NIWA
Taihoro Nukurangi

Report on the 2012 assessments of yellowtail flounder and herring at Woods Hole

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Executive summary

A panel met 5-9 June 2012 at the Northeast Fisheries Science Center in Woods Hole, Massachusetts to review the 2012 assessments of the stocks of Southern New England yellowtail flounder (*Pleuronectes ferrugineus*) and Atlantic herring (*Clupea harengus*) that are fished off the northeast coast of the USA. The assessments, and some additional analyses, were presented and discussed; the Assessment Summary Reports were reviewed and edited; and the panel began drafting its Summary Report.

The review process was well run. The panel was well supported, the assessment teams were ready and able to respond to queries, and helpful comments were received from other participants.

I conclude that both assessments are sound, and thus provide a scientifically credible basis for developing fishery management advice. All terms of reference for the assessments were successfully completed, with only one minor exception, which did not compromise the assessments.

The following recommendations apply to both assessments unless otherwise stated:

- User and Technical Manuals, together with input and report files from base runs should be provided to reviewers of all ASAP assessments;
- The approach to data weighting in assessment models should be formalized;
- The fixing of stock-recruit steepness in assessments should be considered;
- The use of prior distributions on catchability ratios should be considered as a means of including uncertainty about survey calibration constants;
- The use of alternative catch histories should be considered as a means of quantifying uncertainty in matters such as discards and stock boundaries;
- Alternative approaches to estimating initial depletion should be considered;
- Inferring age- or time-dependent natural mortality from somatic weight only should be avoided;
- When Bayesian estimates are available, only these should be presented;
- Ambiguity about the final year in projections should be removed;
- Spring and fall survey biomass indices for yellowtail flounder should be standardized to remove the effects of diurnal variation in catch rates;
- The fact that alternative methods of calculating yellowtail reference points produced very different results should be explored.
- A prior distribution should be used to constrain the factors by which herring survey catchability increased in 1985 (when the trawl doors were changed) to be more similar for the spring and fall surveys; and
- Explanations for the dramatic increase in herring consumption in the mid-1990s should be sought.

1 Background

This report reviews, at the request of the Center for Independent Experts (see Appendix B), the 2012 assessments of the stocks of Southern New England yellowtail flounder (*Pleuronectes ferrugineus*) and Atlantic herring (*Clupea harengus*) that are fished off the northeast coast of the USA. The author was provided with relevant documents (Appendix A), and participated both in the meeting that considered the assessments, and in the writing of the Summary Report from that meeting.

2 Review activities

The 54th Stock Assessment Review Committee (SARC 54) met 5-9 June 2012 at the Northeast Fisheries Science Center of NOAA/NMFS in Woods Hole, Massachusetts. Those attending the meeting included the four Panel members, the Chairman and Coordinator of SARC, the Chief of the Population Dynamics Branch at Woods Hole, members of the stock assessment working groups (WGs), and other interested parties from both the fishing industry and the research community (Appendix C). The assessments, and related material, were presented to the Panel, and some additional analyses requested by the Panel were carried out and discussed. The Assessment Summary Reports were reviewed and edited, and the Panel began drafting their Summary Report.

3 Findings

The review process was very well run. The Panel was well supported and ably chaired. I was impressed by the willingness, and ability, of the assessment teams to respond to panel requests, and was particularly grateful for helpful and constructive comments given by other meeting participants.

I first present findings that are common to both assessments, and then those relating to the two individual assessments. The latter findings are grouped by the Stock Assessment Terms of References (TORs), as given in Annex 2 of Appendix B.

3.1 Findings common to both assessments

The findings in this section relate primarily to the TORs concerning the stock assessment model (i.e., TOR 4 for yellowtail flounder, TOR 5 for herring) though they do also affect other TORs (e.g., on stock status and projections).

3.1.1 ASAP

I find that ASAP (Legault & Restrepo 1999), the modeling package used in the assessments of both stocks, to be an excellent tool for present purposes. It is modern (statistically-based), well-documented, and relatively simple in structure, and thus ideal for use in an environment in which many assessments have traditionally been carried out with less modern tools.

I was surprised not to find the ASAP User and Technical Manuals amongst the background papers provided to me. Also, it would have been useful if the ASAP input and report files for the base runs had been provided as appendices to the assessment reports (as is common, for example, for west coast assessments using Stock Synthesis). These files provide easy access to technical details of the assessments that can be important, but are sometimes overlooked, or difficult to find, in the main text of the assessment reports.

3.1.2 Data weighting

I found the approach to data weighting in both assessments rather ad hoc, and not well described. For example, both assessment reports mentioned the goodness-of-fit to mean age as a criterion for weighting age composition data sets, apparently in response to a recommendation of Francis (2011), but this criterion seems to have been applied qualitatively, rather than quantitatively. I think it was a mistake to use the same effective sample size for all years of each age-composition data set, because this practice ignores information about years in which sampling was particularly weak or strong (e.g., note the reference to 'extremely poor sampling in 1999' on p. 41 of the yellowtail report). I was concerned that the iterative reweighting used for the herring assessment resulted in some very high CVs (coefficients of variation) for survey indices (see Table A5-1 in the herring assessment report), which might have resulted in these data being swamped by the age composition data.

I don't believe it is possible to remove all subjective elements from data weighting in stock assessments, but I think both the present assessments would have been improved by a less ad hoc approach. As a starting point to developing more formal methods I would suggest consideration of the approach proposed by Francis (2011), which was based on the following guiding principles:

- do not let other data stop the model from fitting abundance data well;
- when weighting age or length composition data, allow for correlations; and
- do not down-weight abundance data because they may be unrepresentative.

3.1.3 Uncertainty about stock-recruit steepness

As is very common in stock assessments, the available data were not informative about the steepness of the stock-recruit relationship for either stock, so there was great uncertainty about the value of this parameter. I was surprised at the very different responses to this uncertainty in these two assessments. For yellowtail, the response was to assume no stock-recruit relationship and base biological reference points (BRPs) on a spawning potential ratio of 40%, rather than MSY; for herring, the decision was made to estimate steepness within the assessment model, and use this estimated steepness to calculate MSY-based BRPs.

Of these two responses, the former seems to me more defensible. Recent research has cast considerable doubt on our ability to estimate steepness within an assessment model (Lee et al. 2012). Further, given the very wide confidence limits implied by the steepness profile calculated for the herring assessment, it is likely that BRPs for this stock will be unstable (because estimates of steepness – and thus BRPs – may change substantially with additional data, and any changes in data weighting, in future assessments).

There is a third possible response to uncertainty in steepness, which seems better to me. That is to fix steepness, using either a default value (in New Zealand and Australia a value of 0.75 is common, for reasons given in Francis 1993), or an average from published values for the same or similar species. The effect of uncertainty about this parameter can then be evaluated by sensitivity runs with lower and higher values of steepness. Fixing steepness should make BRPs more stable.

