ‘models’ review noted that this stock is a candidate for an age-structured analysis and consequently a VPA for 1982 – 2006 was undertaken for this meeting. It exhibited well-behaved retrospective and residual patterns and was considered a suitable basis for the derivation of BRPs.

When examining the Beverton and Holt stock-recruitment relationship using data from the VPA, it was noted that the fit was highly dependent upon the assumed level of asymptotic recruitment (R_0). The Panel considered that the data were not informative of the form of the relationship between recruitment and spawning stock biomass and chose a non-parametric approach as the basis for the BRPs.

The F_{MSY} proxy ($F_{40\%MSP}$) of 0.25 was derived using the partial recruitment and weights at age from the most recent five years of the VPA. As observed in other GARM III stocks, observed weights at age have declined recently which will impact the partial recruitment. Using a non-parametric approach, recruitment estimates from the full time series of the VPA were used in a stochastic projection (AGEPRO) to provide a B_{MSY} proxy of 15,500 t and an MSY of 3400 t.

Gulf of Maine (GOM) Winter Flounder

The Gulf of Maine winter flounder stock is the smallest of the three GARM stocks of this species. Current BRPs for this stock are based upon a VPA using 1982 – 2002 data. The revised BRPs presented here are based on a VPA with survey series split between 1993 and 1994. Splitting the survey series served to diminish the severe retrospective pattern seen in an unsplit VPA, although some bias remains in the recruitment estimates (less so in the most recent years). The VPA was applied to re-estimated catch-at-age data for 1982-2006.

A non-parametric approach was adopted for deriving revised BRPs. The B_{MSY} proxy (3557 t) was chosen as the median of stochastic projected (AGEPRO) SSB values after 50 years of fishing at $F_{40\%MSP}$ (0.27). Recruitment from the full time-series of estimates from VPA was used in the projections. The associated MSY is 854 t.

There is considerable uncertainty associated with this assessment and the resulting BRP estimates. Conflicting trends between relatively stable recruitment indices and declining catches and the failure to track year-classes in the catch and survey age compositions lead to a lack of confidence in the results. In particular, the appropriate level for the biomass reference point is doubtful because of uncertainty about the level of average recruitment. The VPA indicated a steeper decline in recruitment than indicated by alternative models (i.e. SCALE), although there was broad congruence between the different assessments in the upper limits of recruitment. Based on the VPA and SCALE models, it is possible to state that B_{MSY} should be at least 3,000 t, but it is unclear how much larger than this would be appropriate. The assessment difficulties were not resolved by attempting SCALE assessments which incorporated differences in growth and natural mortality between males and females. The Panel recommends further exploration of the SCALE assessment approach as time permits.

Notwithstanding the problems encountered, the updated VPA was considered to be the best available basis for developing BRPs. An important outcome is that the new assessment indicates a stock that is less resilient to exploitation than appeared from the previous assessment.

Southern New England – Mid Atlantic (SNE/MA) Winter Flounder

The current BRPs for this stock are based upon a 1982 – 1998 VPA which provided recruitment and spawning stock biomass for an externally estimated Beverton and Holt stock – recruitment relationship. The GARM III 'models' review, while noting that an age-structured model was appropriate as a basis for determination of stock status and derivation of BRPs, could not assess the overall utility of which modeling approach to use and encouraged model explorations to address the severe retrospective pattern that has been observed.

The VPA formulation presented at this meeting used a split survey time series (pre and post 1994), which appears to have reduced the retrospective problem. It is emphasized that while this modification to the VPA addresses the retrospective pattern, the underlying causes are still unknown. This split VPA was thus accepted as the basis of BRP calculations.

After examination of the stock – recruitment relationship using data from the VPA, the Panel determined that a non-parametric approach should be used to estimate BRPs. Thus, the F_{MSY} proxy of 0.26 was determined using 40% MSP considerations, with B_{MSY} (37608 t) then derived using a stochastic projection (AGEPRO) with recruitment estimates of all year- classes produced at spawning stock biomasses of 6000t (breakpoint) or greater. This sub-set of the recruitments was chosen to reflect the higher productivity apparent at larger stock sizes observed earlier in the time series. The break point identified as that which minimized the residual variance after taking mean values either side of the break point (the "razor" analysis). The associated MSY with these BRPs is 9658 t.

It is notable that the recruitment time series for this stock shows similarities with other flatfish stocks in the area, for example in relation to the period of high recruitment in the early 1980s. While recent productivity appears to have been much lower, it should not be overlooked that the stock is apparently being subjected to fully recruited fishing mortalities between 0.8 and 1.

Redfish

Current BRPs for the redfish stock are based upon a statistical catch at age model specifically developed for this resource ('RED'). The review of GARM III assessment models (NEFSC, 2008) supported use of an age-structured approach to modeling, particularly given the strong evidence for infrequent large pulses of recruitment which persist in the stock over decadal time periods.

The model adopted for the estimation of BRPs for the redfish stock was based on a new age-structured approach (ASAP), using a longer time series of landings data (1913 - 2006), and revised weights and maturities at age. In relation to the former, weights at age now are considerably larger than estimated previously.

Panel discussion focused on the choice of natural mortality (M) and the selection of recruitments to be used to determine B_{MSY}. With regard to the former, there were some concerns that the assumed M of 0.05 was low compared to estimates used for other redfish stocks. This value should be corroborated with supporting data if possible for the August 2008 review. With regards to recruitment, the model was apparently able to explain the high catches early in the time series; however the estimates prior to 1969 were largely determined by the Beverton and Holt stock – recruitment relationship assumed in the model. For the stochastic projections, the Panel chose to use recruitment estimates from the model for 1969 onwards (period for which age composition data of landings and / or survey data are available) in a non-parametric determination of BRPs.

This stock exhibits low productivity, which is reflected in the F_{MSY} (0.04 based on the F producing 50% of unfished SPR as opposed to the 40% used on other GARM III stocks). The B_{MSY} from the stochastic projections (AGEPRO) is 239,309 t while the associated MSY is 8951 t.

Georges Bank – Gulf of Maine (GB/GOM) White Hake

Current BRPs for this stock were derived upon an index-based analysis (AIM) of catch and survey data from 1964 – 2000.

Stock reconstructions using ASAP were conducted using both a short (1963 - 2005) and a long (1893 - 2005) catch time series. Tight priors were placed on the survey catchability (q) parameter to resolve issues with a historical retrospective pattern; however this created unreasonable patterns in the survey residuals. Suggestions for developing the model further for future assessments include: initialize the population (ie. 1893) assuming fishing mortality has been constant, and explore sensitivity to the assumed value; fix recruitment residuals for cohorts which are not represented in the age-composition data at zero (but, bias-corrected) unless doing a Bayesian analysis; no prior on the survey q, unless doing a Bayesian analysis; fit the catch data exactly (either a high weighting on catch fits or explicit solution of the catch equations); and examine uncertainty in the catch due to red / white hake misidentification through sensitivity analysis. Development of the long-term statistical catch age analysis is encouraged; resulting estimates of R_0 (virgin recruitment) should allow estimation of parametric stock-recruitment relationships. These explorations should be undertaken as time permits.

Notwithstanding concerns with the *q* prior, survey residual patterns, and the use of a pooled age-length key for estimating 2001-2006 age compositions, the short time-series ASAP analysis was considered appropriate for calculating BRPs. Certainly, the use of an analytical assessment model for estimating BRPs is considered an important step forward for this stock. A relatively strong and systematic retrospective pattern, particularly in SSB estimates, should have minimal impact on BRP estimates although it could result in appreciable bias in stock projections. A model formulation assuming different pre- and post-1994 survey catchabilities should be investigated for the August GARM review in relation to resolving the retrospective pattern.

The revised BRPs are based on a non-parametric approach using $F_{40\%MSP}$ with recruitment estimates from a statistical catch-age analysis (ASAP) of 1963-2005 catch, survey, and age-composition data. All recruitment estimates produced by SSB greater than or equal to 10,000 t (breakpoint) were included in the BRP calculations. The F_{MSY} and B_{MSY} proxies were 0.21 and 56,500 t respectively with an associated MSY of 7,000 t.

Georges Bank – Gulf of Maine (GB/GOM) Pollock

The current BRPs for Pollock are based upon an index-based (AIM) analysis of the 1963 – 2000 dataset. NESFC (2008) considered that this 'relative trend' class of models is likely informative given the strong relationship between the relative fishing mortality and replacement yield for this resource and thus could be the basis of the 2008 assessment and revised BRPs. Thus, new BRPs for the stock are based on an updated AIM analysis. The main change from the previous analysis is the inclusion of recreational landings in the catch time-series. NEFSC fall survey data for 1963-2007 were included in the analysis.

The F_{MSY} proxy (5.76 catch / fall survey index) was derived as the Relative F corresponding to a Replacement Ratio of 1, estimated from the Replacement R - Relative F relationship. The B_{MSY} proxy (2.0 kg / tow in the fall survey) was selected by visual interpretation of the survey time-series in comparison with relative F estimates. This resulted in a decreased value compared with the current proxy in order to resolve a mis-match between the landings data and the relative F estimates. During the 1980s and early 1990s, landings close to the old MSY were associated with relative F values in excess of the F_{MSY} proxy. This mis-match was resolved by adjustment of the B_{MSY} proxy downward to ensure that landings below the new (lower) MSY (11, 516 t estimated as product of F_{MSY} and B_{MSY} proxies) coincided with Relative F estimates below the F_{MSY} proxy.

One inconsistency in the survey data remains. Biomass indices have generally increased since the early 1990s but this coincides with a period when fish older than age 8 were generally absent from the survey catches. This raises questions about the availability to the survey gear of this highly mobile species. Concerns were also raised about the high Replacement Ratios at low relative F values implied by the Relative F – Replacement Ratio model for deriving the F_{MSY} proxy. Suggestions were made for alternative model formulations (e.g. log-linear with priors on *a* or logistic). However, AIM is used to deduce when Relative F is too high, not for establishing B_{MSY}, and *a* and *b* can be viewed as nuisance parameters in this context. As time permits, if the alternative formulations can be fit, the parameter estimates might be useful for validating the chosen value of B_{MSY} and put the biomass reference points in the same context from which the F index reference points were derived.

Georges Bank – Gulf of Maine (GB/GOM) Windowpane Flounder

The current BRPs for this stock are based upon an index-based (AIM) analysis conducted in 2005 (NEFSC, 2005). The GARM III 'models' review (NEFSC, 2008) considered that this approach would be adequate for assessment and BRP derivation. An age-based assessment for this stock is not possible as there is no age composition data available from either the research surveys or fishery samples.

Commercial landings data are available for 1975 – 2006. Catches ranged between about 3700 and 2000 t during 1985 – 1991 but since 1994, catch has been primarily bycatch in other targeted fisheries. Since 2000, most of the catch has been comprised of discards, these being about 10 - 20 times the landings.

The 2005 AIM analysis was updated with the most recent survey information. Biomass indices from the 1975 – 2006 NMFS fall survey were used due to the lack of significant relationships between Relative F and Replacement Ratios for the other surveys considered. The Relative F (catch / fall survey biomass index) increased during 1977 – 1991, then declined through 2002 but then increased during 2002 – 2006. Replacement Ratios were near to or greater than 1.0 during 1995 – 2001 then declined to below one thereafter. A marginally significant Relative F – Replacement Ratio relationship indicated that the stock can replace itself at a Relative F of 0.62 which was thus chosen as the F_{MSY} proxy.

To determine the biomass BRPs, the trends in catch and fall survey biomass indices were examined during the period when the discards were most precisely estimated (1989 – 2006). The stock appeared to be able to sustain a median catch of 700t during 1995 – 2001 as Replacement Ratios were near or above 1.0 during this period and thus this was chosen as the MSY proxy. Division of the MSY proxy by the F_{MSY} proxy of 0.62 provided a B_{MSY} proxy of 1.14 kg / tow in the NMFS fall survey.

It is important to note that whereas the current BRPs were stated in terms of landings, the updated BRPs are stated in terms of landings plus discards.

Southern New England – Mid Atlantic (SNE/MA) Windowpane Flounder

The current BRPs for this stock are based upon a surplus production model (ASPIC). The GARM III 'models' review (NEFSC, 2008) considered that there were benefits to using a common approach for both windowpane stocks and that an index – based method (AIM) would be adequate for assessment and BRP derivation. An age-based assessment for this stock is not possible as there is no age composition data available from either the research surveys or fishery samples.

Commercial landings data are available for 1975 – 2006. Catches have been primarily discards, which were highest during 1982 – 1991, ranging between 3600 – 5400 t annually, and then declining to a time series low in 2001 before gradually increasing thereafter. In recent years, discards have been about 7 – 8 times the landings.

The AIM analysis used biomass indices from the 1975 – 2006 NMFS fall survey. Survey indices from previous assessments were computed based upon data from only the offshore sampling strata. As the inshore strata comprise a substantial portion of the total windowpane habitat, these were included in the current analysis.

The Relative F (catch / fall survey biomass index) increased during 1980 – 1990, then declined through 2001 with a slight increase thereafter. Replacement Ratios were near to or greater than 1.0 during 1995 – 2001 then rapidly declined and have been below 1.0 since 2004. Replacement Ratios suggest that the stock was able to replace itself during 1980 – 82 but has not been able to replace itself for extended periods since then. A significant Relative F – Replacement Ratio relationship indicated that the stock can replace itself at a Relative F of 1.53 which was thus chosen as the F_{MSY} proxy.

To determine the biomass BRPs, the trends in catch and fall survey biomass indices were examined during the period when the discards were most precisely estimated (1989 – 2006). The stock appeared to be able to sustain a median catch of 500t during 1995 – 2001 as Replacement Ratios were near or above 1.0 during this period and thus this was chosen as the MSY proxy. Division of the MSY proxy by the F_{MSY} proxy provided a B_{MSY} proxy of 0.33 kg / tow in the NMFS fall survey.

It is important to note that whereas the current BRPs were stated in terms of landings, the updated BRPs are stated in terms of landings plus discards. Also, the previous BRPs were estimated using fall survey data from only the offshore sampling strata. The updated BRPs are more reflective of the stock as they are based upon an analysis using survey indices from the entire habitat of windowpane flounder.

Ocean pout

Existing BPRs, based on the AIM method, were updated using a new catch time series that now includes discard estimates.

An AIM analysis was conducted using 1968-2006 catch and survey data, however the relationship between Relative F and Replacement Ratio was not significant thereby invalidating the assumptions underlying the use of AIM for calculating BRPs. The lack of a significant relationship between Relative F and Replacement Ratio is largely attributed to the four most recent Relative F estimates, which are among the lowest in the time series, yet the trend in the survey abundance index (used for the Replacement Ratio) continues downward. For this reason the AIM analysis was not updated, however previous BRPs were adjusted to account for discards as well as the landings estimates.

The Ocean pout fishery is essentially a discard fishery and catches are at historical low levels. The survey abundance index declined dramatically in 2004 and is currently at a historical low level. This suggests that Ocean pout may be in a depensatory state where the stock cannot rebuild to BRPs even in the absence of removals.

Thus the revised F_{MSY} and B_{MSY} proxies are 0.76 (catch / survey index) and 4.94 kg / tow respectively while the MSY is 3754 t.

Atlantic Halibut

As was pointed out at the GARM III 'models' review, the tagging data for this stock showed a relatively high proportion of recoveries from Canadian waters, suggesting that the stock boundaries should be reviewed and that this might be better treated as a trans-boundary issue.

The current BRPs for this stock are based upon an index-based approach. NEFSC (2008) suggested attempting a one parameter depletion analysis for the determination of stock status and revision of the BRPs. A replacement yield model (which is a form of surplus production model) was developed and reviewed at this meeting and while it had issues to be resolved (e.g. how high catches are dealt with early in the time series and with the estimation of catches during 1800-1900), it was considered informative for BRP determination.

A yield per recruit analysis using updated biological information was used to estimate $F0.1 = 0.04$ as a proxy for F_{MSY}. B_{MSY} (70,000 t) was then derived using the replacement yield model assuming $r = 2 * F_{MSY}$ (as implied by the Schaefer production model) and $M = 0.06$. The associated MSY is 2800 t. The Panel considered that the estimate of natural mortality (0.06), while consistent with the maximum age observed in the data, is low compared to other halibut stocks (e.g. typically in the order of 0.14 – 0.15), and should be reviewed in time for the August 2008 review in the light of information from Pacific Halibut and Atlantic Halibut stocks in, for instance, West Greenland and Canadian Atlantic waters. Consideration of the estimate of natural mortality and revisions to the replacement yield model will have implications for the BPRs which will need to be considered at the August GARM III review.

ToR 5. Appropriate models for forecasting and for evaluating rebuilding scenarios

Other than comment in working paper 4.2 on the need to consider using different recruitment scenarios for short and long-term projections, no analyses were tabled that explicitly addressed ToR 5. There was also some limited discussion about the need to consider different weights at age and fishery selectivity to be used in short term versus medium to longer term projections. The Panel suggests that in developing rebuilding scenarios, careful consideration be given to consistent use of the stream of recruitments used in those scenarios with those used in this review to derive the BRPs. There is limited experience with potential difficulties that may be encountered when imputing a 'sharp breakpoint' between two recruitment stanzas rather than a 'smooth' transition of recruitment from low biomass to higher biomass, and warrants some caution when interpreting rebuilding projections.

CONCLUDING REMARKS

The meeting required an extensive suite of working papers prepared by scientists at the NEFSC and substantial and in-depth discussions at the meeting itself. This was a very substantial workload for the Center, which the Panel acknowledges being of very high quality. The Panel would also like to acknowledge the valuable contributions at the meeting made by all participants, particularly that of Doug Butterworth, who attended on behalf of the fishing industry. Finally, the Panel would like to again thank Andrea Strout of the NEFSC who assisted the chair in preparing this report. All these contributions made it possible for the GARM III ‘BRPs’ review to generally meet its terms of reference.

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APPENDICES

Appendix 1. Terms of Reference

1. For relevant stocks, determine the influence of retrospective patterns in parameter estimates (e.g., fishing mortality, biomass, and/or recruitment) from assessment models on the computation of BRPs and on specification of initial conditions for forecasting.

2. Trends in Stock Productivity:

   a.) For relevant stocks, identify trends in biological parameters (i.e., life history and/or recruitment) and assess their importance for the computation of BRPs and for specification of rebuilding scenarios;

   b.) If possible, summarize trends in pertinent environmental variables that might be related to the trends in those biological parameters relevant to BRPs.

3. Ecosystem approaches to Gulf of Maine/Georges Bank fisheries:

   a.) Determine the production potential of the fishery based on food chain processes and estimate the aggregate yield from the ecosystem;

   b.) Comment on aggregate single stock yield projections in relation to overall ecosystem production, identifying potential inconsistencies between the two approaches.

4. Biological Reference Points (B_{target}, $B_{threshold}$, F_{target}, $F_{threshold}$):

   a.) For each stock, list what the current BRPs and/or BRP Proxies are (e.g., B_{MSY}, B_{MAX}, F_{MSY}, $F_{40\%MSP}$, historical survey catch per tow, etc.), and give their values (i.e., typically from GARM II);

   b.) For each stock, update or redefine BRPs or BRP proxies that will be used for stock status determination, and compute their expected values and precision. Note: These BRPs and their proxies must be comparable and consistent with outputs from the recommended assessment models from the GARM III "Modeling" Meeting.

