Northeast Fisheries Science Center Reference Document 05-13

A Report of the Stock Assessment Workshop (SAW)
Northern and Southern Demersal Working Groups

Assessment of 19 Northeast Groundfish Stocks through 2004

2005 Groundfish Assessment Review Meeting (2005 GARM), Northeast Fisheries Science Center, Woods Hole, Massachusetts, 15-19 August 2005

by

Ralph K. Mayo and Mark Terceiro, editors

September 2005

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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-AtlanticYellowtail 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 ½ 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 ½ B_{MSY} remained the same, 12 below and 6 at or above ½ 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 ½ 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 ½ 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.

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

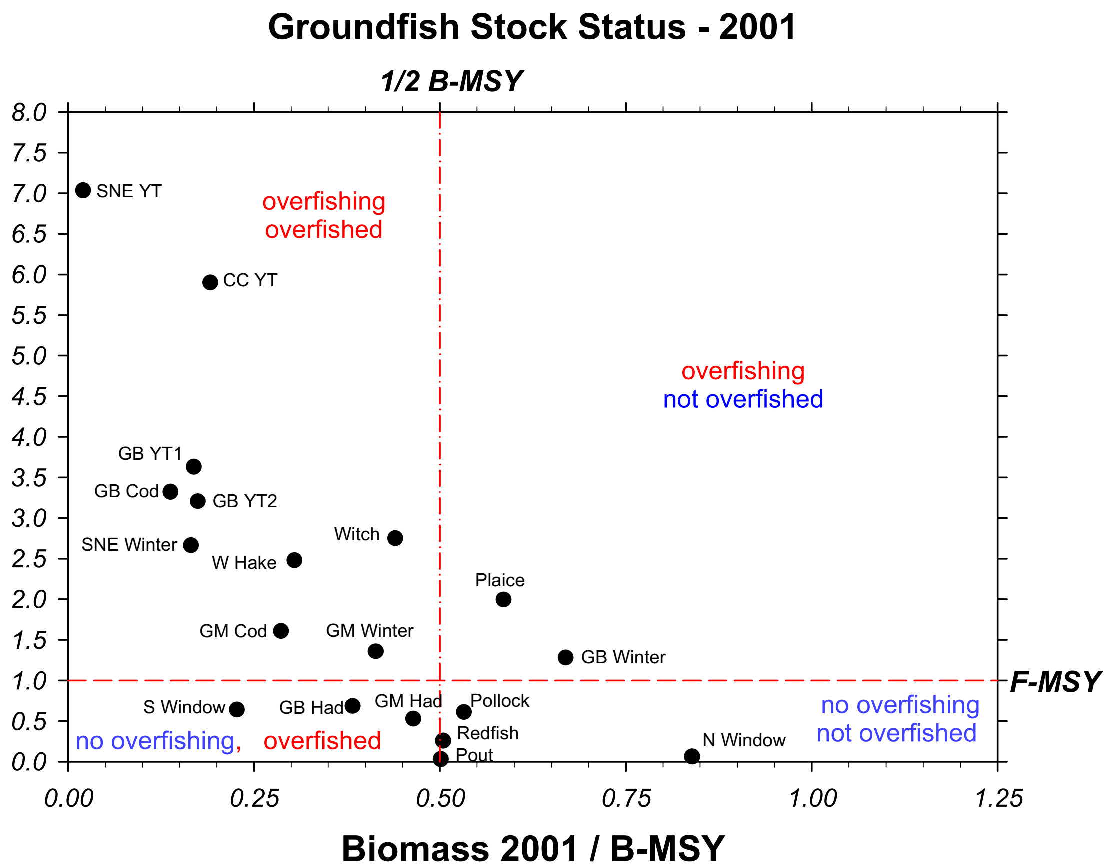

Figure 1. State of 18 groundfish stocks in 2001 with respect to F_{MSY} and B_{MSY} based on the current assessment.

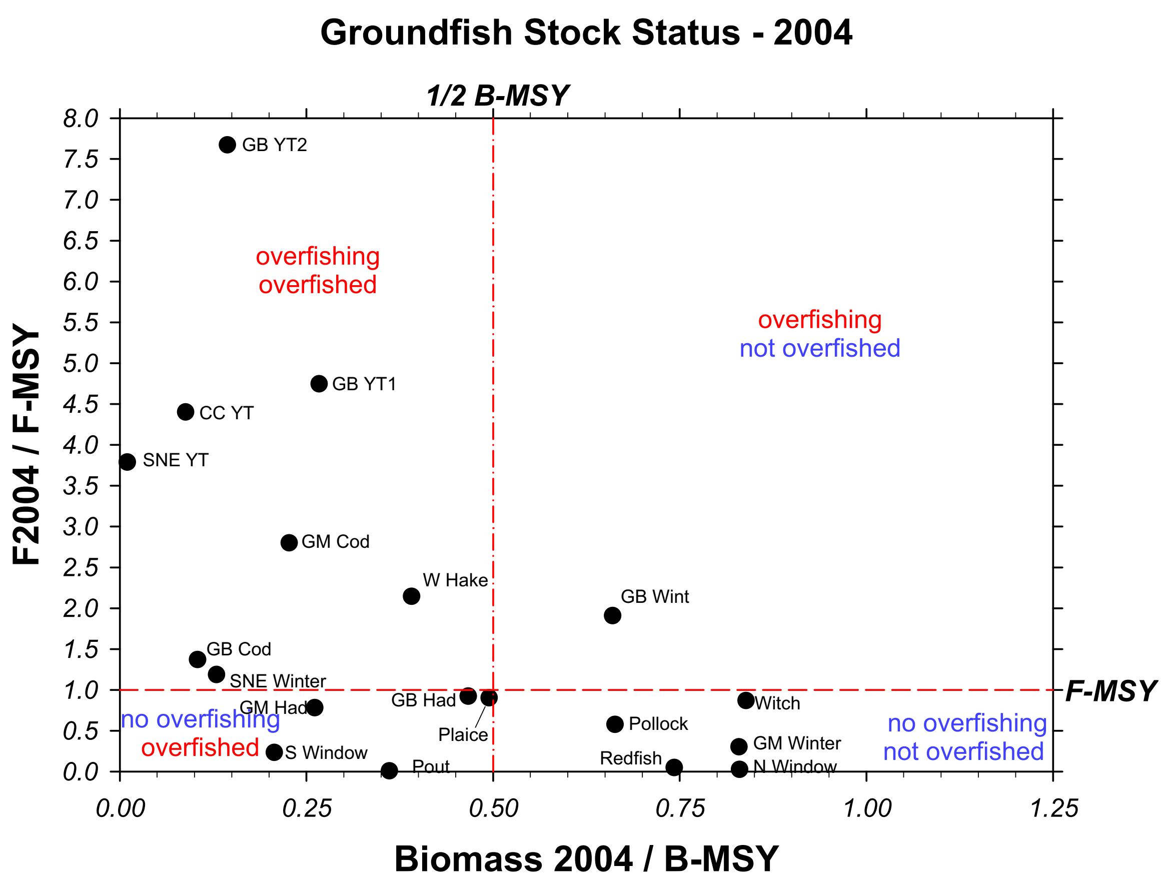

Figure 2. State of 18 groundfish stocks in 2004 with respect to F_{MSY} and B_{MSY}.

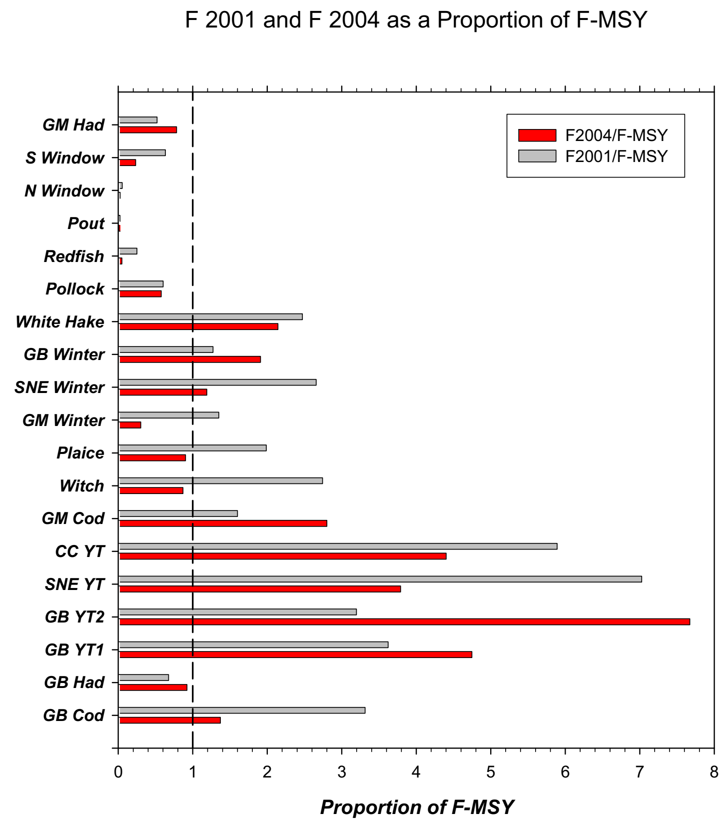

Figure 3. Comparisons between 2001 and 2004 F with respect to F_{MSY} based on the current assessment.

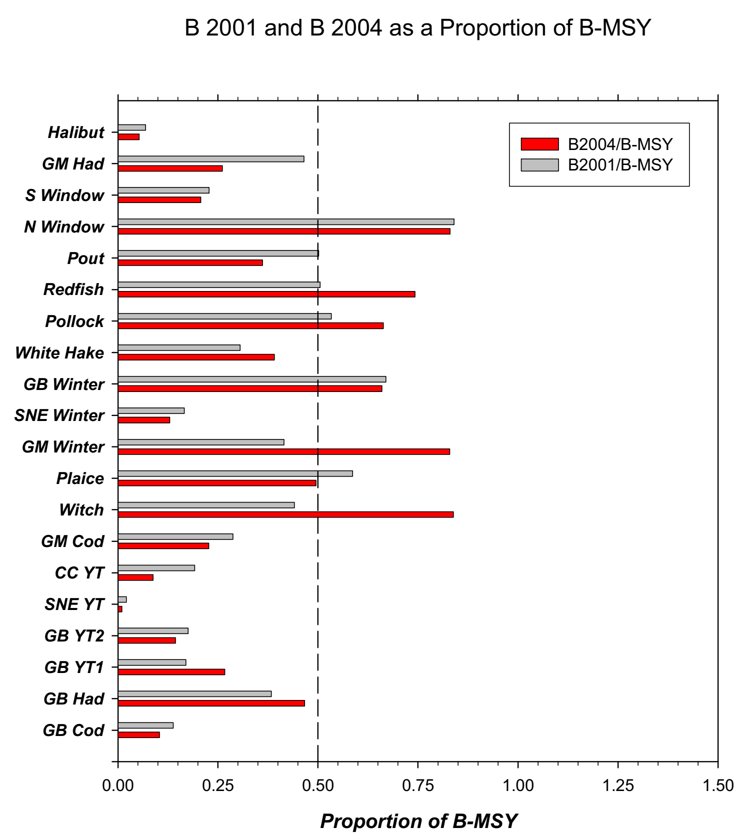

Figure 4. Comparisons between 2001 and 2004 stock biomass with respect to B_{MSY} based on the current assessment.

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.

<u>Retrospective Patterns</u>

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.

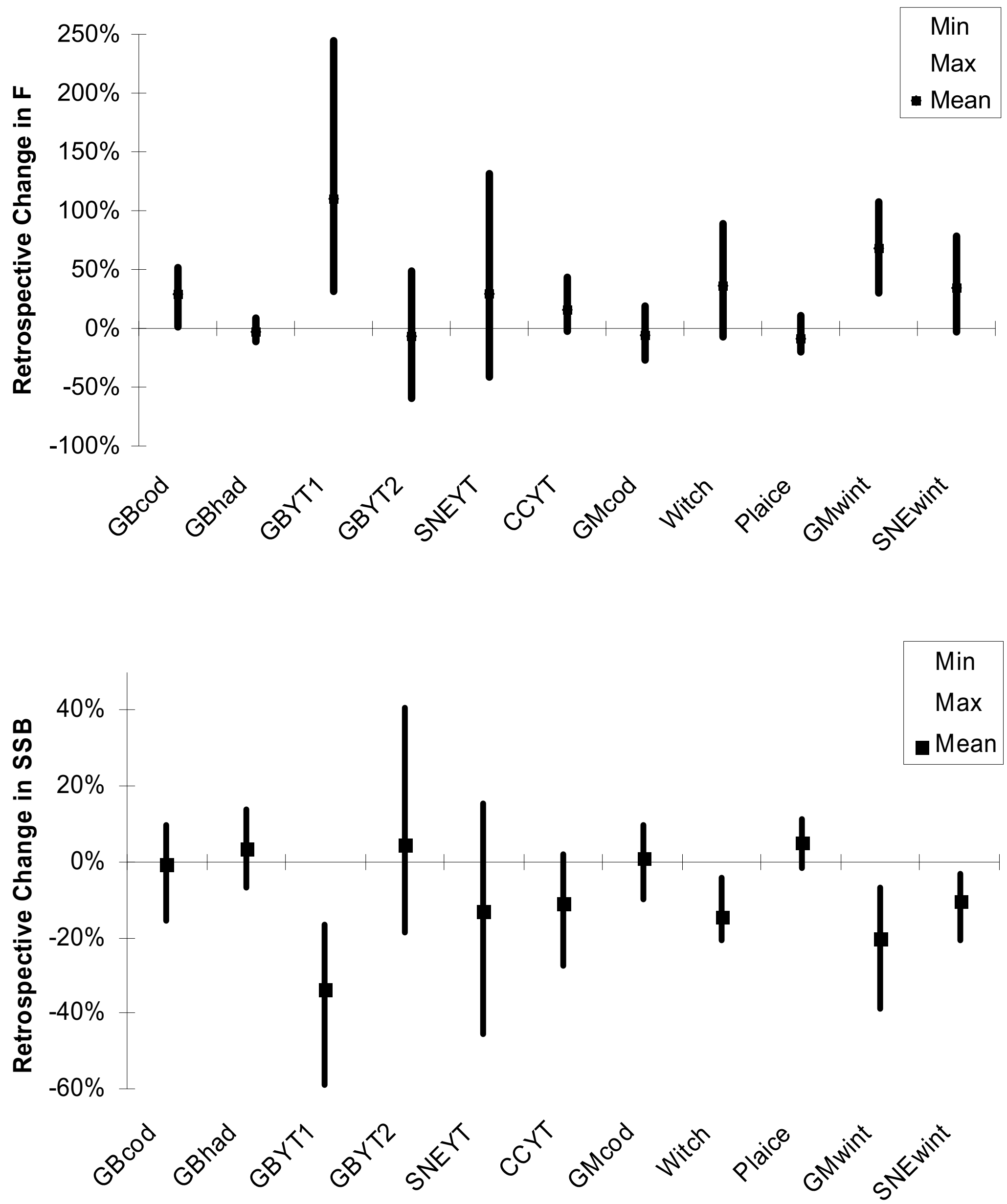

Figure 5. Arithmetic average, minimum and maximum of one year retrospective change in terminal year estimates of fully recruited fishing mortality (F), spawning stock biomass (SSB), and recruitment (R) over the past five years for each of the age based assessments.

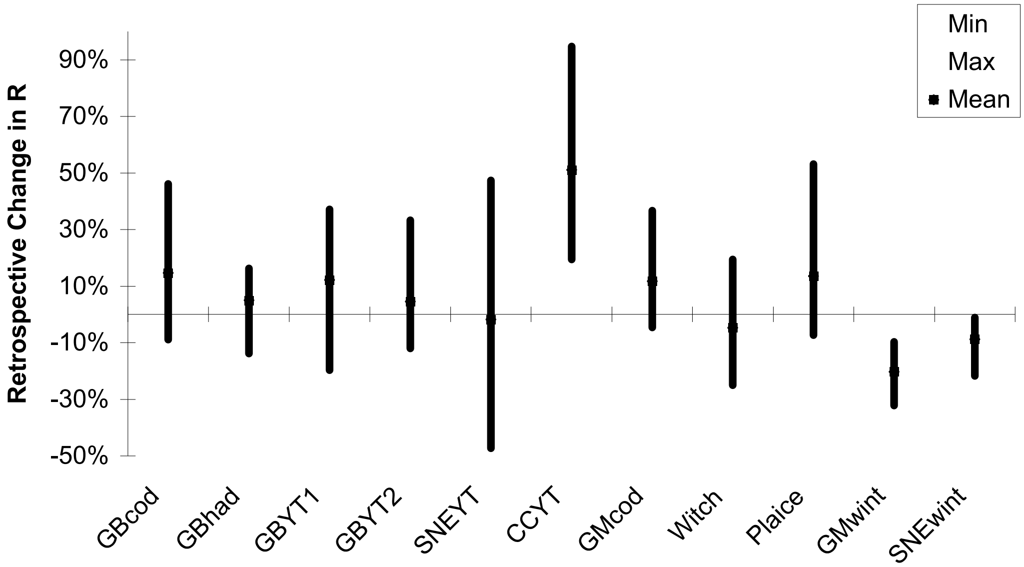

Figure 5 (continued).

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.

Chapter	Stock	Abbreviation
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-AtlanticYellowtail 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

Section 1

1.1 Introduction

The Groundfish Assessment Review Meeting (GARM) is a regional peer review process developed in 2002 to provide assessment updates for the stocks managed under the Northeast Multispecies Fishery Management Plan (Multispecies FMP). The first meeting (GARM I) occurred during October 8-11, 2002, in Woods Hole, Massachusetts. The GARM is distinct from the Northeast Stock Assessment Review Committee (SARC) process, which produces "benchmark" stock assessments. The purpose of the GARM is to provide assessment updates, using existing model formulations and data sources. The goals of the GARM are to provide peer review of assessment updates, summarize stock status for individual components and the resource as a whole, and provide estimates of adjustments in fishing mortality rates, as necessary, to achieve biological reference points. The GARM provides comments and recommendations regarding specific stock assessments and generic data collection and analysis procedures.

Background and History

In the Northeast region, stock assessments are peer reviewed through the Northeast Regional Stock Assessment Workshop (SAW) process. The SAW provides for a thorough review of new or revised stock assessments. Many stocks are reviewed every two to five years. In addition, the transboundary Georges Bank stocks of cod, haddock and yellowtail flounder are jointly assessed by Canadian and US scientists at regular meetings of the Transboundary Resource Assessment Committee or TRAC. Since the SAW cannot reassess every stock every year, the assessment peer review process also includes more frequent stock assessment updates to ensure that management actions are based on the most recent status information available.

There are 12 species of groundfish, comprising 19 distinct stocks, managed under the New England Fishery Management Council's Northeast Multispecies Fishery Management Plan (Groundfish FMP). The status of 11 stocks in the complex was updated in 1999 (NEFSC 2000), and the status of 19 stocks was updated in 2000 (NEFSC 2001) to provide current status information relevant to annual management adjustments.

The status of 20 stocks was updated at GARM I (NEFSC 2002a) with the inclusion of Gulf of Maine winter flounder. GARM II reviewed assessments for 19 stocks, one less stock compared to GARM I. Following the completion of the assessment update at GARM I, SAW 36 reviewed a proposed combined Southern New England–Mid Atlantic assessment of yellowtail flounder and concluded that these should be assessed as a single unit stock. SAW 36 also reviewed a revised Cape Cod yellowtail flounder assessment that included additional areas in the Gulf of Maine and concluded that the Gulf of Maine/ Cape Cod yellowtail flounder should be assessed as a single unit stock.

SAW 36 also reviewed a Gulf of Maine winter flounder VPA-based assessment developed by the ASMFC Technical Committee, and this assessment approach is included in the present GARM II update.

1.2 Terms of Reference

Terms of reference for the meeting were:

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.

1.3 Participants

The following individuals participated in some or all of GARM II (August 15-19, 2005):

Name	***Affiliation***	***Email***
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1.4 Assessed Stocks

The GARM reviewed the status of 19 fishery stocks included as the large mesh species complex in the Northeast Multispecies Fishery Management Plan (FMP). Stocks considered at this meeting (and letter designations of order in the report) are:

A. Georges Bank Cod
B. Georges Bank Haddock
C. Georges Bank Yellowtail Flounder
D. So. New England/Mid-AtlanticYellowtail 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

1.5 Overview

Most stock assessments reviewed at the GARM were routine updates of assessments previously reviewed in the SAW or elsewhere. Accordingly, the details of the analytical stock assessment modeling are not incorporated herein but are described in relevant references. The results are, however, summarized and input data are presented and evaluated.

The GARM meeting incorporated peer reviews by both regional stock assessment scientists (both NMFS and non-NMFS people) and external experts from the New England Fishery Management Council's Statistical and Scientific Committee.

<u>Review of Amendment 13 Management Measures</u>

Amendment 13 to the NEFMC Multispecies Fishery Management Plan was implemented in May, 2004. A summary of the numerous changes to management measures during 2002 through 2004 was reviewed. Changes in 2002 and 2003 were the result of interim measures that implemented a court order in the case of *CLF et al. v. Evans*. The major changes included a reduction in allocated days-at-sea (DAS), gear changes (including increases in mesh size and limits on the number of gillnets), changes to possession limits, and changes to seasonal/rolling closed areas. Amendment 13 to the Northeast Multispecies FMP was implemented May 1, 2004. The major change in this amendment was the categorization of DAS into four different categories with limits on how those DAS can be used. Most of the gear changes of the interim rule were continued, seasonal/rolling closed areas remained the same, additional possession limits were adopted, and a DAS leasing program allowed the exchange of DAS between permits. A program was adopted to target yellowtail flounder in Closed Area II. Over the course of 2004, two framework adjustments created additional opportunities to target GB haddock and other healthy stocks.

Recent management changes have complicated the assessment process. The creation of different categories of DAS, and the programs that allow their use to target healthy stocks, complicate the estimation of the catch-at-age – in particular because of the different levels of discards that may occur in each program. At present, landings in the dealer and VTR databases cannot be directly attributed to a particular program. Panelists recommend that an identifier be created that attributes landing information to a specific management program. The full report is included as Appendix I.

Review of Ageing Precision and Accuracy

A report was presented describing evaluations of precision and, when possible, accuracy of age data provided for the GARM assessments. These evaluations were based on exercises in which random sub-samples were re-aged and compared against production ageing samples or reference collections. Results indicated high levels of accuracy and precision in age data for Georges Bank stocks of cod and haddock, high levels of precision for Gulf of Maine cod, and reliable levels of age determination consistency for yellowtail flounder, witch flounder, American plaice, winter flounder, and redfish. The full report is included as Appendix II.

Stock Assessment Results

Results of the stock assessment updates are provided as fishing mortality rates and biomasses in 2004, relative to management reference points. The biological reference points (F-MSY and B-MSY) are, in most cases, those developed by the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish (NEFSC 2002b). In one case (white hake) GARM I rejected the analytical stock assessment results (based on an ASPIC surplus production model) and substituted an index-based assessment evaluation and developed appropriate index-based reference points based on the replacement ratio method (NEFSC 2002b) (section 2L). Reference points for Southern New England/ Mid–Atlantic and Gulf of Maine/Cape Cod yellowtail flounder (section 2D and 2E) and Gulf of Maine winter flounder (section 2I) were derived from the analyses reviewed at SAW 36. A detailed summary of each of the 19 stock assessments reviewed at the 2005 GARM is given in Section 2.

1.6 References

NEFSC 2000. Assessment of 11 Northeast Groundfish Stocks through 1999: a report to the New England Fishery Management Council's Multi-Species Monitoring Committee. Northeast Fisheries Science Center Reference Document 00-05, 175 p.

NEFSC 2001. Assessment of 19 Northeast Groundfish Stocks through 2000: a report to the New England Fishery Management Council's Multi-Species Monitoring Committee. Northeast Fisheries Science Center Reference Document 01-20, 217 p.

NEFSC 2002a. Assessment of 20 Groundfish Stocks through 2001. Northeast Fisheries Science Center Reference Document 02-16.

NEFSC 2002b. Final report of the Working Group on re-evaluation of biological reference points for New England groundfish. Northeast Fisheries Science Center Reference Document 02-04. 123 p.

Section 2.

2.1 Stock Assessments

This section contains 19 chapters, each summarizing the results of the 19 stock assessments reviewed at the GARM in August, 2005. Ten stocks were assessed using Virtual Population Analysis (VPA) calibrated using the Adaptive Approach (Parrack 1986, Gavaris 1988, Conser and Powers 1990). One stock was assessed using ASPIC (Prager 2004). Six stocks were assessed using An Index Method (NEFSC 2002) and one stock was assessed using an age structured forward projection method as described in Mayo et al. (2002). The final stock (Atlantic halibut) was not evaluated in any formal modeling context, but changes in biomass and exploitation were noted based on trends in catch and survey biomass indices.

The GARM panel reviewed each assessment and offered suggestions and recommendations related to data quality issues, model formulation, and catch projections to be conducted by the NEFMC Groundfish Plan Development Team. Projection guidance for the age-structured assessments varies among stocks and is specifically provided in each chapter. The GARM Panel agreed to base starting conditions for index-based projections on the most recent 3 years of NEFSC bottom trawl survey biomass indices. The relative F associated with rebuilding is the same as given in Amendment 13. Thus, reference points remain as before.

2.2 References

Conser, R.J. and J.E. Powers. 1990. Extension of the ADAPT VPA tuning method designed to facilitate assessment work on tuna and swordfish stocks. ICCAT, Coll. Vol. Sel. Pap. 32:461-467.

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Mayo, R.K., J. Brodziak, M. Thompson, J.M. Burnett and S.X. Cadrin. 2002. Biological Characteristics, Population Dynamics, and Current Status of Redfish, Sebastes fasciatus Storer, in the Gulf of Maine-Georges Bank Region. NMFS, Northeast Fisheries Science Center Reference Document 02-05, 130 p.

NEFSC 2002. Final report of the Working Group on re-evaluation of biological reference points for New England groundfish. Northeast Fisheries Science Center Reference Document 02-04. 123 p.

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Prager, M.H. 2004. User's manual for ASPIC: a stock production model incorporating covariates (ver.5). Beaufort Lab. Doc. BL-2004-01. 27 p.

A. Georges Bank Atlantic Cod by **L. O'Brien , N. J. Munroe, L. Col**

1.0 Background

This stock was last assessed and peer reviewed in October 2002 (O'Brien *et al.* 2002). Landings were 12,769 mt in 2001 and fully recruited F (ages 4-8, unweighted average) was estimated to be 0.38 in 2001, the second lowest F in the time series (1978-2000). Spawning stock biomass was 29,170 mt in 2001 and continued the increasing trend from the record low estimate of 17,375 mt in 1995. Since 1991, recruiting year classes have all been below the long term average and the 2000 and 2001 year classes were the lowest in the time series. The NEFSC spring and autumn bottom trawl survey indices continued to remain near record low values. Autumn recruitment indices for age 2 fish from the 1994 through 1998 year classes were all below the time series (1963-2000) average. The most recent above average autumn recruitment index occurred in 1993.

The current assessment presented here is considered an update and the methodology has remained the same as in the 2002 assessment (O'Brien *et al.* 2002).

2.0 Fishery

Total commercial landings of Georges Bank cod (Table A1, Figure A1) decreased 20% in 2002 to 10,274 mt, 22% in 2003 to 7,963 mt, and 42% in 2004 to a record-low 4,583 mt. USA landings decreased 67% (3,471mt) and Canadian landings decreased 48% (1,112mt) in 2004 relative to 2001 landings (Table A1). Recreational landings were estimated at 346 mt in 2004, an 11% increase from 2003.

USA landings were dominated in weight by age 4 in 2002, and by age 5 in 2003 and 2004. Canadian landings were dominated in weight by the 1998 year class at age 4 in 2002, at age 5 in 2003 and at age 6 in 2004.

3.0 Research Surveys

NEFSC spring and autumn survey biomass and abundance indices have fluctuated during 2002 to 2005, but continue to remain below the long term average (Table A2, Figure A2-A3). The recruitment indices for age 1 from the NEFSC 2004 autumn bottom trawl survey indicate that the 2003 year class , while below average, is still the strongest since 1992 (Table A3, Fig.A4). The age 0 index is not generally used as an indicator of year class strength, however, the 2004 index is well above average and the highest since the 1975 year class. The Canadian 2004 spring survey index of abundance for age 1 indicated that the 2003 year class was above average (Table A3, Figure A5). The 2005 Canadian indices are not representative since the survey did not cover all of the Georges Bank strata.

4.0 Assessment

Input data and Analyses

The current assessment is an update assessment and employs the same VPA formulation as in the 2001 assessment (O'Brien *et al.* 2002). A slight variation from the previous assessment is that the number of surveys available as tuning indices in the terminal year is decreased from three to two since the DFO 2005 spring survey did not sample the entire Georges Bank strata due to mechanical problems.

Catch at age (1-10+) has been updated with total 2004 landings (USA and Canadian).
The USA commercial port sampling for this stock has increased from 1 sample per 104 mt landed in 2002, to 1 sample per 68 mt landed in 2003, and 1 sample per 27 mt in 2004. Samples were well distributed between quarters, so that quarterly catch at age by market category could be estimated without pooling (Table A4). Spatial coverage was poor for eastern Georges Bank (SA 561, 562), as it has been for several years. As in the last assessment, additional length samples from western Georges Bank and combined US and Canadian age samples from eastern Georges Bank were applied to characterize the landings from eastern Georges Bank. The catch at age includes total landings from both the USA and Canadian fisheries (Table A5).

Discards at age were estimated using the Observer Database from 1989-2004. A discard to kept ratio was applied to landings to estimate total discards (mt), and total discards at length were estimated from sampled length frequencies of observed tows. The age composition of the discarded length frequency was estimated using a combination of commercial data for all ages and research survey data for ages 1-3 only.

Research survey indices have been estimated for the 2002-2005 NEFSC and 2002-2004 Canadian Department of Fisheries and Oceans (DFO) spring (ages 1-8) bottom trawl surveys and the NEFSC 2002-2004 autumn (ages 1-6) bottom trawl survey (Table A3). The ADAPT calibration method (Parrack 1986) ,(Gavaris 1988), (Conser and J.E. Powers. 1990) was used to derive estimates of instantaneous fishing mortality and beginning year stock sizes in 2004. A conditional non-parametric bootstrap procedure (Efron 1982) was used to evaluate the precision of fishing mortality and spawning stock biomass. A retrospective analysis was performed for terminal year fishing mortality, spawning stock biomass, and age 1 recruitment.

Assessment results

Fully recruited fishing mortality (ages 4-8) was estimated at 0.24 in 2004 (Table A6, Figure A6). Spawning stock biomass in 2004 was estimated at 22,564 mt, a 25% decrease from 2001 but a 23% increase from the record low in 1995 (Table A6, Figure A7). Recruitment (millions of age 1 fish) of the 2004 year class (10.4 million) is estimated to be similar to the 1998 year class (12.8 million) (Table A6, Figure A7). Recruitment of the 2003 year class (21.2 million) is the first year class estimated above the long-term average (1977-2003) of 14.7 million fish. The survival ratio of recruit/SSB was above average for the 2003 and 2004 year classes (Figure A8).

VPA Diagnostics

Stock size estimates for ages 1-8 were well estimated with CVs ranging from 0.29 to 0.57 (Appendix A2). The distribution of F estimates from the bootstrap analysis ranged from 0.14 to 0.31 with an 80% probability that F in 2004 was between 0.17 and 0.26. The distribution of SSB estimates from the bootstrap analysis ranged from 16,721 mt to 30,137 mt with an 80% probability that SSB in 2004 was between 19,704 mt to 27,122 mt.

The strong retrospective pattern present in the previous assessment (O'Brien *et al.* 2002) with this model formulation is not as evident for the most current years (Figure A9). The terminal year estimates of fishing mortality were the same for 2004 and 2003, but are then less than the converged estimates from 1994-2002. SSB estimates were similar for 2000-2004, but are greater than converged estimates from 1994-1999. The pattern in the terminal year estimates of recruits are generally less than converged estimates.

Sensitivity Analyses

Analyses were conducted to determine the sensitivity of fishing mortality and spawning stock biomass estimates to the addition of discards to the catch at age. Differences in F are minimal with F being slightly higher, and SSB slightly lower than the base run estimates when discards are included in the catch at age.

5.0 Biological Reference Points

Biological reference points were established for Georges Bank cod based on a Beverton-Holt stock recruit model (NEFSC 2002.) as:

MSY= 35,236 mt
SSB_{MSY} = 216,780 mt and
F_{MSY}= 0.175

In 2004, spawning stock biomass was estimated at 22,564 mt, about 10% of the target SSB_{MSY}. The stock is considered to be overfished. F was estimated at 0.24, therefore overfishing is occurring on this stock.

6.0 Summary

Georges Bank Atlantic cod are overfished and overfishing is occurring. Fishing mortality has been steadily declining since 1997, except for a slight increase in 2001, and is currently at the lowest exploitation in the time series. Spawning stock biomass reached a record low in 1995 and slowly increased, primarily due to growth ,until 2001. Since 2001, however, SSB has been declining. The 2002-2004 F trajectory is less than that projected for A13 and the SSB is slightly higher than the A13 projection (Figure A10). Catch during 2002-2004 was also less than the A13 projection.

The 1999 and 1998 year class accounts for the majority of the US catch and the 1998 year class accounts for the majority of the Canadian catch in 2004. The 1998 (12.8 million age 1 fish) year class, while below the long term average (14.7 million age 1 fish), represents the strongest year class since the last above-average year class that occurred in 1990 (17.8 million age1 fish). The 2000, 2001, and 2002 year classes are among the lowest in the time series. The 2003 (21.2 million age 1 fish) year class is the first above average year class since the 1990 and will enter the fishery during 2005.

The NEFSC and DFO survey biomass and abundance indices fluctuated during 2002 to 2005, however, all the indices continue to remain below the long term average. The most recent NEFSC surveys indicate that the 2003 year class may be similar in size to the 1998 year class, and the DFO spring survey indicates that the year class is above average.

The lack of strong recruitment in the last decade suggests that recovery of this stock will be largely dependent on reducing fishing mortality in the near term and husbanding the strong 2003 year class, and potentially the 2004 year class, to increase SSB.

7. 0 Sources of Uncertainty

Landings data for 1994-2004 are derived by proration and are provisional.

Estimation of eastern Georges Bank landings are derived on small number of samples supplemented by western length frequency and Canadian age data. Increased sampling of landings in statistical areas 561-562 would be an improvement.

The 2004 NMFS fall survey index for age 0 may be optimistic.

8.0 Panel Discussion

The NMFS fall 2004 survey had the highest age 0 index since the 1975 year class. The panel discussed whether the high number of age 0 cod in 2004 was a sampling artifact. An examination of catch locations indicated that age 0 cod were caught in multiple tows in 2004, but were highly localized. Additionally, the NMFS spring survey age 1 and age 2 indices in 2005 were lower than the fall 2004 age 0 and age 1 indices respectively, indicating a possible year effect. The panel decided to not use the age 1 index for 2005 in the projections based on the uncertainty of the index. Concern was also expressed that the mean weight and number per tow at age generally increased in 2004 over all ages. It was recommended that confidence intervals be examined for NMFS survey indices.

Lower abundance indices were observed in the Canadian DFO spring 2005 survey; however there is uncertainty in these data due to incomplete surveying and vessel changes. It was noted that a conversion factor needs to be calculated between the Canadian R/V Needler and R/V Teleost in order to use the Canadian spring 2005 indices. At the present time it was concluded that the 2005 Canadian survey will not be used in the VPA input for 2004.

In recent years, there has been a decline in mean weight at age of older fish in commercial fishery catches. It was discussed whether this could be due to small sample sizes of older ages in the U.S. commercial data, however the decline was consistent over all older ages. Mean weight at age has also been declining for older fish in the Canadian surveys, indicating possible lower productivity in the stock for recent years.

The recommendation was made that discards and recreational catches be included in future catch at age input data to account for all removals. For this assessment, discards and recreational catches were not included in order to be consistent with 2002 reference points, however, a sensitivity run with discards was presented which did not show substantial differences from the base run.

The mean F is currently estimated as an average of ages 4-8, however, since 1994 the landings of age groups 7 and 8 have declined. The panel discussed that an F averaged over ages 4-6 may be more representative of the current age structure of the landings.

The panel noted that trends in partial recruitment need to be examined since this could change the estimation of reference points. A three year average was agreed to be sufficient for the present time since the projections are only going to be made over a four-year period.

Projection Determination:

Recruitment at age 1 in 2005 will be estimated from the stock recruitment relationship.
Mean weights at age will be averaged over the last three years in order to account for declining mean weights at age in older ages. Maturity ogive and partial recruitment will be averaged over the last three years as well.

Research Recommendations:

Examine variances of NMFS survey mean weights and mean numbers per tow by year, especially for 2004.

Include discards and recreational catches in the catch at age.

Examine changes in partial recruitment and explore the effect of estimating average F for age groups 4-6 compared to the current average F for ages 4-8.

9.0 References

Conser, R.J. and J.E. Powers. 1990. Extensions of the ADAPT VPA tuning method designed to facilitate assessment work on tuna and swordfish stocks. Int. Comm. Conserv. Atlantic Tunas. Coll. Vol .Sci. Pap. **32**: 461-467.

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O'Brien, L., N.J. Munroe, and L. Col. 2002. A. Georges Bank Atlantic Cod *in*: Assessment of 20 Northeast groundfish stocks through 2001. A report of the groundfish assessment review meeting (GARM), Northeast Fisheries Science Center, Woods Hole, Massachusetts, October 8-11, 2002. NEFSC Ref. Doc. 02-16: 522 .

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Table A1. Commercial landings (metric tons, live) of Atlantic cod from the Georges Bank and South (NAFO Division 5Z and Subarea 6) stock, 1960 2004 (* = Provisional data).

	Country						
Year	USA	Canada	USSR	Spain	Poland	Other	Total
1960	10834	19	-	-	-	-	10853
1961	14453	223	55	-	-	-	14731
1962	15637	2404	5302	-	143	-	23486
1963	14139	7832	5217	-	-	1	27189
1964	12325	7108	5428	18	48	238	25165
1965	11410	10598	14415	59	1851	-	38333
1966	11990	15601	16830	8375	269	69	53134
1967	13157	8232	511	14730	-	122	36752
1968	15279	9127	1459	14622	2611	38	43136
1969	16782	5997	646	13597	798	119	37939
1970	14899	2583	364	6874	784	148	25652
1971	16178	2979	1270	7460	256	36	28179
1972	13406	2545	1878	6704	271	255	25059
1973	16202	3220	2977	5980	430	114	28923
1974	18377	1374	476	6370	566	168	27331
1975	16017	1847	2403	4044	481	216	25008
1976	14906	2328	933	1633	90	36	19926
1977	21138	6173	54	2	-	-	27367
1978	26579	8778	-	-	-	-	35357
1979	32645	5978	-	-	-	-	38623
1980	40053	8063	-	-	-	-	48116
1981	33849	8499	-	-	-	-	42348
1982	39333	17824	-	-	-	-	57157
1983	36756	12130	-	-	-	-	48886
1984	32915	5763	-	-	-	-	38678
1985	26828	10443	-	-	-	-	37271
1986	17490	8504	-	-	-	-	25901
1987	19035	11844	-	-	-	-	30880
1988	26310	12741	-	-	-	-	39242
1989	25097	7895	-	-	-	-	33098
1990	28193	14364	-	-	-	-	42503
1991	24175	13462	-	-	-	-	37630
1992	16855	11673	-	-	-	-	28567
1993	14594	8524	-	-	-	-	23113
1994	9893	5278	-	-	-	-	15169
1995	6759	1100	-	-	-	-	7859
1996	7020	1926	-	-	-	-	8905
1997	7537	2919	-	-	-	-	10435
1998	6959	1908	-	-	-	-	8832
1999	8061	1819	-	-	-	-	9880
2000	7617	1572	-	-	-	-	9189
2001	10635	2143	-	-	-	-	12778
2002	8998	1276	-	-	-	-	10274
2003	6646	1317	-	-	-	-	7963
2004	3471	1112	-	-	-	-	4583

Table A2. Standardized stratified mean catch per tow in numbers and weight (kg)for Atlantic cod in NEFSC offshore spring and autumn research vessel bottom trawl surveys on Georges Bank (Strata 13-25), 1963 - 2005. [1,2,3]

	Spring		Autumn	
Year	No/Tow	Wt/Tow	No/Tow	Wt/Tow
1963	-	-	4.37	17.8
1964	-	-	2.79	11.4
1965	-	-	4.25	11.8
1966	-	-	4.90	8.1
1967	-	-	10.33	13.6
1968	4.73	12.7	3.31	8.6
1969	4.63	17.8	2.24	8.0
1970	4.34	15.8	5.12	12.6
1971	3.39	14.3	3.19	9.8
1972	9.16	19.3	13.09	22.9
1973	57.81	94.5	12.28	30.9
1974	14.74	36.4	3.49	8.2
1975	6.89	26.1	6.41	14.1
1976	7.06	18.6	10.43	17.7
1977	6.19	15.3	5.44	12.5
1978	12.31	31.2	8.59	23.3
1979	5.00	16.2	5.95	16.5
1980	7.68	24.1	2.91	6.7
1981	10.44	26.1	9.20	20.3
1982	32.96	101.9	3.34	6.1
1983	7.70	23.5	4.14	6.1
1984	4.08	15.3	4.73	10.0
1985	7.03	21.7	2.31	3.1
1986	5.04	16.7	2.99	3.7
1987	3.24	9.9	2.33	4.4
1988	5.87	13.5	3.07	5.6
1989	4.80	10.9	4.84	4.7
1990	4.79	11.7	4.78	11.5
1991	4.31	8.9	0.96	1.4
1992	2.67	7.4	1.72	3.0
1993	2.40	7.0	2.15	2.2
1994	0.95	1.2	1.82	3.3
1995	3.29	8.4	3.62	5.6
1996	2.70	7.5	1.10	2.7
1997	2.32	5.2	0.87	1.9
1998	4.36	11.7	1.87	2.8
1999	2.15	4.7	1.02	3.0
2000	3.57	8.2	1.31	1.4
2001	1.86	5.5	1.05	2.1
2002	2.08	5.0	4.70	11.3
2003	1.98	4.2	1.25	2.1
2004	5.38	14.3	4.21	5.9
2005	1.96	4.5		
1963-2004 Average	7.3	18.7	4.30	9.0

[1] During 1963-1984, BMV oval doors used in spring and autumn surveys; since 1985, Portuguese polyvalent doors used in both surveys.
Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents.
Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were usedin this standardization (NEFC 1991).
[2] Spring surveys during 1980-1982, 1989-1991 and 1994 and autumn surveys during 1977-1981,1989-1991,and1993 were accomplished with the R/V Delaware II; in all other years, the surveys were accomplished using the R/V Albatross IV. Adjustments have been made to the R/V Delaware II catch per tow data to standardize these to R/V Albatross IV equivalents.
Conversion coefficients of 0.79 (numbers) and 0.67 (weight) were used in this standardization (NEFC 1991)
[3] Spring surveys during 1973-1981 were accomplished with a '41 Yankee' trawl; in all other years,spring surveys were accomplished with a 36 Yankee' trawl. No adjustments have been made to the catch per tow data for these gear differences.

Table A3. Standardized (for vessel and door changes) stratified mean catch per tow at age (numbers) of Atlantic cod in NEFSC offshore spring and autumn bottom trawl surveys on Georges Bank (Strata 13-25), 1963 - 2005.

	AGE											
Year	0	1	2	3	4	5	6	7	8	9	10+	No./tow
SPRING												
1968	0.513	0.136	1.615	0.825	0.665	0.385	0.246	0.140	0.083	0.056	0.058	4.722
1969	0.000	0.123	0.546	1.780	0.888	0.451	0.326	0.215	0.128	0.072	0.112	4.641
1970	0.000	0.338	0.804	0.430	1.241	0.162	0.844	0.263	0.058	0.056	0.147	4.342
1971	0.000	0.206	0.860	0.438	0.254	0.570	0.114	0.324	0.365	0.128	0.132	3.391
1972	0.056	3.000	1.838	2.732	0.445	0.166	0.323	0.084	0.285	0.071	0.158	9.159
1973	0.056	0.546	42.258	6.344	6.387	0.657	0.515	0.367	0.058	0.217	0.404	57.808
1974	0.000	0.444	4.558	5.971	0.761	1.988	0.442	0.100	0.265	0.064	0.144	14.735
1975	0.000	0.064	0.327	2.092	2.941	0.377	0.744	0.084	0.115	0.147	0.000	6.890
1976	0.111	1.298	1.955	0.915	0.661	1.607	0.153	0.261	0.029	0.000	0.068	7.058
1977	0.000	0.044	3.389	1.084	0.553	0.267	0.717	0.052	0.066	0.000	0.021	6.193
1978	3.312	0.372	0.192	5.531	0.972	0.778	0.142	0.712	0.065	0.141	0.096	12.312
1979	0.108	0.428	1.298	0.275	1.852	0.547	0.236	0.084	0.139	0.013	0.022	5.000
1980	0.105	0.031	2.217	2.690	0.212	1.705	0.374	0.186	0.031	0.030	0.096	7.676
1981	0.301	2.302	1.852	2.811	1.685	0.106	0.879	0.258	0.132	0.000	0.113	10.438
1982	0.169	0.508	5.435	9.502	8.324	6.208	0.293	1.866	0.369	0.082	0.203	32.958
1983	0.081	0.332	1.952	3.017	0.796	0.697	0.443	0.027	0.219	0.000	0.138	7.701
1984	0.000	0.402	0.431	0.761	1.238	0.422	0.400	0.209	0.000	0.215	0.000	4.078
1985	0.244	0.111	2.653	0.663	1.110	1.412	0.265	0.192	0.180	0.037	0.161	7.029
1986	0.092	0.872	0.409	1.844	0.365	0.540	0.618	0.062	0.125	0.101	0.015	5.044
1987	0.000	0.020	1.613	0.378	0.763	0.062	0.179	0.136	0.033	0.027	0.025	3.235
1988	0.180	0.720	0.609	3.150	0.409	0.644	0.064	0.037	0.049	0.000	0.007	5.868
1989	0.000	0.310	1.410	0.666	1.583	0.235	0.351	0.051	0.040	0.055	0.093	4.794
1990	0.042	0.173	0.922	1.737	0.674	0.912	0.130	0.143	0.013	0.016	0.027	4.790
1991	0.195	1.027	0.528	0.689	0.929	0.479	0.328	0.054	0.041	0.000	0.045	4.313
1992	0.000	0.123	1.252	0.468	0.168	0.273	0.142	0.159	0.020	0.037	0.028	2.670
1993	0.110	0.009	0.399	1.306	0.205	0.090	0.138	0.029	0.034	0.021	0.055	2.396
1994	0.030	0.125	0.272	0.200	0.217	0.033	0.006	0.044	0.000	0.019	0.000	0.945
1995	0.482	0.050	0.382	0.854	0.534	0.599	0.107	0.234	0.028	0.022	0.000	3.290
1996	0.000	0.073	0.214	0.736	1.247	0.174	0.209	0.028	0.018	0.000	0.000	2.699
1997	0.302	0.291	0.437	0.170	0.489	0.422	0.050	0.134	0.020	0.000	0.000	2.315
1998	0.018	0.111	0.665	1.298	0.848	0.755	0.533	0.102	0.031	0.000	0.000	4.360
1999	0.067	0.212	0.291	0.609	0.510	0.238	0.119	0.064	0.031	0.007	0.000	2.148
2000	0.053	0.221	0.807	0.830	1.141	0.370	0.102	0.026	0.020	0.000	0.000	3.569
2001	0.000	0.061	0.235	0.794	0.160	0.383	0.177	0.023	0.018	0.012	0.000	1.862
2002	0.018	0.065	0.093	0.383	0.993	0.239	0.225	0.039	0.000	0.000	0.028	2.083
2003	0.000	0.016	0.213	0.271	0.623	0.696	0.064	0.080	0.012	0.000	0.000	1.975
2004	0.000	0.637	0.058	0.579	1.407	1.354	0.893	0.179	0.261	0.013	0.000	5.380
2005	0.0614	0.0119	0.4838	0.1378	0.631	0.2744	0.2053	0.1274	0.0298	0		1.9628
average	0.289	0.427	2.297	1.752	1.196	0.730	0.321	0.190	0.099	0.066	0.096	7.294

Table A3 continued. Standardized (for vessel and door changes) stratified mean catch per tow at age (numbers) of Atlantic cod in NEFSC offshore spring and autumn bottom trawl surveys on Georges Bank (Strata 13-25), 1963 - 2004.

	AGE											
Year	0	1	2	3	4	5	6	7	8	9	10+	No./tow
AUTUMN												
1963	0.019	0.719	0.778	0.920	0.897	0.354	0.326	0.175	0.103	0.014	0.069	4.374
1964	0.009	0.640	0.699	0.588	0.538	0.145	0.136	0.062	0.050	0.030	0.083	2.980
1965	0.173	1.299	0.998	0.707	0.484	0.167	0.179	0.112	0.081	0.023	0.023	4.246
1966	1.025	1.693	1.000	0.515	0.264	0.100	0.095	0.062	0.039	0.002	0.017	4.812
1967	0.072	7.596	1.334	0.523	0.406	0.133	0.133	0.055	0.051	0.012	0.070	10.385
1968	0.070	0.314	1.611	0.783	0.271	0.073	0.067	0.027	0.023	0.008	0.048	3.295
1969	0.000	0.343	0.622	0.626	0.331	0.094	0.061	0.019	0.023	0.022	0.059	2.200
1970	0.434	1.699	1.361	0.532	0.696	0.153	0.000	0.033	0.055	0.055	0.098	5.116
1971	0.400	0.602	0.617	0.408	0.310	0.478	0.164	0.042	0.090	0.000	0.075	3.186
1972	0.948	7.473	1.191	1.841	0.399	0.241	0.568	0.116	0.204	0.021	0.084	13.085
1973	0.203	1.748	6.060	1.164	2.039	0.210	0.225	0.175	0.062	0.137	0.253	12.276
1974	0.461	0.410	0.667	1.509	0.161	0.089	0.112	0.000	0.059	0.021	0.000	3.489
1975	2.377	0.992	0.421	0.628	1.682	0.111	0.156	0.000	0.000	0.000	0.037	6.406
1976	0.000	6.144	2.073	0.762	0.275	0.738	0.054	0.269	0.037	0.052	0.021	10.425
1977	0.152	0.237	3.434	0.691	0.253	0.173	0.394	0.007	0.027	0.000	0.077	5.444
1978	0.395	1.845	0.391	4.058	0.964	0.336	0.165	0.343	0.050	0.030	0.014	8.590
1979	0.115	1.625	1.677	0.162	1.687	0.321	0.184	0.031	0.113	0.010	0.025	5.948
1980	0.280	0.820	0.564	0.774	0.053	0.265	0.057	0.067	0.027	0.000	0.000	2.905
1981	0.261	3.525	2.250	1.559	0.589	0.054	0.579	0.057	0.064	0.018	0.083	9.039
1982	0.362	0.577	1.910	0.242	0.068	0.115	0.000	0.031	0.033	0.000	0.000	3.337
1983	1.283	0.850	1.089	0.740	0.069	0.033	0.004	0.010	0.015	0.000	0.044	4.136
1984	0.179	1.909	0.682	0.929	0.825	0.024	0.059	0.039	0.000	0.039	0.044	4.728
1985	1.002	0.181	0.843	0.067	0.106	0.077	0.028	0.000	0.000	0.000	0.003	2.306
1986	0.076	2.279	0.129	0.329	0.008	0.049	0.073	0.016	0.000	0.007	0.022	2.987
1987	0.204	0.414	1.353	0.108	0.200	0.028	0.012	0.000	0.000	0.000	0.007	2.325
1988	0.550	0.875	0.437	0.904	0.060	0.194	0.000	0.011	0.039	0.000	0.000	3.069
1989	0.251	2.798	1.046	0.161	0.507	0.055	0.015	0.007	0.000	0.000	0.000	4.841
1990	0.157	0.364	1.624	1.814	0.412	0.286	0.069	0.022	0.011	0.000	0.022	4.781
1991	0.041	0.408	0.175	0.274	0.031	0.029	0.000	0.000	0.000	0.000	0.000	0.957
1992	0.035	0.412	0.949	0.174	0.100	0.044	0.010	0.000	0.000	0.000	0.000	1.724
1993	0.178	0.970	0.532	0.383	0.017	0.025	0.022	0.000	0.000	0.022	0.000	2.149
1994	0.067	0.406	0.664	0.433	0.153	0.068	0.021	0.000	0.006	0.000	0.000	1.819
1995	0.160	0.245	1.811	1.249	0.087	0.054	0.011	0.000	0.000	0.000	0.000	3.616
1996	0.022	0.240	0.196	0.414	0.143	0.060	0.027	0.000	0.000	0.000	0.000	1.101
1997	0.006	0.236	0.321	0.109	0.129	0.049	0.009	0.007	0.000	0.000	0.000	0.867
1998	0.070	0.336	1.026	0.352	0.041	0.035	0.004	0.000	0.004	0.000	0.000	1.867
1999	0.070	0.140	0.154	0.310	0.255	0.087	0.000	0.000	0.000	0.000	0.000	1.016
2000	0.020	0.571	0.538	0.071	0.079	0.031	0.000	0.000	0.000	0.000	0.000	1.308
2001	0.028	0.047	0.381	0.459	0.059	0.055	0.008	0.008	0.000	0.000	0.000	1.045
2002	0.234	0.478	0.707	1.396	1.627	0.118	0.131	0.012	0.000	0.000	0.000	4.703
2003	0.327	0.166	0.309	0.201	0.156	0.082	0.000	0.007	0.000	0.000	0.000	1.248
2004	1.6853	0.7448	0.1358	0.7101	0.252	0.3215	0.2524	0.0647	0.0195	0.000	0.000	4.186
average	0.360	1.318	1.066	0.728	0.421	0.146	0.126	0.063	0.051	0.029	0.056	4.364

Table A3 continued. Stratified mean catch per tow at age (numbers) of Atlantic cod in Canadian spring bottom trawl survey

	AGE										
Year	1	2	3	4	5	6	7	8	9	10+	No./ tow
SPRING											
1986	0.60	2.27	2.81	0.37	0.65	0.44	0.26	0.04	0.07	0.03	7.54
1987	0.25	2.13	0.93	1.09	0.34	0.12	0.22	0.08	0.03	0.07	5.26
1988	0.28	1.01	4.66	0.58	1.02	0.13	0.08	0.17	0.04	0.07	8.04
1989	1.63	2.78	1.38	2.85	0.36	0.42	0.05	0.10	0.12	0.06	9.75
1990	0.42	2.44	3.78	2.08	3.87	0.42	0.93	0.12	0.12	0.35	14.53
1991	1.18	1.16	1.84	2.15	1.05	1.31	0.16	0.22	0.03	0.09	9.19
1992	0.11	2.86	1.77	0.80	0.98	0.60	0.43	0.12	0.07	0.02	7.76
*1993	0.05	0.60	2.83	1.04	0.62	1.23	0.44	0.42	0.07	0.12	7.42
*1994	0.02	0.80	0.89	1.65	0.60	0.23	0.45	0.11	0.15	0.04	4.94
1995	0.07	0.67	1.50	0.86	0.60	0.19	0.04	0.05	0.02	0.02	4.02
1996	0.14	0.49	2.31	4.02	1.09	0.79	0.33	0.08	0.11	0.03	9.39
1997	0.32	0.53	0.55	1.25	1.23	0.27	0.06	0.03	0.02	0.01	4.27
1998	0.01	0.67	0.95	0.35	0.35	0.28	0.07	0.02	0.00	0.02	2.72
1999	0.33	0.32	1.49	1.09	0.41	0.26	0.15	0.01	0.02	0.01	4.09
2000	0.10	0.44	1.05	3.92	1.71	0.78	0.40	0.24	0.01	0.03	8.68
2001	0.00	0.06	0.64	0.42	1.11	0.52	0.26	0.17	0.16	0.06	3.40
2002	0.01	0.09	0.57	2.05	0.68	1.22	0.40	0.17	0.05	0.08	5.32
2003	0.00	0.02	0.30	0.65	1.21	0.32	0.34	0.16	0.01	0.00	3.01
2004	0.54	0.10	0.39	0.42	0.45	0.39	0.07	0.12	0.02	0.01	2.50
*2005	0.05	2.04	2.78	14.18	3.42	1.59	1.45	0.12	0.15	0.02	25.80
average	0.31	1.07	1.67	2.09	1.09	0.58	0.33	0.13	0.06	0.06	6.41

* R/V Needler indices not included in VPA calibration (entire GB not surveyed)

2005											
R/V Teleost	0.02	1.34	0.47	2.91	1.13	0.51	0.41	0.01	0.05	0.01	6.86

Table A4. USA sampling of commercial Atlantic cod landings, by market category, for the Georges Bank and South cod stock (NAFO Division 5Z and Subarea 6), 1978 2004.