3.1.4 Uncertainty about survey calibrations

The biomass indices from the spring and fall surveys included corrections, or calibrations, for changes in catch rates caused by various changes in vessel and gear. I was concerned that the uncertainty associated with these calibrations was not carried through into the assessment. That is understandable, because ASAP does not yet provide any mechanism to include that uncertainty. One approach that has been used in New Zealand to address this problem is to allow the user to provide prior distributions for ratios of catchabilities.

The concept is perhaps best described with an example. Consider the calibration constant of 1.22, which was used to scale up yellowtail survey indices to compensate for the change in trawl doors in 1985, and suppose that the standard error of this constant was 0.1. The idea is to split the survey time series at 1985, so that ASAP estimates a separate catchability constant, *q*, for pre- and post-1985, and to apply a normal (say) prior with mean 1.22 and standard deviation 0.1 to the ratio of these *q*s to discourage *q* estimates whose ratio differs substantially from 1.22. This involves adding a term $0.5[((q_{post}/q_{pre})-1.22)/0.1]^2$ to the objective function. An approach like this has been used in some New Zealand assessments and is implemented (in a slightly more complicated form) in CASAL (see section 6.7.5 in Bull et al. 2012).

3.1.5 Alternative catch histories

I saw scope in both assessments to use alternative catch histories as a way of evaluating the effect of uncertainties that are otherwise difficult to quantify. For yellowtail flounder, the substantial uncertainties concerning discards could be explored by constructing two alternative catch histories representing the plausible upper and lower limits in the level of discards. For herring, uncertainty about stock boundaries could be evaluated by constructing alternative catch histories which, for example, make different assumptions about catches from the Scotian Shelf.

3.1.6 Initial depletion

This finding relates to an issue that occurred to me only after the review meeting, but was not discussed in the assessment reports or during the meeting.

Because both the assessed stocks have been exploited for much longer than the periods covered by the assessment models, there is reason to expect that the stocks may have been depleted in the first year of the assessment. That is, we might expect that the initial depletion, $SSB_{initial}/SSB_0$, would be less than 1 (where $SSB_{initial}$ and SSB_0 are the estimated spawning biomasses for the first year of the assessment and the unexploited stock, respectively). In fact, this was not the case: by my calculation, the initial depletion was 1.39 for yellowtail and 0.99 for herring. Although I can't rule out the possibility that these estimates are correct, I am concerned that they may be wrong because the model structure and data did not allow good estimates of initial depletion.

There are two modifications to these assessments that might shed light on this matter. The first is to extend the assessment period closer to the beginning of these fisheries by constructing much longer catch histories. I don't know how difficult this might be, but I suspect that the initial years in the current assessments were determined by the availability of age-composition data (as is required for VPA-type assessments, but not with statistical models) rather than historic catches. With this approach we must ignore all variations in recruitment for years before the first age-composition data, and assume that $SSB_{initial} = SSB_0$ in the new (earlier) initial model year. The hope is that the additional information (the catches for earlier years) might allow the model to obtain a better estimate of depletion for the year that is currently the initial year in these assessments.

The second modification is to retain the current assessment period but make the simplifying assumption that in the years preceding the initial year, the population had reached equilibrium under a constant fishing mortality, $F_{pre\text{-}initial}$, which must be estimated (and which need not be the same as F in the initial year). With this approach, the numbers at age in the initial year (and thus $SSB_{initial}$) would be determined by the estimated values of $F_{pre\text{-}initial}$ and SSB_0. This second approach is a refinement of a suggestion I made during the review meeting, that a catch-curve analysis of the estimated initial numbers at age might be a useful diagnostic for stocks where there were substantial catches in years before the first assessment year.

3.1.7 Natural mortality

I think that both assessments made inappropriate and unnecessary use of a regression equation from Lorenzen (1996) to infer trends in *M* (natural mortality): age-dependent *M* for yellowtail; and age- and time-dependent *M* for herring.

The use of Lorenzen's equation (which predicts *M* from somatic weight) was *inappropriate* because this equation is highly imprecise when used to predict *M* for an individual species (let alone for variation in *M* within a species). This imprecision is evident in the wide scatter about the regression line in Lorenzen's Figure 1 (from this scatter I infer that predicted and observed *M*s would differ by a factor of more than 2 for about one-third of his data points). I note that for both herring and yellowtail the estimated *M*s from Lorenzen's equation were scaled down substantially (by a factor of about 3 for yellowtail) to be more consistent with other estimates (e.g., from Hoenig's method). If Lorenzen's equation is so unreliable for mean *M* for these species, why should we consider it reliable for predicting how *M* varies within these species?

The power of Lorenzen's equation (and of an analogous equation I have seen that relates longevity to somatic weight in terrestrial animals) is in inferring differences in *M* between fish or animals of very different weights (note that Lorenzen's data cover about six orders of magnitude in somatic weight, and three orders of magnitude in *M*). From the terrestrial equation I would be very happy to infer that dogs live longer than mice. But I would not want to use this equation to make any inference about the relative longevity of poodles and Labradors, and I certainly would not want to calculate how much my dog's life expectancy had increased because it had put on weight.

The use of Lorenzen's equation in these assessments was *unnecessary* because it made no contribution to goodness of fit in the assessment models. For both species, alternative models with constant *M* (apart from the step increase in 1996 for herring) fitted the age composition data just as well as the base models. This being so, Occam's razor suggests that we stick to the simpler (constant *M*) assumption. Note that if age-dependent *M* does produce a clearly better fit to the age composition data, then it is more sensible to estimate the age dependence within the assessment model.

I should make it clear that I am firmly of the belief that *M* varies with both age and time. However, I don't think it defensible to include such variation in assessment models unless it is clearly supported by appropriate data.

3.1.8 Reporting Bayesian results

Both assessments reported two types of results: those associated with the minimum value of the objective function (including CVs derived from the inverse Hessian matrix at this minimum); and full Bayesian estimates derived from MCMC (Markov Chain Monte Carlo) samples of the parameter posterior distribution. This is common practice and sensible. Although the Bayesian results are generally deemed to be more sound, statistically, they are time-consuming to generate, and so are not always produced for all alternative model runs.

However, whenever both types of results are available it is good practice for all final estimates to derive from the Bayesian results only, with point estimates being the medians (or possibly the means) of the posteriors, and uncertainty expressed by MCMC-derived confidence intervals. This practice did not seem to have been followed in these assessments.

3.1.9 The projection period

I was surprised to find that the WGs for the two assessments had different interpretations of the period covered by 3-year projections (which were required by the TORs for both stocks). This was because of differing views as to whether 2012, the first year of projections, should be included in the 3-year period. The difference of views is understandable, because catches in 2012 were fixed at an assumed level, while those in subsequent years were determined by a specified level of fishing mortality. However, it does not seem sensible to allow ambiguity in such a simple matter.

3.2 Findings for yellowtail flounder

3.2.1 TOR 1: landings and discards

Estimate landings and discards by gear type and where possible by fleet, from all sources. Describe the spatial distribution of fishing effort. Characterize uncertainty in these sources of data.