5. For each stock, identify appropriate models for forecasting and for evaluating rebuilding scenarios.

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Appendix 3. Agenda

Date /Day	***Start***	***End***	***Duration (min)***	***Topic***	***Presenter***
28-Apr	9:00	9:10	10	Introduction	
1	9:10	9:30	20	Overview of GARM and objectives of this meeting	Chair
				TOR #4 Biological Reference Points: a. Current values and proxies	
1	9:30	9:45	15	*Working Paper 4.1* Overview of current BRPs methods and estimates	Rago
1	9:45	10:00	15	Discussion	
1	10:00	10:30	30	*Working Paper 4.2* Setting SSBmsy via Stochastic Simulation Ensures Consistency with Rebuilding Projections. Chris Legault	Legault
1	10:30	10:45	15	Break	
1	10:45	11:00	15	Discussion	
				TOR #2: Trends in Stock Productivity	
1	11:00	11:45	45	WP 2.1 Trends in Average length, weight and maturity at age for relevant stocks and trends in environmental variables.	*O'Brien*
1	11:45	12:00	15	Discussion	
1	12:00	12:15	15	WP 2.2 Implications of biological trends for estimation of biological reference points and rebuilding schedules.	*Rago et al*
1	12:15	12:30	15	Discussion	
1	12:30	13:30	60	Lunch	

Date /Day	***Start***	***End***	***Duration (min)***	***Topic***	***Presenter***
				TOR #3 Ecosystem Approaches to Gulf of Maine/Georges Bank Fisheries	
1	13:30	13:50	20	*WP 3.1* US Northeast Shelf LME Biomass, target biological reference points for fish and worldwide cross-system comparisons. Overholtz, Link, Fogarty, Col, Legault.	Overholtz
1	13:50	14:00	10	Discussion	
1	14:00	14:20	20	WP 3.2 Energy Budget contextualization of fish biomasses at B_MSY	Link
1	14:20	14:30	10	Discussion	

1	14:30	14:50	20	WP 3.3 Estimates of aggregate surplus production for the GARM and other stock groups for the US Northeast Shelf LME. Overholtz, Fogarty, Link, Legault, Col.	Overholtz
1	14:50	15:00	10	Discussion	
1	15:00	15:15	15	Break	
1	15:15	15:35	20	WP 3.4 An Aggregate and MS Production Model: A Simulator Tool	Link
1	15:35	15:45	10	Discussion	
1	15:45	16:10	25	WP 3.5 Fishery Production Potential	Fogarty
1	16:10	17:00	50	Discussion—WP 3.6 Synthesis: Implications for single species reference points	Link/Fogart y
				TOR #4 Biological Reference Points:	
1	17:00	17:15	15	WP 4.3. Sensitivity of the Long-term Observation-error Survey Series (LOSS) model to variable stock-recruit steepness and stock depletion inputs: A test case using Gulf of Maine haddock (Palmer and Legault).	Palmer/Leg ault
1	17:15	17:25	10	Discussion	
1	17:25	17:40	15	Supplementary Paper WP 4.7 Size-specific tag recovery rates of cod and implications for estimation of fishing mortality in analytical models. Miller and Hart	Miller/Hart
1	17:40	17:50	10	Discussion	
1	17:50	18:00	10	Summary/Followup (Chair)	

Date /Day	***Start***	***End***	***Duration (min)***	***Topic***	***Presenter***
29-Apr	***9:00***	9:15	15	Progress review and Order of the Day (Chair)	Chair
				TOR #1 Influence of retrospective patterns on parameter estimates and specification of initial conditions for forecasting.	
2	9:15	9:35	20	*WP 1.1* Specifying Initial Conditions for Forecasting When Retrospective Pattern is Present.	Legault/ Terceiro
2	9:35	9:50	15	Discussion	
2	9:50	10:10	20	*WP 1.2.* A simulation study to evaluate estimation of biological reference points from VPA and ASAP.	Brooks/ Legault/ Seaver

2	10:10	10:25	15	Discussion	
2	10:25	10:40	15	Break	
				TOR #4 Biological Reference Points: b. Update by stock	
2	10:40	11:25	45	WP 4.A Georges Bank Cod	O'Brien
2	11:25	11:55	30	Discussion	
2	11:55	12:55	60	Lunch	
2	12:55	13:40	45	WP 4.F Gulf of Maine Cod	Mayo
2	13:40	14:05	25	Discussion	
2	14:05	14:30	25	WP 4.F.1 Gulf of Maine Cod	Butterworth
	14:30	14:40	10	Discussion	
2	14:40	15:30	50	WP4.B. Georges Bank Haddock	Brooks
2	15:30	15:55	25	Discussion	
2	15:55	16:10	15	Break	
2	16:10	17:05	55	WPs 4.C. Georges Bank + 4.D. Southern New England + 4.E Cape Cod-Gulf of Maine yellowtail flounder	Legault
2	17:05	17:50	45	Discussion	
2	17:50	18:00	10	Summary/Followup	Chair
Date /Day	***Start***	***End***	***Duration (min)***	***Topic***	***Presenter***
30-Apr	***9:00***	9:15	15	Progress review and Order of the Day (Chair)	Chair
3	9:15	10:00	45	WP 4.N. Gulf of Maine/ Georges Bank Acadian Redfish	Miller
3	10:00	10:15	15	Discussion	
3	10:15	11:00	45	4.K. Georges Bank winter flounder	Hendrickson
3	11:00	11:15	15	Break	
3	11:15	11:30	15	Discussion	
3	11:30	12:30	60	*WP* 4.I. Gulf of Maine Winter Flounder	Nitschke
3	12:30	12:45	15	Discussion	
3	12:45	13:45	60	Lunch	
3	13:45	14:30	45	WP 4.J. Southern New England Winter flounder	Terceiro
3	14:30	14:45	15	Discussion	
3	14:45	15:30	45	*WP* 4.G. Witch Flounder	Wigley
3	15:30	15:45	15	Discussion	
3	15:45	16:00	15	Break	
3	16:00	16:45	45	4.H. Gulf of Maine/Georges Bank American Plaice	O'Brien
3	16:45	17:00	15	Discussion	
3	17:00	17:30	30	*WP* 4.M. Georges Bank/Gulf of Maine Pollock	Mayo

3	17:30	17:45	15	Discussion	
3	17:45	18:00	15	Summary/Followup	Chair
	19:30	22:30		Social/Dinner --British Beer Company, Falmouth Heights	
Date /Day	***Start***	***End***	***Duration (min)***	***Topic***	***Presenter***
1-May	***9:00***	9:15	15	Progress review and Order of the Day	Chair
4	9:15	10:05	50	*WP* 4.L. White Hake	Sosebee
4	10:05	10:20	15	Discussion	
4	10:20	10:35	15	Break	
	10:35	10:55	20	WP.4.L.1 White Hake alt	Butterworth
	10:55	11:05	10	Discussion	
4	11:05	12:00	55	*WP* 4.R. Gulf of Maine Haddock	Palmer
4	12:00	12:15	15	Discussion	
4	12:15	13:15	60	Lunch	
4	13:15	13:35	20	*WP* 4.O. Ocean pout	Wigley
4	13:35	13:45	10	Discussion	
4	13:45	14:05	20	WP 4.P. Gulf of Maine/Georges Bank Windowpane Flounder	Hendrickson
4	14:05	14:15	10	Discussion	
4	14:15	14:35	20	*WP* 4.Q. Southern New England – Mid-Atlantic Windowpane	Hendrickson
4	14:35	14:45	10	Discussion	
4	14:45	15:05	20	*WP* 4.S. Atlantic Halibut	Col
4	15:05	15:15	10	Discussion	
4	15:15	15:30	15	Break	
4	15:30	17:50	140	Review/Revisions/Follow-up	TBD
4	17:50	18:00	10	Summary/Followup (Chair)	Chair
2-May	***9:00***	9:30	30	Progress review and Order of the Day	Chair
5	9:30	10:30	60	Review of Outstanding Issues as necessary	TBD
5	10:30	10:45	15	Break	
5	10:45	12:00	75	Report Development [CLOSED]	
5	12:00	13:00	60	Lunch	
5	13:00	16:00	180	Report Development, Summary and Assignments [CLOSED]	
5	16:00	16:00	0	Adjourn	

Appendix 4. Statement of Work of CIE Reviewers

General

The Groundfish Assessment Review Meeting (GARM) brings together stock assessment experts to peer review work on the status of 19 important fish stocks that are managed by the New England Fishery Management Council. GARM-III takes place in 2007-2008, and it will consist of four meetings that are cumulative in nature (i.e., successive meetings incorporate methods and results that were accepted at previous GARM-III meetings). Each meeting will have a chair as well as external panelists. A brief description and dates of the four GARM-III meetings are given below:

4. "Data Methods" Meeting (October 29 – November 2, 2007)
Review the commercial and survey data that will be used in the stock assessments. Identify appropriate statistical methods for analyzing those data (including bycatch and discard issues, changes in growth rates and other life history traits, issues related to merging databases, etc.). Other sources of data to be considered are tagging programs for cod and yellowtail flounder, and Industry-Based Surveys. Candidate sources of data relevant to ecological and ecosystem considerations will also be described.

5. "Modeling" Meeting (February 25 – 29, 2008)
Determine the most appropriate stock assessment methods and models for each of the 19 stocks. Perform runs of those models to obtain results (historical and current estimates of F and B) based on commercial and survey data, probably through calendar year (CY) 2006. The runs of the models will be used to evaluate diagnostics of model fit and appropriateness, including retrospective analyses.

6. "Biological Reference Point (BRP)" Meeting (April 28 – May 2, 2008)
Update or redefine BRPs for each of the 19 stocks. Use data available through CY2006. Consider whether the BRPs are reasonable in light of results from the "Modeling" Meeting. Define the appropriate initial conditions for forecasting and rebuilding strategies, particularly with respect to trends in biological attributes, recruitment and survival rates. Comment on relevant ecosystem considerations as they relate to rebuilding strategies.

4. GARM-III "Final" Meeting (August 4 - 8, 2008)
Use all of the methods proposed from the previous three meetings, along with survey and catch information through CY2007, to estimate historical and current fishing mortality rates and biomass for each stock. Based on procedures from the BRP Meeting, finalize the BRPs, appropriate initial conditions, and biological assumptions related to forecasts. Determine the status of each stock.

This SOW applies specifically to the GARM-III "Biological Reference Point (BRP)" Meeting, which will take place at the Woods Hole Laboratory of the Northeast Fisheries Science Center (NEFSC) in Woods Hole, Massachusetts, from April 28 – May 2, 2008. The meeting will have a chairman (non-CIE) as well as external panelists, three of whom will be from the Center of Independent Experts (CIE).

Overview of CIE Peer Review Process

The Office of Science and Technology implements measures to strengthen the National Marine Fisheries Service's (NMFS) Science Quality Assurance Program (SQAP) to ensure the best available high quality science for fisheries management. For this reason, the NMFS Office of Science and Technology coordinates and manages a contract for obtaining external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of stock assessments and various scientific research projects. The primary objective of the CIE peer review is to provide an impartial review, evaluation, and recommendations in accordance to the Statement of Work (SoW), including the Terms of Reference (ToR) herein, to ensure the best available science is utilized for the National Marine Fisheries Service management decisions.

The NMFS Office of Science and Technology serves as the liaison with the NMFS Project Contact to establish the SoW which includes the expertise requirements, ToR, statement of tasks for the CIE reviewers, and description of deliverable milestones with dates. The CIE, comprised of a Coordination Team and Steering Committee, reviews the SoW to ensure it meets the CIE standards and selects the most qualified CIE reviewers according to the expertise requirements in the SoW. The CIE selection process also requires that CIE reviewers can conduct an impartial and unbiased peer review without the influence from government managers, the fishing industry, or any other interest group resulting in conflict of interest concerns. Each CIE reviewer is required by the CIE selection process to complete a Lack of Conflict of Interest Statement ensuring no advocacy or funding concerns exist that may adversely affect the perception of impartiality of the CIE peer review. The CIE reviewers conduct the peer review, often participating as a member in a panel review or as a desk review, in accordance with the ToR producing a CIE independent peer review report as a deliverable. The Office of Science and Technology serves as the COTR for the CIE contract with the responsibilities to review and approve the deliverables for compliance with the SoW and ToR. When the deliverables are approved by the COTR, the Office of Science and Technology has the responsibility for the distribution of the CIE reports to the Project Contact.

Requirements for CIE Reviewers

Three CIE reviewers are requested to conduct an impartial and independent peer review in accordance with the Terms of Reference (ToR) herein. Each CIE reviewer's duties shall not exceed a maximum of 14 days conducting pre-review preparations with document review, participation on the GARM panel review meeting, editorial assistance to the GARM Chair, and completion of the CIE independent peer review report in accordance with the ToR and Schedule of Milestones and Deliverables. CIE reviewers shall have working knowledge and recent experience in the application of modern fishery stock assessment models. Reviewers should have experience in development of biological reference points that includes an appreciation for the varying quality and quantity of data available to support estimation for individual fish species living within the ecosystem. Expertise should include statistical catch-at-age, traditional VPA approaches, and index-based methods. Desirable background includes life-history theory, risk analyses, stock-forecasting methodology, and ecosystem fisheries ecology. Some experience with groundfish (such as cod, haddock, flounder) population dynamics would be useful.

Specific Activities and Responsibilities

The CIE's deliverables shall be provided according to the schedule of milestones listed on page 6. The GARM Chair will use contributions from the CIE panelists as well as from other external panelists, to produce the GARM Panel Summary Report. In addition, each CIE panelist will write an individual independent report. These reports will provide peer-review information for a presentation to be made by NOAA Fisheries at meetings of the New England and Mid-Atlantic Fishery Management Councils in 2008. The GARM Panel Summary Report shall be an accurate and fair representation of the GARM panel viewpoint on the quality and soundness of the science, methods and results with regard to each Term of Reference (see Annex 1). The report shall also contain recommendations for improvement that might be implemented in a future GARM meeting.

Charge to GARM panel

The panel is to determine and write down its viewpoint on the quality and soundness of the science, methods and results with regard to each Term of Reference (see Annex 1). Criteria to consider include whether: (1) the data are adequate and were used properly; (2) the analyses and models were appropriate and correctly accomplished; and (3) the conclusions are correct/reasonable. Where possible, the chair shall identify or facilitate agreement among the panelists regarding each Term of Reference.

During the course of the review, the panel is allowed limited flexibility to deviate from the results and recommendations of earlier GARM-III meetings. This flexibility may include only minor alterations in procedures previously established at the peer review of the "Data Methods" Meeting in October 2007 and the "Modeling" Meeting in February 2008. Large scale changes, such as changing a stock definition would not be possible in view of the difficulties of implementing these changes in time available before the final GARM meeting in August 2008.

Furthermore, if the panel rejects certain assessment models or Biological Reference Points (BRP), the panel should explain why they are not suitable, and the panel should recommend suitable alternatives. If such alternatives cannot be identified, then the panel should indicate that the existing (status quo) models and/or BRPs are the best available at this time.

Roles and responsibilities

(1) Prior to the meeting

(GARM Chair and CIE panelists)

Review the reports produced by the Working Groups, and read background reports.

(2) During the Open meeting

(GARM Chair)

Act as chairperson, where duties include control of the meeting, coordination, facilitation of the presentations and discussions, and ensuring that all Terms of Reference of the GARM are reviewed and completely addressed.

During the question and answer periods, provide appropriate feedback to the assessment scientists on the sufficiency of the analyses and when possible, suggest improved approaches. It is permissible to discuss the working papers, and to request additional information to clarify or revise existing analyses, if that information can be produced rather quickly.

(CIE panelists)

Participate in panel discussions on the quality and soundness of the science, methods and results with regard to each Term of Reference (see Annex 1).

During the question and answer periods, provide appropriate feedback to the assessment scientists on the sufficiency of the analyses. It is permissible to request additional information if it is needed to clarify or revise existing analyses, if that information can be produced rather quickly.

(3) After the Open meeting

(GARM Chair, CIE and non-CIE panelists)

The GARM Chair will lead preparing, editing, and completing the GARM Panel Summary Report, based on contributions from the panelists (CIE and non-CIE). This report (see Annex 3 for information on contents) is to comment on the quality and soundness of the science, methods, and results with regard to each Term of Reference. If any modeling approaches and/or BRPs are considered inappropriate, the GARM Panel Summary Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing modeling approaches and/or BRPs are the best available at this time.

The panelists and the chair will discuss whether their views on each Term of Reference can be summarized into a consensus conclusion. In cases where multiple, differing views exist on a given Term of Reference, the GARM Panel Summary Report will note that there was no consensus and will summarize the various opinions and the reason(s) for these.

(GARM Chair)

The Chair's role during GARM Panel Summary Report development will be to facilitate rather than to force consensus from the panel.

The GARM Chair shall prepare the introduction to the GARM Panel Summary Report, summarizing the background of the work to be conducted as part of the review process, and whether the process was adequate to successfully address the Terms of Reference.

As appropriate, the chair will include suggestions (in an Appendix) on how to improve the process.

The GARM chair will finalize all editorial and formatting changes of the draft GARM Panel Summary Report prior to its final approval by all panelists. The GARM chair will then submit the approved GARM Panel Summary Report to the NEFSC contact (i.e., SAW Chair).

(GARM CIE panelists)
Each CIE panelist shall prepare a CIE independent peer review report (see Annex 2). This report should comment on the quality and soundness of the science, methods, and results with regard to each Term of Reference.

If any modeling approaches and/or BRPs are considered inappropriate, the CIE independent peer review report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing modeling approaches and/or BRPs are the best available at this time.

During the meeting, questions which are not in the Terms of Reference but are directly related to the meeting may have been raised. Questions not explicitly referenced in the TOR but relevant to its intent can be documented and addressed.

Schedule of Milestones and Deliverables

The milestones and schedule are summarized in the table below. No later than May 16, 2008, the CIE panelists should submit their CIE independent peer review reports to the CIE for review[4]. The CIE reports shall be sent to "University of Miami Independent System for Peer Review," and sent to Dr. David Sampson, via e-mail to David.Sampson@oregonstate.edu and to Mr. Manoj Shivlani via e-mail to mshivlani@ntvifederal.com

Milestone	**Date**
Open workshop at Northeast Fisheries Science Center (NEFSC) (report writing begins as soon as open Workshop ends)	April 28 – May 2, 2008
GARM Chair and CIE panelists work at the NEFSC drafting reports. Report writing starts during the meeting. Panelists leave meeting with at least the summary bullets.	May 1 - 2
Draft of GARM Panel Summary Report, reviewed by all panelists, due to the GARM Chair **	May 16
CIE panelists submit CIE independent peer review reports to CIE for approval	May 16
GARM Chair sends Final GARM Panel Summary Report, approved by CIE panelists, to NEFSC contact (i.e., SAW Chairman)	May 23

[4] All reports will undergo an internal CIE review before they are considered final.

CIE provides reviewed CIE independent peer review reports to NMFS COTR for approval	May 30
COTR notifies CIE of approval of CIE independent peer review reports	June 6 *
COTR provides final CIE independent peer review reports to NEFSC contact	June 6

* Assuming no revisions are required of the reports.
** The GARM Panel Summary Report will not be submitted, reviewed, or approved by the CIE.

The SAW Chairman will assist the GARM chairman prior to, during, and after the meeting in ensuring that documents are distributed in a timely fashion. NEFSC staff and the SAW Chairman will make the final GARM Panel Summary Report and CIE independent peer review reports available to the public. Staff and the SAW Chairman will also be responsible for production and dissemination of the collective Working Group papers.

Acceptance of Deliverables

Upon review and acceptance of the CIE reports by the CIE Coordination and Steering Committees, CIE shall send via e-mail the CIE reports to the COTRs (William Michaels William.Michaels@noaa.gov and Stephen K. Brown Stephen.K.Brown@noaa.gov) at the NMFS Office of Science and Technology by the date in the Schedule of Milestones and Deliverables. The COTRs will review the CIE reports to ensure compliance with the SoW and ToR herein, and have the responsibility of approval and acceptance of the deliverables. Upon notification of acceptance, CIE shall send via e-mail the final CIE report in *.PDF format to the COTRs. The COTRs at the Office of Science and Technology have the responsibility for the distribution of the final CIE reports to the Project Contacts.

Key Personnel

Contracting Officer's Technical Representative (COTR):

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Request for Changes

Requests for changes shall be submitted to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the Contractor within 10 working days after receipt of all required information of the decision on substitutions. The contract will be modified to reflect any approved changes. The Terms of Reference (ToR) and list of pre-review documents herein may be updated without contract modification as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToR are not adversely impacted.

ANNEX 1: Draft Terms of Reference for the GARM-III "Biological Reference Point (BRP)" Meeting *(Last Revised: 1/11/08; A final draft will be distributed to the Panel prior to the meeting.)*

1. For relevant stocks, determine the influence of retrospective patterns in parameter estimates (e.g., fishing mortality, biomass, and/or recruitment) from assessment models on the computation of BRPs and on specification of initial conditions for forecasting.

