

## EXECUTIVE SUMMARY

The Groundfish Assessment Review Meeting (GARM), a regional peer-review process developed to provide assessment updates for the 19 stocks managed under the Northeast Multispecies Fishery Management Plan (Multispecies FMP), occurred during 15-19 August, 2005, in Woods Hole, Massachusetts. The Terms of Reference were as follows:

Using models or proxy methods employed at the 2002 Groundfish Assessment Review Meeting (GARM) and subsequent SARC or TRAC meetings for the stocks listed below:

- (a) provide updated catch information (landings and discards, where appropriate) for the stocks to be assessed. Catch-at-age data (based on port sampling) will be estimated, where applicable,
- (b) provide updated research vessel survey indices (through spring 2005) for all appropriate survey series, including NMFS spring and autumn series, Canadian series, and state survey series,
- (c) for stocks where sufficient data are available, estimate 2004 fishing mortality rates and spawning stock biomass, and provide estimates of 2005 stock sizes and associated measures of uncertainty,
- (d) for the remaining stocks where sufficient landings and survey data are available, use proxy methods to estimate the 2004 exploitation ratio and biomass index,
- (e) evaluate stock status relative to applicable Amendment 13 biological reference points ( $F_{MSY}$  and  $B_{MSY}$ ;) and relative to Amendment 13 projected  $F$ , biomass and catches.

Assessments through calendar year 2004 were reviewed for the following stocks:

- A. Georges Bank Cod
- B. Georges Bank Haddock
- C. Georges Bank Yellowtail Flounder
- D. So. New England/Mid-Atlantic Yellowtail Flounder
- E. Gulf of Maine/Cape Cod Yellowtail Flounder
- F. Gulf of Maine Cod
- G. Witch Flounder
- H. American Plaice
- I. Gulf of Maine Winter Flounder
- J. So. New England/Mid-Atlantic Winter Flounder
- K. Georges Bank Winter Flounder
- L. White Hake
- M. Pollock
- N. Acadian Redfish
- O. Ocean Pout
- P. Gulf of Maine/Georges Bank Windowpane
- Q. So. New England/Mid-Atlantic Windowpane
- R. Gulf of Maine Haddock
- S. Atlantic Halibut

The GARM Panel first reviewed a summary of management measures implemented during 2002-2004. This was followed by a presentation by NEFSC staff on the precision and accuracy of fish ages derived by fish scales. Details of each stock assessment are found in Section 2 of this report. The following section provides a synthesis of the overall pattern of changes across stocks.

## Stock Assessment Results

Of the 18 stocks for which  $F_{MSY}$  (or its proxy) could be estimated, 10 were fished below  $F_{MSY}$  in 2004, and 8 above. Additionally, the biomasses of 6 of the 19 stocks for which  $B_{MSY}$  (or its proxy) could be estimated were at or above  $\frac{1}{2} B_{MSY}$ , while the biomasses of 13 stocks were below the threshold.

Stock biomasses have increased in only 6 of the 19 stocks since 2001. For the six stocks that increased in biomass between 2001 and 2004, the average increase was 50%. For the remaining stocks, the average decrease was 19%. For Georges Bank yellowtail flounder, alternative model formulations were used for assessment (denoted as GB YT1 and GB YT2, see Chapter C). One model suggested that the biomass increased (GB YT1) while the other (GB YT2) suggested a decrease. If model GB YT1 is used then 7 stocks increased. Landings of the complex of 19 groundfish stocks have declined by 7% since 2002, driven primarily by decreases in landings of Georges Bank cod and American plaice but offset primarily by increases in landings of Georges Bank haddock and pollock.

Fishing mortality (F) rates declined for 13 of 19 stocks between 2001 and 2004. For the 13 stocks where F declined, the average percent decline was 50% (range: 1% to 80%). For the 6 stocks where F increased, the average percent increase was 49% (range: 31% to 73%). The 6 stocks showing increases in F since 2001 were Georges Bank haddock (39%), Georges Bank yellowtail flounder (GB YT2 140%), Gulf of Maine cod (75%), Georges Bank winter flounder (50%), Gulf of Maine haddock (50%), and Atlantic halibut (50%).