I conclude that this TOR was successfully met.

Work in this TOR involved significant revisions of data and assumptions, including the use of spatial stratification in the calculation of discards (a good idea) and the revision of length-weight parameters and rate of discard mortality. One weakness of the assessment was that the substantial uncertainty in the discard estimates was not expressed in the results of the assessment (see TOR 4).

3.2.2 TOR 2: survey data

Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Investigate the utility of commercial or recreational LPUE as a measure of relative abundance, and characterize the uncertainty and any bias in these sources of data.

I conclude that this TOR was successfully met.

The available survey data, and their attendant uncertainties, were well described. I was disappointed that no attempt was made to standardize for the strong diurnal variation in catch rates that is very evident in Figure B43 in the assessment report. It may well be that the standardized catch rates will differ very little from those used in the assessment (as the WG apparently assumed), but we won't know that until the standardization is done. I endorse the conclusion that, given the major changes in the management of this stock, LPUE is not likely to be a good index of abundance for this stock.

3.2.3 TOR 3: stock definition

Evaluate the validity of the current stock definition, and determine whether it should be changed. Take into account what is known about migration among stock areas.

I conclude that this TOR was successfully met. A wide range of information bearing on the question of stock definition was discussed and evaluated and I saw no evidence supporting a change in the existing stock definition.

3.2.4 TOR 4: the assessment

Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-5), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

I conclude that this TOR was successfully met.

The sequence of models presented, linking the previous (GARM III) assessment and a fully updated VPA, was valuable in exploring some of the differences in data and assumptions between the previous and current assessments. I endorse the use of time-varying fishery selectivity (in blocks of years) to deal with changes in management and fishing practice. The major uncertainties in the assessment were well characterized by the use of MCMCs and alternative model runs, but it would have been good to have seen an exploration of the effects of uncertainty about discards (by, e.g., bracketing this uncertainty with two alternative catch histories representing plausible upper and lower limits in the level of discards).

3.2.5 TOR 5: causes of recruitment variability

Investigate causes of annual recruitment variability, particularly the effect of temperature. If possible, integrate the results into the stock assessment (TOR-4).

I conclude that this TOR was successfully met.

This was a very difficult task. Many researchers have tried to identify environmental causes of recruitment variability in fish stocks, but few putative causes have stood the test of time (Myers 1998). Thus it was not surprising to me that the cold pool variable, though apparently having some link to variation in yellowtail recruitment, was not able to explain the dominant feature in this variation: the sudden drop in mean recruitment that occurred around 1990. This variable was included in an alternative assessment model, but I support the WG's decision not to include it in the base model.

3.2.6 TOR 6: stock status definitions

State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

I conclude that this TOR was successfully met.

A major source of uncertainty in this assessment concerned the interpretation of the sudden drop in mean yellowtail recruitment that occurred about 1990. I support the WGs decision to calculate two sets of BRPs – one each for the two competing scenarios that might explain this drop: the 'two-stanza' scenario links the drop to a decrease in spawning biomass, positing that expected recruitment falls when this biomass falls below a threshold; whereas in the 'recent' scenario the drop is assumed to be a productivity shift, unrelated to biomass, but caused by unknown environmental changes. I believe the weight of evidence makes the latter scenario more likely to be true than the former, but not so strongly that it would sensible to present BRPs for just one scenario.

The values of MSY and B_{MSY} calculated by the WG under the 'two-stanza' scenario differed markedly from those calculated (during the review meeting) using a more conventional modelling approach (with a Beverton-Holt stock-recruit relationship). I did not infer that the WG's method of calculation (which I found interesting and innovative) was wrong. But I do think it is difficult to be confident that this is the better method until we know why the more conventional method produces BRPs that are so different (see TOR 9).

3.2.7 TOR 7: current stock status

Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model, should one be developed for this peer review. In both cases, evaluate whether the stock is rebuilt (if in a rebuilding plan).

a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.

b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-6).

I conclude that this TOR was successfully met.

I support the WG's decision to present two alternative evaluations of stock status corresponding to the competing explanations for the drop in mean recruitment that occurred about 1990: the 'two-stanza' and 'recent' scenarios. Though the latter scenario seems to me to be more likely, I believe the WG would not have adequately conveyed a major uncertainty concerning stock status had they presented results from just one scenario. I note that the marked difference in the 'two-stanza' BRPs calculated by different methods (see TOR 6) was not sufficient to change estimated stock status.

3.2.8 TOR 8: projections

Develop approaches and apply them to conduct stock projections and to compute the pdf (probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

a. **Provide numerical annual projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment, and recruitment as a function of stock size).**
b. **Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.**
c. **Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.**

I conclude that this TOR was successfully met.

The results of the projections (which were calculated using a standard approach) depended strongly on which of the two scenarios described under TOR 6 was assumed. Under the 'recent' scenario, the stock has already rebuilt, because the target biomass is now estimated to be lower than previously thought; under the 'two-stanza' scenario the stock cannot rebuild by 2014, even with no fishing mortality. Neither scenario can be ruled out, but I consider the former to be more likely. Although the consideration of these two scenarios covered the main source of uncertainty in this assessment, there were other, lesser, sources of uncertainty (e.g., levels of natural mortality and discards) that could have been evaluated in the projections.

The high level of discards in this fishery is a source of vulnerability, as is the recent poor recruitment under the 'two-stanza' scenario.

3.2.9 TOR 9: research recommendations

Review, evaluate and report on the status of research recommendations listed in most recent peer reviewed assessment and review panel reports. Identify new research recommendations.

I conclude that this TOR was successfully met.

The WG provided a very thorough discussion of research recommendations from previous assessments. I don't believe that the cold pool index merits more attention, but suggest that attention be focused on predictors that show a sudden change around 1990, and could thus have caused the recent drop in mean yellowtail recruitment.

I recommend two areas for future research: standardization (perhaps using a GLM or GAM) of survey catch rates for time of day (see TOR 2); and an exploration of why two alternative methods of calculating BRPs under the 'two-stanza' scenario produced such different results (see TOR 6). The aim of this latter exploration would be to determine which method is better for this stock.

3.3 Findings for herring

3.3.1 TOR 1: landings and discards

Estimate catch from all sources including landings and discards. Describe the spatial distribution of fishing effort. Characterize uncertainty in these sources of data.

I conclude that this TOR was successfully met.

I support the decision to use two fleets (fixed and mobile) and thus reduce year-to-year variation in selectivity. Clear evidence of strong and weak year classes in the age composition data is a clear signal of good quality data. There seemed to be no major sources of uncertainty in these data (except for matters relating to stock definition).

3.3.2 TOR 2: survey data

Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, larval surveys, age-length data, predator consumption rates, etc.). Investigate the utility of commercial LPUE as a measure of relative abundance, and characterize the uncertainty and any bias in these sources of data.

I conclude that this TOR was successfully met.