2. Trends in Stock Productivity:
   a.) For relevant stocks, identify trends in biological parameters (i.e., life history and/or recruitment) and assess their importance for the computation of BRPs and for specification of rebuilding scenarios;

   b.) If possible, summarize trends in pertinent environmental variables that might be related to the trends in those biological parameters relevant to BRPs.

3. Ecosystem approaches to Gulf of Maine/Georges Bank fisheries:
   a.) Determine the production potential of the fishery based on food chain processes and estimate the aggregate yield from the ecosystem;

   b.) Comment on aggregate single stock yield projections in relation to overall ecosystem production, identifying potential inconsistencies between the two approaches.

4. Biological Reference Points (B_{target}, $B_{threshold}$, F_{target}, $F_{threshold}$):
   a.) For each stock, list what the <u>current</u> BRPs and/or BRP Proxies are (e.g., B_{MSY}, B_{MAX}, F_{MSY}, $F_{40\%MSP}$, historical survey catch per tow, etc.), and give their values (i.e., typically from GARM II);

   b.) For each stock, update or redefine BRPs or BRP proxies that will be used for stock status determination, and compute their expected values and precision. Note: These BRPs and their proxies must be comparable and consistent with outputs from the recommended assessment models from the GARM III "Modeling" Meeting.

5. For each stock, identify appropriate models for forecasting and for evaluating rebuilding scenarios.

ANNEX 2: Contents of GARM-III CIE independent peer review report

1. The Independent CIE Report should comment on the quality and soundness of the science, methods and results with regard to each Term of Reference. CIE panelists should consider whether the work provides a scientifically credible basis for developing fishery management advice. Scientific criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable.

2. If any modeling approaches and/or BRPs are considered inappropriate, the Independent CIE Report should include recommendations and justification for suitable alternatives. If such

alternatives cannot be identified, then the report should indicate that the existing modeling approaches and/or BRPs are the best available at this time.

3. Any independent analyses conducted by the CIE panelists as part of their responsibilities under this agreement should be incorporated into their Independent CIE Reports. It would also be helpful if the details of those analyses (e.g., computer programs, spreadsheets etc.) were made available to the respective assessment scientists.

4. Additional questions that were not in the Terms of Reference but that are directly related to the meeting can be addressed. This section need only be included if additional questions were raised during the GARM meeting.

ANNEX 3: Contents of GARM-III Panel Summary Report

1. The first section the report shall consist of an introduction prepared by the GARM chair that will include the background, a review of activities and comments on the appropriateness of the process in reaching the goals of the GARM. The next section will contain comments on the quality and soundness of the science, methods and results with regard to each Term of Reference. The GARM Panel should consider whether the work provides a scientifically credible basis for developing fishery management advice. Scientific criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable.

If the CIE panelists, the non-CIE panelists and GARM chair do not reach an agreement on a Term of Reference, the report should explain why. It is permissible to express majority as well as minority opinions.

2. If any modeling approaches and/or BRPs are considered inappropriate, the GARM Panel Summary Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing modeling approaches and/or BRPs are the best available at this time.

3. The report shall also include: a.) the bibliography of all materials provided during the meeting and any papers cited in the GARM Panel Summary Report; and separate appendices with b.) a copy of the CIE Statement of Work; c.) the assessment with the Terms of Reference used for the GARM BRP Meeting, including any changes to the Terms of Reference or specific topics/issues directly related to the assessments and requiring Panel advice; d.) a list of participants; e.) the meeting agenda, f.) a list of working papers; and g.) Presentation Highlights and Meeting Discussion Summary for each working paper. The Highlights and Discussion Summary are to be written by the assessment scientists and rapporteurs, respectively, with editing and oversight by the GARM Chairman.

Appendix 5. List of Working Papers

1.1 Legault C, Terceiro M. Specifying Initial Conditions for Forecasting When Retrospective Pattern is Present.

1.2 Legault C, Seaver A, Brooks L. A Simulation Study to Evaluate Estimation of Biological Reference Points from VPA and ASAP.

2.1 O'Brien L. Trends in Average Length, Weight and Maturity at Age for Relevant Stocks.

2.2 Rago et al. Implications of Biological Trends for Estimation of Biological Reference Points and Rebuilding Schedules.

3.1 Overholtz W, Link J, Fogarty M, Col L, Legault C. US Northeast Shelf LME Biomass, Target Biological Reference Points for Fish and Worldwide Cross-System Comparisons.

3.2 Link J, Overholtz W, Legault C, Col L, Fogarty M. Energy Budget Contextualization of Fish Biomasses at B_MSY

3.3 Overholtz W, Fogarty M, Link J, Legault, Col L. Estimates of Aggregate Surplus Production for the GARM and Other Stock Groups for the US Northeast Shelf LME.

3.4 Link J, Gamble R, Overholtz W, Legault C, Col L, Fogarty M. An Aggregate and MS Production Model: A Simulator Tool

3.5 . Fogarty M, Overholtz WJ, Link J. Fishery Production Potential of the Northeast Continental Shelf of the United States.

3.6 Link et al. Synthesis of Ecosystem Considerations.

4.1 Rago et al. Overview of Current BRPs Methods and Estimates.

4.2 Legault C. Setting SSBmsy via Stochastic Simulation Ensures Consistency with Rebuilding Projections.

4.3 Palmer M, Legault C. Sensitivity of the Long-term Observation-error Survey Series (LOSS) Model to Variable Stock-Recruit Steepness and Stock Depletion Inputs: A Test Case using Gulf of Maine haddock

4.4. Palmer M. (Supplementary Paper): A Method to Apportion Landings with Unknown Area, Month and Unspecified Market Categories Among Landings with Similar Region and Fleet Characteristics

4.5. Palmer M, Wigley S, O'Brien L, Mayo R, Rago P. (Supplementary Paper): A Description of Discard Estimation Methods Where Observer Coverage is Unavailable

4.6 Legault C, Palmer M, Wigley S (Supplementary Paper): Uncertainty in Landings Allocation Algorithm at Stock Level is Insignificant.

4.7 Miller T, Hart D. (Supplementary Paper): Analysis of Tagging Data for Evidence of Decreased Fishing Mortality for Large Gulf of Maine Cod.

4.8 Butterworth D, Rademeyer R. (Supplementary Paper): Implications of Tagging Analyses for the Shape of Selectivity at Age of GoM cod.

4.8a Butterworth D. (Supplementary Paper). Further Runs of ASPM/SCAA for GoM cod

4.A. Georges Bank Cod . O'Brien L.
4.B. Georges Bank Haddock. Brooks L.
4.C Georges Bank yellowtail flounder. Legault C
4.D Southern New England-Mid Atlantic yellowtail flounder. Legault C, Cadrin S.
4.E Cape Cod-Gulf of Maine yellowtail flounder. Legault C, Cadrin S, King J, Sherman S.
4.F. Gulf of Maine Cod. Mayo R
4.F.1 Gulf of Maine Cod, Butterworth D
4.F.1a Gulf of Maine Cod Addendum, Butterworth D, Rademeyer R
4.G. Witch Flounder. Wigley S
4.H. Gulf of Maine/Georges Bank American Plaice. O'Brien L
4.I. Gulf of Maine Winter Flounder. Nitschke P
4.J. Southern New England Winter flounder. Terceiro M
4.K. Georges Bank winter flounder. Hendrickson L
4.L. White Hake. Sosebee K
4.L.1 White Hake, Butterworth D
4.M. Georges Bank/Gulf of Maine Pollock. Mayo R
4.N. Gulf of Maine/ Georges Bank Acadian Redfish. Miller T
4.O. Ocean pout . Wigley S
4.P. Gulf of Maine/Georges Bank Windowpane Flounder. Hendrickson L
4.Q. Southern New England – Mid-Atlantic Windowpane Flounder . Hendrickson L
4.R. Gulf of Maine Haddock. Palmer M
4.S. Atlantic Halibut. Col L

WP 5.1. Rago P, Brodziak R. (Supplementary Paper): Overview of age-based projection model (AgePro) for reference point estimation and scenario analyses.

Appendix 6. Presentation Highlights and Discussion

This appendix includes the presentation highlights provided by the senior author of each working paper along the rapporteur's notes of the ensuing discussion. In regard to the latter, the emphasis was to capture the main points made. There was only modest editing of these during preparation of this report. Notwithstanding this, the text gives a sense of the main topics discussed, areas of agreement, and areas of future work. While these were referred to by the Panel, statements in this Appendix should not be considered the final conclusions of the Panel, which are stated in the body of this report.

ToR 1. Influence of Retrospective Patterns

Working Paper 1.1: Legault, C. and M. Terceiro. Specifying Initial Conditions for Forecasting when Retrospective Pattern Present

Rapporteur: Tim Miller

Presentation Highlights

There is currently no generally agreed methodological approach to adjusting projections to account for retrospective patterns in the stock assessment. This paper presents three alternative approaches and compares the resulting time series of spawning stock biomass, landings, and fishing mortality rate based on a summer flounder-like stock assessment. The three adjustments for retrospective patterns all reduce landings in the quota setting year, but the magnitude of the reduction is quite variable and the implications for future years in the projections are quite different. Adjusting the fishing mortality rate in the quota setting year is not recommended in the context of rebuilding programs because the future catches are greater than the unadjusted projections. Adjusting all ages in the starting population creates the largest decrease in projected catch, but typically cannot be justified based on the patterns observed at age. Making adjustments to the starting population based on the age specific retrospective patterns produces the most consistent approach, although the overall impact is relatively minor. A number of technical questions remain regarding exactly how to compute the retrospective adjustments at age. Management strategy evaluation work is required in the future to determine if any adjustment method performs better than the others.

Discussion

The chair and the presenter agreed that the methodology is not yet ready for the formal assessment process. A reviewer noted that perhaps retrospective patterns could be obtained when model misspecification is consistent over time, but it was not the case in the scenarios explored here. The presenter suggested that age-specific adjustments to initial population numbers at age is the best approach for dealing with retrospective patterns when they exist, but it may not always help and the question of what magnitude of a retrospective pattern warrants adjustment still remains. There was a proposal to assess the aggregate biomass for retrospective patterns and if one was suspected, look at age-specific patterns. Determining a default adjustment procedure was proposed as an important first step in using the methodology for formal stock assessment. In the near term, while the best adjustment procedure is still being determined, the chair thought (and others agreed) that it important to caution the Council that the results of any adjustment procedure are not robust and use the results with that in mind. Further work that will help determine best adjustment methodology includes simulation. However, it will be important to constrain the set of scenarios for simulation to include the only the most problematic GARM stocks.

Working Paper 1.2: Liz Brooks, C. Legault, A. Seaver. A simulation study to evaluate estimation of BRPs from VPA & ASAP

Rapporteur: Tim Miller

Presentation Highlights

A simulation study was performed to evaluate two NOAA Fisheries Toolbox assessment models (VPA and ASAP) with respect to their ability to estimate biological reference points (BRPs) and the parameters of a stock recruit function. Data sets with different lengths of time, three different levels of recruitment variability (0%, 20%, and 80% CV), and two levels of steepness (h=0.60, 0.88) were simulated with PopSim, a simulation program in the Toolbox. Each simulated dataset was fit in the VPA and in ASAP. The estimated time series of spawning biomass and recruits from each model were passed to SRFIT, another Toolbox program, to estimate the stock recruit function and the corresponding BRPs. These externally estimated reference point values were compared to the true values to determine bias and precision. In addition, the internally estimated BRPs from ASAP were compared to the true values.

Between externally estimated BRPs from VPA and ASAP runs on the same data sets, the bias in estimates of the stock-recruit parameters was similar, but slightly less for ASAP, which carried through to less bias in the BRPs. Comparing internally versus externally estimated stock-recruit parameters for ASAP, the external estimates of R_0 were generally less precise, but slightly less biased for CV=0% and CV=20%. However, the bias in external estimates was quite severe when CV=80%. This may relate to misspecification in the default level of recruitment variability assumed in ASAP and SRFit; it would require further detailed tuning to evaluate the impact of that model setting. When the ASAP model was applied to data from three different time periods with different amounts of data in each period, we found that the model performance was improved by extending the series as far back as there were indices (1963), but extending back to 1935 when only total catch was available produced no gain and oftentimes exacerbated the bias. For the VPA model runs using catch at age data that started in 1977 or in 1995, the shorter time series (only 12 years of data) did a very poor job of estimating unexploited levels of recruitment. This could be due to the length of the time series, or to the limited amount of contrast in stock size (the depletion level in SSB was pretty flat over that time period, ranging from 6% to 16%). Although there is not time to fully evaluate these hypotheses, based on the cases explored in this simulation, we conclude that short time series from an overfished stock are likely to produce informative time series of SSB and recruitment from which to estimate BRPs.

In all comparisons, the pattern of bias and precision in steepness carried through to the bias and precision of F_{MSY} while unexploited recruitment (R_0) largely determined the bias and precision in MSY and SSB_{MSY}.

Discussion

The inability to better estimate reference points with longer time series in some cases was unexpected by several people. The chair raised a concern that there was a stock-recruit curve assumed for the simulations, but that VPA does not assume one. Some simulations where a “random” stock-recruit relationship is assumed would provide interesting results. However, the expected fact that short time series did not provide reliable estimation of reference points was thought to be an important result of this study and the chair thought that, in these cases, incorporating other information from related stocks in a statistically rigorous way would be a good option.

ToR 2. Trends in Stock Productivity

Working Paper 2.1 Part II. O’ Loretta O’Brien, Michele Traver, Jessica Blaylock, Betty Holmes, Jiashen Tang, Liz Brooks, Laurel Col, Mike Fogarty, Kevin Friedland, Larry Jacobson, Joe Kane, Jason Link, and Paul Rago. Trends in Average Length and Weight, and Proportion Mature at Age for Relevant Stocks and Trends in Environmental Variables

Rapporteur: Jessica Blaylock

Presentation Highlights

This paper presents the results of several approaches aimed at detecting trends in length, weight, and maturity for twenty groundfish stocks.

Z-score analyses combined with a Loess smooth fit of the NEFSC Survey stratified mean lengths and mean weights at age indicate that six stocks show no particular trend in either mean length or mean weight in more recent years, while two stocks show an increasing trend, and the remaining twelve stocks show a decline in length and mean weight at age in recent years. Female maturity ogives estimated with data smoothed with 3- or 5-year moving average show no trend for 8 stocks, an increasing trend for 11 stocks, and decreasing trends for 2 stocks.

Quintile Plots (Visual Report) show three different patterns across the stocks: 1) faster growth during periods of low density and slower growth during periods of high density, suggesting density dependence in some stocks such as GB Haddock; 2) reverse non-density dependent growth, as in GB Cod; and 3) a mix of patterns 1 & 2, as in GB Yellowtail. A reordering of these plots showed that juveniles and adults are trending together, and that mean weight seems to be declining more in Gadids than in Flatfish in recent years.

Analysis of environmental data, such as the Northwest Atlantic Oscillation (NAO), sea surface temperature, and primary productivity, shows an earlier period of low anomalies, low temperatures and low productivity, followed by a more recent trend to positive anomalies, higher temperatures, and high productivity.

Finally, copepod and zooplankton abundance data exhibit a distinct pattern of negative anomalies prior to 1989, and generally positive values in the following years. Food habits data showed no strong trends.

Discussion

Panelists questioned the implications of these trends for the determination and use of Biological Reference Points (BRPs). This brought the use of a three to five year average for mean weights for BRP determination back into question. This issue had been widely discussed during the GARM III ‘Data Inputs’ review, but the results of WP 2.1 might influence the decision to use a short-term versus a long-term approach concerning BRPs. In other words, should one incorporate recent trends in long-term projections using a three to five year average or use the time series average instead? There was also some concern about potentially incorporating trends for which the exact cause is unknown. This discussion is continued in the review of Working Paper 2.2.

It was observed that most trends seem to be year effects rather than cohort effects. This is expected since these trends are assumed to be linked to environmental patterns affecting all ages, so we would not expect to see cohort effects.

In response to the suggestion to look at other sources of data in addition to the survey data, the presenter reminded the Panel that it was the observation of decreased catch weights that was the initial reason for undertaking this analysis. Survey data was therefore analyzed to determine if the trends also occurred at the population level.

Finally, there was some concern about the significance of changes in the parameters, given that no error bars were presented. There is some question about whether conclusion on trends would be different if we had error bars, and whether recent values are truly significantly different than previous ones. The presenter asserted that the time-series trend was shown to be significant for ten of the stocks in a previous analysis using randomization tests, and that the calculation of confidence intervals cannot be easily incorporated into computations at this time.

Working Paper 2.2: Rago et al. Implications of biological trends for estimation of biological reference points and rebuilding schedules

Rapporteur: Jessica Blaylock

Presentation Highlights

This paper evaluates the potential effects changes in life history parameters can have on Biological Reference Point (BRP) estimation and rebuilding strategies. Determination of size at age, maturity and survival has a direct influence on fisheries management since these measures reflect stock productivity and are used to determine BRPs, which are the basis for defining rebuilding plans. Changes in life history parameters have been observed for numerous stocks in the region (Working Paper 2.1), but the exact cause of these changes is not always clear. Mis-estimation of these parameters can have serious consequences, as illustrated by the Pacific Halibut and GB Haddock stocks.

It is thus critical to estimate correct values for life history parameters, both for long-term goals such as efficient management and successful rebuilding, but also in relation to the more immediate decisions that have to be made concerning BRP estimation.

Discussion

Much of the discussion reconsidered the decision to use the 5-year moving average for weight, length and maturity in relation to Biological Reference Point (BRP) estimation. When this decision was made at the GARM III ‘Data Inputs’ review, it was agreed that this approach would be suitable for most stocks. In the current meeting, Working Paper 2.1 showed trends in life history that differed across stocks, suggesting a different approach to each stock might be preferable. Despite this, and because it is not clear how sensitive the BRPs are to the observed trends, the Panel cautioned that the 5-year average approach should still be used unless analysts have compelling reasons not to do so. Consensus was reached to use the 5-year moving window approach as a default for BRP estimation, while staying open to specific case-by-case deviations from this method. This is especially valid because some stocks do not seem to be recovering (i.e. Cod), and many of the stocks are on the southern edge of their distribution, where they are expected to be most influenced by changes such as climactic and environmental variations. Whatever the final decision is concerning BRP estimation, the chosen approach will have to be clearly explained to management bodies.

These conclusions led to questions about implications for forecasting as mentioned in Term of Reference 1, especially relative to 'specification of initial conditions'. While using a 5-year period average seemed acceptable for SSB, there was agreement that TACs would need a different forecasting approach that would take any trend into account.

A few other topics also required brief clarification: 1) density dependence is currently not built into any of the forecasting tools, and 2) the number of years to be used for recruitment is determined on a case-by-case basis.

ToR 3. Ecosystem Approaches to Gulf of Maine / Georges Bank Fisheries

Working Paper 3.1: W.J. Overholtz, J.S. Link, M. Fogarty, L. Col, and C. Legault. US Northeast Shelf LME Total Fish Biomass, Target Biological Reference Points for Fish and Worldwide Cross System Comparisons.

Rapporteur: Tony Chute

Presentation Highlights

The total target biomass for the US Northeast Shelf ecosystem is 6.1 million mt, 67% demersal species and 33% pelagic species. The GARM stocks, commercial pelagic fishes, and elasmobranchs have similar B_{MSY} biomass targets at 5.78, 5.24, and 4.69 t/km2, respectively. The LME biomass targets for pelagic and demersal fishes are similar in scale to biomass estimates from previous studies of the region. The total B_{MSY} target biomasses for the Northeast LME for demersal and pelagic fish resources are similar to the current Northeast LME biomass and similar to the average biomass of many other temperate marine systems. The target biomass for the Northeast LME is below the average for the nine other temperate marine systems (24.485 versus 32.763 t/km2). The target biomass for the demersal component is moderately higher than the average for the demersal group from nine other systems, while the target pelagic biomass is well below the average for pelagic fish from these systems.

Conclusions

On an ecosystem basis, current biomass management targets (Bmsys) for GARM, pelagic, and elasmobranch fishes are reasonable. The current targets compare favorably with the results of current and historical studies in the region and are also in general agreement with results of many studies for other worldwide ecosystems.