	Number of Samples, by Market Category & Quarter															Annual Sampling Intensity			
	Scrod					Market					Large					No. of Tons Landed/Sampled			
Year	Q1	Q2	Q3	Q4	∑	Q1	Q2	Q3	Q4	∑	Q1	Q2	Q3	Q4	∑	Scrd	Mkt	Lge	∑
1978	17	15	6	3	41	9	12	13	9	43	1	0	1	2	4	69	374	1922	302
1979	2	5	14	8	29	6	19	11	8	44	2	0	4	1	7	88	407	1742	408
1980	7	10	13	4	34	12	14	5	1	32	3	0	0	0	3	136	588	5546	580
1981	4	10	11	3	28	6	9	10	2	27	2	0	0	0	2	149	634	6283	594
1982	5	9	32	9	55	6	20	27	13	66	8	8	9	5	30	156	279	410	260
1983	4	12	17	10	43	12	19	22	14	67	2	15	16	3	36	185	291	259	252
1984	6	8	8	7	29	8	15	8	11	42	18	5	3	3	29	138	441	358	329
1985	6	7	16	5	34	11	11	12	8	42	4	8	7	5	24	201	299	310	268
1986	6	7	7	6	26	8	10	10	11	39	6	5	10	8	29	142	215	186	186
1987	7	8	6	8	29	6	8	9	10	33	6	6	4	2	18	240	220	267	238
1988	8	6	7	5	26	13	7	9	9	38	4	4	3	1	12	283	331	532	346
1989	2	7	9	9	27	7	8	8	7	30	3	4	1	1	9	210	450	660	380
1990	8	9	10	4	31	10	13	9	8	40	4	4	4	0	12	295	315	538	340
1991	6	11	7	5	29	12	13	8	8	41	4	6	3	5	18	158	293	423	275
1992	6	7	7	10	30	8	10	6	9	33	5	5	3	1	14	149	215	377	219
1993	5	16	7	6	34	10	10	7	9	36	6	1	3	2	12	126	173	339	178
1994	3	9	8	2	22	5	11	7	4	27	1	4	3	1	9	92	187	290	167
1995	2	3	13	2	20	2	4	10	2	18	0	1	0	1	2	83	181	880	167
1996	6	2	12	3	23	5	6	11	6	28	0	2	1	1	4	59	143	400	127
1997	3	11	3	10	27	5	16	9	9	39	3	6	0	5	14	50	105	148	94
1998	3	7	23	5	38	10	10	15	3	38	1	2	1	0	3	44	92	573	88
1999	5	3	10	3	21	7	14	10	7	38	2	5	2	0	9	80	118	205	118
2000	21	19	16	27	83	20	14	13	16	63	2	2	2	2	8	18	72	192	49
2001	11	9	13	3	36	9	10	8	10	37	6	12	6	10	34	72	163	55	98
2002	5	7	7	1	20	8	10	11	6	35	14	8	6	3	31	80	153	63	104
2003	4	8	6	10	28	7	16	10	6	39	5	11	10	4	30	21	113	52	68
2004	8	11	4	10	33	13	9	7	14	43	24	12	2	11	49	8	50	20	27

Table A5. Landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of total commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978 2004.

	Age											% of Total Landings	
Year	1	2	3	4	5	6	7	8	9	10+	Total	USA	Canada
	Total Commercial Landings in Numbers (000's) at Age												
1978	2	392	7708	2290	826	129	344	47	40	15	11793	74.1	26.4
1979	34	1989	900	4870	1212	458	77	253	4	48	9845	81.2	18.8
1980	89	3778	5829	500	2308	1076	445	87	167	10	14289	80.9	19.1
1981	27	3206	4224	2466	236	1408	417	123	130	62	12299	84.1	15.8
1982	331	9142	3828	2790	2002	281	674	213	71	83	19416	74.1	25.9
1983	108	4286	8062	2456	1055	776	95	235	100	65	17237	72.2	27.8
1984	81	1307	3423	3337	841	516	458	44	171	121	10300	89.0	11.0
1985	134	6427	2443	1368	1885	412	218	203	21	97	13209	68.4	31.6
1986	156	1329	4588	801	482	630	87	72	47	29	8221	71.5	28.2
1987	26	7474	1406	2121	279	252	270	63	38	24	11953	64.2	35.8
1988	10	1574	7992	1008	1492	243	160	196	50	47	12770	71.8	28.6
1989	0	2084	2919	4145	330	539	82	43	50	18	10209	81.3	18.9
1990	7	4943	5049	1884	2267	229	245	36	17	38	14716	74.2	25.7
1991	52	1525	3243	3282	1458	1088	126	70	23	23	10891	67.7	32.3
1992	70	4171	2167	1037	1480	403	308	34	33	10	9714	58.8	41.3
1993	4	1033	4247	1115	440	472	159	143	32	17	7662	67.0	33.0
1994	2	398	1526	1826	394	96	137	46	38	6	4470	68.4	31.5
1995	0	393	1059	693	291	45	26	15	2	1	2525	86.7	13.1
1996	1	208	907	1240	242	124	15	2	4	0	2743	79.7	19.9
1997	3	517	640	884	795	132	84	15	10	4	3084	74.0	25.8
1998	0	740	1191	424	326	239	39	13	7	5	2984	81.7	18.0
1999	1	286	1926	706	201	97	119	17	2	3	3359	83.7	16.3
2000	14	752	687	1062	284	75	42	37	4	1	2958	84.5	15.5
2001	0	685	2382	643	597	166	45	22	11	2	4554	86.4	13.6
2002	0	51	967	1347	318	331	67	17	8	5	3111	89.4	10.6
2003	0.2	71	371	754	751	124	122	23	6	3	2226	83.3	16.7
2004	0	31	319	222	264	230	49	41	10	4	1170	74.7	25.3

Table A5 - continued. Landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of total commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978 2004.

	Age											% of Total Landings	
Year	1	2	3	4	5	6	7	8	9	10+	Total	USA	Canada
					Total Commercial Landings in Weight (Tons) at Age								
1978	1	513	18975	7952	3581	750	2539	394	467	186	35357	75.2	24.8
1979	30	2971	1936	20504	5923	3285	710	2612	47	606	38623	84.5	15.5
1980	75	5517	14385	1834	13038	7185	3732	790	1404	157	48116	83.2	16.8
1981	24	4790	9960	8424	1226	10167	3578	1215	1849	1115	42348	79.9	20.1
1982	253	12819	10198	10695	10717	1832	6306	2117	891	1330	57157	68.8	31.2
1983	104	6387	19166	8124	4891	4963	759	2420	1122	951	48886	75.2	24.8
1984	85	2137	8389	12076	4274	3400	4079	448	1934	1855	38678	85.1	14.9
1985	121	9112	5096	5319	9590	2641	1765	2076	242	1309	37271	72.0	28.0
1986	145	1959	11232	2934	2701	4525	781	719	597	400	25994	67.3	32.4
1987	19	11072	3509	8884	1620	1945	2419	635	431	344	30879	61.6	38.4
1988	8	2394	18847	3537	8052	1613	1405	1949	556	690	39051	67.4	33.1
1989	0	3370	6626	15631	1777	3611	667	453	584	273	32992	76.1	24.3
1990	5	7711	12431	6638	11091	1450	2072	382	223	554	42557	66.2	33.6
1991	59	2481	8266	11223	6956	6413	933	736	223	346	37637	64.2	35.7
1992	80	6432	5340	3988	6963	2482	2318	333	401	192	28528	59.1	41.1
1993	3	1585	9567	3718	2184	3013	1195	1315	316	220	23118	63.1	36.9
1994	2	581	3309	6676	1892	716	1096	430	364	102	15171	65.2	34.8
1995	0	572	2221	2652	1599	328	273	175	21	20	7859	86.0	13.8
1996	1	313	2209	4201	1190	823	128	21	59	2	8946	78.5	21.0
1997	3	817	1484	3120	3263	792	676	135	112	53	10456	72.1	27.7
1998	0	1098	2743	1483	1539	1417	325	118	82	61	8867	78.5	21.1
1999	1	446	4283	2437	986	622	874	160	26	45	9880	81.6	18.4
2000	13	1275	1690	3752	1345	436	317	322	30	8	9189	82.9	17.1
2001	0	1036	5594	2029	2604	915	284	183	110	18	12778	83.2	16.8
2002	0	91	2189	4134	1364	1771	453	141	74	57	10274	87.6	12.4
2003	0.1	138	874	2287	3029	615	754	186	51	28	7963	83.5	16.5
2004	0	60	826	707	1082	1157	291	322	90	51	4583	75.7	24.3

Table A5- continued. Landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of total commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978 2004.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Mean
					Total Commercial Landings Mean Weight (kg) at Age						
1978	0.707	1.310	2.461	3.469	4.336	5.787	7.374	8.492	11.785	13.200	2.983
1979	0.889	1.494	2.149	4.211	4.888	7.178	9.183	10.313	11.699	12.625	3.923
1980	0.836	1.460	2.468	3.668	5.647	6.676	8.390	9.089	8.432	15.400	3.368
1981	0.882	1.495	2.358	3.415	5.213	7.222	8.565	9.888	14.170	18.565	3.446
1982	0.765	1.402	2.664	3.834	5.352	6.511	9.363	9.897	12.503	16.723	2.946
1983	0.971	1.490	2.377	3.309	4.637	6.393	7.964	10.286	11.227	14.554	2.836
1984	1.053	1.635	2.451	3.619	5.083	6.582	8.909	10.104	11.303	15.356	3.756
1985	0.907	1.418	2.086	3.887	5.087	6.412	8.097	10.236	11.418	13.494	2.822
1986	0.929	1.475	2.447	3.660	5.603	7.191	8.915	9.955	12.687	14.104	3.161
1987	0.726	1.481	2.495	4.187	5.810	7.726	8.949	10.013	11.414	15.000	2.584
1988	0.786	1.520	2.359	3.511	5.401	6.647	8.776	9.987	11.143	15.298	3.062
1989	-	1.617	2.269	3.772	5.396	6.694	8.222	10.718	11.665	17.111	3.235
1990	0.831	1.560	2.462	3.522	4.892	6.333	8.456	10.648	12.580	14.526	2.891
1991	1.114	1.627	2.548	3.420	4.769	5.891	7.410	10.520	9.686	15.373	3.456
1992	1.148	1.542	2.464	3.843	4.704	6.156	7.509	9.846	12.059	19.025	2.937
1993	0.872	1.534	2.253	3.333	4.967	6.379	7.510	9.217	9.699	13.236	3.017
1994	0.906	1.459	2.168	3.657	4.804	7.432	8.013	9.368	9.698	16.659	3.394
1995	0.906	1.471	2.095	3.830	5.492	7.384	10.715	11.617	10.383	14.953	3.087
1996	0.882	1.507	2.435	3.387	4.912	6.622	8.369	8.438	12.883	12.002	3.212
1997	0.954	1.577	2.321	3.532	4.103	6.019	8.050	8.631	11.870	12.795	3.390
1998	0.579	1.483	2.302	3.497	4.735	5.934	8.185	8.610	12.684	14.606	2.969
1999	0.830	1.565	2.223	3.452	4.891	6.422	7.341	9.685	12.153	13.735	2.941
2000	0.956	1.696	2.461	3.533	4.731	5.797	7.530	8.596	8.817	12.831	3.107
2001	0.880	1.516	2.349	3.157	4.356	5.516	6.323	8.178	9.766	11.951	2.806
2002	0.551	1.768	2.265	3.068	4.290	5.345	6.759	8.428	9.711	12.127	3.303
2003	0.524	1.941	2.353	3.034	4.031	4.954	6.178	7.924	9.239	10.793	3.577
2004	0.704	1.950	2.586	3.192	4.090	5.032	5.945	7.838	9.273	12.219	3.920

Table A5 - continued. Landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of total commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978 2004.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Mean
					Total Commercial Landings Mean Length (cm) at Age						
1978	39.5	50.0	60.8	67.9	72.7	80.4	80.2	93.1	103.4	106.5	64.1
1979	44.7	52.2	57.7	73.2	76.8	87.5	95.3	99.5	103.4	106.4	69.6
1980	43.8	51.8	61.2	69.7	80.9	86.0	92.4	93.8	92.4	114.6	65.6
1981	44.4	52.2	60.2	68.4	78.2	88.0	93.5	97.5	110.3	119.5	65.6
1982	42.2	51.2	62.4	70.5	79.1	84.3	96.0	97.4	105.8	115.0	61.9
1983	45.5	52.3	60.4	67.0	75.3	84.4	90.7	99.1	101.9	111.4	62.4
1984	47.2	54.0	61.5	69.8	77.8	85.5	94.4	98.6	102.3	112.8	68.6
1985	44.9	51.1	57.5	71.4	78.0	84.3	91.3	98.8	102.3	108.2	61.1
1986	45.0	51.9	61.1	69.2	80.7	87.7	94.4	98.0	105.9	108.4	64.3
1987	40.7	51.8	61.2	73.0	81.8	90.1	94.5	98.2	102.5	111.2	59.7
1988	40.8	52.8	60.4	68.5	79.5	85.3	93.6	97.7	101.5	111.2	64.1
1989	0.0	53.8	60.0	70.4	79.2	85.2	91.7	100.3	103.2	113.3	65.7
1990	41.7	53.5	61.0	68.7	76.6	83.2	92.1	100.2	106.0	110.8	62.9
1991	47.7	53.6	62.2	67.7	75.8	80.9	87.8	99.4	95.9	113.9	67.0
1992	46.2	52.4	60.8	70.6	75.1	82.2	87.9	96.0	104.3	116.0	62.4
1993	42.2	52.7	59.6	67.0	76.3	83.6	88.2	95.1	95.9	107.0	63.0
1994	43.1	51.7	58.9	69.6	75.8	88.2	90.7	95.3	95.9	115.8	65.8
1995	43.0	50.6	58.2	70.9	80.5	88.5	100.9	103.8	99.1	113.0	64.6
1996	45.1	52.7	61.2	68.0	76.9	85.5	90.7	91.0	106.9	104.6	66.4
1997	43.7	53.4	60.2	68.8	72.1	82.3	91.2	93.1	104.2	106.5	66.7
1998	37.8	52.4	60.1	68.8	76.0	82.2	91.4	93.1	106.4	111.9	61.7
1999	41.5	53.4	59.6	68.6	76.9	84.1	88.5	96.6	103.4	109.0	64.0
2000	45.4	54.9	61.8	69.4	76.3	81.5	89.2	93.7	93.8	107.9	65.4
2001	43.0	53.1	60.8	66.7	74.1	80.2	83.6	91.4	97.5	103.6	63.4
2002	37.0	55.8	60.1	66.2	73.8	79.3	85.6	92.0	96.5	104.2	67.0
2003	36.5	57.4	61.0	66.1	72.4	77.2	83.4	90.8	95.5	100.3	69.0
2004	40.1	57.6	62.7	67.1	72.8	77.9	82.3	90.5	95.5	104.8	70.9

Table A6. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), spawning stock biomass (mt), and percent mature of Georges Bank cod, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1978-2004.

Stock Numbers (Jan 1) in thousands

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	27713	23513	20104	41392	17471	9615	27391	8669	42747	16376	23446	15673	9184	17849
2	4268	22688	19220	16380	33865	14004	7774	22353	6977	34857	13384	19187	12832	7513
3	25526	3139	16776	12319	10510	19458	7588	5182	12486	4512	21777	9531	13819	6034
4	7947	13888	1755	8461	6266	5145	8635	3115	2032	6085	2422	10571	5159	6752
5	2878	4422	6964	985	4698	2609	1990	4051	1312	943	3063	1067	4895	2521
6	1124	1605	2524	3613	594	2037	1181	869	1611	640	519	1153	574	1959
7	1434	802	900	1093	1686	232	965	500	339	752	296	205	455	263
8	67	862	587	334	517	772	104	376	212	199	371	97	93	151
9	146	12	477	402	162	231	419	45	124	109	106	126	40	44
10+	55	149	29	192	189	150	297	209	77	69	99	45	90	44
Total	71158	71082	69336	85171	75959	54252	56344	45370	67918	64541	65483	57654	47142	43129

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	6641	8183	5252	3248	5928	10096	4577	12809	7928	3436	3352	2283	21220	10398
2	14566	5374	6696	4298	2659	4852	8263	3747	10486	6478	2813	2745	1869	17373
3	4771	8147	3465	5122	3165	1990	3505	6097	2810	7904	4684	2257	2183	1502
4	2006	1943	2828	1456	3236	1774	1051	1795	3248	1679	4316	2960	1512	1499
5	2559	703	582	664	566	1533	655	478	831	1698	793	2315	1741	1037
6	745	755	178	120	281	245	537	243	209	423	850	361	1216	1187
7	620	244	191	58	58	119	82	225	111	103	196	397	184	787
8	101	228	56	32	24	34	21	32	77	53	44	100	214	106
9	60	52	57	4	13	17	13	5	12	29	24	21	61	139
10+	18	28	9	2	0	2	9	7	3	5	15	10	21	53
Total	32088	25656	19313	15005	15930	20662	18714	25438	25713	21810	17087	13448	30220	34081

Table A6 - continued

Fishing Mortality

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
2	0.11	0.10	0.24	0.24	0.35	0.41	0.21	0.38	0.24	0.27	0.14	0.13	0.55	0.25
3	0.41	0.38	0.48	0.48	0.51	0.61	0.69	0.74	0.52	0.42	0.52	0.41	0.52	0.90
4	0.39	0.49	0.38	0.39	0.68	0.75	0.56	0.66	0.57	0.49	0.62	0.57	0.52	0.77
5	0.38	0.36	0.46	0.31	0.64	0.59	0.63	0.72	0.52	0.40	0.78	0.42	0.72	1.02
6	0.14	0.38	0.64	0.56	0.74	0.55	0.66	0.74	0.56	0.57	0.73	0.73	0.58	0.95
7	0.31	0.11	0.79	0.55	0.58	0.60	0.74	0.66	0.33	0.51	0.92	0.59	0.91	0.75
8	1.48	0.39	0.18	0.52	0.61	0.41	0.63	0.91	0.47	0.43	0.88	0.68	0.56	0.72
9	0.36	0.43	0.48	0.44	0.65	0.64	0.59	0.71	0.53	0.48	0.72	0.57	0.62	0.85
10+	0.36	0.43	0.48	0.44	0.65	0.64	0.59	0.71	0.53	0.48	0.72	0.57	0.62	0.85
Total	0.54	0.35	0.49	0.47	0.65	0.58	0.64	0.74	0.49	0.48	0.79	0.60	0.65	0.84

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.38	0.24	0.07	0.11	0.09	0.13	0.10	0.09	0.08	0.12	0.02	0.03	0.02
3	0.70	0.86	0.67	0.26	0.38	0.44	0.47	0.43	0.31	0.41	0.26	0.20	0.18
4	0.85	1.01	1.25	0.74	0.55	0.80	0.59	0.57	0.45	0.55	0.42	0.33	0.18
5	1.02	1.18	1.38	0.66	0.64	0.85	0.79	0.63	0.47	0.49	0.59	0.44	0.18
6	0.91	1.18	0.91	0.52	0.66	0.89	0.67	0.58	0.50	0.57	0.56	0.48	0.23
7	0.80	1.27	1.58	0.68	0.34	1.52	0.74	0.88	0.54	0.66	0.47	0.42	0.35
8	0.46	1.18	2.37	0.72	0.15	0.73	1.29	0.80	0.76	0.61	0.56	0.29	0.24
9	0.91	1.09	1.27	0.71	0.56	0.84	0.67	0.61	0.46	0.53	0.46	0.39	0.24
10+	0.91	1.09	1.27	0.71	0.56	0.84	0.67	0.61	0.46	0.53	0.46	0.39	0.24
Total	0.81	1.16	1.50	0.67	0.47	0.96	0.82	0.69	0.55	0.58	0.52	0.39	0.24

Table A6 continued. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), spawning stock biomass (mt), and percent mature of Georges Bank cod, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1978-2004.

SSB at start of spawning season

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	913	1104	850	1960	1200	903	3123	773	8512	2224	3479	2473	633	1961
2	1410	7539	6913	5782	16137	6344	4303	11650	5027	25329	8902	13721	6610	4211
3	33845	3729	22417	15928	15642	26058	10500	6878	18776	7101	32836	14540	22024	9011
4	20219	38255	4297	21379	15793	12648	21655	8075	4842	17024	6128	27180	12814	16501
5	8798	16585	30442	3958	17473	9639	7110	14906	5434	3937	12377	4189	18051	8432
6	4882	8130	12541	20322	2957	10520	5655	4242	8582	3704	2764	5937	2947	8681
7	8215	5550	5918	7296	12172	1460	6226	3166	2345	5361	2024	1327	2845	1537
8	367	6810	5034	2696	4165	6840	811	2985	1705	1691	2930	811	769	1218
9	1331	112	3967	4100	1564	2116	3961	417	1252	1034	958	1193	409	373
10+	659	1698	392	3199	2750	1899	3992	2422	956	919	1304	681	1143	565
Total	80639	89512	92771	86621	89852	78426	67335	55513	57432	68324	73700	72053	68245	52490

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	764	640	72	44	76	971	203	935	175	62	29	42	705	
2	9011	3447	2817	1839	1155	3090	5325	1938	5222	3251	1488	929	619	
3	7401	11456	5195	7881	5166	3078	5495	9169	4808	13550	7638	3402	3633	
4	5218	4508	6375	3584	7612	4406	2625	4450	8169	4129	10444	6818	3743	
5	8375	2442	1788	2578	2136	4798	2271	1721	3000	5938	2559	7313	5756	
6	3351	3286	896	632	1469	1112	2292	1177	990	1901	3614	1488	5093	
7	3488	1300	1013	451	418	652	494	1241	685	543	1071	2056	911	
8	775	1504	307	266	219	248	139	242	518	364	283	674	1383	
9	561	411	422	37	137	145	121	43	96	237	188	165	483	
10+	287	296	117	28	0	21	113	87	34	56	160	100	237	
Total	39229	29289	19003	17340	18387	18521	19078	21003	23697	30033	27474	22987	22564	

Table A6 continued

Percent mature (females)

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	7	7	7	7	13	13	13	13	28	28	28	28	12	12
2	34	34	34	34	47	47	47	47	67	67	67	67	52	52
3	78	78	78	78	84	84	84	84	91	91	91	91	90	90
4	96	96	96	96	97	97	97	97	98	98	98	98	99	99
5+	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	12	12	12	2	2	2	13	13	13	3	3	7	7
2	52	52	52	39	39	39	57	57	57	44	44	34	34
3	90	90	90	95	95	95	92	92	92	95	95	79	79
4	99	99	99	100	100	100	100	100	100	100	100	96	96
5+	100	100	100	100	100	100	100	100	100	100	100	100	100

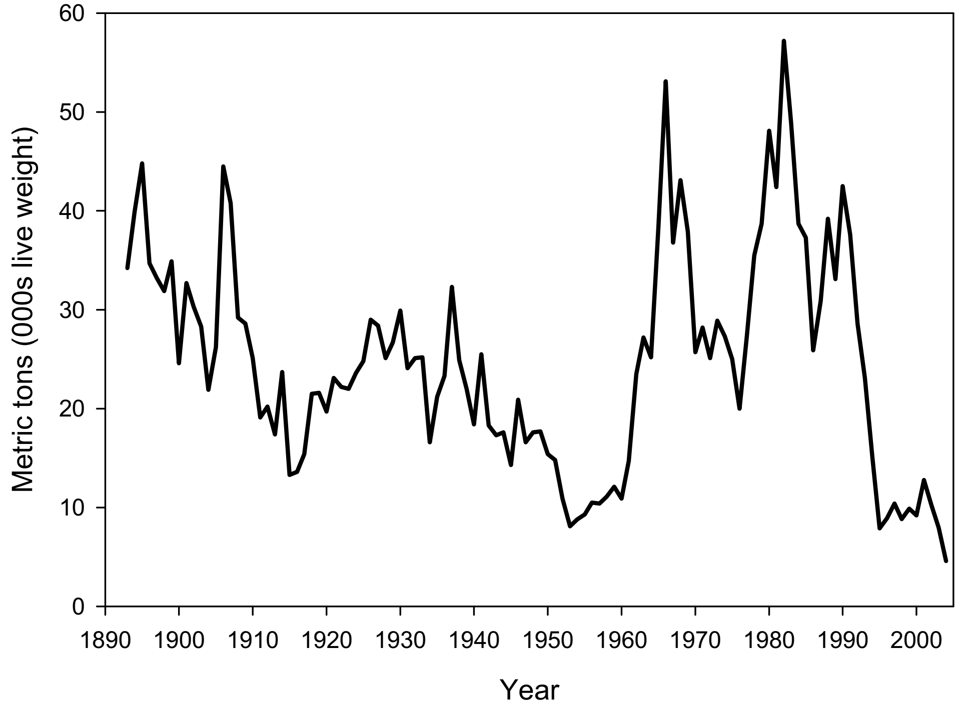

Figure A1a. Total commercial landings of Georges Bank cod (NAFO Division 5Z ans Subarea 6), 1893-2004.

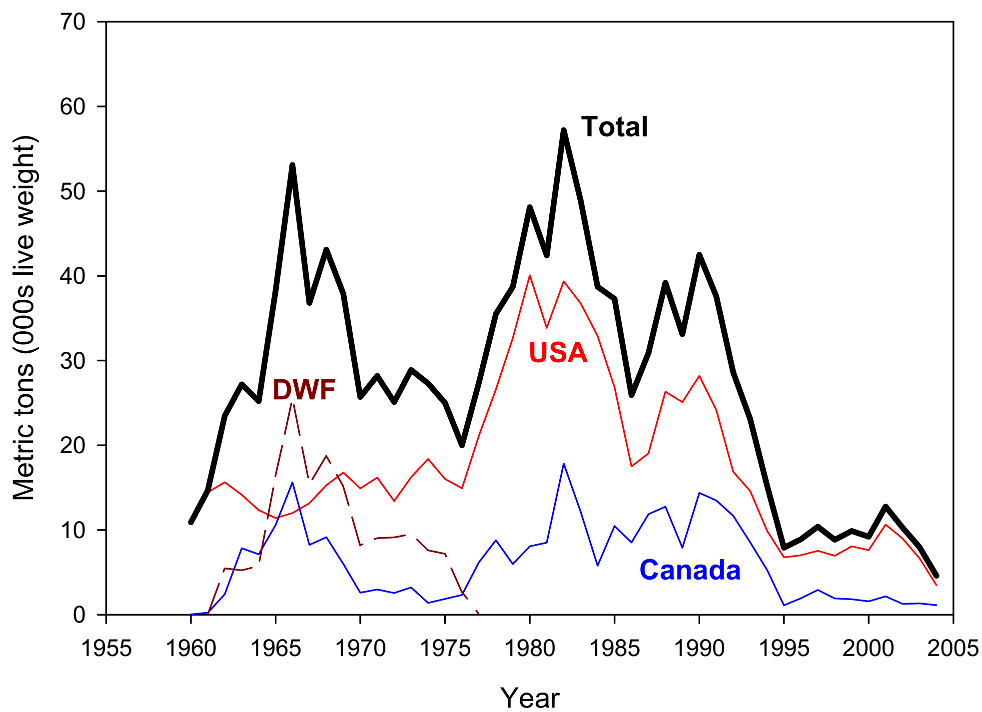

Figure A1b. Total commercial landings of Georges Bank cod (NAFO Division 5Z ans Subarea 6), 1960-2004.

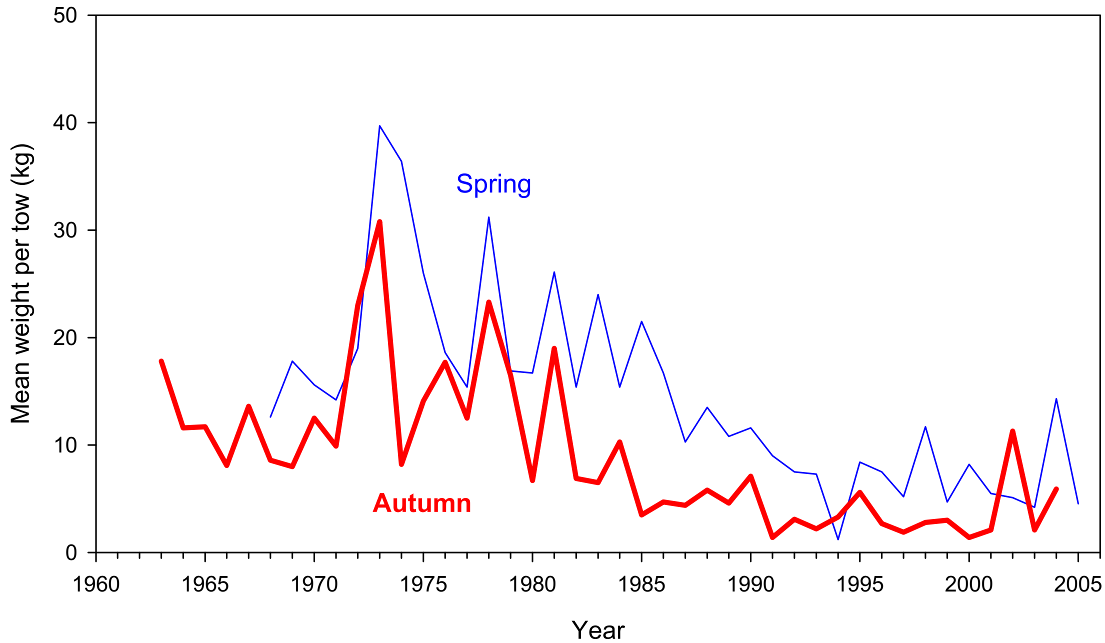

Figure A2. Standardized stratified mean catch per tow (kg) of Atlantic cod in NEFSC spring and autumn research vessel bottom trawl surveys on Georges Bank, 1963-2005.

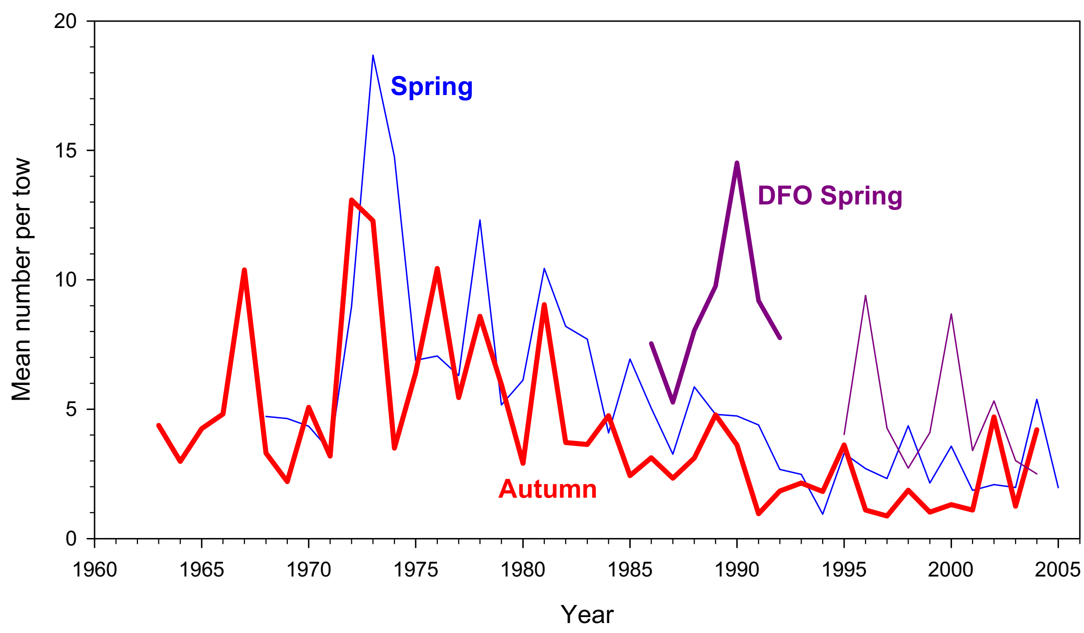

Figure A3. Standardized stratified mean number per tow of Atlantic cod in NEFSC and DFO spring and NEFSC autumn research vessel bottom trawl surveys on Georges Bank, 1963-2005.

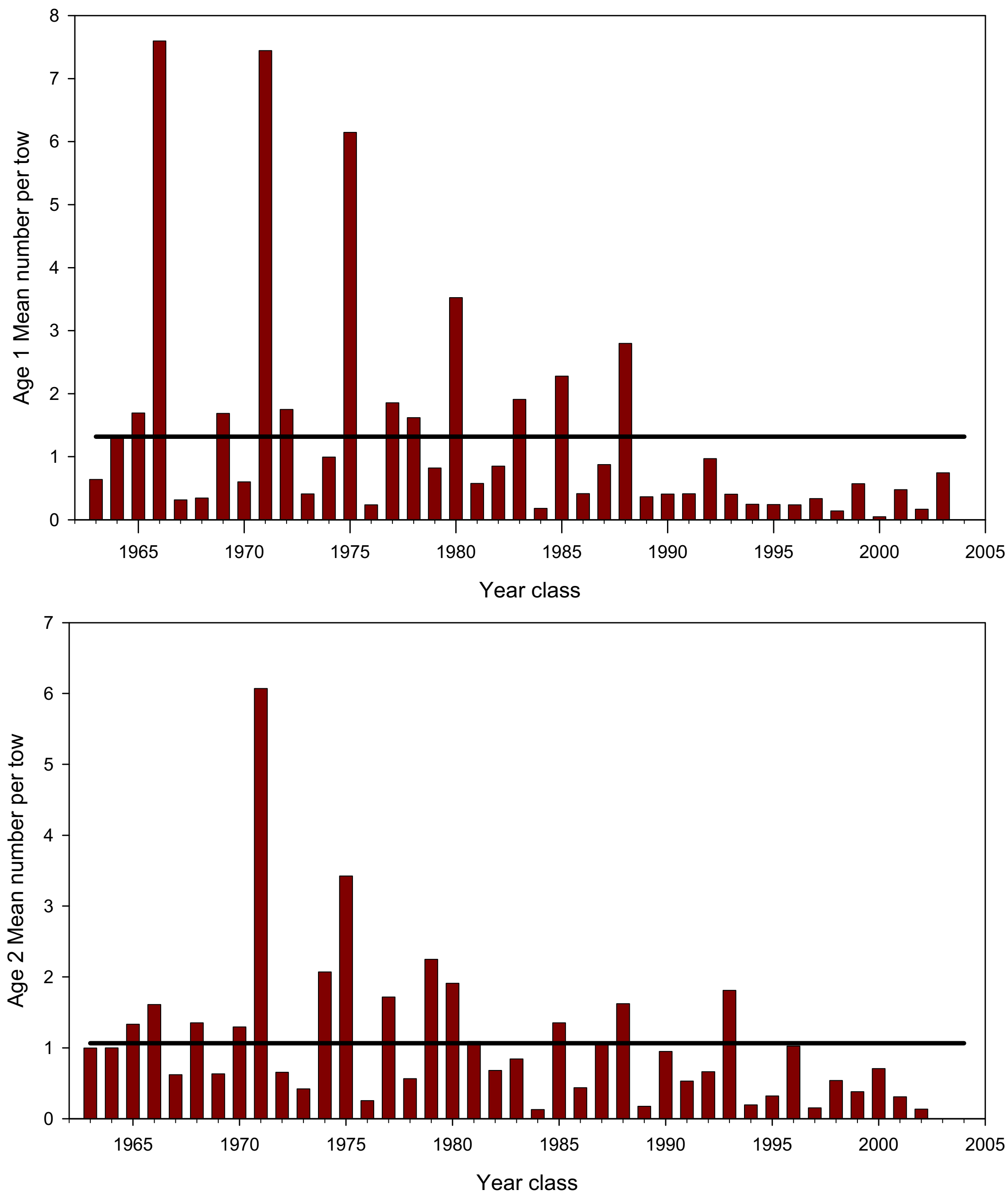

Figure A4. Relative year class strength of age 1 and age 2 Georges Bank cod based on standardized catch (number) per tow indices from NEFSC autumn research vessel bottom trawl surveys, 1963-2004. Horizontal line represents the time series average.

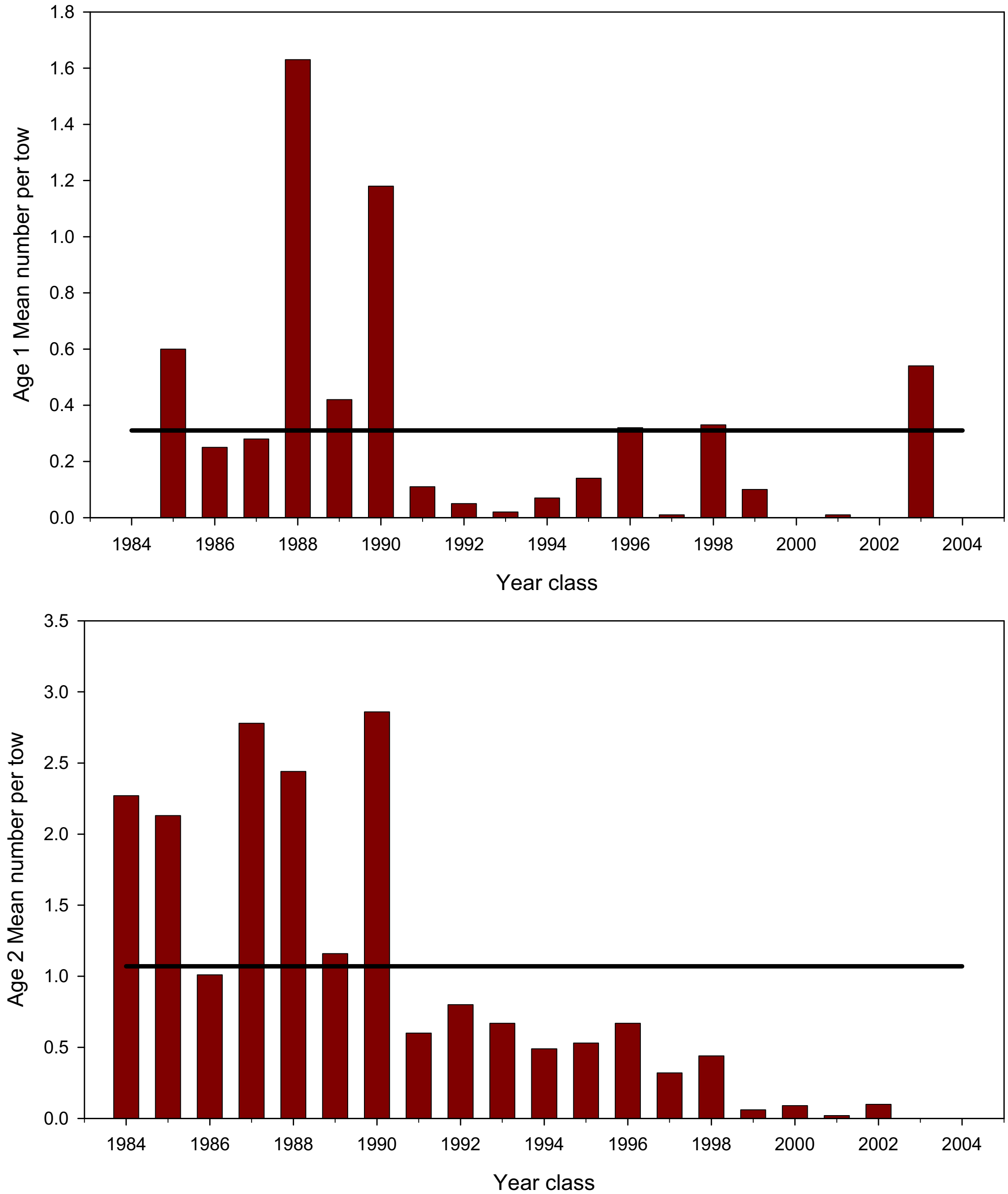

Figure A5. Relative year class strength of age 1 and age 2 Georges Bank cod based on standardized catch (number) per tow indices from DFO spring research vessel bottom trawl surveys, 1986-2004. Horizontal line represents the time series average.

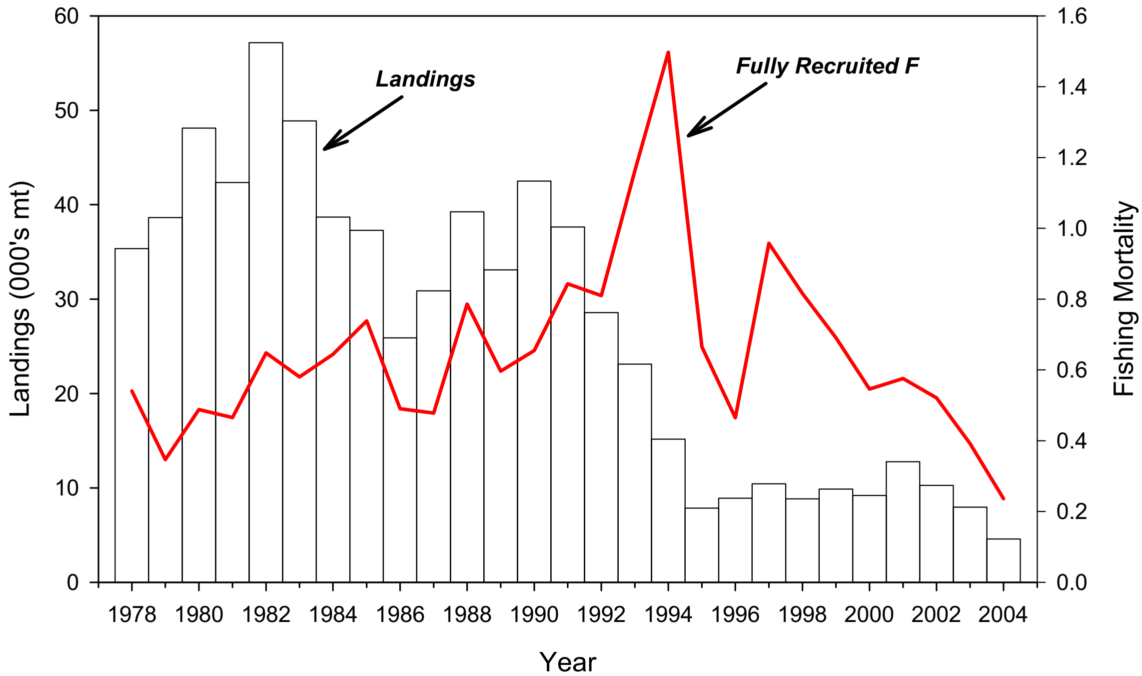

Figure A6. Trends in total commercial landings and fishing mortality for Georges Bank cod, 1978-2005.

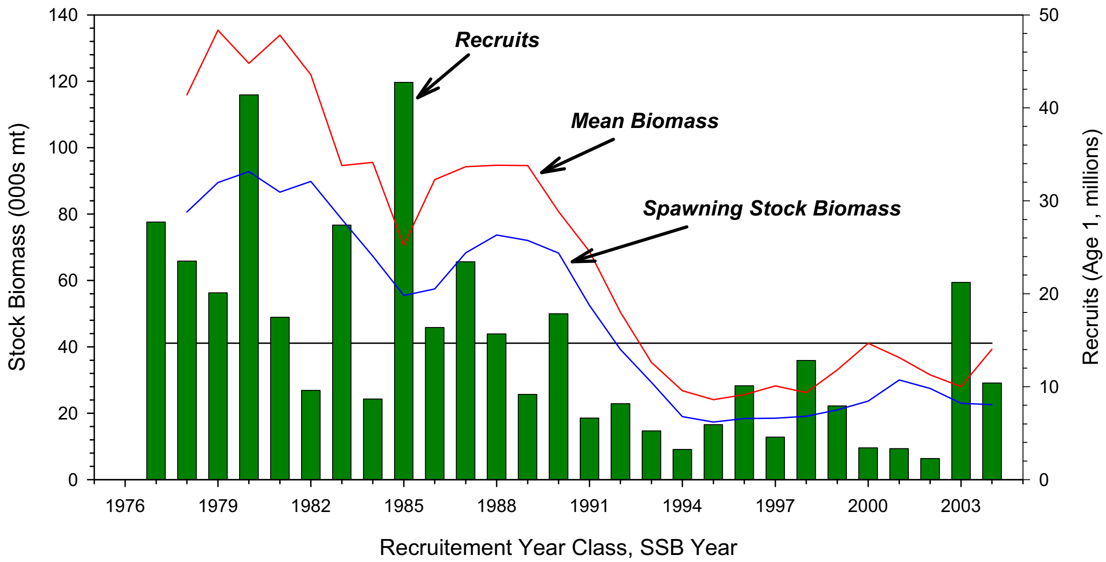

Figure A7. Trends in stock biomass and recruitment for Georges Bank Atlantic cod, 1978-2004. Horizontal line is the average recruitment for the time serioes.

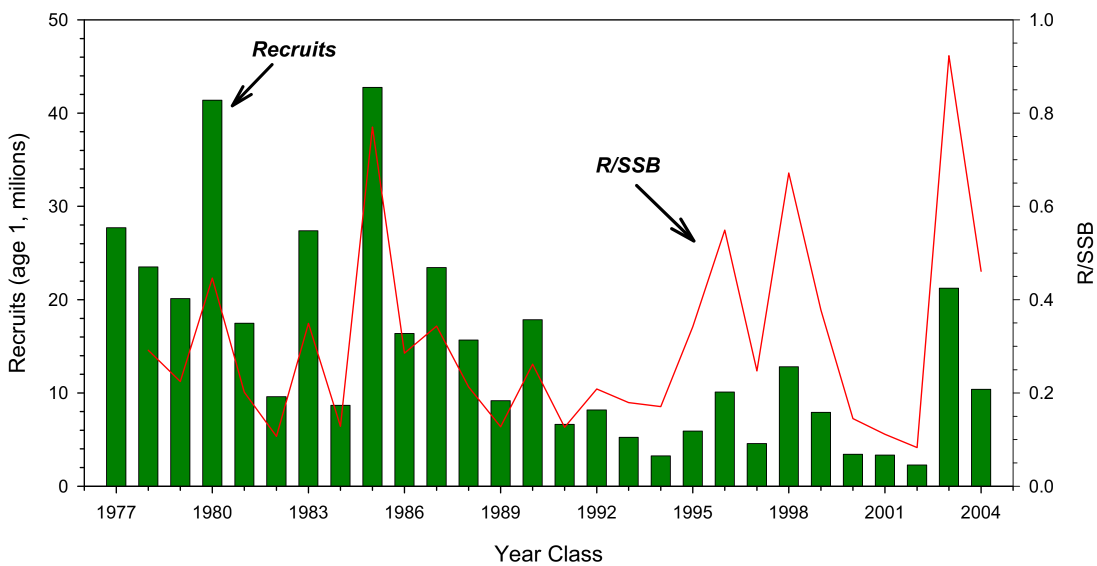

Figure A8. Trends in recruitment and recruitment/SSB survival ratio for Georges Bank cod, 1978-2004.

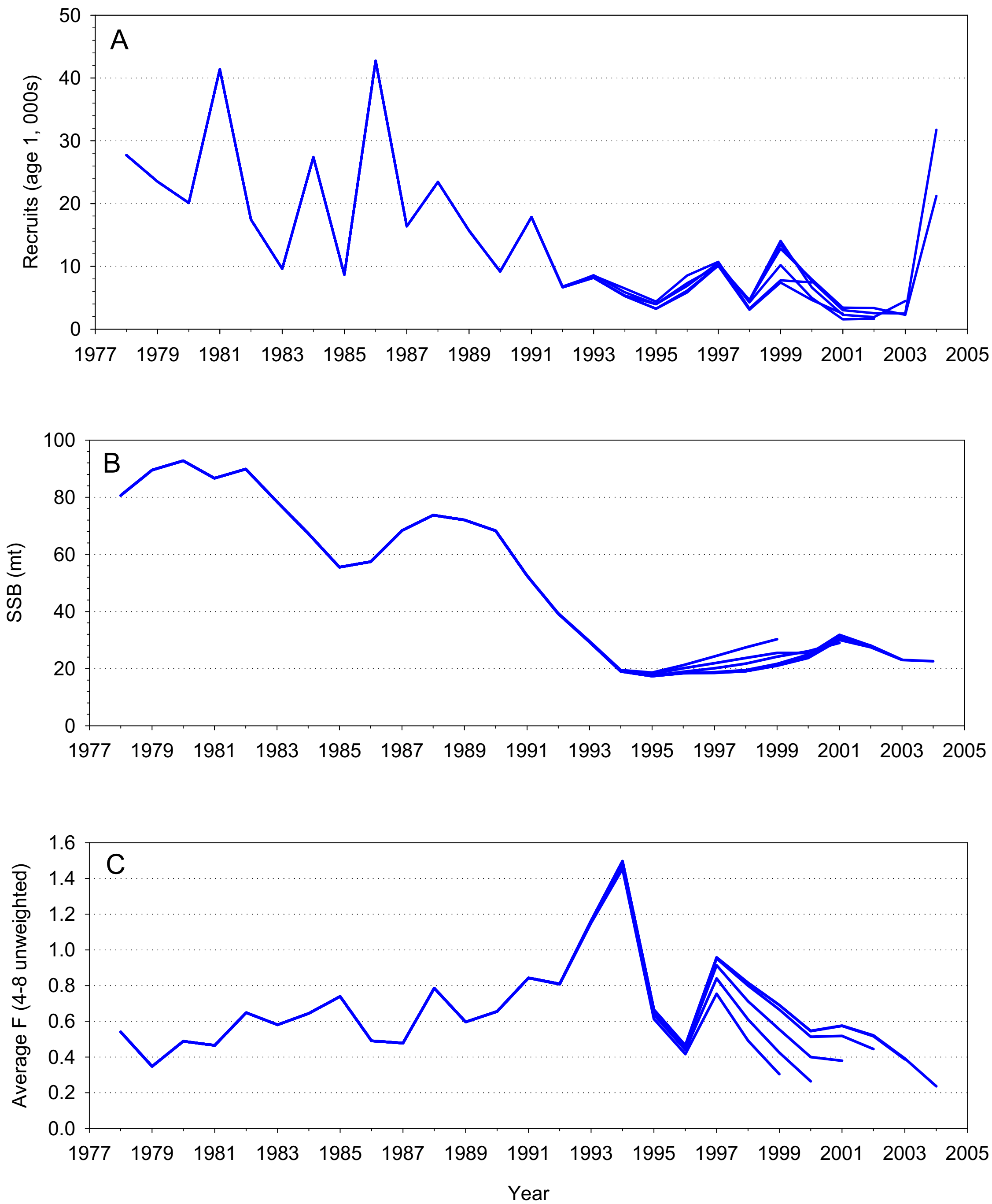

Figure A9. Retrospective analysis of Georges Bank cod recruits at age 1(A), spawning stock biomass (B), and fishing mortality (C) (average F, aged 4-8, unweighted), based on the final ADAPT VPA formulation, 2004-1995.

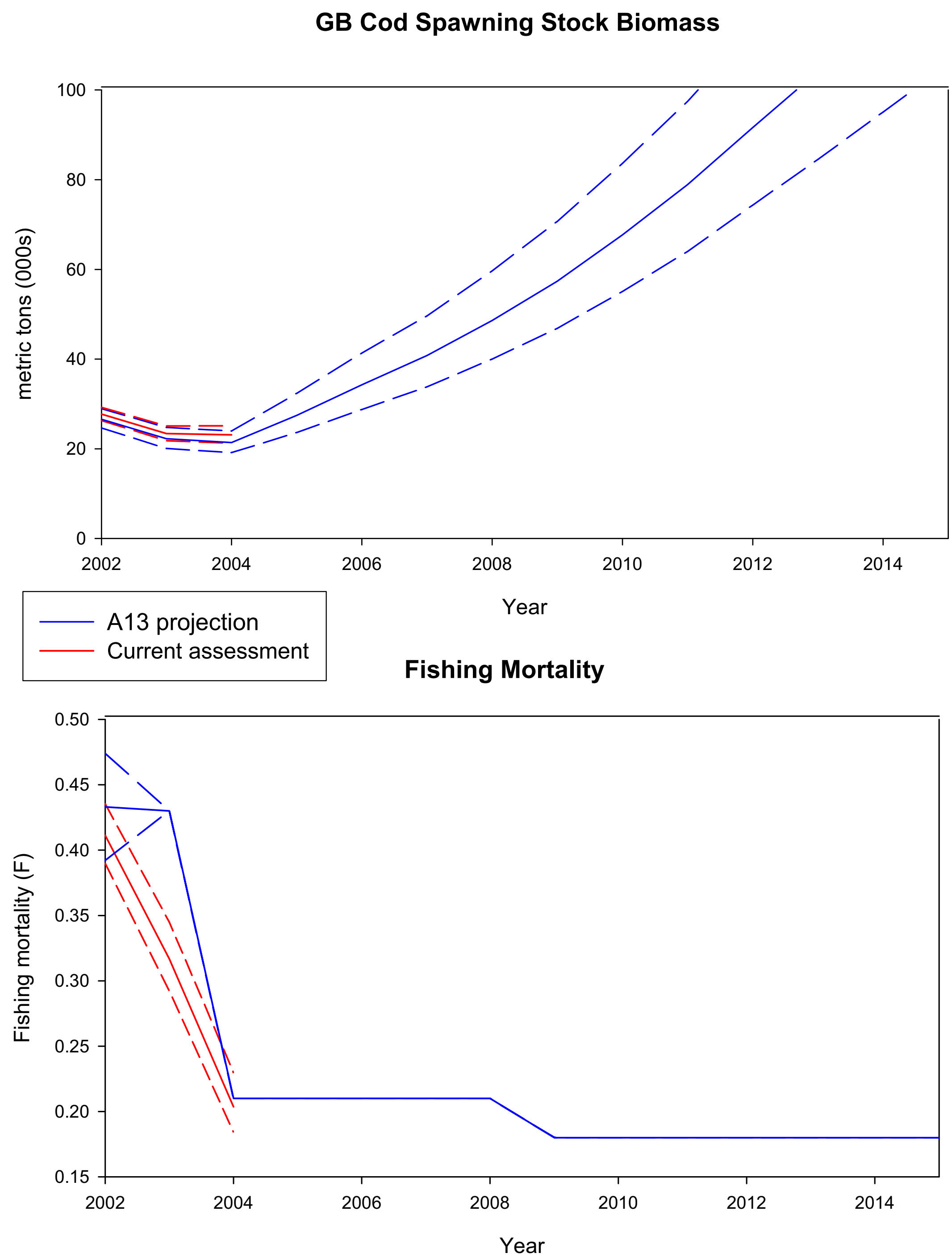

Figure A10. Comparison of A13 projections and current assessment bootstrap estimates of spawning stock biomass (SSB) and fishing mortality (F) , 2002-2004.

B. Georges Bank Haddock by **Jon Brodziak, Michele Traver and Laurel Col**

1.0 Background

The Georges Bank haddock stock was last assessed at the Groundfish Assessment Review Meeting in 2002. Based on that assessment, the stock was overfished and was not experiencing overfishing. Spawning biomass in 2001 was 74,400 mt, roughly 30% of B_{MSY}. Fishing mortality in 2001 was F=0.22, roughly 85% of F_{MSY}. Spawning biomass in 2001 was over 6-fold greater than the near-record low of 11,400 mt in 1993. In this report, we update the Georges Bank haddock assessment using updated fishery data for 1972-2001 along with fishery data for 2002-2004 and research survey data for 2002-2005. Updated estimates of spawning biomass and fishing mortality are used to determine stock status. Sensitivity analyses of 2002 assessment results to updated VPA software and updated fishery and biological data are conducted.

2.0 Assessment for 2005

2.1 2001-2004 Catches

For this assessment, US haddock landings for 2001-2004 were prorated into Georges Bank and Gulf of Maine stock components using a standard algorithm (Figure B1). Total catches of Georges Bank haddock increased from a low of 2,351 mt in 1995 to 17,584 mt in 2004 (Table B1, Figure B2). Revised prorated US Georges Bank haddock landings totaled 4,631 mt in 2001, a 0.1% decrease from the value reported in the last assessment (Brodziak et al. 2002). US landings in 2004 were 7,179 mt, a 55% increase over 2001 landings (Table B2). Canadian landings totaled 9,745 mt in 2004, a 44% increase over 2001 landings. US discards of Georges Bank haddock during 2001-2004 were estimated using at-sea observer sampling data. Quarterly US discards for the western and eastern Georges Bank haddock substocks (Figure 1) were estimated for otter trawl, longline (hook), gillnet, and other (all other gears that caught some haddock) fishing gears using reported landings and observed discard to kept ratios similar to previous assessments (Brown and Munroe 2000). US discards of western Georges Bank haddock increased from about 100 mt during 2001-2003 to over 400 mt in 2004 (Table B3.1). US discards of eastern Georges Bank haddock increased from about 50 mt during 2001-2003 to over 150 mt in 2004 (Table B3.2). Estimates of discards of eastern Georges Bank haddock in the Canadian sea scallop fishery during 1972-2004 (Van Eeckhaute and Brodziak 2005) were also included in the updated fishery catch data. Canadian discards ranged from a high of 186 mt in 1985 to a low of 29 mt in 2000 and have remained below 100 mt since 1998.

Total catch numbers at age of Georges Bank haddock were estimated using available fishery length and age composition data. The Canadian catch at age of eastern Georges Bank haddock during 1972-2004 was taken from the most recent TRAC assessment of this substock (Van Eeckhaute and Brodziak 2005). The US catch at age of western and eastern Georges Bank haddock during 2001-2004 was estimated using fishery length and age-length composition data collected by port sampling and at-sea observers, along with research survey age-length composition data to characterize sublegal discards.

US commercial fishery length sampling intensity for western Georges Bank haddock averaged over 200 lengths/100 mt during 2001, 2003 and 2004, but was only 124 lengths/100 mt in 2002

(Table B4.1) while age sampling averaged about 50 ages/100 mt during 2001-2004. Sampling intensity for eastern Georges Bank haddock during 2001-2004 was similar to that for western Georges Bank (Table B4.2), although there were some quarters where no length samples were available. Fisheries in both management areas primarily use similar otter trawl gear (Tables B3.1 and B3.2) and observed fishery length selectivity is similar. As a result, US commercial length frequency data for eastern Georges Bank haddock were augmented with length composition data from US statistical areas 521, 522 and 525 during 2001-2002 and areas 522, and 525 during 2003-2004. US discard length composition data for western and eastern Georges Bank were taken from domestic at-sea observer data.

Annual US catch at age of western and eastern Georges Bank haddock during 2001-2004 were computed for landings and discards (Tables B5.1 and B5.2) using quarterly age-length keys applied to large and scrod market categories. For eastern Georges Bank haddock, there were few age-length composition data in some quarters (Table B4.2). As a result, Canadian commercial fishery age-length keys from eastern Georges Bank were used to augment US age-length composition data for quarters 2, 3, and 4, while the Canadian spring survey age-length key was used for quarter 1. Canadian catch at age during 2001-2004 (Table B5.3) was derived using quarterly age-length composition and length composition data and were taken from the most recent TRAC assessment (Van Eeckhaute and Brodziak 2005). Mean weights at age of US western and eastern Georges Bank haddock catches were computed for landings and discards (Table B6). US fishery catch-at-age data were combined with Canadian fishery catch-at-age data were to compute total catch at age of Georges Bank haddock (Table B7). Similarly, mean weight-at-age data for western and eastern Georges Bank haddock (Table B6) were averaged to compute the mean weights at age of Georges Bank haddock during 2001-2004 (Table B8).