Four stocks continue to exhibit high fishing mortality rates compared to their  $F_{MSY}$  reference levels. Cape Cod/Gulf of Maine and Southern New England/Mid-Atlantic yellowtail flounder fishing mortality rates in 2004 were at least three times their respective  $F_{MSY}$  levels, compared to over five times the  $F_{MSY}$  levels in 2001. Gulf of Maine cod and white hake experienced fishing mortality levels in 2004 that were at least two times their respective  $F_{MSY}$  levels. Mortality for these two stocks has increased since 2001. Fishing mortality for these four stocks also exceeded Amendment 13 targets for fishing years 2004-2005. Cape Cod/Gulf of Maine yellowtail flounder, Gulf of Maine Cod, and Southern New England/Mid-Atlantic yellowtail flounder were about three times the Amendment 13 targets, while white hake was 15% above the Amendment 13 target.

Two additional stocks, Georges Bank yellowtail flounder and Georges Bank winter flounder, exhibited fishing mortality rates in 2004 that are well above their respective  $F_{MSY}$  levels. The 2002 GARM assessments indicated that fishing mortality in 2001 for both of these stocks was less than  $F_{MSY}$ . The current assessments, however, now estimate that in 2001 Georges Bank yellowtail flounder fishing mortality was three times the  $F_{MSY}$  level, and Georges Bank winter flounder mortality was above  $F_{MSY}$ .

Changes can be seen in the status of the stocks from 2001 to 2004, as determined by the current assessments, by comparing Figures 1 and 2. Stocks falling into each category are listed in Table 1.

The number of stocks where biomass was below  $\frac{1}{2} B_{MSY}$  remained the same, 12 below and 6 at or above  $\frac{1}{2} B_{MSY}$ , although there were changes in the stock composition of the categories. The number of stocks where F exceeded  $F_{MSY}$  declined from 11 in 2001 to 8 in 2004 and the number of stocks where biomass was below  $\frac{1}{2} B_{MSY}$  and F exceeded  $F_{MSY}$  declined from 9 in 2001 to 7 in 2004.

Direct comparisons between the state of these stocks in 2001 and 2004 are also provided in Figures 3 and 4. Stocks showing substantial decreases in the ratio of F to  $F_{MSY}$  include Georges Bank Cod, Southern New England/Mid Atlantic and Cape Cod/Gulf of Maine yellowtail flounder, Gulf of Maine winter flounder, Southern New England/Mid Atlantic winter flounder, witch flounder, and American plaice. For stocks with F to  $F_{MSY}$  ratios above one, fishing mortalities have increased for Gulf of Maine cod, Georges Bank yellowtail flounder and Georges Bank winter flounder.

Stocks showing substantial increases in the ratio of B to  $B_{MSY}$  include Gulf of Maine winter flounder, witch flounder, pollock, and redfish. Georges Bank haddock and white hake also increased in biomass but are still below  $\frac{1}{2} B_{MSY}$ .

Stocks where the ratio of B to  $B_{MSY}$  have decreased by more than 25% include Southern New England/Mid Atlantic yellowtail flounder, Cape Cod/Gulf of Maine yellowtail flounder, Gulf of Maine haddock and ocean pout.

Table 1. Classification of 18 groundfish stocks in 2004 and 2001 from the current assessments compared to classification from the 2002 assessment.

Stock Status	Results from Current Assessments		Results from 2002 GARM
	2004	2001	2001
Biomass <1/2 Bmsy AND F > Fmsy	GB Cod GB YT SNE/MA YT CC/GOM YT SNE/MA Winter W Hake GOM Cod	GB Cod GB YT SNE/MA YT CC/GOM YT SNE/MA Winter W Hake GOM Cod Witch GOM Winter	GB Cod  SNE YT and MA YT CC YT SNE/MA Winter W Hake GOM Cod  Plaice
Biomass < 1/2 Bmsy AND F < Fmsy	GB Haddock GOM Haddock So. Window Plaice Pout	GB Haddock GOM Haddock So. Window	GB Haddock GOM Haddock So. Window
Biomass > 1/2 Bmsy AND F > Fmsy	GB Winter	GB Winter Plaice	Witch
Biomass > 1/2 Bmsy AND F < Fmsy	Pollock Redfish No. Window  GOM Winter  Witch	Pollock Redfish No. Window Pout	Pollock Redfish No. Window Pout GOM Winter GB Winter GB YT