I commend the decision to stop applying commercial age-length keys to survey lengths, and agree with the decisions to use the shrimp survey, but not the winter, larval, and state-run surveys, in the assessment. The length-specific Bigelow-Albatross calibration function used for the fall survey (see Table A2-1 in the assessment report) seems unnecessarily and implausibly complex, though I doubt that this is consequential (i.e., changing to a simpler, and thus more plausible, function is not likely to change the assessment much). It is of concern that it was not possible to provide a calibration for the changes between the Yankee 36 and Yankee 41 nets, since the corresponding calibration constant used for yellowtail (1.75) was substantially different from 1.

3.3.3 TOR 3: the acoustic survey

Evaluate the utility of the NEFSC fall acoustic survey to the stock assessment of herring. Consider degree of spatial and temporal overlap between the survey and the stock. Compare acoustic survey results with measures derived from bottom trawl surveys.

I conclude that this TOR was successfully met.

I agree with the WG's decision not to use the acoustic survey in the base assessment. In my view the sharp and substantial drop in the survey index after the first three surveys (see Figure A3-3 in the assessment report) is the main reason not to use it: this drop is inconsistent with other data, particularly the catch history. I note also that herring echoes extend right to the boundary of the survey area in several years (see Figure A3-1 in the assessment report), so it is quite possible that the proportion of the stock covered by this survey varied substantially from year to year.

3.3.4 TOR 4: stock definition

Evaluate the validity of the current stock definition, and determine whether it should be changed. Take into account what is known about migration among stock areas.

I conclude that this TOR was successfully met.

The stock structure of herring in this area is clearly complex. Though there appear to be several spawning stocks, with complex movement patterns that are only partially known, it is often not possible to confidently allocate commercial or survey catches (or echoes) to specific spawning stocks. In these circumstances stock definitions for assessment purposes must of necessity be pragmatic compromises, rather than scientifically precise. I saw no evidence supporting a change in the existing stock definition.

3.3.5 TOR 5: the assessment

Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-6), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

I conclude that this TOR was successfully met.

I support the WG's choice of base model, and specifically the hypothesis that *M* (natural mortality) increased by 50% in the mid-1990s. It is rare that such a hypothesis can be justified in an assessment model, but the strong temporal trend in the consumption data, (TOR 6) and the fact that the increase in *M* removed a strong retrospective pattern, justify it in this case. Analyses carried out during the review provided additional support for the use of a value of 50% for the increase in *M.* The uncertainty in the assessment was well characterized by the use of MCMCs and alternative model runs.

It is a concern that the factor by which survey catchability was estimated to increase when the trawl doors were changed in 1985 was so different in the fall and spring surveys (the estimated factors were 13.6 and 2.64, respectively). Such a large difference seems implausible.

The assessment used a high recruitment CV in order that estimates of recruitment deviates be 'unconstrained' (p. 158 in the Assessment Report). I think this was a mistake (it's certainly contrary to the common practice of making this CV similar to that of the estimated recruitment deviates). This CV helps define the Bayesian prior distribution for the recruitment deviates, and it is precisely the function of such priors to constrain estimates in cases where the data are relatively uninformative. However, an alternative run (during the review meeting) with a lower CV showed that the assessment results – including the size of the very strong 2008 cohort, which is influential in projections (see TOR 10) – were not very sensitive to this CV.

The WG devised two responses to difficulties caused by occasional high proportions of age 1 fish: the removal of all age 1 fish from survey indices and age compositions; and the reduction of effective sample sizes for the fixed fleet from 29 (for 1965-1994) to 5 (post-1994). I strongly support the intent of these measures (to make the assessment robust to occasional outliers) but am concerned that the baby might have been thrown out with the bath water (the first measure removes *all* age 1 fish from survey data because of problems with *some* of them; the second down-weights *all* post-1994 fixed-fleet composition data because of problems with just one age). I wonder whether the sought-after robustness could have been achieved by using (a) a lower recruitment CV to constrain estimated recruitment deviates (see preceding paragraph), and (b) a more robust likelihood (some examples of robust likelihoods for proportions data are given in Section 6.7.1 of Bull et al. 2012).

3.3.6 TOR 6: herring consumption

Consider the implications of consumption of herring, at various life stages, for use in estimating herring natural mortality rate (M) and to inform the herring stock-recruitment relationship. Characterize the uncertainty of the consumption estimates. If possible integrate the results into the stock assessment.

I conclude that this TOR was successfully met.

The estimates of herring consumption, although very uncertain, were of great value in this assessment because their dramatic increase in the mid-1990s (see Figure A6-5 in the assessment report) was crucial in the formulation of the base model (see TOR 5).

I think further research aimed at trying to find the primary cause(s) of this dramatic increase could be useful. An analysis carried out during the review meeting showed that the increase was not caused by an increase in predator abundance. In this analysis, the annual estimates of the abundance of each predator were replaced by their time averages, and this was shown to have comparatively little effect on the time trend in annual herring consumption. I wonder whether similar analyses (i.e., the replacement of annual values with their time averages), applied to other factors that are used in calculating annual herring consumption, might be revealing. Presumably the dramatic increase described above was caused by prey switching (towards herring) by some or all predators. If we knew which prey, or group of prey, the predators switched away from, we might be in a better position to detect any future change back to pre-1990s levels of herring consumption.

3.3.7 TOR 7: stock status definitions

State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

I conclude that this TOR was successfully met.

I endorse the WG's decision to calculate BRPs using the increased value of *M* assumed in the assessment for recent years (see TOR 5). The uncertainty in BRPs was well characterized using a range of alternative assumptions (e.g., concerning *M* and steepness)

3.3.8 TOR 8: current stock status

Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model, should one be developed for this peer review. In both cases, evaluate whether the stock is rebuilt (if in a rebuilding plan).

- **a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.**
- **b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-7).**

I conclude that this TOR was successfully met.

I endorse the WG's conclusion that the herring stock is not overfished and that overfishing is not occurring. This conclusion was shown to be robust to a wide range of alternative assumptions.

3.3.9 TOR 9: alternative harvest policies

Using simulation/estimation methods, evaluate consequences of alternative harvest policies in light of uncertainties in model formulation, presence of retrospective patterns, and incomplete information on magnitude and variability in M.

I conclude that that this Term of Reference was not completed, but that some useful initial work was underway.

The task described in this Term of Reference seemed to me to be very substantial – particularly as no guidance was given as to what types of harvest policies to consider – and out of place in a project that is primarily aimed at a stock assessment. We have had some success with this sort of study in New Zealand (particularly for rock lobster fisheries, e.g., Breen & Kim 2006), but that has required close engagement and extensive consultation with both fishery managers and stakeholders to ensure that the results are relevant to management. I note that the relevant research projects described as underway in the assessment report all focus on assessment problems (e.g., retrospective patterns and miss-specification of natural mortality) rather than the effect of these problems on harvest policies.

3.3.10 TOR 10: projections

Develop approaches and apply them to conduct stock projections and to compute the pdf (probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

a. **Provide numerical annual projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).**
b. **Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.**
c. **Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.**

I conclude that this TOR was successfully met.