2.2 Survey Indices

NEFSC spring survey and autumn survey indices (Table B9, Figure B3) were computed using standardized research survey data (Table B10). Number per tow at age indices for the NEFSC spring (Table B11) and autumn (Table B12) surveys were computed using survey-specific age-length keys.

Canadian winter survey indices in 2001-2004 (Table B13) were taken from the most recent TRAC assessment (Van Eeckhaute and Brodziak 2005). Analyses of female proportion mature at age during 2001-2004 were updated from the 2002 assessment to compute recent spawning biomass (Table B14).

3.0 Assessment Results

3.1 VPA Results

An updated VPA analysis for Georges Bank haddock was conducted. The VPA formulation was identical to that used for the 2002 GARM assessment (Table B15, Figure B4). The updated VPA included updated research survey indices collected during 2001-2005. VPA diagnostics indicated a good overall fit to the survey data with the lowest mean squared residual observed in the last 7 assessments (Table B15). Coefficients of variation of numbers at age estimates for ages 1-8 in the terminal year plus one ranged from 58% at age-1 to 23% at age-6. Maximal coefficients of variation of catchability ranging from 0.15 (NEFSC fall survey) to 0.51 (NEFSC spring survey Yankee 41 net, 1972-81 across surveys.

VPA results indicate that total stock size increased 4-fold from 163.7 million in 2001 to 869.1 million in 2004 (Table B16). Spawning biomass also increased by 22% from 96.0 thousand mt in 2001 to 116.8 thousand mt in 2004 (Table B17, Figure B5.1). Fishing mortality (age-6 and average F on ages 4-7, unweighted) increased from 2001 to 2004 (Tables B18 and B19, Figure B5.2). Average F was 0.18 in 2001 and increased to 0.24 in 2004 (+39%). Results indicate that the 1998 (47 million) and 2000 (91 million) year classes are strong, while the 2003 year class appears to be exceptionally strong (789 million) and may be the largest ever observed (Figure B5.3). Bootstrap analysis indicates that estimates of spawning biomass and average F in 2004 are relatively precise with coefficients of variation of 13-16% (Table B20, Figure B6). Retrospective analysis suggests a minor pattern of overestimation of F and underestimation of spawning biomass (Figure B7).

3.2 Sensitivity Analyses

3.2.1 Effect of updated VPA software on 2002 VPA results
The NEFSC VPA software was enhanced to include more options for estimation of stock size and F in 2004. The old software (FACT) was compared to the new software (GARM) using the 2002 VPA input data for Georges Bank haddock from the 2002 GARM. Results of this comparison showed that there were minimal differences in estimates of numbers-at-age in the terminal year plus one, fishing mortality at age in the terminal year, average F, and spawning biomass (Table B21). Overall, the software changes had no significant impact on VPA results.

3.2.2 Effect of updated VPA software and fishery and biological data on 2002 VPA results
The input data for the Georges Bank haddock VPA was revised in this assessment to include Canadian scallop fishery discards in the catch at age for 1972-2004, US discard-at-age estimates for 2001-2004, updated proration of 2001 US haddock landings to stock area, revised mean weight-at-age data in 2001, and revised female percent mature at age in 2001. The effect of using the revised data with the GARM VPA software was compared to the effect of using the old data with the FACT VPA software (Table B21). The use of the new data moderately increased the estimates of stock size at age and spawning (Table B21) but had no discernable effect on estimates of fishing mortality. Overall, this showed that the primary effect of using the new data was to increase stock size to account for increases in catch at age due to the inclusion of additional estimates of fishery discards.

4.0 Sources of Uncertainty

- Increased quarterly sampling of US landings from eastern Georges Bank haddock would improve estimates of US catch-at-age data.
- Proration of landings are based on preliminary logbook data and are subject to change.

5.0 Summary Stock Status

5.1 Biological Reference Points

For Georges Bank haddock, spawning biomass (B_{MSY}) and the fishing mortality to produce MSY (F_{MSY}) are B_{MSY} = 250,300 mt and F_{MSY} = 0.263 (NEFSC 2002). The overfished threshold ($B_{THRESHOLD}$) for Georges Bank haddock is $B_{THRESHOLD}$ = ½ B_{MSY} = 125,200 mt. The overfishing threshold ($F_{THRESHOLD}$) for Georges Bank haddock is $F_{THRESHOLD} = F_{MSY}$ = 0.26.

5.2 Stock Status in 2004

In 2004, spawning biomass was 116,800 mt (93% of $B_{THRESHOLD}$ and 47% of B_{MSY}). Therefore, the Georges Bank haddock stock was overfished in 2004 (Figure B8). In 2004, the fishing mortality was 0.24 (92% of $F_{THRESHOLD}$). Therefore, overfishing was not occurring on the Georges Bank haddock stock in 2004 (Figure B9).

5.3 Comparison with Projected Amendment 13 Rebuilding Trajectory

The projected Amendment 13 rebuilding trajectory for Georges Bank haddock was compared to VPA estimates of spawning biomass and fishing mortality in 2004. For this stock, an adaptive rebuilding plan was adopted in which $F_{REBUILD}=F_{MSY}=0.26$ during 2004-2008. Median spawning biomass on the rebuilding trajectory was projected to be 129.8 kt in 2004. For comparison, the 80% confidence interval based on bootstrapping was (0.21, 0.31) and the $F_{REBUILD}$ value for 2004 falls within the probable range of the VPA estimate of F_{2004}. Similarly, the 80% confidence interval for SSB_{2004} was (97.9, 138.8) kt and the $SSB_{REBUILD}$ in 2004 falls within the probable range of the VPA estimate of SSB_{2004}. Overall, this suggests that current estimates of F and SSB are consistent with projected values on the rebuilding trajectory.

6.0 GARM Comments

The Panel noted that the 2003 year-class appears to be the highest recruitment on record, at an estimated value of 789 million age-1 fish. The size of 2003 year-class is still uncertain since the fish have not yet recruited to the fishery. The magnitude and growth pattern of the 2003 year-class appears to be very similar to the historically large 1963 year-class, which was also the slowest growing year class in the time series.

The Panel discussed the estimation of discards during 2001-2004 using at-sea observer data. It was noted that on the order of 2-5% of haddock landings were observed in this period. The Panel considered the discard estimates to be appropriate for inclusion in the catch at age given recent increases in recruitment.

The Panel discussed how haddock catch at age estimates were derived during 2001-2004 using length-weight relationships, length frequency data, and age-length keys. The Panel concluded that the estimation methods were reasonable.

The Panel discussed whether it was consistent for F to increase from 0.16 in 2003 to 0.24 in 2004 even though population size (age-1+) increased from 2003 to 2004. It was apparent that the increase in the average F for fully recruited ages 4-7 was due to both increases in catch, as well as inclusion of the comparatively weak 1997, 1999, and 2001 year classes in the catch. In 2004, more fish of ages 6-7 were harvested leading to increases in F on ages 6-7. The Panel noted that ages 6-7 may have been targeted by the fishery. In particular, the 2004 Fs on ages 6 and 7 were 0.3 and 0.44, 3-fold higher than the Fs on ages 4 and 5.

The Panel discussed the decreasing trends in fishery mean weights at age. Possible mechanisms for the observed decreases were density-dependence, increased discarding or environmental impacts on fish growth. In 2001-2004, mean weights at age decreased significantly, especially in 2004. The Panel noted that haddock abundance during 2001-2004 was the highest since the 1960s and that this high abundance may have reduced average food ration per capita. After reviewing comparing short-term and long-term mean weights at age in the NEFSC spring and fall surveys and the DFO winter survey, the Panel concluded that significant decreases in mean weights at age were also apparent in all three surveys. This suggested that the observed decreases in fishery mean weights at age represented a broad-scale, population-wide pattern.

The Panel also discussed whether the length-weight relationship for Georges Bank haddock had changed in recent years. In particular, the Panel was interested in whether the decline in mean weights at age was due to a change in average length at age or due to a change in the length-weight relationship. After reviewing available data, the Panel concluded that the decrease in mean weights at age was primarily due to a decline in lengths at age although there were some minor decreases in average weight at length during 2001-2004. It was also noted that there was no clear relationship between water temperature anomalies in recent years and the observed decline in mean weights.

Sources of Uncertainty

Increased quarterly sampling of US landings from eastern Georges Bank haddock would improve estimates of the US catch at age.

The proration of US haddock landings is based on preliminary logbook data and are subject to change.

The size of 2003 year-class is estimated to be very large but still subject to uncertainty since the fish have not yet recruited to the fishery. If the slow growth of this year class persists, it may delay recruitment of the 2003 year-class to the landings and result in a prolonged exposure to discarding.

Projection Advice

Recent trends in mean weights indicate that a short-term average is appropriate for projections. The Panel recommends the use of the recent 3-year average (2002-2004) mean weights at age for the entire Georges Bank stock.

The Panel agreed that it was reasonable to use the existing Georges Bank haddock 2-state stock-recruitment model, including the 2002-2004 estimates of recruitment.

The panel reviewed both long and short term (2001-2004) partial recruitment patterns for the Georges Bank haddock projections. The panel concluded that the short term partial recruitment pattern was more appropriate due to recent changes in growth and mesh size.

Research Recommendation

Investigate how best to compute the average F on fully-recruited age classes, in light of possible changing targeting of fully recruited age classes.

7.0 References

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Brown, R. W., and N. J. Munroe. 2000. Stock assessment of Georges Bank haddock, 1931-1999. Northeast Fisheries Science Center Ref. Doc. 00-12, NEFSC, Woods Hole, MA 02543.

Northeast Fisheries Science Center [NEFSC]. 2002. Final Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish. NEFSC Reference Document 02-04, Woods Hole, MA, 02543.

Van Eeckhaute, L., and J. Brodziak. 2005. In review. Assessment of eastern Georges Bank haddock. Transboundary Resource Assessment Committee Research Document.

Table B1. Georges Bank haddock catch biomass (mt), 1960-2004

Year	USA	Canada	USSR	Spain	Other	Total
1960	40800	77	0	0	0	40877
1961	46384	266	0	0	0	46650
1962	49409	3461	1134	0	0	54004
1963	44150	8379	2317	0	0	54846
1964	46512	11625	5483	2	464	64086
1965	52823	14889	81882	10	758	150362
1966	52918	18292	48409	1111	544	121274
1967	34728	13040	2316	1355	30	51469
1968	25469	9323	1397	3014	1720	40923
1969	16456	3990	65	1201	540	22252
1970	8415	1978	103	782	22	11300
1971	7306	1630	374	1310	242	10862
1972	3869	742	137	1098	20	5866
1973	2777	1661	602	386	3	5429
1974	2396	622	109	764	559	4450
1975	3989	1544	8	61	4	5606
1976	2904	1521	4	46	9	4484
1977	7934	3060	0	0	0	10994
1978	12160	10356	0	0	0	22516
1979	14279	5368	0	0	0	19647
1980	17470	10168	0	0	0	27638
1981	19176	5835	0	0	0	25011
1982	12625	5002	0	0	0	17627
1983	8682	3327	0	0	0	12009
1984	8807	1587	0	0	0	10394
1985	4273	3670	0	0	0	7943
1986	3339	3507	0	0	0	6846
1987	2156	4841	0	0	0	6997
1988	2492	4197	0	0	0	6689
1989	1430	3197	0	0	0	4627
1990	2001	3468	0	0	0	5469
1991	1395	5563	0	0	0	6958
1992	2005	4191	0	0	0	6196
1993	687	3841	0	0	0	4528
1994	218	2525	0	0	0	2743
1995	218	2133	0	0	0	2351
1996	313	3695	0	0	0	4008
1997	888	2682	0	0	0	3570
1998	1841	3473	0	0	0	5314
1999	2775	3729	0	0	0	6504
2000	3366	5431	0	0	0	8797
2001	4754	6751	0	0	0	11505
2002	6477	6517	0	0	0	12994
2003	5703	6873	0	0	0	12576
2004	7746	9838	0	0	0	17584
Average 1960-2004	13256	5064	3208	248	109	21884
Average 1980-1999	4640	4032	0	0	0	8671
Average 2000-2004	5609	7082	0	0	0	12691

Table B2. USA and Canadian commercial landings (mt) of Georges Bank haddock by major gear, 1964-2004.

	United States				Canada			
Year	Otter Trawl	Longline	Other	Total	Otter Trawl	Longline	Other	Total
1964	45617	742	153	46512	11624	1	0	11625
1965	52034	716	73	52823	14862	22	5	14889
1966	51686	1127	105	52918	17905	63	324	18292
1967	33825	814	89	34728	12923	96	21	13040
1968	24930	495	44	25469	9201	111	11	9323
1969	15494	950	12	16456	3955	22	13	3990
1970	7979	430	6	8415	1900	76	2	1978
1971	7004	300	2	7306	1475	154	1	1630
1972	3674	190	5	3869	411	198	0	609
1973	2675	100	2	2777	1461	102	0	1358
1974	2308	80	8	2396	374	87	1	462
1975	3839	143	7	3989	1247	111	0	1358
1976	2840	51	13	2904	1192	154	15	1361
1977	7842	36	56	7934	2814	94	1	2909
1978	11962	63	135	12160	9716	171	292	10179
1979	14138	30	111	14279	4907	274	1	5182
1980	17170	30	270	17470	9510	590	1	10101
1981	19031	3	142	19176	4644	1015	0	5659
1982	12484	2	139	12625	4222	709	0	4931
1983	8588	35	59	8682	2396	813	3	3212
1984	8661	79	67	8807	624	838	1	1463
1985	4194	43	36	4273	2745	626	41	3484
1986	3298	24	17	3339	2734	594	35	3415
1987	2124	21	11	2156	3521	1046	89	4703
1988	2408	32	52	2492	3183	695	97	4046
1989	1356	24	50	1430	1976	977	106	3060
1990	1949	15	37	2001	2411	853	76	3340
1991	1340	28	27	1395	4028	1309	119	5456
1992	1974	17	14	2005	2583	1384	90	4058
1993	659	16	12	687	2489	1143	96	3727
1994	175	33	10	218	1597	714	100	2411
1995	144	59	15	218	1647	390	28	2065
1996	210	63	40	313	2689	947	26	3663
1997	754	76	58	888	1991	722	36	2749
1998	1692	55	94	1841	2422	921	27	3371
1999	2605	27	143	2775	2760	887	33	3680
1999	2605	27	143	2775	2760	887	33	3680
1999	2605	27	143	2775	2760	887	33	3680
2000	3217	31	118	3366	4146	1186	71	5402
2001	4443	49	139	4631	5112	1633	29	6774
2002	6081	40	209	6330	4954	1521	12	6488
2003	5353	160	52	5564	4985	1776	14	6775
2004	6596	474	110	7179	7744	2000	1	9745

Table B3.1 Western Georges Bank haddock catch (mt) with discards based on observer data, 2001-2004

WGB 2001			QTR 1			QTR 2				QTR 3				QTR 4			
	D/K Ratio	Annual Landings (mt)	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch
HOOK	0.12	49.28	4.59	0.54	5.13	0.12	2.92	0.34	3.26	0.12	38.60	4.56	43.16	0.12	3.17	0.37	3.54
OTTER TRAWL	0.01	3835.88	1332.44	18.31	1350.75	0.03	887.42	28.48	915.90	0.01	1050.58	14.11	1064.69	0.03	565.44	15.02	580.46
GILLNET	0.01	137.07	70.78	0.73	71.51	0.00	33.16	0.00	33.16	0.06	18.79	1.11	19.90	0.02	14.34	0.31	14.65
OTHER		0.05		0.00	0.00			0.00	0.00			0.00	0.00	0.13	0.05	0.01	0.06
Totals by QTR			1407.81	19.58	1427.39		923.50	28.82	952.32		1107.97	19.77	1127.74		583.00	15.71	598.71
Total Landings	4022																
Total Discards	84																
Total DK Ratio	2%																
Total Catch 2001	4106																

WGB 2002			QTR 1			QTR 2				QTR 3				QTR 4			
	D/K Ratio	Annual Landings (mt)	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch
HOOK	0.12	39.54	11.81	1.39	13.20	0.12	2.67	0.32	2.99	0.07	19.30	1.29	20.59	0.19	5.76	1.07	6.83
OTTER TRAWL	0.04	5166.02	1405.93	49.88	1455.81	0.01	1718.57	15.90	1734.47	0.01	1336.95	13.64	1350.59	0.02	704.57	15.23	719.80
GILLNET	0.01	203.86	70.37	0.57	70.94	0.00	52.67	0.14	52.81	0.17	73.06	12.18	85.24	0.01	7.76	0.05	7.81
OTHER	0.13	4.17	0.02	0.00	0.02	0.13	3.91	0.52	4.43	0.13	0.09	0.01	0.10	0.13	0.15	0.02	0.17
Totals by QTR			1488.13	51.85	1539.98		1777.82	16.87	1794.69		1429.40	27.11	1456.51		718.24	16.37	734.61
Total Landings	5414																
Total Discards	112																
Total DK Ratio	2%																
Total Catch 2002	5526																

WGB 2003			QTR 1			QTR 2				QTR 3				QTR 4			
	D/K Ratio	Annual Landings (mt)	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch
HOOK	0.24	159.72	8.67	2.05	10.72	0.12	1.16	0.14	1.30	0.12	31.10	3.67	34.77	0.12	118.79	14.03	132.82
OTTER TRAWL	0.01	3789.61	1354.12	18.82	1372.94	0.01	1354.20	17.88	1372.08	0.02	511.16	7.82	518.98	0.01	570.13	6.56	576.69
GILLNET	0.00	47.87	3.44	0.00	3.44	0.11	8.51	0.91	9.42	0.10	26.31	2.58	28.89	0.06	9.61	0.62	10.23
OTHER	0.13	3.71	0.03	0.00	0.03	0.13	3.31	0.44	3.75	0.13	0.36	0.05	0.41	0.13	0.01	0.00	0.01
Totals by QTR			1366.26	20.88	1387.14		1367.18	19.36	1386.54		568.93	14.12	583.05		698.54	21.20	719.74
Total Landings	4001																
Total Discards	76																
Total DK Ratio	2%																
Total Catch 2003	4076																

WGB 2004			QTR 1			QTR 2				QTR 3				QTR 4			
	D/K Ratio	Annual Landings (mt)	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch
HOOK	0.01	472.46	44.82	0.64	45.46	0.01	2.65	0.04	2.69	0.01	64.17	0.71	64.88	0.01	360.82	5.23	366.05
OTTER TRAWL	0.12	4801.31	1380.47	164.69	1545.16	0.04	1484.08	55.21	1539.29	0.12	934.64	109.82	1044.46	0.06	1002.12	57.61	1059.73
GILLNET	0.09	25.69	2.58	0.22	2.80	0.06	6.23	0.38	6.61	0.03	14.50	0.41	14.91	0.14	2.38	0.33	2.71
OTHER	0.21	84.22	0.01	0.00	0.01	0.21	47.31	10.07	57.38	0.13	36.90	4.85	41.75			0.00	0.00
Totals by QTR			1427.88	165.56	1593.44		1540.27	65.69	1605.96		1050.21	115.79	1166.00		1365.32	63.17	1428.49
Total Landings	5384																
Total Discards	410																
Total DK Ratio	8%																
Total Catch 2004	5794																

Table B3.2 Eastern Georges Bank haddock catch (mt) with discards based on observer data, 2001-2004

EGB 2001			QTR 1			QTR 2				QTR 3				QTR 4			
	D/K Ratio	Annual Landings (mt)	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch
HOOK				0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
OTTER TRAWL	0.03	606.60	172.30	4.34	176.64	0.10	308.10	31.58	339.68	0.03	57.21	1.57	58.78	0.03	68.99	2.03	71.02
GILLNET	0.02	1.83	0.92	0.02	0.94	0.02	0.91	0.02	0.93			0.00	0.00			0.00	0.00
OTHER				0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
Totals by QTR			173.22	4.35	177.57		309.01	31.60	340.61		57.21	1.57	58.78		68.99	2.03	71.02
Total Landings	608																
Total Discards	40																
Total DK Ratio	7%																
Total Catch 2001	648																

EGB 2002			QTR 1			QTR 2				QTR 3				QTR 4			
	D/K Ratio	Annual Landings (mt)	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch
HOOK				0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
OTTER TRAWL	0.07	914.84	165.14	11.92	177.06	0.04	573.08	20.32	593.40	0.02	98.81	1.80	100.61	0.01	77.81	0.81	78.62
GILLNET				0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
OTHER		1.20		0.00	0.00	0.12	1.17	0.14	1.31	0.12	0.03	0.00	0.03			0.00	0.00
Totals by QTR			165.14	11.92	177.06		574.25	20.45	594.70		98.84	1.80	100.64		77.81	0.81	78.62
Total Landings	916																
Total Discards	35																
Total DK Ratio	4%																
Total Catch 2002	951																

EGB 2003			QTR 1			QTR 2				QTR 3				QTR 4			
	D/K Ratio	Annual Landings (mt)	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch
HOOK				0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
OTTER TRAWL	0.03	1563.40	179.41	4.66	184.07	0.04	1041.06	42.16	1083.22	0.04	92.09	3.54	95.63	0.05	250.84	13.04	263.88
GILLNET				0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
OTHER				0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
Totals by QTR			179.41	4.66	184.07		1041.06	42.16	1083.22		92.09	3.54	95.63		250.84	13.04	263.88
Total Landings	1563																
Total Discards	63																
Total DK Ratio	4%																
Total Catch 2003	1627																

EGB 2004			QTR 1			QTR 2				QTR 3				QTR 4			
	D/K Ratio	Annual Landings (mt)	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch	D/K Ratio	Landings	Discards	Total Catch
HOOK		1.11		0.00	0.00			0.00	0.00			0.00	0.00	0.01	1.11	0.02	1.13
OTTER TRAWL	0.04	1794.26	265.84	11.11	276.95	0.09	1195.85	109.47	1305.32	0.11	309.01	34.28	343.29	0.04	23.56	0.99	24.55
GILLNET	0.05	0.40	0.32	0.01	0.33	0.05	0.08	0.00	0.08			0.00	0.00			0.00	0.00
OTHER				0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
Totals by QTR			266.16	11.12	277.28		1195.93	109.47	1305.40		309.01	34.28	343.29		24.67	1.00	25.67
Total Landings	1796																
Total Discards	156																
Total DK Ratio	9%																
Total Catch 2004	1952																

Table B4.1 USA landings and sampling intensity of western Georges Bank haddock by quarter and market category, 2001-2004

2001	Market Category Landings (mt)			
Qtr	Large	Scrod	Uncl	Total
1	978	355	74	1408
2	655	249	20	924
3	611	493	4	1108
4	297	284	2	583
Total	2541	1381	100	4022
Qtr	Lengths per 100 mt			
1	75	97	0	173
2	123	91	0	214
3	211	122	0	334
4	313	120	0	433
Wt Avg	158	106	0	264
Qtr	Ages per 100 mt			
1	25	39	0	64
2	49	28	0	77
3	73	35	0	108
4	103	38	0	141
Wt Avg	55	35	0	90

2002	Market Category Landings (mt)			
Qtr	Large	Scrod	Uncl	Total
1	1037	438	14	1488
2	1074	594	110	1778
3	978	419	32	1429
4	446	264	8	718
Total	3534	1715	164	5414
Qtr	Lengths per 100 mt			
1	38	45	0	82
2	18	26	0	44
3	101	99	0	200
4	139	122	0	261
Wt Avg	61	63	0	124
Qtr	Ages per 100 mt			
1	17	15	0	33
2	6	12	0	17
3	33	26	0	59
4	39	42	0	82
Wt Avg	21	20	0	41

2003	Market Category Landings (mt)			
Qtr	Large	Scrod	Uncl	Total
1	895	457	15	1366
2	773	555	40	1367
3	337	225	7	569
4	394	267	38	699
Total	2398	1503	100	4001
Qtr	Lengths per 100 mt			
1	62	65	0	127
2	116	77	0	192
3	241	126	0	367
4	245	101	0	346
Wt Avg	138	84	0	222
Qtr	Ages per 100 mt			
1	17	21	0	38
2	29	27	0	57
3	79	37	0	116
4	71	30	0	101
Wt Avg	39	27	0	67

2004	Market Category Landings (mt)			
Qtr	Large	Scrod	Uncl	Total
1	837	548	43	1428
2	570	883	87	1540
3	363	523	163	1050
4	486	780	99	1365
Total	2256	2735	393	5384
Qtr	Lengths per 100 mt			
1	120	73	0	193
2	119	20	0	139
3	205	97	0	302
4	242	131	0	373
Wt Avg	167	77	0	245
Qtr	Ages per 100 mt			
1	36	24	0	59
2	15	3	0	18
3	36	17	0	53
4	34	16	0	50
Wt Avg	29	15	0	44

Table B4.2 USA landings and sampling intensity of eastern Georges Bank haddock by quarter and market category, 2001-2004

2001	Market Category Landings (mt)			
Qtr	Large	Scrod	Uncl	Total
1	61	110	3	173
2	162	144	2	309
3	38	19		57
4	47	22		69
Total	309	295	5	608
Qtr	Lengths per 100 mt			
1	337	68	0	405
2	186	39	0	225
3	0	281	0	281
4	0	0	0	0
Wt Avg	190	65	0	256
Qtr	Ages per 100 mt			
1	111	23	0	134
2	51	17	0	68
3	0	132	0	132
4	0	0	0	0
Wt Avg	58	28	0	85

2002	Market Category Landings (mt)			
Qtr	Large	Scrod	Uncl	Total
1	96	68	1	165
2	279	281	14	574
3	56	43	0	99
4	51	24	2	78
Total	482	416	18	916
Qtr	Lengths per 100 mt			
1	94	0	0	94
2	92	47	0	139
3	275	0	0	275
4	0	0	0	0
Wt Avg	105	29	0	134
Qtr	Ages per 100 mt			
1	47	0	0	47
2	27	18	0	45
3	66	0	0	66
4	0	0	0	0
Wt Avg	33	11	0	44

2003	Market Category Landings (mt)			
Qtr	Large	Scrod	Uncl	Total
1	82	96	0	179
2	493	540	8	1041
3	50	37	6	92
4	26	222	3	251
Total	652	894	17	1563
Qtr	Lengths per 100 mt			
1	119	0	0	119
2	128	53	0	182
3	219	0	0	219
4	427	43	0	470
Wt Avg	180	42	0	223
Qtr	Ages per 100 mt			
1	43	0	0	43
2	36	14	0	50
3	84	0	0	84
4	95	12	0	107
Wt Avg	49	12	0	60

2004	Market Category Landings (mt)			
Qtr	Large	Scrod	Uncl	Total
1	71	193	3	266
2	233	960	3	1196
3	65	238	6	309
4	4	21		25
Total	372	1411	12	1796
Qtr	Lengths per 100 mt			
1	147	0	0	147
2	138	37	0	174
3	339	97	0	437
4	0	0	0	0
Wt Avg	172	41	0	213
Qtr	Ages per 100 mt			
1	35	0	0	35
2	33	9	0	41
3	59	27	0	86
4	0	0	0	0
Wt Avg	37	11	0	48

Table B5.1 Catch at age of western Georges Bank Haddock, 2001-2004

2001 WGB Catch at age (thousands of fish)

	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+	Total
Landings at age 2001	0.0	58.4	479.2	287.3	369.8	299.2	181.5	93.8	56.2	1825.6
Discards at age 2001	4.3	7.1	23.9	13.3	7.8	4.9	2.9	1.1	0.6	65.9
Catch at age 2001	4.3	65.5	503.1	300.6	377.6	304.1	184.4	94.9	56.8	1891.5

2002 WGB Catch at age (thousands of fish)

	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+	Total
Landings at age 2002	0.0	2.2	70.8	925.0	430.1	351.5	195.0	139.0	219.1	2332.8
Discards at age 2002	1.0	46.6	18.3	42.1	7.4	3.5	0.9	0.8	1.3	121.9
Catch at age 2002	1.0	48.8	89.1	967.1	437.5	355.0	195.9	139.8	220.4	2454.7

2003 WGB Catch at age (thousands of fish)

	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+	Total
Landings at age 2003	0.0	0.8	82.6	144.9	926.4	178.6	246.3	93.0	144.7	1817.1
Discards at age 2003	1.1	4.1	28.8	6.1	20.3	2.1	2.4	0.9	1.7	67.4
Catch at age 2003	1.1	4.9	111.4	151.0	946.7	180.7	248.7	93.9	146.4	1884.5

2004 WGB Catch at age (thousands of fish)

	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+	Total
Landings at age 2004	0.0	0.2	23.3	760.6	212.7	1202.7	178.4	125.9	136.5	2640.6
Discards at age 2004	375.1	19.3	34.4	206.8	22.5	58.2	10.3	2.1	3.0	731.6
Catch at age 2004	375.1	19.5	57.7	967.4	235.2	1260.9	188.7	128.0	139.5	3372.2

Table B5.2 USA catch at age of eastern Georges Bank Haddock, 2001-2004

2001 US EGB Catch at age (thousands of fish)

	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+	Total
Landings at age 2001	0.0	0.7	71.0	35.2	68.9	29.5	20.2	26.3	40.4	292.2
Discards at age 2001	1.0	3.3	10.4	3.5	4.0	1.4	1.1	1.3	2.1	28.1
Catch at age 2001	1.0	4.0	81.4	38.7	72.9	30.9	21.3	27.6	42.5	320.3

2002 US EGB Catch at age (thousands of fish)

	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+	Total
Landings at age 2002	0.0	5.4	12.5	176.3	52.7	75.0	26.5	22.1	60.3	430.8
Discards at age 2002	0.1	48.0	12.4	10.0	1.1	0.8	0.1	0.2	0.1	72.8
Catch at age 2002	0.1	53.4	24.9	186.3	53.8	75.8	26.6	22.3	60.4	503.6

2003 US EGB Catch at age (thousands of fish)

	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+	Total
Landings at age 2003	0.0	0.0	94.8	46.6	295.8	77.4	105.2	43.2	91.5	754.5
Discards at age 2003	3.8	2.8	35.5	7.1	11.6	2.6	2.0	0.6	1.3	67.3
Catch at age 2003	3.8	2.8	130.3	53.7	307.4	80.0	107.2	43.8	92.8	821.8

2004 US EGB Catch at age (thousands of fish)

	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+	Total
Landings at age 2004	0.0	0.0	1.3	340.3	152.0	246.7	104.3	94.7	74.5	1013.8
Discards at age 2004	165.6	15.0	24.5	67.9	24.8	17.4	6.7	0.9	0.7	323.5
Catch at age 2004	165.6	15.0	25.8	408.2	176.8	264.1	111.0	95.6	75.2	1337.3

Table B5.3 Canadian catch at age of eastern Georges Bank haddock (thousands of fish), 2001-2004

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+	Total
2001	26	63	1639	486	758	224	178	198	151	3724
2002	1	304	197	1676	316	581	83	84	218	3459
2003	1	6	1675	227	1153	339	363	63	134	3961
2004	178	3	37	3186	410	1216	401	322	185	5939

Table B6 Mean weights at age of western and eastern Georges Bank haddock landings and discards, 2001-2004

Mean weights at age (kg) of western Georges Bank haddock landings, 2001-2004

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+
2001	0.25	1.34	1.47	1.80	2.29	2.68	3.11	3.18	3.76
2002	0.35	1.19	1.39	1.75	1.99	2.71	3.35	3.49	3.38
2003	0.32	1.05	1.35	1.73	1.88	2.37	2.77	3.35	3.30
2004	0.16	0.95	1.25	1.59	1.92	2.07	2.34	3.02	3.28

Mean weights at age (kg) of USA eastern Georges Bank haddock landings, 2001-2004

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+
2001	0.25	1.13	1.29	1.60	2.04	2.34	2.19	2.74	3.31
2002	0.35	1.07	1.18	1.56	1.74	2.44	2.97	3.10	3.31
2003	0.32	1.05	1.31	1.52	1.83	1.99	2.54	2.89	3.09
2004	0.16	0.95	1.05	1.40	1.52	1.84	1.96	2.39	2.73

Mean weights at age (kg) of western Georges Bank haddock discards 2001-2004

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+
2001	0.18	0.64	1.06	1.33	1.78	1.95	2.73	1.85	3.45
2002	0.23	0.58	0.77	1.12	1.33	1.93	2.09	1.73	2.65
2003	0.21	0.50	0.90	1.09	1.48	1.86	2.47	2.98	2.27
2004	0.12	0.37	0.84	1.17	1.18	1.61	1.59	2.08	2.61

Mean weights at age (kg) of eastern Georges Bank haddock discards 2001-2004

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+
2001	0.18	0.64	1.06	1.33	1.78	1.95	2.73	1.85	3.19
2002	0.23	0.58	0.77	1.12	1.33	1.93	2.09	1.73	2.58
2003	0.21	0.50	0.90	1.09	1.48	1.86	2.47	2.98	2.42
2004	0.12	0.37	0.84	1.17	1.18	1.61	1.59	2.08	2.45

Mean weights at age (kg) of Canadian eastern Georges Bank haddock landings, 2001-2004

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+
2001	0.39	1.10	1.47	1.76	2.11	2.37	2.19	2.52	3.31
2002	0.41	1.01	1.42	1.76	1.94	2.34	2.66	2.38	3.31
2003	0.48	0.76	1.38	1.59	1.85	1.89	2.34	2.84	3.09
2004	0.48	0.59	1.10	1.51	1.64	1.88	2.00	2.28	2.73

Table B7 Georges Bank haddock catch at age (thousands of fish), 1963-2004

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+	Total
1963	2910	4047	7418	11152	8198	2205	1405	721	1096	39152
1964	10101	15935	4554	4776	8722	5794	2082	1028	1332	54324
1965	9601	125818	44496	5356	4391	6690	3772	1094	1366	202584
1966	114	6843	100810	19167	2768	2591	2332	1268	867	136760
1967	1150	168	2891	20667	10338	1209	993	917	698	39031
1968	8	2994	709	1921	14519	3499	667	453	842	25612
1969	2	11	1698	448	654	5954	1574	225	570	11136
1970	46	158	16	570	186	214	2308	746	464	4708
1971	1	1375	223	40	289	246	285	1469	928	4856
1972	160	2	460	83	33	123	80	68	1265	2273
1973	2607	2113	3	393	54	31	78	15	455	5750
1974	48	4481	682	2	73	2	2	55	258	5602
1975	199	1069	1928	388	4	43	4	4	91	3731
1976	149	491	570	913	224	0	24	4	116	2491
1977	1	19858	190	689	522	362	4	40	113	21778
1978	1	767	14509	307	571	521	140	14	68	16899
1979	1	26	1742	7238	530	414	318	97	46	10413
1980	8	31170	349	980	6087	597	549	154	81	39976
1981	1	1755	11076	837	944	2590	333	159	95	17791
1982	1	1174	1645	3761	394	573	1127	107	111	8893
1983	0	216	821	697	2261	275	188	808	77	5343
1984	0	94	301	736	402	1500	237	270	550	4090
1985	0	2464	563	199	472	233	539	80	156	4706
1986	6	55	2848	226	148	175	152	270	61	3941
1987	0	2035	132	1645	124	74	91	108	138	4348
1988	4	53	2439	137	953	152	56	65	108	3969
1989	0	1302	89	904	147	369	47	29	46	2933
1990	2	11	1480	176	889	100	181	47	45	2932
1991	6	456	93	2186	104	417	74	157	73	3565
1992	7	252	327	135	1560	113	330	28	96	2848
1993	7	297	359	307	107	676	39	163	78	2031
1994	1	281	846	178	68	72	157	45	45	1693
1995	9	92	615	471	62	32	8	58	19	1367
1996	5	54	577	958	470	69	22	5	8	2169
1997	30	178	290	768	556	216	19	16	40	2114
1998	1	203	423	511	705	536	151	22	42	2594
1999	1	40	1070	587	502	514	338	144	41	3235
2000	0	392	620	1583	558	497	362	246	86	4263
2001	31	133	2223	826	1209	559	383	321	251	5935
2002	2	406	311	2829	808	1012	306	246	498	6418
2003	6	14	1916	432	2407	600	719	201	373	6668
2004	719	38	121	4561	822	2741	701	546	400	10648
Average 1963-2004	665	5460	5106	2399	1782	1062	552	298	336	17656
Average 1980-1999	5	2109	1317	820	848	464	232	137	95	6027
Average 2000-2004	152	196	1038	2046	1161	1082	494	312	322	6786

Table B8 Georges Bank haddock mean catch weights at age (kg), 1963-2004

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+
1963	0.57	0.87	1.18	1.47	1.68	2.15	2.35	3.04	3.10
1964	0.50	0.83	1.12	1.43	1.64	2.01	2.40	2.64	2.97
1965	0.58	0.69	1.03	1.35	1.67	1.99	2.26	2.66	3.11
1966	0.58	0.73	0.89	1.26	1.70	2.07	2.28	2.87	3.18
1967	0.66	0.70	0.95	1.18	1.42	2.05	2.31	2.66	3.10
1968	0.59	0.81	1.05	1.32	1.57	2.10	2.32	2.62	2.86
1969	0.52	0.78	1.10	1.69	1.75	1.99	2.52	2.99	3.63
1970	0.71	1.27	1.22	1.93	2.19	2.39	2.58	3.23	3.75
1971	0.67	1.03	1.31	1.74	2.39	2.81	2.92	3.10	3.72
1972	0.62	1.03	1.74	2.04	2.42	2.92	3.06	3.44	3.66
1973	0.60	1.03	1.58	2.13	2.41	3.29	3.42	3.86	3.94
1974	0.72	1.06	1.82	2.32	2.83	3.76	4.05	3.92	4.26
1975	0.62	0.98	1.63	2.21	2.20	2.94	4.00	4.05	4.33
1976	0.50	0.99	1.39	1.99	2.66	3.08	3.69	4.67	4.94
1977	0.53	1.07	1.44	2.17	2.73	3.21	4.15	4.00	4.99
1978	0.53	0.94	1.50	2.04	2.79	3.19	3.37	3.61	5.11
1979	0.53	1.00	1.28	2.02	2.51	3.14	3.78	3.79	4.87
1980	0.55	0.94	1.21	1.73	2.17	2.82	3.60	3.56	3.87
1981	0.39	0.87	1.24	1.83	2.30	2.72	3.71	4.04	4.44
1982	0.22	0.97	1.45	1.88	2.37	2.76	3.24	3.96	4.09
1983	0.33	1.02	1.37	1.83	2.21	2.65	3.25	3.36	4.27
1984	0.33	0.92	1.32	1.83	2.20	2.67	2.96	3.41	3.72
1985	0.33	0.99	1.39	1.98	2.46	2.72	3.06	3.72	3.80
1986	0.45	0.94	1.36	1.83	2.56	2.83	2.96	3.46	3.78
1987	0.43	0.83	1.43	2.00	2.25	2.63	3.02	3.77	4.29
1988	0.42	0.98	1.34	1.68	2.06	2.45	2.97	3.49	3.96
1989	0.53	0.89	1.48	1.79	2.21	2.57	3.24	3.56	3.82
1990	0.64	0.97	1.48	1.78	2.12	2.55	2.81	2.99	4.16
1991	0.58	1.20	1.31	1.82	2.18	2.65	2.85	3.05	4.34
1992	0.54	1.18	1.64	1.77	2.19	2.52	2.97	3.37	4.27
1993	0.66	1.17	1.73	2.17	2.12	2.63	2.65	3.12	4.01
1994	0.45	1.09	1.64	2.21	2.63	2.73	2.90	3.78	4.55
1995	0.43	0.97	1.49	2.03	2.54	2.82	3.28	3.09	3.98
1996	0.46	1.10	1.50	1.84	2.33	2.54	3.42	3.52	3.71
1997	0.42	1.00	1.69	1.89	2.21	2.55	3.14	3.38	3.66
1998	0.51	0.97	1.49	1.92	2.33	2.69	3.03	3.04	4.07
1999	0.68	1.10	1.53	1.83	2.11	2.34	2.70	2.97	3.68
2000	0.66	1.13	1.46	1.89	2.25	2.37	2.73	2.99	3.30
2001	0.36	1.17	1.46	1.75	2.16	2.53	2.63	2.73	3.41
2002	0.30	0.91	1.34	1.73	1.95	2.47	3.13	3.07	3.34
2003	0.26	0.65	1.36	1.61	1.85	2.05	2.52	3.09	3.17
2004	0.21	0.39	1.00	1.50	1.67	1.95	2.07	2.47	2.91
Average 1963-2004	0.50	0.96	1.38	1.82	2.19	2.60	3.01	3.34	3.86
Average 1980-1999	0.47	1.00	1.45	1.88	2.28	2.64	3.09	3.43	4.02
Average 2000-2004	0.36	0.85	1.32	1.70	1.98	2.27	2.62	2.87	3.23

Table B10 Conversion factors used to adjust for changes in door type and survey vessel in the NMFS surveys during 1968-2005.

		Spring		Fall	
Year	Door	Vessel	Conversion	Vessel	Conversion
1968	BMV	Albatross IV	1.49	Albatross IV	1.49
1969	BMV	Albatross IV	1.49	Albatross IV	1.49
1970	BMV	Albatross IV	1.49	Albatross IV	1.49
1971	BMV	Albatross IV	1.49	Albatross IV	1.49
1972	BMV	Albatross IV	1.49	Albatross IV	1.49
1973	BMV	Albatross IV	1.49	Albatross IV	1.49
1974	BMV	Albatross IV	1.49	Albatross IV	1.49
1975	BMV	Albatross IV	1.49	Albatross IV	1.49
1976	BMV	Albatross IV	1.49	Albatross IV	1.49
1977	BMV	Albatross IV	1.49	Delaware II	1.2218
1978	BMV	Albatross IV	1.49	Delaware II	1.2218
1979	BMV	Albatross IV	1.49	Delaware II	1.2218
1980	BMV	Albatross IV	1.49	Delaware II	1.2218
1981	BMV	Delaware II	1.2218	Delaware II	1.2218
1982	BMV	Delaware II	1.2218	Albatross IV	1.49
1983	BMV	Albatross IV	1.49	Albatross IV	1.49
1984	BMV	Albatross IV	1.49	Albatross IV	1.49
1985	Polyvalent	Albatross IV	1	Albatross IV	1
1986	Polyvalent	Albatross IV	1	Albatross IV	1
1987	Polyvalent	Albatross IV	1	Albatross IV	1
1988	Polyvalent	Albatross IV	1	Albatross IV	1
1989	Polyvalent	Delaware II	0.82	Delaware II	0.82
1990	Polyvalent	Delaware II	0.82	Delaware II	0.82
1991	Polyvalent	Delaware II	0.82	Delaware II	0.82
1992	Polyvalent	Albatross IV	1	Albatross IV	1
1993	Polyvalent	Albatross IV	1	Delaware II	0.82
1994	Polyvalent	Delaware II	0.82	Albatross IV	1
1995	Polyvalent	Albatross IV	1	Albatross IV	1
1996	Polyvalent	Albatross IV	1	Albatross IV	1
1997	Polyvalent	Albatross IV	1	Albatross IV	1
1998	Polyvalent	Albatross IV	1	Albatross IV	1
1999	Polyvalent	Albatross IV	1	Albatross IV	1
2000	Polyvalent	Albatross IV	1	Albatross IV	1
2001	Polyvalent	Albatross IV	1	Albatross IV	1
2002	Polyvalent	Albatross IV	1	Albatross IV	1
2003	Polyvalent	Delaware II	0.82	Delaware II	0.82
2004	Polyvalent	Albatross IV	1	Albatross IV	1
2005	Polyvalent	Albatross IV	1		

Table B11 Georges Bank haddock NEFSC spring survey number at age indices, 1968-2005

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+
1968	0.40	2.83	0.46	0.70	6.72	1.68	0.25	0.45	0.34
1969	0.00	0.07	0.58	0.25	0.42	4.23	1.03	0.28	0.46
1970	0.67	0.25	0.00	0.33	0.46	0.46	2.00	0.98	0.85
1971	0.00	1.16	0.25	0.00	0.12	0.12	0.09	0.82	0.22
1972	4.02	0.09	0.61	0.12	0.03	0.04	0.13	0.03	1.30
1973	30.68	4.84	0.00	0.54	0.09	0.00	0.18	0.01	1.28
1974	2.13	13.29	2.86	0.00	0.24	0.00	0.01	0.10	0.37
1975	0.94	0.97	3.32	0.63	0.00	0.13	0.09	0.01	0.15
1976	80.79	0.30	0.60	0.92	0.43	0.00	0.04	0.00	0.10
1977	0.61	33.41	0.42	1.22	0.60	0.45	0.00	0.04	0.12
1978	0.07	0.97	15.93	0.36	0.94	0.82	0.16	0.06	0.10
1979	36.12	1.58	1.13	5.71	0.33	0.16	0.37	0.06	0.04
1980	5.20	46.70	0.51	1.04	4.87	0.67	0.37	0.46	0.24
1981	3.30	3.29	19.49	2.19	0.76	1.78	0.24	0.11	0.05
1982	0.76	1.53	0.94	4.07	0.42	0.28	0.61	0.00	0.00
1983	0.43	0.55	0.58	0.22	2.41	0.01	0.04	1.16	0.18
1984	2.09	1.18	0.64	0.63	0.58	0.72	0.07	0.04	0.30
1985	0.00	4.96	0.76	0.40	0.87	0.34	1.17	0.10	0.25
1986	2.49	0.18	2.06	0.24	0.11	0.21	0.12	0.33	0.11
1987	0.00	3.62	0.06	0.81	0.08	0.10	0.05	0.22	0.01
1988	1.55	0.04	0.99	0.13	0.32	0.12	0.11	0.12	0.00
1989	0.02	3.49	0.45	0.71	0.14	0.41	0.06	0.05	0.01
1990	0.86	0.00	5.72	0.33	0.58	0.06	0.13	0.00	0.01
1991	0.54	1.07	0.24	1.85	0.09	0.10	0.02	0.04	0.02
1992	0.40	0.18	0.11	0.07	0.33	0.03	0.03	0.03	0.00
1993	1.17	0.65	0.18	0.14	0.12	0.37	0.06	0.02	0.02
1994	0.70	2.68	1.00	0.15	0.10	0.07	0.16	0.02	0.05
1995	0.50	1.29	2.32	0.91	0.17	0.11	0.03	0.18	0.11
1996	1.09	4.59	8.86	5.21	2.62	0.35	0.07	0.07	0.00
1997	1.79	1.02	3.35	3.66	2.01	0.89	0.13	0.07	0.00
1998	0.82	2.95	1.25	1.06	0.85	0.21	0.06	0.01	0.06
1999	10.21	2.03	2.14	0.72	0.64	0.51	0.20	0.20	0.02
2000	1.83	2.37	4.10	2.01	1.11	1.11	1.01	0.48	0.13
2001	10.01	0.86	2.44	0.83	0.30	0.21	0.12	0.08	0.07
2002	0.18	19.25	6.72	3.22	1.09	0.48	0.61	0.17	0.53
2003	0.01	0.25	5.45	1.21	4.85	0.96	1.14	0.86	0.89
2004	112.14	1.85	1.20	9.06	2.18	2.67	0.43	0.96	0.42
2005	0.80	53.34	0.16	0.38	3.35	0.45	1.01	0.19	0.08
Average 1968-2005	8.30	5.78	2.58	1.37	1.09	0.56	0.33	0.23	0.23
Average 1980-1999	1.70	4.10	2.58	1.23	0.90	0.37	0.19	0.16	0.07
Average 2000-2005	20.83	12.99	3.34	2.79	2.15	0.98	0.72	0.46	0.35

Table B12 Georges Bank haddock NEFSC autumn survey number at age indices, 1963-2004

Year	Age-0	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9+
1963	83.93	25.39	9.22	6.81	8.34	5.95	2.04	1.68	1.18	0.46
1964	2.37	112.87	63.74	5.83	1.79	3.81	1.56	0.69	0.25	0.33
1965	0.33	10.16	77.39	9.70	1.07	0.80	0.91	0.80	0.25	0.27
1966	6.14	0.95	2.89	18.39	3.35	0.52	0.49	0.33	0.12	0.07
1967	0.03	6.72	0.36	1.00	6.76	1.62	0.49	0.21	0.33	0.18
1968	0.09	0.06	0.95	0.13	0.33	3.86	1.27	0.27	0.16	0.39
1969	0.39	0.03	0.00	0.28	0.13	0.16	1.52	0.51	0.09	0.27
1970	0.04	4.13	0.21	0.01	0.28	0.27	0.51	1.37	0.48	0.40
1971	2.43	0.00	0.31	0.07	0.01	0.22	0.03	0.09	0.75	0.28
1972	6.75	2.52	0.00	0.52	0.09	0.00	0.09	0.06	0.03	1.30
1973	3.23	9.00	1.61	0.00	0.19	0.04	0.00	0.07	0.01	0.72
1974	0.75	1.77	0.98	0.31	0.00	0.01	0.00	0.00	0.00	0.22
1975	23.48	0.63	0.72	4.86	0.92	0.00	0.03	0.00	0.01	0.30
1976	4.32	64.17	0.52	0.54	0.82	0.30	0.00	0.04	0.10	0.25
1977	0.13	2.14	18.73	0.56	0.57	0.64	0.34	0.04	0.01	0.09
1978	13.22	0.84	1.04	9.27	0.18	0.26	0.45	0.01	0.00	0.01
1979	1.32	45.57	0.04	0.90	3.81	0.26	0.28	0.05	0.01	0.00
1980	11.68	2.71	12.72	0.45	0.18	1.70	0.48	0.46	0.09	0.06
1981	0.38	6.13	2.08	3.70	0.21	0.42	0.53	0.00	0.00	0.01
1982	1.36	0.00	1.33	0.34	1.40	0.13	0.07	0.21	0.01	0.10
1983	5.80	0.24	0.21	0.27	0.30	0.94	0.12	0.00	0.10	0.01
1984	0.03	3.32	0.88	0.24	0.28	0.06	0.45	0.00	0.00	0.12
1985	11.35	0.65	1.53	0.22	0.05	0.10	0.07	0.17	0.00	0.05
1986	0.00	5.11	0.09	1.21	0.06	0.13	0.13	0.02	0.03	0.03
1987	1.80	0.00	0.79	0.10	0.77	0.06	0.06	0.02	0.02	0.00
1988	0.07	3.02	0.18	1.30	0.12	0.40	0.12	0.11	0.00	0.03
1989	0.47	0.05	2.71	0.20	0.66	0.09	0.13	0.02	0.02	0.00
1990	0.77	0.67	0.02	1.19	0.05	0.17	0.04	0.00	0.00	0.00
1991	2.16	0.21	0.24	0.05	0.22	0.02	0.02	0.00	0.00	0.02
1992	2.85	2.08	0.23	0.24	0.00	0.47	0.02	0.08	0.03	0.06
1993	1.52	4.04	2.01	0.30	0.00	0.06	0.15	0.02	0.00	0.00
1994	0.91	0.77	0.81	0.67	0.12	0.05	0.02	0.17	0.06	0.00
1995	2.27	7.14	4.90	2.32	0.38	0.01	0.00	0.07	0.02	0.00
1996	1.31	0.54	0.93	1.04	0.49	0.14	0.01	0.01	0.00	0.01
1997	0.32	2.47	1.47	0.75	0.55	0.33	0.13	0.00	0.07	0.08
1998	4.32	2.79	2.47	0.72	0.41	0.18	0.16	0.02	0.00	0.01
1999	1.82	0.84	3.37	8.05	3.52	2.32	0.82	1.32	0.75	0.31
2000	4.14	2.82	5.48	3.10	1.10	0.66	0.13	0.27	0.09	0.19
2001	0.85	8.77	1.68	7.44	2.12	1.16	0.36	0.22	0.13	0.01
2002	0.12	1.91	22.27	5.45	8.54	1.87	0.62	0.53	0.68	0.10
2003	154.54	0.07	0.45	8.55	1.77	3.36	0.29	0.28	0.00	0.22
2004	1.63	163.65	0.22	0.84	13.62	1.18	4.54	0.50	0.67	0.15
Average 1963-2004	8.61	12.07	5.90	2.57	1.56	0.83	0.46	0.26	0.16	0.17
Average 1980-1999	2.56	2.14	1.95	1.17	0.49	0.39	0.18	0.14	0.06	0.05
Average 2000-2004	32.26	35.45	6.02	5.08	5.43	1.65	1.19	0.36	0.31	0.13

Table B13 Georges Bank haddock DFO winter survey number at age indices, 1986-2004

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8
1986	4.06	0.22	6.05	1.07	0.19	0.29	0.34	0.37
1987	0.03	3.04	0.69	2.51	0.67	0.08	0.30	0.10
1988	1.47	0.05	8.53	0.17	2.85	0.18	0.17	0.11
1989	0.03	5.34	0.72	2.12	0.19	0.42	0.03	0.03
1990	0.93	0.11	9.87	0.13	3.36	0.23	1.09	0.13
1991	0.75	1.67	0.14	8.99	0.11	1.60	0.09	0.44
1992	3.30	2.95	1.13	0.17	3.82	0.03	1.06	0.04
1993	3.96	2.16	0.55	0.45	0.04	1.28	0.02	0.32
1994	3.32	11.52	4.08	0.42	0.24	0.02	0.70	0.01
1995	1.94	2.62	4.30	2.22	0.56	0.03	0.00	0.48
1996	6.11	2.89	4.84	5.04	2.92	0.26	0.24	0.04
1997	1.74	1.16	0.99	2.34	2.37	1.70	0.23	0.09
1998	2.41	8.18	3.08	2.57	3.76	3.67	1.98	0.24
1999	19.75	3.41	7.16	2.21	1.40	1.35	1.26	0.33
2000	18.33	68.60	9.32	8.91	2.11	1.55	1.94	1.14
2001	22.28	2.83	10.88	3.09	4.13	1.29	1.15	1.41
2002	1.98	31.70	6.65	15.36	4.32	5.32	1.59	1.32
2003	1.37	2.55	69.32	5.14	13.24	2.94	2.69	1.21
2004	147.70	0.41	1.99	39.57	3.94	7.38	1.24	0.73
Average 1986-2004	12.71	7.97	7.91	5.39	2.64	1.56	0.85	0.45
Average 1986-1999	3.56	3.24	3.72	2.17	1.61	0.80	0.54	0.20
Average 2000-2004	38.33	21.22	19.63	14.41	5.55	3.69	1.72	1.16

Table B14 Percentage maturity of female Georges Bank haddock at age, 1963-2001.

	Age				
Year	1	2	3	4	Source
1963-1967	0	0	78	100	Clark (1959)
1968 - 1972	0	28	76	100	Livingstone (pers. comm., March 1980) as cited in Clark et al. (1982)
1973 - 1976	0	34	92	100	Livingstone (pers. comm., March 1980) as cited in Clark et al. (1982)
1977	0	61	100	100	Overholtz (1987)
1978	0	26	99	100	Overholtz (1987)
1979	0	8	71	100	Overholtz (1987)
1980	0	41	100	100	Overholtz (1987)
1981	0	52	94	100	Overholtz (1987)
1982	0	31	67	100	Overholtz (1987)
1983	0	11	39	100	Overholtz (1987)
1984	12	33	94	100	O'Brien (pers. comm.)
1985 - 1987	39	73	92	98	Brown et al. (2000)
1988 - 1990	3	33	89	99	Brown et al. (2000)
1991 - 1992	5	72	99	100	Brown et al. (2000)
1993 - 1994	7	30	71	94	Brown et al. (2000)
1995 - 1997	2	34	93	100	Brown et al. (2000)
1998 - 2000	4	49	95	100	Brown et al. (2000)
2001-2004	1	60	95	99	Current Assessment

Table B15 Georges Bank haddock virtual population analysis (VPA) run descriptions including a summary of accepted VPA formulations from the previous six stock assessments and current assessment.

VPA Run #	SARC-24	SARC-27	NDWG-1999	TRAC-2000	TRAC-2001	GARM 2002	GARM 2005
Terminal Year of Catch at Age	1996	1997	1998	1999	2000	2001	2004
Ages Estimated	1-8	1-8	1-8	1-8	1-8	1-8	1-8
Tuning Indices							
US Spring 1-8	Yes	Yes	Yes	Yes	Yes	Yes	Yes
US Spring 1973-1981 (Yankee 41 years) separate index	No	Yes	Yes	Yes	Yes	Yes	Yes
Canada Spring 1-8	Yes	Yes	Yes	Yes	Yes	Yes	Yes
US Autumn 0-5 Lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes
US Autumn 6-8 Lagged	Yes	No	No	No	No	No	No
Terminal Year US Spring Indices	No	No	Yes	No	No	Yes	Yes
Discards							
Post 1993 Discard Estimates Included	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Diagnostics							
Sum of Squares	398.66	338.16	352.20	375.25	386.81	404.75	433.31
Mean squared residuals	0.725	0.696	0.683	0.708	0.701	0.695	0.647
CV n1	0.62	0.61	0.49	0.61	0.61	0.50	0.58
CV n2	0.40	0.39	0.35	0.39	0.39	0.35	0.37
CV n3	0.31	0.31	0.29	0.31	0.31	0.29	0.3
CV n4	0.29	0.27	0.27	0.29	0.28	0.27	0.26
CV n5	0.27	0.27	0.25	0.27	0.28	0.26	0.25
CV n6	0.26	0.25	0.26	0.26	0.25	0.26	0.23
CV n7	0.33	0.27	0.25	0.30	0.27	0.28	0.3
CV n8	0.34	0.31	0.27	0.29	0.30	0.31	0.34
Max CV q (US Spring)	0.17	N/A	N/A	N/A	N/A	N/A	N/A
Max CV q (US Spring - Yankee 36)	N/A	0.21	0.19	0.20	0.19	0.18	0.2
Max CV q (US Spring - Yankee 41)	N/A	0.34	0.34	0.35	0.34	0.34	0.51
Max CV q (Canadian Spring)	0.26	0.25	0.24	0.23	0.23	0.22	0.24
Max CV q (US Autumn)	0.17	0.15	0.15	0.15	0.14	0.14	0.15

Table B16. VPA estimates of Georges Bank haddock beginning year stock numbers at age, 1963-2005

AGE	1963	1964	1965	1966	1967
1	189461.	462186.	32366.	4090.	14686.
2	31983.	152489.	369285.	17883.	3246.
3	32327.	22539.	110482.	189565.	8515.
4	44770.	19798.	14357.	50644.	65418.
5	28469.	26634.	11917.	6958.	24302.
6	9017.	15949.	13985.	5824.	3220.
7	5326.	5401.	7868.	5480.	2453.
8	2757.	3099.	2558.	3075.	2401.
9	4190.	4055.	3741.	2956.	3026.
Total	348300.	712151.	566560.	286474.	127267.