## Groundfish Stock Status - 2001

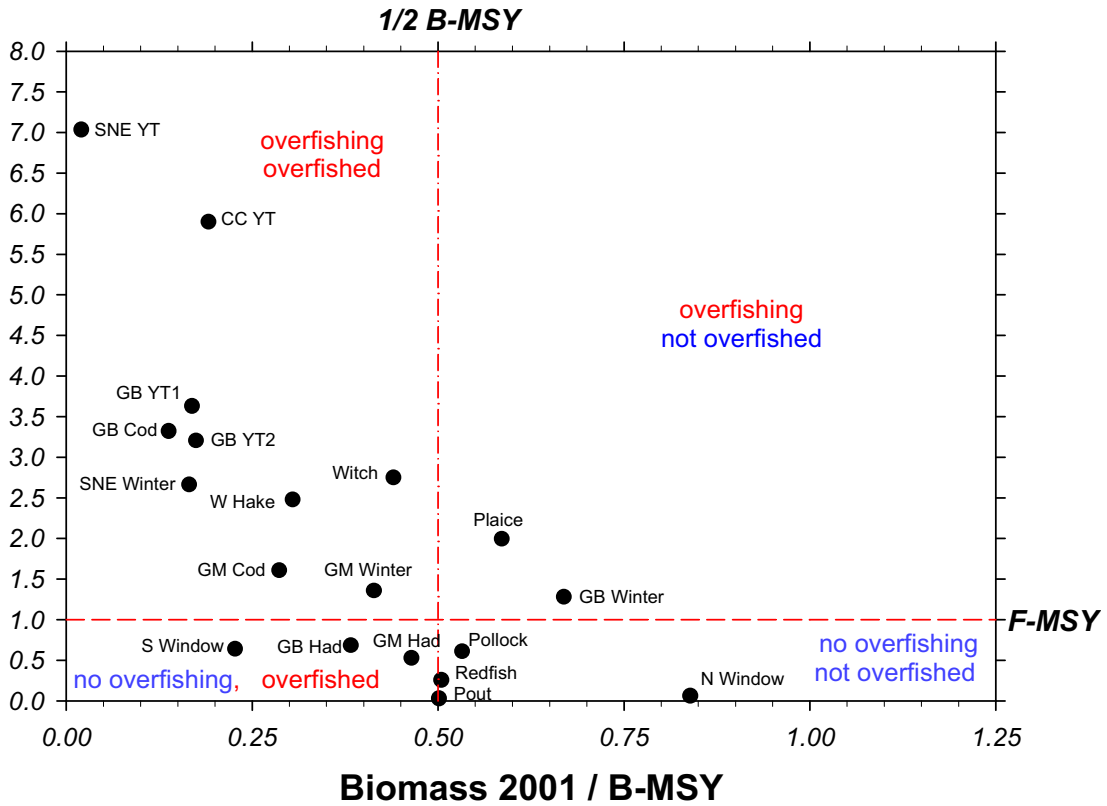


Figure 1. State of 18 groundfish stocks in 2001 with respect to  $F_{MSY}$  and  $B_{MSY}$  based on the current assessment.

