2.0 STOCK ASSESSMENTS OF 19 NORTHEAST GROUNDFISH STOCKS

Issues Relevant to all Assessments

Retrospective error and the determination of current status and basis of F rebuild

The issue of retrospective patterns (systematic under or over-estimation of spawning stock biomass (SSB) and / or fishing mortality in modeled stock reconstructions) was raised in both the GARM III models and BRP reviews. The former considered potential factors responsible for retrospective patterns while the latter provided guidance on how to address retrospective patterns in relation to the determination of stock status and BRPs. The GARM III 'models' review identified four potential causes of retrospective patterns: an unrecorded change in catches, a change in natural mortality, a change in the abundance index catchability, and a change in fishery selectivity.

Almost all the assessments of the GARM III stocks considered at the current review exhibited a pattern with an over-estimation of SSB and an under-estimation of fishing mortality (F) in the last, current, year of the analysis. It was not possible to determine which single factor or combination of factors was responsible for the observed retrospective patterns. However, it was considered appropriate to adjust for the retrospective when formulating catch advice. To judge whether or not this pattern was severe enough to require adjustment in the 2007 population numbers for the stock and rebuilding plan projections, the Panel compared this pattern to the estimates of uncertainty available for the current year's SSB and F. If the pattern was greater than this uncertainty, then the Panel considered that an adjustment to the 2007 population numbers was required. Of the 14 GARM III stocks that were assessed using an age-based assessment model, seven of these had retrospective patterns severe enough that an adjustment was deemed necessary (table 8).

Table 8. Retrospective Patterns in 14 GARM III Northeast Groundfish Stocks; retrospective patterns were not determined for other stocks which used Relative Trend (Index) models (Pollock, the two Windowpane stocks and Ocean Pout) as well as Halibut.

Species	*Stock*	*Retrospective Pattern*	*Adjustment*
Cod	GB	Moderate	Split Survey Time Series
Cod	GOM	Small	Not required
Haddock	GB	Small	Not required
Haddock	GOM	Small	Not required
Yellowtail Flounder	GB	Large	Split Survey Time Series
Yellowtail Flounder	SNE/MA	Small	Not required
Yellowtail Flounder	CC/GOM	Small	Not required
American Plaice	GB/GOM	Moderate	Rho Adjustment
Witch Flounder		Moderate	Split Survey Time Series
Winter Flounder	GB	Small	Not required
Winter Flounder	GOM	Large	Split Survey Time Series
Winter Flounder	SNE/MA	Large	Split Survey Time Series
Redfish		Moderate	Rho Adjustment
White Hake	GB/GOM	Small	Not required

Adjustment for the retrospective pattern was approached in two ways. The first involved an analysis to identify a split in the survey time series which would either reduce or remove the

retrospective pattern. This split survey approach (herein termed 'Split') was recommended by GARM III 'models' review as a means to adjust for retrospective patterns in some assessments (e.g. Georges Bank yellowtail) and its broader application was considered at this meeting. The second approach was an adjustment to the numbers at age in the terminal year of the analysis based upon a measure, Rho (Mohn, 1999) of the age-specific retrospective pattern over the previous seven years (herein termed 'Rho Adjusted'). The number of years (seven) to include in the analysis was arbitrary but generally spans the recent time period of the retrospective pattern in most of the assessments.

Regarding the Split approach, an analysis was considered (working paper 1.2) to determine the potential utility of a split in the survey time series for all GARM III assessments. A moving window analysis was employed to detect non-stationarity in the estimates of the survey catchability (q). The analysis provided temporal patterns in q at age, which in turn was used to infer the most appropriate year to split the survey time series. In many cases, splitting the survey time series sometime around 1995 significantly reduced the retrospective pattern. The Split approach was employed in five of the GARM III assessments (table 8).

In a few cases (plaice and redfish), the Split approach did not improve the retrospective pattern and thus the Rho Adjusted approach was used. While the Rho Adjusted approach may be more transparent than the Split approach, it produces a discontinuity in the last year of the analysis, complicating the calculations of the stock projections. Using the Split approach to adjust for the retrospective pattern has the advantage over the Rho Adjusted approach in that it produces a reconstruction of the population dynamics without a discontinuity in the most recent year.

In each of the assessments provided below, where a retrospective pattern adjustment was made, the results of both the Split and Rho Adjusted approach are presented along with the results of the Base, unadjusted, model. A comparison between the two adjustments across all stocks generally shows that either produces the same overall change in current status from the Base model. Also indicated is the Final, adjusted, model that the Panel considered should be the basis for management advice. Preference was given to the Split approach when this reduced the retrospective pattern. Otherwise, the Rho Adjusted approach was employed.

The GARM III 'models' review noted a number of potential causes for the retrospective pattern. These all relate to some unexplained change within the time series of observations. The Panel did not consider the adjustment for the retrospective pattern as a final solution to the problem. Rather, it encouraged further work on the nature and causes of the problem which would result in its more explicit treatment in future assessments.