Discussion

The carrying capacity of the system is supposedly only 70% of the summed B_{MSY} of all the species (GARM spp, pelagics, elasmobranchs). A 2-tier system where the individual MSYs as well as the carrying capacity of the system should be adopted. The fish don't need to just feed each other; their populations need to be able to withstand human removals. We will look at the whole Northeast shelf ecosystem and the MSYs of managed species based on single species models, an energy budget, and surplus production models.

One of the presenters noted that they looked at the current biomass and target BRPs for individual fish species from the Northeast shelf ecosystem, summed them up and converted to biomass per unit area for comparison with other systems around the world. They collected all the B_{MSY} and current biomass information available for the 19 GARM species, pelagics and some elasmobranchs. Species which had a kg/tow proxy for a BRP used that information and swept area biomass to calculate current biomass and a B_{MSY}. The ratio of current biomass to B_{MSY} was then calculated. Biomass of squid, sand lance, mesopelagics, anadromous fish etc was also added. It was estimated using ECOPATH that 12 tons per km2 of demersals were currently in the system, and the target biomass is 16 tons. For pelagics, the current biomass is 11.4 tons and the target biomass is 8.4. When compared to other LMEs, the biomass per unit area fell within reasonable bounds.

It was acknowledged that the entire shelf ecosystem was used for analysis when some fish species inhabited only part of it. Sub-areas were considered too small for comparison with other ecosystems. Migration out of the system was accounted for. The ratio of pelagics to demersals was similar to that found in other systems. When biomass and kg/tow of some species were known, they were used to estimate a catchability value which was useful for the species that only had kg/tow information. The Northeast shelf system was not obviously similar to any of the other systems used for comparison.

Working Paper 3.2: J.S. Link, W.J. Overholtz, C. Legault, L. Col, M.J. Fogarty. Energy budget contextualization for fish biomasses at Bmsy.

Rapporteur: Tony Chute

Presentation Highlights (from slides presented to meeting)

Model Structure

- EMAX for four NEUS regions combined into one total
- Areal weighted for B, P/B and C/B
- Common diet with all nodes (group of species) from SNE
- Summed for fisheries and bycatch
- Used mass-balance equations
    - C = P + R + E

Model applications

- Current biomass combined for all four NEUS regions
- Then balanced: used as baseline
- Main objective was to ascertain effects of having fish nodes at Bmsy

Model scenarios

- BMSY for eight fish groups
- All pelagics B doubled from BMSY values
- All pelagics B halved from BMSY values
- All demersals B halved from BMSY values
- Rebalanced each scenario
    - Compared difference from input & difference from current baseline
    - Locked P/B, C/B ratios
    - Changes demersals: perturbed & rebalanced
    - Compared rebalanced scenarios to current baseline

Results

- Bmsy: had to up small pelagics & down demersals to make model work
- Double pelagics
- Half pelagics
- Half demersals
- Flow to detritus tracked
- Cybernetic metrics summarized

Summary

- Overall, results inconclusive given multiple caveats of network model
- Recall, just equilibrium rebalancing; doesn't account for responses in F
- Fish components of the system could be increased relative to current biomass levels
- Overall, scenarios had minimal change relative to balanced baseline
- Unclear if BMSY for all species is energy limited from a systemic perspective
- However, rebalancing relative to input levels suggests may not be able to have all fish spp at BMSY due to flow constraints
- All scenarios were balanced largely predicated upon a higher small pelagic-comm biomass and a lower demersal-omniv. and pisc. Biomass

Discussion

The presenters used the EMAX model to make an energy budget for the Northeast shelf ecosystem. The system was four sub-regions, and nodes within each sub-region. For the diet portion of the model, the Southern New England diet web was used, because it contained the most nodes. The model is an equilibrium model and accounted for fish entering and leaving nodes, and used biomass, consumption per unit biomass and production per unit biomass. Model runs were started with target biomass of each species in the nodes, then the model ran with double the pelagics, half the pelagics, and half the demersals (perturbing the system). C/B and P/B were fixed but diets could change. Results were shown as percentage or number increase or decrease in various species groups. At target biomasses, the model reduced demersal benthivores and increased small pelagics; at double the pelagics, the model increases the demersals, but halve the pelagics and the model wants to increase them and reduce the demersals, and if the demersals are halved, the pelagics increase by a large amount. The different scenarios delivered similar results with the exception of the double pelagics. A large proportion of pelagics increases the "flow to detritus" in the model. No fishing mortality was included in the model. It was not clear whether the system itself put any constraints in the Bmsys.

"Pedigrees" were given to each node depending on the confidence level they inspired before the model was run, and some parameters were more flexible, like diets and species composition. Life history parameters can be added into the model, such as larger fish becoming more prevalent as species recover. Small pelagics were always increased in each run of the model, but they are currently over Bmsy. They may have an impact on the recovery of the GARM species and that point needs to be raised.

Working Paper 3.3: W.J. Overholtz, M. Fogarty, J.S. Link, C. Legault, and L. Col. Estimates of aggregate surplus production for the GARM and other stocks groups for the US Northeast Shelf LME.

Rapporteur: Tony Chute

Presentation Highlights

Overall, the results from both surplus production modeling approaches suggest that the expected aggregate yield is lower, the Bmsy biomass is lower and the overall fishing mortality rate should be lower for the GARM III stocks as a whole than is suggested from the single species results. The expected yield for the pelagic complex is similar or slightly higher, the Bmsy biomass is higher, and the overall fishing mortality rate is lower than suggested from the single species target results. This suggests the need for an overall 2nd layer of consideration for the GARM III stocks as a whole, and managing the pelagic stocks at a higher level of biomass than suggested by the single species results.

Discussion

Aggregate (summed) surplus production was estimated for all stock groups using the ASPIC model which uses landings and survey indices as input data. Methods like this have also been used in the Gulf of Alaska and the Bering Sea ecosystems. Each group, GARM spp, pelagics and elasmobranchs, had its own parameters developed initially by using sensitivity analysis. Sometimes survey data was lacking, but again those species with a kg/tow proxy were given a q based on swept area biomass. Final ASPIC results indicated a fairly low aggregate Fmsy of 0.11, and a high Bmsy for the group. It looked like a better recovery for all species with the addition of the pelagic group. The results of a 1998 study which calculated individual species MSY and Bmsy were summed and compared to the ASPIC results and were found to be different.

To attempt to take into account environmental variables, another model was used with SST, SST range, CO2 and bottom temperature as input (positive, negative or neutral). CO2 showed a significant result indicating a higher F and lower MSY, but most did not seem to affect the model appreciably. A higher Bmsy for pelagics and a lower F for all spp was shown to be best for recovery.

It might be possible to come up with a value for natural mortality (M) using this type of model. It is important to look at the residual patterns before bootstrapping. The aggregate Fmsy takes the different species in different nodes into account, sometimes it is easier to think of it as "fishing effort". The output changes when the B1/K goes from 0.5 to 0.6 in table 7, and that may be evidence of some sort of "wall" in the model. All zooplankton and phytoplankton is being eaten in the model. Some models make the plankton more dynamic. There are many analyses that can be done with this model, including adding up "known" MSYs from an age-structured models and seeing how ASPIC output compares. For the purpose of this analysis, the species needed to be summed for comparison with other studies.

Working Paper 3.4: J.S. Link, R. Gamble, W.J. Overholtz, C. Legault, L. Col, M.J. Fogarty. An Aggregate and MS Production Model: A Simulator Tool

Rapporteur: Larry Jacobson

Presentation Highlights

A logistic model was augmented to include ecosystem effects on a fish organized into three guilds (GARM species, small pelagic species and elasmobranch guilds). The model included fishing, predation, inter- and intra-guild competition. Model parameters were from single species stock assessments (e.g. Fmsy and Bmsy), food habits data and other sources. The model was used to simulate biomass dynamics of guilds and individual species under various assumptions under various levels of fishing, competition and predation. The main purpose was to examine how fishing, predation and competition affect carrying capacity and stock rebuilding plans for simulated GARM stocks individually, as guilds and in aggregate.

Long term projections for aggregate biomass showed four main patterns. First, all groups had approximately equal carrying capacity with GARM species dominating slightly in simulations with no fishing and no species interactions. Second, harvesting impacted the pelagics and elasmobranchs more than GARM species guild. Third, species interactions impacted pelagics the most (as would be expected due to predation). Finally, with no harvest or interactions, the system produced a total biomass close to system carrying capacity. As either interactions or harvest intensified, aggregate carrying capacity was reduced. With both factors occurring, carrying capacity was reduced by approximately one-half.

There were five main patterns in multispecies simulation results. First, with no harvest or interactions, most species achieved the carrying capacity levels expected based on assumed parameter estimates and carrying capacity for the entire system was high. Second when species interactions are turned on, not all species reached their expected carrying capacities and many species approached carrying capacity much more slowly than expected. Third, reductions in carrying capacity due to harvesting were smaller than reductions due to species interactions. Fourth, with harvest and species interactions, carrying capacity and stock biomass was substantially lower for all species, guilds and the ecosystem as a whole than in the absence of these factors.

Discussion

Discussants generally agreed with the overall results indicating reduction in carrying capacity due to species interactions and their potential importance. However, no procedures for adjusting actual reference points used by managers were presented.

Several members of the audience pointed out that production parameter estimates from single species assessments implicitly include “average” predation and species interaction effects during years included in the model. It was argued that model presented as parameterized had heuristic value but should not be used for management purposes as parameterized because species interaction effects were “double counted”. The authors agreed with the point but indicated that the intent was heuristic, the model was preliminary and similar overall results would be obtained using adjusted parameters.

Working Paper 3.5: Fogarty, M., W. Overholtz and J. Link. Fishery Production Potential on the Northeast Continental Shelf of the United States

Rapporteur: Larry Jacobson

Presentation Highlights

The Northeast Continental Shelf of the United States has undergone dramatic shifts in species composition of harvested fish populations over the last five decades. We have documented a steady decline in the mean trophic level of the catch since 1960 with a current dominance by low trophic level invertebrates and small pelagic fishes. At the height of the distant water fleet fishery, an estimated 35% of the primary productivity was required to account for the observed commercial landings. Currently, approximately 10% of the primary production is appropriated to account for the observed catch (landings plus discards). Under our best current estimates of primary production, mean trophic level of the catch, transfer efficiencies, consideration of total removals (landings and discard) from the system at MSY levels, it appears that important constraints on available energy must be considered in setting harvest policies at an ecosystem level. Further consideration of food requirements for threatened species and apex predators under rebuilding strategies highlights the potential constraints on available energy to meet overall ecosystem management objectives. This perspective of necessarily involves consideration of possible tradeoffs among harvesting of GARM species and other system components. Application of an ecosystem overfishing criterion based on the primary production required to account for observed catch levels and the mean trophic level of the catch, the Northeast Continental Shelf is classified as overfished at the ecosystem level. If changes in system productivity states resulting in lower growth rates for GARM and other species are confirmed, the ecological transfer efficiencies for these components will shift to lower levels and the estimated fishery production potential will be correspondingly lower, exacerbating the constraints on the system removals.

Discussion

This working paper compared preliminary estimates of total MSY for GARM species from preliminary stock assessments to updated estimates of potential production based on primary production and trophic structure assumptions. Trends in relative amounts of primary production associated with catches of various species were calculated also. Consumptive demands of fish (including GARM species), marine mammals, turtles, birds and protected species were included in calculations.

Results indicate that 7.2% of total primary production was required to support the commercial fishery during 2005. Including discard estimates and recreational catch, 9.55% of total primary production was required. In contrast, almost 35% of total primary production was required during peak years of exploitation by the distant water fleets. The estimated mean trophic level at MSY for all species represented by stock assessments during 2005 was 3.1. Based on a recently published classification system that uses percent of total primary production and mean trophic level, ecosystem overfishing occurred on the northeast shelf during 2005.

Results were sensitive to relatively uncertain assumptions about mean trophic levels. Based on one plausible estimate of mean trophic level, MSY for finfish and invertebrates is 1.29 million t or about 83% of the estimated primary production potential. If discards and incidental losses were included, then primary production required to support the fishery might be near or exceed 100% of the total available. Thus, results suggest that production potential may be a limiting factor in achieving MSY biomass levels for all fisheries simultaneously. It may be important to considering this possibility in formulating harvest policies for GARM and other northeast stocks.

Members of the audience seemed to recognize potential limits on stock biomass and fishery productivity due to limits on available primary production. After discussion, however, the Panel decided that the paper did not propose any particular immediate adjustment to harvest recommendations for GARM species during the current management cycle.

Working Paper 3.6: Link JS et al: Implications for Single Species Reference Points

Rapporteur: Larry Jacobson

Presentation Highlights

Proposed Ecosystem Terms of Reference Updates

1) Simulation studies to examine the performance of the aggregate model when applied to data generated using full age-structured models for an assemblage of species.
2) If the simulations in (a) confirm the utility of the aggregate model, we will compare our final results with results of single species production model analyses using the same estimation methods.
3) We will compare results from production models (both aggregate and single species) with the final results from GARM analyses of BRPs to determine overall applicability of the production models.
4) If we find convincing evidence that the aggregate case remains appreciably lower than the sum of the single species levels, we will examine possible ways of integrating the multispecies perspective with the individual species reference points in a simulation exercise.
5) We will update and refine the broader ecosystem analyses to provide an overall context for the GARM analyses. These will be used in a qualitative way.

Discussion

No working paper was presented under this agenda item. Instead, the previous working papers were discussed.

Several lines of evidence in WP3.5 and WP3.6 indicate that the ecosystem may not be able to support Bmsy levels for all managed stocks simultaneously, particularly if consumption by large marine mammals increases and considering discard.

ToR 4. Biological Reference Points by Stock

Working Paper 4.1. Rago, P. Overview of Current Biological Reference Point Methods and Estimates for Multispecies Groundfish in the Northeast US

Rapporteur: Elizabeth Brooks

Presentation Highlights

This report provides a summary of current Biological Reference Points (BRP) for the 19 GARM III stocks and background on their methods of estimation. The definition of BRPs is an essential component of stock assessment. Measures of abundance and harvest rates derived from assessment models are compared to standards that constitute desirable states for each stock. These states are based on the concept of maximum sustainable yield. When sufficient information is available, BRPs can be based on fishing mortality and biomass values that produce maximum sustainable yield. In other instances, the BRPs are based on a proxy value that should approximate the fishing morality rates and biomass levels associated with maximum sustainable yield. The range of approaches reflects the range of available data types and quantity, and historical exploitation patterns.

Biological reference points for the GARM III stocks can be classified into three groups: “parametric”, “nonparametric”, and “index”. Parametric BRPs are derived from specification of an explicit functional relationship between recruitment and stock size. “Internal” parametric estimates are derived as part of the model identification and estimation process (GB winter flounder (fl.), surplus production model). “External” parametric estimators of BRPs use model outputs of abundance, SSB, recruits and fishing mortality as inputs to stand alone models such as SRFIT (GB cod, GOM cod, GOM winter fl., and SNE winter fl.). If parametric models (internal or external) are not acceptable, a “nonparametric” method is used to derive proxy values for Fmsy and Bmsy (GB haddock, GB yellowtail fl., SNE yellowtail fl., CC/GOM yellowtail fl., Amer. Plaice, witch fl., and redfish). These proxies are derived by combining standard yield per recruit (YPR) and SSB per recruit (SSB/R) methods with model-based estimates of absolute recruitment. Model parameters can be used to define appropriate partial recruitment vectors for YPR analyses leading to estimates of proxy estimates of Fmsy. SSB/R estimates for proxy Fmsy values can be multiplied by some function of the recruitment time series to obtain an estimate of SSBmsy or Bmsy.

Index methods the GARM III stocks this approach is formalized as the AIM model in the NOAA Fisheries Toolbox. This empirical approach finds a reference point for relative F where the population replaces itself (Pollock, northern windowpane fl., southern windowpane fl., Ocean pout, GOM haddock, and white hake). A major limitation of the AIM model is that the relative biomass target must be externally supplied. For a number of stocks even the index methods fail to provide precise quantitative guidance. For these stocks proxy reference points were deduced by examining historical landings, relevant aspects of the fisheries, and behavior of surveys (halibut).

Discussion

Clarification was requested as to whether rebuilding requirements were separate or distinct from specifying BRPs. It was noted that care is needed in how one re-samples recruitment into the future. Clarification was also requested as to what determines the decision for when to reject the fit of a stock-recruit model. The approach was outlined in Brodziak and Legault (2005). Typically, it takes into account multiple models, looking at the degree of fit for all models, variances, etc. The rules within parametric world look at AIC, but making the jump from saying “no parametric model fits are acceptable” to move to a non-parametric approach is not well-defined. One typically looks at diagnostics such as patterns in residuals. A panelist noted that one might also want to look at the level of SSB contrast (observations between SSB_{MSY} and SSB_0. This was acknowledged by the presenter, but emphasized that one doesn’t always have (rarely has) that type of contrast.

The meaning of $B_{threshold}$ was unfamiliar to some of the panelists, who questioned what happened when a resource goes to that threshold. It was clarified that $B_{threshold}$ is the point below which management action is triggered and a rebuilding plan is established. The equivalent threshold for fishing mortality is $F_{threshold} = F_{MSY}$.

A panelist suggested that it would be good to get clarity on terminology, targets, threshold, limits, Fmax, $F_{40\%MSP}$, etc. We need to think about the different types of proxies, justification and implication of when a proxy is chosen.

Working Paper 4.2. Legault, C. Setting SSBmsy via Stochastic Simulation Ensures Consistency with Rebuilding Projections

Rapporteur: Elizabeth Brooks

Presentation Highlights

Current approaches to setting biological reference points and conducting projections contain an inconsistency. Specifically, fishing at the Fmsy rate for many generations does not produce the SSBmsy with 50% probability. This inconsistency arises whether a parametric or empirical approach is used due to the variance in projected recruitment causing the stock to be more or less productive than assumed in the deterministic calculations of the reference points. The proposed solution is to utilize the available projection software to make the SSBmsy value an emergent property of fishing at Fmsy for many generations. This approach ensures consistency between the reference points and the projections used to determine fishing levels necessary to rebuild overfished stocks to the SSBmsy level. This paper provides a demonstration of large the inconsistency can be in a typical situation and discusses a number of related issues including an extension of this approach to solve for Fmsy, the standard approach to deal with lognormal error distributions, historical significance of this inconsistency, biologic and fishery vectors used in the calculations, and Fmsy relative to its proxies.

Discussion

A panelist was concerned that you end up having a different definition for Bmsy if your rebuilding target were 50% or 75%. Bmsy should be independent of your rebuilding target. The speaker clarified that 50% would still be the Bmsy target, but management could shoot for a different rebuilding target. The speaker was not proposing that we change the 50% target; the management choice of a rebuilding percentile is an independent choice.

Regarding projecting to get the median, a panelist asked if this is a switch to use the median vs. the mean. If you are happy to go with the average F, then you can use bias correction, so it seems the difference is whether we accept median or mean. The panelists' inclination is to stick with the mean, only because you don't have to do the simulations and therefore your results would be invariant to simulation trials. It is quicker and easier. The speaker responded that the issue is that in the deterministic calculation, you can solve for the values, but the implied precision is unreal. For mean vs. median, because we are working in a probabilistic situation, and because there is talk of moving to alternative percentiles, we need a method that is consistent with that. It works in the parametric case, but not so easy for the empirical approach. The projections accept two parameters for the stock recruitment function, and you assume (fix) some level of variability about that. This approach takes into account whatever level of uncertainty is specified.

A panelist questioned the decision to not do same thing for Fmsy as is being proposed for Bmsy. The speaker responded that when we do the empirical approach, we have a different model to derive Fmsy. The panelist rejoined that it seems like you have an F that you would get for a different model. The speaker responded that the tradeoff is you have to look at variability in yield from year to year.

There was a fair amount of discussion regarding the mean versus the median for reference points. The main point of debate was that the median is a management decision, whereas the mean is an expectation or maximum likelihood result. Choosing the median is just another way of defining an SSB reference point, but it doesn't correspond to the population dynamics implied SSBmsy. The speaker responded that this is a proposed proxy. It is an easy fix to ensure that you meet your rebuilding target.