## Groundfish Stock Status - 2004

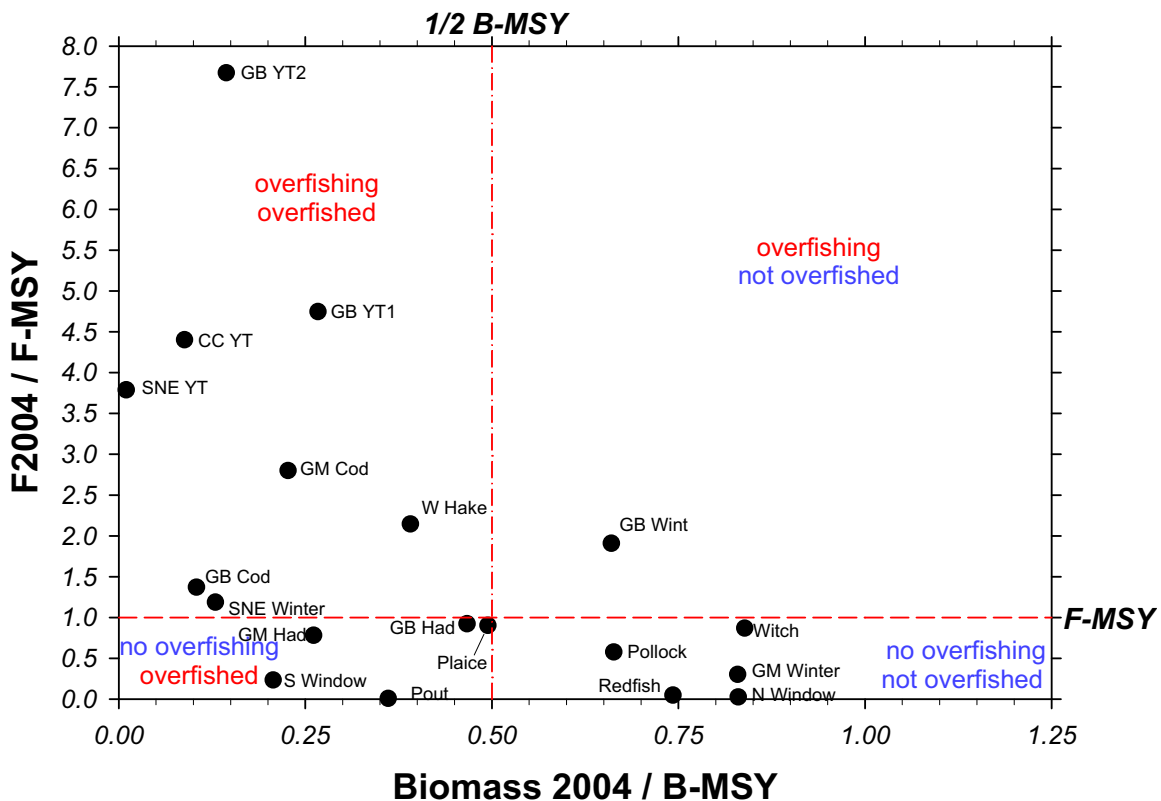


Figure 2. State of 18 groundfish stocks in 2004 with respect to  $F_{MSY}$  and  $B_{MSY}$ .

F 2001 and F 2004 as a Proportion of F-MSY

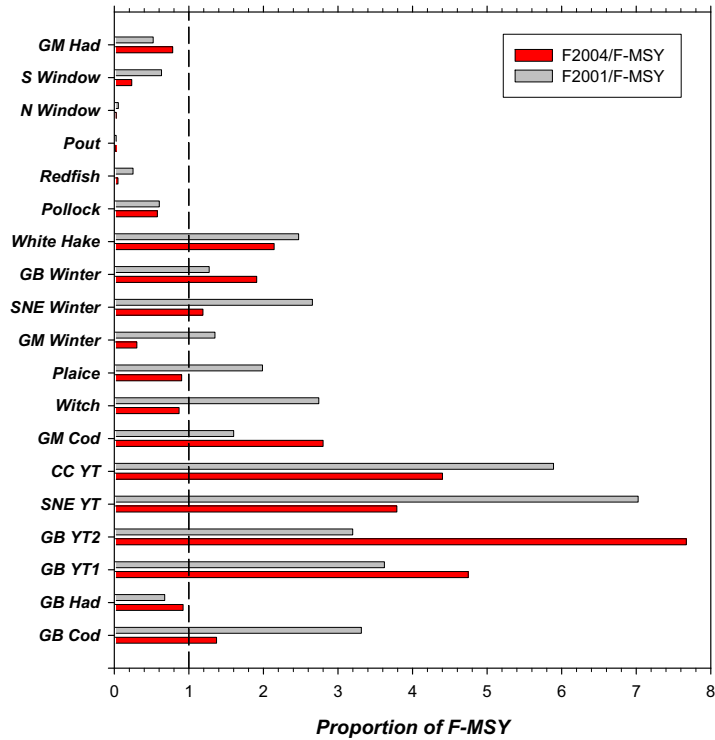


Figure 3. Comparisons between 2001 and 2004 F with respect to  $F_{MSY}$  based on the current assessment.