Recruitment Assumptions and Rebuilding Plans

The GARM III 'BRP' review determined that the recruitment and spawning stock biomass derived from most assessments did not display compelling support for any particular functional form of the stock-recruitment relationship and therefore, a non-parametric approach to stock projections, involving use of $F_{40\%MSP}$ along with a chosen recruitment time series, was generally adopted. The recruitment time series considered typical of productivity conditions at the BRPs was chosen through inspection of the stock – recruitment relationship based on the population reconstructions (VPA in most cases). A determination was made on a spawning stock biomass (termed the 'breakpoint') below which recruitment appeared to be diminished. A determination was also made on whether or not exceptionally large year-classes had occurred which appeared to be unrelated to the size of the spawning stock biomass. In both cases,

recruitment estimates below the breakpoint and of the exceptionally large year-classes were excluded from the BRP estimation. While SSB breakpoints could not be identified for many of the GARM III stocks (and the entire recruitment time series was thus used), breakpoints were identified for seven of the stocks (Table 9) for which analytical models were developed.

Table 9. Recruitment Time Series used in Estimation of 14 GARM III Groundfish Stock BRPs. Recruitment estimates are not available for the index based assessments (Pollock, two windowpanes, ocean pout) or halibut

Species	Stock	Model	Recruitment Time Series used for BRP Estimation
Cod	**GB**	VPA	Recruitment from SSB greater than 50,000 t
Cod	**GOM**	VPA	Recruitment from full VPA Time Series
Haddock	**GB**	VPA	Recruitment from SSB greater than 75,000 t (excluding two large year-classes - 1963 and 2003)
Haddock	**GOM**	VPA	Recruitment from SSB greater than 3,000 t (excluding large 1962 year-class and including hindcast estimates back to 1962)
Yellowtail Flounder	**GB**	VPA	Recruitment from SSB greater than 5,000 t (including hindcasts back to 1963)
Yellowtail Flounder	**SNE/MA**	VPA	Recruitment from SSB greater than 5,000 t (excluding hindcast estimates)
Yellowtail Flounder	**CC/GOM**	VPA	Recrutiment from full VPA Time Series (including hindcast estimates back to 1977)
American Plaice	**GB/GOM**	VPA	Recruitment from full VPA Time Series
Witch Flounder		VPA	Recruitment from full VPA Time Series
Winter Flounder	**GB**	VPA	Recruitment from full VPA Time Series
Winter Flounder	**GOM**	VPA	Recruitment from full VPA Time Series
Winter Flounder	**SNE/MA**	VPA	Recruitment from SSB greater than 5,700 t
Redfish		ASAP	Recruitment from 1969-2006
White Hake	**GB/GOM**	SCAA	Recruitment from entire series.

The Panel considered the issue of SSB breakpoints in the estimation of $F_{REBUILD}$ for rebuilding plans. $F_{REBUILD}$ is determined through iteratively calculating the fishing mortality that produces a 50% probability that the stock will recover to B_{MSY} by the end of the rebuilding plan period (see Section 1.1 for the stock-specific rebuilding plan periods). The GARM III 'BRP' review suggested that in developing rebuilding scenarios, careful consideration be given to consistent use of the stream of recruitments used in those scenarios with those used to derive the BRPs.

The Panel considered that for stock projections, either for short – term yield or $F_{REBUILD}$ estimation, the same recruitment assumptions for BRPs should be used. Some of the stocks are currently at an SSB below their breakpoints and recruitment can be expected to be low until SSB grows above the breakpoints. To reflect these short – term stock conditions, the Panel considered that the SSB breakpoints should be used. Thus, for all the $F_{REBUILD}$ estimates reported below, where SSB breakpoints are indicated in Table 9, a two stanza projection was employed with the recruitment estimates stochastically chosen from the recruitment time series either below or above the SSB breakpoint depending upon the level of SSB. Where no breakpoint has been identified, the entire recruitment time series was used to determine $F_{REBUILD}$

On a final note, the Panel considered the assumptions to apply to the 2008 fishery in stock and rebuilding projections. The assumption that was used in all the assessments was that the catch in 2008 would be equal to that in 2007. An alterative assumption that F 2008 equal F 2007 was not considered as robust. The Panel recognized however, that it is optimal to use the observed catch in projections.

Stock Assessments

In evaluating the assessment models, assumptions and results of each stock, the Panel considered the following:

a.) Was the assessment consistent with previously agreed standards and recommendations?
b.) Has the assessment incorporated new information appropriately?
c.) Comment on the sufficiency of stock assessment for management purposes (i.e. stock status)
d.) Provide suggestions for improvement of stock assessments and ecosystem models.
e.) If necessary, the Panel should attempt to reconcile differences between stock assessment formulations, and then recommend what is most appropriate. The rationale for the recommendation and its uncertainty should be described

The Panel's conclusions and research recommendations on each of the stock assessments are provided below. These address items 3 – 5 above which are specific to each stock. Regarding items 1 and 2, the Panel considered that all 19 assessments were consistent with the previously agreed standards and recommendations made at the first three GARM III meetings. Where the previous reviews had recommended explorations of different assessment model assumptions, these were undertaken and provided to the Panel for its consideration. Comment on these is provided, as appropriate, below. The Panel also considered that the 19 assessments had incorporated the most recent information appropriately. Considerable attention was paid at the meeting to the examination of model fit to these data to ensure that the models recommended at the previous GARM III meetings remained valid. Where issues remained, these are commented on below.

All of the assessments except white hake were carried out using the methods implemented and documented in the NOAA Fisheries Toolbox (2008) *[http://nft.nefsc.noaa.gov]*. The assessment model for white hake (Age Structured Production Model--ASPM) was developed by Butterworth and Rademeyer (2008) . More details are provided in Chapter L.