AGE	1968	1969	1970	1971	1972
1	482.	1045.	4696.	317.	8610.
2	10987.	388.	853.	3803.	259.
3	2506.	6307.	307.	557.	1882.
4	4380.	1415.	3639.	237.	256.
5	35021.	1869.	757.	2466.	158.
6	10654.	15687.	944.	452.	1758.
7	1553.	5585.	7513.	581.	151.
8	1120.	676.	3159.	4080.	221.
9	2995.	2208.	1647.	2848.	3524.
Total	69698.	35179.	23516.	15342.	16820.

AGE	1973	1974	1975	1976	1977
1	19727.	10615.	7856.	105602.	14031.
2	6905.	13802.	8648.	6253.	86324.
3	210.	3757.	7282.	6116.	4677.
4	1127.	169.	2463.	4230.	4493.
5	135.	571.	137.	1667.	2643.
6	100.	62.	402.	108.	1163.
7	1329.	55.	49.	290.	89.
8	53.	1017.	43.	37.	216.
9	1873.	1154.	1496.	1174.	883.
Total	31459.	31202.	28374.	125476.	114518.

AGE	1978	1979	1980	1981	1982
1	6179.	83910.	10592.	7402.	2510.
2	11487.	5058.	68693.	8665.	6060.
3	52825.	8713.	4118.	28399.	5515.
4	3658.	30221.	5566.	3057.	13337.
5	3058.	2718.	18238.	3674.	1751.
6	1694.	1989.	1748.	9474.	2161.
7	628.	919.	1256.	896.	5431.
8	69.	388.	468.	538.	435.
9	762.	607.	686.	733.	812.
Total	80359.	134522.	111364.	62838.	38011.

Table B16 Continued.

AGE	1983	1984	1985	1986	1987
1	3207.	17565.	1844.	15267.	1995.
2	2054.	2626.	14380.	1510.	12494.
3	3905.	1487.	2065.	9555.	1187.
4	3039.	2459.	947.	1185.	5267.
5	7543.	1862.	1353.	596.	767.
6	1079.	4146.	1163.	684.	355.
7	1254.	637.	2051.	742.	403.
8	3432.	857.	309.	1195.	471.
9	825.	2690.	2168.	1816.	2168.
Total	26339.	34329.	26280.	32551.	25107.

AGE	1988	1989	1990	1991	1992
1	17052.	1112.	2841.	2552.	10401.
2	1633.	13957.	911.	2324.	2084.
3	8397.	1289.	10253.	735.	1493.
4	853.	4685.	976.	7062.	519.
5	2836.	575.	3023.	640.	3821.
6	516.	1468.	338.	1677.	431.
7	224.	285.	871.	187.	998.
8	248.	133.	191.	550.	87.
9	1939.	1634.	1379.	1202.	1228.
Total	33698.	25140.	20782.	16930.	21061.

AGE	1993	1994	1995	1996	1997
1	15415.	16091.	12443.	12222.	25106.
2	8509.	12614.	13173.	10179.	10002.
3	1479.	6698.	10074.	10702.	8284.
4	928.	888.	4722.	7694.	8241.
5	304.	485.	567.	3442.	5435.
6	1733.	153.	336.	409.	2395.
7	251.	814.	61.	245.	273.
8	522.	170.	525.	42.	181.
9	965.	1000.	877.	1079.	905.
Total	30105.	38915.	42778.	46013.	60822.

AGE	1998	1999	2000	2001	2002
1	13722.	46906.	18902.	90863.	5359.
2	20528.	11233.	38400.	15474.	74364.
3	8028.	16623.	9161.	31085.	12549.
4	6521.	6191.	12644.	6941.	23445.
5	6055.	4878.	4540.	8926.	4938.
6	3949.	4322.	3542.	3215.	6219.
7	1766.	2750.	3075.	2452.	2129.
8	206.	1309.	1947.	2191.	1663.
9	839.	798.	1558.	2571.	3384.
Total	61612.	95011.	93769.	163717.	134049.

Table B16 Continued.

AGE	2003	2004	2005
1	1335.	788886.	9879.
2	4386.	1088.	645236.
3	60518.	3578.	857.
4	9993.	47817.	2821.
5	16646.	7792.	35037.
6	3316.	11460.	5638.
7	4180.	2175.	6920.
8	1467.	2776.	1153.
9	3461.	3517.	4301.
Total	105302.	869090.	711840.

Table B17. VPA estimates of Georges Bank haddock spawning stock biomass (mt), 1963-2004

AGE	1963	1964	1965	1966	1967
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	23910.	15503.	65562.	88804.	4684.
4	54720.	22653.	14729.	48018.	57345.
5	37829.	35203.	15397.	8693.	26450.
6	16142.	24562.	19988.	8724.	5009.
7	10314.	10178.	13259.	9497.	4410.
8	6440.	6559.	5254.	6415.	4914.
9	11355.	10249.	9744.	8115.	8294.
Total	160710.	124907.	143932.	178266.	111107.

AGE	1968	1969	1970	1971	1972
1	0.	0.	0.	0.	0.
2	1958.	69.	175.	764.	57.
3	1415.	3943.	214.	449.	1685.
4	3964.	1612.	4810.	312.	357.
5	38997.	2395.	1280.	4866.	290.
6	15654.	23067.	1710.	853.	4331.
7	2751.	11142.	14614.	1205.	341.
8	2266.	1511.	7955.	9685.	602.
9	7431.	7015.	5357.	9025.	10831.
Total	74435.	50755.	36114.	27160.	18494.

AGE	1973	1974	1975	1976	1977
1	0.	0.	0.	0.	0.
2	1611.	3190.	2265.	1549.	18428.
3	234.	4259.	7688.	6080.	4254.
4	1830.	307.	4480.	6773.	7088.
5	247.	1283.	291.	3695.	5511.
6	243.	177.	1068.	268.	2913.
7	3928.	187.	177.	887.	297.
8	157.	3489.	160.	146.	745.
9	6495.	4357.	6054.	5358.	4034.
Total	14745.	17249.	22184.	24755.	43270.

AGE	1978	1979	1980	1981	1982
1	0.	0.	0.	0.	0.
2	2497.	1154.	12829.	1767.	1102.
3	47145.	6921.	3405.	20558.	4323.
4	5820.	46365.	7466.	3957.	17658.
5	6757.	5507.	32417.	6418.	3231.
6	4290.	5249.	3935.	20028.	4751.
7	1830.	2695.	3417.	2419.	14374.
8	238.	1217.	1459.	1769.	1466.
9	3611.	2750.	2437.	2978.	3034.
Total	72188.	71859.	67365.	59894.	49941.

Table B17 Continued.

AGE	1983	1984	1985	1986	1987
1	0.	382.	82.	1155.	130.
2	296.	450.	4824.	515.	4493.
3	3248.	1449.	1849.	8693.	1153.
4	4380.	3353.	1336.	1661.	7292.
5	13238.	3321.	2421.	1180.	1409.
6	2371.	8446.	2543.	1582.	822.
7	3415.	1489.	5122.	1879.	1043.
8	9997.	2443.	899.	3446.	1391.
9	3263.	8934.	7677.	6469.	8690.
Total	40208.	30266.	26753.	26579.	26423.

AGE	1988	1989	1990	1991	1992
1	1123.	100.	126.	99.	361.
2	650.	5135.	347.	1022.	885.
3	6965.	1318.	10077.	714.	1748.
4	1174.	6373.	1411.	9833.	684.
5	4883.	970.	5082.	1143.	6249.
6	1044.	2964.	692.	3488.	883.
7	549.	727.	2085.	416.	2378.
8	704.	383.	522.	1394.	229.
9	7190.	5892.	5407.	4874.	4872.
Total	24281.	23862.	25749.	22983.	18289.

AGE	1993	1994	1995	1996	1997
1	525.	326.	63.	72.	130.
2	1907.	3036.	2796.	2256.	2171.
3	1317.	6040.	11293.	11339.	9992.
4	1399.	1458.	7958.	11669.	12838.
5	495.	1057.	1239.	6820.	10121.
6	3438.	292.	844.	939.	5400.
7	588.	2014.	166.	706.	718.
8	1360.	470.	1447.	131.	570.
9	3599.	4271.	3303.	3801.	3109.
Total	14629.	18963.	29109.	37732.	45049.

AGE	1998	1999	2000	2001	2002
1	91.	468.	180.	194.	11.
2	4202.	2722.	10855.	7775.	24190.
3	8609.	17742.	10200.	35383.	14099.
4	10915.	9445.	19705.	10113.	33897.
5	11690.	9058.	8455.	16478.	8265.
6	8798.	9273.	7229.	6916.	13008.
7	4550.	6791.	7143.	5555.	5451.
8	587.	3618.	5066.	5446.	4295.
9	3201.	2754.	4813.	8107.	10280.
Total	52642.	61872.	73646.	95968.	113496.

Table B17 Continued.

AGE	2003	2004
1	3.	1058.
2	1111.	196.
3	60302.	2578.
4	13651.	62496.
5	27202.	11785.
6	5961.	19229.
7	9422.	3821.
8	4165.	6196.
9	10100.	9430.
Total	131916.	116787.

Table B18. VPA estimates of Georges Bank haddock fishing mortality at age, 1963-2004

AGE	1963	1964	1965	1966	1967
1	0.0171	0.0244	0.3933	0.0312	0.0902
2	0.1500	0.1222	0.4668	0.5420	0.0587
3	0.2903	0.2510	0.5800	0.8639	0.4648
4	0.3194	0.3076	0.5243	0.5343	0.4248
5	0.3794	0.4442	0.5160	0.5706	0.6246
6	0.3125	0.5066	0.7370	0.6646	0.5288
7	0.3416	0.5473	0.7393	0.6250	0.5840
8	0.3382	0.4514	0.6292	0.5986	0.5406
9	0.3382	0.4458	0.5099	0.3879	0.2921

AGE	1968	1969	1970	1971	1972
1	0.0185	0.0021	0.0109	0.0035	0.0207
2	0.3551	0.0318	0.2275	0.5035	0.0086
3	0.3715	0.3500	0.0591	0.5761	0.3127
4	0.6515	0.4260	0.1891	0.2051	0.4378
5	0.6031	0.4828	0.3145	0.1381	0.2576
6	0.4458	0.5362	0.2862	0.8949	0.0801
7	0.6327	0.3697	0.4105	0.7651	0.8527
8	0.5833	0.4537	0.3000	0.5008	0.4070
9	0.3686	0.3331	0.3695	0.4414	0.4987

AGE	1973	1974	1975	1976	1977
1	0.1572	0.0050	0.0283	0.0016	0.0001
2	0.4085	0.4395	0.1463	0.0904	0.2911
3	0.0164	0.2224	0.3432	0.1084	0.0457
4	0.4808	0.0138	0.1902	0.2705	0.1849
5	0.5727	0.1509	0.0336	0.1600	0.2448
6	0.4079	0.0378	0.1266	0.0001	0.4170
7	0.0672	0.0434	0.0961	0.0952	0.0524
8	0.3822	0.0614	0.1117	0.1314	0.2248
9	0.3103	0.2822	0.0694	0.1153	0.1512

AGE	1978	1979	1980	1981	1982
1	0.0002	0.0001	0.0008	0.0001	0.0004
2	0.0764	0.0057	0.6833	0.2518	0.2393
3	0.3585	0.2481	0.0980	0.5558	0.3959
4	0.0971	0.3050	0.2152	0.3571	0.3699
5	0.2299	0.2412	0.4549	0.3310	0.2837
6	0.4112	0.2595	0.4685	0.3565	0.3440
7	0.2812	0.4760	0.6482	0.5227	0.2588
8	0.2549	0.3204	0.4467	0.3918	0.3141
9	0.1026	0.0880	0.1401	0.1534	0.1626

Table B18 Continued.

AGE	1983	1984	1985	1986	1987
1	0.0001	0.0001	0.0001	0.0004	0.0001
2	0.1231	0.0403	0.2087	0.0408	0.1974
3	0.2626	0.2512	0.3555	0.3956	0.1302
4	0.2901	0.3975	0.2621	0.2353	0.4190
5	0.3984	0.2706	0.4812	0.3179	0.1967
6	0.3275	0.5039	0.2493	0.3301	0.2618
7	0.1801	0.5219	0.3398	0.2549	0.2844
8	0.2990	0.4235	0.3331	0.2846	0.2905
9	0.1081	0.2542	0.0824	0.0376	0.0726

AGE	1988	1989	1990	1991	1992
1	0.0003	0.0001	0.0008	0.0026	0.0008
2	0.0366	0.1084	0.0138	0.2427	0.1430
3	0.3834	0.0787	0.1729	0.1492	0.2751
4	0.1945	0.2383	0.2212	0.4143	0.3357
5	0.4584	0.3303	0.3891	0.1961	0.5906
6	0.3916	0.3227	0.3930	0.3187	0.3407
7	0.3229	0.2017	0.2596	0.5688	0.4493
8	0.3419	0.2733	0.3157	0.3745	0.4291
9	0.0636	0.0318	0.0367	0.0695	0.0901

AGE	1993	1994	1995	1996	1997
1	0.0005	0.0001	0.0008	0.0005	0.0013
2	0.0393	0.0248	0.0077	0.0059	0.0198
3	0.3099	0.1496	0.0696	0.0613	0.0394
4	0.4491	0.2482	0.1163	0.1475	0.1083
5	0.4856	0.1686	0.1275	0.1627	0.1196
6	0.5560	0.7245	0.1128	0.2056	0.1045
7	0.1875	0.2388	0.1653	0.1050	0.0804
8	0.4196	0.3450	0.1305	0.1552	0.1032
9	0.0933	0.0504	0.0235	0.0082	0.0503

AGE	1998	1999	2000	2001	2002
1	0.0001	0.0001	0.0001	0.0004	0.0004
2	0.0110	0.0039	0.0113	0.0095	0.0060
3	0.0598	0.0736	0.0775	0.0821	0.0277
4	0.0903	0.1102	0.1483	0.1403	0.1425
5	0.1372	0.1202	0.1453	0.1613	0.1982
6	0.1619	0.1403	0.1675	0.2122	0.1972
7	0.0992	0.1452	0.1389	0.1887	0.1721
8	0.1221	0.1290	0.1500	0.1757	0.1775
9	0.0565	0.0586	0.0624	0.1137	0.1768

Table B18 Continued.

AGE	2003	2004
1	0.0051	0.0010
2	0.0035	0.0388
3	0.0355	0.0379
4	0.0488	0.1110
5	0.1732	0.1235
6	0.2216	0.3045
7	0.2095	0.4352
8	0.1633	0.2436
9	0.1264	0.1336

Table B19. VPA estimates of Georges Bank haddock average fishing mortality for ages 4-7, 1963-2004

Average Fishing Mortality For Ages 4- 7

Year	Average F	N Weighted	Biomass Wtd	Catch Wtd
1963	0.3382	0.3395	0.3396	0.3415
1964	0.4514	0.4272	0.4404	0.4406
1965	0.6292	0.6192	0.6373	0.6330
1966	0.5986	0.5562	0.5657	0.5585
1967	0.5406	0.4833	0.4967	0.4956
1968	0.5833	0.5756	0.5687	0.5819
1969	0.4537	0.4879	0.4811	0.4961
1970	0.3000	0.3330	0.3500	0.3584
1971	0.5008	0.3315	0.3592	0.5655
1972	0.4070	0.1819	0.1744	0.3853
1973	0.3822	0.2785	0.2320	0.4274
1974	0.0614	0.1087	0.1096	0.1413
1975	0.1117	0.1733	0.1690	0.1816
1976	0.1314	0.2285	0.2170	0.2455
1977	0.2248	0.2346	0.2480	0.2576
1978	0.2549	0.2137	0.2385	0.2694
1979	0.3204	0.3021	0.3033	0.3052
1980	0.4467	0.4151	0.4349	0.4402
1981	0.3918	0.3598	0.3644	0.3633
1982	0.3141	0.3342	0.3206	0.3402
1983	0.2990	0.3458	0.3406	0.3586
1984	0.4235	0.4287	0.4395	0.4455
1985	0.3331	0.3421	0.3421	0.3607
1986	0.2846	0.2754	0.2806	0.2807
1987	0.2905	0.3777	0.3664	0.3923
1988	0.3419	0.3930	0.4007	0.4168
1989	0.2733	0.2620	0.2668	0.2676
1990	0.3157	0.3363	0.3358	0.3500
1991	0.3745	0.3859	0.3810	0.3959
1992	0.4291	0.5246	0.5211	0.5395
1993	0.4196	0.4897	0.4905	0.5075
1994	0.3450	0.2596	0.2594	0.3061
1995	0.1305	0.1178	0.1182	0.1181
1996	0.1552	0.1530	0.1539	0.1542
1997	0.1032	0.1110	0.1108	0.1114
1998	0.1221	0.1221	0.1244	0.1285
1999	0.1290	0.1254	0.1278	0.1268
2000	0.1500	0.1494	0.1494	0.1498
2001	0.1757	0.1653	0.1689	0.1686
2002	0.1775	0.1610	0.1645	0.1646
2003	0.1633	0.1460	0.1550	0.1736
2004	0.2436	0.1546	0.1654	0.1980

Table B20. Bootstrap analyses of VPA estimates of Georges Bank haddock 2005 stock size at age (000s), 2004 fishing mortality at age, 2004 average fishing mortality for ages 4-7, and 2005 January 1st, 2004 mean, and 2004 spawning biomass (mt)

Number of Bootstrap Repetitions Requested = 1000
Number of Bootstrap Repetitions Completed = 1000
Bootstrap Output Variable: Stock Estimates (2005)

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
N 1	9879.	11928.	8374.	0.7020
N 2	645236.	669643.	226845.	0.3388
N 3	857.	892.	313.	0.3508
N 4	2821.	2879.	745.	0.2588
N 5	35037.	35659.	8156.	0.2287
N 6	5638.	5756.	1296.	0.2252
N 7	6920.	7230.	2155.	0.2980
N 8	1153.	1190.	416.	0.3496

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
N 1	2050.	273.	20.7478	7829.	1.0695
N 2	24407.	7215.	3.7827	620828.	0.3654
N 3	35.	10.	4.1217	821.	0.3810
N 4	58.	24.	2.0669	2762.	0.2697
N 5	623.	259.	1.7771	34414.	0.2370
N 6	118.	41.	2.0902	5521.	0.2348
N 7	311.	69.	4.4928	6609.	0.3260
N 8	38.	13.	3.2651	1115.	0.3732

	LOWER 80. % CI	UPPER 80. % CI
N 1	4074.	22316.
N 2	372811.	1000000.
N 3	540.	1280.
N 4	1982.	3882.
N 5	25379.	46652.
N 6	4212.	7452.
N 7	4689.	9987.
N 8	673.	1738.

Table B20 Continued.

Bootstrap Output Variable: Fishing Mortality at Age (2004)

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
AGE 1	0.0010	0.0011	0.000489	0.4380
AGE 2	0.0388	0.0757	0.345088	4.5602
AGE 3	0.0379	0.0397	0.010666	0.2687
AGE 4	0.1110	0.1146	0.026292	0.2295
AGE 5	0.1235	0.1266	0.026893	0.2124
AGE 6	0.3045	0.3130	0.081932	0.2618
AGE 7	0.4352	0.4625	0.145436	0.3145
AGE 8	0.2436	0.2542	0.042497	0.1672
AGE 9	0.1336	0.1368	0.019333	0.1413

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
AGE 1	0.000111	0.000016	11.0555	0.0009	0.5469
AGE 2	0.036913	0.010975	95.2357	0.0018	186.8730
AGE 3	0.001784	0.000342	4.7077	0.0361	0.2953
AGE 4	0.003586	0.000839	3.2305	0.1074	0.2448
AGE 5	0.003092	0.000856	2.5032	0.1204	0.2233
AGE 6	0.008465	0.002605	2.7796	0.2961	0.2767
AGE 7	0.027329	0.004680	6.2801	0.4078	0.3566
AGE 8	0.010618	0.001385	4.3596	0.2329	0.1824
AGE 9	0.003256	0.000620	2.4374	0.1303	0.1484

	LOWER 80. % CI	UPPER 80. % CI
AGE 1	0.000649	0.001740
AGE 2	0.026040	0.060798
AGE 3	0.027659	0.053442
AGE 4	0.084460	0.149963
AGE 5	0.094689	0.161942
AGE 6	0.220269	0.421159
AGE 7	0.308434	0.654753
AGE 8	0.206285	0.308014
AGE 9	0.114521	0.161721

Table B20 Continued.

Bootstrap Output Variable: Average F (2004) AGES 4 - 7

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
AVG F	0.2436	0.2542	0.042497	0.1672
N WTD	0.1546	0.1561	0.025912	0.1660
B WTD	0.1654	0.1665	0.026543	0.1594
C WTD	0.1980	0.2050	0.031608	0.1542

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
AVG F	0.010618	0.001385	4.3596	0.2329	0.1824
N WTD	0.001450	0.000821	0.9380	0.1532	0.1692
B WTD	0.001138	0.000840	0.6883	0.1642	0.1616
C WTD	0.006940	0.001023	3.5050	0.1911	0.1654

	LOWER 80. % CI	UPPER 80. % CI
AVG F	0.206285	0.308014
N WTD	0.125718	0.191840
B WTD	0.134996	0.202197
C WTD	0.166422	0.245121

Table B20. Bootstrap analyses of VPA estimates of Georges Bank haddock 2005 stock size at age (000s), 2004 fishing mortality at age, 2004 average fishing mortality for ages 4-7, and 2005 January 1st, 2004 mean, and 2004 spawning biomass (mt)

Number of Bootstrap Repetitions Requested = 1000
Number of Bootstrap Repetitions Completed = 1000
Bootstrap Output Variable: Stock Estimates (2005)

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
N 1	9879.	12419.	8412.	0.6773
N 2	645236.	690848.	287594.	0.4163
N 3	857.	898.	303.	0.3378
N 4	2821.	2929.	775.	0.2645
N 5	35037.	35948.	8240.	0.2292
N 6	5638.	5780.	1313.	0.2272
N 7	6920.	7271.	2085.	0.2868
N 8	1153.	1193.	407.	0.3412

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
N 1	2540.	278.	25.7141	7339.	1.1462
N 2	45612.	9208.	7.0691	599623.	0.4796
N 3	41.	10.	4.8172	815.	0.3720
N 4	108.	25.	3.8291	2713.	0.2855
N 5	911.	262.	2.6000	34126.	0.2415
N 6	141.	42.	2.5085	5497.	0.2389
N 7	352.	67.	5.0846	6568.	0.3175
N 8	40.	13.	3.5057	1112.	0.3660

	LOWER 80. % CI	UPPER 80. % CI
N 1	3907.	22838.
N 2	362798.	1096168.
N 3	549.	1297.
N 4	2005.	3914.
N 5	25680.	46706.
N 6	4172.	7456.
N 7	4760.	9924.
N 8	722.	1711.

Table B21. Comparative Results from ADAPT/VPA runs incorporating software and data updates since the 2002 GARM.

	GARM/FACT	GARM/NFT	Updated Data/NFT [1]
Terminal Year	2001	2001	2001
RSS	404.747	397.378	397.886
N t+1 age 1 (cv)	4450 (0.50)	4449 (0.48)	4527 (0.48)
N t+1 age 2 (cv)	61500 (0.35)	61423 (0.34)	62483 (0.34)
N t+1 age 3 (cv)	11700 (0.29)	11741 (0.28)	11944 (0.28)
N t+1 age 4 (cv)	19400 (0.27)	19471 (0.26)	19793 (0.26)
N t+1 age 5 (cv)	5173 (0.26)	5262 (0.25)	5351 (0.25)
N t+1 age 6 (cv)	4330 (0.26)	4224 (0.27)	4311 (0.27)
N t+1 age 7 (cv)	1740 (0.28)	1772 (0.27)	1812 (0.27)
N t+1 age 8 (cv)	1020 (0.31)	1229 (0.28)	1259 (0.28)
F age 1	0.00	0.00	0.00
F age 2	0.01	0.01	0.01
F age 3	0.10	0.09	0.10
F age 4	0.13	0.13	0.13
F age 5	0.22	0.23	0.23
F age 6	0.25	0.25	0.25
F age 7	0.29	0.24	0.24
F age 8	0.22	0.21	0.21
F (ages 4-7)	0.21	0.21	0.21
SSB (mt)	**74429**	**77719**	**82315**

[1] Revised data includes revised catch biomass and catch-at-age data for 1972-2001 which includes Canadian sea scallop fishery discards and updated catch proration, mean weights-at-age, discard, and female percent mature at age data for 2001.

Figure B1. Western and eastern Georges Bank haddock management units.

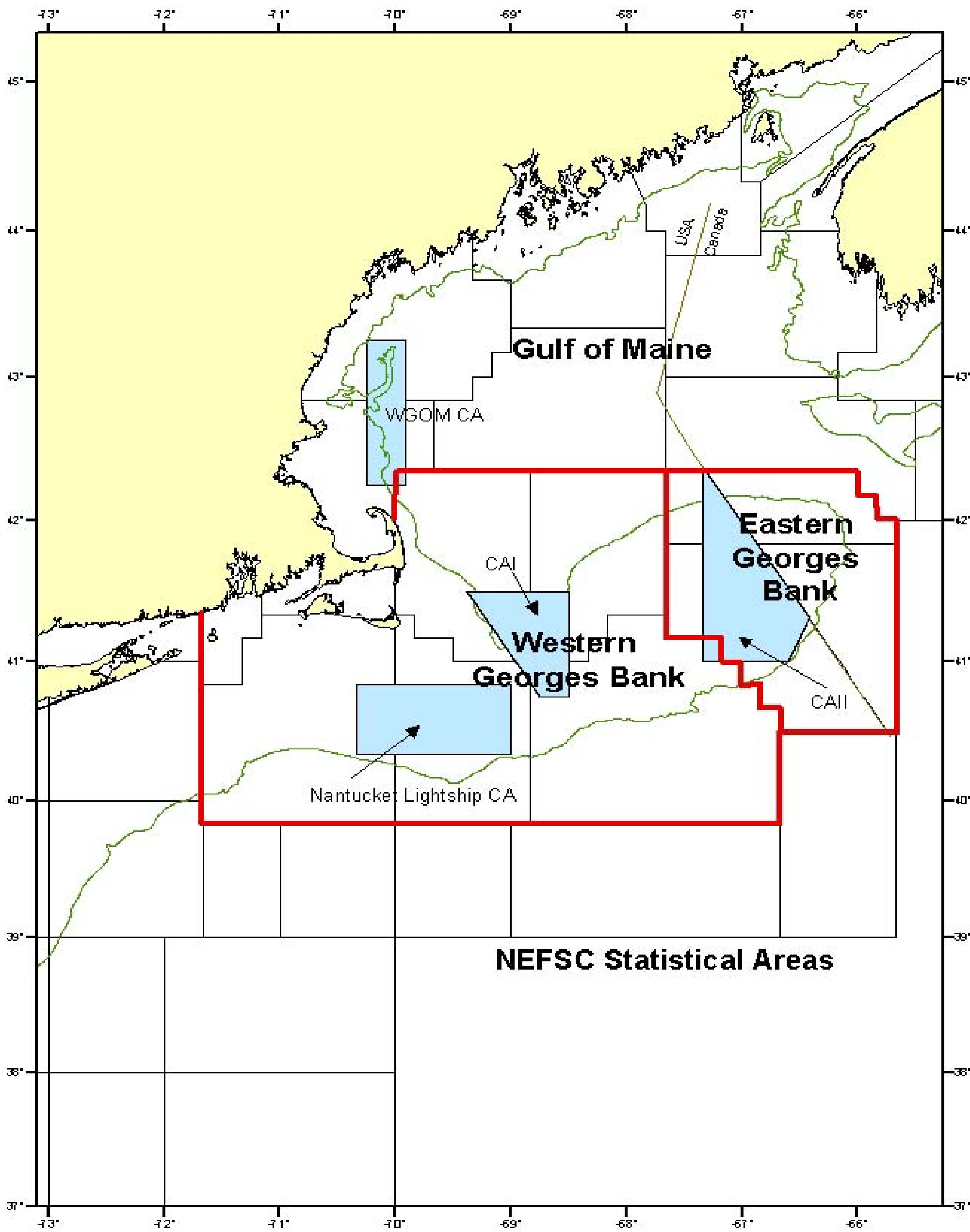


Figure B2. Total commercial catch (thousand mt) of haddock from Georges Bank and south, 1904-2004.

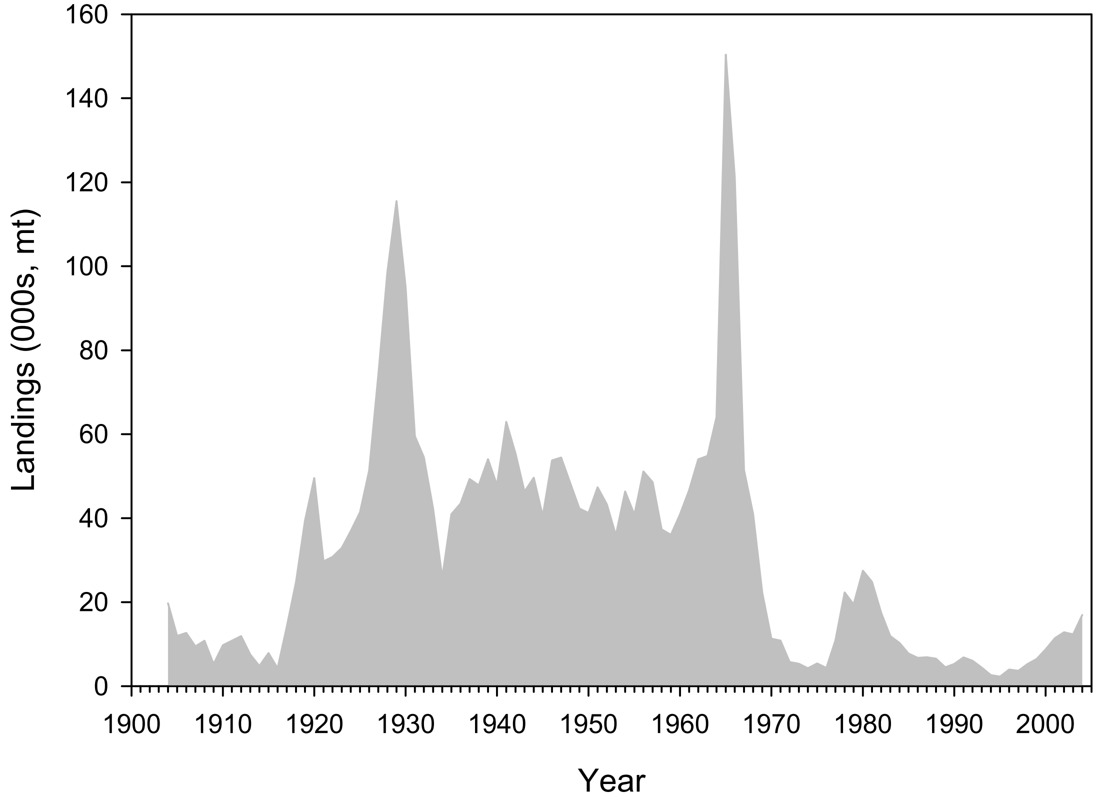


Figure B3. Georges Bank haddock research survey indices, 1963-2005.

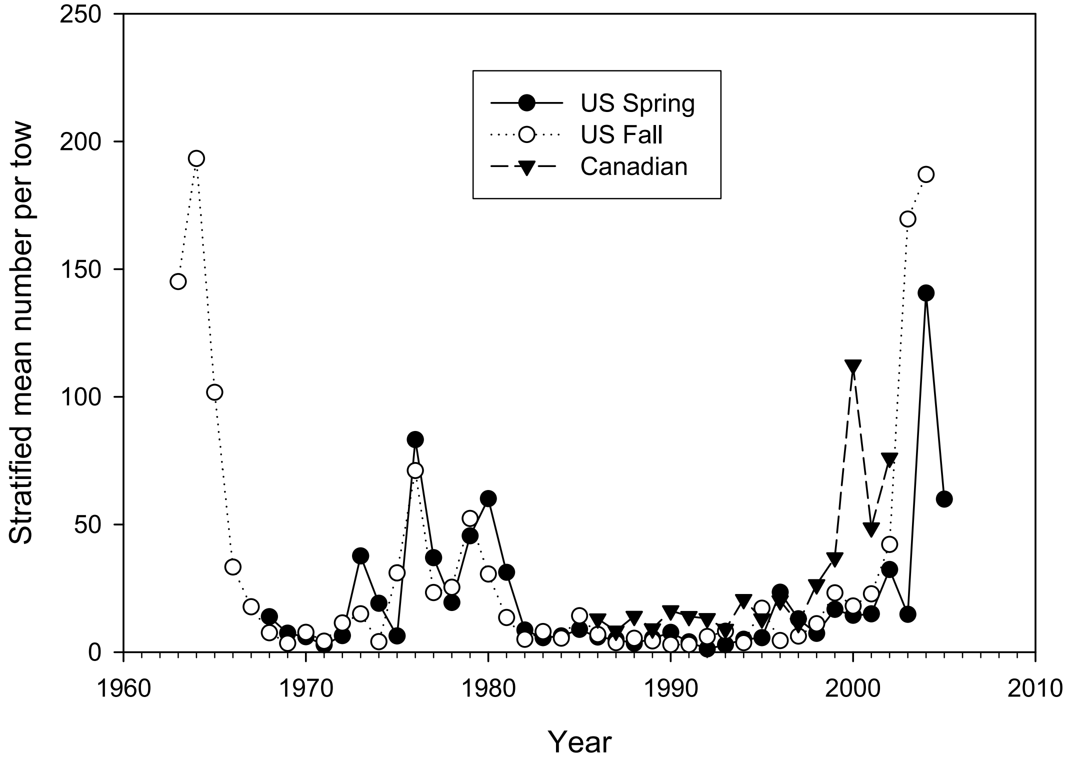


Figure B4. Georges Bank haddock VPA tuning residuals, age-2 through age-8 by survey.

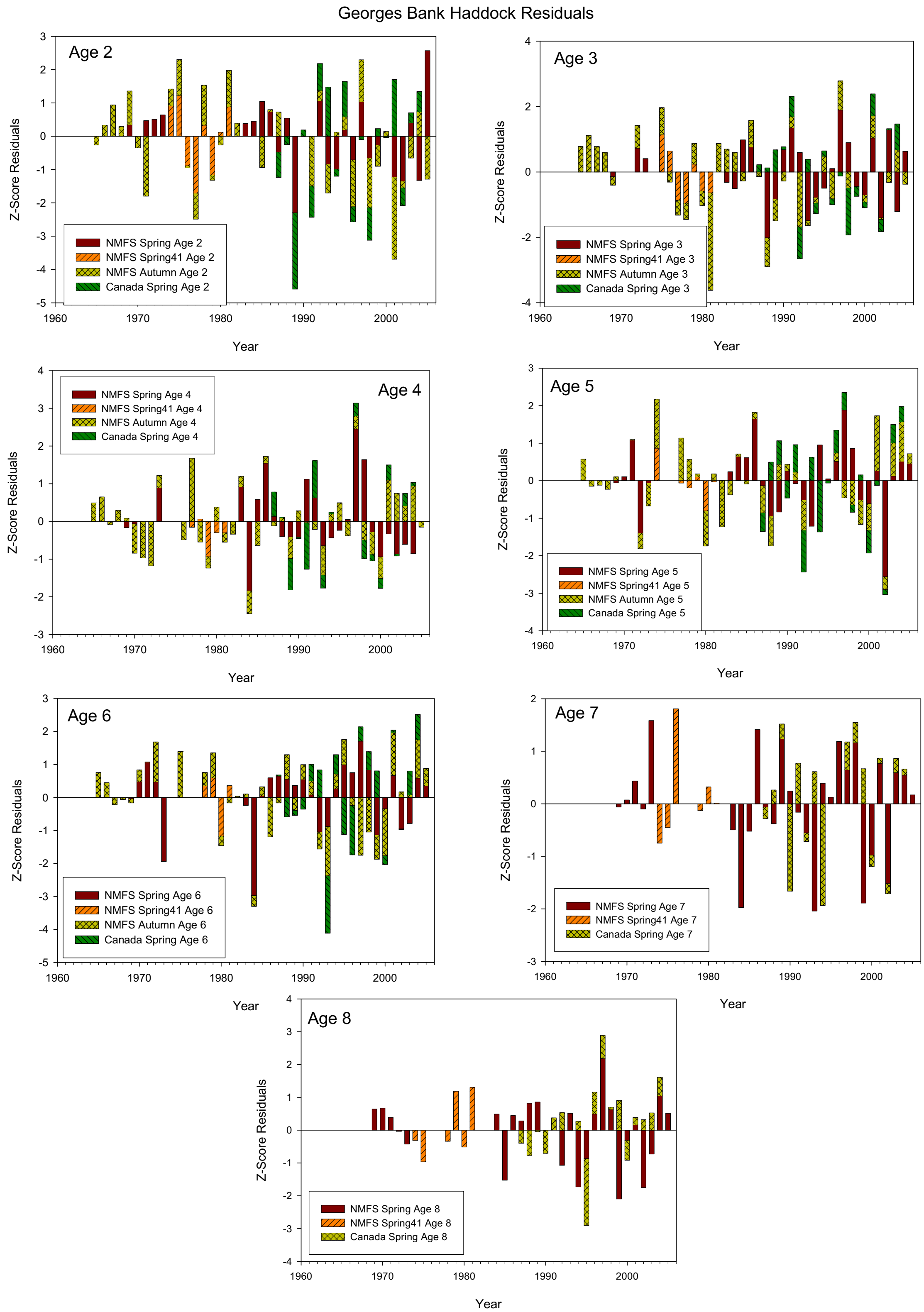


Figure B5.1 VPA estimates of Georges Bank haddock spawning biomass, 1963-2004

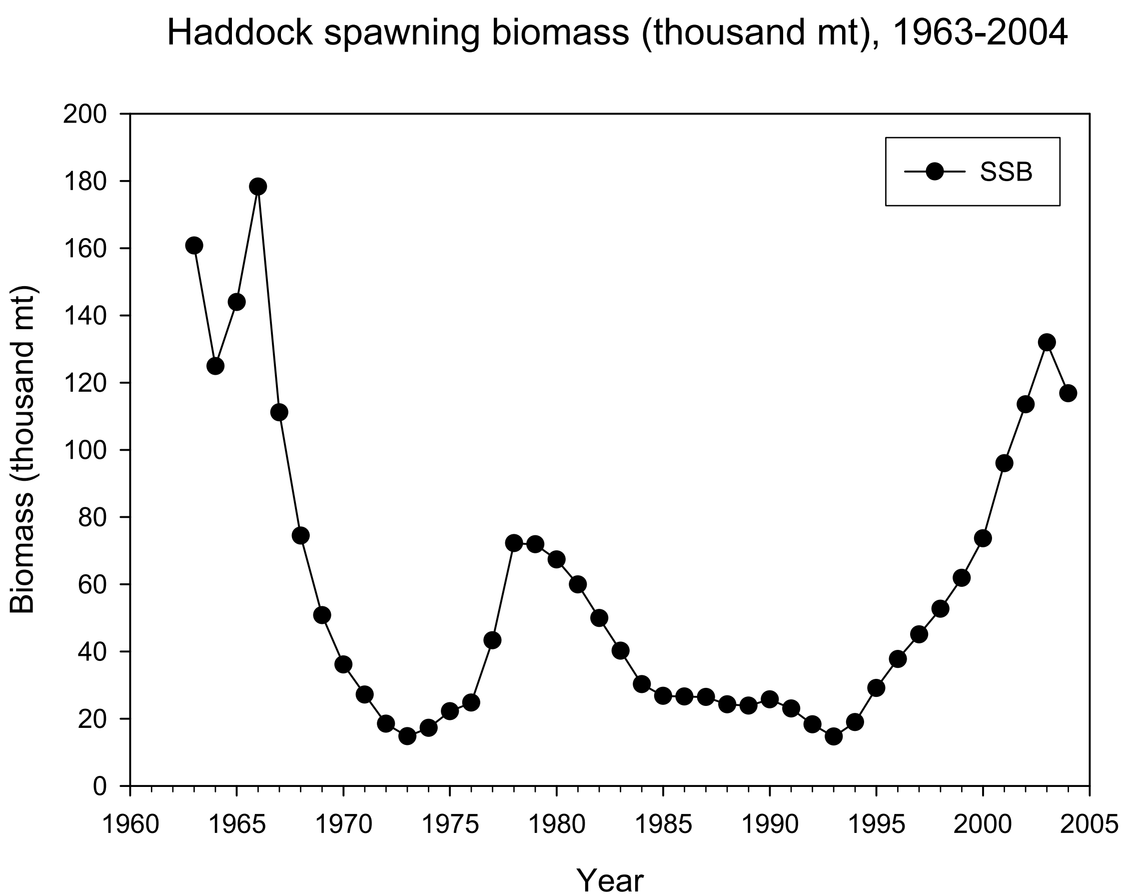


Figure B5.2 VPA estimates of Georges Bank haddock fishing mortality, 1963-2004

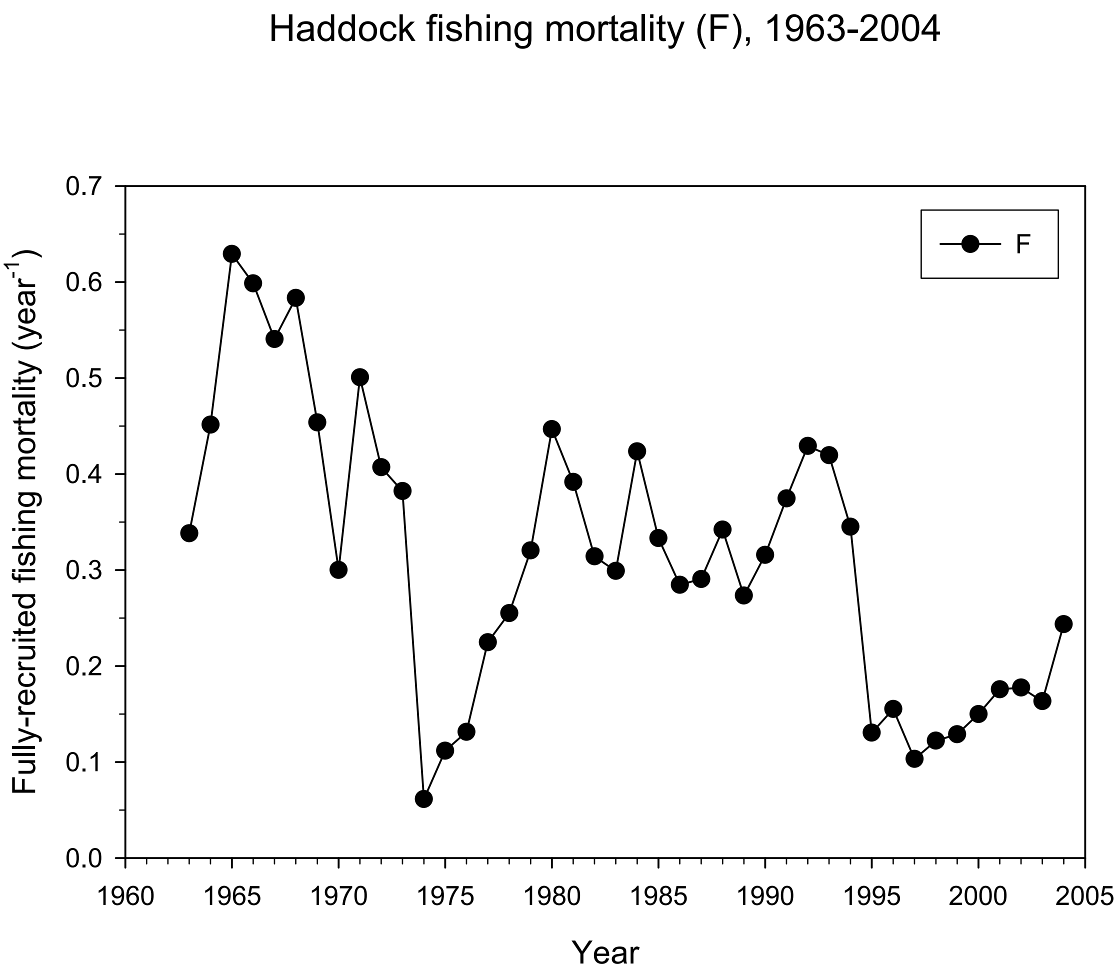


Figure B5.3 VPA estimates of Georges Bank haddock recruitment, 1963-2005

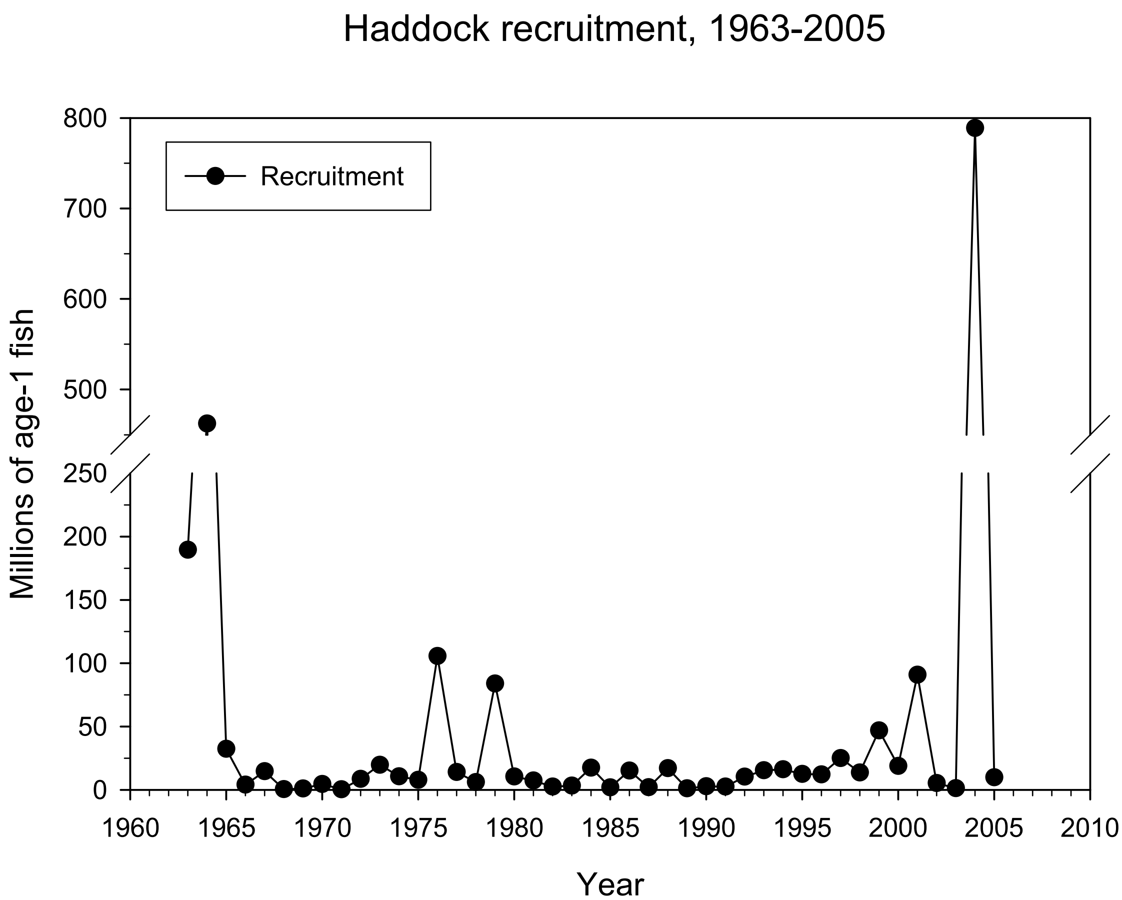
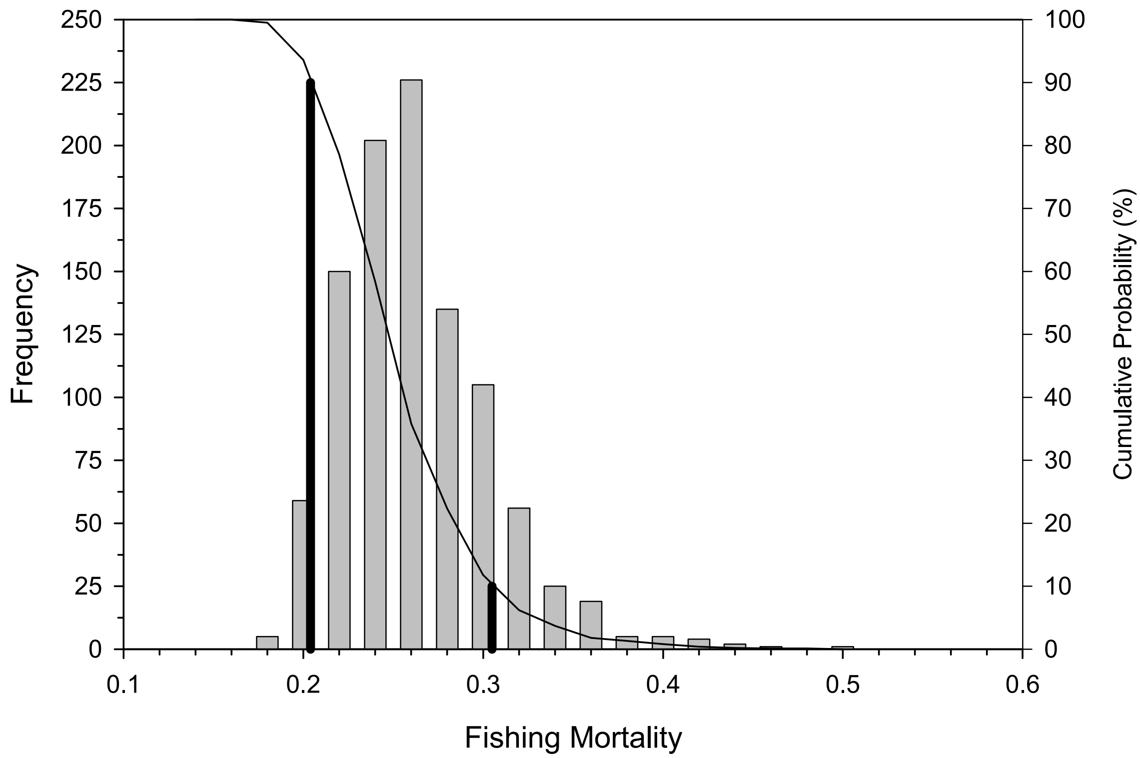
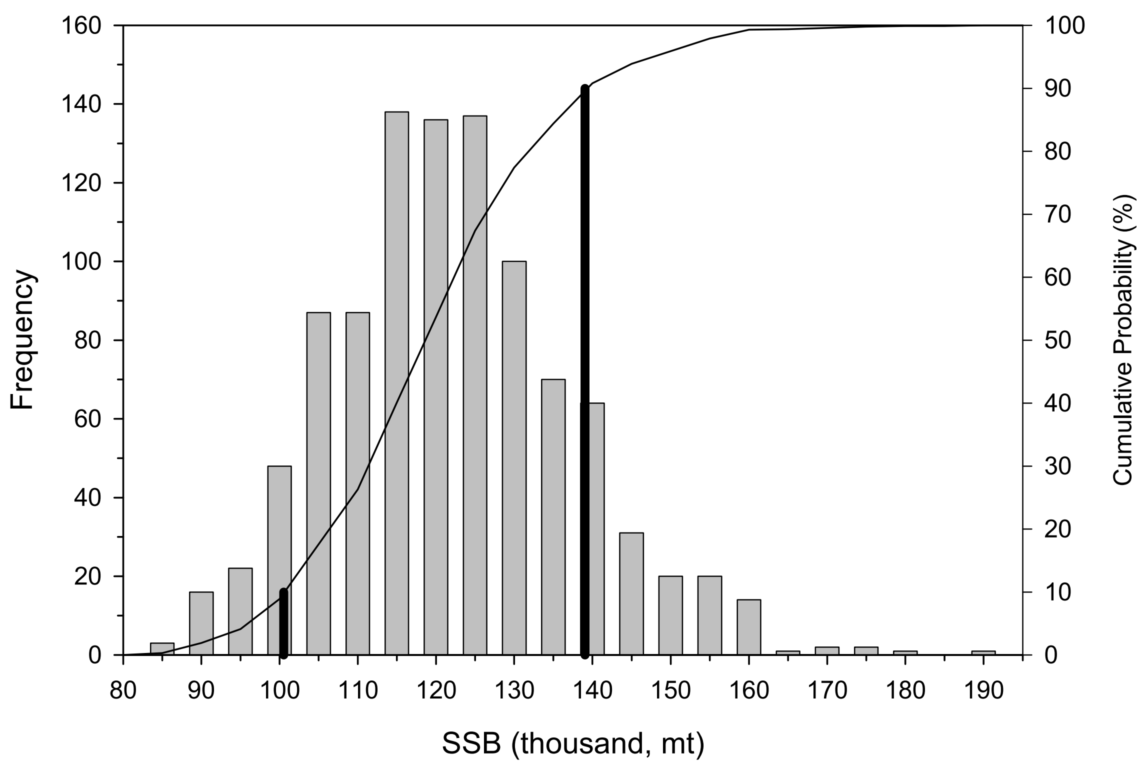


Figure B6. Precision of 2004 estimates of fishing mortality and spawning biomass.



Precision of the estimated fully recruited F in 2004 based on 1000 bootstrap realizations of the VPA for Georges Bank Haddock.



Precision of the estimated spawning stock biomass in 2004 based on 1000 bootstrap realizations of the VPA for Georges Bank Haddock.

Figure B7.1 Retrospective analysis of VPA estimates of Georges Bank haddock spawning biomass 1999-2004.

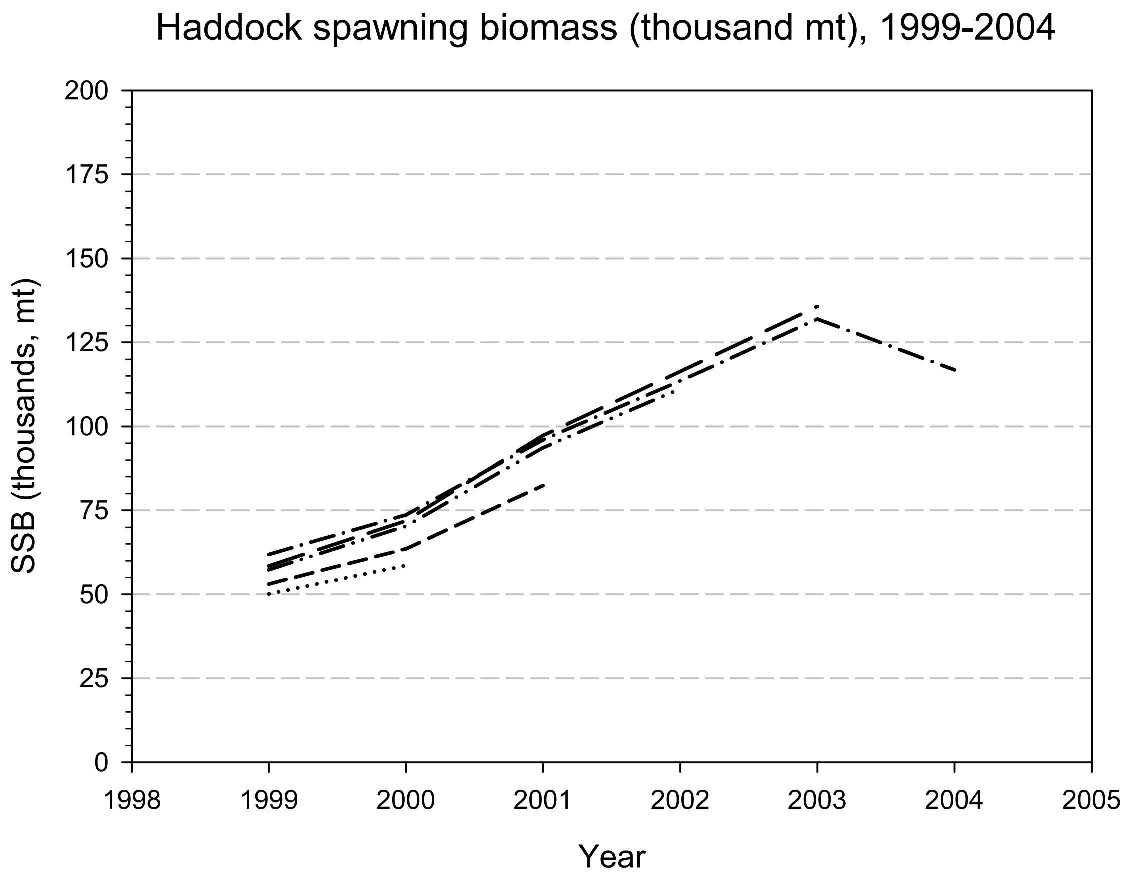


Figure B7.2 Retrospective analysis of VPA estimates of Georges Bank haddock fishing mortality, 1999-2004.