B 2001 and B 2004 as a Proportion of B-MSY

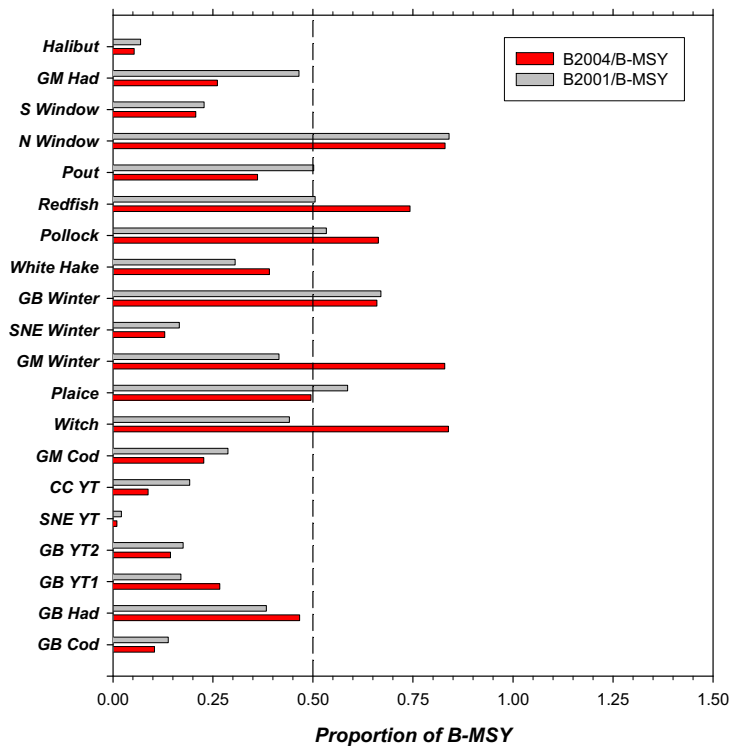


Figure 4. Comparisons between 2001 and 2004 stock biomass with respect to  $B_{MSY}$  based on the current assessment.

## Generic Issues

Three substantial issues affecting interpretation of the current assessment results were discussed by the GARM panel.

- Some stock assessments display relatively strong retrospective patterns in F, SSB and recruitment. The extent of the retrospective patterns was quantified to allow for comparisons among assessments.
- Many stocks exhibit persistent declines in mean weights at age over the most recent 5 years
- The 2004 commercial landings data were collected in a different manner after May 1, 2004. This change in procedure to self-reporting appears to have introduced additional uncertainty in the proration of total landings to stock area. In addition, lack of identifiers in the commercial landings records for B DAS trips and SAPs is problematic.

A summary of the GARM discussion on each of these issues is given in the full report. The discussion and a summary of the retrospective patterns observed in the age structured assessments follow.

### Retrospective Patterns

Retrospective patterns are consistent changes in estimated quantities that occur when additional years of information are added to a model. There are two types of retrospective patterns: historical and within model. The historical retrospective analysis is conducted by examining the results of each final assessment for a number of successive years and determining whether there was a consistent pattern between assessments of overestimating or underestimating values such as fully recruited fishing mortality rate, spawning stock biomass, or recruitment in successive years; for example, by comparing results for assessments conducted at the 2002 GARM with current assessments (Table 1). This type of retrospective pattern can be caused by changes in the data, type of assessment model, or assessment model formulation.

Within-model retrospective analysis uses the same data, type of assessment model, and assessment model formulation and trims the most recent year's data in successive model runs. The within model retrospective patterns are most useful for determining if there is an internal inconsistency in the data because the only changes in the different runs are the number of years of data in the model. Within-model retrospective analyses were conducted for all eleven age-based stock assessments.

The within-model retrospective pattern can be clearly seen in the plot of fully-recruited F (Figure C4 in Section 2) for Georges Bank yellowtail flounder under the "Base Case" model formulation. As additional years of data are added, the 1999 value of fully-recruited F is consistently revised upward, from 0.16 in the model ending in year 1999, to 0.25 in the model ending in year 2000, and so on to 0.69 in the model ending in year 2004. Due to the backward convergence of virtual population analysis (VPA), the estimates are the same from all models for years 1973-1991.

Retrospective patterns are not an intrinsic property of VPA as they are not seen in some VPA results, such as for Georges Bank haddock. Moreover, retrospective patterns have been observed in other types of stock assessment models, including forward projecting models. Causes of

retrospective patterns vary among assessments but have been attributed to missing catches, changes in natural mortality, stock misidentification, and changes in index catchability (Mohn 1999, Cadigan and Farrell 2005).