A member of the audience strongly supported the proposed projection approach. He pointed out that you have a process that has an inconsistency, and this method solves the inconsistency. A nightmare of added complexity could ensue if one were to carry this any further; what is needed is a robust proxy rather than something perfect. One shouldn't get carried away with the mass at age, and say you'll work with it over the short term horizon. It is not worth nitpicking every year. The proposed approach is viable and consistent. It was pointed out, however, that there are two things to take care of in this proposed approach. 1) the issue of what is in and what is not in when you consider recruitments (ex: for haddock, is it a mixture distribution or a single distribution; considering a single distribution you get an unbelievable distribution); 2) given the different results for fitted S-R vs. proxy, you've got to look at some measure of precision of that estimate (the proxy); you will likely see that there is a wide range that may be in a more reasonable range. The speaker responded to the first point by saying that with the exceptionally large year-classes for haddock, even if one sets the bar high by including them, you still have consistency—even if it is unrealistic.

A panelist asked if, when going through stocks later, would the expected value for SSBmsy from deterministic as well as AGEPRO estimates be presented, just so that the Panel understands the magnitude of the adjustment. The speaker replied that for some that would be the case, but probably not for all. The SRFit values probably exist for most, so it is a matter of compiling those. The panelist followed up, saying that it is important for the Panel to see the estimates so that they can understand the adjustment, and to understand what is causing the size of the adjustment; it becomes a point of whether you believe the estimate of sigma for recruitment deviations.

The Panel decided to accept the approach in principle, but to look at results on a case by case basis to see if it makes sense.

Working Paper 4.3: Michael Palmer and Chris Legault. Sensitivity of the Long-term Observation-error Survey Series (LOSS) model to variable stock-recruit steepness and stock depletion inputs: A test case using Gulf of Maine haddock

Rapporteur: Gary Shephard

Presentation Highlights

The GARM III 'models' review Panel recommended that for stocks currently using the Relative Trend class of models "alternative models should be explored that both have a stronger basis in biology and more explicitly address uncertainty". Specifically, age-structured models were recommended that incorporate life history parameters and which allowed direct estimates of biological reference points; e.g., age-structured production model. Biological reference points for the Gulf of Maine haddock stock have been determined using An Index Method (AIM) since 2002. This model is assumed to be informative given the strong relationship between the relative fishing mortality and replacement yield for this resource. Because of this strong relationship, the Gulf of Maine haddock stock is good candidate to assess the performance of age-structured production models on northeast United States groundfish stocks.

The application of a specific age-structured production model, the Long-term Observation-error Survey Series (LOSS), to the Gulf of Maine haddock stock is examined. Despite a clear minimum value of the objective function, none of the LOSS model runs are statistically different from one another with values of the objective function ranging from 21.795 to 22.517. However, there are large differences in the implications between the runs for stock status determination. Given the inability to determine a "best" model formulation and the wide ranging implications on stock status, the LOSS model is not a good candidate with which to determine biological reference points for Gulf of Maine haddock.

Discussion

The intent was to examine the use of an alternative model for Gulf of Maine haddock assessment. It was concluded that there was no clear best model based on the objective function and there were implications in the biological reference point in choosing the wrong model.

The Panel suggested the development of a model incorporating process error. In addition, a follow-up model was suggested using an informed prior such as the use of age one estimates. However, since the log-likelihood did not provide adequate contrast, incorporation of process error could have a big influence on the outcome. Use of some catch at age information would constrain the process error. The approach has worked for some species but inevitably poor data creates poor results without any information as a prior. A more extensive modeling exercise has been undertaken in the GoM haddock assessment.

Working Paper 4.7: D. Hart and T. Miller. Analyses of tagging data for evidence of decreased fishing mortality for large Gulf of Maine Cod, Gadus morhua

Rapporteur: Gary Shephard

Presentation Highlights

Two complimentary analyses of Atlantic cod tagging data from a tagging study carried out by the Gulf of Maine Research Institute were performed using the methodology we employed previously for yellowtail flounder at the previous Groundfish Assessment Review Data Meeting. The first compares expected probability of recovery by age class for tagged fish based on estimates of age-specific fishing mortality by Butterworth and Rademeyer (2008) and a standard VPA with the observed proportions of recoveries for different length classes (and approximate corresponding ages) in the Atlantic cod tagging data. The second analysis fits a finite-state continuous-time model to the Atlantic cod tagging data to estimate different fishing mortality parameters within the Gulf of Maine, Georges Bank and Canadian 4X stock areas for fish in three size classes (≤60, > 60 and ≤ 85, >85) at release. Maximum likelihood estimates of instantaneous migration, natural mortality and tag-shedding rates, tag reporting probability and a non-mixing scalar to adjust fishing mortality in the first month after release are also provided by the second analysis. Although the latter parameters are not the focus here, it is desirable to "control" for different migration between and mortality rates within regions when estimating these size-specific fishing mortality rates. Neither of the analyses we undertook showed evidence (statistical or otherwise) that larger (older) Atlantic cod are subjected to lower fishing mortality in the Gulf of Maine than smaller (younger) Atlantic cod. Ideally, we would like to consider a model for the tagging data that allows fishing mortality to change over the life history of a given fish as it grows larger and older, because fish that are small at release will experience different fishing intensities as it grows. However, the use of size at release should provide results that are a good approximation.

Discussion

Tag results from a cod tagging program in the Gulf of Maine were presented. The Panel questioned if the high reward tags were randomly assigned among all sizes. The model produced variable M by size and it was suggested a constant M model may influence the results as the higher M may confound the dome question. However in the largest size class the M was fairly uniform compared to the next smaller size category and was unlikely creating any undue influence. The high reward reporting rate remained an issue in that a higher reporting rate by size could camouflage any dome selectivity pattern. Perhaps further examination of high reward reporting rates would be helpful. Some modifications to the Miller model were suggested, such as constant M, but time constraints did not permit new runs.

Working Paper 4.8 (Supplementary Paper): Butterworth, D. Implications of Tagging Analyses for the Shape of Selectivity at Age for Gulf of Maine cod

Rapporteur: Gary Shephard

Presentation Highlights

WP 4.8 (Supplementary) discussed alternative possible interpretations of the results of the tag-recapture data for cod provided in Hart and Miller (GARM-III BRP TOR 4.7). Building on the basic framework underlying estimation from such data previously presented in Butterworth and Rademeyer (Supplement 2 to GARM-III TOR 2), it was shown that the high estimates of M in the Hart and Miller analyses could reflect either higher natural mortality than 0.2, or permanent emigration of portions of the population, given that the other interpretation of a tag-induced additional mortality rate of 0.8 for older animals seemed unrealistically large. Thus the tag-recapture results were open to interpretation as a validation of permanent emigration (which would be reflected as an apparent decline in selectivity at large ages), or of higher natural mortality. A further possibility was that there is either large immediate mortality of tagged cod, or under-reporting of high reward tags, which would lead to increased estimates of F and decreased ones of M. Specifications for a suggested further run of the Hart and Miller analysis were put forward, anticipating that the results would show whether the requisite decrease in M could be obtained without increasing F to an extent that would render it incompatible with the assessment. Suggestions were made of approaches to independently test hypotheses that would lead to domed shaped selectivity. Specifically the possibility of older stronger swimming cod being able to escape capture by trawl nets could be examined by mounting cameras on nets, and of older cod preferentially inhabiting untrawlable rocky ground by placement of longlines in such areas.

WP 4.8a presented the results of runs of the ASPM (SCAA) assessments for Gulf of Maine cod presented in WP 4.F.1 adjusted to commence in 1964 as requested during discussions, and covering values of M=0.3 as well as the conventional M=0.2 for both Ricker and Beverton-Holt stock recruitment relationships, and for both estimated and flat selectivity at large ages. Notable results were clear preferences in likelihood terms of Ricker over Beverton-Holt relationships, and of M=0.3 over M=0.2. For M=0.3 and the Ricker relationship, extension from flat to dome shaped survey selectivity was not justified in terms of AIC. Thus a change from

M=0.2 to M=0.3 would seem to provide a way forward towards satisfying the requirement for assessment models to fit proportion at age data at large ages without at the same time having to postulate decreasing selectivity at these ages. However there remained a number of aspects of these analyses that needed to be investigated further, including alternative formulations of the stock-recruitment relationship which might have implications for values estimated for the spawning stock biomass at MSY.

Discussion

The discussion turned to an alternative interpretation of the tagging model results. The suggestion was made that a permanent emigration to parts unknown would account for a dome shaped selectivity pattern in GoM cod. The chair remarked that the saturation of the area with fishing effort made it improbable that a refuge for large fish existed within the confines of the Gulf of Maine. Also a high reward reporting rate less than 100% was suggested as a factor influencing M and consequently the selectivity pattern in the Miller model. The alternative Butterworth model implied that the Miller model had likely over estimated M. It was noted that M in the Miller model is actually a combination of all factors that could result in tag not being recovered.

The issue of dome shaped selectivity was further discussed. Gear avoidance was proposed as a possible mechanism. However the mixture of gear types in the fishery would make that mechanism less likely. The survey gear could have a dome if fish were concentrated in unfishable habitat or the survey changed over time. It was pointed out that the change in age distribution over the survey time series suggested that excessive fishing mortality on large cod was a more plausible explanation. The issue of dome shaped selectivity was not resolved and participants waited the next iteration of this discussion.

Working Paper 4.A: O'Brien L. Georges Bank Cod

Rapporteur: Sue Wigley

Presentation Highlights

Georges Bank Atlantic cod is a transboundary stock that is harvested by both US and Canadian fishing fleets. The stock includes landings from statistical areas 521-522, 525-526, 561-562, 551-552, 537-539 and south. GB cod range in depth from 32 m to 226 m, occupying cool, shallow water in the spring and warmer, deep water in the autumn.

A VPA model formulation was accepted as the final assessment for GB cod (O'Brien et al., 2006) at the GARM-II meeting (NEFSC, 2005). The biological reference points (BRPs) were developed based on landings only from the 2001 assessment (O'Brien and Munroe, 2001), using a Beverton-Holt stock-recruit relationship with an assumed prior for the unfished recruitment as (NEFSC, 2002):

F_{MSY} = 0.175,
MSY = 35,200 t and
SSB_{MSY} = 217,000 t.

At the GARM III BRP meeting, a VPA formulation was accepted as a preliminary assessment model and a non-parametric YPR analysis was chosen for estimation of BRPs.

These estimates are provisional and may change after the GARM III Assessment Meeting in August 2008:

$F_{MSY} = 0.25$,
MSY = 30,220 t and
$SSB_{MSY} = 143,343$ t.

The current April 2008 VPA formulation includes landings, commercial discards, and recreational catch in the catch at age as recommended by the GARM II Panel (NEFSC, 2005) for the period 1978-2006. The NEFSC spring and autumn, and DFO spring survey abundance indices are used to calibrate the VPA. A three-year moving average was used to estimate the proportion mature at age. An ASAP model formulation was also run but not used for estimation of BRPs. In the YPR analysis, VPA results were used to derive a five year average, 2002-2006, for the PR, stock weights, catch weights, and proportion mature at age.

The provisional BRPs from the current YPR are higher for F_{MSY}, slightly lower for MSY, and lower for SSB_{MSY} compared to the previous BRPs. This is due in part to a change from a parametric to a non-parametric model for estimation of the BRPs. The lower values are also due to a change in the partial recruitment vector with GB cod becoming fully recruited at age 5 instead of age 4 as seen in previous assessments. In addition, the mean weights at age have declined in recent years, and there is an updated maturity ogive.

Discussion

An updated assessment that included landings, commercial discards, and recreational catch through 2006 was presented. Based on GARM 'models' review advice, two models (VPA and ASAP) were used to assess this stock. Results from the two models were similar with relatively small percent differences in F and SSB between the VPA and ASAP formulations. ASAP estimates of Age 1 recruitment of the 2003 and 2005 year classes are about 35% less than VPA estimates. Regarding the ASAP model, a point of clarification was made; the ASAP formulation did account for changes in mean weights at age, however it did not account for changes in selectivity. Given a more pronounced retrospective pattern in the ASAP, the VPA (with split in all survey tuning indices) was selected as the most appropriate model for biological reference point estimation and that best model for stock status determination would occur at a later meeting.

There has been a shift in fully recruited fishing mortality from age 4 to age 5. The Panel noted that the revised biological reference points (BRPs) are not comparable to current BRPs due to this shift in selectivity as well as the addition of discards in the catch-at-age and the declining trends in mean weights that have occurred in age 5-8 yr old fish in recent years.

The Panel commented that recruitment has been low for the past 15 years, biomass has been low, and fishing mortality has been high for this stock. SSBmsy estimates for all models are outside the range of the time series observations. The BRPs may not be met given current conditions.

The Panel discussed the large differences between the parametric (Beverton-Holt S-Rfit) and the non-parametric (YPR) approach to derive SSBmsy (274,211 t and 93,995 t, respectively). The Panel suggested a closer examination of the stock-recruit relationship, specifically: 1) examine recruitment when SSB is greater than 40,000 t; 2) compare the stock spawning biomass and recruitment derived from the ASAP and VPA models, 3) use ASAP formulation with a selectivity block at 1999 to account for the change in mesh size regulations, and 4) examine the impact of trimming the recruitment series based on residual variances.

The requested analyses were conducted during the meeting. A non-parametric approach using values of recruitment (14 values) when SSB was greater than 50,000 t was presented. Recruitment from SSB greater than 50,000 t was determined to be the best cut-point based on a 'razor' analysis, i.e. total variance of recruitment is estimated as a function of cut points on SSB where the preferred SSB cut point corresponds to the lowest variance in recruitment.

It was noted that the current BRP established in 2002 used a prior on recruitment of 23 million fish. The first B-H model BRPs presented was based on the upper 90% of recruitment (29 million fish) whereas the revised recruitment prior of 21 million fish is based on the 50,000 t SSB cut-point. The use of hindcasted values would have resulted in higher values for the prior on recruitment. The Panel expressed concern regarding the use of the ASAP re-run to derive BRPs due to the wide range of SSBmsy and MSY that results between the deterministic and the stochastic analyses. Because the results depended upon the prior and sigma used, the issue could not be resolved.

For this stock, the Panel agreed that the revised BRPs should be based on the projection results of the non-parametric approach (YPR) where $F_{40\%MSP}$ = Fmsy = 0.25, SSBmsy = 143,343 t, MSY = 30,220 t using an empirical cdf of recruitment associated with SSB greater than 50,000 t. These reference points are provisional and may change at the August 2008 GARM.

Working Paper 4.B: Brooks L. Georges Bank Haddock

Presentation Highlights

The Georges Bank stock of haddock (*Melanogrammus aegelfinus*) is found in the waters of Georges Bank at depths of 40 to 150 m. The stock spans NEFSC statistical areas 521, 522, 525, 526, 537, 538, 539, 551, 552, 561, 562. The stock was last assessed at GARM-II in 2004 using an ADAPT VPA model. The reference points were derived from the working group on biological reference points (NEFSC 2002), where $F_{40\%MSP}$ served as a proxy for F_{MSY}, and SSB/R and YPR were scaled by the average recruitment level for years where SSB>75,000 t, excluding the 1963 year class. The GARM-III agreed that an ADAPT VPA (v2.7.7) was the preferred assessment model. Model inputs included new estimates of discard at age for years 1989-2006, following the method of observed ratio of discarded haddock to kept of all species (approved method from GARM III 'models' review). Landings at age were re-estimated for years 1989-2006 using the landings allocation methodology agreed to at the GARM III 'data input' review. One further difference between the GARM-III and GARM-II formulation is that the GARM-III VPA used a single maturity ogive for all years, whereas the GARM-II assessment used time-varying stanzas of maturity. The reference points for GARM-III were calculated according to the AGEPRO projection methodology accepted at the GARM-III reference point meeting. Bootstrapped numbers at age for the terminal year were projected for 100 years at $F_{40\%MSP}$ (a proxy for F_{MSY}) using AGEPRO and taking the median value of SSB and yield at equilibrium. An average of the last five years of selectivity and weight at age were used, and the selectivity was forced to be flat topped by scaling such that the fully selected age and all older ages had a selectivity value of 1.0. Projected recruitment was resampled from the cdf of recruitment values that corresponded to years where SSB greater than 75,000 t, excluding the 1963 and 2003 year classes. The recruitment values came from applying the accepted VPA framework to data that extended back to 1931. The BRPs for GARM-III were:

$F_{MSY}=F_{40\%MSP}=0.34$, $SSB_{MSY}=164,300$ t, and MSY=35,000 t. The rate for F_{MSY} is higher than that from GARM-II because the partial recruitment has shifted towards older ages, in part because of smaller fish length at age. The values for SSB_{MSY} and MSY are lower than values from GARM-II because fish weigh less at age now than in 2000 (the last year of data used to calculate existing reference points). These BRP values are provisional and may change at the final GARM-III meeting.

Discussion

It was noted that this assessment differs from previous analyses by the inclusion of revised discards, and maturity ogives. The addition of the revised discards back to 1989 resulted in a slight increase in the estimated stock sizes.

It was suggested that one should look for year effects and age effects in the bootstrapped survey indices. Because the parametric fit to the Beverton-Holt S/R function did not provide reasonable results, the AGEPRO approach was attempted, resampling the CDF of recruitment. This also produced an unreasonable outcome. The default was to use SSB/R multiplied by average recruitment. The average used excluded the large 1963 and 2003 year classes. This generated considerable discussion, with Panel members on both sides of the issue. It was seen to be acceptable if only one of these appeared. But now that the 2003 year class has appeared at the similar magnitude as 1963, it is possible that these may appear again. These year classes were included in the CDF used by AGEPRO, but not when calculating the average recruitment for the SSB/R analysis. There will be a lesser effect on the median compared to the mean.

The question of density-dependent effects on weights at age was raised. Are these effects transient meaning that the stock may return to earlier conditions and a longer period to average the mean weights at age may be more appropriate. For this meeting the “true” values were presumed to be bounded by those used in the 2002 BRP meeting and GARM III.

For the ASAP run, considerable effort was placed on matching the catch at age a closely as possible. This was achieved by inserting a series of selectivity blocks. Based on this, it appears that selectivity has changed over time, especially in recent years. This led to a question on the basis of using a 5 year recent average instead of the most recent few years. It was suggested that changes in the partial recruitment may occur as the 2003 year class passes through the fishery. In general, selection of a partial recruitment pattern should take into account the same considerations as changes in growth.

There were many reasons such as autocorrelation for rejecting the deterministic stock-recruit fit in addition to the residual pattern. It was noted that autocorrelation is present in many groundfish stocks.

The calculation of SSBmsy using the SSB/R approach is deterministic, and was used as a fallback approach. One of the consequences of lower partial recruitment and mean weights at age is higher F 40% MSP that says fish harder. Concern was raised that there will be an increase in exploitation as the change in partial recruitment will affect the TAC. Average recruitment was calculated using estimated recruits produced by SSB levels greater than the median SSB as was done by the 2002 BRP Working Group.

A discussion ensued on whether to use median SSB as the breakpoint at the present meeting, or whether the transition from the lower recruitment stanza to the higher one occurs at another SSB level. The s/r plot should be examined to look for the SSB breakpoint. It was concluded that 75,000 t of SSB may still be a valid value for use as the transition point.

A lengthy discussion took place regarding three assumptions related to this approach: 1) whether to remove the 2 largest year-classes (1963 and 2003), 2) whether to use an arbitrary eyeball approach to determine the transition point, and 3) how to incorporate stochasticity.

On point 1, the Panel agreed that it is appropriate to remove these 2 very large year classes. This is equivalent to managing for a lower distribution of recruitment and take advantage of a bonanza when it occurs. It may be possible to test to see when we are at the transition point.

On point 2, it was suggested that the 75,000 t breakpoint is arbitrary. There may be an objective way to find the breakpoint, such as the breakpoint that provides the best AIC. Use a 3 parameter step function, including the value to the left, the one to the right and the change point. Actually, choice of 75,000 t is not arbitrary as it was based on odds ratios.

On point 3, it was suggested that instead of taking the average, one can bootstrap the distribution of recruitment in calculating the median. Using this approach may not be consistent with the AGEPRO approach. AGEPRO allows for 2-stage re-sampling and can be tried here.