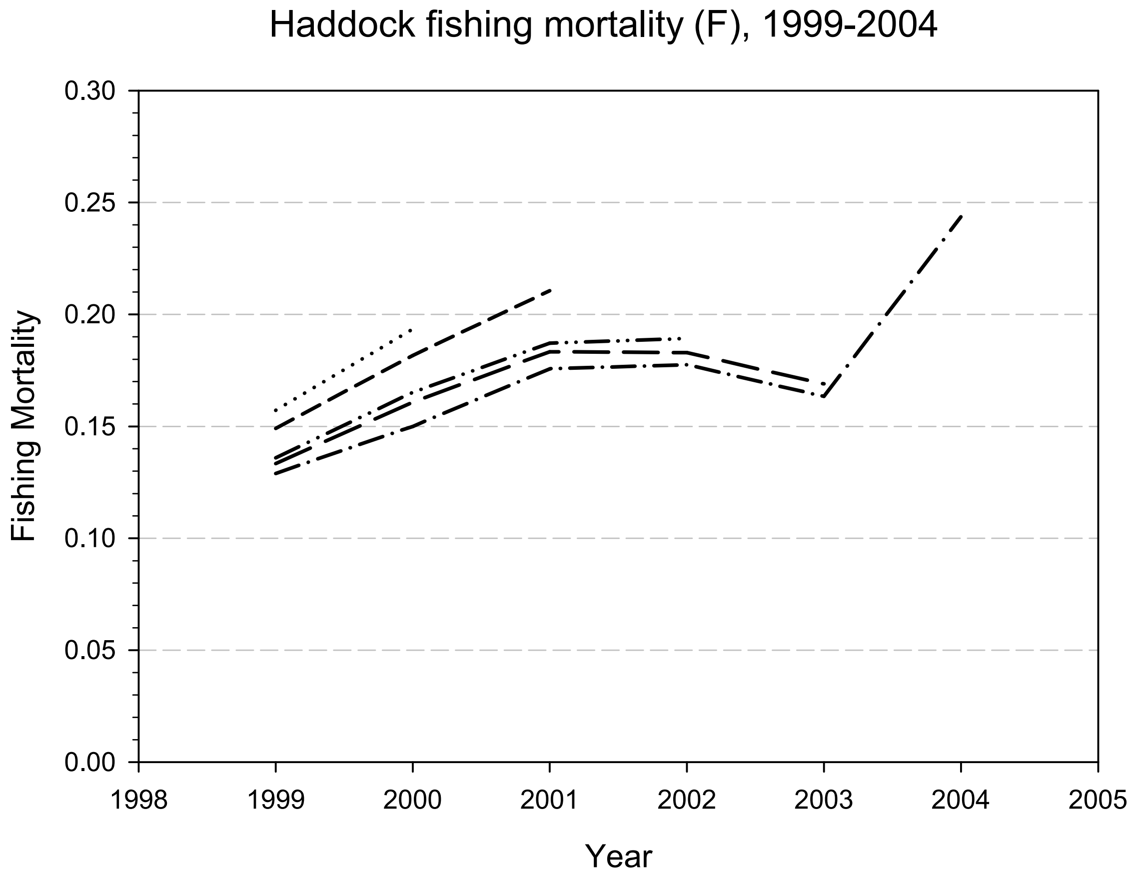


Figure B7.3 Retrospective analysis of VPA estimates of Georges Bank haddock recruitment,1999-2004.

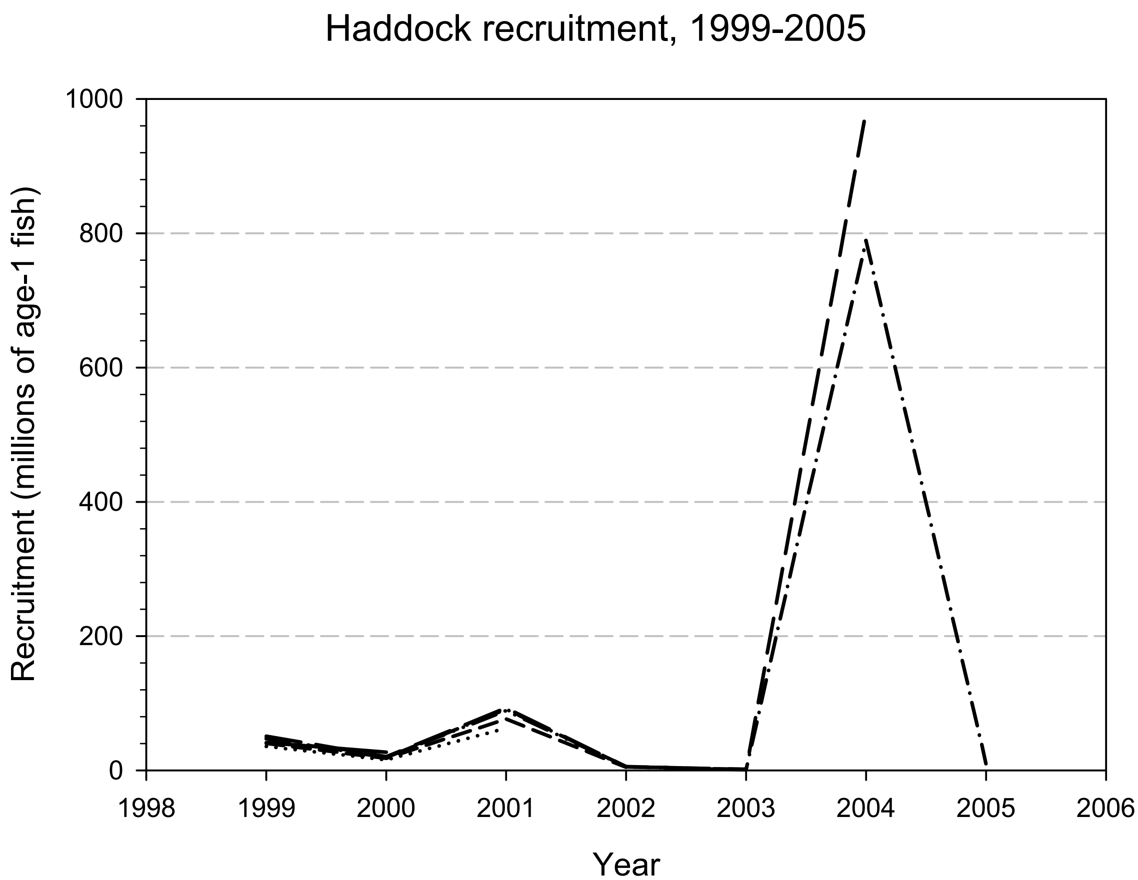


Figure B8. Trends in spawning stock biomass (line) and recruitment (bars) for Georges Bank haddock from 1931-2004.

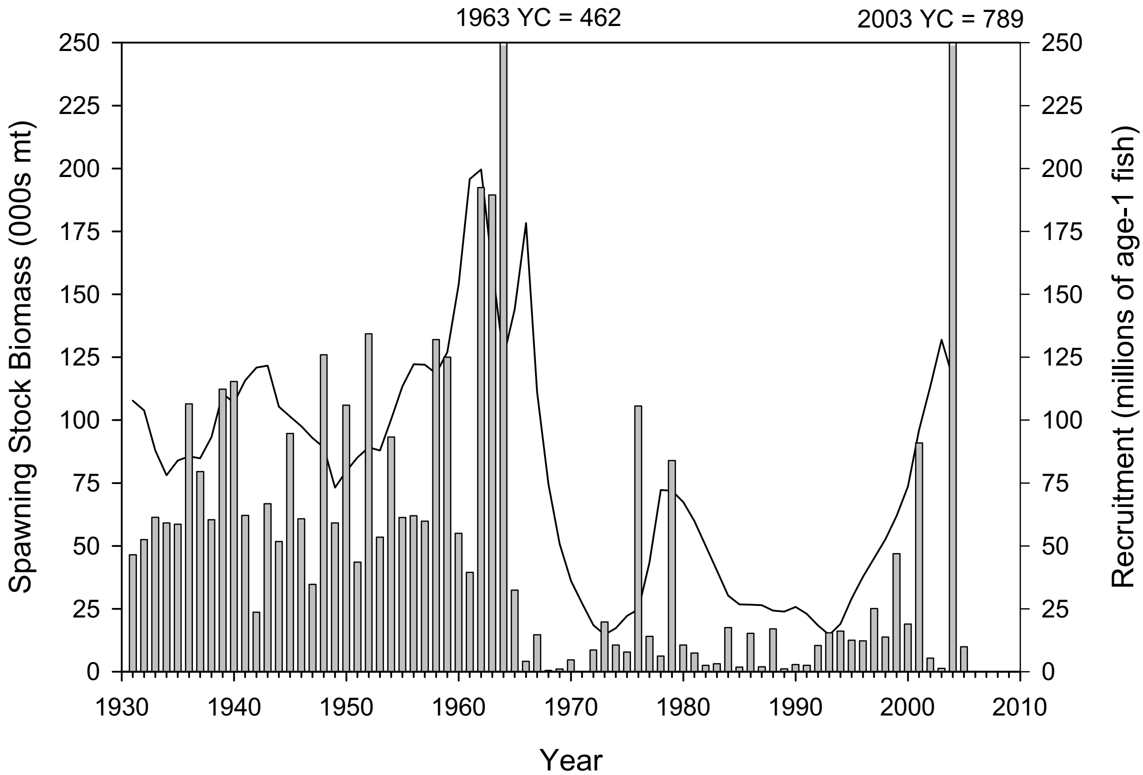
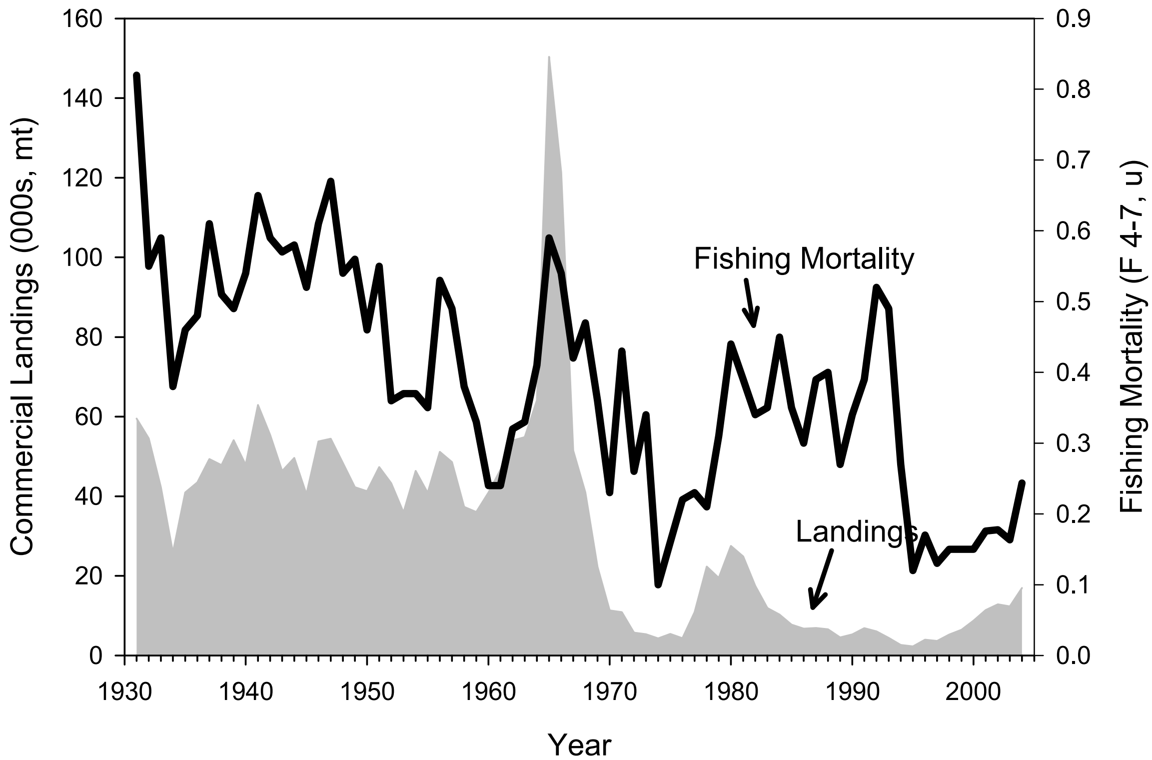


Figure B9. Trends in commercial landings (thousand mt, live weight) and fishing mortality (unweighted mean, ages 4-7) for Georges Bank haddock from 1931-2004.



C. Georges Bank Yellowtail Flounder by C.M. Legault

1.0 Background

The Georges Bank yellowtail flounder stock has exhibited a strong retrospective problem with updated spawning stock biomass estimated lower in successive assessments and fully recruited F estimated higher: 2001 SSB was 39,000 t and fully recruited F was 0.13 in the 2002 assessment (NEFSC 2002b; Stone 2002), 2001 SSB was 16,000 t and fully recruited F was 0.48 in the 2003 assessment (Stone and Legault 2003), and 2001 SSB was 9,000 t and fully recruited F was 0.88 in the 2004 assessment (Legault and Stone 2004). A benchmark assessment was conducted in 2005 that revised US landings and discards, revised Canadian landings and surveys, and added Canadian discards. This report reflects the 2005 Transboundary Resource Assessment Committee (TRAC) assessment (Stone and Legault 2005).

2.0 Assessment Data

2.1 US Landings

U.S. landings were prorated as described in Cadrin et al. (1998; Table C1; Figure C1). US landings from Georges Bank in 2004 were the largest since 1983 due to a Special Access Program in Closed Area II. Sampling intensity of landings in 2002-2004 increased relative to that in 2001 (Table C2). Both the large and small categories were sampled in both halves of the year. Landings at length by half year and market category were used with half year specific age-length keys to estimate landings at age and mean weights at age.

2.2 US Discards

US discarded catch for trawl gear in years 2002-2004 was estimated from observer information on discard to kept ratios by half-year. US discarded catch for scallop dredge gear in years 2001-2004 was estimated from a regression between annual discarded yellowtail flounder and landed scallop meat weight (Stone and Legault 2005). US discards were approximately 9% of the US catch in years 2002-2004 (Table C1; Figure C1). Discards at age and associated mean weights at age were estimated from sea sampled lengths and pooled commercial, observer, and survey age-length keys.

2.3 Canadian Landings

Canadian landings in 2004 were well below previous levels and the allowed quota for that fishery (0.1 kt caught vs quota of 1.9 kt; Table C1; Figure C1). Length frequencies collected by Canadian samplers were used with sex specific age-length keys provided from US landings to generate the Canadian landings by age in 2002. In 2003 and 2004, scale samples from Canadian landings were aged by the US readers and these age-length keys used directly for these landings.

2.4 Canadian Discards

During the 2005 benchmark assessment, yellowtail flounder discards from the Canadian scallop fleet were estimated for the entire time series and used in the stock assessment for the first time (Stone and Legault 2005). Inclusion of this catch did not cause a large change in the assessment results because the magnitude is relatively constant throughout the time series used in the assessment, 1973 onward (Table C1; Figure C1). Discards at length were estimated from ogives of relative selectivity compared to research survey catches at length and converted to ages using age-length keys from US and Canada commercial landings and observers by quarter.

2.5 Total Catch at Age

Total catch at age was formed by adding the US landings, US discards, Canadian landings, and Canadian discards for use in virtual population analysis (Table C3a). Average weight at age was computed as the catch weighted average of the weights at age from these four sources (Table C3b).

2.6 Research Vessel Survey Indices

Survey abundance and biomass indices are reported in Table C4. Estimates from research vessel surveys are from valid tows on Georges Bank (NEFSC offshore strata 13-21; Canadian strata 5Z1-5Z4; NEFSC scallop strata 54, 55, 58-72, 74) standardized according to net, vessel, and door changes (Legault and Stone 2004). The three surveys of biomass show a similar pattern of rapid increase from lows in the early to mid 1990s to highs in the early 2000s followed by a decline in the most recent years (Figure C2).

3.0 Assessment Results

3.1 Age-Based Analysis

The 2005 benchmark assessment could not select a single formulation for Georges Bank yellowtail flounder VPA stock assessment. Instead, the previously used “Base Case VPA” (same formulation as GARM; NEFSC 2002b) was used along with a “Major Change VPA” which extended the ages from 6+ to 12, split the survey time series in 1995, and allowed for power functions relating survey abundance at age to model estimates. These two formulations were thought to bracket the possible status of the stock. The updated Base Case VPA calibration of Georges Bank yellowtail flounder is summarized in Table C4 and compared to the Major Change VPA in Figure C3. Results indicate that the fully recruited fishing mortality rate never dropped below Fmsy (0.25) and is currently above 1 in 2004. Spawning biomass increased considerably since 1995, but is well below values previously estimated, and recruitment is moderate. However, the Base Case analysis continues to show a strong retrospective pattern of underestimating F and overestimating SSB in the terminal year, as seen in previous assessments (Figure C4). The Major Change VPA does not show a retrospective pattern, updated estimates are both above and below previously estimated values. Bootstrap analysis indicates that abundance was estimated with moderate precision (CV=32-40%). These results cannot be directly compared to the results presented in the TRAC using Canadian software (TRAC 2005) because the Canadian VPA results are all bias-corrected while these are not. However, trends are similar between the results from US and Canadian software.

3.2 Stock Status

Proxies for MSY reference points were derived from yield and SSB per recruit analyses and the assumption of constant recruitment (NEFSC 2002a). Long-term average recruitment is 53.8 million at age-1.
MSY = 12,900 t
SSBmsy = 58,800 t.
Fmsy = 0.25 fully recruited (derived from F40%)

Therefore, according to both VPA results, the stock is overfished and overfishing is occurring, e.g. SSB2004=15,700 t (Base Case VPA) or 8,500 t (Major Change VPA) < 29,400 t = ½ 58,800 and F2004=1.19 (Base Case VPA) or 1.75 (Major Change VPA) > 0.25 = Fmsy.

3.3 Comparison with GARM Projections
In the GARM report (NEFSC 2002b), projections were presented for spawning stock biomass under an Frebuild=0.22 in years 2003 through 2009 which would achieve a 50% probability of Bmsy in 2009. Due to the strong retrospective pattern in the Base Case VPA, the SSB in years 2002 through 2004 are now estimated to be well below the GARM projections (Figure C5).

4.0 Sources of Uncertainty

- Retrospective patterns continue in the VPA for this assessment. Updated VPAs may indicate higher F and lower SSB in 2004 than the values reported here.
- The two formulations of VPA produce different numerical results, but both point to the stock being overfished and that overfishing is occurring.
- Estimates of prorated landings and discard ratios are based on preliminary logbook data and are subject to change.

5.0 GARM Panel Comments

The possible causes of the retrospective problem were discussed. Although several hypotheses were posed to explain the conflict between the relatively low catch and few old fish in the fishery and surveys, none of the hypotheses are supported by information on the fishery or resource. A net movement of a large portion of the adult population is not supported by the ongoing tagging study. Underestimation of catch would have to be approximately 3,000 t to cause the observed retrospective differences. Natural mortality would have to be more than four times the rate assumed in the assessment, but fish size at age actually increased in recent years. The survey catchability would have had to double in 1995 to cause the pattern. Reduced vulnerability of old fish to the fishery is also not supported by information on gear selectivity, geographic comparisons of age and size distributions, nor observations of fish movement in and out of the closed areas.

Projection Advice - The group agreed that both the ‘base case’ results with retrospective patterns, and ‘major change’ results with no retrospective patterns should be considered to assess stock status and evaluate management alternatives using mean weights, partial recruitment and recruitment options documented in the 2005 TRAC document. Mean weights and partial recruitments are calculated as the average of the most recent three years. Recruitment for 2005 is estimated as the geometric mean of the most recent 10 years for each bootstrap. Recruitment for years 2006 – 2009 is generated from two stage resampling of cumulative distribution function for recruitment below and above 5 thousand t, as was used in the setting of the biomass reference point.

6.0 References

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TRAC (Transboundary Resource Assessment Committee). 2005. Georges Bank yellowtail flounder Status Report 2005/03.

Table C1. Catch of Georges Bank yellowtail flounder (thousand t).

Year	US Landings	US Discards	Canada Landings	Canada Discards	Foreign	Total Catch
1963	11.0	5.6	0.0	0.0	0.1	16.7
1964	14.9	4.9	0.0	0.0	0.0	19.8
1965	14.2	4.4	0.0	0.0	0.8	19.4
1966	11.3	2.1	0.0	0.0	0.3	13.7
1967	8.4	5.5	0.0	0.0	1.4	15.3
1968	12.8	3.6	0.1	0.0	1.8	18.3
1969	15.9	2.6	0.3	0.0	2.4	21.3
1970	15.5	5.5	0.1	0.0	0.3	21.4
1971	11.9	3.1	0.1	0.0	0.5	15.6
1972	14.2	1.2	0.0	0.5	2.2	18.0
1973	15.9	0.4	0.0	0.4	0.3	17.0
1974	14.6	1.0	0.0	0.6	1.0	17.2
1975	13.2	2.7	0.0	0.7	0.1	16.7
1976	11.3	3.0	0.0	0.6	0.0	15.0
1977	9.4	0.6	0.0	0.6	0.0	10.6
1978	4.5	1.7	0.1	0.7	0.0	6.9
1979	5.5	0.7	0.0	0.7	0.0	6.9
1980	6.5	0.4	0.1	0.6	0.0	7.5
1981	6.2	0.1	0.0	0.7	0.0	7.0
1982	10.6	1.4	0.0	0.5	0.0	12.5
1983	11.4	0.1	0.1	0.5	0.0	12.0
1984	5.8	0.0	0.0	0.5	0.0	6.3
1985	2.5	0.0	0.0	0.7	0.0	3.3
1986	3.0	0.0	0.1	0.4	0.0	3.5
1987	2.7	0.2	0.1	0.5	0.0	3.6
1988	1.9	0.3	0.1	0.6	0.0	2.8
1989	1.1	0.1	0.0	0.5	0.0	1.8
1990	2.8	0.8	0.0	0.5	0.0	4.1
1991	1.8	0.2	0.1	0.5	0.0	2.6
1992	2.9	1.9	0.1	0.5	0.0	5.3
1993	2.1	1.1	0.7	0.4	0.0	4.3
1994	1.6	0.2	2.1	0.4	0.0	4.3
1995	0.4	0.0	0.5	0.3	0.0	1.2
1996	0.8	0.1	0.5	0.4	0.0	1.7
1997	1.0	0.1	0.8	0.4	0.0	2.3
1998	1.8	0.1	1.2	0.7	0.0	3.8
1999	2.0	0.5	2.0	0.6	0.0	5.0
2000	3.7	0.4	2.9	0.4	0.0	7.4
2001	3.8	0.3	2.9	0.8	0.0	7.9
2002	2.5	0.2	2.6	0.5	0.0	5.9
2003	3.3	0.4	2.1	0.8	0.0	6.6
2004	6.2	0.5	0.1	0.4	0.0	7.3

Table C2. Sampling history of the Georges Bank yellowtail flounder fishery.

		US					Canada		
			Length Samples						
Year	Half	Trips	Small	Large	Ages	Landings (t)	Trips	Lengths	Landings (t)
2000	1	8	94	782	200	2223	5	1120	92
	2	12	598	1288	405	1455	53	13048	2767
	All	11	692	2070	605	3678	58	14168	2859
2001	1	15	696	1055	433	2779	3	647	37
	2	15	1073	576	381	989	30	6824	2876
	All	30	1769	1631	814	3768	33	7471	2913
2002	1	15	469	880	313	2110	1	250	2
	2	11	333	788	239	421	25	5222	2640
	All	26	802	1668	552	2531	26	5472	2642
2003	1	27	1169	1603	640	2092	5	1066	365
	2	19	822	1040	476	1251	22	4877	1705
	All	46	1991	2643	1116	3343	27	5943	2070
2004	1	48	2113	3049	1113	3075	2	500	33
	2	26	1237	1565	579	3132	6	1509	63
	All	74	3350	4614	1692	6207	8	2009	96

Table C3a. Total catch (thousands) at age of Georges Bank yellowtail flounder.

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1973	359	5175	13565	9473	3815	1285	283	55	23	4	0	0
1974	2368	9500	8294	7658	3643	878	464	106	71	0	0	0
1975	4636	26394	7375	3540	2175	708	327	132	26	14	0	0
1976	635	31938	5502	1426	574	453	304	95	54	11	2	0
1977	378	9094	10567	1846	419	231	134	82	37	10	0	0
1978	9962	3542	4580	1914	540	120	45	16	17	7	6	0
1979	321	10517	3789	1432	623	167	95	31	27	1	3	0
1980	318	3994	9685	1538	352	96	5	11	1	0	0	0
1981	107	1097	5963	4920	854	135	5	2	3	0	0	0
1982	2164	18091	7480	3401	1095	68	20	7	0	0	0	0
1983	703	7998	16661	2476	680	122	13	16	4	0	0	0
1984	514	2018	4535	5043	1796	294	47	39	0	0	0	0
1985	970	4374	1058	818	517	73	8	0	0	0	0	0
1986	179	6402	1127	389	204	80	17	15	0	1	0	0
1987	156	3284	3137	983	192	48	38	26	25	0	0	0
1988	499	3003	1544	846	227	24	26	3	0	0	0	0
1989	190	2175	1121	428	110	18	12	0	0	0	0	0
1990	231	2114	6996	978	140	21	6	0	0	0	0	0
1991	663	147	1491	3011	383	67	4	0	0	0	0	0
1992	2414	9167	2971	1473	603	33	7	1	1	0	0	0
1993	5233	1386	3327	2326	411	84	5	1	0	0	0	0
1994	59	1432	6631	1856	568	95	23	1	0	0	0	0
1995	62	233	1428	986	211	17	23	4	2	0	0	0
1996	54	566	1922	941	234	11	9	3	0	0	0	0
1997	60	745	1502	1827	442	36	55	11	5	0	0	0
1998	64	1496	3224	2134	782	143	26	3	0	2	0	0
1999	37	3694	3583	1731	743	180	34	1	1	0	0	0
2000	155	3840	5985	3120	832	340	43	36	1	0	0	0
2001	284	3065	7622	2824	1093	293	254	23	9	0	0	0
2002	256	4437	3854	1845	670	263	113	62	11	5	0	0
2003	160	3818	4965	2297	777	328	213	93	39	15	1	0
2004	78	1336	3491	4093	2088	919	429	85	73	20	2	0

Table C3b. Total weight (kg) at age of Georges Bank yellowtail flounder.

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1973	0.101	0.348	0.462	0.527	0.603	0.690	1.063	1.131	1.275	1.389	1.170	
1974	0.115	0.344	0.496	0.607	0.678	0.723	0.904	1.245	1.090		1.496	1.496
1975	0.113	0.316	0.489	0.554	0.619	0.690	0.691	0.654	1.052	0.812		
1976	0.108	0.312	0.544	0.635	0.744	0.813	0.854	0.881	1.132	1.363	1.923	
1977	0.116	0.342	0.524	0.633	0.780	0.860	1.026	1.008	0.866	0.913		
1978	0.102	0.314	0.510	0.690	0.803	0.903	0.947	1.008	1.227	1.581	0.916	
1979	0.114	0.329	0.462	0.656	0.736	0.844	0.995	0.906	1.357	1.734	1.911	
1980	0.101	0.322	0.493	0.656	0.816	1.048	1.208	1.206	1.239			
1981	0.122	0.335	0.489	0.604	0.707	0.821	0.844	1.599	1.104			
1982	0.115	0.301	0.485	0.650	0.754	1.065	1.037	1.361				
1983	0.140	0.296	0.441	0.607	0.740	0.964	1.005	1.304	1.239			
1984	0.162	0.239	0.379	0.500	0.647	0.743	0.944	1.032				
1985	0.181	0.361	0.505	0.642	0.729	0.808	0.728					
1986	0.181	0.341	0.540	0.674	0.854	0.976	0.950	1.250		1.686		
1987	0.121	0.324	0.524	0.680	0.784	0.993	0.838	0.771	0.809			
1988	0.103	0.328	0.557	0.696	0.844	1.042	0.865	1.385				
1989	0.100	0.327	0.520	0.720	0.866	0.970	1.172	1.128				
1990	0.105	0.290	0.395	0.585	0.693	0.787	1.057					
1991	0.121	0.237	0.369	0.486	0.723	0.850	1.306					
1992	0.101	0.293	0.365	0.526	0.651	1.098	1.125	1.303	1.303			
1993	0.100	0.285	0.379	0.501	0.564	0.843	1.130	1.044				
1994	0.195	0.255	0.348	0.469	0.620	0.810	0.723	1.257				
1995	0.167	0.246	0.352	0.463	0.584	0.766	0.805	0.532	0.810			
1996	0.140	0.292	0.412	0.563	0.721	0.916	1.062	1.287				
1997	0.206	0.319	0.421	0.537	0.690	0.837	0.878	1.184	1.126			
1998	0.184	0.325	0.447	0.543	0.690	0.903	0.932	1.195		1.473		
1999	0.190	0.369	0.503	0.638	0.756	0.900	1.030	1.496	1.822			
2000	0.220	0.379	0.481	0.613	0.762	0.915	1.020	0.996	1.229			
2001	0.225	0.343	0.456	0.624	0.808	1.013	1.023	1.272	1.483			
2002	0.263	0.382	0.489	0.668	0.829	0.983	1.062	1.282	1.389	1.433		
2003	0.226	0.360	0.477	0.652	0.830	0.945	1.033	1.148	1.273	1.432	1.708	
2004	0.194	0.292	0.436	0.581	0.723	0.884	1.001	1.206	1.207	1.306	1.421	

Table C4a. NEFSC Spring survey indices of Georges Bank yellowtail abundance and biomass.

			Stratified Mean Number per Tow at Age										
NEFSC Spring Survey					Age								
Year	1	2	3	4	5	6	7	8	9	10	11	12	kg/tow
1968	0.149	3.364	3.579	0.316	0.084	0.160	0.127	0.000	0.000	0.000	0.000	0.000	2.813
1969	1.015	9.406	11.119	3.096	1.423	0.454	0.188	0.057	0.000	0.000	0.000	0.000	11.170
1970	0.093	4.485	6.030	2.422	0.570	0.121	0.190	0.000	0.000	0.000	0.000	0.000	5.312
1971	0.791	3.335	4.620	3.754	0.759	0.227	0.050	0.010	0.000	0.019	0.000	0.000	4.607
1972	0.138	7.136	7.198	3.514	1.094	0.046	0.122	0.000	0.000	0.000	0.000	0.000	6.450
1973	1.931	3.266	2.368	1.063	0.410	0.173	0.023	0.020	0.000	0.000	0.000	0.000	2.938
1974	0.316	2.224	1.842	1.256	0.346	0.187	0.085	0.000	0.000	0.000	0.009	0.000	2.719
1975	0.420	2.939	0.860	0.298	0.208	0.068	0.000	0.013	0.000	0.000	0.000	0.000	1.676
1976	1.034	4.368	1.247	0.311	0.196	0.026	0.048	0.019	0.018	0.000	0.000	0.000	2.273
1977	0.000	0.671	1.125	0.384	0.074	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.999
1978	0.936	0.798	0.507	0.219	0.026	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.742
1979	0.279	1.933	0.385	0.328	0.059	0.046	0.041	0.000	0.000	0.000	0.000	0.000	1.227
1980	0.057	4.644	5.761	0.473	0.057	0.037	0.000	0.000	0.000	0.000	0.000	0.000	4.456
1981	0.012	1.027	1.779	0.721	0.205	0.061	0.000	0.026	0.000	0.000	0.000	0.000	1.960
1982	0.045	3.742	1.122	1.016	0.455	0.065	0.000	0.026	0.000	0.000	0.000	0.000	2.500
1983	0.000	1.865	2.728	0.531	0.123	0.092	0.061	0.092	0.000	0.000	0.000	0.000	2.642
1984	0.000	0.093	0.809	0.885	0.834	0.244	0.000	0.000	0.000	0.000	0.000	0.000	1.646
1985	0.110	2.198	0.262	0.282	0.148	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.988
1986	0.027	1.806	0.291	0.056	0.137	0.055	0.000	0.000	0.000	0.000	0.000	0.000	0.847
1987	0.000	0.128	0.112	0.133	0.053	0.055	0.000	0.000	0.000	0.000	0.000	0.000	0.329
1988	0.078	0.275	0.366	0.242	0.199	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.566
1989	0.047	0.424	0.740	0.290	0.061	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.729
1990	0.000	0.065	1.108	0.393	0.139	0.012	0.045	0.000	0.000	0.000	0.000	0.000	0.699
1991	0.435	0.000	0.254	0.675	0.274	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.631
1992	0.000	2.010	1.945	0.598	0.189	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.566
1993	0.046	0.290	0.500	0.317	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.482
1994	0.000	0.621	0.638	0.357	0.145	0.043	0.000	0.000	0.000	0.000	0.000	0.000	0.660
1995	0.040	1.180	4.810	1.490	0.640	0.010	0.000	0.000	0.000	0.000	0.000	0.000	2.579
1996	0.030	0.990	2.630	2.700	0.610	0.060	0.000	0.000	0.000	0.000	0.000	0.000	2.853
1997	0.019	1.169	3.733	4.081	0.703	0.134	0.000	0.000	0.000	0.000	0.000	0.000	4.359
1998	0.000	2.081	1.053	1.157	0.759	0.323	0.027	0.000	0.000	0.000	0.000	0.000	2.324
1999	0.050	4.746	10.820	2.720	1.623	0.426	0.329	0.000	0.024	0.000	0.000	0.000	9.307
2000	0.183	4.819	7.666	2.914	0.813	0.422	0.102	0.000	0.000	0.000	0.000	0.000	6.696
2001	0.000	2.315	6.563	2.411	0.483	0.352	0.101	0.000	0.000	0.000	0.000	0.000	5.008
2002	0.188	2.412	12.333	4.078	1.742	0.378	0.408	0.086	0.000	0.000	0.000	0.000	9.566
2003	0.202	4.370	6.764	2.876	0.442	0.128	0.536	0.198	0.000	0.000	0.000	0.000	6.719
2004	0.049	0.986	2.178	0.680	0.283	0.110	0.052	0.082	0.000	0.000	0.000	0.000	1.887
2005	0.000	2.013	5.080	2.403	0.270	0.037	0.052	0.025	0.000	0.000	0.000	0.000	3.401

Table C4b. NEFSC Fall survey indices of Georges Bank yellowtail abundance and biomass.

NEFSC Fall Survey	Stratified Mean Number per Tow at Age												
	Age												
Year	1	2	3	4	5	6	7	8	9	10	11	12+	kg/tow
1963	14.722	7.896	11.226	1.858	0.495	0.281	0.034	0.164	0.069	0.000	0.000	0.000	12.791
1964	1.721	9.723	7.370	5.998	2.690	0.383	0.095	0.028	0.000	0.000	0.000	0.000	13.625
1965	1.138	5.579	5.466	3.860	1.803	0.162	0.284	0.038	0.000	0.000	0.000	0.000	9.104
1966	8.772	4.776	2.070	0.837	0.092	0.051	0.000	0.000	0.000	0.000	0.000	0.000	3.989
1967	9.137	9.313	2.699	1.007	0.309	0.076	0.061	0.000	0.000	0.000	0.000	0.000	7.577
1968	11.782	11.946	5.758	0.766	0.944	0.059	0.000	0.000	0.000	0.000	0.000	0.000	10.535
1969	8.106	10.381	5.855	1.662	0.553	0.149	0.182	0.000	0.000	0.000	0.000	0.000	9.278
1970	4.610	5.133	3.144	1.952	0.451	0.063	0.017	0.000	0.000	0.000	0.000	0.000	4.978
1971	3.627	6.949	4.904	2.248	0.551	0.234	0.024	0.024	0.000	0.000	0.000	0.000	6.362
1972	2.424	6.525	4.824	2.095	0.672	0.279	0.000	0.000	0.000	0.000	0.000	0.000	6.328
1973	2.494	5.497	5.104	2.944	1.216	0.416	0.171	0.000	0.031	0.000	0.000	0.000	6.600
1974	4.623	2.854	1.524	1.060	0.460	0.249	0.131	0.000	0.000	0.000	0.000	0.000	3.734
1975	4.625	2.511	0.877	0.572	0.334	0.033	0.000	0.000	0.000	0.000	0.000	0.031	2.365
1976	0.336	1.929	0.475	0.117	0.122	0.033	0.000	0.033	0.033	0.000	0.000	0.000	1.533
1977	0.928	2.161	1.649	0.618	0.113	0.056	0.036	0.016	0.000	0.000	0.000	0.000	2.828
1978	4.729	1.272	0.773	0.406	0.139	0.011	0.000	0.024	0.000	0.000	0.000	0.000	2.383
1979	1.312	1.999	0.316	0.122	0.138	0.038	0.064	0.000	0.007	0.000	0.000	0.000	1.520
1980	0.761	5.086	6.050	0.678	0.217	0.162	0.006	0.000	0.033	0.000	0.000	0.000	6.722
1981	1.584	2.333	1.630	0.500	0.121	0.083	0.013	0.000	0.000	0.000	0.000	0.000	2.621
1982	2.424	2.185	1.590	0.423	0.089	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.271
1983	0.109	2.284	1.914	0.473	0.068	0.012	0.000	0.000	0.038	0.000	0.000	0.000	2.131
1984	0.661	0.400	0.306	2.428	0.090	0.029	0.000	0.018	0.000	0.000	0.000	0.000	0.593
1985	1.350	0.560	0.160	0.040	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.709
1986	0.280	1.110	0.350	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.820
1987	0.113	0.390	0.396	0.053	0.079	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.509
1988	0.019	0.213	0.102	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.171
1989	0.248	1.992	0.774	0.069	0.066	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.977
1990	0.000	0.326	1.517	0.280	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.725
1991	2.100	0.275	0.439	0.358	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.730
1992	0.151	0.396	0.712	0.162	0.144	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.576
1993	0.842	0.136	0.587	0.536	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.545
1994	1.200	0.220	0.980	0.710	0.260	0.030	0.030	0.000	0.000	0.000	0.000	0.000	0.897
1995	0.280	0.120	0.350	0.280	0.050	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.354
1996	0.140	0.350	1.870	0.450	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.303
1997	1.392	0.533	3.442	2.090	1.071	0.082	0.000	0.000	0.000	0.000	0.000	0.000	3.781
1998	1.900	4.817	4.202	1.190	0.298	0.055	0.019	0.000	0.000	0.000	0.000	0.000	4.347
1999	3.090	8.423	5.727	1.432	1.436	0.260	0.000	0.000	0.000	0.000	0.000	0.000	7.973
2000	0.629	1.697	4.814	2.421	0.948	0.800	0.027	0.000	0.000	0.000	0.000	0.000	5.838
2001	3.518	6.268	8.091	2.601	1.718	0.714	1.334	0.000	0.000	0.000	0.000	0.000	11.553
2002	2.093	5.751	2.127	0.594	0.277	0.000	0.027	0.027	0.000	0.000	0.000	0.000	3.760
2003	1.102	5.006	2.809	0.565	0.100	0.092	0.075	0.025	0.000	0.000	0.000	0.000	4.039
2004	0.876	5.508	5.010	2.106	0.924	0.176	0.000	0.000	0.000	0.000	0.000	0.000	5.117

Table C4c. Canadian survey indices of Georges Bank yellowtail abundance and biomass.

	Stratified Mean Number per Tow at Age												
Canadian Survey					Age								
Year	1	2	3	4	5	6	7	8	9	10	11	12	kg/tow
1987	0.120	0.988	2.002	0.638	0.121	0.000	0.020	0.024	0.000	0.000	0.000	0.000	1.250
1988	0.000	1.588	1.292	0.760	0.295	0.009	0.018	0.000	0.000	0.000	0.000	0.000	1.235
1989	0.114	0.941	0.583	0.364	0.088	0.014	0.023	0.007	0.000	0.000	0.000	0.000	0.471
1990	0.000	2.359	3.383	1.064	0.322	0.008	0.016	0.000	0.000	0.000	0.000	0.000	1.513
1991	0.024	0.858	1.531	3.230	0.725	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.758
1992	0.055	10.745	3.969	1.034	0.301	0.010	0.000	0.018	0.009	0.000	0.000	0.000	2.475
1993	0.079	2.245	3.265	4.406	1.635	0.046	0.011	0.000	0.000	0.000	0.000	0.000	2.642
1994	0.000	6.056	3.464	3.006	0.781	0.133	0.030	0.044	0.000	0.000	0.000	0.000	2.753
1995	0.210	1.190	4.281	2.554	0.785	0.050	0.036	0.000	0.000	0.000	0.000	0.000	2.027
1996	0.446	6.655	8.579	6.615	1.010	0.092	0.017	0.033	0.000	0.000	0.000	0.000	5.303
1997	0.022	9.781	14.674	17.957	4.324	0.532	0.110	0.089	0.000	0.000	0.000	0.000	13.293
1998	0.893	3.179	4.891	4.504	2.021	0.459	0.033	0.012	0.000	0.020	0.000	0.000	4.293
1999	0.159	11.841	27.242	7.949	7.296	2.214	0.335	0.037	0.000	0.000	0.000	0.000	17.666
2000	0.011	9.468	32.902	17.802	5.539	2.955	0.324	0.217	0.000	0.000	0.000	0.000	19.949
2001	0.291	15.176	47.131	13.353	3.696	1.954	0.897	0.100	0.000	0.000	0.000	0.000	22.158
2002	0.088	9.667	33.733	11.269	5.970	1.540	0.955	0.383	0.079	0.000	0.000	0.000	20.699
2003	0.066	6.759	27.355	13.450	3.570	0.862	0.618	0.250	0.117	0.044	0.000	0.000	16.249
2004	0.033	3.599	16.260	9.205	2.273	0.627	0.234	0.463	0.092	0.000	0.000	0.000	9.000
2005	0.600	1.602	27.959	20.564	5.696	1.041	0.397	0.099	0.014	0.014	0.000	0.000	13.357

Table C4d. NEFSC scallop survey indices of Georges Bank yellowtail abundance.

Scallop Survey	
Year	Age-1
1982	0.313
1983	0.140
1984	0.233
1985	0.549
1986	0.103
1987	0.047
1988	0.116
1989	0.195
1990	0.100
1991	2.117
1992	0.167
1993	1.129
1994	1.503
1995	0.609
1996	0.508
1997	1.062
1998	1.872
1999	1.038
2000	0.912
2001	0.789
2002	1.005
2003	0.880
2004	0.330

Table C5a. Estimates of stock size from Base Case VPA.

JAN-1 Population Numbers

AGE	1973	1974	1975	1976	1977
1	29386.	52186.	70632.	24731.	17280.
2	24172.	23735.	40589.	53646.	19675.
3	29516.	15136.	10932.	9853.	15555.
4	17301.	12051.	5010.	2427.	3172.
5	6967.	5733.	3078.	977.	720.
6	3013.	2392.	1708.	1562.	851.
Total	110355.	111234.	131951.	93196.	57252.

AGE	1978	1979	1980	1981	1982
1	54436.	25511.	24034.	62999.	22847.
2	13807.	35603.	20596.	19390.	51482.
3	7988.	8122.	19711.	13269.	14885.
4	3391.	2468.	3267.	7498.	5537.
5	957.	1074.	748.	1302.	1783.
6	374.	560.	240.	221.	156.
Total	80952.	73337.	68595.	104679.	96691.

AGE	1983	1984	1985	1986	1987
1	6582.	10842.	16748.	8473.	9199.
2	16754.	4755.	8413.	12837.	6775.
3	25939.	6579.	2089.	2990.	4801.
4	5517.	6473.	1379.	767.	1439.
5	1515.	2305.	871.	402.	281.
6	345.	486.	137.	223.	201.
Total	56653.	31441.	29637.	25692.	22696.

AGE	1988	1989	1990	1991	1992
1	22878.	9732.	11542.	22787.	18342.
2	7390.	18280.	7796.	9241.	18058.
3	2617.	3364.	13006.	4485.	7433.
4	1153.	771.	1749.	4419.	2335.
5	309.	198.	250.	562.	956.
6	72.	54.	47.	104.	67.
Total	34419.	32399.	34390.	41598.	47191.

AGE	1993	1994	1995	1996	1997
1	13961.	10669.	11145.	13220.	18556.
2	12842.	6744.	8682.	9069.	10775.
3	6613.	9265.	4234.	6898.	6914.
4	3427.	2447.	1735.	2186.	3922.
5	606.	749.	371.	544.	949.
6	134.	157.	83.	53.	230.
Total	37583.	30031.	26249.	31969.	41344.

JAN-1 Population Numbers

AGE	1998	1999	2000	2001	2002
1	24156.	26119.	22406.	25986.	39088.
2	15138.	19719.	21351.	18204.	21019.
3	8150.	11045.	12821.	14024.	12145.
4	4310.	3787.	5830.	5153.	4697.
5	1579.	1626.	1555.	1995.	1706.
6	349.	473.	785.	1058.	1158.
Total	53682.	62768.	64746.	66421.	79814.

AGE	2003	2004	2005
1	34263.	14985.	0.
2	31772.	27908.	12199.
3	13218.	22572.	21643.
4	6487.	6376.	15336.
5	2194.	3253.	1593.
6	1946.	2380.	1408.
Total	89880.	77474.	52179.

Table C5b. Estimates of fishing mortality from Base Case VPA.

Fishing Mortality Calculated

AGE	1973	1974	1975	1976	1977
1	0.0136	0.0513	0.0751	0.0287	0.0244
2	0.2681	0.5752	1.2157	1.0381	0.7014
3	0.6957	0.9056	1.3051	0.9334	1.3234
4	0.9045	1.1648	1.4349	1.0151	0.9988
5	0.9045	1.1648	1.4349	1.0151	0.9988
6	0.9045	1.1648	1.4349	1.0151	0.9988

AGE	1978	1979	1980	1981	1982
1	0.2246	0.0140	0.0147	0.0019	0.1102
2	0.3306	0.3913	0.2397	0.0644	0.4855
3	0.9746	0.7108	0.7665	0.6740	0.7925
4	0.9500	0.9941	0.7202	1.2366	1.0958
5	0.9500	0.9941	0.7202	1.2366	1.0958
6	0.9500	0.9941	0.7202	1.2366	1.0958

AGE	1983	1984	1985	1986	1987
1	0.1251	0.0537	0.0660	0.0236	0.0189
2	0.7347	0.6226	0.8343	0.7835	0.7512
3	1.1881	1.3628	0.8020	0.5313	1.2268
4	0.6727	1.8053	1.0320	0.8036	1.3377
5	0.6727	1.8053	1.0320	0.8036	1.3377
6	0.6727	1.8053	1.0320	0.8036	1.3377

AGE	1988	1989	1990	1991	1992
1	0.0243	0.0218	0.0223	0.0326	0.1565
2	0.5870	0.1404	0.3530	0.0177	0.8046
3	1.0221	0.4540	0.8795	0.4527	0.5742
4	1.5607	0.9246	0.9352	1.3311	1.1495
5	1.5607	0.9246	0.9352	1.3311	1.1495
6	1.5607	0.9246	0.9352	1.3311	1.1495

AGE	1993	1994	1995	1996	1997
1	0.5276	0.0061	0.0062	0.0045	0.0036
2	0.1265	0.2656	0.0300	0.0713	0.0792
3	0.7939	1.4752	0.4609	0.3647	0.2726
4	1.3208	1.6859	0.9604	0.6348	0.7094
5	1.3208	1.6859	0.9604	0.6348	0.7094
6	1.3208	1.6859	0.9604	0.6348	0.7094

Fishing Mortality Calculated

AGE	1998	1999	2000	2001	2002
1	0.0029	0.0016	0.0077	0.0121	0.0073
2	0.1152	0.2305	0.2203	0.2047	0.2638
3	0.5664	0.4390	0.7114	0.8939	0.4272
4	0.7751	0.6904	0.8726	0.9057	0.5611
5	0.7751	0.6904	0.8726	0.9057	0.5611
6	0.7751	0.6904	0.8726	0.9057	0.5611

AGE	2003	2004
1	0.0052	0.0058
2	0.1419	0.0542
3	0.5290	0.1865
4	0.4903	1.1867
5	0.4903	1.1867
6	0.4903	1.1867

Table C5c. Estimates of spawning biomass from Base Case VPA.

Spawning Stock Biomass

AGE	1973	1974	1975	1976	1977
1	0.	0.	0.	0.	0.
2	2907.	2660.	3200.	4496.	2080.
3	9107.	4641.	2798.	3276.	4234.
4	5754.	4142.	1404.	929.	1218.
5	2652.	2201.	964.	438.	341.
6	1527.	1162.	681.	859.	521.
Total	21947.	14807.	9048.	9998.	8394.

AGE	1978	1979	1980	1981	1982
1	0.	0.	0.	0.	0.
2	1564.	4120.	2485.	2851.	5706.
3	2447.	2516.	6366.	4463.	4726.
4	1449.	984.	1460.	2489.	2097.
5	476.	480.	416.	506.	783.
6	224.	329.	192.	101.	99.
Total	6159.	8429.	10919.	10409.	13412.

AGE	1983	1984	1985	1986	1987
1	0.	0.	0.	0.	0.
2	1646.	750.	1835.	2702.	1373.
3	6351.	1300.	695.	1191.	1388.
4	2328.	1403.	530.	340.	516.
5	779.	647.	380.	226.	116.
6	267.	168.	65.	149.	93.
Total	11371.	4269.	3506.	4608.	3487.

AGE	1988	1989	1990	1991	1992
1	0.	0.	0.	0.	0.
2	1624.	4824.	1670.	1860.	1810.
3	876.	1332.	3276.	1261.	1690.
4	385.	347.	638.	1135.	700.
5	125.	107.	108.	215.	355.
6	34.	36.	24.	48.	42.
Total	3044.	6647.	5717.	4519.	4597.

AGE	1993	1994	1995	1996	1997
1	0.	0.	0.	0.	0.
2	1661.	737.	1009.	1230.	1591.
3	1424.	1380.	973.	1932.	2056.
4	911.	523.	495.	869.	1442.
5	181.	212.	134.	277.	448.
6	61.	57.	41.	39.	153.
Total	4239.	2908.	2652.	4346.	5690.

Spawning Stock Biomass

AGE	1998	1999	2000	2001	2002
1	0.	0.	0.	0.	0.
2	2243.	3162.	3532.	2743.	3441.
3	2276.	3661.	3628.	3486.	3933.
4	1559.	1667.	2286.	2028.	2285.
5	726.	848.	758.	1017.	1030.
6	213.	301.	520.	715.	1024.
Total	7018.	9639.	10723.	9990.	11713.

AGE	2003	2004
1	0.	0.
2	5158.	3812.
3	4002.	7205.
4	3172.	2079.
5	1366.	1320.
6	1651.	1290.
Total	15349.	15705.

Figure C1. Total catch of Georges Bank yellowtail flounder.

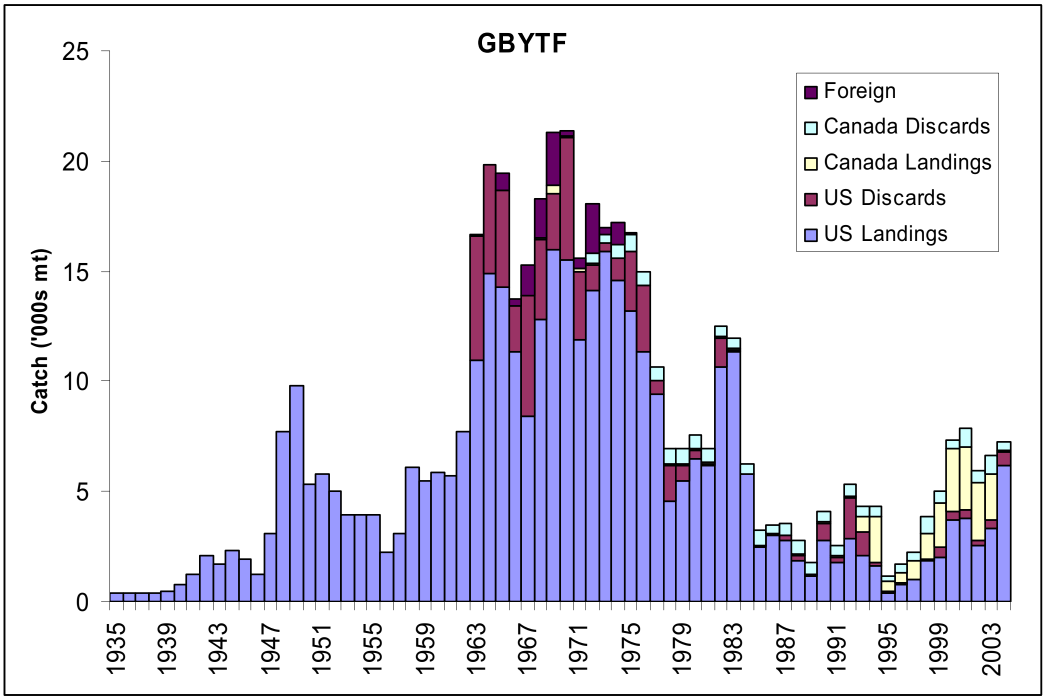


Figure C2. Survey indices of Georges Bank yellowtail flounder biomass.

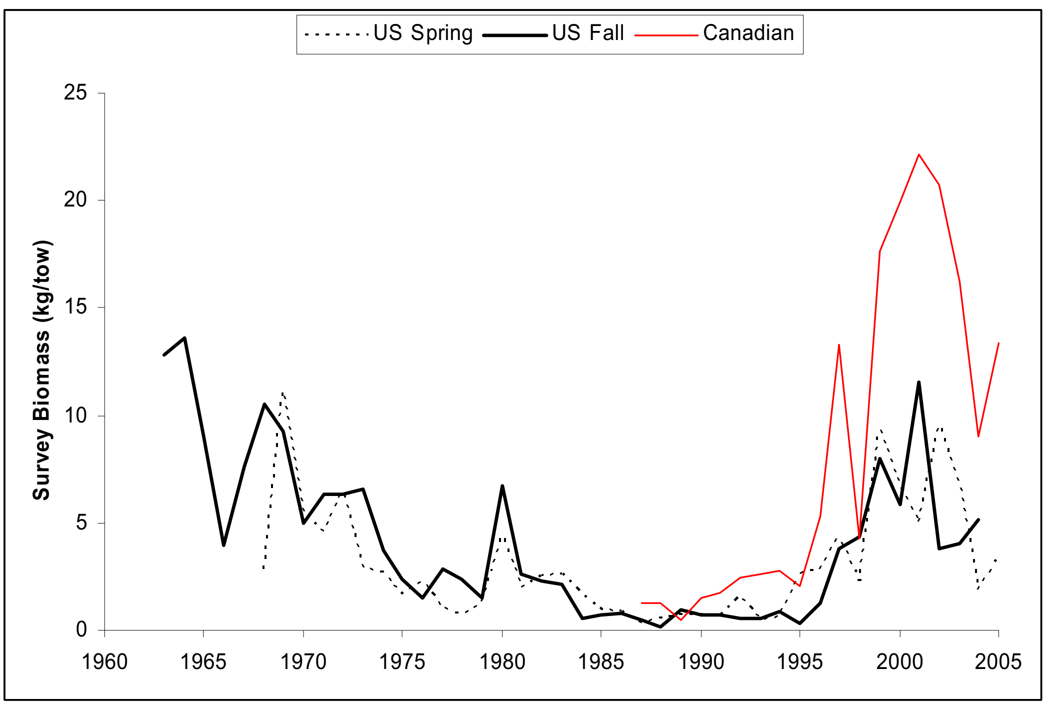


Figure C3. Summary of Georges Bank yellowtail flounder VPA results.