There are many different ways to quantify within-model retrospective patterns. The one-year update at the terminal year of each assessment was selected here to reflect how the terminal year estimate is changed with the addition of one year of data. This metric is computed as the relative change in the terminal year value to its new estimate as the terminal year is increased by one. The Georges Bank yellowtail flounder “Base Case” model formulation is used to illustrate this process. For example, the 1999 fully-recruited  $F$  in the assessment ending in 1999 was 0.16 while the 1999 fully-recruited  $F$  in the assessment ending in 2000 was 0.25, producing a retrospective statistic of  $(0.25-0.16)/0.16 = 56\%$ . The statistic is computed for the 2000 estimate by comparing results for assessments ending in 2000 and 2001. Estimates for subsequent years are computed in an analogous manner such that the estimate for 2003 is based on a comparison of the estimated values assessments ending in 2003 and 2004. The arithmetic averages of these five statistics for 1999 to 2003, along with their minimum and maximum values, are shown in Figure 5 for fully recruited  $F$ , spawning stock biomass, and recruitment.

Stocks that are completely above or below the line demonstrate a strong retrospective pattern over the past five years, and those with means farther away from zero have stronger retrospective patterns than those with means closer to zero. Based on the one year updates over the past five years, the Georges Bank yellowtail flounder Base Case, Gulf of Maine winter flounder, witch flounder and Southern New England winter flounder demonstrate strong retrospective patterns in both fully recruited  $F$  and spawning stock biomass. Strong retrospective patterns in recruitment were observed for Cape Cod-Mid Atlantic yellowtail flounder, Gulf of Maine winter flounder, and Southern New England winter flounder. The fully-recruited  $F$  and spawning stock biomass relative changes are usually in opposite directions because the catch is constant (i.e., not estimated by the model) and fully-recruited  $F$  often occurs on ages that contribute most to the calculation of spawning stock biomass. In general retrospective patterns in recruitment do not correspond to either the fully-recruited  $F$  or the spawning stock biomass due to the differences in ages.

Demonstration of past retrospective patterns does not mean that the pattern will continue into the future, but should be used as a warning sign that more caution should be used when setting management measures. Since retrospective patterns have been observed to flip from positive to negative with no apparent explanation, ad hoc adjustments for retrospective patterns are not recommended. There is no apparent scientific consensus on methods for correcting for retrospective patterns. Recent papers on retrospective patterns have provided valuable insights on the sensitivity of models to changes in underlying data or parameters (Cadigan and Farrell 2005). However, the same authors have refrained from recommending adjustments without strong external evidence. Without such evidence retrospective patterns should be considered as an additional source of uncertainty in the assessment. This uncertainty is also relevant for the development of precautionary management regulations.