The Panel questioned the type of reference point that is required for this almost rebuilt stock. There is a need to capture stochasticity and maintain consistency and not alter the measure of central tendency. The median Bmsy is the median value of the biomass that provides MSY at Fmsy rather than the expected value (the mean). This does depend on the underlying distribution.

Finally the Panel concluded that The VPA model 3 is the most appropriate. The Panel also supported exclusion of the 2 very large year classes, and to use the 75,000 mt SSB breakpoint.

Working Papers 4.C, D & E: Legault C et al.: Georges Bank, Southern New England/Mid Atlantic, Cape Cod/Gulf of Maine Yellowtail Flounder

Rapporteur: Lisa Hendrickson

Presentation Highlights Georges Bank

Georges Bank yellowtail flounder are generally found in depths between 40 and 70 m. The biological reference points in GARM-II were derived from a VPA as Fmsy = 0.25, SSBmsy = 58,800 t, and MSY = 12,900 t. The biological reference points in GARM-III were derived from a VPA as Fmsy = 0.25, SSBmsy = 46,000 t, and MSY = 10,000 t. These updated values are provisional and may change at the final GARM-III meeting. The updated values assume $F_{40\%MSP}$ as a proxy for Fmsy and recruitments associated with SSB values greater than 5,000 t including hindcast recruitments. The updated VPA has catch information for years 1973 to 2006 and the hindcast values are for years 1963-1972. All hindcast values are assumed to have SSB above 5,000 t. Changes to the data include revisions to the US commercial landings due to the new trip-based allocation scheme and revisions to the US commercial discards due to the application of the SBRM approach. The NEFSC Spring and Fall surveys along with the DFO survey were used as age-specific tuning indices and the NEFSC scallop survey provided an age-1 index of abundance as well. The changes in biological reference points are relatively minor and reflect mainly changes in estimated recruitments due to the change from the “Base Case” VPA to the “Major Change” VPA and the retrospective pattern observed in the “Base Case” VPA.

Discussion Georges Bank

Parametric (assumed Beverton-Holt S-R relationship) and empirical (YPR and SSB/R model) approaches were utilized to estimate biological reference points (BRPs) for the “base case” VPA run (strong retrospective pattern) versus the “major change” run (survey series split between 1994 and 1995 resulting in improved retrospective pattern, this is the model used for management purposes). The Panel noted that the BRPs were similar for input data from both the “major change” model and the “base case” model. The Panel discussed the Beverton-Holt (B-H) stock-recruitment model formulations at length and noted that the inclusion of an R_0 prior resulted in lower F_{MSY} and higher SSB_{MSY} estimates than those estimated without an R_0 prior and that the estimated steepness parameters were high (0.79-0.86). As a result, the Panel recommended acceptance of the empirical BRP estimate of $F_{40\%MSP}$ and SSB_{MSY}, but was concerned about the effects of the inclusion of the less-precise estimates of hindcast recruitment (1963-1972) and the inclusion of all of the SSB values. Consequently, the Panel requested and reviewed a per-recruit model run with an SSB cut point of 5,000 t and inclusion of all hindcast recruitment estimates (SSB values were assumed to be greater than 5,000 t), in order to increase the likelihood of high recruitment in the future. There was some concern about the fact that catches were high during the period for which recruitment was hindcast (1963-1972) and therefore the R and SSBmsy may be underestimated. Conversely, the large extrapolation in the hindcast calculations caused concern that these values may be too high. It was suggested that the hindcast recruitment values and associated catches during the period be used to solve for F for confirmation that the hindcast values are reasonable.

The Panel accepted the empirical reference point estimates that incorporated data from the “major change” VPA model ($F_{40\%MSP}$ = 0.25, as an F_{MSY} proxy, and SSB_{MSY} = 46,000 t). The associated MSY value is 10,000 t.

Presentation Highlights SNEMA

Southern New England-Mid Atlantic yellowtail flounder are generally found in depths between 40 and 70 m. The biological reference points in GARM-II were derived from a VPA as Fmsy = 0.26, SSBmsy = 69,500 t, and MSY = 14,200 t. The biological reference points in GARM III were derived from a VPA as Fmsy = 0.26, SSBmsy = 27,600 t, and MSY = 6,300 t. These updated values are provisional and may change at the final GARM III meeting. The updated values assume $F_{40\%MSP}$ as a proxy for Fmsy and recruitments associated with SSB values greater than 5,000 t but does not include hindcast recruitments. The updated VPA has catch information for years 1973 to 2006. The new VPA uses ages 1-6+ while the previous VPA used ages 1-7+. The new VPA does not exhibit a retrospective pattern while the previous one did. Changes to the data include revisions to the commercial landings due to the new trip-based allocation scheme and revisions to the commercial discards due to the application of the SBRM approach. The NEFSC Winter, Spring and Fall surveys were used as age-specific tuning indices. The changes in biological reference points are relatively large and reflect mainly changes in recruitments used in the calculations. Only VPA estimated recruitments are used in the updated biological reference points while the GARM II values used hindcast recruitments as well. This change is due to the continued low recruitment in recent years potentially indicating a change in stock productivity.

Discussion SNEMA

Similar to the GB stock, Panel members recommended acceptance of the empirical BRP estimates based on input data from the VPA model but were concerned about the effect of including the two largest hindcast recruitment values and all of the SSB values in the estimation. Survey indices suggest that the stock has been much less productive since the early 1990s, and because the stock is at the southern limit of its range, sustainability may be affected by changes in environmental conditions. As a result, the Panel reviewed two additional model runs that included an SSB cut point of 5,000 t and either the exclusion or inclusion of the hindcast recruitment values for 1963-1972.

The Panel accepted the empirical reference point estimates that incorporated data from the final VPA model run ($F_{40\%MSP}$ = 0.26, as an F_{MSY} proxy, and an SSB_{MSY} estimate of 27,600 t). The associated MSY value is 6,300 t.

Presentation Highlights Cape Cod-Gulf of Maine

Cape Cod-Gulf of Maine yellowtail flounder are generally found in depths between 40 and 70 m. The biological reference points in GARM-II were derived from a VPA as Fmsy = 0.17, SSBmsy = 12,600 t, and MSY = 2,300 t. The biological reference points in GARM-III were derived from a VPA as Fmsy = 0.24, SSBmsy = 8,300 t, and MSY = 1,800 t. These updated values are provisional and may change at the final GARM-III meeting. The updated values assume $F_{40\%MSP}$ as a proxy for Fmsy and both VPA and hindcast recruitments. The updated VPA has catch information for years 1985 to 2006 and the hindcast values are for years 1977-1984. The new VPA uses ages 1-6+ while the previous VPA used ages 1-5+. The new VPA does not exhibit a retrospective pattern while the previous one did. Changes to the data include revisions to the US commercial landings due to the new trip-based allocation scheme and revisions to the US commercial discards due to the application of the SBRM approach as well as the addition of two new survey series: the Maine-New Hampshire Inshore Trawl Survey Spring and Fall series. The NEFSC Spring and Fall surveys and Massachusetts Spring and Fall surveys, along with the ME-NH surveys, were used as age-specific tuning indices. The changes in biological reference points are relatively minor and reflect mainly changes in estimated partial recruitment (for Fmsy) and recruitments (SSBmsy and MSY) due to the change from the age 5+ VPA to the age 6+ VPA using the new data.

Discussion Cape Cod-Gulf of Maine

A R_0 prior was required to estimate the steepness parameter for the B-H curve, otherwise steepness was estimated as 1.0 and very high estimates of F_{MSY}, equal to F_{max}, were obtained. However, even with the incorporation of a prior, high steepness estimates (0.949 and 0.954, respectively) were obtained for models that used VPA and ASAP input data. As a result, the Panel recommended acceptance of the empirical BRP estimates based on input data from the VPA model. However, the Panel had concerns about the effects of the inclusion of hindcast recruitment values and all of the SSB data on the BRP estimates. Therefore, the Panel requested and reviewed an additional model run that included hindcast recruitment estimates for 1977-1984. There was no obvious breakpoint present in the SSB data series, so the entire series was used in the final model run.

The Panel accepted the results of the empirical approach which resulted in an $F_{40\%MSP}$ estimate of 0.24 (= F_{MSY} proxy) and SSB_{MSY} estimate of 8,300 t. The associated MSY value is 1,800 t.

Working Paper 4.F: Mayo R. Gulf of Maine Cod

Rapporteur: Sue Wigley

Presentation Highlights

Atlantic cod (*Gadus morhua*) inhabiting the waters of the Gulf of Maine are found at most depths ranging from the shallow parts of the western Gulf of Maine out to depths down to 300+ m. The stock comprises NEFSC statistical areas 511-515. The stock was last assessed at GARM II in 2004 using a VPA model. The existing reference points at that time were: Fmsy = 0.23, SSBmsy = 82, 830 t, and MSY = 16,600 t. The GARM III agreed assessment is a VPA model using the same formulation as at GARM II. The reference points based on results of this assessment are: $F_{40\%MSP}$ proxy Fmsy = 0.23, SSBmsy = 71,150 t and MSY = 14,936 t. The GARM III assessment includes catch data through 2006 and survey data through spring 2007. The catch data have been revised since the GARM II assessment, including: revised catch by stock based on the allocation scheme agreed at the October 2007 GARM III Data Meeting, revised catch at age from 1994 forward, revised recreational estimates from 1982 forward, and revised Massachusetts DMF survey indices from 1982 forward. These data changes were minor and did not contribute to any substantial differences in the assessment. The biological reference points estimated at the GARM III Biological Reference Point Meeting are similar to those in place at GARMII. Fmsy is the same, and SSBmsy is about 14% lower and MSY is about 10% lower than the existing reference points. The revised reference points were based on a period of lower partial recruitment and average weights at age than the existing reference points.

Discussion

VPA and ASAP models were presented with updated information through 2006 (WP 4.F). The VPA analyses included a BASE run that used the same formulation as in previous assessments and a SPLIT run that used survey tuning indices that were split between 1994 and 1995. Retrospective patterns were not present in either the BASE or the SPLIT VPA formulations. An alternative forward-projecting model (ASAP) was also performed to investigate the fishery selectivity pattern. A single logistic selectivity pattern and a double logistic pattern for two time periods were explored. Results indicated a similar fully recruited F in most years; however estimates of F from ASAP were lower than from the VPA. Retrospective patterns of F were considerably different between the two ASAP formulations. The Panel agreed with the conclusion of the GARM III 'models' Panel that the catch at age data are sufficient to employ an age – structured model assuming negligible errors in the catch-at-age, thus, the VPA base assessment was preferred model for estimation of biological reference points.

Discussion focused on the magnitude of the hindcast recruitment from the S-R model; the Panel noted that the mean of the hindcast recruitment was approximately twice the mean of the non-hindcast recruitment. The Panel noted that high recruitment occurred at high biomass. Given the low current biomass, the Panel commented that it appeared unlikely that stock re-building could be achieved by 2014.

Additional discussion focused on the flat-top partial recruitment vector used in the VPA, lack of older fish in the population and the previously high fishing mortality on this stock. This topic was also discussed during the cod tagging analysis (WP 4.7) that indicated no evidence of a decline in the return rates for older fish compared to younger fish in the population.

Working Paper 4.F.1: Butterworth D. Gulf of Maine Cod

Rapporteur: Sue Wigley

Presentation Highlights

WP 4.F.1 (plus Addendum) updated the ASPM (SCAA) assessments for Gulf of Maine cod presented in Butterworth and Rademeyer (GARM III Working paper 2.2a) through the addition of data for two more years, with the plus group extended from age 7 to age 8 on AIC grounds. Based largely on AIC considerations (though for technical reasons these are admittedly approximately calculated), the best assessment selected was that with a Ricker stock recruitment function and dome shaped selectivity. Amongst a number of sensitivity tests, an early gear change, use of the Baranov form rather than Pope's approximation, and commencing the assessment in different years (all prior to abundance index data becoming available) did not lead to any differences of note in estimates of key quantities. A simulation study showed the ASPM estimator to introduce only a slight bias towards a domed shape when the underlying reality exhibits asymptotically flat selectivities. Assessment variants which force flat selectivity in NEFSC surveys and the commercial fishery at large ages were not simply less preferred, but indeed strongly rejected under the AIC model selection criterion (e. g. relative AIC-weights of less than 10-13 for the standard M=0.2 specification). Such variants are not compatible with the low proportions of older cod in surveys and commercial catches – a feature for which cogent explanation needs to be offered before they might be accepted as providing a reliable basis for assessment. The greater rate of decline of commercial selectivity for old cod compared to that for the NEFSC surveys provides indirect confirmation of some dome effect, though further evidence from other sources would be desirable. The assessment could hardly distinguish different values of M, though increasing M above 0.2 suggested a lesser downward selectivity slope at large ages and a better resource status. Search over a range of stock recruitment relationships suggested the Ricker form to be preferred, though without completely eliminating the Beverton-Holt form in AIC terms. Reference point estimates for each of these forms were put forward. Under the best ASPM assessment, the stock was estimated to be at present at some 80% of its MSY level in terms of spawning biomass, with most assessment variants suggesting somewhat higher levels than this.

The Alt-VPA methodology of Butterworth and Rademeyer (GARM III Working paper 2.2a) was applied to these updated data for the period 1982-2006 for which catch-at-age data are available. The fits of the models showed a preference for domed over asymptotically flat selectivity. However, the narrow range of estimates of Bsp values virtually precludes fits of different stock-recruitment curves from being able to distinguish between options as different as Ricker and Beverton-Holt (from which also very different estimates of Reference Points follow). Because of the clearly high variance that would accompany Reference Points inferred from this VPA analysis, they were not advanced, with a preference for approaches that can accommodate a wider range of data and hence achieve reasonable precision being expressed.

Discussion

An alternative assessment (SCAA/ASPM; WP4.F.1) was also presented where sensitivity to natural mortality, stock-recruitment and selectivity was explored. From this study, change in survey gear, the starting year, and the catch equation used (Pope vs. Baranov) had little effect on biological reference points. However, natural mortality did have an impact on BRPs. It was noted that there is a confounding relationship between M, selectivity, and the stock-recruitment relationship (either Ricker or Beverton-Holt). Additional analyses would be needed to isolate each of the three factors. Given the tagging (WP 4.7) result discussions, arguments were made (and counters to these also offered) that there is no evidence of older fish in the population as suggested by this alternative SCAA/ASPM assessment.

The discussion of the alternative SCAA/ASPM assessment focused on the years used in the assessment, the selectivity pattern, and natural mortality. It was pointed out that it is inappropriate to use landings data prior to 1963. While total species landings may be accurate prior to 1963, stock landings were derived via ad-hoc methods and thus the quality of the stock landings is different pre- and post-1963. The long history of cod fishing in New England indicates that 'pristine' conditions were not present in 1956 as suggested. Additionally, there is no survey data available to calibrate the model prior to 1963. WP 4.F.1 had shown that key results were not sensitive to whether the analysis commenced in 1960 rather than 1893. It was recommended that data from 1963 onward should be used.

The Panel pointed out that the alternative SCAA/ASPM analysis and the VPA analysis used a different time period as well as different age groups. The two assessments were not comparable due to the input differences.

Subsequent SCAA/ASPM analyses (WP4.8.a) were conducted during the meeting and presented where the time period of the alternative assessment was limited to 1964 onward and the implication of M=0.2 and M=0.3 were explored. Results indicated when M=0.3, statistical model selection criteria admitted the choice of a model with flat-topped survey selectivity, though for the case of a Ricker (and not a Beverton-Holt) stock recruitment relationship.

The Panel noted that the alternative SCAA/ASPM assessment is useful for exploring the interdependency of M, selectivity, and stock–recruitment; however, the unsolved issue of input data comparability remains. Without resolution of the above issue, there must be strong evidence to move away from the current approach (VPA analyses).

The Panel agreed that the choice of S-R model (Ricker or Beverton-Holt) could not be resolved at this meeting, and they recommended an empirical, non-parametric approach be used for biological reference points. The Panel suggested further examination of older age groups in the VPA assessment (beyond the current 7+ age groups); however the Panel recognized that there may be limitations in the survey data that may prevent extending to older age groups. The Panel also suggested extending the VPA time period back to 1963, if possible.

The Panel agreed that there was enough information to provide preliminary estimates of BPRs based on the VPA assessment. The Panel felt a flat-top partial recruitment assumption should be the default unless there is compelling evidence that older fish are not caught by the fishery. Further, a flat-top survey catchability at age is preferred unless there is a plausible explanation for older fish to avoid the survey gear or to have emigrated out of the survey area. The Panel also agreed that the all recruitment values from the time series (1982 -2006) should be used. The revised reference points are: SSBmsy = 71,150 t, $F_{40\%MSP}$=Fmsy=0.23 and MSY = 14,936 t. These revised reference points are provisional and may change at the August 2008 GARM.

Working Paper 4.G: Wigley S. Witch Flounder
Rapporteur: Laurel Col

Presentation Highlights

Witch flounder are common throughout the Gulf of Maine and in deeper areas on and adjacent to Georges Bank and along the shelf edge as far south as Cape Hatteras; witch flounder are assessed as a unit stock. During the SAW/SARC 37 (NEFSC 2003), a VPA assessment was conducted. The current biological reference points were estimated for witch flounder using yield and spawning stock biomass per recruit analyses (Thompson and Bell 1934) and the arithmetic mean of the VPA Age 3 recruitment (NEFSC 2003). The current biological reference points from that analysis are: SSBmsy = 25,248 t; Fmsy = $F_{40\%MSP}$= 0.23; and MSY = 4,375 t.

To update the biological reference points, two VPA formulations were performed for witch flounder: a BASE run and SPLIT run where survey tuning indices were split into two series between 1994 and 1995. The retrospective patterns observed in previous assessments persist in the BASE run while the retrospective patterns diminish in the SPLIT run. The VPA SPLIT run is selected as the preferred run for estimation of biological reference points.

Based on yield per recruit analyses using the 5-year (2002-2006) averages for partial recruitment, stock weights, catch weights and the 2005 maturity vector (2003-2007 pooled maturity data), the revised Fmsy = $F_{40\%MSP}$ = 0.22. Based on the long-term (100 year) stochastic projection, revised SSBmsy is 10,863 t and revised MSY is 2,195 t. The stochastic projection used the same partial recruitment vector, mean weight at age and maturity vectors used in the yield per recruit analysis. A constant F scenario was used (F = Fmsy = 0.22). Estimates of age 3 recruitment used in the projection was derived by re-sampling the cumulative density function based on the empirical observations during 1982 to 2006 (1979 to 2003 year classes) from the VPA SPLIT RUN. Fishing mortality was apportioned among landings and discards based on the proportions observed during 2002 – 2006. The proportions of F and M which occurs before spawning equals 0.1667 (March 1); M = 0.15. The revised SSBmsy and MSY values are lower than the current reference point values; this is attributed to the lower estimates of recruitment from the VPA SPLIT run, as well as the lower yield and SSB per recruit estimates. The revised reference points are provisional and may change at the August 2008 GARM.

Discussion

The Panel recommended the non-parametric (empirical) approach to determine biological reference points given the negative the stock-recruitment relationship for this species. This method was consistent with the previous biological reference point evaluation in 2002. For this stock, the Panel agreed that the VPA split formulation was the preferred model to use for the estimation of biological reference points given the diminished retrospective pattern. The underlying mechanism for splitting the time series in 1994 was questioned and it was commented that this time period was concurrent with several major changes in management regulations. By splitting the time series to address the retrospective pattern, it was felt that biological reference point estimation and associated management advice would be sounder. The best model for stock status will be determined at a later meeting. For witch flounder, the Panel agreed that the revised BRPs should be based on a non-parametric approach where $F_{40\%MSP}$ = Fmsy = 0.22, SSBmsy = 10,863 t and MSY = 2,195mt using all recruitment values.

Working Paper 4.H: O’Brien L. Georges Bank/ Gulf of Maine American Plaice
Rapporteur: Anne Richards

Presentation Highlights

American plaice is distributed along the Northwest Atlantic continental shelf from southern Labrador to Rhode Island in relatively deep waters (Collette and Klein-MacPhee 2002). Off the U.S. coast, American plaice are managed as a single stock in the Gulf of Maine-Georges Bank region where the greatest commercial concentrations exist between 90 and 182 m (50 and 100 fathoms).