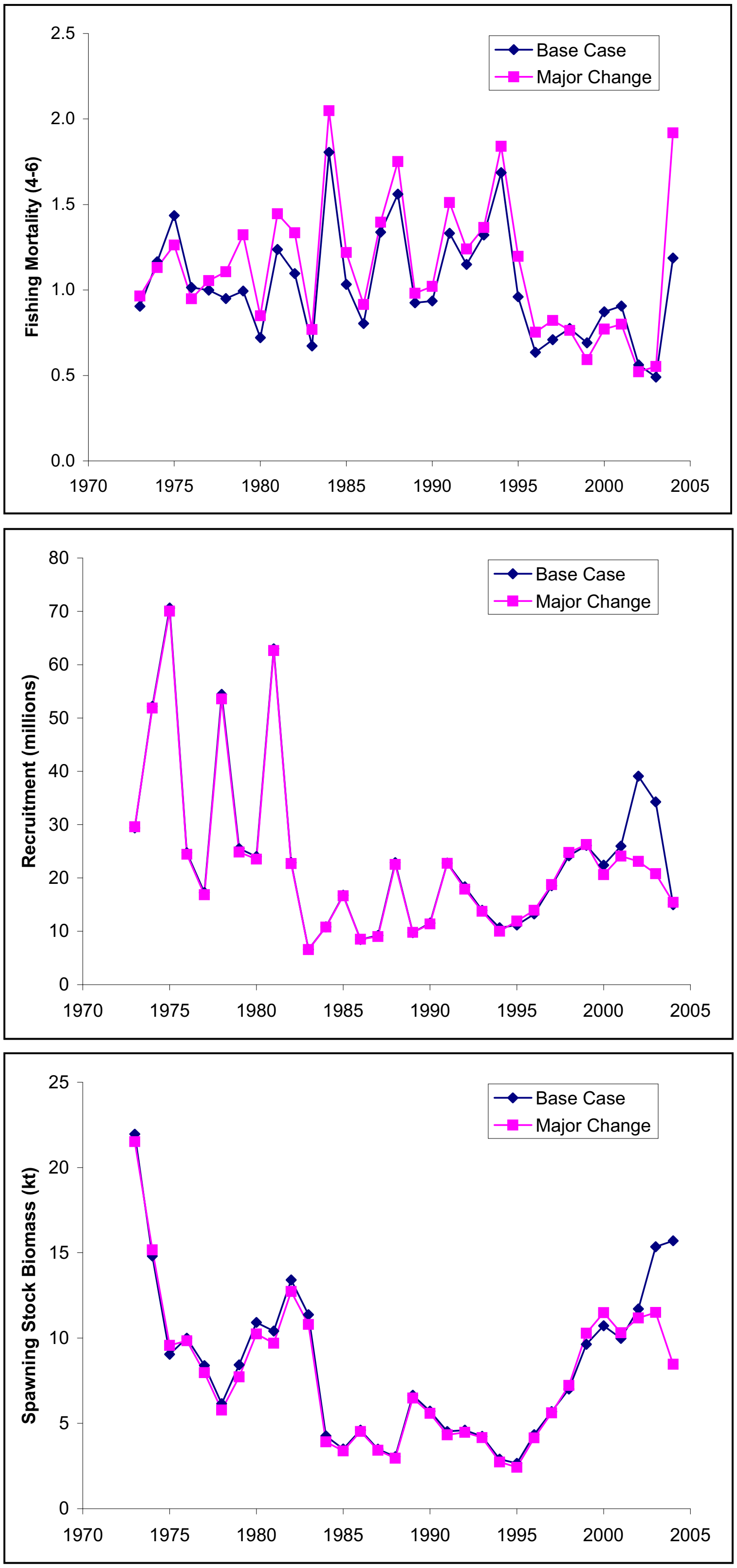
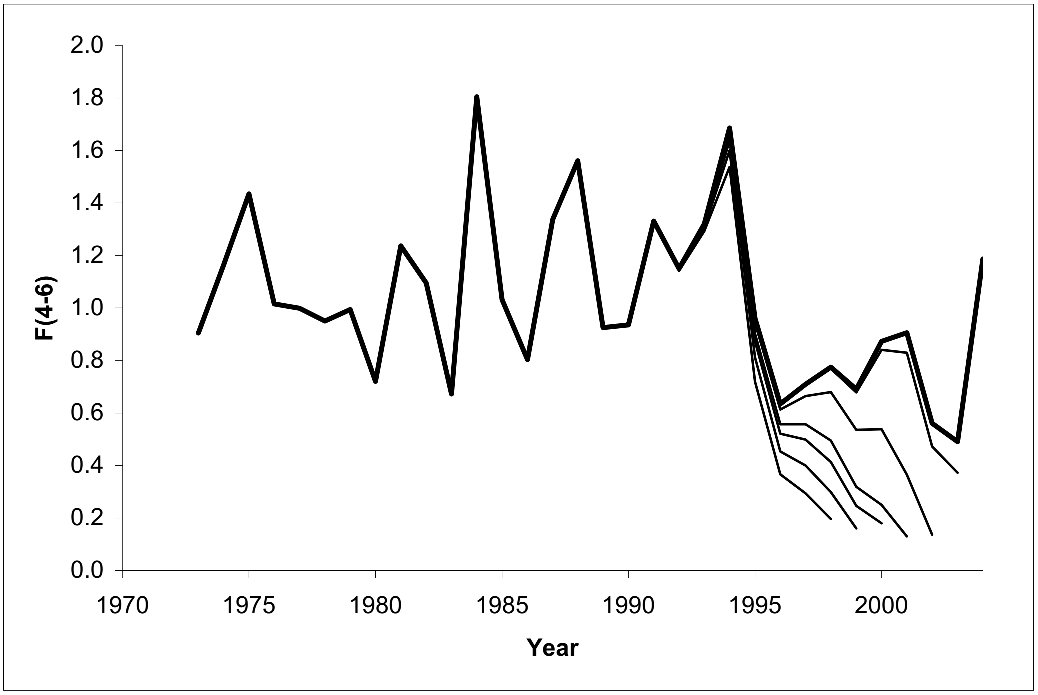


Figure C4. Retrospective patterns in Georges Bank yellowtail flounder Base Case VPA.



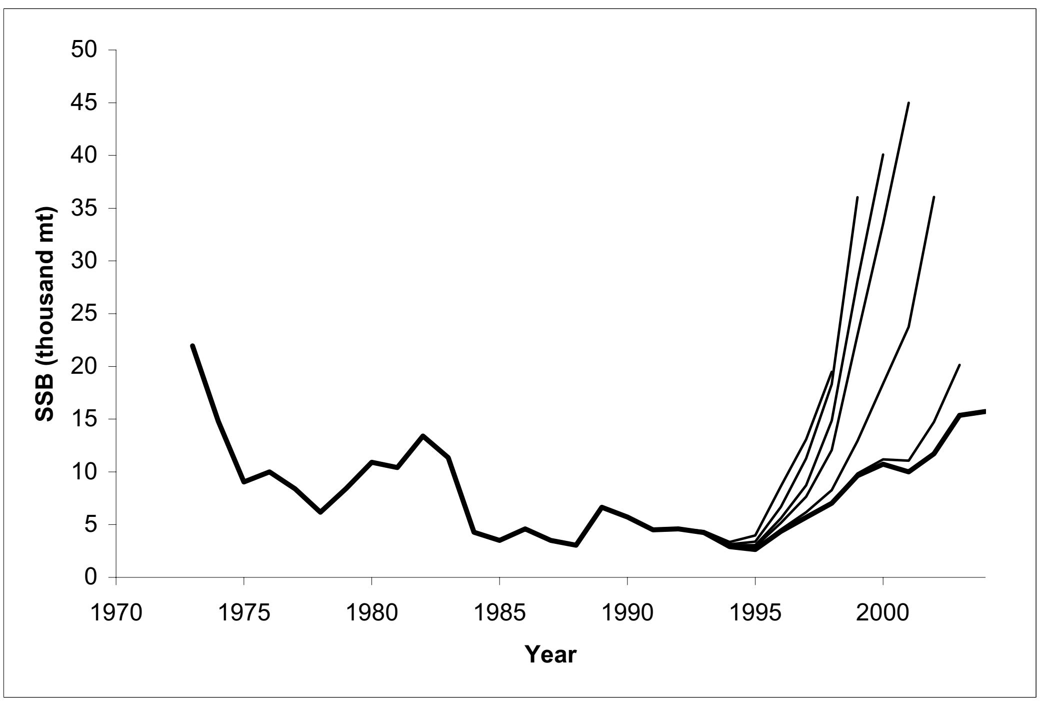
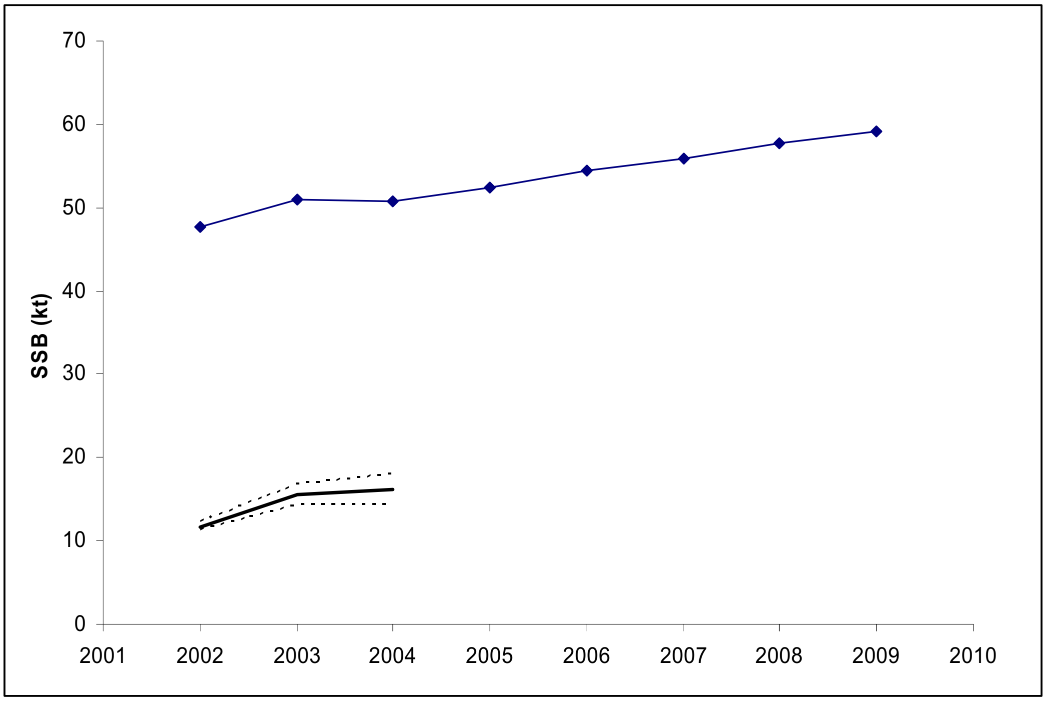


Figure C5. Comparison of projections from GARM assuming Frebuild=0.22 in years 2003 through 2009 (solid line with symbols; NEFSC 2002b) and results of Base Case VPA from 2005 assessment (heavy solid line = median, dashed lines = interquartile range).



D. Southern New England-Mid Atlantic Yellowtail Flounder by **S.X. Cadrin and C.M. Legault**

1.0 Background

The southern New England-Mid Atlantic yellowtail stock was at low biomass at relatively high F in 2001 (SSB was 1,900 mt and fully recruited F was 0.91; Cadrin 2003). This report updates catch and survey indices from the SAW36 analysis and estimates 2004 fishing mortality and 2005 stock abundance.

2.0 2005 Assessment

2.1 2002-2004 Landings

U.S. landings were prorated as described in NEFSC (1998; Table D1; Figure D1). Landings from southern New England-Mid Atlantic have steadily decreased since 2001 to 165mt in 2004. Port sampling was incomplete in 2002-2004 (Table D2), and does not allow for estimation of catch at age by geographic region, market category and half-year as done in the previous assessment (Cadrin 2003). Alternatively, 2002 and first-half 2003 landings at age were estimated by stock area, market category and half-year; second-half 2003 and 2003-2004 landings at age were derived from industry-based survey samples (Figure D2) for >33cm yellowtail, not separated by market category (Table D2).

2.2 2002-2004 Discards

Discarded catch from the trawl fishery was estimated from discard to kept ratios by half-year (NEFSC 1998). Discards from the scallop dredge fishery were estimated from discard to effort, because no yellowtail were landed by the scallop dredge fishery during 2002-2004. The number of observed trips, lengths and ages for 2002-2004 increased substantially (Table D3). Proportion of discarded catch increased from 14% of total catch in 2002 to 45% in 2004 (Table D1, Figure D1), primarily from trawl discards in the second half of 2004. Discards at age were estimated from observer lengths and combined observer and survey age-length keys. Total catch at age and mean weights at age are reported in Table D4 and Figure D3.

2.3 2002-2005 Survey Indices

Survey abundance and biomass indices are reported in Table D5. Estimates are from valid tows in the southern New England-Mid Atlantic area [offshore strata 1, 2, 5, 6, 9, 10, 69, 73, 74 (strata 69, 73, 74 excluded from the fall series); scallop strata 33, 34, 35, 46], standardized according to net, vessel, and door changes (NEFSC 1998). Survey data indicate a decrease in stock biomass since the 2002 stock assessment, weak recruitment and poor survival to older ages (Figures D4 and D5).

3.0 Assessment Results

3.1 Age-Based Analysis

Results of an updated VPA calibration of southern New England-Mid Atlantic yellowtail is summarized in Table D6. This analysis updates the assessment reported by Cadrin (2003) by including 2002-2004 landings and discards, 2002-2004 scallop and fall indices, and 2002-2005 winter and spring indices. Results indicate that fishing mortality remained high during 2002-2004, averaging 0.84 (Figure D6). Spawning biomass decreased to 695mt in 2004.

Retrospective analysis indicates a reversal in 2002 of the previous pattern of overestimating SSB and underestimating F (Figure D7). Bootstrap analysis indicates that abundance was estimated with moderate precision (CV=34-47%).

Reference points for status determination were estimated from yield and SSB per recruit analyses and the assumption of constant recruitment (Cadrin 2003). Assuming that F_{MSY} is approximately $F_{40\%}$ (0.26 on fully-recruited ages) and long-term average recruitment (61.57 million at age-1), MSY=14,200 mt and SSB_{MSY}=69,500 mt. Therefore, the stock is severely overfished (2004 SSB=1%SSB_{MSY}) and overfishing is occurring (2004 $F= 4 \cdot F_{MSY}$). The estimate of 2004 fishing mortality (0.99) is more than twice the F desired for the rebuilding program (0.37), and 2004 SSB is approximately 10% of the projected value (Figures D8 and 9).

3.2 Biomass-Based Analysis

Due to poor sampling in the late 1990s, a biomass dynamics model (ASPIC) was applied to the southern New England-Mid Atlantic yellowtail stock assessment to provide alternative perspectives on stock status. Biomass estimates from ASPIC are greater than those from the VPA in the last ten years, and estimates of F are lower, but the ASPIC estimate of 2004 biomass is only 6% of the ASPIC estimate of B_{MSY} (Figure D10). Therefore, ASPIC results also suggest that the stock is severely overfished.

4.0 Sources of Uncertainty

- Although historical perspective from production models are valuable, current biomass levels may not be reliable, because the model assumes high productivity at low stock size.
- Estimates of prorated landings and discard ratios are based on preliminary logbook data and are subject to change.

5.0 GARM Discussion

It was noted that there a number of trips with all discard and no kept in 2004 as well as a pattern of both large and small sizes discarded. This may be due in part to the inclusion of trips not using a groundfish day-at-sea, such as those targeting summer flounder that also catch and discard yellowtail. Industry representatives noted that even though catches have been low in recent years, there has still been a directed fishery for this stock with the possible exception of 2004. There will be additional disincentives to landing yellowtail in this region next year, since 1.5 DAS will be charged for every DAS fished. Therefore, continued discarding of legal sized fish as well as discards due to boats fishing on non-groundfish trips is likely.

Differences in the estimated fishing mortality rate for old fish between the SAW36 and updated versions of the ADAPT VPA software were discounted by the Panel because so few animals are present at the old ages. The Panel recommended use of the new software because it contains a number of improvements.

It was noted that the switching direction of retrospective bias coincides with the change to using observer samples in addition to port sampling. The Panel recommended that future assessments test using port sampling alone to see if the retrospective pattern is removed.

Patterns in residuals for the ASPIC fit were noted which led to discounting of the ASPIC model results. It was also noted that recent good sampling has increased confidence in the current VPA results. The Panel agreed that VPA is most appropriate method to measure stock status.

Projection Advice - The Panel recommended the average of 1994-2004 for both mean weights at age and partial recruitment for projections because there is no trend over time. The Panel agreed on using the most recent ten years of recruits-per-SSB to account for the low values of recruitment seen in the past decade while also accounting for the low SSB. The Panel notes that this choice of recruitment differs from that used in Amendment 13 projections and would not be expected to achieve rebuilding to Bmsy in long-term projections. However, since only short term projections will be conducted, the Panel thought the current low recruitment should be reflected in these short term projections.

Research Recommendations

- Given the large decline in the stock abundance, the Panel noted that changes in maturity would be expected and recommended that this be explored in future assessments.
- Results appear to be sensitive to the 'oldest age' assumption, and alternative methods should be considered for the next benchmark assessment.
- The NEFSC winter survey is now showing a trend in recent years, and should be included in future ASPIC runs.

6.0 References

Cadrin, S.X. 2003. Stock assessment of yellowtail flounder in the southern New England-Mid Atlantic area. NEFSC Ref. Doc. 03-02.

NEFSC (Northeast Fisheries Science Center). 1998. Southern New England yellowtail flounder. NEFSC Ref. Doc. 98-15: 328-350.

Table D1. Catch of southern New England-Mid Atlantic yellowtail flounder (thousand mt).

	U.S. landings	U.S. discards	foreign catch	total catch	percent discards
1935	6.0	2.4	0.0	8.4	29%
1936	6.8	2.7	0.0	9.5	28%
1937	7.6	3.0	0.0	10.6	28%
1938	7.7	3.1	0.0	10.8	29%
1939	9.5	3.8	0.0	13.3	29%
1940	14.2	5.7	0.0	19.9	29%
1941	19.3	7.7	0.0	27.0	29%
1942	28.4	9.9	0.0	38.3	26%
1943	18.0	7.3	0.0	25.3	29%
1944	10.6	4.8	0.0	15.4	31%
1945	10.4	4.2	0.0	14.6	29%
1946	10.8	4.4	0.0	15.2	29%
1947	12.1	4.9	0.0	17.0	29%
1948	9.9	4.0	0.0	13.9	29%
1949	4.9	1.9	0.0	6.8	28%
1950	4.9	1.9	0.0	6.8	28%
1951	2.9	1.1	0.0	4.0	28%
1952	3.2	1.2	0.0	4.4	27%
1953	2.3	0.8	0.0	3.1	26%
1954	1.7	0.6	0.0	2.3	26%
1955	2.5	0.9	0.0	3.4	26%
1956	4.1	1.4	0.0	5.5	25%
1957	6.2	2.2	0.0	8.4	26%
1958	9.5	3.6	0.0	13.1	27%
1959	8.2	3.1	0.0	11.3	27%
1960	8.8	3.2	0.0	12.0	27%
1961	13.0	4.7	0.0	17.7	27%
1962	13.5	5.3	0.0	18.8	28%
1963	22.6	5.4	0.2	28.2	19%
1964	21.8	9.5	0.0	31.3	30%
1965	22.5	7.0	1.4	30.9	23%
1966	22.5	5.3	0.7	28.5	19%
1967	25.1	7.7	2.8	35.6	22%
1968	25.4	6.3	3.5	35.2	18%
1969	23.7	2.4	18.3	44.4	5%
1970	21.4	4.5	2.6	28.5	16%
1971	15.9	2.2	1.3	19.3	11%
1972	17.6	1.8	3.1	22.5	8%
1973	12.44	1.71	0.40	14.55	12%
1974	8.28	8.69	0.12	17.09	51%
1975	3.83	1.90	0.00	5.73	33%
1976	1.85	1.58	0.00	3.44	46%
1977	3.34	1.89	0.00	5.22	36%
1978	3.06	5.03	0.00	8.09	62%
1979	5.45	4.43	0.00	9.88	45%
1980	6.30	1.72	0.00	8.02	21%
1981	5.40	1.21	0.00	6.61	18%
1982	10.73	5.04	0.00	15.76	32%
1983	18.50	3.71	0.00	22.21	17%
1984	10.10	1.12	0.00	11.22	10%
1985	3.60	1.22	0.00	4.82	25%
1986	3.55	1.07	0.00	4.62	23%
1987	1.77	0.88	0.00	2.65	33%
1988	0.99	1.79	0.00	2.78	64%
1989	2.90	5.45	0.00	8.35	65%
1990	8.24	9.68	0.00	17.92	54%
1991	4.11	2.32	0.00	6.43	36%
1992	1.64	1.06	0.00	2.70	39%
1993	0.67	0.10	0.00	0.77	13%
1994	0.39	0.26	0.00	0.65	40%
1995	0.19	0.09	0.00	0.28	32%
1996	0.46	0.09	0.00	0.54	17%
1997	0.78	0.04	0.00	0.82	5%
1998	0.58	0.13	0.00	0.70	18%
1999	1.16	0.15	0.00	1.31	11%
2000	0.97	0.05	0.00	1.01	5%
2001	1.05	0.07	0.00	1.12	6%
2002	0.75	0.13	0.00	0.88	14%
2003	0.42	0.08	0.00	0.50	16%
2004	0.17	0.13	0.00	0.30	45%
mean	8.56	3.07	0.49	12.12	27%

Table D2. Samples of southern New England-Mid Atlantic yellowtail flounder from port samples and the industry-based survey (bold indicates no samples; ages used to categorized pooled market categories).

				landings	samples			% of	
year	region	half	category	mt	lengths	ages	kg	landings	
					port samples				
2002	SNE	Jan-Jun	unlassified	15	**0**	321	**0**	**0.00%**	
			large	328	749		400	0.12%	
			small	156	428		229	0.15%	
		Jul-Dec	unlassified	9	**0**	349	**0**	**0.00%**	
			large	70	231		108	0.15%	
			small	70	329		154	0.22%	
	MA	Jan-Jun	unlassified	56	373	127	199	0.36%	
			large	19	103		55	0.28%	
			small	10	105		56	0.59%	
		Jul-Dec	unlassified	14	214	48	100	0.70%	
			large	4	116		54	1.27%	
			small	2	**0**		**0**	**0.00%**	
2003	SNE	Jan-Jun	unlassified	4	**0**	183	**0**	**0.00%**	
			large	134	267		143	0.11%	
			small	91	397		212	0.23%	
		Jul-Dec	unlassified	10	**0**	87	**0**	**0.00%**	
			large	47	121		57	0.12%	
			small	34	213		99	0.30%	
	MA	Jan-Jun	unlassified	35	**0**	**0**	**0**	**0.00%**	
			large	15	**0**		**0**	**0.00%**	
			small	7	**0**		**0**	**0.00%**	
		Jul-Dec	unlassified	21	**0**		**0**	**0.00%**	
			large	16	**0**		**0**	**0.00%**	
			small	5	**0**		**0**	**0.00%**	
2004	SNE	Jan-Jun	unlassified	1	**0**	73	**0**	**0.00%**	
			large	44	203		108	0.25%	
			small	20	119		64	0.32%	
		Jul-Dec	unlassified	14	**0**	15	**0**	**0.00%**	
			large	34	99		46	0.14%	
			small	29	**0**		**0**	**0.00%**	
	MA	Jan-Jun	unlassified	10	**0**	13	**0**	**0.00%**	
			large	2	74		40	1.87%	
			small	1	**0**		**0**	**0.00%**	
		Jul-Dec	unlassified	2	**0**	**0**	**0**	**0.00%**	
			large	5	**0**		**0**	**0.00%**	
			small	3	**0**		**0**	**0.00%**	
					IBS samples >33cm				
2003	SNEMA	Jan-Jun		286	1375	404	291	0.10%	*
	SNEMA	Jul-Dec		133	2034	109	1041	0.78%	
2004	SNE	Jan-Jun		65	2543	239	1393	2.15%	
		Jul-Dec		77	2378	191	1040	1.35%	
	MA	Jan-Jun		13	1880	88	1164	8.81%	
		Jul-Dec		10	392	100	224	2.20%	

* combined port, observer & IBS samples used for landings at age.

Table D3. Discard estimates and sample sizes for southern New England-Mid Atlantic yellowtail flounder, 2002-2004.

Trawl Fishery

year	half	observed trips w/YT	observed kept (mt)	discard (mt)	d/k	landings (mt)	% observed	discards (mt)	discard lengths	observer ages all	
2002	Jan-Jun	1	2.734	0.035	0.0129	578.0	0.47%	7.5	0	39	*
	Jul-Dec	6	0.176	0.011	0.0645	169.5	0.10%	10.9	28	263	
2003	Jan-Jun	27	33.455	1.369	0.0409	284.1	11.78%	11.6	179	229	
	Jul-Dec	10	2.249	0.062	0.028	132.6	1.70%	3.6	14	221	**
2004	Jan-Jun	14	1.050	0.113	0.1075	77.4	1.36%	8.3	153	449	**
	Jul-Dec	28	0.739	0.911	1.2326	87.4	0.85%	107.7	375	430	**

Dredge Fishery

year	half	observed trips w/YT	effort (d) all obs trips	discard (mt)	d/e	total effort (d)	% observed	discards (mt)	discard lengths	
2002	Jan-Jun	0	0	*	0.0140	3897	0.00%	54.5	0	*
	Jul-Dec	7	50	0.693	0.0140	3780	1.31%	52.9	303	
2003	Jan-Jun	16	111	1.261	0.0114	3616	3.06%	41.2	229	
	Jul-Dec	8	92	0.408	0.0044	4677	1.97%	20.7	103	
2004	Jan-Jun	4	105	0.006	0.0001	4410	2.37%	0.2	0	*
	Jul-Dec	24	258	1.327	0.0051	3459	7.47%	17.8	703	

*Jul-Aug estimate
** survey ages

Table D4a. Catch at age (thousands) of southern New England-Mid Atlantic yellowtail flounder.

Catch at age (thousands)				Age				
Year	1	2	3	4	5	6	7+	sum
1973	220	5632	11951	7978	5226	5305	917	37229
1974	861	28519	5556	7370	3687	1598	1474	49065
1975	8910	4129	1884	1130	1597	792	416	18859
1976	214	6677	1181	327	449	477	230	9554
1977	5513	5027	4891	507	278	304	167	16687
1978	8698	14191	2164	1470	247	61	70	26901
1979	205	19419	8667	1062	438	101	29	29921
1980	1006	10215	6595	3829	512	129	22	22308
1981	38	7029	7578	2926	1111	161	17	18860
1982	169	35696	14358	1858	415	79	7	52583
1983	2668	19288	42837	3601	385	146	37	68963
1984	517	6200	19990	8129	878	245	16	35975
1985	2239	8074	2175	1968	1109	204	38	15807
1986	463	9970	3326	635	356	127	21	14897
1987	1594	3437	2368	926	167	55	9	8556
1988	5899	2109	536	506	134	26	6	9217
1989	24	19920	3347	462	48	3	0	23804
1990	192	2056	42644	2209	90	5	0	47197
1991	446	1610	5169	9703	168	34	17	17147
1992	477	1453	2097	2739	297	14	4	7082
1993	13	457	447	711	145	4	0	1777
1994	154	748	312	281	309	127	4	1934
1995	7	308	180	219	31	7	5	757
1996	22	427	626	249	60	17	5	1406
1997	2	103	1166	538	62	5	3	1878
1998	3	511	635	306	81	14	4	1554
1999	6	105	2321	288	103	13	5	2841
2000	35	567	1091	447	15	3	1	2160
2001	1	275	1413	424	129	32	19	2293
2002	8	372	931	383	50	9	5	1758
2003	4	94	566	231	69	13	5	982
2004	6	101	73	133	160	50	19	541
mean	1269	6710	6221	1986	588	318	112	17203

Table D4b. Mean weight at age (kg) of southern New England-Mid Atlantic yellowtail flounder catch.

Mean weight at age			Age				
Year	1	2	3	4	5	6	7+
1973	0.210	0.296	0.348	0.375	0.382	0.418	0.474
1974	0.203	0.308	0.352	0.396	0.439	0.431	0.477
1975	0.218	0.289	0.376	0.432	0.435	0.457	0.505
1976	0.228	0.303	0.408	0.498	0.499	0.543	0.548
1977	0.215	0.283	0.381	0.504	0.513	0.481	0.586
1978	0.234	0.293	0.383	0.536	0.662	0.686	0.636
1979	0.189	0.301	0.364	0.475	0.590	0.673	0.620
1980	0.206	0.281	0.384	0.500	0.682	0.874	1.132
1981	0.140	0.262	0.342	0.474	0.596	0.669	0.475
1982	0.226	0.263	0.353	0.499	0.660	0.822	0.956
1983	0.175	0.261	0.339	0.496	0.668	0.815	0.834
1984	0.182	0.237	0.295	0.388	0.487	0.652	0.662
1985	0.183	0.260	0.365	0.408	0.504	0.577	0.745
1986	0.186	0.284	0.331	0.463	0.587	0.614	0.804
1987	0.247	0.268	0.353	0.404	0.520	0.587	0.863
1988	0.270	0.293	0.396	0.493	0.611	0.795	0.937
1989	0.311	0.338	0.394	0.553	0.735	0.957	
1990	0.301	0.327	0.378	0.455	0.763	0.884	
1991	0.206	0.262	0.337	0.414	0.678	0.900	0.599
1992	0.167	0.316	0.368	0.434	0.599	0.804	1.375
1993	0.122	0.354	0.430	0.451	0.641	1.040	
1994	0.068	0.203	0.352	0.444	0.573	0.710	0.902
1995	0.123	0.299	0.401	0.458	0.663	0.720	0.743
1996	0.148	0.373	0.408	0.466	0.592	0.710	0.780
1997	0.140	0.288	0.415	0.478	0.583	0.912	0.996
1998	0.162	0.294	0.411	0.565	0.768	0.848	0.970
1999	0.221	0.290	0.441	0.562	0.673	1.020	1.098
2000	0.034	0.352	0.475	0.606	0.756	1.090	1.040
2001	0.153	0.378	0.438	0.622	0.763	0.938	
2002	0.161	0.355	0.474	0.640	0.843	1.028	1.329
2003	0.109	0.318	0.415	0.598	0.616	0.787	0.857
2004	0.153	0.292	0.422	0.501	0.563	0.732	0.653
mean	0.184	0.298	0.385	0.487	0.614	0.755	0.807

Table D5. Survey indices of southern New England yellowtail-Mid Atlantic abundance and biomass.

Fall Survey

year	age-0	age-1	age-2	age-3	age-4	age-5	age-6	age-7	age-8	age-9	sum	kg/tow
1963	0.030	14.778	12.274	9.972	4.944	0.683	0.059	0.082	0.000	0.000	42.822	14.023
1964	0.000	13.900	19.067	3.381	5.356	2.643	0.543	0.036	0.000	0.000	44.925	13.972
1965	0.166	22.272	12.835	4.327	1.489	1.184	0.146	0.000	0.000	0.000	42.418	10.228
1966	0.569	34.899	10.656	2.342	0.902	0.175	0.000	0.000	0.000	0.000	49.542	9.033
1967	0.177	23.579	29.045	12.719	1.212	0.260	0.047	0.124	0.000	0.000	67.164	14.018
1968	0.000	13.882	21.622	24.639	1.571	0.263	0.325	0.069	0.000	0.000	62.370	13.038
1969	0.056	10.440	11.316	33.936	4.454	0.049	0.019	0.019	0.000	0.000	60.288	14.472
1970	0.067	4.414	8.047	29.866	18.927	3.305	0.359	0.047	0.000	0.000	65.032	16.211
1971	0.000	14.540	12.485	6.886	12.452	1.909	0.162	0.123	0.000	0.000	48.556	8.975
1972	0.000	3.245	32.938	33.089	33.080	18.618	2.305	0.101	0.000	0.000	123.376	31.543
1973	0.000	1.779	1.747	4.086	2.318	1.564	0.768	0.162	0.000	0.000	12.422	3.125
1974	0.132	0.695	1.185	0.433	1.640	0.687	0.297	0.146	0.014	0.042	5.271	1.545
1975	0.000	1.533	0.416	0.136	0.217	0.213	0.048	0.070	0.000	0.000	2.634	0.602
1976	0.000	1.964	4.204	0.350	0.046	0.073	0.190	0.220	0.099	0.000	7.147	1.954
1977	0.028	2.289	1.439	0.519	0.044	0.040	0.035	0.065	0.000	0.000	4.459	1.125
1978	0.000	2.080	4.771	0.296	0.236	0.024	0.006	0.048	0.000	0.021	7.481	2.004
1979	0.000	1.493	3.283	1.579	0.241	0.026	0.026	0.000	0.000	0.000	6.646	1.818
1980	0.000	1.153	2.908	0.757	0.313	0.000	0.000	0.000	0.000	0.000	5.130	1.354
1981	0.000	9.511	9.498	1.251	0.198	0.103	0.037	0.000	0.000	0.000	20.597	4.046
1982	0.000	2.040	17.794	4.392	0.535	0.215	0.000	0.000	0.000	0.000	24.976	5.706
1983	0.000	1.920	11.278	5.593	0.458	0.038	0.000	0.026	0.000	0.000	19.314	4.490
1984	0.000	1.444	1.275	1.529	0.334	0.000	0.000	0.000	0.000	0.000	4.582	1.033
1985	0.000	0.869	0.375	0.134	0.080	0.000	0.000	0.000	0.000	0.000	1.458	0.298
1986	0.000	0.606	1.826	0.523	0.123	0.025	0.000	0.000	0.000	0.000	3.104	0.754
1987	0.073	1.067	0.451	0.359	0.030	0.024	0.000	0.024	0.000	0.000	2.028	0.401
1988	0.000	4.370	0.310	0.141	0.156	0.021	0.034	0.000	0.000	0.000	5.032	0.510
1989	0.000	0.198	10.492	1.370	0.072	0.000	0.000	0.000	0.000	0.000	12.132	2.359
1990	0.000	0.539	1.847	3.117	0.194	0.000	0.000	0.000	0.000	0.000	5.696	1.305
1991	0.000	0.588	0.243	1.516	0.367	0.000	0.000	0.000	0.000	0.000	2.713	0.755
1992	0.000	0.168	0.024	0.072	0.285	0.000	0.000	0.000	0.000	0.000	0.548	0.147
1993	0.000	0.332	0.028	0.130	0.104	0.000	0.000	0.000	0.000	0.000	0.594	0.116
1994	0.000	0.732	0.448	0.107	0.129	0.066	0.025	0.000	0.000	0.000	1.507	0.308
1995	0.000	0.139	0.645	0.257	0.115	0.000	0.000	0.025	0.028	0.000	1.209	0.304
1996	0.000	0.448	0.161	0.320	0.000	0.000	0.000	0.000	0.000	0.000	0.929	0.208
1997	0.000	0.822	0.519	1.459	0.271	0.024	0.000	0.000	0.000	0.000	3.095	0.851
1998	0.023	0.890	1.620	0.124	0.049	0.000	0.023	0.000	0.000	0.000	2.728	0.655
1999	0.000	1.238	0.392	0.279	0.028	0.028	0.000	0.000	0.000	0.000	1.964	0.468
2000	0.000	0.049	1.669	0.303	0.171	0.000	0.000	0.023	0.000	0.000	2.215	0.718
2001	0.000	0.390	0.611	0.158	0.071	0.000	0.000	0.000	0.000	0.000	1.231	0.419
2002	0.026	0.254	1.722	0.855	0.154	0.013	0.000	0.000	0.000	0.000	3.024	1.094
2003	0.588	1.170	0.000	0.302	0.204	0.000	0.050	0.000	0.000	0.000	2.313	0.433
2004	0.000	0.070	0.098	0.000	0.023	0.048	0.025	0.000	0.000	0.000	0.264	0.101
mean	0.046	4.733	6.037	4.610	2.228	0.770	0.132	0.034	0.003	0.001	18.594	4.441

Table D5 cont.

Spring Survey

year	age-1	age-2	age-3	age-4	age-5	age-6	age-7	age-8	age-9	age-10	age-11	sum	kg/tow
1968	1.014	29.910	38.854	13.103	1.076	0.040	0.184	0.000	0.000	0.000	0.000	84.181	18.645
1969	2.941	18.796	29.464	14.069	1.599	0.147	0.048	0.000	0.000	0.000	0.000	67.064	14.311
1970	1.045	7.311	18.942	16.237	3.518	0.656	0.123	0.005	0.022	0.000	0.000	47.860	12.066
1971	0.447	7.616	8.124	20.765	3.713	0.371	0.004	0.000	0.000	0.004	0.000	41.043	9.552
1972	0.196	12.355	11.201	5.986	9.887	2.394	0.303	0.000	0.000	0.000	0.000	42.321	10.815
1973	0.838	5.467	14.753	8.335	6.432	7.987	0.852	0.230	0.083	0.000	0.000	44.977	12.115
1974	0.511	2.188	2.607	5.016	2.891	1.154	1.291	0.145	0.027	0.000	0.000	15.830	4.918
1975	0.358	1.171	0.406	0.665	0.709	0.531	0.156	0.197	0.000	0.000	0.000	4.193	1.307
1976	0.016	4.182	0.536	0.256	0.245	0.338	0.096	0.031	0.000	0.000	0.000	5.699	1.666
1977	1.618	1.557	2.758	0.242	0.154	0.189	0.093	0.080	0.006	0.046	0.000	6.743	1.963
1978	2.681	10.302	1.791	0.778	0.253	0.126	0.123	0.158	0.010	0.000	0.000	16.221	3.513
1979	1.002	2.967	1.601	0.255	0.124	0.018	0.018	0.014	0.000	0.000	0.012	6.009	1.318
1980	0.683	6.353	4.298	2.684	0.261	0.070	0.005	0.009	0.015	0.001	0.005	14.384	4.830
1981	0.810	18.598	4.817	2.502	0.580	0.113	0.000	0.000	0.000	0.000	0.000	27.420	6.930
1982	0.149	17.329	5.610	1.406	0.467	0.135	0.017	0.000	0.000	0.000	0.000	25.114	5.865
1983	0.016	5.329	8.803	0.598	0.191	0.000	0.000	0.000	0.000	0.000	0.000	14.938	4.097
1984	0.038	0.453	0.902	2.110	0.354	0.262	0.000	0.000	0.000	0.000	0.000	4.119	1.302
1985	0.267	1.613	0.406	0.480	0.714	0.135	0.019	0.000	0.000	0.000	0.000	3.634	0.948
1986	0.016	2.893	0.916	0.237	0.124	0.016	0.000	0.000	0.000	0.000	0.000	4.201	1.052
1987	0.000	0.086	0.701	0.167	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.954	0.319
1988	0.285	0.357	0.125	0.174	0.294	0.029	0.000	0.000	0.000	0.000	0.000	1.263	0.378
1989	0.162	11.211	0.537	0.113	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.022	2.090
1990	0.090	0.485	15.349	2.194	0.079	0.000	0.000	0.000	0.000	0.000	0.000	18.197	5.064
1991	0.228	0.611	2.509	4.156	0.539	0.060	0.000	0.000	0.000	0.000	0.000	8.103	2.508
1992	0.036	0.051	0.571	1.597	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.255	0.794
1993	0.016	0.253	0.112	0.441	0.071	0.000	0.000	0.000	0.000	0.000	0.000	0.894	0.341
1994	0.016	0.269	0.016	0.000	0.068	0.019	0.000	0.000	0.000	0.000	0.000	0.389	0.136
1995	0.016	1.169	0.068	0.092	0.019	0.037	0.000	0.016	0.016	0.000	0.000	1.433	0.329
1996	0.000	0.398	1.303	0.566	0.072	0.000	0.000	0.000	0.000	0.000	0.000	2.339	0.747
1997	0.053	0.885	1.144	0.327	0.067	0.000	0.000	0.000	0.000	0.000	0.000	2.475	0.789
1998	0.068	3.016	0.386	0.161	0.036	0.021	0.000	0.000	0.000	0.000	0.000	3.688	0.848
1999	0.036	0.651	1.930	0.349	0.074	0.000	0.023	0.000	0.000	0.000	0.000	3.062	1.138
2000	0.019	1.245	1.006	0.559	0.043	0.000	0.000	0.000	0.000	0.000	0.000	2.873	0.990
2001	0.000	0.069	1.158	0.240	0.082	0.023	0.000	0.000	0.000	0.000	0.000	1.572	0.657
2002	0.049	1.191	0.235	0.200	0.067	0.000	0.000	0.000	0.000	0.000	0.000	1.742	0.510
2003	0.031	0.075	0.203	0.107	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.449	0.165
2004	0.016	0.136	0.302	0.092	0.035	0.000	0.019	0.000	0.000	0.000	0.000	0.600	0.232
2005	0.147	0.205	0.097	0.067	0.152	0.000	0.016	0.000	0.000	0.000	0.000	0.684	0.222
mean	0.419	4.704	4.856	2.824	0.922	0.391	0.089	0.023	0.005	0.001	0.000	14.235	3.565

Table D5 cont.

Winter Survey

year	age-1	age-2	age-3	age-4	age-5	age-6	age-7	age-8	sum	kg/tow
1992	0.011	1.619	3.477	8.063	0.959	0.000	0.000	0.000	14.129	5.264
1993	0.596	1.924	1.057	2.487	0.292	0.000	0.000	0.000	6.357	2.118
1994	0.366	8.654	0.742	1.654	0.966	0.353	0.118	0.000	12.854	3.924
1995	0.090	10.681	2.698	0.597	0.253	0.185	0.016	0.000	14.519	3.464
1996	0.041	1.285	8.235	0.851	0.140	0.065	0.015	0.015	10.648	3.346
1997	0.156	2.380	9.785	2.958	0.529	0.000	0.038	0.000	15.846	5.720
1998	0.118	7.841	1.596	1.158	0.112	0.000	0.018	0.000	10.843	2.780
1999	0.243	2.909	10.176	0.777	0.311	0.056	0.023	0.000	14.494	5.226
2000	0.109	4.917	3.006	1.160	0.073	0.100	0.000	0.000	9.364	3.025
2001	0.028	0.895	8.542	1.615	0.254	0.096	0.046	0.000	11.475	4.786
2002	0.012	2.735	2.578	2.047	0.100	0.020	0.000	0.000	7.492	2.589
2003	0.332	0.697	2.597	0.529	0.043	0.000	0.026	0.000	4.224	1.544
2004	0.051	0.962	0.319	0.589	0.143	0.044	0.000	0.000	2.107	0.83
2005	0.402	0.769	0.616	0.519	0.586	0.032	0.043	0.000	2.967	0.95
mean	0.182	3.448	3.959	1.786	0.340	0.068	0.024	0.001	9.808	3.255

Scallop Survey

year	all	age-1
1982	3.123	0.362
1983	0.858	0.255
1984	0.309	0.180
1985	0.577	0.465
1986	0.199	0.015
1987	0.150	0.054
1988	7.482	7.359
1989	3.774	0.579
1990	0.370	0.158
1991	0.230	0.151
1992	0.169	0.108
1993	0.192	0.170
1994	0.732	0.573
1995	0.507	0.072
1996	38.479	0.120
1997	0.886	0.736
1998	0.567	0.253
1999	0.456	0.357
2000	0.432	0.082
2001	0.106	0.063
2002	0.152	0.020
2003	0.219	0.123
2004	0.137	0.054
mean	2.613	0.535

Table D6. VPA results for southern New England-Mid Atlantic yellowtail flounder.

Abundance (thousands)				Age				
	1	2	3	4	5	6	7	Total
1973	43,474	17,865	28,167	16,418	8,974	10,043	1,857	126,798
1974	10,625	35,395	9,531	12,247	6,223	2,618	2,867	79,507
1975	31,495	7,920	3,174	2,776	3,358	1,759	1,466	51,948
1976	14,570	17,724	2,748	894	1,250	1,305	1,146	39,637
1977	50,332	11,735	8,470	1,181	436	617	701	73,472
1978	54,235	36,220	5,060	2,509	508	105	205	98,842
1979	32,063	36,533	16,814	2,184	724	193	57	88,569
1980	44,421	26,066	12,340	5,924	827	196	58	89,832
1981	138,444	35,458	12,098	4,136	1,386	214	29	191,765
1982	64,210	113,314	22,671	3,048	738	129	11	204,121
1983	16,677	52,417	60,475	5,570	814	229	72	136,254
1984	19,160	11,240	25,463	10,752	1,302	318	39	68,274
1985	20,990	15,219	3,592	2,760	1,447	271	56	44,336
1986	7,288	15,159	5,155	973	479	182	31	29,267
1987	15,034	5,548	3,390	1,211	222	70	13	25,488
1988	124,006	10,867	1,432	633	153	31	7	137,129
1989	17,618	96,190	6,989	688	60	4	-	121,548
1990	8,064	14,402	60,729	2,693	145	6	-	86,040
1991	3,901	6,429	9,931	11,135	206	37	19	31,659
1992	2,265	2,791	3,807	3,454	337	17	5	12,675
1993	2,032	1,423	970	1,219	349	7	-	6,001
1994	2,946	1,652	752	390	355	155	5	6,254
1995	3,389	2,273	676	333	65	11	12	6,759
1996	1,941	2,769	1,582	390	74	25	9	6,791
1997	5,777	1,569	1,880	729	94	7	8	10,065
1998	3,011	4,728	1,192	484	110	21	6	9,553
1999	4,278	2,463	3,409	401	120	17	6	10,694
2000	3,027	3,497	1,921	691	68	5	3	9,212
2001	1,864	2,447	2,350	586	161	42	25	7,474
2002	802	1,525	1,754	646	96	15	8	4,846
2003	1,887	649	912	594	182	33	13	4,270
2004	1,231	1,541	447	235	277	87	33	3,849
2005	---	1,002	1,170	300	72	85	37	---
mean	23,471	18,062	9,729	2,975	958	571	267	56,967

Table D6 cont.

Fishing Mortality	Age							
	1	2	3	4	5	6	7	4-6
1973	0.01	0.43	0.63	0.77	1.03	0.86	0.86	0.89
1974	0.09	2.21	1.03	1.09	1.06	1.08	1.08	1.08
1975	0.37	0.86	1.07	0.60	0.75	0.68	0.68	0.67
1976	0.02	0.54	0.64	0.52	0.51	0.51	0.51	0.51
1977	0.13	0.64	1.02	0.64	1.22	0.77	0.77	0.88
1978	0.20	0.57	0.64	1.04	0.77	0.99	0.99	0.93
1979	0.01	0.89	0.84	0.77	1.10	0.84	0.84	0.91
1980	0.03	0.57	0.89	1.25	1.15	1.24	1.24	1.21
1981	0.00	0.25	1.18	1.52	2.17	1.65	1.65	1.78
1982	0.00	0.43	1.20	1.12	0.97	1.09	1.09	1.06
1983	0.19	0.52	1.53	1.25	0.74	1.17	1.17	1.05
1984	0.03	0.94	2.02	1.81	1.37	1.75	1.75	1.64
1985	0.13	0.88	1.11	1.55	1.88	1.65	1.65	1.69
1986	0.07	1.30	1.25	1.28	1.72	1.40	1.40	1.47
1987	0.12	1.15	1.48	1.87	1.78	1.85	1.85	1.83
1988	0.05	0.24	0.53	2.15	3.38	2.30	2.30	2.61
1989	0.00	0.26	0.75	1.36	2.12	1.40	1.40	1.62
1990	0.03	0.17	1.50	2.37	1.16	2.26	2.26	1.93
1991	0.14	0.32	0.86	3.30	2.30	3.27	3.27	2.96
1992	0.26	0.86	0.94	2.09	3.65	2.16	2.16	2.63
1993	0.01	0.44	0.71	1.03	0.61	0.92	0.92	0.86
1994	0.06	0.69	0.61	1.59	3.28	2.09	2.09	2.32
1995	0.00	0.16	0.35	1.30	0.75	1.19	1.19	1.08
1996	0.01	0.19	0.57	1.22	2.21	1.33	1.33	1.59
1997	0.00	0.08	1.16	1.69	1.30	1.64	1.64	1.54
1998	0.00	0.13	0.89	1.20	1.68	1.27	1.27	1.38
1999	0.00	0.05	1.40	1.58	3.01	1.77	1.77	2.12
2000	0.01	0.20	0.99	1.26	0.28	1.12	1.12	0.88
2001	0.00	0.13	1.09	1.61	2.17	1.71	1.71	1.83
2002	0.01	0.31	0.88	1.07	0.86	1.04	1.04	0.99
2003	0.00	0.17	1.16	0.56	0.54	0.56	0.56	0.55
2004	0.01	0.08	0.20	0.99	0.99	0.99	0.99	0.99
mean	0.06	0.52	0.97	1.36	1.52	1.39	1.39	1.42

Table D6 cont.

Spawning Biomass (mt)	Age							
	1	2	3	4	5	6	7	Total
1973	1,089	3,012	6,789	4,110	2,052	2,705	580	20,337
1974	248	2,953	1,966	2,829	1,614	661	808	11,079
1975	702	1,090	690	860	985	558	519	5,404
1976	395	2,921	773	330	465	527	488	5,899
1977	1,227	1,731	1,905	419	124	198	279	5,883
1978	1,399	5,704	1,338	801	225	44	80	9,591
1979	723	5,177	3,883	692	248	84	23	10,830
1980	1,083	3,936	2,945	1,617	321	94	35	10,031
1981	2,318	5,706	2,283	956	307	66	7	11,643
1982	1,734	16,976	4,369	878	299	62	6	24,324
1983	322	7,494	9,782	1,507	368	105	34	19,612
1984	412	1,225	2,916	1,809	330	92	6	6,790
1985	436	1,865	746	543	307	72	17	3,986
1986	157	1,707	914	243	126	57	12	3,216
1987	422	626	583	207	51	17	4	1,910
1988	3,915	1,960	409	117	21	9	2	6,433
1989	655	19,863	1,814	199	17	2	-	22,550
1990	287	2,985	11,095	420	63	2	-	14,852
1991	91	1,002	2,112	1,073	49	8	3	4,338
1992	41	420	854	577	41	5	2	1,940
1993	30	286	280	329	160	5	-	1,090
1994	23	171	185	82	48	42	2	553
1995	50	432	211	82	29	4	5	813
1996	34	650	458	101	16	9	4	1,272
1997	97	298	435	158	29	3	5	1,025
1998	58	898	305	153	39	10	3	1,466
1999	113	477	757	108	21	8	3	1,487
2000	12	772	545	228	42	3	2	1,604
2001	34	596	589	171	46	18	11	1,465
2002	15	323	519	244	52	9	7	1,169
2003	25	131	211	259	82	19	8	735
2004	22	297	156	72	95	39	13	694
mean	568	2,928	1,963	693	271	173	93	6,688

Figure D1. Total catch of southern New England-Mid Atlantic yellowtail flounder.

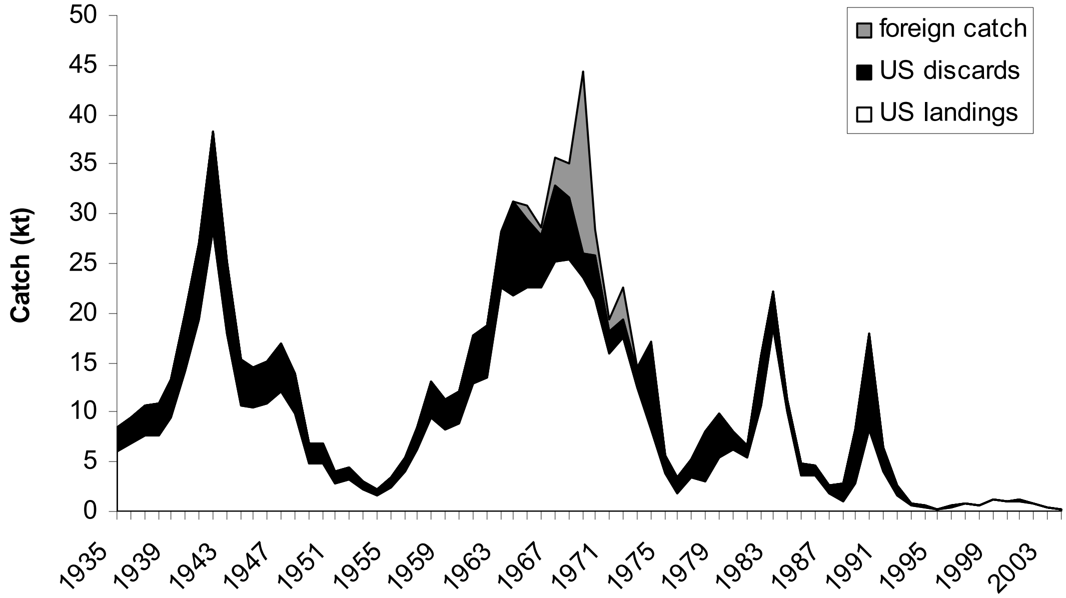


Figure D2. Geographic coverage of the southern New England-Mid Atlantic yellowtail flounder industry-based survey (labels indicate stratum numbers, random tows from the spring 2005 survey).

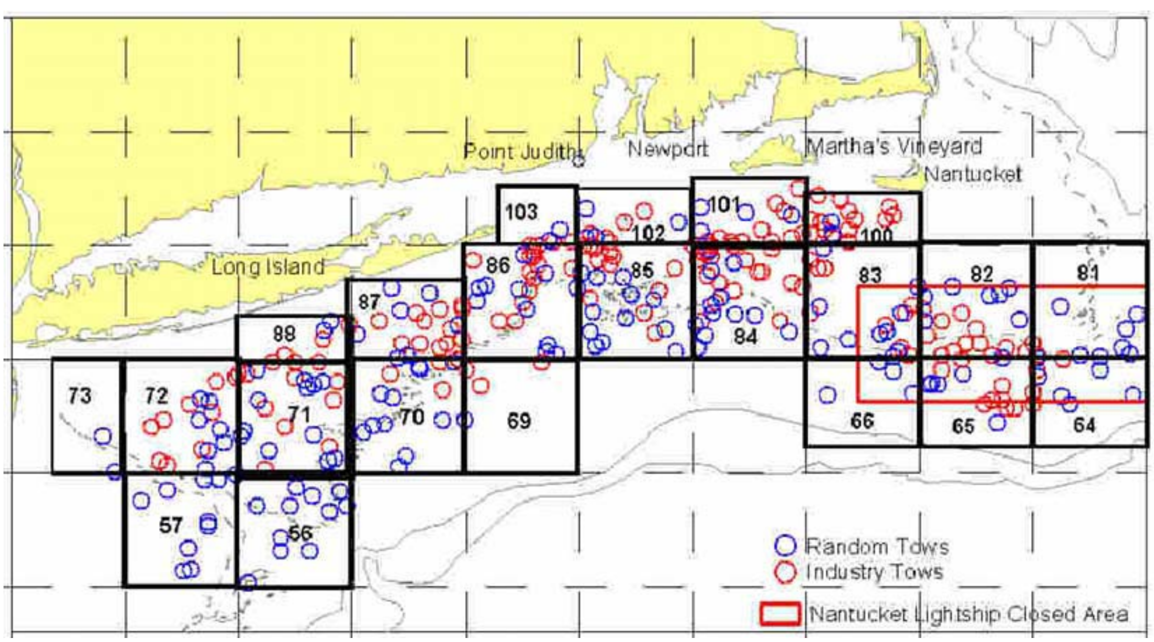


Figure D3. Age distribution of southern New England-Mid Atlantic yellowtail flounder catch.

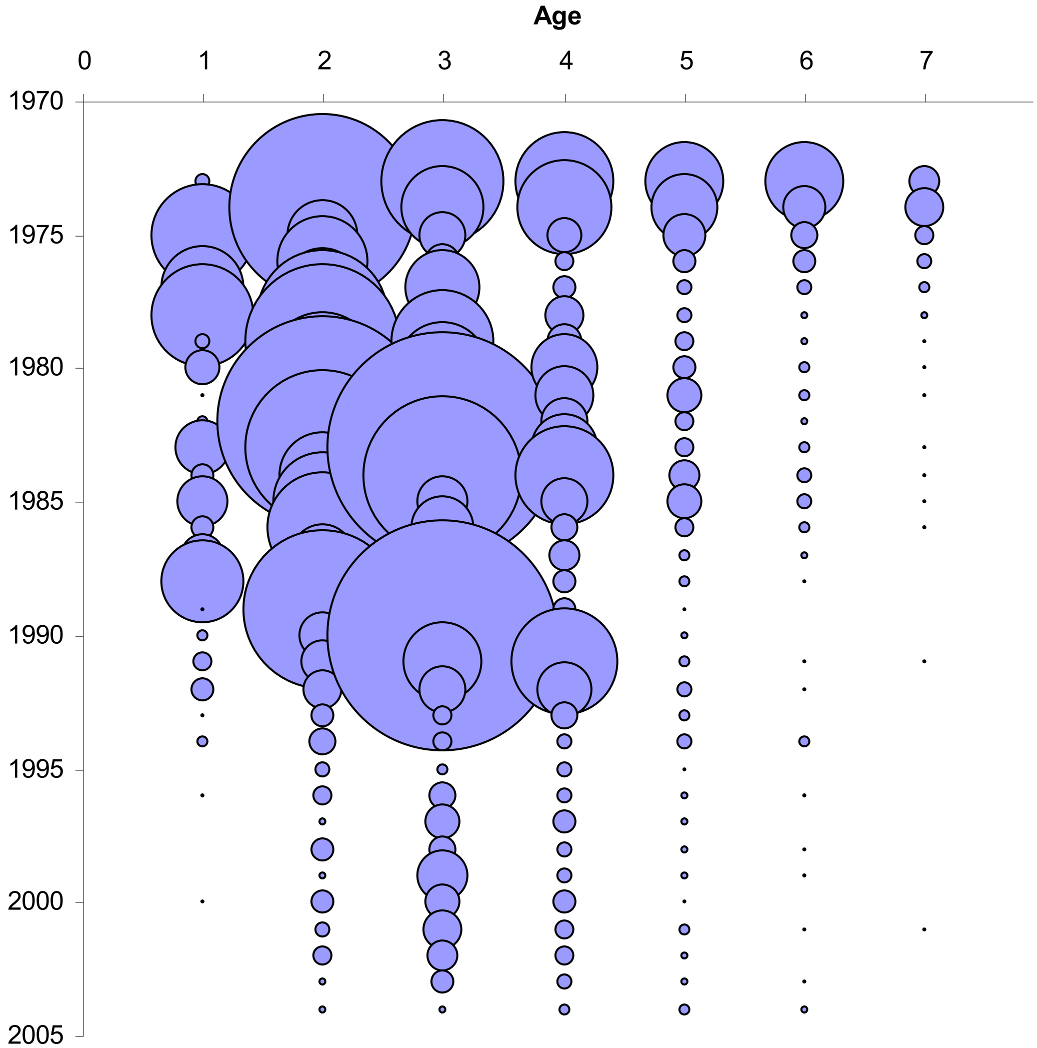


Figure D4. Survey indices of southern New England-Mid Atlantic yellowtail flounder biomass.

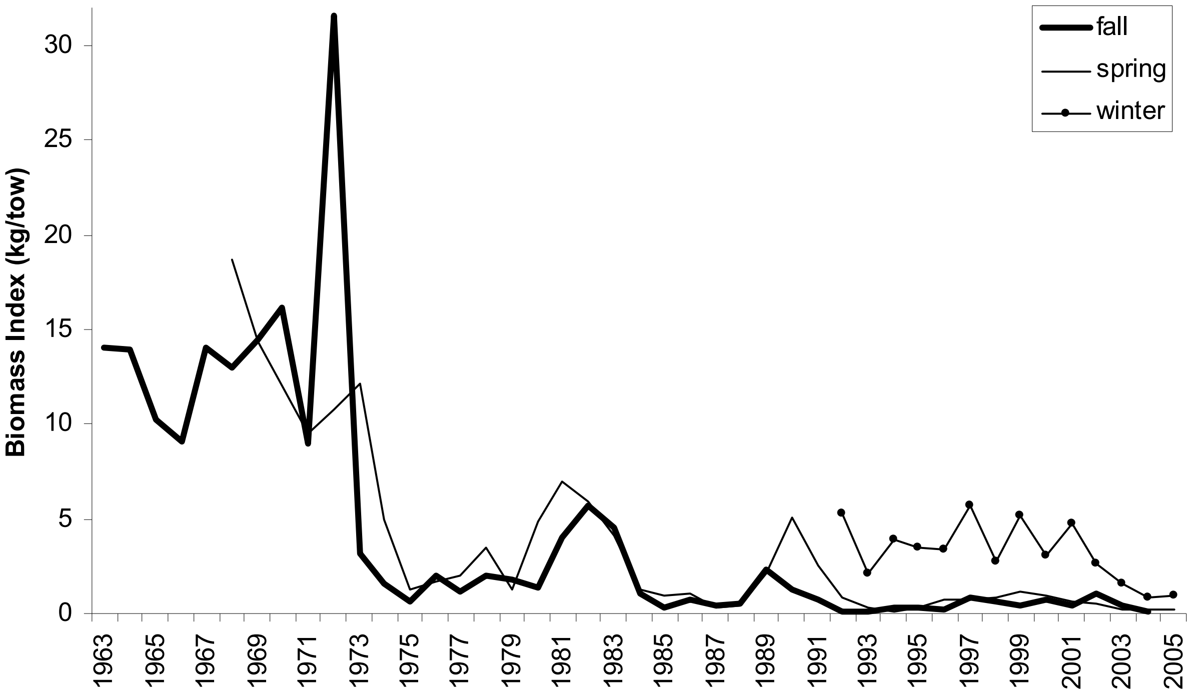


Figure D5. Survey indices of southern New England-Mid Atlantic yellowtail flounder abundance at age (relative circle size indicates relative abundance).