## Changes in Average Weights at Age

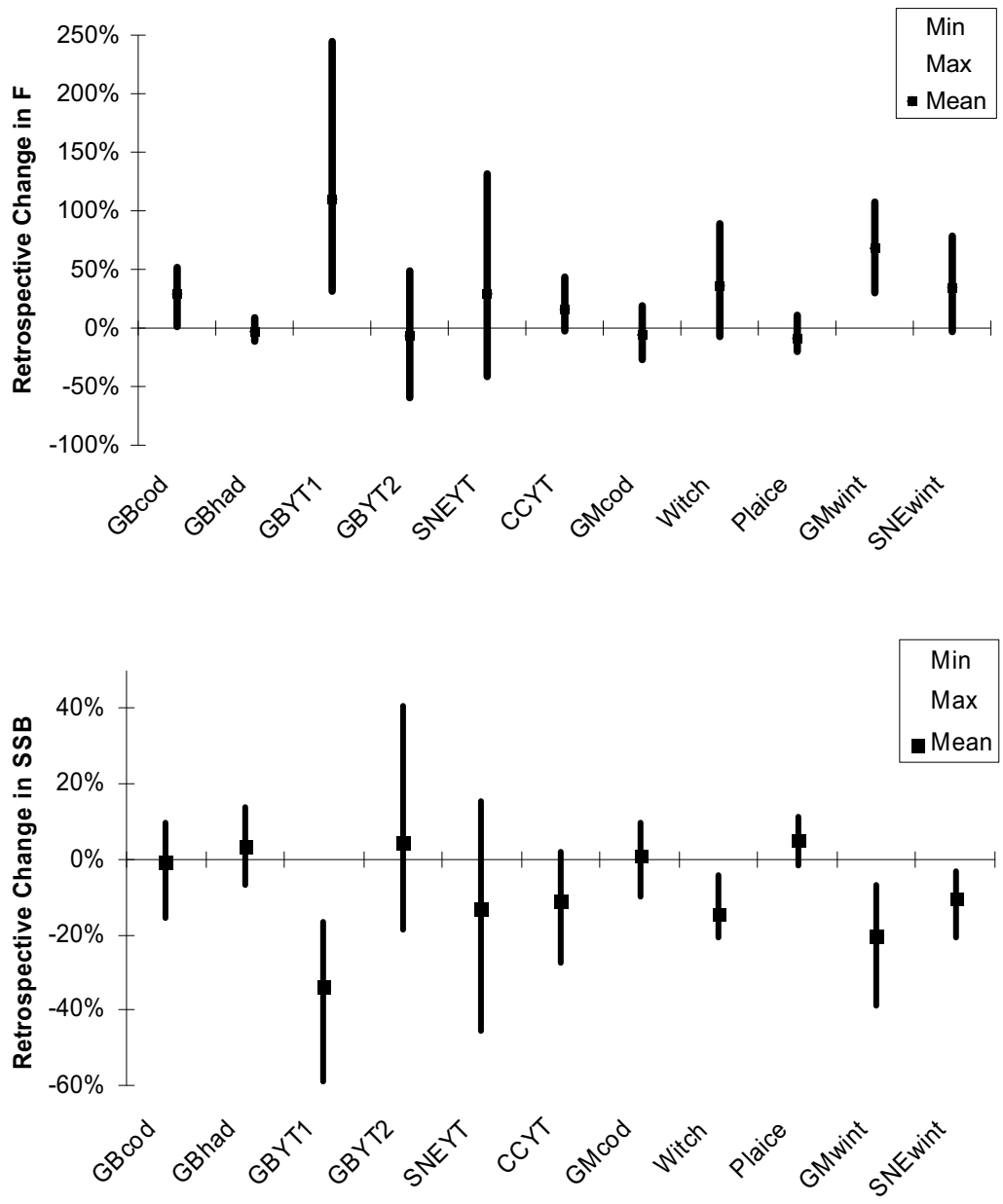
Reductions in average weights-at-age were noted in some of the ten VPA-based assessments. Possible causes for the apparent declines were identified, but a detailed discussion of the causal mechanisms and supporting evidence is beyond the scope of the GARM. Inferences about the reductions in average weight-at-age are based on the values used in the assessment model and are defined as the “Stock Weights”. To confirm that these changes were not simply artifacts of fishery changes, it was only possible to review average weights-at-age in the survey for Georges Bank haddock.

In general terms, the magnitude of the changes in average weight-at-age varied by plus or minus 30% over the last decade. To illustrate the pattern of changes across species and years, the average weights at age were binned by quintile intervals (i.e., 1=0-20%-ile, 2=21-40%-ile, 3=41-60%-ile, 4=61-80%-ile, 5=81-100%-ile). On Georges Bank, average sizes of both cod and haddock fall into the lowest quintile in recent years. Georges Bank yellowtail flounder exhibited smaller than average sizes at age between 1990 and 1997 but have rebounded slightly since then. In the Gulf of Maine, average weights of cod and yellowtail flounder do not show a consistent pattern across ages since 2000. In contrast, winter flounder, American plaice and witch flounder have average weights in the lowest quintile in recent years. Southern New England stocks of yellowtail flounder and winter flounder have average weights in the highest quintiles in recent years.

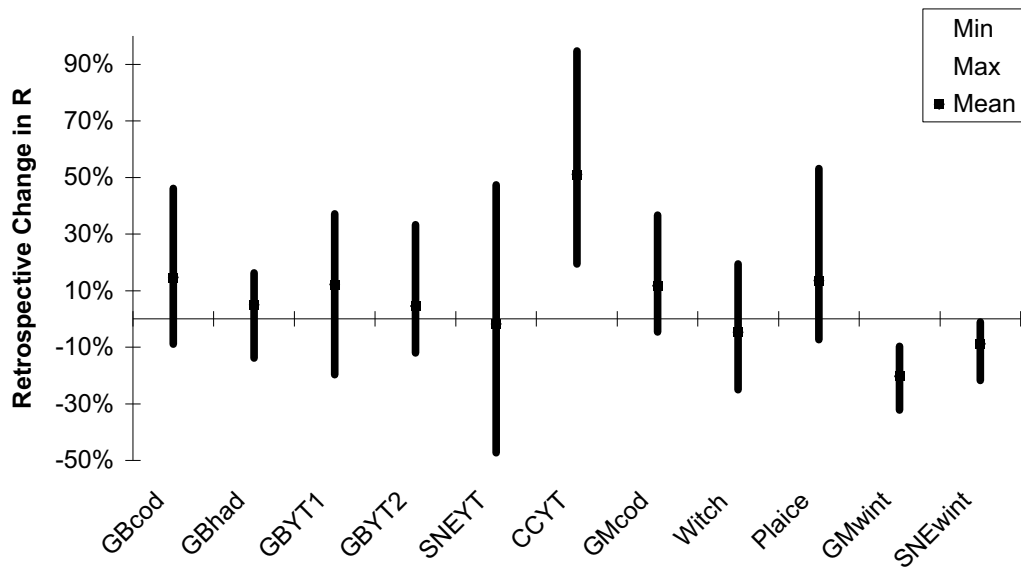
## 2004 Commercial Fishery Landings Data