I found that the WG's projection methods were sound, and was pleased to see them applied to a wide range of scenarios so as to cover the major uncertainties in the assessment. The WG identified and described the key sources of this stock's vulnerability to becoming overfished (e.g., contributions from other herring stocks, and uncertainty about the strength of the 2008 year class and the persistence of high natural mortality).

3.3.11 TOR 11: research recommendations

For any research recommendations listed in recent peer reviewed assessment and review panel reports, review, evaluate and report on the status of those research recommendations. Identify new research recommendations.

I conclude that this TOR was successfully met.

There were no recommendations from previous assessments, but the WG presented a long list of new recommendations, all of which have some merit. This list is currently written rather tersely, which is perfectly adequate as an aide-memoire to those doing the current assessment, but which may not be very clear when considered by those doing the next assessment to be reviewed.

I would endorse recommendation h (Evaluate use of length-based models) if this is intended to refer to models that can use both length- and age-composition data. However, the term 'length-based' is more usually used to refer to models devised for stocks where no age data are available (so the models keep track only of numbers at length, rather than numbers at age – see, e.g., Kristensen et al. 2006). Such models cannot use age-composition data, and so are inappropriate for this stock.

I have two research recommendations. The first is to evaluate the use of a prior distribution to constrain the factors by which survey catchability increased in 1985 (when the trawl doors were changed) to be more similar for the spring and fall surveys (see TOR 5). This is precisely the sort of situation for which Bayesian priors are intended: there are no data directly relating to how different the factors should be for the two surveys, but expert opinion could be used to define a plausible range, and thus a prior distribution, for their ratio My second recommendation is to seek explanations for the dramatic increase in herring consumption in the mid-1990s (as discussed above under TOR 6).

4 Conclusions and recommendations

I conclude that the assessments of yellowtail flounder and herring are generally sound, and thus provide a scientifically credible basis for developing fishery management advice. All terms of reference for the assessments were successfully completed, with only one minor exception. The exception was TOR 9 for herring, and the failure to complete this TOR was understandable (given the very substantial task involved) and did not compromise the assessment of this stock.

4.1 Recommendations common to both assessments

I have nine recommendations for future assessments that are not specific to either stock (they derive directly from findings in Sections 3.1.1–3.1.9, where more detail is provided):

- User and Technical Manuals, together with input and report files from base runs should be provided to reviewers of all ASAP assessments;
- The approach to data weighting in assessment models should be formalized;
- The fixing of stock-recruit steepness in assessments should be considered;
- The use of prior distributions on catchability ratios should be considered as a means of including uncertainty about survey calibration constants;
- The use of alternative catch histories should be considered as a means of quantifying uncertainty in matters such as discards and stock boundaries;
- Alternative approaches to estimating initial depletion should be considered;
- Inferring age- or time-dependent natural mortality from somatic weight only should be avoided;
- When Bayesian estimates are available, only these should be presented; and
- Ambiguity about the final year in projections should be removed.

4.2 Recommendations for individual assessments

For future yellowtail flounder assessments I recommend that

- Spring and fall survey biomass indices be standardized to remove the effects of diurnal variation in catch rates; and
- The fact that alternative methods of calculating reference points produced very different results should be explored.

For future herring assessments I recommend that

- The use of a prior distribution to constrain the factors by which survey catchability increased in 1985 (when the trawl doors were changed) to be more similar for the spring and fall surveys; and
- Explanations for the dramatic increase in herring consumption in the mid-1990s should be sought.

5 References

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Appendix A Bibliography of materials provided for review

Yellowtail Flounder

Background Papers

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2 McBride, R., Press, Y., & Wuenschel, M. 2012. Classifying female yellowtail flounder maturity: comparing at-sea, macroscopic maturity classifications with results from a gonad histology method.

3 McElroy, W. D., Towle, E. K., Press, Y. K., McBride, R. S., & Wuenschel, M. J.. 2012. Comparison of fecundity among stocks of female yellowtail flounder, *Limanda ferruginea*.

4 McElroy, W. D., Press, Y. K., & Wuenschel, M. J. 2012. Reproductive effort as a predictor of the natural mortality rate for southern New England yellowtail flounder: the Gunderson method.

5 Alade, L., & Cadrin, S, 2012. A review of yellowtail flounder stock structure off New England.

6 Alade, L., Hart, D., & Legault, C. 2012. Influence of spatial stratification on discard estimation for the Southern New England Mid-Atlantic yellowtail flounder.

7 Alade. L. 2012. Southern New England-Mid Atlantic yellowtail length-weight relationship.

8 Barkley, A., & Cadrin, S. 2012. Results of the application of reflex action mortality predictors onboard commercial fishing vessels.

9 Gervelis, B., Burchard, K., & Hoey, J. 2011. A comparison of discard estimates of yellowtail flounder using study fleet self-reported data and NEFOP observer data.

10 Alade, L. A. 2012. Southern New England Mid-Atlantic yellowtail flounder commercial landings.

11 Hare, J., Richardson, D., & Mountain, D. 2012. Indices of the Mid-Atlantic cold pool and relationship to Southern New England/ Mid-Atlantic yellowtail flounder recruitment.

12 Richardson, D. E., Walsh, H., & Hare, J. 2012. Southern New England yellowtail flounder larval data.

13 Anonymous. 2012. Revised Spatial Stratification for estimating discards for SNEMA yellowtail flounder.

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Working Papers

1 Southern Demersal Working Group, Stock Assessment Workshop (SAW 54). 2012. Southern New England Mid-Atlantic (*Limanda ferruginea*) stock assessment updated through 2011. A report of the Southern Demersal Working Group for SARC 54, June 5th – 9th, 2012. Northeast Fisheries Science Center. Woods Hole, MA. SAW/SARC 54.

2 Anonymous. 2012. Southern New England Yellowtail Flounder Assessment Summary for 2012. SAW/SARC 54.

Atlantic Herring

Background Papers

1 Shepherd, G., Cieri, M., Power, M., & Overholtz, W. 2009. Transboundary Resources Assessment Committee Gulf of Maine/Georges Bank Atlantic Herring Stock Assessment Update. TRAC Reference Document 2009/04.

2 Transboundary Resources Assessment Committee. 2009. Gulf Of Maine-Georges Bank Herring Stock Complex. Status Report 2009/04.

3 Transboundary Resource Assessment Committee. 2006. Gulf of Maine-Georges Bank Herring Stock Complex. Status Report 2006/01.

4 Gavaris, S. 2003. Transboundary Resource Assessment Committee (TRAC): Report of Meeting held 10-14 February 2003. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2003/014.

5 O'Boyle, R., & Overholtz, W. 2006. Proceedings of the Transboundary Resources Assessment Committee (TRAC). Benchmark Review of Stock Assessment Models for Gulf of Maine and Georges Bank Herring 2 – 5 May 2006 Woods Hole, Massachusetts.