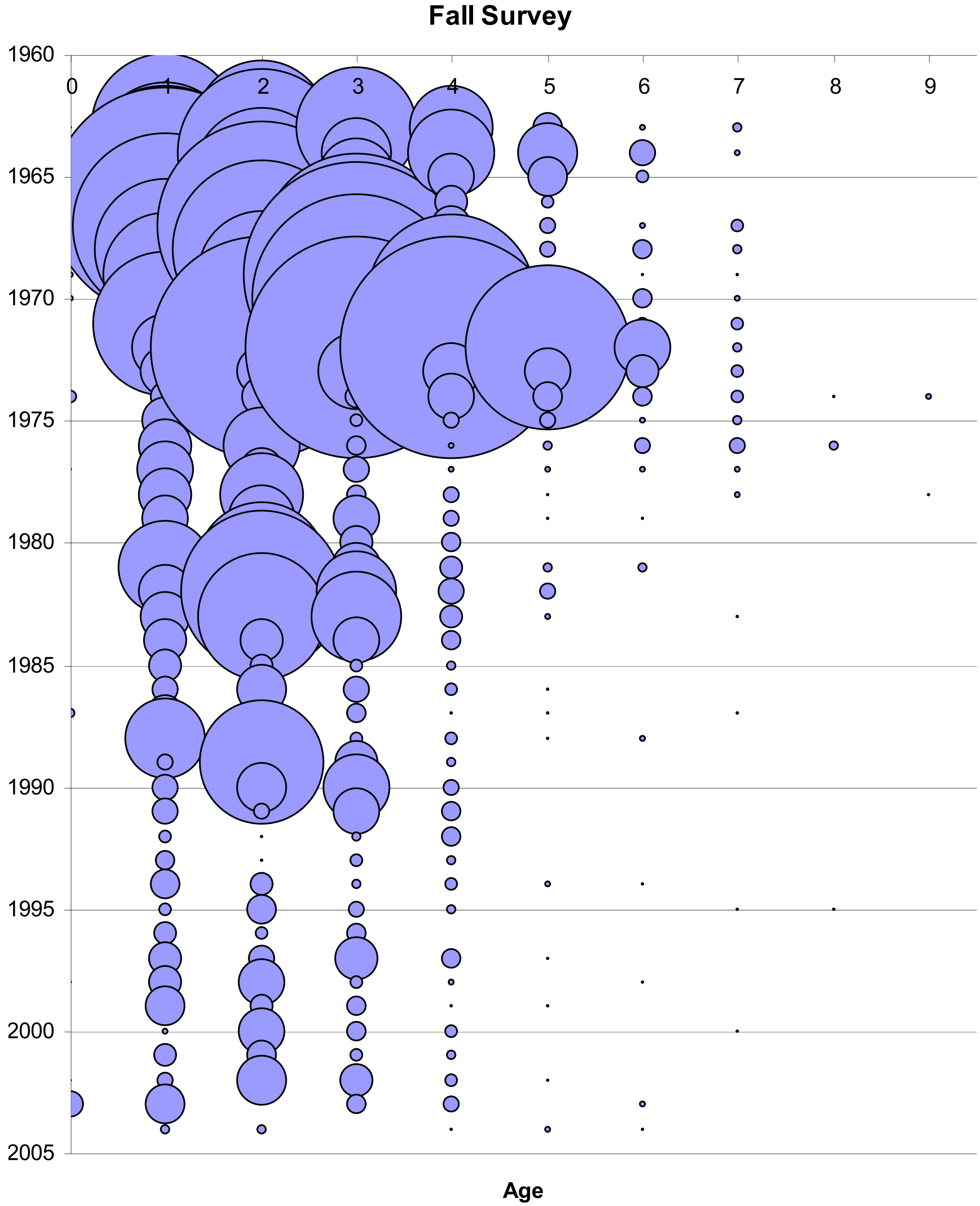


Figure D5, cont.

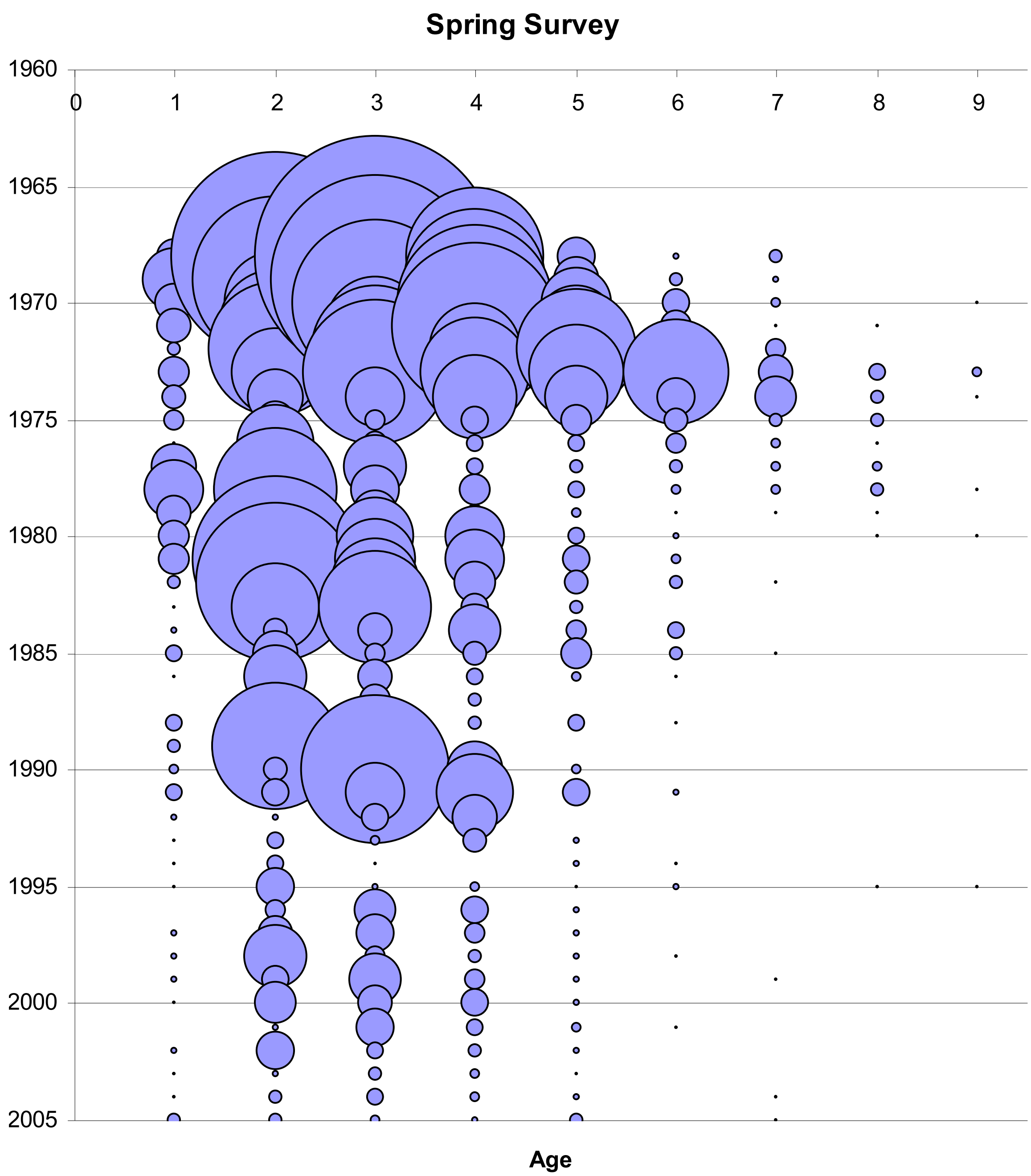


Figure D5, cont.

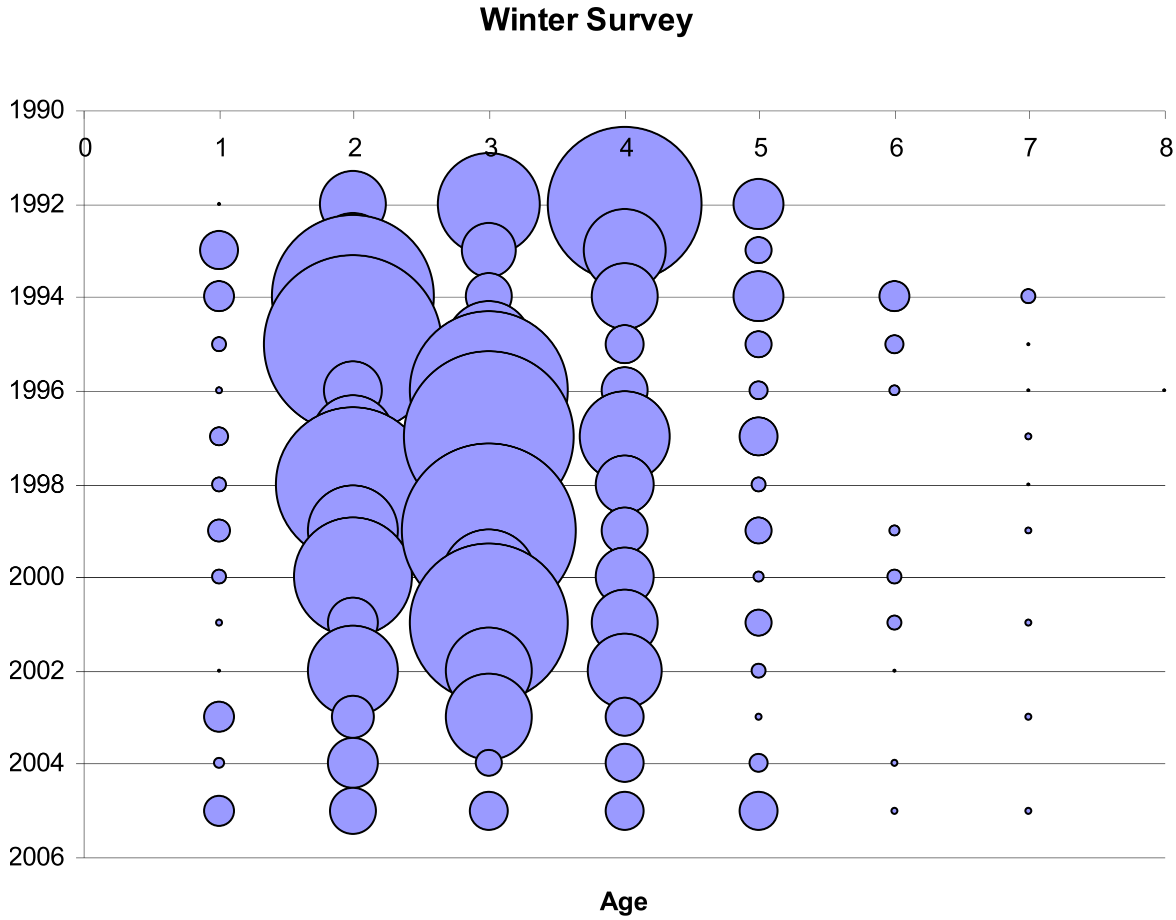
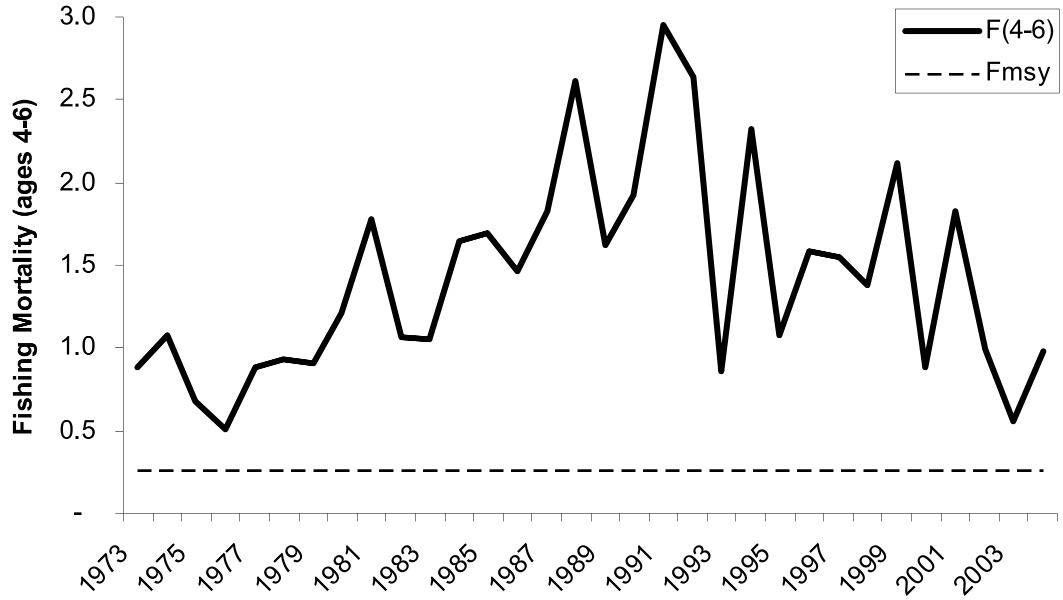


Figure D6. Summary of southern New England-Mid Atlantic yellowtail flounder VPA results.



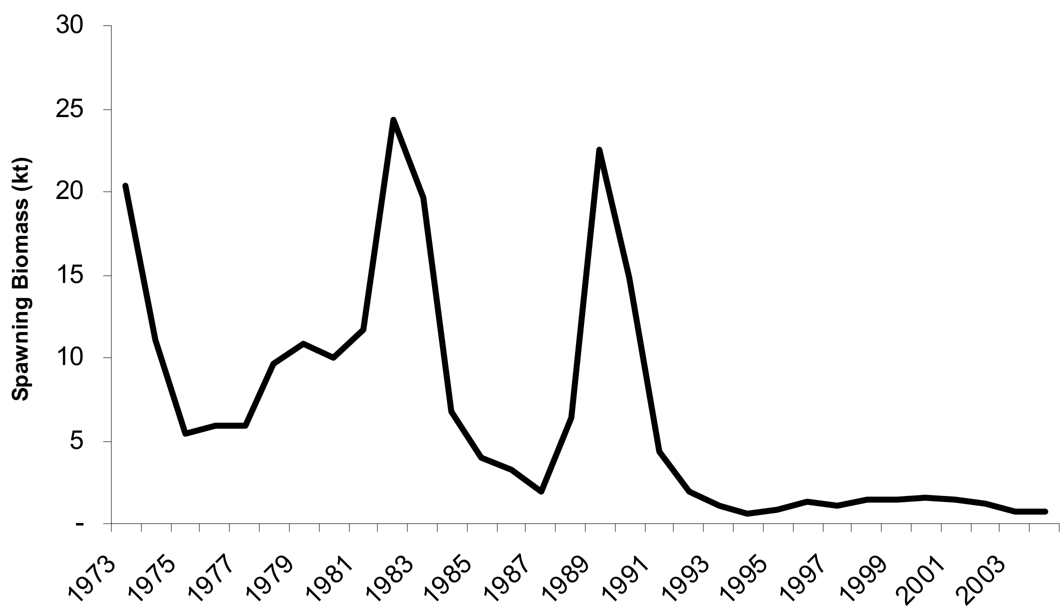


Figure D6 cont.

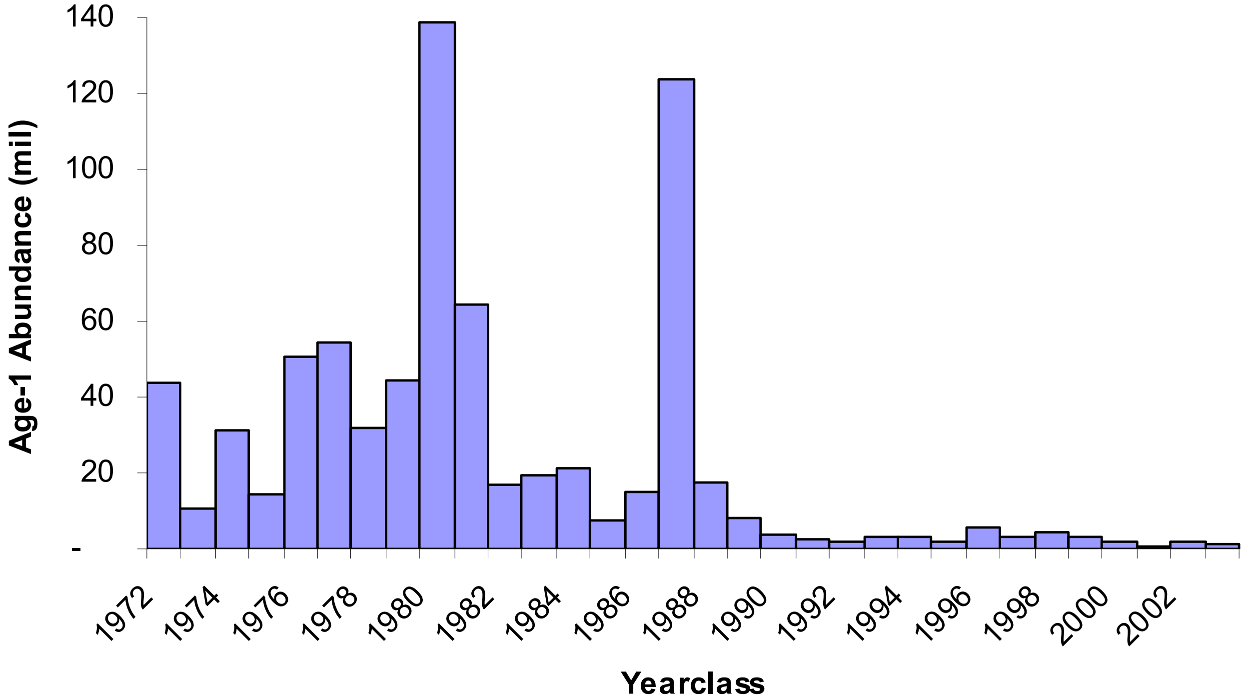
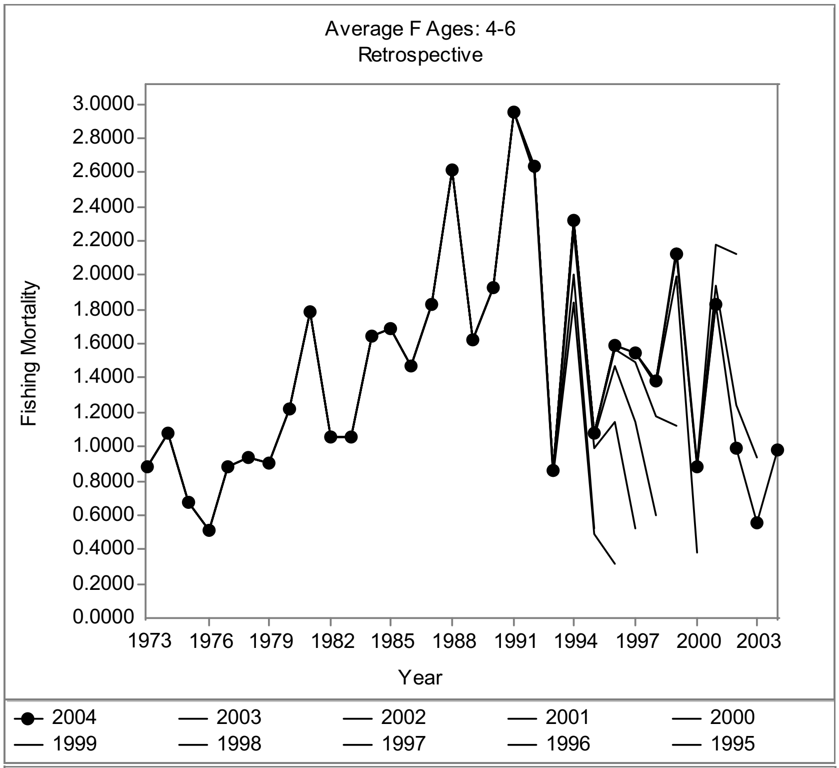


Figure D7. Retrospective analysis of the southern New England-Mid Atlantic yellowtail flounder VPA.



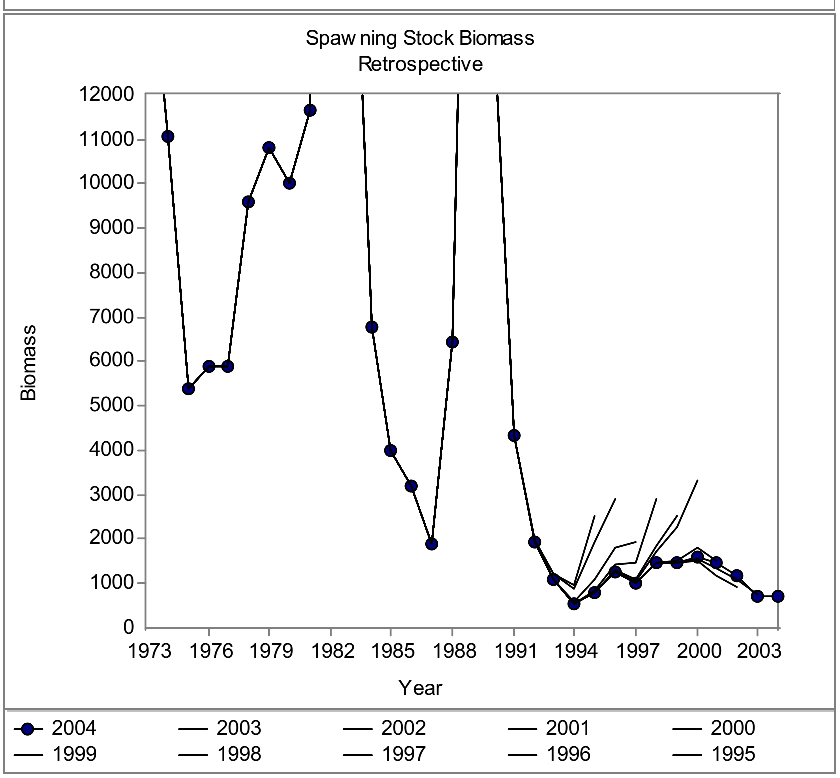


Figure D8. Rebuilding status of Southern New England-Mid Atlantic yellowtail flounder.

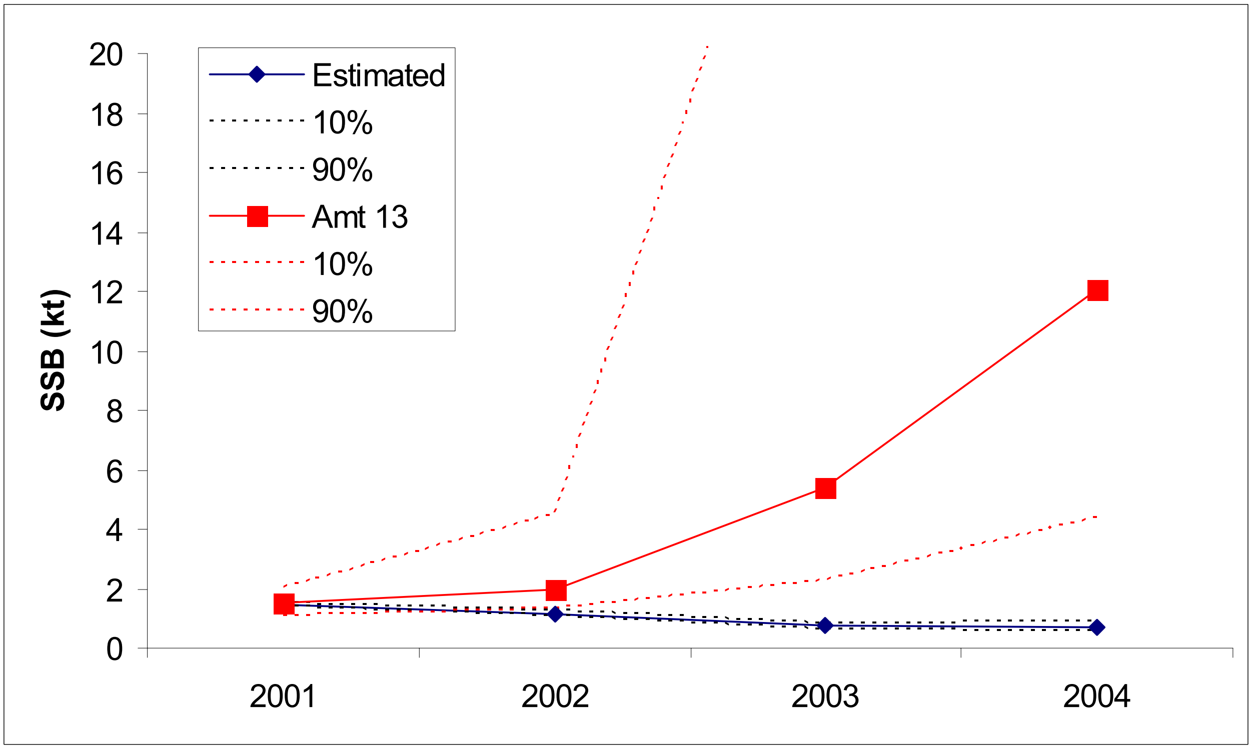


Figure D9. Comparison to rebuilding plan for Southern New England-Mid Atlantic yellowtail flounder.

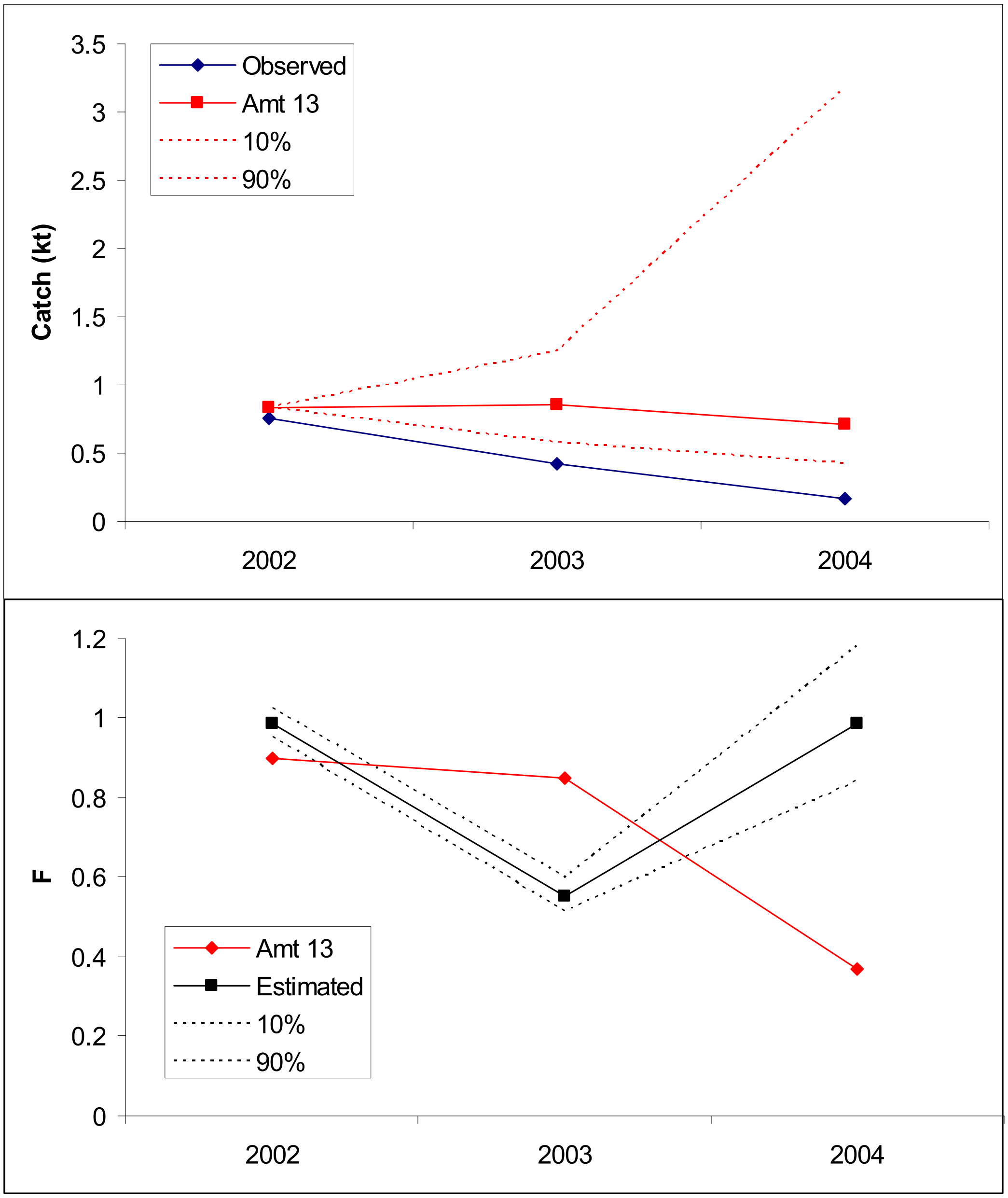
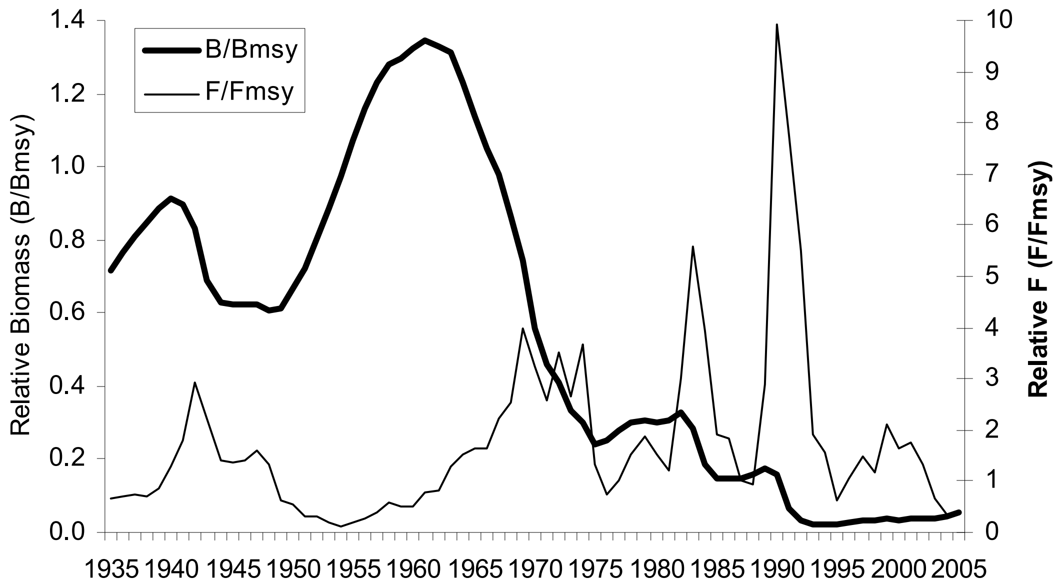
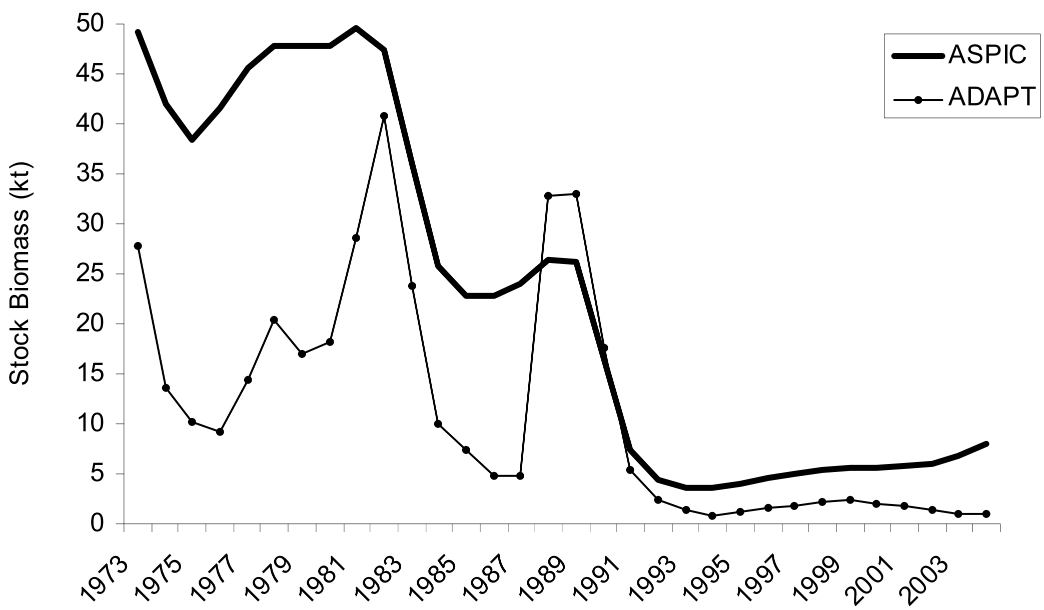


Figure D10. Mean biomass of southern New England-Mid Atlantic yellowtail flounder and fishing mortality on biomass estimated by ASPIC.





E. Cape Cod-Gulf of Maine Yellowtail Flounder by **S.X. Cadrin, C.M. Legault and J. King**

1.0 Background

The Cape Cod-Gulf of Maine yellowtail flounder stock was at low biomass and was overexploited in 2001 (SSB was 3,200 mt and fully recruited F was 0.75; Cadrin and King 2003). This report updates catch and survey indices and estimates 2004 fishing mortality and 2005 abundance.

2.0 2005 Assessment

2.1 2002-2004 Landings

U.S. landings were prorated as described in Cadrin et al. (1999; Table E1; Figure E1). Landings steadily declined from 2,505 in 2001 to 829mt in 2004. Sampling intensity was similar to recent years (Table E2) and was used to derive landings at age.

2.2 2002-2004 Discards

Estimates of discarded catch for 2002-2004 were derived from observer data by fishery as described by Cadrin and King (2003). The number of observed trips, lengths and ages for 2002-2004 increased substantially (Table E3). Discard rates varied between 5% and 14% of total catch for 2002-2004 (Table E1). Discards at age were estimated from observer lengths and age-length keys and 2004 survey keys. Total catch at age and mean weights at age are reported in Table E4 and Figure E2.

2.3 2002-2005 Survey Indices

Survey abundance and biomass indices are reported in Table E5. Estimates are from valid tows in the Cape Cod-Gulf of Maine area [offshore strata 25-27, 39, 40 (stratum 27 excluded from the fall series); inshore strata 56-66; Massachusetts strata 17-36] standardized according to net, vessel, and door changes (NEFSC 1998). Survey data generally indicate a decrease in biomass since the 2003 stock assessment with weak recruitment (Figures E3 and E4).

3.0 Assessment Results

Results of an updated VPA calibration of Cape Cod yellowtail are summarized in Table E6. This analysis updates the assessment reported in Cadrin and King (2003) by including 2002-2004 landings and discards, 2002-2004 fall indices, and 2003-2005 spring indices. Results indicate that F remained high during 2002-2004 (averaging 0.87), age-1 recruitment decreased to the lowest in the time series in 2002 and 2003, and SSB decreased to 1,100mt in 2004 (Figure E5). Retrospective analysis indicates a tendency toward underestimating F and overestimating SSB in the most recent years, but improved consistency in 2003 (Figure E6). Bootstrap analysis indicates that abundance was estimated with moderate precision (CV=31-47%).

Reference points for status determination were estimated by from yield and SSB per recruit analyses and the assumption of constant recruitment (Cadrin and King 2003). Assuming that F_{MSY} is approximately $F_{40\%}$ (0.17 on fully-recruited ages) and long-term average recruitment (10.5 million at age-1), MSY=2,300 mt and SSB_{MSY}=12,600 mt. Therefore, the stock is overfished (2004 SSB=9%SSB_{MSY}) and overfishing is occurring (2004 F=4 · F_{MSY}). The estimate of 2004 fishing mortality (0.75) is nearly three times the F desired for the rebuilding program (0.26), and 2004 SSB is approximately 25% of the projected value (Figures E7 and E8).

5.0 Sources of Uncertainty

- Estimates of prorated landings and discard ratios are based on preliminary logbook and data and are subject to change.

6.0 GARM Discussion

The use of age data for estimation of landings at age was discussed. Given the increased number of port samples, only dedicated port samples were used to characterize age at length. Including observer and survey age data could misclassify age distribution of length distributions from port samples. There are indications that yellowtail exhibit demographic changes over small geographic areas, which could make borrowing samples for age keys problematic. The Panel supported the decision to use port samples only.

Projection Advice - An increase in weight at age in recent years was noted. The group decided to use the most recent three-year averages of weight at age for projections (excluding the 2002 weight of age-1 which is based on few fish). Similarly, the group decided to use the most recent three-year averages of partial recruitment for projections. Given the noisy relationship of stock-recruitment and production of the large 1987 cohort from low SSB, the group decided to use the entire series of recruitment observations (age-1 abundance, 1985–2004) for projections.

7.0 References

Cadrin, S.X., J. King, and L. Suslowicz. 1999. Status of the Cape Cod yellowtail flounder stock for 1998. NEFSC Ref. Doc. 99-04.

Cadrin, S.X. and J. King 2003. Stock assessment of yellowtail flounder in the Cape Cod-Gulf of Maine area. NEFSC Ref. Doc. 03-03.

Table E1. Total catch of Cape Cod-Gulf of Maine yellowtail flounder (mt).

year	landings	discards	total catch	%discard
1935	400	100	500	20%
1936	400	100	500	20%
1937	500	200	700	29%
1938	500	200	700	29%
1939	600	200	800	25%
1940	900	300	1200	25%
1941	1300	400	1700	24%
1942	1512	500	2012	25%
1943	1334	400	1734	23%
1944	1531	500	2031	25%
1945	1214	400	1614	25%
1946	1214	400	1614	25%
1947	1122	300	1422	21%
1948	710	200	910	22%
1949	1221	400	1621	25%
1950	1387	400	1787	22%
1951	862	200	1062	19%
1952	837	200	1037	19%
1953	840	200	1040	19%
1954	1114	300	1414	21%
1955	1320	400	1720	23%
1956	1426	400	1826	22%
1957	2426	700	3126	22%
1958	1639	500	2139	23%
1959	1564	500	2064	24%
1960	1539	500	2039	25%
1961	1822	600	2422	25%
1962	1900	600	2500	24%
1963	3600	1000	4600	22%
1964	1857	600	2457	24%
1965	1506	500	2006	25%
1966	1835	300	2135	14%
1967	1591	800	2391	33%
1968	1581	600	2181	28%
1969	1422	300	1722	17%
1970	1310	400	1710	23%
1971	1718	700	2418	29%
1972	1521	300	1821	16%
1973	1724	0	1724	0%
1974	2158	200	2358	8%
1975	2220	0	2220	0%
1976	3845	100	3945	3%
1977	3722	0	3722	0%
1978	4071	400	4471	9%
1979	4439	500	4939	10%
1980	5567	600	6167	10%
1981	3574	600	4174	14%
1982	3635	400	4035	10%
1983	2209	300	2509	12%
1984	1365	20	1385	1%
1985	1171	154	1326	12%
1986	1205	367	1572	23%
1987	1353	271	1624	17%
1988	1275	355	1630	22%
1989	1117	437	1555	28%
1990	3222	1239	4461	28%
1991	1737	515	2251	23%
1992	1031	715	1746	41%
1993	786	145	932	16%
1994	1299	281	1580	18%
1995	1330	349	1680	21%
1996	1171	237	1408	17%
1997	1114	283	1398	20%
1998	1243	297	1540	19%
1999	1211	147	1357	11%
2000	2413	196	2609	8%
2001	2505	483	2988	16%
2002	2024	103	2127	5%
2003	1802	165	1967	8%
2004	829	133	962	14%
mean	1706	366	2072	19%

Table E2. Samples of Cape Cod-Gulf of Maine yellowtail flounder (ages used to categorized pooled market categories).

year	half	category	landings mt	samples lengths	ages	kg	% of landings
2002	Jan-Jun	unlassified	181	304	346	131	0.07%
		large	320	295		170	0.05%
		small	194	655		277	0.14%
	Jul-Dec	unlassified	177	225	676	86	0.05%
		large	584	990		536	0.09%
		small	568	1640		651	0.11%
2003	Jan-Jun	unlassified	339	565	512	253	0.07%
		large	297	352		238	0.08%
		small	281	1194		495	0.18%
	Jul-Dec	unlassified	236	421	900	186	0.08%
		large	367	1452		776	0.21%
		small	283	1233		484	0.17%
2004	Jan-Jun	unlassified	165	263	539	107	0.06%
		large	211	338		253	0.12%
		small	156	647		281	0.18%
	Jul-Dec	unlassified	77	162	204	57	0.07%
		large	88	267		148	0.17%
		small	132	349		140	0.11%

Table E3. Discard estimates and sample sizes for Cape Cod-Gulf of Maine yellowtail flounder, 2002-2004.

Large-Mesh Trawl Fishery

year	half	observed trips w/YT	kept (mt)	discard (mt)	d/k	landings (mt)	% observed	discards (mt)	discard lengths	observer ages all
2002	Jan-Jun	53	3.059	0.257	0.0839	602.7	0.51%	50.6	250	431
	Jul-Dec	149	55.325	2.108	0.0381	1290.8	4.29%	49.2	3380	1912
2003	Jan-Jun	101	29.415	2.524	0.0858	701.6	4.19%	60.2	3208	1638
	Jul-Dec	124	15.996	1.754	0.1096	846.3	1.89%	92.8	1378	426
2004	Jan-Jun	78	13.785	2.147	0.1557	359.5	3.83%	56.0	1575	296
	Jul-Dec	211	19.767	4.358	0.2205	284.2	6.96%	62.7	4656	169

Gillnet Fishery

year	half	observed trips w/YT	observed kept (mt)	discard (mt)	d/k	landings (mt)	% observed	discards (mt)	discard lengths
2002	Jan-Jun	68	7.905	0.059	0.0075	77.3	10.23%	0.6	15
	Jul-Dec	75	1.156	0.027	0.0233	38.4	3.01%	0.9	55
2003	Jan-Jun	120	10.805	0.412	0.0382	213.4	5.06%	8.1	660
	Jul-Dec	81	0.496	0.019	0.0384	38.4	1.29%	1.5	24
2004	Jan-Jun	168	15.608	0.710	0.0455	171.0	9.13%	7.8	1742
	Jul-Dec	179	2.222	0.472	0.2124	10.3	21.51%	2.2	1010

Small Mesh Trawl Fishery

year	half	observed trips w/YT	observed kept (mt)	discard (mt)	d/k	landings (mt)	% observed	discards (mt)	discard lengths
2002	Jan-Jun	4	0.976	0.002	0.0019	0.4		0.0	0
	Jul-Dec	21	12.983	0.716	0.055	1.2		0.1	619
2003	Jan-Jun	13	0.050	0.020	0.4082	1.2	4.1%	0.5	54
	Jul-Dec	7	0.199	0.139	0.6998	0.6	35.5%	0.4	187
2004	Jan-Jun	11	0.499	0.199	0.3978	1.6	31.8%	0.6	119
	Jul-Dec	22	1.213	0.360	0.2965	2.7	45.3%	0.8	273

Dredge Fishery

year	half	observed trips w/YT	effort (d) all obs trips	discard (mt)	d/e	total effort (d)	% observed	discards (mt)	discard lengths
2002	Jan-Jun	0	0	**	0.0038	312	0.00%	1.2	0 **
	Jul-Dec	4	9.03	0.034	0.0038	197	4.58%	0.7	85
2003	Jan-Jun	3	5.24	0.032	0.0061	276	1.90%	1.7	37
	Jul-Dec	1	14.18	0.001	0.0001	223	6.35%	0.0	0
2004	Jan-Jun	1	0.17	0.002	0.0106	104	0.16%	1.1	5
	Jul-Dec	14	5.47	0.194	0.0354	45	12.05%	1.6	406

* survey ages

**Jul-Aug estimates used

Table E4. Catch at age (above) and mean weights at age (below) of Cape Cod-Gulf of Maine yellowtail flounder.

Total catch at age (thousands) age

	1	2	3	4	5	6	7	8+	sum
1985	686	1245	907	635	329	109	3	8	3924
1986	95	4225	785	304	40	7	0	1	5457
1987	19	1885	2331	309	116	34	13	6	4714
1988	452	2582	1503	744	199	41	0	0	5520
1989	118	2297	1812	298	38	4	2	2	4571
1990	84	2897	9400	493	35	18	7	4	12938
1991	465	1372	1765	1953	298	39	34	1	5927
1992	1709	3979	1961	731	191	7	6	1	8585
1993	159	425	1074	795	111	29	17	8	2619
1994	75	535	1653	1031	367	143	79	10	3893
1995	458	751	2754	1069	239	85	5	0	5361
1996	7	592	1593	1077	339	12	5	3	3628
1997	2	912	1574	889	195	14	0	1	3586
1998	108	707	2299	563	163	44	3	0	3888
1999	17	564	1549	770	122	52	3	0	3076
2000	9	1144	3059	1310	158	22	13	4	5718
2001	20	1705	3811	1261	173	29	13	1	7014
2002	47	1166	2513	1002	60	13	1	0	4802
2003	0	589	1858	1152	154	39	11	10	3814
2004	0	71	938	422	239	70	11	1	1752
mean	227	1482	2257	840	178	41	11	3	5039

Weight at age (kg) age

	1	2	3	4	5	6	7	8+
1985	0.132	0.266	0.357	0.489	0.600	0.727	1.195	1.392
1986	0.103	0.250	0.428	0.534	0.730	0.906		1.397
1987	0.056	0.232	0.393	0.548	0.652	0.821	1.036	1.193
1988	0.123	0.206	0.338	0.523	0.696	0.841		
1989	0.129	0.270	0.383	0.650	0.928	1.410	1.239	1.239
1990	0.079	0.254	0.370	0.550	0.824	0.911	0.990	1.222
1991	0.124	0.236	0.342	0.517	0.737	0.984	1.063	1.087
1992	0.053	0.135	0.325	0.498	0.602	0.741	1.524	1.908
1993	0.089	0.160	0.358	0.418	0.737	0.949	1.008	1.167
1994	0.085	0.220	0.365	0.458	0.572	0.584	0.851	1.108
1995	0.072	0.220	0.322	0.410	0.529	0.781	1.115	
1996	0.040	0.190	0.383	0.469	0.528	0.910	1.190	1.181
1997	0.093	0.302	0.381	0.459	0.569	0.779	1.303	1.306
1998	0.047	0.261	0.391	0.527	0.614	0.993	1.625	
1999	0.086	0.309	0.409	0.557	0.574	0.882	1.336	
2000	0.051	0.361	0.435	0.562	0.610	0.823	0.874	0.908
2001	0.032	0.319	0.409	0.564	0.720	1.006	0.927	1.930
2002	0.251	0.358	0.431	0.557	0.682	1.100	1.170	
2003		0.363	0.426	0.554	0.673	0.812	1.041	1.226
2004		0.338	0.393	0.505	0.641	0.815	1.048	1.599
mean	0.091	0.262	0.382	0.517	0.661	0.889	1.141	1.324

Table E5. Survey indices of Cape Cod-Gulf of Maine yellowtail abundance and biomass.

NMFS Spring Survey

year	1	2	3	4	5	6	7	8+	sum	kg/tow
1977	0.775	0.329	0.185	0.049	0.093	0.000	0.000	0.000	1.431	0.566
1978	0.000	0.057	0.247	0.036	0.088	0.000	0.000	0.000	0.427	0.209
1979	0.228	0.315	0.748	0.770	0.068	0.021	0.000	0.019	2.169	0.795
1980	0.000	4.150	2.189	0.828	0.167	0.000	0.000	0.000	7.334	2.426
1981	0.041	2.921	2.198	1.143	0.584	0.473	0.179	0.000	7.538	2.468
1982	0.016	1.195	3.009	1.519	0.416	0.232	0.219	0.099	6.705	2.814
1983	1.190	3.203	2.093	1.298	0.092	0.064	0.000	0.000	7.939	2.340
1984	0.039	1.020	0.606	0.394	0.257	0.023	0.032	0.069	2.440	0.809
1985	0.047	0.806	0.865	0.205	0.123	0.043	0.000	0.000	2.089	0.615
1986	0.024	1.786	0.198	0.137	0.100	0.000	0.000	0.000	2.245	0.470
1987	0.062	1.599	2.356	0.637	0.538	0.570	0.611	0.304	6.676	2.971
1988	0.896	3.781	0.922	0.513	0.268	0.097	0.057	0.000	6.533	1.077
1989	0.177	2.179	1.442	0.372	0.274	0.038	0.038	0.038	4.559	0.863
1990	2.285	6.144	0.210	0.000	0.099	0.000	0.000	0.000	8.739	1.948
1991	0.421	3.554	2.834	1.049	0.222	0.000	0.047	0.000	8.128	1.783
1992	0.155	0.915	1.835	0.498	0.018	0.000	0.000	0.000	3.421	0.764
1993	0.064	0.656	1.045	0.563	0.000	0.000	0.000	0.000	2.327	0.501
1994	0.347	2.631	1.578	0.951	0.593	0.208	0.000	0.000	6.308	1.201
1995	0.182	1.040	3.978	2.991	0.432	0.048	0.000	0.000	8.670	2.036
1996	0.015	0.547	1.430	2.009	0.335	0.000	0.000	0.000	4.336	1.108
1997	0.021	0.934	2.025	1.545	0.288	0.000	0.000	0.000	4.813	1.311
1998	0.000	0.748	2.934	0.887	0.144	0.000	0.000	0.000	4.712	1.155
1999	0.018	0.848	3.633	1.853	0.332	0.147	0.000	0.000	6.831	1.977
2000	0.238	3.931	17.630	5.837	0.953	0.715	0.000	0.000	29.305	9.506
2001	0.000	1.201	4.878	1.030	0.216	0.000	0.000	0.000	7.324	2.292
2002	0.015	1.563	7.071	3.262	0.213	0.026	0.000	0.026	12.176	3.694
2003	0.094	0.863	2.405	1.758	0.787	0.000	0.000	0.025	5.933	1.910
2004	0.367	0.597	2.617	0.359	0.140	0.000	0.000	0.000	4.080	1.076
2005	0.089	0.582	3.820	1.284	0.000	0.000	0.000	0.000	5.776	1.424
mean	0.279	1.848	2.621	1.168	0.266	0.104	0.046	0.021	6.353	1.835

Table E5 cont.

NMFS Fall Survey

year	1	2	3	4	5	6	7	8+	sum	kg/tow
1977	4.882	9.330	4.987	0.788	0.197	0.053	0.062	0.123	20.421	7.526
1978	0.354	3.540	2.383	0.152	0.168	0.015	0.015	0.015	6.642	2.047
1979	4.003	4.072	1.227	0.306	0.075	0.016	0.000	0.000	9.698	2.596
1980	10.534	8.937	4.115	1.556	0.340	0.000	0.037	0.000	25.518	6.557
1981	1.596	4.965	1.330	0.532	0.266	0.177	0.000	0.000	8.866	1.881
1982	0.572	2.743	2.593	0.313	0.379	0.000	0.000	0.000	6.599	2.056
1983	0.285	0.546	0.312	0.020	0.000	0.000	0.000	0.000	1.162	0.264
1984	0.320	1.124	0.443	0.763	0.546	0.151	0.075	0.075	3.497	1.380
1985	4.609	1.778	1.352	0.068	0.068	0.068	0.000	0.000	7.943	1.583
1986	1.308	3.613	0.297	0.019	0.019	0.000	0.000	0.000	5.257	0.970
1987	0.564	1.357	0.476	0.057	0.049	0.000	0.000	0.000	2.503	0.556
1988	3.128	4.587	0.443	0.134	0.000	0.000	0.000	0.000	8.292	1.126
1989	1.657	5.338	2.008	0.417	0.146	0.066	0.000	0.000	9.631	2.202
1990	3.500	6.201	2.874	0.046	0.010	0.000	0.000	0.000	12.630	2.345
1991	1.840	1.643	1.639	0.332	0.000	0.000	0.000	0.000	5.453	1.202
1992	2.537	2.758	1.878	0.948	0.183	0.142	0.000	0.000	8.447	1.932
1993	4.445	4.507	0.601	0.099	0.000	0.000	0.000	0.000	9.652	1.106
1994	2.472	7.368	2.596	0.824	0.354	0.000	0.000	0.000	13.615	2.701
1995	0.516	0.713	1.068	0.297	0.171	0.000	0.000	0.000	2.765	0.783
1996	1.058	2.907	4.928	1.179	0.133	0.000	0.000	0.000	10.205	2.614
1997	1.049	2.440	2.945	1.223	0.670	0.115	0.000	0.000	8.441	2.277
1998	1.022	2.984	1.197	0.986	0.234	0.000	0.000	0.000	6.422	1.637
1999	4.147	8.090	5.532	1.697	0.698	0.027	0.000	0.000	20.191	5.983
2000	0.955	6.729	4.455	0.260	0.000	0.000	0.000	0.000	12.399	3.472
2001	0.117	3.835	2.231	0.114	0.019	0.000	0.000	0.000	6.316	1.889
2002	0.409	1.414	0.547	0.166	0.019	0.000	0.000	0.000	2.555	0.708
2003	0.597	8.775	1.846	0.434	0.253	0.000	0.000	0.000	11.905	3.443
2004	0.237	1.154	0.628	0.024	0.000	0.000	0.000	0.000	2.044	0.488
mean	2.097	4.052	2.033	0.491	0.178	0.030	0.007	0.008	8.895	2.262

Table E5 cont.

MADMF Spring Survey				age					
	1	2	3	4	5	6	7	8+	sum	kg/tow
1978	2.71	20.69	11.82	1.60	0.63	0.54	0.10	0.13	38.22	10.16
1979	2.63	22.58	13.85	3.68	0.86	0.00	0.17	0.00	43.77	11.38
1980	2.68	17.62	10.10	2.30	0.15	0.00	0.00	0.00	32.85	10.03
1981	5.61	58.83	9.00	2.26	1.59	0.27	0.00	0.00	77.56	16.35
1982	0.69	17.06	17.04	4.45	0.94	0.06	0.04	0.00	40.28	12.85
1983	3.13	8.50	11.51	4.28	0.04	0.17	0.03	0.00	27.66	9.00
1984	0.43	18.13	7.56	2.29	0.85	0.00	0.00	0.00	29.26	7.37
1985	1.97	8.27	7.15	1.52	0.59	0.39	0.05	0.05	19.99	5.21
1986	1.73	15.39	1.74	0.24	0.21	0.04	0.00	0.00	19.36	4.52
1987	2.53	4.95	5.31	0.97	0.27	0.11	0.08	0.00	14.22	3.67
1988	3.10	14.46	2.52	0.60	0.05	0.02	0.00	0.00	20.74	3.83
1989	0.67	22.26	3.18	1.08	0.06	0.00	0.00	0.00	27.25	4.73
1990	0.63	11.77	15.57	0.63	0.14	0.01	0.02	0.01	28.77	6.60
1991	0.06	5.34	3.31	2.15	0.48	0.12	0.05	0.00	11.50	3.32
1992	1.30	11.03	9.71	2.38	1.45	0.03	0.03	0.00	25.94	6.54
1993	0.63	7.99	6.31	1.94	0.23	0.06	0.20	0.03	17.38	4.60
1994	2.67	24.02	7.53	1.49	0.33	0.12	0.00	0.00	36.15	6.23
1995	7.51	14.64	24.96	2.88	1.20	0.02	0.02	0.00	51.22	10.38
1996	1.17	18.03	14.70	6.78	1.74	0.00	0.04	0.00	42.46	9.25
1997	0.52	16.94	12.22	4.04	0.54	0.00	0.00	0.00	34.26	7.55
1998	0.55	4.96	13.50	1.25	0.19	0.02	0.00	0.00	20.46	5.17
1999	0.10	6.34	10.90	1.28	0.08	0.00	0.00	0.00	18.70	5.08
2000	0.83	21.92	33.29	11.28	1.30	0.52	0.00	0.00	69.14	20.37
2001	0.22	10.21	38.20	10.39	1.68	0.00	0.00	0.00	60.71	19.34
2002	0.36	1.29	13.84	5.34	0.26	0.17	0.00	0.00	21.27	7.43
2003	0.04	8.22	8.68	9.70	1.45	0.07	0.00	0.00	28.16	8.154
2004	0.15	2.50	8.30	4.24	0.53	0.02	0.00	0.00	15.74	4.626
2005									28.94	7.95
mean	1.65	14.59	11.92	3.37	0.66	0.10	0.03	0.01	32.21	8.27

Table E5 cont.