Mandatory Dealer Electronic Reporting (DER) was implemented on May 1, 2004 as part of Amendment 13. The Dealers were not required to report the gear type used by the fishermen, and consequently a high proportion of the 2004 landings were reported without identifying gear type. The gear information in 2004 Vessel Trip Report (VTR) data was used to augment the 2004 landings data. Another data issue in the 2004 landings data is the identification of trips participating in the various Special Access Programs (SAPs) allowed under Amendment 13. The 2004 DER and VTR databases do not identify whether trips fished in a SAP or in the US/CAN Resource Sharing Area. Thus, trip and landings data could not be partitioned appropriately to correspond to SAP-specific discard ratios derived from the Fisheries Observer Program. Finally, since State data and late Dealer data continue to enter the data collection system after the end of the calendar year, the 2004 landings are subject to changes over time.





**Figure 5.** Arithmetic average, minimum and maximum of one year retrospective change in terminal year estimates of fully recruited fishing mortality (F), spawning stock biomass (SSB), and recruitment (R) over the past five years for each of the age based assessments.



**Figure 5 (continued).**

### Projected vs. Realized Catches

Subsequent to the 2002 GARM, projections were carried out to evaluate rebuilding strategies. Total catches were derived from the final projections conducted under either the phased or adaptive strategy for the age-based stocks, and for the index stocks based on the 3-year average survey biomass index and an assumed population growth. From 2002 to 2004 the total realized catches for all stocks were 18% less than projected (see Table 3.2 in Section 3). Differences ranged from -95% for Gulf of Maine/Georges Bank windowpane flounder to + 29 % for white hake (>60 cm). Realized catches for most of the gadids and flounders fell short of projections by about 10 to 30% except for Gulf of Maine cod where realized catches exceeded projections by 11% and Gulf of Maine winter flounder where realized catches fell short of projections by 60%. In 2002 realized catches exceeded projections by 4%, but in 2003 and 2004, realized catches were 18% and 33%, respectively, below the projections.

## List of Stock Abbreviations

This report represents the work of 15 authors and a variety of abbreviations are used throughout the report. These are necessary for both graphical and tabular summaries. For clarity, a list of abbreviations is provided below.

<u>Chapter</u>	<u>Stock</u>	<u>Abbreviation</u>
A.	Georges Bank Cod	GB COD
B.	Georges Bank Haddock	GB Had, GB Haddock
C.	Georges Bank Yellowtail Flounder	GBYT GBYT1—refers to base model GBYT2—refers to “major change” model
D.	So. New England/Mid-Atlantic Yellowtail Flounder	SNE/MA YT
	So. New England Yellowtail Flounder (before 2003)	SNE YT
	Mid-Atlantic Yellowtail Flounder (before 2003)	MA YT
E.	Gulf of Maine/Cape Cod Yellowtail Flounder	CC/GOM YT
	Cape Cod Yellowtail Flounder	CC YT
F.	Gulf of Maine Cod	GOM Cod
G.	Witch Flounder	Witch
H.	American Plaice	Plaice
I.	Gulf of Maine Winter Flounder	GOM Win, GM Wint
J.	So. New England/Mid-Atlantic Winter Flounder	SNE/MA Wint, SNE Wint
K.	Georges Bank Winter Flounder	GB Wint
L.	White Hake	W Hake
M.	Pollock	Pollock
N.	Acadian Redfish	Redfish
O.	Ocean Pout	Pout
P.	Gulf of Maine/Georges Bank Windowpane	No. Window, N Wind
Q.	So. New England/Mid-Atlantic Windowpane	So. Window, S Wind
R.	Gulf of Maine Haddock	GOM Had
S.	Atlantic Halibut	Halibut