6 O'Brien, L., & T. Worcester, T. 2008. Proceedings of the Transboundary Resources Assessment Committee (TRAC): Gulf of Maine/Georges Bank Herring, Eastern Georges Bank Cod and Haddock, Georges Bank Yellowtail Flounder. Report of Meeting held 8 - 11 June 2009 St. Andrews Biological Station, St. Andrews, New Brunswick, Canada.

7 Jech, J. M., & Stroman, F. 2012. Aggregative patterns of pre-spawning Atlantic herring on Georges Bank from 1999-2010. *Aquat. Living Resour.*, **25**: 1–14.

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12 Guan, W., Cao, J., Chen, Y., & Matthew Cieri, M. 2012. A simulation study to evaluate impacts of spatial structure of Atlantic herring fishery on retrospective errors in stock assessment.

13 Reid, R. N., Cargnelli, L. M., Griesbach, S. J., Packer, D. B., Johnson, D. L., Zetlin, C. A., Morse, W. W. & Berrien, P. L. 1999. Essential Fish Habitat Source Document: Atlantic Herring, *Clupea harengus*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-126. 48 pp.

14 Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. Journal of Fish Biology. 49: 627–647.

15 Miller, T. J., Richardson, D. E., & Hare, J. A. In prep. Maximum likelihood estimation of larval production indices from length frequency and growth information collected on ichthyoplankton surveys.

16 Cao, J., Guan, W., Chen, Y., & Cieri, M. In prep. Evaluating factors influencing retrospective errors in estimating stock biomass for Atlantic herring *Clupea harengus*.

Working Papers

1 Anonymous. 2012. Stock Assessment of Atlantic Herring- Gulf of Maine/Georges Bank. SAW/SARC 54. June 5-9 2012, NOAA Fisheries, Northeast Fisheries Science Center. Woods Hole, MA.

1 Appendices 3-6

Anonymous. 2012. Stock Assessment of Atlantic Herring- Gulf of Maine/Georges Bank. Appendices 3-6. SAW/SARC 54. June 5-9 2012, NOAA Fisheries, Northeast Fisheries Science Center. Woods Hole, MA.

2 Anonymous. 2012. Atlantic Herring Assessment Summary for 2012.

Appendix B Statement of work

This appendix contains the Statement of Work that formed part of the consulting agreement between the Center for Independent Experts and the author.
External Independent Peer Review by the Center for Independent Experts

54th Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC): Southern New England yellowtail flounder and Atlantic herring.

Statement of Work (SOW) for CIE Panelists
(including a description of SARC Chairman's duties)

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: The purpose of this meeting will be to provide an external peer review of stock assessments for Southern New England yellowtail flounder (*Pleuronectes ferrugineus*) and Atlantic herring (*Clupea harengus*). Yellowtail flounder is a demersal flatfish distributed from Labrador to Chesapeake Bay generally at depths between 40 and 70 m (20 to 40 fathoms). Off the U.S. coast, three stocks are considered for management purposes: Cape Cod/Gulf of Maine, Georges Bank, and Southern New England/ Mid-Atlantic. The principal fishing gear used to catch yellowtail flounder is the otter trawl. The last peer reviewed assessment of Southern New England yellowtail flounder was in 2008 as part of the GARM III. Atlantic herring is a pelagic fish that is widely distributed in continental shelf waters of the Northeast Atlantic, from Labrador to Cape Hatteras. Important commercial fisheries for juvenile herring (ages 1 to 3) exist along the coasts of Maine and New Brunswick. Development of large-scale fisheries for adult herring is comparatively recent, primarily occurring in the western Gulf of Maine, on Georges Bank, and on the Scotian Shelf. The last peer reviewed assessment of Atlantic herring was in 2009 as part of the TRAC. Yellowtail flounder and Altantic herring are managed by the New England Fishery Management Council. Results of the 2012 peer review will form the scientific basis for fishery management in the northeast region.

Duties of reviewers are explained below in the "**Requirements for CIE Reviewers**", in the "**Charge to the SARC Panel**" and in the "**Statement of Tasks**". The stock assessment Terms of Reference (ToRs), which are carried out by the SAW Working Groups, are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**. The SARC Summary Report format is described in **Annex 4.**

The SARC 54 review panel will be composed of three appointed reviewers from the Center of Independent Experts (CIE), and an independent chair from the SSC of the New England or Mid-Atlantic Fishery Management Council. The SARC panel will write the SARC Summary Report and each CIE reviewer will write an individual independent review report.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review of the stock assessments that are provided, and this review should be in accordance with this SoW and stock assessment ToRs herein. CIE reviewers shall have working knowledge and recent experience in fish stock assessments. For yellowtail, familiarity with forward projecting models and estimation is desirable. For herring, familiarity with pelagic fish and acoustic surveys is desirable. For both stocks, experience with time- and sex-specific natural mortality rate is desirable.

In general, CIE reviewers for SARCs shall have working knowledge and recent experience in the application of modern fishery stock assessment models. Expertise shall include statistical catch-at-age, state-space and index methods. Reviewers shall also have experience in evaluating measures of model fit, identification, uncertainty, and forecasting. Reviewers shall have experience in development of Biological Reference Points that includes an appreciation for the varying quality and quantity of data available to support estimation of BRPs.

Each CIE reviewer's duties shall not exceed a maximum of 15 days to complete all work tasks of the peer review described herein.

Not covered by the CIE, the SARC chair's duties should not exceed a maximum of 15 days (i.e., several days prior to the meeting for document review; the SARC meeting in Woods Hole; several days following the open meeting for SARC Summary Report preparation).

Location and Date of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in Woods Hole, Massachusetts during June 5-9, 2012 (Tuesday through Saturday).

Charge to SARC panel: During the SARC meeting, the panel is to determine and write down whether each stock assessment Term of Reference of the SAW (see **Annex 2**) was or was not completed successfully. To make this determination, panelists should consider whether the work provides a scientifically credible basis for developing fishery management advice. 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. Where possible, the SARC chair shall identify or facilitate agreement among the reviewers for each stock assessment Term of Reference of the SAW.

If the panel rejects any of the current Biological Reference Points (BRP) or BRP proxies (for B_{MSY} and F_{MSY} and MSY), the panel should explain why those particular BRPs or proxies are not suitable and the panel should recommend suitable alternatives. If such alternatives cannot be identified, then the panel should indicate that the existing BRPs or BRP proxies are the best available at this time.

Statement of Tasks:

1. Prior to the meeting
(SARC chair and CIE reviewers)
Review the reports produced by the Working Groups and read background reports.

Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein:

Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email, and FAX number) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and stock assessment ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide by FAX the requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/.
http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html

Pre-review Background Documents: Approximately two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports (i.e., working papers) for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance with the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

2. During the Open meeting
Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and stock assessment ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the stock assessment ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The

NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

(SARC chair)
Act as chairperson, where duties include control of the meeting, coordination of presentations and discussion, making sure all stock assessment Terms of Reference of the SAW are reviewed, control of document flow, and facilitation of discussion. For each assessment, review both the Assessment Report and the draft Assessment Summary Report.