A VPA model formulation was accepted as the final assessment for American plaice at the GARM II meeting (O’Brien et al. 2005, NEFSC, 2005). The biological reference points (BRPs) were developed with a non-parametric YPR analysis (NEFSC 2002) using mean recruitment associated with all SSB estimates from the 2000 assessment (O’Brien and Esteves, 2000):

F_{MSY} = 0.17,
MSY = 4,900 t and
SSB_{MSY} = 28,600 t.

At the GARM III BRP meeting, an update VPA formulation was not presented, however, the YPR analysis was updated using a 3 year average (2002-2004) of partial recruitment, stock weights, catch weights, and maturity at age from the most recent assessment (O’Brien *et al.* 2005). The YPR was then updated further by using research survey mean weights at age averaged over 2003-2007 for stock weights, spawning stock weights, and proportion mature at age. This updated non-parametric YPR analysis was chosen for interim estimation of BRPs. The following estimates are provisional and will change once the final assessment is conducted and presented at the GARM III Assessment Meeting in August 2008:

F_{MSY} = 0.18,
MSY = 4,317 t and
SSB_{MSY} = 20,828 t.

The provisional BRPs from the above YPR analysis are higher for F_{MSY}, slightly lower for MSY, and lower for SSB_{MSY} compared to the previous BRPs. The lower SSB_{MSY} is due to a change in the partial recruitment vector and a decline in the population mean weights at age in recent years.

Discussion

The American Plaice assessment was not completely updated because the data were not available with sufficient time before this meeting; however, the partial update presented takes account of recent changes in mean weight at age which is a primary determinant for reference points. The results therefore indicate a likely direction for change in the BRPs, but there will be further changes in the estimated BRPs when the full assessment is completed for the August 2008 GARM meeting.

Working Paper 4.I: Nitschke P. Gulf of Maine Winter Flounder

Rapporteur: Kathy Sosebee

Presentation Highlights

The Gulf of Maine winter flounder assessment suffers from poor sampling of the landings by market category. A substantial overlap in lengths among market categories did help justify the pooling used to estimate the catch at length and age. The VPA model exhibited a severe retrospective pattern in F, SSB, and recruitment. Splitting of the surveys did improve the retrospective pattern but a lack of fit to the age 1 and 2 recruitment indices was still present. A forward projecting model (SCALE) that tunes to indices at age for the younger ages and length data for the older/larger fish was also examined. Winter flounder exhibits sexually dimorphic growth and males appear to have higher natural mortality than females. Sex specific growth and natural mortality were modeled within the Scale model. The alternative forward projecting Scale model failed to reconcile the conflicting trends between the age 1 and 2 recruitment indices with the declining trend in catch and the adult indices. Lower weights on the recruitment indices and a low penalty on recruitment variation allowed the Scale model to produce a declining trend in recruitment in order for the model to fit to the catch. The scale model has a retrospective pattern similar to the VPA and the splitting of the surveys also improved the retrospective pattern. Parametric stock recruit reference points were not used for either model due to the uncertainty in the estimated recruitment. The entire time series of recruitment (1982-2006) was used to estimate empirical biological reference points. The Scale model estimated a higher F_{msy} proxy ($F_{40\%MSP}$ = 0.44) than the VPA ($F_{40\%MSP}$ = 0.27) due to the difference in the estimated selectivity. However the estimated SSB_{msy} values were similar between the two models (VPA = 3,557 t, Scale = 3,138 t).

Discussion

Several models were attempted for this stock. The VPA which did not have a strong retrospective pattern in 2002 now has a severe pattern. Recruitment and adult biomass trends are not the same. Both the VPA and Scale models have poor fits to the age 1 and 2 recruitment indices. The proposed model is SCALE with split survey series and with recruitment not emphasized. Diagnostics may not indicate SCALE to be a better model.

SCALE captures more biologically (sexually dimorphic growth and differential M) than does the VPA. A model which assumes error in the catch may be more appropriate for this stock which has limited sampling of the landings. SCALE is sensitive to weighting on recruits and the current model has low weight on recruits. The Panel felt that a stock-recruitment curve may not be applicable for this stock even though the SR points appear to be similar between models. The Panel discussed examining catchability from the other stocks of winter flounder but it was noted that growth rates and mesh sizes are different between areas which would make selectivity different. The Panel did not feel confident in the recruitment values. At this time, it is recommended to use the value of $F_{40\%MSP}$=0.27 from the VPA run for the fishing mortality reference point and that the Bmsy proxy is unlikely to be lower than 3000 t. A preliminary SSBmsy reference point could be set at 3557 t with and MSY of 854 t.

Working Paper 4.J: Terceiro M. Southern New England Winter Flounder

Rapporteur: Larry Alade

Presentation Highlights

The GARM III 'models' Panel reviewed the 2005 GARM3 VPA and a version of the assessment implemented in ASAP v2.0.9, which both exhibited a strong retrospective pattern in the late 1990s and into 2001. The Panel advised that model results should be checked for the retrospective pattern when the 2005-2006 catch data were added and that if pattern reappeared, then "consideration should be given to splitting the survey time series pre and post 1994." Splitting the survey series used in calibration acts as a proxy for fishery and biological factors that could have changed in the mid-1990s, resulting in the observed retrospective pattern. Fishery catches were updated through 2006 and survey indices through 2007 to create the GARM III BASE case VPA. The BASE run continued to exhibit a strong retrospective pattern, although it was less severe in recent years than in the 2005 GARM II assessment. Given the persistence of the retrospective pattern in the BASE configuration, survey series were split as per the GARM III 'models' Panel recommendation. Under this SPLIT run configuration, the retrospective pattern was significantly reduced, no appreciable problems in residual patterns developed as a result of splitting the survey series, and the precision of the terminal year estimates was comparable to the BASE run estimates. The SPLIT configuration was selected as the preferred run for the basis of reference point calculations and stock status determination. The Southern New England/Mid-Atlantic (SNE/MA) winter flounder stock complex is overfished and overfishing is occurring. Fishing mortality (F) in 2006 was estimated to be 1.02 (exploitation rate = 59%), about three times F_{MSY} = 0.34. There is an 80% chance that the F in 2006 was between 0.87 and 1.20. SSB in 2006 was estimated to be 2,544 t, about 7% of SSB_{MSY} = 35,240 t. There is an 80% probability that SSB in 2006 was between 2,306 t and 2,860 t. The 2005 year class is estimated to be among the smallest on record, at only 5.6 million fish.

Discussion

The report summarizes a proposed revision of the reference points for the Southern New England Winter flounder assessment based on an ADAPT VPA (TOR 4). The Panel points out that the retrospective pattern continues to be problematic and agree that the split series configuration appears to address the retrospective problem, but the underlying causes are still unknown. The Panel also identifies that the weight at age and maturity at age have been relatively stable as this implies that biological conditions have not changed much. However, the Panel raises concerns about the recruitment time series as they believe that that the R_0 may not be characteristic of the virgin recruitment and may only correspond to the time periods when the stock was exploited. This also led to discussions about the use of priors in the S-R fit as to whether it is informative or not in determining the reference points. The Panel came to consensus with the following recommendations: (a) Move forward with the VPA split series configuration as the basis of the assessment , (b) adopt the non-parametric empirical approach using $F_{40\%MSP}$ as a proxy for F_{MSY} as the basis for the BRPs (c) Calculate the deterministic equivalent of the AGEPRO stochastic projections in determining SSB_{MSY} (d) Coupled with recommendation (b), use a "breakpoint" approach to determine average recruitment above 6000 for SSB in the non-parametric empirical approach (i.e., the top eight estimated recruitments).

Working Paper 4.K: Hendrickson L. Georges Bank winter flounder

Rapporteur: Kathy Sosebee

Presentation Highlights

Winter flounder is a shallow-water species. The Georges Bank stock was assessed at GARM II using a surplus production model (ASPIC) for the period 1963-2004. The current biological reference points were estimated internally from the same model and are: F_{MSY} = 0.32 and B_{MSY} = 9,400 t. The GARM III assessment was conducted utilizing an age-based Virtual Population Analysis (VPA) for the period 1982-2006. The provisional reference point estimates from the VPA model are: F_{MSY} proxy ($F_{40\%MSP}$) = 0.25 and SSB_{MSY} = 15,500 t. The VPA model included: an initial estimate of discards-at-age; landings-at-age for U.S. and Canadian landings; and all ages from the NEFSC spring (1982-2006), and fall surveys (1981-2005, lagged forward one year and age), and the Canada spring surveys (1987-2006). The difference between the current reference point estimates and the provisional estimates are, in part, due to the two different types of models. In addition, different data sets were utilized in each model.

Discussion

It was noted that the projected non-parametric gave a lower value for SSBMSY and MSY although others were higher. The Panel questioned the use of a tight prior on R0 suggesting that using a different prior may give a different answer. An alternative would be to use a prior on steepness obtained from the literature for similar stocks. For SNE-MA winter flounder the BRP Working Group tested all options and models and decided to use the prior on R0 instead of steepness. It may be useful to check if past survey and recruitment were not higher. The Panel recommended using the empirical approach with recruitment values sampled from 1982-2005.

Working Paper 4.L: Sosebee K. Georges Bank/Gulf of Maine White Hake

Rapporteur: Michael Palmer

Presentation Highlights

An assessment was conducted for Gulf of Maine-Georges Bank white hake using ASAP, a forward projecting age-structured model. Two variations of the model were explored, one with a long (1893-2006) time series of catch data and the other with a shorter (1963-2006) time series. Both models showed the same trend in spawning stock biomass, fishing mortality, and recruitment over the similar time frame. The reference points were derived using both Beverton-Holt stock-recruit curve fits and empirical yield-per-recruit estimation. The value for SSBmsy ranged from 35,900 t to 83,800 t depending on the assumptions. A value of 56,500 t was chosen for the reference point with a value of 0.21 for Fmsy proxy and 7,000 t for MSY.

Working Paper 4.L.1: Butterworth D. Georges Bank/Gulf of Maine White Hake

Rapporteur: Michael Palmer

Presentation Highlights

WP 4.L.1 applied the ASPM (SCAA) methodology presented in Butterworth and Rademeyer (GARM III Working paper 2.2a), with an adjustment to be able to incorporate data on proportions at length, to white hake. In a preliminary and (for reasons of time) restricted analysis, four scenarios were considered for the period from 1963 when abundance indices first become available. These reflected the assumptions that spawning biomass in 1963 was at 25% and 50% of its pristine level, and that the catch of hake of length less than 60 cm was either all white hake or all red hake, with the latter assumption leading to somewhat more optimistic appraisals of the current status of white hake. Model fits to survey index trends were broadly reasonable; though there were some difficulties with proportions at length data which would likely be better addressed in future analyses by adopting a length-specific rather than an age-specific selectivity framework. All four scenarios considered suggested an increase in spawning biomass over the last decade, and that the current fishing mortality is less than FMSY. Nevertheless the preliminary nature of all results was stressed, particularly as time had thus far allowed for only a very limited number of variants of the assessment to be investigated. A set of reference point values ranges across the four scenarios considered was presented on an indicative rather than a definitive basis.

Discussion on working papers 4.L and 4.L.1

The Panel expressed concern with the ASAP fits of the survey indices and the use of prior distributions for the survey catchabilities (q). In general the Panel commended the ASAP attempt, but suggested additional formulations be investigated as time permits to include splitting the survey time series and removal of the prior distributions for q's. The Panel expressed concerns with calculating biological reference points (BRP) using the long time series of recruitment (pre-1963). Their concern was based on the uncertainty of these data. The uncertainty was related to the fact that historical recruitment was estimated internally within the ASAP model based on historical landings which may suffer from the same speciation problems that plague the current landings time series. It was clarified that since the historical fishery was a hook and line fishery it is unlikely that an appreciable proportion of the landings comprised red hake. The Panel recommended that BRPs be calculated using recruitment estimates from 1963 and onward, but felt that these BRPs should include a disclaimer that BRPs may change if historical productivity is later determined to have been higher than observed during the time series from 1963. The Panel supported empirical estimates of BRPs (including use of $F_{40\%MSP}$) due to concern with the reliability of stock recruit fits. It was recommended that recruitment resulting from SSB greater than 10,000 t be used to derive B_{MSY} and MSY. If time permitted use of a variance minimizer approach ('razor' analysis) was suggested to provide a more objective measure of the SSB threshold.

Working Paper 4.M: Mayo R. Georges Bank/Gulf of Maine Pollock

Rapporteur: Anne Richards

Presentation Highlights

Pollock (*Pollachius virens*) in habiting the waters of the Gulf of Maine and Georges Bank are found at most depths ranging from the shallow parts of the western Gulf of Maine out to depths down to 300+ m. The stock comprises NEFSC statistical areas 511-616, although most of the fishery occurs in the Gulf of Maine. The stock was last assessed at GARM II in 2004 using an AIM model. The existing reference points at that time were: Fmsy proxy (Relative F) = 5.88, Bmsy proxy = 3.00 kg/tow (NEFSC autumn RV survey, and MSY = 17,640 t. The GARM III agreed assessment is an AIM model using a similar formulation as at GARM II. The reference points based on results of this assessment are: Fmsy proxy = 0.5.758 (Relative F), Bmsy proxy = 2.00 kg/tow (NEFSC autumn RV survey) and MSY = 11,516 t. The GARM III assessment includes commercial and recreational landings data and autumn RV survey data through 2006. The recreational landings data have been revised since the GARM II assessment. These data changes were minor and did not contribute to any substantial differences in the assessment. The biomass reference points estimated at the GARM III Biological Reference Point Meeting are substantially different from those in place at GARM II. The Fmsy proxy is almost the same, but the Bmsy proxy is about 33% lower than the existing Bmsy reference points. Because the Fmsy proxy has not changed appreciably, this results in a similar reduction in the MSY proxy.

Discussion

BRPs were estimated using the status quo method and with two changes: (1) inclusion of recreational landings in the catch time series, and (2) using an assumed Bmsy proxy of 2 kg/tow (vs. 3 kg/tow in the status quo method).

The Panel had no objections to adding recreational landings to the catch series.

The choice of Bmsy proxy is subjective and the revision was based on examination of trends in replacement ratios and survey biomass. When replacement ratios were below 1 (stock not replacing itself), survey biomass indices were generally below 2 kg/tow. The Panel agreed that Bmsy proxy=2 kg/tow is more internally consistent, and approved using this in place of the status quo Bmsy proxy (=3 kg/tow).

The survey shows strong year effects and cohorts can not be tracked, probably because of variability in migratory patterns and thus availability to the survey. However, a clear pattern is the lack of fish older than age 8 since the early 1990s, similar to many other GARM species; this information does not enter into evaluation of stock status with the present method.

Concerns were raised over the high implied population growth rate from the AIM model and suggestions made for alternative formulations for the relationship between replacement ratio and relative F (e.g. log-linear with priors on *a* or logistic). However, AIM is used to deduce when relative F is too high, not for establishing Bmsy, and *a* and *b* can be viewed as nuisance parameters in this context. A suggestion was made that if the alternative formulations can be fit, the parameter estimates might be useful for defending the chosen value of Bmsy and would put the biomass reference points in the same context from which the F index reference points were derived.

Working Paper 4.N: Miller T. Georges Bank/Gulf of Maine Acadian Redfish

Rapporteur: Elizabeth Brooks

Presentation Highlights

The Panel at the GARM III 'models' review was concerned with the problematic estimation of biomass levels prior to the substantial landings starting 1936 using RED and STATCAM. The reviewers suggested implementing a Beverton-Holt stock-recruitment relationship with a steepness as estimated for Pacific Ocean Perch and assume low coefficient of variation (CV, approximately 0.2) of log recruitment residuals in years where age samples is not available and high CV (approximately 0.4) of log recruitment residuals where age samples are available. The reviewers were also interested in relaxing the constant selectivity assumption (i.e., the separability assumption).

In the revised assessment, we have used ASAP (ASAP 2008) as the assessment model because it is also a statistical catch-at-age model and it has options for assuming a Beverton-Holt stock-recruitment relationship. We fit three ASAP models assuming the suggested CVs for log recruitment residuals (0.2 and 0.4, alternative 1) assuming more drastic differences in the CVs for periods with and without age sampling (0.1 without age samples and 0.8 with age samples, alternative 2) and assuming the same CVs as alternative 2 except with a 5 year linear ramp from 0.1 in 1964 to 0.8 in 1969 (alternative 3). In addition, we revised the maturity at age, weight at age and assumed CVs for survey biomass indices and we included discards with landings for total catch estimates between 1989 and 2006 with corresponding CVs provided by variance estimates for the annual discards. The CVs for the biomass indices were estimates provided by the sampling design used in the fall and spring bottom trawl surveys when available. In years where design-based CV estimates were not possible, we assumed CV = 0.3. Further assumptions in the ASAP models were intended to mimic those used previously in STATCAM and RED models where possible. However, we have not attempted to relax the constant selectivity assumption in this assessment because the time span over which age composition data are available from landings (1969-1985) is short relative to the entire time span of landings (1913-2006) and as such there is no ability to estimate different selectivity patterns in the periods prior to and after age observations from landings.

The spawning biomass estimates in the initial period (1913 to 1934) provided by the ASAP alternatives are all greater than those provided by the STATCAM alternatives. Furthermore, the magnitude of the infrequent large recruitment estimates is generally less using the ASAP models. Overall, the diagnostics of the three ASAP alternatives were similar and estimation of initial stock biomass was better behaved than any of the STATCAM alternatives. However, we propose ASAP alternative 3 as the best of the alternative assessment models at this time because the standardized recruitment residuals were best behaved.

We used AGEPRO (AGEPRO 2005) to determine median SB_{MSY} under two alternative scenarios. In the first scenario, we assumed recruitment events are related to spawning biomass in the same manner as the ASAP alternative 3 with 0.8 CV for the residuals (Beverton-Holt spawner-recruit relationship) and the stock is fished at F_{MSY} with fishery age-specific selectivity as estimated from that model. In the second scenario, we assumed recruitment is a random draw from the 94 recruitment estimates provided by ASAP alternative 3 and the stock is fished at $F_{50\%MSP}$ (0.03780) as determined from the revised weight at age and maturity at age and fishery age-specific selectivity as estimated from ASAP alternative 3. For both projection scenarios, we used 100 draws of numbers at age vectors in 2007 from the posterior distribution provided by ASAP alternative 3 and we projected 300 years forward with 100 simulations per numbers at age vector.

The median SB_{MSY} as estimated using AGEPRO, using the first scenario with a Beverton-Holt spawner-recruit function is approximately 353,040mt and the MSY estimate is approximately 13,660 t whereas the median spawning biomass using the 94 estimated recruitments from ASAP and $F_{50\%MSP}$ is approximately 261,280 t ($Yield_{50\%MSP}$ estimate is 9,780mt). Both of these SB_{MSY} estimates are greater than the NEFSC (2002) estimate.

Discussion

A panelist asked about the stock recruit plots for the different CV cases, because he thought he'd see red points above and below the predicted line for CV=20%, but they were all above the line. Another panelist said that the problem with those points is that because there is no age information for those points, they go to the curve. The way you fit the model, prior to data kicking in your estimates are lower. The expected value during that period is lower during that period than after, because of the lognormal distribution. But this influences the shape of the S-R curve and estimates of B_0. In a Bayesian analysis, you'd want the CV constant over time.

A panelist suggested that he thought the point was to find the recruitment that explains the amount of catch removed during that early period. Given that selectivity is constant, ASAP is filling in the recruitment to generate the observed catch.

A member of the audience pointed out that there is a self-consistency problem, but in a frequentist framework, you'd want to make it the S-R curve deterministic prior to some period, then add the bias correction to it. What has happened is the model has had difficulty at the transition point between the CV periods. But, the other question is how strictly you want to interpret them.

The panelists had trouble reading and interpreting the plots of fits to age composition. One panelist thought they were residuals, rather than observed versus predicted. One panelist voiced a preference for bubble plots of observed and another bubble plot of residuals. It was also noted that strong year classes appeared on the diagonal of the age composition plots.

A panelist asked what was the effect of changing the weights at age on the model results. Another panelist asked for clarification, regarding MSP relative to SSB/R and SPR? It was clarified by a NEFSC employee that MSP is % of spawning potential relative to F=0.