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

(SARC CIE reviewers)
For each stock assessment, participate as a peer reviewer in panel discussions on assessment validity, results, recommendations, and conclusions. From a reviewer's point of view, determine whether each stock assessment Term of Reference of the SAW was completed successfully. Terms of Reference that are completed successfully are likely to serve as a basis for providing scientific advice to management. If a reviewer considers any existing Biological Reference Point or BRP proxy to be inappropriate, the reviewer should try to recommend an alternative, should one exist. Review both the Assessment Report and the draft Assessment Summary Report.

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

3. After the Open meeting
(SARC CIE reviewers)
Each CIE reviewer shall prepare an Independent CIE Report (see **Annex 1**). This report should explain whether each stock assessment Term of Reference of the SAW was or was not completed successfully during the SARC meeting, using the criteria specified above in the "Charge to SARC panel" statement.

If any existing Biological Reference Points (BRP) or their proxies 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 BRPs are the best available at this time.

During the meeting, additional questions that were not in the Terms of Reference but that are directly related to the assessments may be raised. Comments on these questions should be included in a separate section at the end of the Independent CIE Report produced by each reviewer.

The Independent CIE Report can also be used to provide greater detail than the SARC Summary Report on specific stock assessment Terms of Reference or on additional questions raised during the meeting.

(SARC chair)

The SARC chair shall prepare a document summarizing the background of the work to be conducted as part of the SARC process and summarizing whether the process was adequate to complete the stock assessment Terms of Reference of the SAW. If appropriate, the chair will include suggestions on how to improve the process. This document will constitute the introduction to the SARC Summary Report (see **Annex 4**).

(SARC chair and CIE reviewers)
The SARC Chair, with the assistance from the CIE reviewers, will prepare the SARC Summary Report. Each CIE reviewer and the chair will discuss whether they hold similar views on each stock assessment Term of Reference and whether their opinions can be summarized into a single conclusion for all or only for some of the Terms of Reference of the SAW. For terms where a similar view can be reached, the SARC Summary Report will contain a summary of such opinions. In cases where multiple and/or differing views exist on a given Term of Reference, the SARC Summary Report will note that there is no agreement and will specify - in a summary manner – what the different opinions are and the reason(s) for the difference in opinions.

The chair's objective during this SARC Summary Report development process will be to identify or facilitate the finding of an agreement rather than forcing the panel to reach an agreement. The chair will take the lead in editing and completing this report. The chair may express the chair's opinion on each Term of Reference of the SAW, either as part of the group opinion, or as a separate minority opinion.

The SARC Summary Report (please see **Annex 4** for information on contents) should address whether each stock assessment Term of Reference of the SAW was completed successfully. For each Term of Reference, this report should state why that Term of Reference was or was not completed successfully. The Report should also include recommendations that might improve future assessments.

If any existing Biological Reference Points (BRP) or BRP proxies are considered inappropriate, the SARC Summary Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRP proxies are the best available at this time.

The contents of the draft SARC Summary Report will be approved by the CIE reviewers by the end of the SARC Summary Report development process. The SARC chair will complete all final editorial and formatting changes prior to approval of the contents of the draft SARC Summary Report by the CIE reviewers. The SARC chair will then submit the approved SARC Summary Report to the NEFSC contact (i.e., SAW Chairman).

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. Each CIE reviewer shall complete the independent peer review addressing each stock assessment ToR listed in **Annex 2**.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.

2) Participate during the panel review meeting at the Woods Hole, Massachusetts during June 5-9, 2012 (Tuesday through Saturday).
3) Conduct an independent peer review in accordance with this SoW and the assessment ToRs (listed in **Annex 2**).
4) No later than June 25, 2012, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and to David Sampson, CIE Regional Coordinator, via email to david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each assessment ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

30 April 2012	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
22 May 2012	NMFS Project Contact will attempt to provide CIE Reviewers the pre-review documents by this date
5-9 June 2012	Each reviewer participates and conducts an independent peer review during the panel review meeting in Woods Hole, MA
9 June 2012	SARC Chair and CIE reviewers work at drafting reports during meeting at Woods Hole, MA, USA
25 June 2012	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
26 June 2012	Draft of SARC Summary Report, reviewed by all CIE reviewers, due to the SARC Chair *
29 June 2012	SARC Chair sends Final SARC Summary Report, approved by CIE reviewers, to NEFSC contact (i.e., SAW Chairman)
9 July 2012	CIE submits CIE independent peer review reports to the COTR
16 July 2012	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

* The SARC Summary Report will not be submitted, reviewed, or approved by the CIE.

The SAW Chairman will assist the SARC chair 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 SARC Summary Report available to the public. Staff and the SAW Chairman will also be responsible for production and publication of the collective Working Group papers, which will serve as a SAW Assessment Report.

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) each CIE report shall be completed with the format and content in accordance with **Annex 1**,
(2) each CIE report shall address each stock assessment ToR listed in **Annex 2**,
(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.).

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Findings of whether they accept or reject the work that they reviewed, and an explanation of their decisions (strengths, weaknesses of the analyses, etc.) for each ToR, and Conclusions and Recommendations in accordance with the ToRs. For each assessment reviewed, the report should address whether each Term of Reference of the SAW was completed successfully. For each Term of Reference, the Independent Review Report should state why that Term of Reference was or was not completed successfully. To make this determination, the SARC chair and CIE reviewers should consider whether the work provides a scientifically credible basis for developing fishery management advice.

a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including a concise summary of whether they accept or reject the work that they reviewed, and explain their decisions (strengths, weaknesses of the analyses, etc.), conclusions, and recommendations.

b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

c. Reviewers should elaborate on any points raised in the SARC Summary Report that they feel might require further clarification.

d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

e. The CIE independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not others read the SARC Summary Report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

Appendix 1: Bibliography of materials provided for review
Appendix 2: A copy of the CIE Statement of Work
Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Stock Assessment Terms of Reference for SAW/SARC54 (June 5-9, 2012) (to be carried out by SAW Working Groups) (file vers.: 10/21/11)

A. Atlantic herring

1. Estimate catch from all sources including landings and discards. Describe the spatial distribution of fishing effort. Characterize uncertainty in these sources of data.

2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, larval surveys, age-length data, predator consumption rates, etc.). Investigate the utility of commercial LPUE as a measure of relative abundance, and characterize the uncertainty and any bias in these sources of data.

3. Evaluate the utility of the NEFSC fall acoustic survey to the stock assessment of herring. Consider degree of spatial and temporal overlap between the survey and the stock. Compare acoustic survey results with measures derived from bottom trawl surveys.

4. Evaluate the validity of the current stock definition, and determine whether it should be changed. Take into account what is known about migration among stock areas.

5. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-6), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

6. Consider the implications of consumption of herring, at various life stages, for use in estimating herring natural mortality rate (M) and to inform the herring stock-recruitment relationship. Characterize the uncertainty of the consumption estimates. If possible integrate the results into the stock assessment.

7. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

8. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model, should one be developed for this peer review. In both cases, evaluate whether the stock is rebuilt (if in a rebuilding plan).
a.When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.
b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-7).

9. Using simulation/estimation methods, evaluate consequences of alternative harvest policies in light of uncertainties in model formulation, presence of retrospective patterns, and incomplete information on magnitude and variability in M.

10. Develop approaches and apply them to conduct stock projections and to compute the pdf (probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

   a. Provide numerical annual projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).

b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.

c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

11. For any research recommendations listed in recent peer reviewed assessment and review panel reports, review, evaluate and report on the status of those research recommendations. Identify new research recommendations.

B. SNE/Mid-Atlantic Yellowtail Flounder

1. Estimate landings and discards by gear type and where possible by fleet, from all sources. Describe the spatial distribution of fishing effort. Characterize uncertainty in these sources of data.

2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Investigate the utility of commercial or recreational LPUE as a measure of relative abundance, and characterize the uncertainty and any bias in these sources of data.

3. Evaluate the validity of the current stock definition, and determine whether it should be changed. Take into account what is known about migration among stock areas.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-5), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

5. Investigate causes of annual recruitment variability, particularly the effect of temperature. If possible, integrate the results into the stock assessment (TOR-4).

6. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

7. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model, should one be developed for this peer review. In both cases, evaluate whether the stock is rebuilt (if in a rebuilding plan).
a.When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.
b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-6).

8. Develop approaches and apply them to conduct stock projections and to compute the pdf (probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

a. Provide numerical annual projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment, and recruitment as a function of stock size).

b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.
c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

9. Review, evaluate and report on the status of research recommendations listed in most recent peer reviewed assessment and review panel reports. Identify new research recommendations.

Appendix to the SAW Assessment TORs:

Clarification of Terms
used in the SAW/SARC Terms of Reference

On "Acceptable Biological Catch" (DOC Nat. Stand. Guidel. Fed. Reg., v. 74, no. 11, 1-16-2009):

Acceptable biological catch (ABC) is a level of a stock or stock complex's annual catch that accounts for the scientific uncertainty in the estimate of [overfishing limit] OFL and any other scientific uncertainty…" *(p. 3208) [In other words, OFL ≥ ABC.]*

ABC for overfished stocks. For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect the annual catch that is consistent with the schedule of fishing mortality rates in the rebuilding plan. *(p. 3209)*

NMFS expects that in most cases ABC will be reduced from OFL to reduce the probability that overfishing might occur in a year. (p. 3180)

ABC refers to a level of ''catch'' that is ''acceptable'' given the ''biological'' characteristics of the stock or stock complex. As such, [optimal yield] OY does not equate with ABC. The specification of OY is required to consider a variety of factors, including social and economic factors, and the protection of marine ecosystems, which are not part of the ABC concept. (p. 3189)

On "Vulnerability" (DOC Natl. Stand. Guidelines. Fed. Reg., v. 74, no. 11, 1-16-2009):

"Vulnerability. A stock's vulnerability is a combination of its productivity, which depends upon its life history characteristics, and its susceptibility to the fishery. Productivity refers to the capacity of the stock to produce MSY and to recover if the population is depleted, and susceptibility is the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery (e.g., loss of habitat quality)." (p. 3205)

Rules of Engagement among members of a SAW Assessment Working Group:

Anyone participating in SAW assessment working group meetings that will be running or presenting results from an assessment model is expected to supply the source code, a compiled executable, an input file with the proposed configuration, and a detailed model description in advance of the model meeting. Source code for NOAA Toolbox programs is available on request. These measures allow transparency and a fair evaluation of differences that emerge between models.

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(END OF ANNEX 2)

Annex 3: Draft Agenda

54th Northeast Regional Stock Assessment Workshop (SAW 54)
Stock Assessment Review Committee (SARC) Meeting

June 5-9, 2012

Stephen H. Clark Conference Room – Northeast Fisheries Science Center
Woods Hole, Massachusetts

Draft AGENDA*   (version: 14 March 2012)

TOPIC PRESENTER(S) SARC LEADER RAPPORTEUR

Tuesday, June 5

1 – 1:30 PM
Welcome **James Weinberg**, SAW Chair
Introduction **Robert O'Boyle**, SARC Chair
Agenda
Conduct of Meeting

1:30 – 3:30 Assessment Presentation (A. Herring)
Jon Deroba, others TBD TBD

3:30 – 3:45 Break

3:45 – 6 Assessment Presentation (A. Herring)
Jon Deroba, others TBD TBD

Wednesday, June 6

9 – 11:45 SARC Discussion w/ presenters (A. Herring)
Robert O'Boyle, SARC Chair **TBD**
11:45 – 1 Lunch

1:00 – 3:15 Assessment Presentation (B. SNE YT)
Larry Alade TBD TBD
3:15 – 3:30 Break

3:30 – 5:30 SARC Discussion w/ presenters (B. SNE YT)
Robert O'Boyle, SARC Chair **TBD**

Thursday, June 7

9 - 11 Revisit w/ presenters (A. herring)
Robert O'Boyle, SARC Chair **TBD**

11 – 11:15 Break

11:15 – 12:30 Revisit w/ presenters (B. SNE YT)
Robert O'Boyle, SARC Chair **TBD**

12:30 – 1:45 Lunch

1:45 – 2:15 (cont.) Revisit w/ presenters (B. SNE YT)
Robert O'Boyle, SARC Chair **TBD**

2:15 -2:30 Break

2:30 – 5:30 Review/edit Assessment Summary Report (A. herring)
Robert O'Boyle, SARC Chair **TBD**

Friday, June 8

9 - 12 Review/edit Assessment Summary Report (B. SNE YT)
Robert O'Boyle, SARC Chair **TBD**

12 – 1:15 **Lunch**

1:15 – 5 SARC Report writing. (closed meeting)

Saturday, June 9
9:00 - 3 PM (cont.) SARC Report writing. (closed meeting)

*All times are approximate, and may be changed at the discretion of the SARC chair. The meeting is open to the public, except where noted.

Appendix C Key personnel

The review panel consisted of

Bob. O'Boyle (chair)	Beta Scientific Consulting, Canada;
Norm Hall	Murdoch University, Australia;
Neil Klaer	CSIRO, Australia; and
Chris Francis	NIWA, New Zealand.

The panel was assisted by

Jim Weinberg	Chairman and Coordinator of SARC;
Paul Rago	Chief of the Population Dynamics Branch at Woods Hole; and
Anne O'Brien	Assistant to Jim Weinberg.

the assessments were presented by

Jon Deroba	for herring; and
Larry Alade	for yellowtail flounder

session rapporteurs were

T. Chute	for herring; and
J. Blaylock	for yellowtail flounder

and helpful contributions were made during the meeting by other members of the two working groups tasked with the assessments (the Herring Working Group and the Southern Demersal Working Group) and other interested parties from the research community and the fishing industry.