A panelist asked what is the F reference. It was noted that the S-R curve was not believed, so an SPR was defaulted to, and because redfish was long lived, they use 50% instead of 40% SPR.

A panelist suggested that he was not sure this model will work for assessing status, but that it may be ok to average over it in a YPR calculation. The value added to what is shown here is that we've shown that catches prior to age composition data have come from average recruitment rather than earlier models that suggested one strong 'bonanza' year-class. It was noted that the previous STATCAM applications to this stock used a single selectivity.

A member of the audience questioned why M=0.05? He suspected that the results will be highly dependent on that assumption (this is whale like). For the distribution of ages, he would not have thought that M was as low as .05. He pointed out that in Figure N20, bottom right, there is a clear temporal pattern in residuals, and that you can reduce that autocorrelation in recruitment residuals with a higher M.

A NEFSC employee pointed out that the value of M is consistent to redfish stocks around the world.

Both an audience member and a Panel member pointed out that weight at age plot shows older fish. One way to support the use of M=0.05 would be to show the age or length data that has been collected to help corroborate that you have such a low M.

A member of the audience asked if he heard correctly that the model didn't show any evidence of a change in selectivity. It was clarified that what he heard was that the residual fits were not bad. The same individual asked if that weren't troubling given the management history. It was clarified by a NEFSC employee that the fishery always used a small mesh; when the mesh changed in 1994, the fishery effectively closed. Therefore, the single selectivity assumption is probably justified.

A panelist commented on the modeling approach, and referenced Fig N10, which shows the pattern of residuals in fit to total catch. The panelists comment is that you should try to fit total catch quite exactly, even when there is uncertainty. The rationale is that you can't expect a model like this to pick up where in catch series the errors should be. It is disturbing to see this residual pattern. This suggestion is just a general approach to modeling. Another panelist asked what this general approach was based on. The first panelist responded, again, that it is unlikely that the data can inform where the errors in catch are or aren't. In the face of uncertain removals, you're better off running models with different assumed levels of removals (as sensitivity cases), and in each of those runs, fit to those removals exactly.

The meeting chair asked if there was sufficient support for the BRPs. A panelist questioned the middle one case (with CV=0.8 fixed) given that in the model fitting exercise the analyst had split the CV. Another panelist was comfortable with the model fit and internally estimated S-R function, because it doesn't require very different recruitment levels than what we've observed. But this is not to say that the panelist was comfortable with the exact S-R function, because the form is largely influenced on predicted recruitments which are based on data from where we have no age comp.

A discussion ensued as to whether predicted recruitment for years where there was no age composition should be included in the projections that sample from the recruitment cdf. Many panelists agreed that it did not make sense to sample from those years without age composition data, and that they should be dropped in making projections to get the reference points. Because those points are basically on the predicted S-R function, which was rejected as a basis for deriving reference points, then those points shouldn't be included; including them is giving an artificially tight central tendency.

Further discussion centered on trying to reconcile the difference in the BRP table of results between the far left and the far right columns. Several assignments were requested of the analyst.

1. take arithmetic average of top of recruitments associated with the top 25% of SSB values, and scale reference points by this.
2. use this same series of recruitments in the AGEPRO approach
3. bring info forward to corroborate lower M.

Working Paper 4.O: Wigley S. Ocean pout

Rapporteur: Laurel Col

Presentation Highlights

Ocean pout is assessed as a unit stock from Gulf of Maine/Cape Cod Bay south to Delaware. An index assessment was presented. Landings, survey indices and exploitation ratios remain at, or near, record low levels and the annual estimates of discards exceeds the landings. Although exploitation has been low, stock size has not increased. The stock appears to be in a depensatory state. Discards are estimated to be an important component of catch and may be sufficiently high to hinder recovery of the stock.

For Ocean pout, the replacement ratio and relative F analyses, as well as age-structured biomass dynamics model analyses, were not informative upon which to base Bmsy, Fmsy, and MSY. Thus, biological reference point proxies for Ocean pout remain based upon research vessel survey biomass trends and exploitation.

The current biological reference points were determined by the Overfishing Definition Panel in 1998. The Bmsy proxy is the median NEFSC spring survey biomass (4.9 kg/tow) during 1980-1991. The MSY is 1,500 t, chosen by visual inspection of landings. The Fmsy proxy is 0.31 (4.9/1.500).

The revised biological reference points are updated using total catch (landings and discards). The Bmsy proxy is the median NEFSC spring survey biomass (4.94 kg/tow) during 1977-1985; the Fmsy proxy is the median exploitation ratio (0.76) during 1977-1985. The 1977-1985 time period corresponds to the time when the replacement ratio was above 1 and biomass increased. Based on these revised proxies, MSY is estimated to be 3,754 t (4.94 * 0.76 * 1000). Differences between current and revised reference points are due to the inclusion of discards in the total catch. The revised biological reference points are provisional and may change at the August 2008 GARM.

Discussion

The Panel expressed concern with the method for determining the biological reference points since AIM showed that the relationship between relative F and the replacement ratio was uninformative. The Panel commented that the time period used to determine MSY, the time when replacement ratio greater than 1, could have encompassed a strong year class.

It was discussed that when the current reference points were determined in 1998, there appeared to be a relationship between biomass and relative F. The 2002 re-evaluation of the reference points defaulted to the 1998 values since the recent data were not informative to update the biological reference points. The Panel discussed that the available data remains generally uninformative for providing updated reference points; however, defaulting to the 1998 reference points is not advisable since discards are important and were not included in 1998 reference point determinations. The Panel therefore concluded that using the method of estimating MSY based on a stable period where replacement ratio was greater than 1 should be applied to the new catch data, since this method is consistent with 1998 reference point determinations. The revised reference points are MSY = 3,754 t, SSB_{MSY} proxy = 4.94 kg/tow, and F_{MSY} = 0.76. The Panel further stated that caution should be taken in interpreting the reference points since the recent depensation would likely inhibit rebuilding. It was commented that the stock may not be able to increase even in the absence of fishing.

Working Paper 4.P: Hendrickson. Georges Bank/Gulf of Maine Windowpane Flounder
Rapporteur: Toni Chute

Presentation Highlights

Windowpane flounder is a shallow-water species. The Gulf of Maine-Georges Bank stock was assessed at GARM II using an index-based method for the period 1963-2004. The current biological reference points are: F_{MSY} proxy = 1.11 and B_{MSY} = 0.94 kg per tow. The F_{MSY} proxy was based on an assumed MSY proxy of 1,000 t and the median of the fall survey biomass index during 1975-1987. The GARM III assessment was conducted utilizing an index-based model called AIM for the period 1975-2006. The provisional reference point estimates are: F_{MSY} proxy (relative F) = 0.62 and B_{MSY} proxy = 1.14 kg per tow. Input data to the AIM model consisted of: initial estimates of discards; landings; and the NEFSC fall survey biomass indices. The provisional F_{MSY} proxy was estimated from the AIM model and represents the relative fishing mortality rate (catch / fall survey biomass index) at which the stock can replace itself. The MSY proxy (= 700 t), assumed as the median catch during a period of time when the stock was replacing itself (1995-2001), was divided by the F_{MSY} proxy to compute the B_{MSY} proxy. The current reference point estimates cannot be compared with the provisional estimates because different survey strata sets were used and the provisional reference point estimates include discards.

Discussion

The population is assessed as two different stocks, northern (GOM/GB) and southern (SNE/MAB). The AIM model was used to estimate the relative F (catch/survey biomass index) at which the population would be stable. Inputs to the AIM model are catch and survey biomass indices.

GOM-GB

For the northern stock, catches and NEFSC fall survey biomass indices were used in the final AIM model run. Biomass indices from the spring NEFSC, Canadian, MA, NJ, and Long Island Sound surveys and the fall MA, NJ, and Long Island Sound surveys were not included in the final model run because the regression of relative Fs against stock replacement ratios was not significant at the p = 0.1 level. Since 1994, catches have been mostly bycatch, and since 2000, consisted of 10-20 times the landings. It is important to note that the previous reference point estimates included only landings and that the revised estimates include discards as well as landings. Since 2004, there has been an increase in pre-recruit abundance in the NEFSC fall surveys.

AIM results indicate the stock can replace itself at a relative F of 0.62. This was considered an Fmsy proxy. During 1995 and 2001, the replacement ratio was greater than or near one which infers that the catch was sustainable during that time period. Therefore, the median catch during 1995-2001 (700 t) was considered as MSY and a BMSY proxy was computed as 1.14 kg per tow. These reference points were selected by the Panel over the BMSY proxy estimate representing the median biomass index because of the greater precision of the discard estimates after 1988. It was also noted that replacement ratios suggest that the stock could not replace itself when a directed fishery occurred during the early part of the time series. The extent of discarding indicates that there is currently no market for GOM-GB windowpane flounder. It was speculated that the AIM regression may have been determined as significant as a result of a few data points.

Working paper 4.Q: Hendrickson L. Southern New England Windowpane Flounder

Rapporteur: Toni Chute

Presentation Highlights

Windowpane flounder is a shallow-water species. The Southern New England-Middle Atlantic Bight stock was assessed at GARM II using an index-based model (AIM) for the period 1963-2004. The current biological reference points are: F_{MSY} proxy = 0.98 and B_{MSY} = 0.92 kg per tow. The F_{MSY} proxy was based on an MSY estimate of 900 t from an ASPIC surplus production model for the period 1963-1996. The GARM III assessment was conducted utilizing an index-based model called AIM for the period 1975-2006. The provisional reference point estimates are: F_{MSY} proxy (relative F) = 1.53 and B_{MSY} proxy = 0.33 kg per tow. Input data to the AIM model consisted of: initial estimates of discards; landings; and the NEFSC fall survey biomass indices. The provisional F_{MSY} proxy was estimated from the AIM model and represents the relative fishing mortality rate (catch / fall survey biomass index) at which the stock can replace itself. The MSY proxy (= 500 t), assumed as the median catch during a period of time when the stock was replacing itself (1995-2001), was divided by the F_{MSY} proxy to compute the B_{MSY} proxy. The current reference point estimates cannot be compared with the provisional estimates because different survey strata sets were used and the provisional reference point estimates include discards.

Discussion

Catches for the southern stock are driven by discards and the survey indices have been at very low levels for the past two decades. The same methods and the same time period of sustainable fishing (1995-2001) used for the northern stock, based on stock-specific trends in replacement ratios, were used to estimate BRPs. It was noted that the southern stock has not shown a positive response to management actions in the past two decades and that replacement ratios suggest that the stock could not sustain itself when the directed fishery occurred. The revised BRP estimates are substantially different from the current BRPs but the two sets are not comparable because of differences in the methods and data used to compute each set of BRPs. The revised BRPs include initial discard estimates and discards are the predominant catch component. Also, the previous BRPs were based on an ASPIC surplus production model which did not contain survey indices covering the entire habitat of windowpane flounder (inshore strata were not included). As a result, the two sets of BRPs are not comparable. It was noted that recent fishing in sea scallop closed areas may also be impacting the stock. The question was asked about what would happen if the stock, at this point mostly discards, crept back above Bmsy and this was interpreted as a signal that a directed fishery would be sustainable? The Panel noted that caution must be taken here because the market for windowpane flounder may change in the future.

Working paper 4.R: Palmer M. Gulf of Maine Haddock

Rapporteur: Ralph Mayo

Presentation Highlights

The Gulf of Maine haddock stock is defined by the United States statistical areas 511 through 515, corresponding to the Northwest Atlantic Fisheries Organization area 5Y. Haddock in this region range in depth from 20 m to 380 m, but are more common at depths ranging from 45 m to 135 m. This stock was last assessed in 2005 at the Groundfish Assessment Review Meeting (GARM) II using biological reference points determined using the method, An Index Method (AIM). The corresponding biological reference points were $F_{MSY[proxy]} = 0.23$, $B_{MSY[proxy]} = 11.09$ kg/tow, and $MSY_{[proxy]} = 5{,}100$ t. These biological reference points (BRPs) and the associated assessment included only commercial landings in the estimates of fishery removals.

Reference points have been recalculated for GARM III using the results from an ADAPT virtual population analysis (VPA) run for the years 1977 to 2006. The VPA included commercial landings at age, commercial discards at age and recreational landings at age and was tuned to both the spring and autumn Northeast Fisheries Science Center bottom trawl survey indices of abundance. Both empirical and deterministic BRPs were calculated, however the deterministic estimates were determined to be unreliable because of the poor fit of the stock-recruit function. AgePro projections were used to determine the BRPs associated with a constant harvest of $F_{40\%MSP} = 0.454$ using the cumulative distribution function (CDF) of age-1 recruitment from 1963 to 2006. The 1962 "bonanza" year class was removed from the recruitment time series as well as those year classes corresponding to spawning stock biomass less than 3,000 t (1986 to 1996). The five year averages (2002 to 2006) of partial recruitment, stock weights, catch weights and spawning stock weights, the 1977 to 2006 average female maturity at age and an assumed constant natural mortality of 0.2 were used as input vectors in the AgePro projections. The resultant BRPs were $SSB_{MSY} = 5{,}995$ t and MSY = 1,360 t; however, these are considered provisional and subject to change at the final GARM III meeting.

The updated BRPs for this stock were appreciably different from those previously calculated using the AIM method. This is not unexpected given that these updates were determined using the results from an age-based model. The estimated $F_{40\%MSP}$ was higher than that estimated for Georges Bank haddock. This difference is likely due to the lower partial recruitment at age relative to the Georges Bank stock resulting from a higher proportion of the fishery removals made up of the recreational hook and line fishery and larger trawl mesh sizes used in the Gulf of Maine commercial fishery.

Discussion

The VPA exhibits a weak retrospective pattern, but was considered to be a reliable basis for calculating biological reference points. The Panel focused first on the estimate of the Fmsy proxy ($F_{40\%MSP}$). The estimate was considerably higher than the estimate for Georges Bank haddock.

Several factors were discussed as possible reasons for this difference. Fishery selectivity is delayed on this stock compared to the Georges Bank stock. This is due to lower mean weights at age and the larger mesh used by fishermen in the Gulf of Maine. Since 2002, these fishermen use 6.5 inch square mesh to target flatfish, resulting in greater escapement of roundfish compared to the 6 inch diamond mesh used on Georges Bank.

This supports the observation that larger haddock are taken in the Gulf of Maine compared to Georges Bank. The recreational fishery accounts for a large proportion of the landings in recent years and these fish are also relatively large. There was an abrupt drop in F in 2002, especially at age 2 when the mesh went to 6.5 inch square. The VPA appears to be picking this up. It was also noted that the $F_{40\%MSP}$ is contingent on continued use of the 6.5 inch square mesh. The delayed partial recruitment also indicates that stock is able to spawn at least once before they are selected.

A multiplicative model was used to explain age and year effects on the partial recruitment matrix. Younger ages in recent years show lower partial recruitment compared to earlier years. Largest differences occur in the most recent years.

Spring survey weights at age are similar to the RIVARD stock weights used in the SSB/R. There was a very large decline in survey weights at age in recent yrs, about½ of earlier weights. This argues for a lower Bmsy than the existing value from the AIM analysis. The Bmsy from the AIM model was based on an average from a period of heavy exploitation during the 1950s and 1960s when landings were very high.
Replacement ratios were never above 1.0 when the catch was above 2,000 t.

There was consensus that there is a need to explain the factors that account for the lower partial recruitment and mean weights resulting in the higher $F_{40\%MSP}$.

Four recruitment options were reviewed, including hindcasting to 1963, and dropping 3 large year classes. The SSBmsy estimates show that the stock is rebuilt and F is low, a reversal from the last assessment. The Panel felt that it is difficult to accept that stock is above SSBmsy compared to 1970s. A larger SSBmsy estimate is more appropriate because the recent biomass increase is based on 1 year class (1998), not a rebuilt stock.

The Panel focused on current stock productivity. High historical landings imply that the stock was more productive during the 1950s. Is productivity lower now? SSB in the 1970s is a product of good recruitment of 1975 year class and recent SSB is a product of the 1998 year class. It was felt that the fishery is not maximizing yield per recruit with the use of the larger mesh. We may be underestimating the overall productivity by focusing on recent recruitment. Since recruitment dynamics in the Gulf of Maine is similar to Georges Bank, it could be that current productivity is underestimated by half if productivity is similar to what we saw for Georges Bank during the 1930-1950s.

The Panel ultimately agreed to accept $F_{40\%MSP}$ as the Fmsy proxy and to use the recruitment option, hindcast back to 1963, and remove just the highest year class (1962) and other recruitment data when SSB was less than 3000 t. The Panel also recommended that recruitment patterns on Georges Bank be compared to Gulf of Maine to see if Gulf of Maine recruitment can be hindcast back to the 1930s.

Should a Fmsy proxy higher than $F_{40\%MSP}$ be used because of reduced productivity? This issue should be examined in the future.

Working Paper 4.S: Col L. Atlantic Halibut

Rapporteur: Larry Alade

Presentation Highlights

Previously an index-based method was used to assess Atlantic halibut, where the 5-year moving average of the swept-area biomass was compared to biomass reference points ($B_{threshold}$ = 2,700 t and B_{MSY} = 5,400 t). The previous reference points were determined based on a MSY of 300 t, estimated from the landings time series, and yield per recruit and biomass per recruit analyses using growth curve and length-weight equations from published literature. Although reliable fishing mortality estimates were not available using the index-based method, previous reference points were given as $F_{0.1}$ = 0.06 and F_{target} = 0.04. Index-based reference points were updated using a length-weight relationship from NEFSC spring and autumn surveys, and von Bertalanffy growth parameters and maturity at age estimates from recent studies in the Gulf of Maine region. Revised biomass reference points were slightly higher, with $B_{threshold}$ = 3,200 t and B_{MSY} = 6,400 t, and revised overfishing reference points were slightly lower, with $F_{0.1}$ = 0.04 and F_{target} = 0.02.

An alternative replacement yield model was performed for Atlantic halibut, incorporating the time series of commercial catch. US discards were estimated using the Standardized Bycatch Reporting Methodology combined ration estimation. Due to low observed encounter rates of halibut and the implementation of the Atlantic halibut regulations in 1999, an average discard ratio from 1989 to 1998 was applied to the 1893-1998 landings and an average discard ratio from 1999-2006 was applied to the landings in those years. The resulting average US discards were added to the total landings, and a linear increase in catch was assumed from 1800-1892 to approximate the entire time series of Atlantic halibut catch in the Gulf of Maine-Georges Bank region. Simulations of varying carrying capacities and intrinsic growth rates were performed, and the model with the best fit was determined using a negative log-likelihood function. The resulting biomass in 2006 was estimated to be 21,000 t, well below the model estimated biomass reference points of $B_{threshold}$ = 75,000 t and B_{MSY} = 150,000 t. Unlike the index-based method, current fishing mortality is estimable using the replacement yield model, and the 2006 estimated F of 0.0022 was below the F_{MSY} estimate of 0.003.

Discussion

This paper summarizes a proposed revision of the references points for the Atlantic Halibut assessment based on an Index based approach (old and revised approach) and an alternative replacement yield model for TOR 4. The Panel initially expressed concern with moving forward using the replacement yield model because the model was highly sensitive to priors on K and r. The Panel recommends using the updated life history parameters for the Gulf of Maine region for the YPR model, and that M should be consistent with published estimates from other halibut stocks. The Panel also recommended fixing r in the replacement yield model as two times the $F_{0.1}$ (proxy for F_{MSY}) from the YPR model. The Panel recommended using a parabolic function as basis for landings from 1800-1893, and using the replacement yield model to estimate B_{MSY}, $B_{threshold}$, current biomass and current F. A partial re-run of the replacement yield model was conducted by the analyst based on some of the recommendations made by the Panel to provide a tentative place-holder for BRP estimates. The current parameterization of the re-run included a new intrinsic growth rate value, twice the $F_{0.1}$ as a proxy for F_{MSY} (r = 0.08) which yielded a B_{MSY} = 70,000 t, an F_{MSY} = 0.04 and MSY = 2800 t. The analyst noted that further analyses that will include a change in M for the YPR analyses and the incorporation of a parabolic function for the Pre-1893 landings will have implications on these BRP estimates and therefore subjected to revisions before the August meeting.