MADMF Fall Survey					age					
	0	1	2	3	4	5	6	7	8+	sum	kg/tow
1978	0.04	7.13	7.74	1.45	0.11	0.00	0.01	0.00	0.00	16.48	2.80
1979	0.03	24.11	22.82	1.78	0.06	0.00	0.00	0.00	0.00	48.80	7.33
1980	0.03	26.54	12.38	2.70	0.35	0.00	0.00	0.00	0.00	42.00	5.90
1981	0.00	2.93	6.54	1.54	0.23	0.17	0.00	0.00	0.00	11.41	2.76
1982	0.00	9.58	3.36	5.54	0.30	0.08	0.00	0.00	0.00	18.86	4.20
1983	0.00	9.68	6.68	1.60	0.13	0.00	0.00	0.00	0.00	18.09	3.39
1984	0.04	1.91	3.00	0.86	0.39	0.10	0.02	0.00	0.04	6.37	1.18
1985	0.04	5.70	1.63	1.03	0.00	0.00	0.00	0.00	0.02	8.42	1.17
1986	0.01	2.60	4.95	0.20	0.03	0.01	0.00	0.00	0.00	7.80	1.36
1987	0.44	5.85	2.30	0.49	0.07	0.02	0.00	0.00	0.00	9.17	1.09
1988	0.00	8.96	11.24	2.27	0.15	0.00	0.00	0.00	0.00	22.62	3.71
1989	0.00	2.64	5.22	0.96	0.10	0.00	0.00	0.00	0.00	8.92	1.52
1990	0.00	5.20	11.93	4.84	0.01	0.00	0.00	0.00	0.00	21.98	4.16
1991	0.00	3.76	5.14	5.03	0.86	0.00	0.00	0.00	0.00	14.78	3.23
1992	0.20	7.18	3.62	2.08	0.47	0.20	0.00	0.00	0.00	13.75	2.00
1993	0.00	8.39	7.29	5.80	1.43	0.00	0.00	0.00	0.00	22.91	3.99
1994	0.00	2.36	11.79	1.79	0.15	0.00	0.00	0.00	0.00	16.09	3.27
1995	0.00	8.38	15.16	5.85	0.00	0.00	0.00	0.00	0.00	29.40	5.75
1996	0.01	1.87	3.94	2.18	0.17	0.00	0.00	0.00	0.00	8.17	1.56
1997	0.00	1.01	7.38	1.14	0.16	0.10	0.00	0.00	0.00	9.79	2.10
1998	0.00	7.05	6.74	2.25	0.00	0.00	0.00	0.00	0.00	16.05	2.68
1999	0.15	4.73	11.94	4.10	0.65	0.08	0.00	0.00	0.00	21.66	4.71
2000	0.00	1.36	8.25	3.53	0.22	0.10	0.00	0.03	0.00	13.48	3.46
2001	0.00	0.57	8.06	4.23	0.14	0.00	0.00	0.00	0.00	13.00	3.55
2002	0.16	1.67	0.84	3.04	1.15	0.05	0.00	0.00	0.00	6.91	1.629
2003	0.17	0.41	7.04	3.86	3.01	0.07	0.00	0.00	0.00	14.56	4.002
2004	0.61	2.40	9.89	8.66	2.73	0.02	0.00	0.00	0.00	24.30	5.694
mean	0.07	6.07	7.66	2.92	0.48	0.04	0.00	0.00	0.00	17.25	3.27

Table E6. Results of the Cape Cod-Gulf of Maine yellowtail flounder VPA.

Abundance (thousands)			Age			
	1	2	3	4	5+	sum
1985	12,302	3,195	1,696	1,168	828	19,189
1986	6,030	9,451	1,489	568	90	17,628
1987	8,083	4,851	3,915	509	278	17,636
1988	28,835	6,600	2,266	1,096	354	39,151
1989	11,318	23,199	3,068	495	76	38,156
1990	11,618	9,160	16,915	872	113	38,678
1991	13,054	9,436	4,878	5,344	1,018	33,730
1992	9,617	10,267	6,484	2,397	672	29,437
1993	10,358	6,327	4,806	3,535	734	25,760
1994	7,120	8,336	4,796	2,963	1,721	24,936
1995	6,298	5,762	6,341	2,431	750	21,582
1996	9,352	4,742	4,038	2,700	900	21,732
1997	8,140	7,650	3,347	1,864	440	21,441
1998	9,866	6,662	5,438	1,316	493	23,775
1999	11,494	7,980	4,815	2,372	545	27,206
2000	9,912	9,395	6,023	2,541	380	28,251
2001	6,250	8,107	6,657	2,163	372	23,549
2002	3,782	5,099	5,095	2,002	148	16,126
2003	4,000	3,054	3,119	1,897	352	12,422
2004	6,158	3,275	1,967	873	664	12,937
2005	---	5,042	2,617	762	595	---
mean	9,679	7,504	4,751	1,898	549	24,666

Fishing Mortality						
	1	2	3	4	5+	4-5
1985	0.064	0.563	0.894	0.894	0.894	0.894
1986	0.018	0.681	0.873	0.873	0.873	0.873
1987	0.003	0.561	1.073	1.073	1.073	1.073
1988	0.018	0.566	1.321	1.321	1.321	1.321
1989	0.012	0.116	1.058	1.058	1.058	1.058
1990	0.008	0.430	0.952	0.952	0.952	0.952
1991	0.040	0.175	0.511	0.511	0.511	0.511
1992	0.219	0.559	0.407	0.407	0.407	0.407
1993	0.017	0.077	0.284	0.284	0.284	0.284
1994	0.012	0.074	0.480	0.480	0.480	0.480
1995	0.084	0.156	0.654	0.654	0.654	0.654
1996	0.001	0.149	0.573	0.573	0.573	0.573
1997	0.000	0.141	0.734	0.734	0.734	0.734
1998	0.012	0.125	0.630	0.630	0.630	0.630
1999	0.002	0.081	0.439	0.439	0.439	0.439
2000	0.001	0.145	0.824	0.824	0.824	0.824
2001	0.004	0.265	1.002	1.002	1.002	1.002
2002	0.014	0.291	0.788	0.788	0.788	0.788
2003	0.000	0.240	1.074	1.074	1.074	1.074
2004	0.000	0.024	0.749	0.749	0.749	0.749
mean	0.026	0.271	0.766	0.766	0.766	0.766

Table E6 cont.

Spawning Biomass (mt)

	1	2	3	4	5+	sum
1985	0	50	313	363	341	1,067
1986	0	131	332	192	44	699
1987	0	65	728	165	120	1,078
1988	0	81	331	302	135	849
1989	0	439	559	191	45	1,234
1990	0	141	3136	297	62	3,636
1991	0	155	999	2067	598	3,819
1992	0	78	1305	931	334	2,648
1993	0	72	1146	1214	492	2,924
1994	0	131	1083	1027	843	3,084
1995	0	87	1151	698	315	2,251
1996	0	62	901	920	365	2,248
1997	0	159	698	581	176	1,614
1998	0	121	1216	494	248	2,079
1999	0	176	1225	1018	284	2,703
2000	0	234	1369	929	164	2,696
2001	0	171	1340	734	176	2,421
2002	0	119	1179	739	74	2,111
2003	0	74	633	618	154	1,479
2004	0	81	422	297	311	1,111
mean	-	131	1,003	689	264	2,088

Figure E1. Total catch of Cape Cod-Gulf of Maine yellowtail flounder.

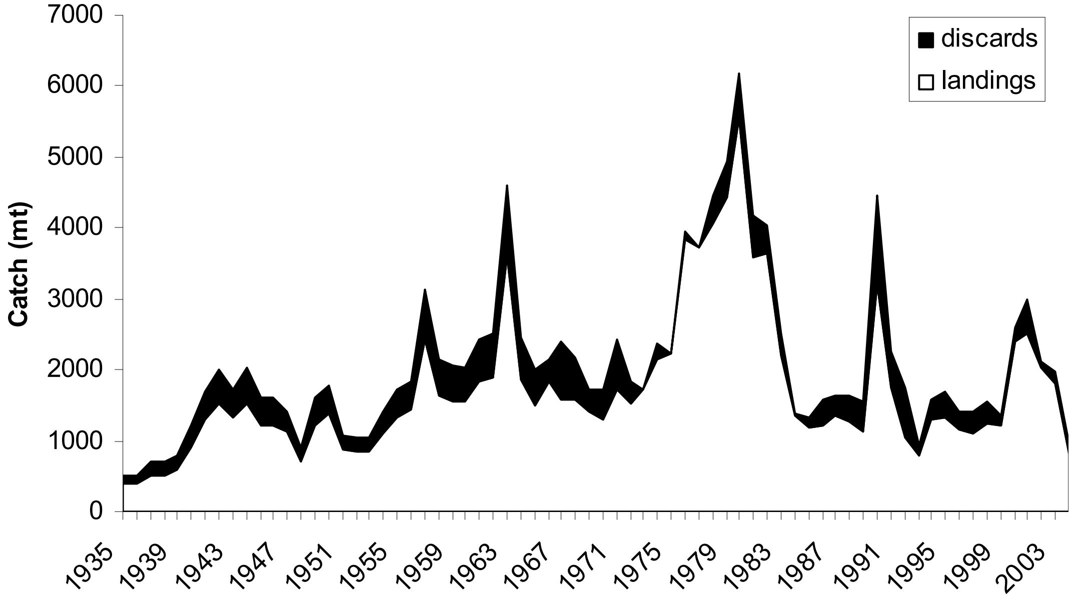


Figure E2. Age distribution of Cape Cod-Gulf of Maine yellowtail flounder catch.

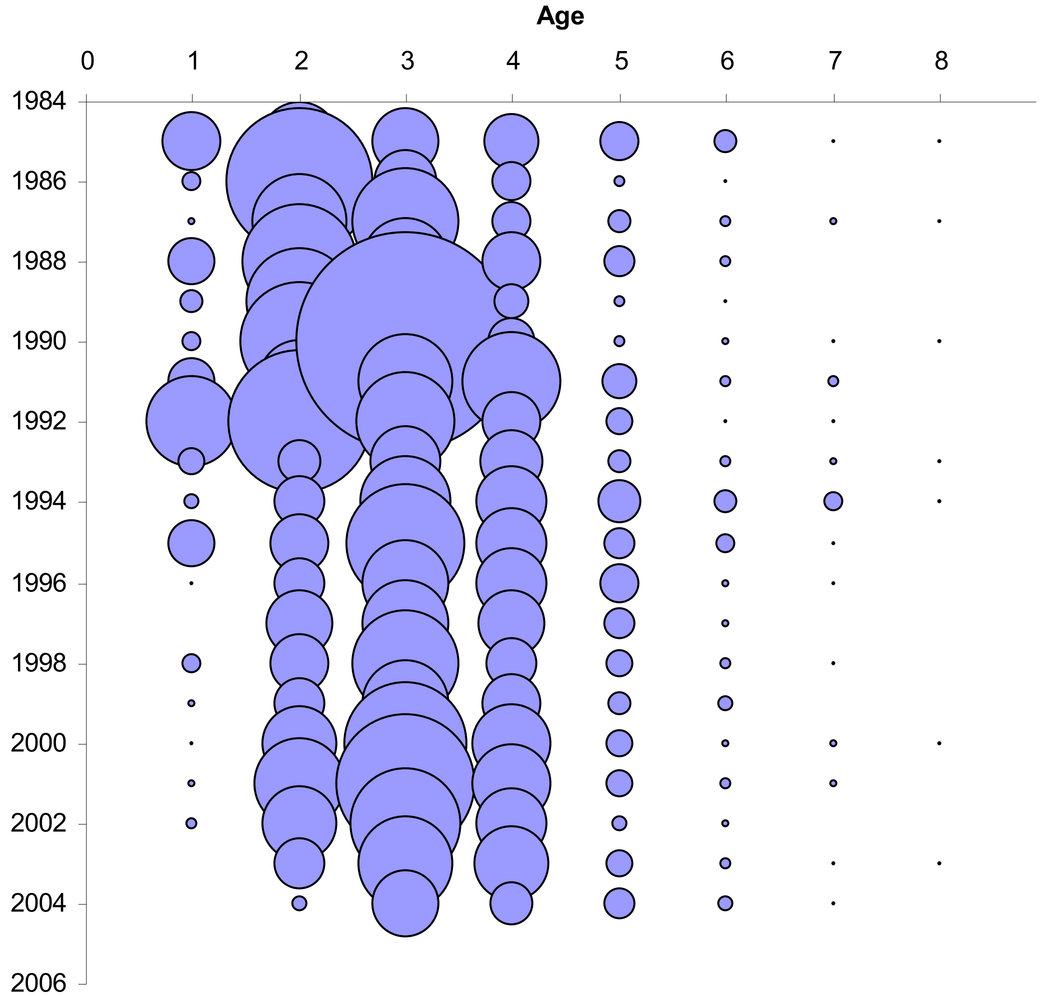


Figure E3. Survey indices of Cape Cod-Gulf of Maine yellowtail flounder biomass.

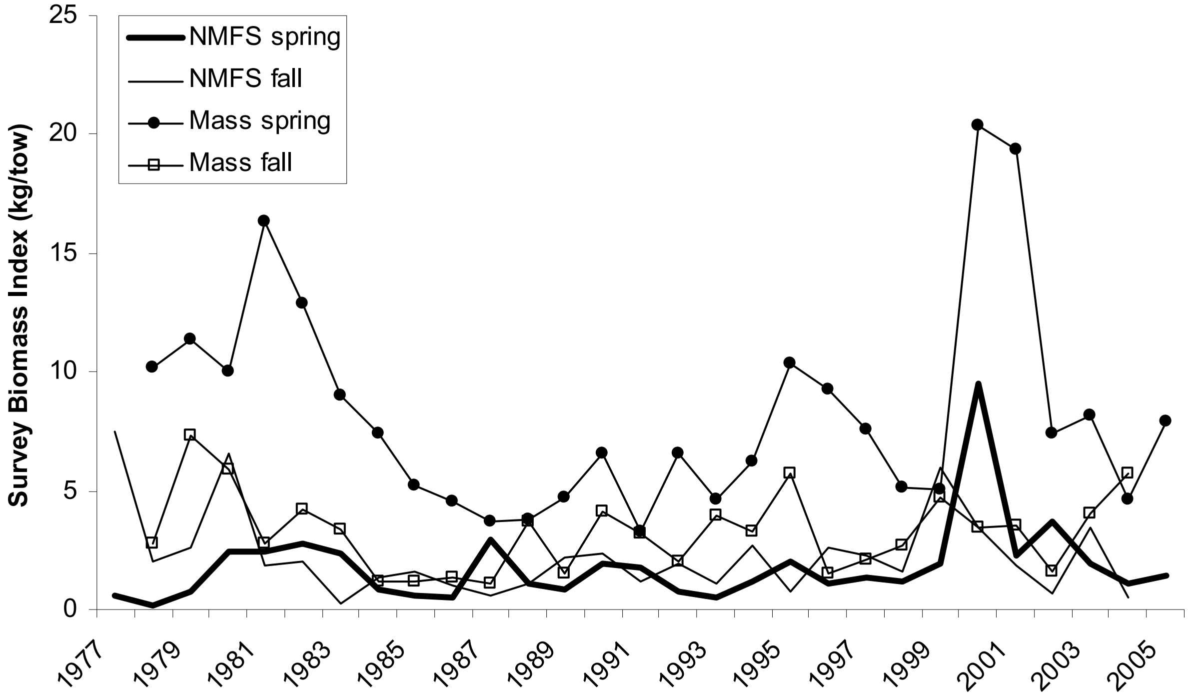


Figure E4. Survey indices of Cape Cod-Gulf of Maine yellowtail flounder abundance at age.

Figure E4 cont.

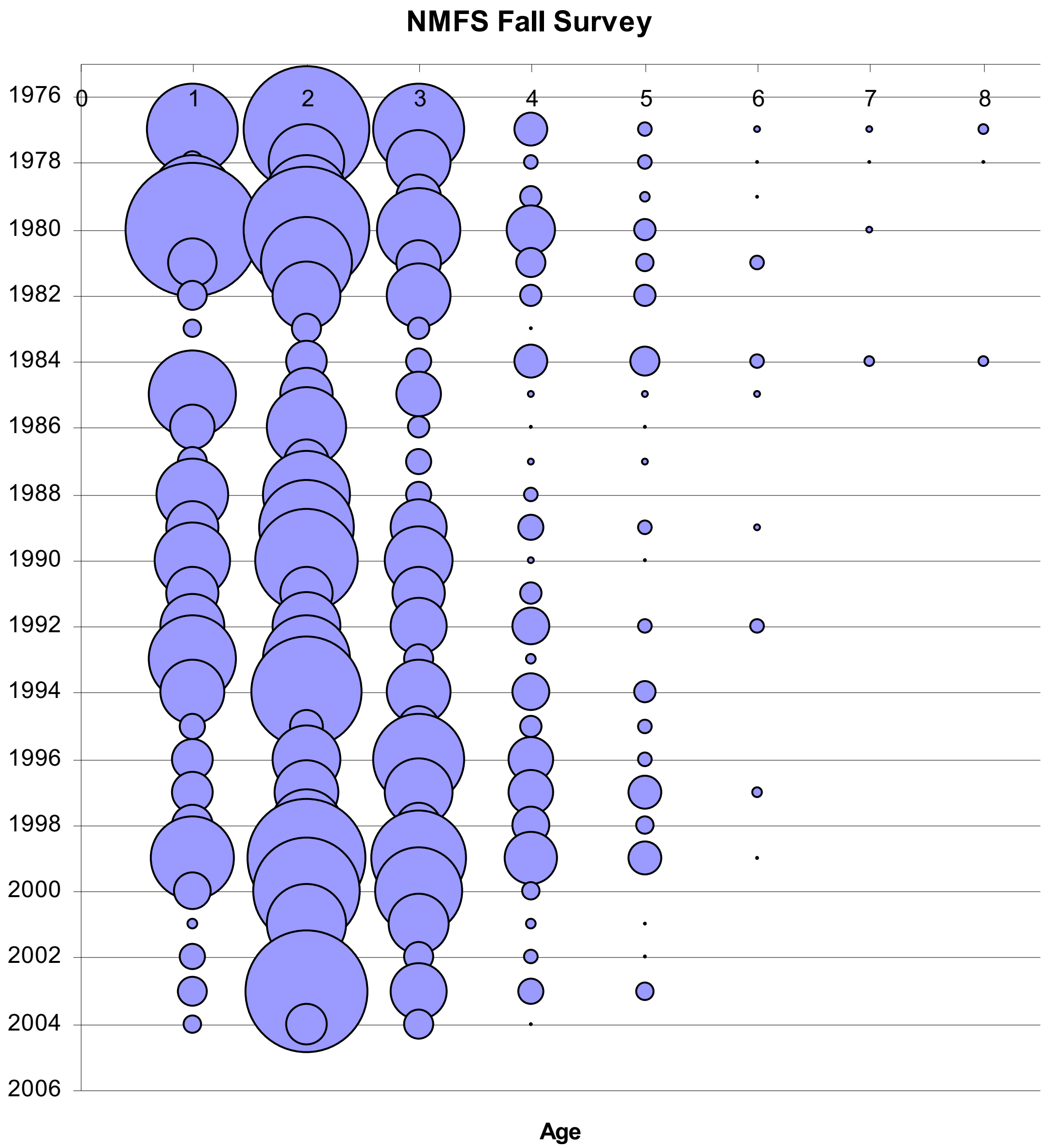


Figure E4 cont.

Figure E4 cont.

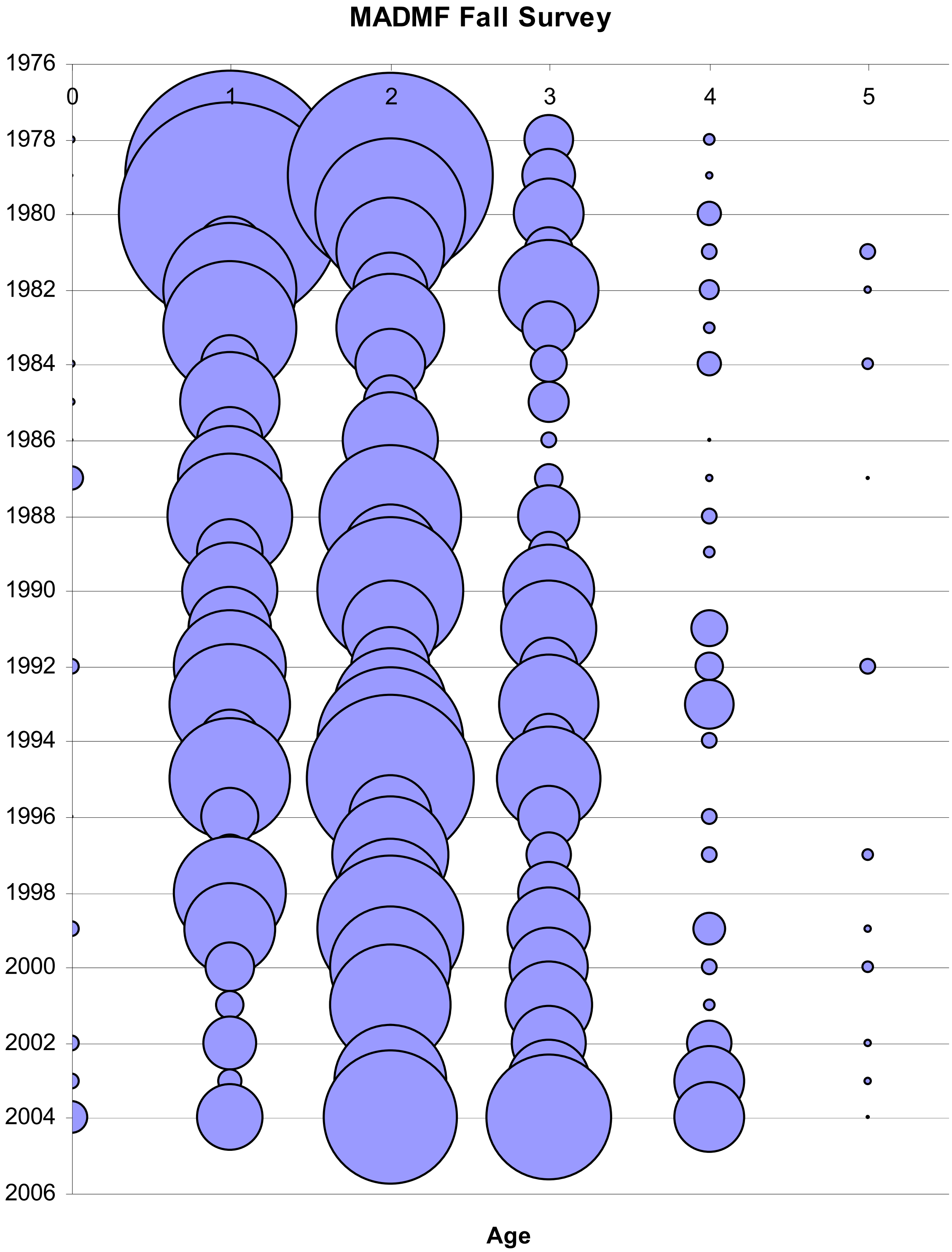


Figure E5. Cape Cod-Gulf of Maine yellowtail flounder VPA results.

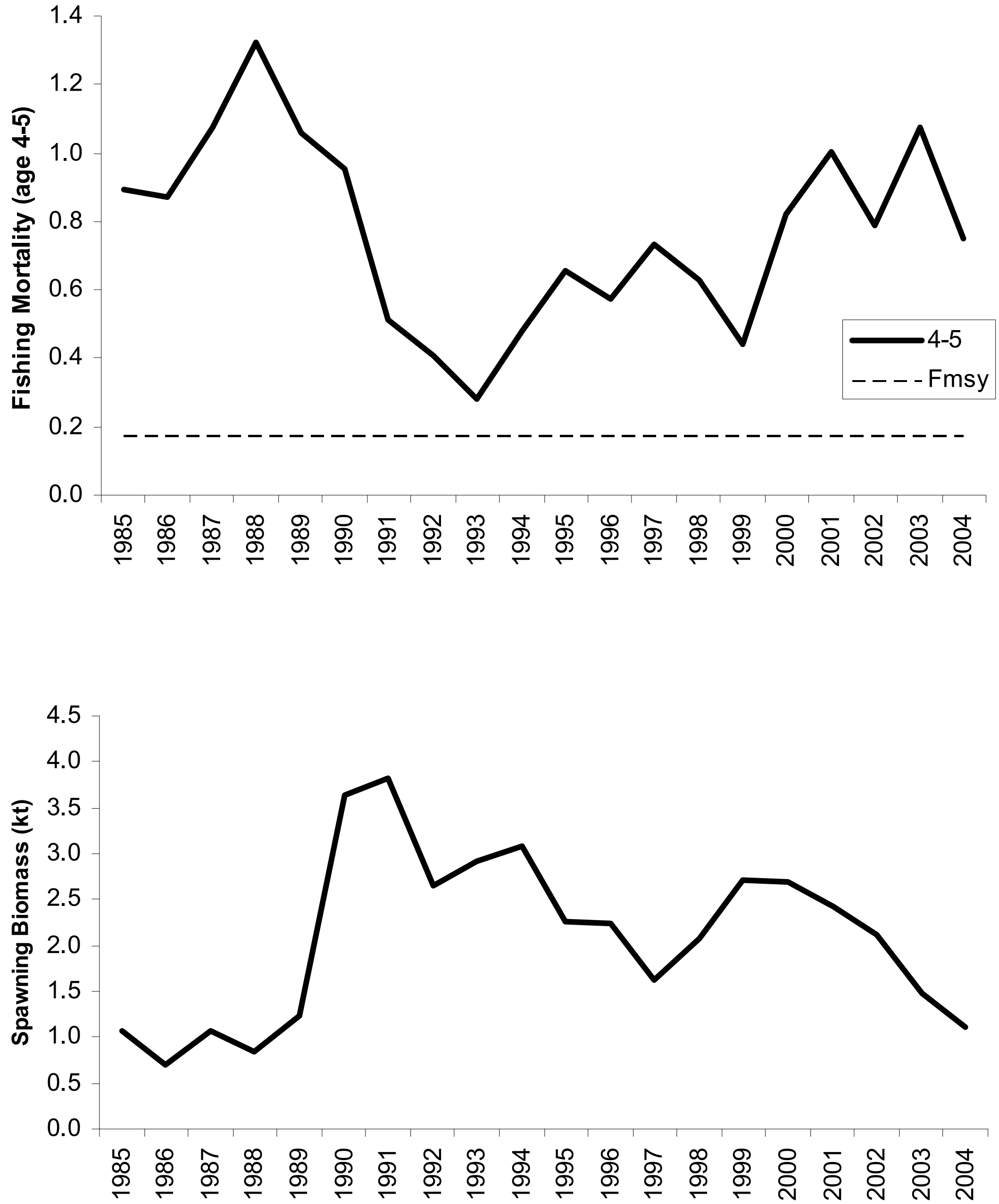


Figure E5 cont.

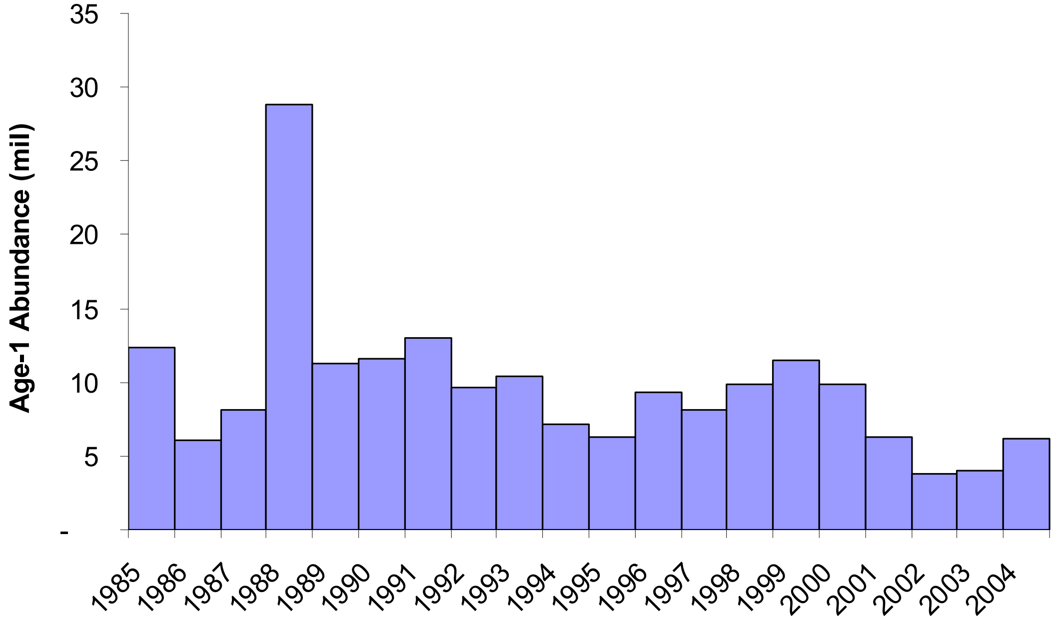
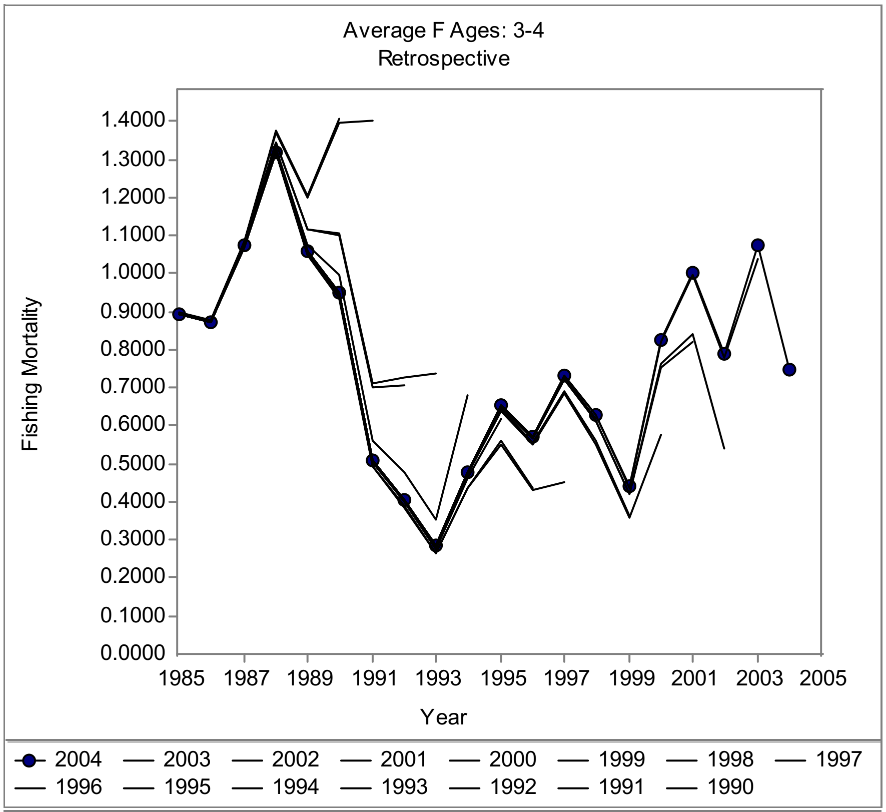


Figure E6. Retrospective analysis of the Cape Cod-Gulf of Maine yellowtail flounder VPA.



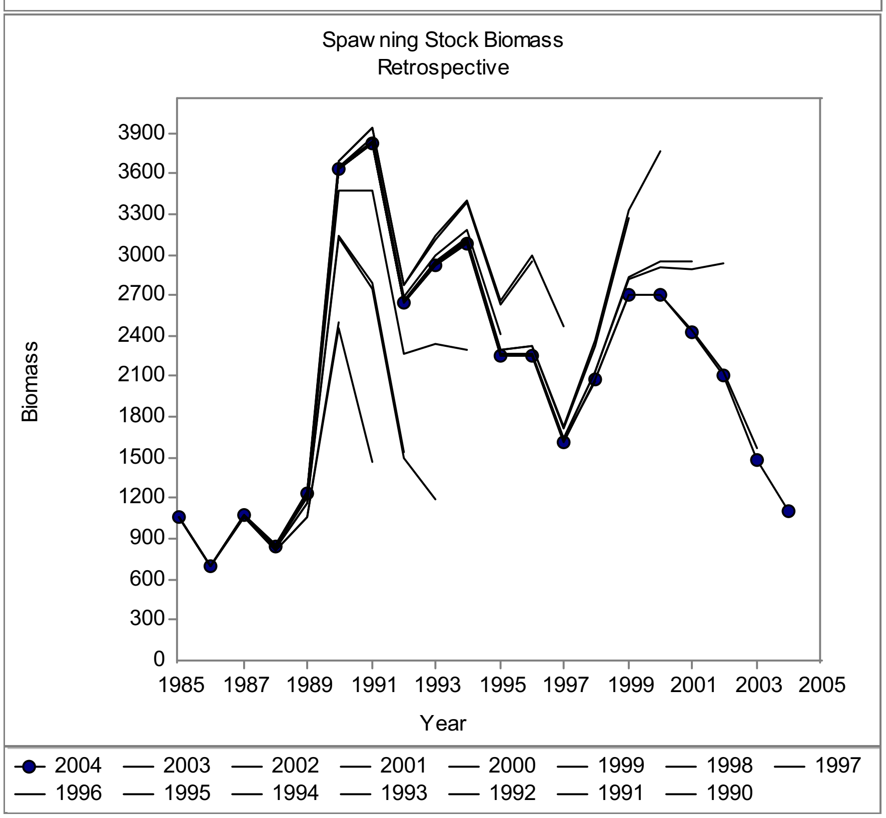


Figure E7. Rebuilding status of Cape Cod-Gulf of Maine yellowtail flounder

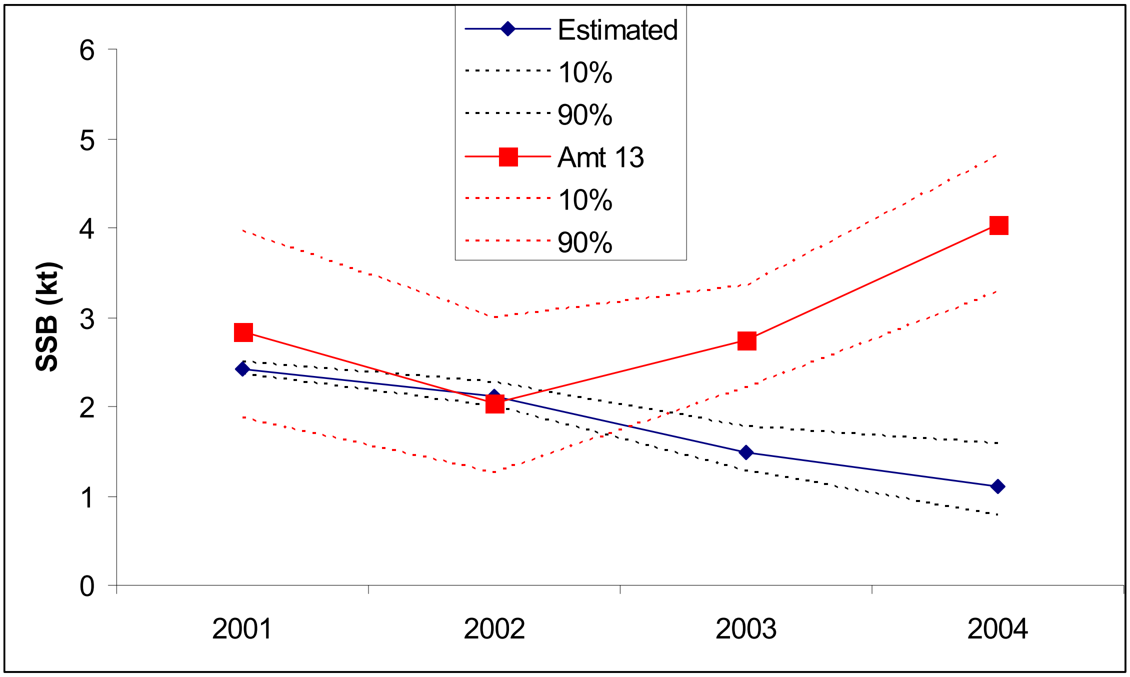
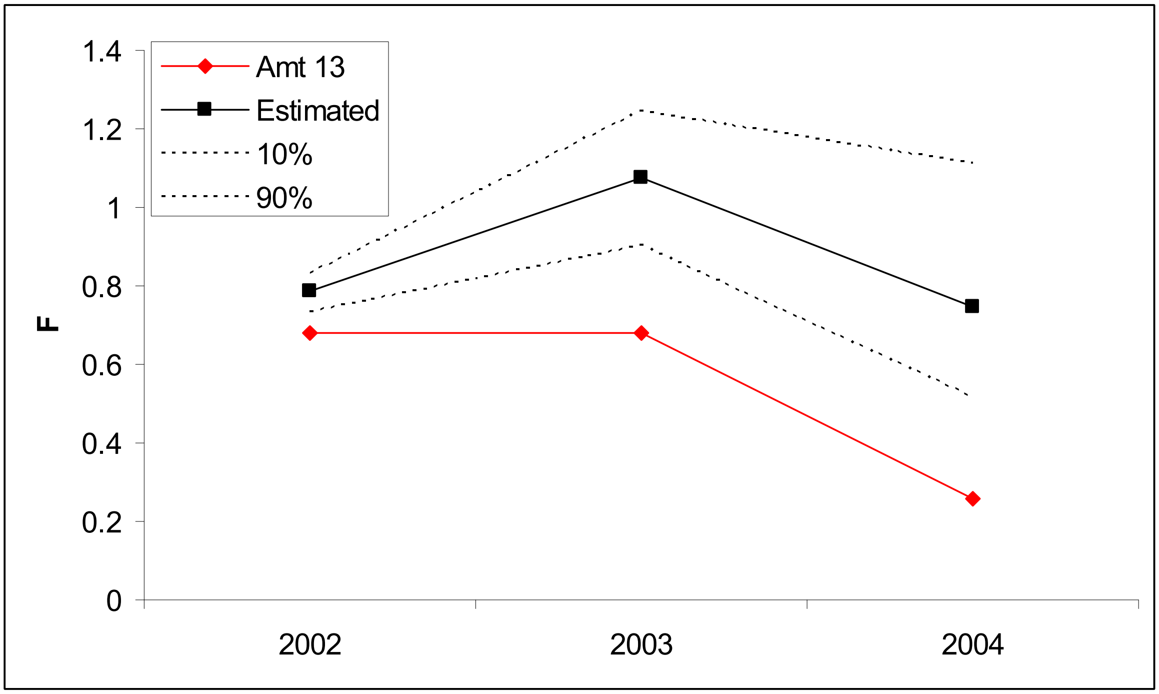
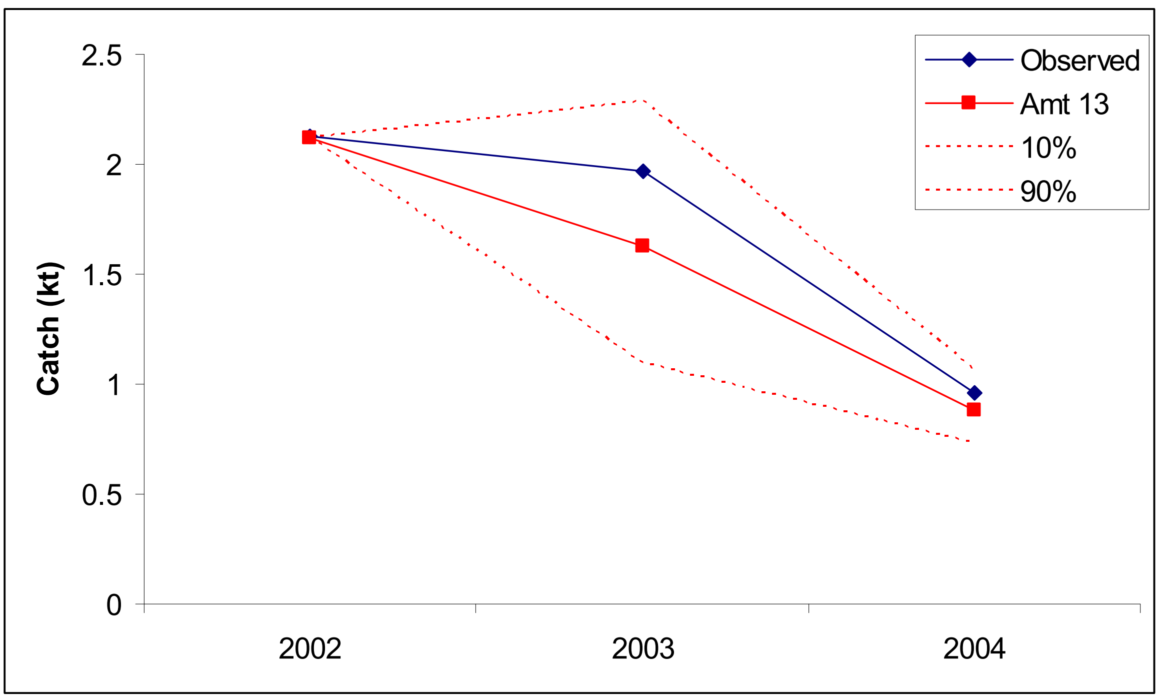


Figure E8. Comparison to rebuilding plan for Cape Cod-Gulf of Maine yellowtail flounder.





F. Gulf of Maine Cod by **R.K. Mayo and L. Col**

1.0 Background

The Gulf of Maine Atlantic cod stock was last assessed in 2002 at the 2002 Groundfish Assessment Review Meeting (GARM I) (Mayo and Col 2002). The methodology applied in the present assessment is the same as in the 2002 assessment and the 2001 assessment as described in Mayo *et al.* (2002). Since 2002, there have been changes in the software implementation of the ADAPT/VPA method, and some minor changes in the estimation of the stock specific MRFSS catches and the availability of additional commercial age samples from 2000 and 2001. As well, the NEFSC spring and autumn abundance survey indices at age were recalculated over the entire series to reconcile results in years when both Albatross IV and Delaware II were employed during to conduct a portion of a single survey. Changes in the survey indices were minor.

In the 2002 assessment, fully recruited fishing mortality (ages 4+) in 2001 was estimated to be 0.47, and the 2000 F was estimated to be 0.56. Spawning stock biomass was estimated to have declined to 10,600 mt in 1997 and 1998, a decline from a recent high of 14,600 mt in 1995 and a series high of 24,200 mt in 1990. The strength of the most recent recruiting year classes was estimated to be very low. The 1993, 1994 and 1995 year classes were estimated as the lowest in the VPA series dating back to 1982 (1980 year class). The recruit/SSB survival ratios for these most recent year classes were also estimated to be very low compared to previous year classes. NEFSC spring and autumn research vessel bottom trawl survey indices for Gulf of Maine cod had declined to record low levels in the mid-1990s; indices from both surveys fluctuated at relatively low levels but had begun to increase in 2001 and 2002. The 1994-1996 year classes derived from the NEFSC and Commonwealth of Massachusetts surveys were also among the lowest in the respective series, but the Mass. DMF survey and the 2001 and 2002 NEFSC surveys indicated the 1998 year class to be larger than the recent average.

2.0 The Fishery

Commercial landings of Gulf of Maine cod declined to 1,636 metric tons (mt) in 1999, a 61 % decline from 1998 (Table F1; Figure F1). Commercial landings increased to 4,423 mt in 2001 and have since fluctuated between 3,800 and 4,100 mt. Discard estimates have been derived on a gear-quarter basis from 1989 through 2004 based on NEFSC Observer Program data; these results indicate a substantial increase in the overall discard /kept ratio in 1999 compared to previous years (Table F2). Ratios calculated for years after 1999 were lower, but still remain substantially greater than the pre-1999 ratios. Recent discards estimated from the Observer Program data have ranged from 856 mt in 2004 to 2,630 mt in 1999. Discards have also been estimated based on Vessel Trip Reports, filtered to exclude vessels that do not report discards. Discards based on these data have ranged from 456 mt in 2004 to 3,390 mt in 2004.

The number of commercial port samples for this stock declined from 78 in 1997 to 46 in 1998 to 15 in 1999. Port sampling has since improved, increasing to 62 samples in 2000 and 113 samples in 2001. In 2003 and 2004, the number of port samples exceeded 190 (Table F3); however a large part of this increase is due to acquisition of more ‘Large’ market category samples, many consisting of as few as 4-5 fish. Sampling was not well distributed among quarters and market categories in 1999 and 2000, as only 1 biological sample was taken in the 3rd and 4th quarter of 1999, requiring substantial pooling over quarter. In 1999 and 2000 samples from each market category were pooled on an annual basis, but improved sampling beginning in 2001 allowed a return to the traditional quarterly or semi-annual pooling of samples within each market category.

The estimated recreational catch of Gulf of Maine cod (retained component only) has varied considerably over the past decade ranging from 353 mt in 1997 to 2,826 mt in 2001 (Table F4). The total catch (including commercial landings and discard and recreational landings) from this fishery had been dominated by age 3 and 4 fish through 2001 (Table F5a). During the most recent three years, the fishery has been dominated by age 4-6 fish, and the age structure of the catch appears to have expanded compared to the late 1990s. The fishery in 2004 was supported, to a large extent, by two relatively weak year classes (1999 and 2000). Mean weights of the catch have been relatively stable over time, except for a slight increase in the mean weight of age 2, 3 and 4 fish since 1999 (Table F5b).

3.0 Research Vessel Surveys

NEFSC research vessel bottom trawl survey abundance and biomass indices for Gulf of Maine cod remained relatively low through autumn 1999 and spring 2000 (Table F6; Figure F2). The autumn 1999 indices increased slightly from 1998, while the spring 2000 indices decreased slightly from the 1999. However, biomass indices began to increase substantially in 2001 and spring 2002, but the large apparent increase evident in autumn 2002 resulted from a single large haul unduly influencing the stratified mean. Spring indices in 2003, 2004 and 2005 suggest a substantial decline in biomass since 2002 to levels evident during the mid-1990s. Autumn indices through 2004 suggest that biomass remains above the mid-1990s lows.

Recruitment indices for the 1994-1997 year classes derived from the NEFSC (Tables F7 and F8, Figure F3) and Massachusetts DMF (Table F9, Figure F4) bottom trawl surveys are among the lowest in the respective series, although indices for the 1998 year class appear to be above the recent average . The 2000 year class appears to be the extremely weak in all surveys. More recently, there are indications in both NEFSC and MA DMF survey that the 2003 year class may be relatively strong compared those produced over the past decade.

Total mortality (Z) estimates derived from the NEFSC spring and autumn surveys show elevated rates during the period since 1980 compared to the 1960s and 1970s (Figure F5). Both surveys also indicate a declining trend since the mid 1990s with a recent increase in Z indicated by the spring survey.

4.0 Assessment

<u>Input Data and Analyses</u>

The present assessment represents a three-year update to the previous assessment (Mayo and Col 2002). The same VPA formulation used in the previous assessment was employed in the present update. Catch at age data were updated for 2002, 2003 and 2004 with the inclusion of commercial discards (1,500 mt in 2002 and 1,000 mt in 2003 and 2004), revised 1994-2001 recreational catch at age, and revised 2000 and 2001 commercial landings at age based on additional length and age samples. NEFSC and Mass. DMF survey abundance indices (stratified mean number per tow at age) were updated through spring 2005. As in recent VPAs, commercial CPUE indices were included only through 1993.

Comparisons between the software and data used in the 2002 GARM VPA with updated software and revised data as indicated above (Table F10) revealed only minor effects on estimates of terminal populations and their Cvs.

Precision of the 2004 spawning stock biomass and fully recruited fishing mortality were derived from 1,000 bootstrap replicates of the VPA. Survey residuals are given in Figure F6. A retrospective analysis of terminal year estimates of stock sizes, fully recruited fishing mortality and SSB were also carried out (Figure F9).

Assessment Results

Fully recruited fishing mortality (ages 4+) in 2004 is estimated at 0.63 (Table F11; Figure F7), a substantial increase since 2002. Spawning stock biomass increased to 23,800 mt in 2001, but SSB has since declined to 18,800 mt in 2004 (Table F11; Figure F8). The 1998 year class is estimated to be equivalent to the 1992 year class (approximately 8-9 million fish), and the initial estimate of the 2003 year class (22 million fish) suggests it may be the largest since the 1987 year class. The 2000 year class (1 million fish) is by far the lowest in the entire VPA series and the 1999 year class (4.4 million fish) is below the long term mean (6.3 million fish), and the1993-1995 year classes are about ½ the long term average (Table F11).

VPA Diagnostics and Uncertainty

With the current VPA formulation, a retrospective pattern is evident in the estimates of terminal F whereby fully recruited F now appears to have again been underestimated in 2002 and 2003 as was the case from 1994-1997. The opposite pattern is evident for SSB and recruitment strength (Figure F9).

Based on the variability indicated by the survey residuals, the bootstrap analysis suggests that there is a 90% probability that 2004 fully recruited fishing mortality is greater than 0.50, and 2004 SSB is less than 22,600 mt (Figure F10).

Sensitivity Analyses

The estimate of the strength of the 2003 year class is very sensitive to the MA DMF 2004 autumn age 1 index, included as the 2005 age 2 index in the VPA calibration. Exclusion of this single datum results in an estimate of 15 million fish vs. 22 million fish at age 1 in 2004. This value does not substantially affect the estimate of 2004 spawning stock biomass, but does influence starting conditions for projections. Precision of the age 2 population estimate in 2005 is only slightly reduced from 33% when the index is included to 34% when excluded. The recruitment retrospective pattern remains unchanged.

5.0 Biological Reference Points

The following biological reference points were obtained from an age-structured production model (NEFSC 2002) performed on yield and SSB/recruit analyses and the VPA estimates of SSB and age 1 recruitment obtained from the 2001 assessment (Mayo et al. 2002):

MSY	16,600 mt
SSB_{MSY}	82,830 mt
F_{MSY}	0.225 (fully recruited)

6.0 Summary

Fishing mortality appears to have declined considerably between 1998 and 2002, but has since increased once again. Spawning biomass increased substantially in 2001, in large part due to maturation of the above-average 1998 year class at age 3. SSB remained high in 2002 but declined in 2003 and 2004 as F on the fully recruited ages began to increase. Fishing mortality increased sharply in 2004 because the fully recruited ages (4 and 5) that supported the fishery in 2004 correspond to 2 very poor year classes (1999 and 2000).

Comparisons between the projected and realized fishing mortality rates, spawning stock biomass, and catch during 2002-2004 are illustrated in Figure F11. Realized F exceeded the target Fs by a wide margin in 2003 and 2004. The target Fs were outside of the interquartile range in both years. Similarly, SSB declined between 2003 and 2004 below the interquartile range of the projected 2004 SSB. Realized catches exceeded the 75th percentile of the projected catches in each of the three years.

It is now clear that the sharp increase in the autumn 2002 NEFSC survey index was an artifact resulting from a very large catch at a single station influencing the overall mean. This also appears to be the case with the spring 2002 index to a lesser extent.

Overall, there is evidence that the biomass of Gulf of Maine cod increased in 2001 and 2002. The flowing excerpt from the 2002 GARM report (Mayo and Col 2002) is still relevant, perhaps more so, with respect to the 2003 year class:

“Further increases in biomass may occur if fishing mortality is reduced to maximize the contribution of the 1998 year class to the spawning stock. Based on the current maturity ogive, this year class will be fully mature at age 4 in 2002. But given the expected relatively poor strength of the 1999 and 2000 year classes, rebuilding of the stock may plateau unless additional average or above average year classes recruit in the next several years.”

Based on the results from the present assessment, the F in 2004 (0.63) is above Fmsy and spawning stock biomass in 2004 (18,800 mt) is below ½ Bmsy. Thus, overfishing is still occurring and the stock remains in an overfished condition.

7.0 GARM Comments

There was discussion on the method of estimating discards compared to how discards were estimated for 1999-2000 and presented at SAW 33. Although sensitivity runs of bracketing the discard estimate by 500 mt increments were presented at SAW 33, the final assessment accepted by the SARC panel had one set of discard estimates. The same methodology was applied in the VPA model formulation for the assessment at the GARM in 2002 and again in 2005. This is consistent with the model results that were applied in the A13 projections.

Regulations for the party charter vessels imposed stricter bag limits for cod in 2002.
A summary of landings from the party charter VTR records may possibly reflect this shift in regulation.

The total catch (mt) in the recreational catch at age differs from the MFRSS estimate of total catch. The difference is due to the different methods for deriving the mean weight at age by MRFSS and in the assessment. The assessment mean weight is based on the sampled length frequency whereas the MRFSS estimate is an overall mean.

The 2003 year class is estimated to be very strong, close in size to the very strong 1987 year class. This estimate is sensitive, however, to the age 2 Massachusetts survey index and is reduced by 32% when the index is excluded from the VPA calibration. In addition, the year class appears smaller at age 1 than at age 0 in the Massachusetts autumn survey. A retrospective pattern in recruits shows that year classes are generally over-estimated in this model formulation. The 2003 year class will influence the rebuilding of the stock and if it is over estimated, the projection is likely to overestimate future biomass.

Projection Advice - Mean weight at age, partial recruitment, and the maturity ogive will be averaged over 2002-2004 for the projection analysis. The 2004 year class at age 1 will be set at the geometric mean of 6.3 million. Recruitment will be estimated from the stock recruit relationship.

Research Recommendation - For the 2008 benchmark assessment use biological data from the industry based survey in the Gulf of Maine.

8.0 Sources of Uncertainty

- Commercial landings may have been underestimated in 2004 due to a change to a self-reporting dealer system.

- The recent retrospective pattern in VPA is now suggesting that F is being underestimated and spawning biomass and recruitment is being overestimated in the terminal year in 2002 and 2003.

- The 2003 year class may be overestimated as age 1 based on diagnostics from the VPA given the impact of the Massachusetts age 2 autumn survey indices.

9.0 References

Mayo, R.K., E.M. Thunberg, S.E. Wigley and S.X. Cadrin. 2002. The 2001 Assessment of the Gulf of Maine Atlantic Cod Stock.. Northeast Fisheries Science Center Reference Document 02-02, 154p.

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NEFSC. 2001. 33rd Northeast Regional Stock Assessment Workshop (33rd SAW). Stock Assessment Review Committee (SARC) Consensus Summary of Assessments. Northeast Fisheries Science Center Reference Document 01-18, 281p.

NEFSC 2002. Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish. Northeast Fisheries Science Center Reference Document 02-04, 254p.

Table F1. Commercial landings (metric tons, live) of Atlantic cod from the Gulf of Maine (NAFO Division 5Y), 1960 - 2004.[1]

Year	Gulf of Maine USA	Canada	USSR	Other	Total
1960	3448	129	-	-	3577
1961	3216	18	-	-	3234
1962	2989	83	-	-	3072
1963	2595	3	133	-	2731
1964	3226	25	-	-	3251
1965	3780	148	-	-	3928
1966	4008	384	-	-	4392
1967	5676	297	-	-	5973
1968	6360	61	-	-	6421
1969	8157	59	-	268	8484
1970	7812	26	-	423	8261
1971	7380	119	-	163	7662
1972	6776	53	11	77	6917
1973	6069	68	-	9	6146
1974	7639	120	-	5	7764
1975	8903	86	-	26	9015
1976	10172	16	-	-	10188
1977	12426	-	-	-	12426
1978	12426	-	-	-	12426
1979	11680	-	-	-	11680
1980	13528	-	-	-	13528
1981	12534	-	-	-	12534
1982	13582	-	-	-	13582
1983	13981	-	-	-	13981
1984	10806	-	-	-	10806
1985	10693	-	-	-	10693
1986	9664	-	-	-	9664
1987	7527	-	-	-	7527
1988	7958	-	-	-	7958
1989	10397	-	-	-	10397
1990	15154	-	-	-	15154
1991	17781	-	-	-	17781
1992	10891	-	-	-	10891
1993	8287	-	-	-	8287
1994*	7877	-	-	-	7877
1995*	6798	-	-	-	6798
1996*	7194	-	-	-	7194
1997*	5421	-	-	-	5421
1998*	4156	-	-	-	4156
1999*	1636	-	-	-	1636
2000*	3730	-	-	-	3730
2001*	4423	-	-	-	4423
2002*	4096	-	-	-	4096
2003*	4028	-	-	-	4028
2004*	3798	-	-	-	3798

* Provisional

[1] USA 1960-1993 landings from NMFS, NEFSC Detailed Weighout Files and Canvass data.

[2] USA 1994-2004 landings estimated by prorating NMFS, NEFSC Detailed Weighout data by Vessel Trip Reports.

Table F2 Discard and total commercial catch estimates (metric tons, live) for Gulf of Maine cod by otter trawl, shrimp trawl, and sink gillnet gear derived from 1989-2004 NEFSC Sea Sample data.

		Discard Estimates				
Year	Total Landings	Included Landings	Discard Estimate	Discard to Landings Ratio	Total Discard	Total Catch
1989	10397	10182	1513	0.1486	1545	11942
1990	15154	14827	3521	0.2375	3598	18752
1991	17781	17374	1025	0.0590	1049	18830
1992	10891	10511	582	0.0554	603	11494
1993	8287	8058	320	0.0397	329	8616
1994	7877	7522	228	0.0303	239	8116
1995	6798	6500	408	0.0627	426	7224
1996	7194	6837	189	0.0277	199	7393
1997	5421	4974	164	0.0330	179	5600
1998	4156	3760	139	0.0370	154	4310
1999	1636	1332	2141	1.6074	2630	4266
2000	3730	3401	1067	0.3137	1170	4900
2001	4424	4068	1491	0.3665	1621	6045
2002	4096	3825	1821	0.4761	1950	6046
2003	4028	3799	1401	0.3688	1486	5514
2004	3798	3602	812	0.2254	856	4654

Table F3 USA sampling of commercial Atlantic cod landings from the Gulf of Maine cod stock (NAFO Division 5Y), 1982 - 2004.

Year	Number of Samples				Number of Samples, by Market Category & Quarter															Annual Sampling Intensity			
	Length Samples		Age Samples		Scrod					Market					Large					No. of Tons Landed/Sample			
	No.	No. Fish Measured	No.	No. Fish Aged	Q1	Q2	Q3	Q4	∑	Q1	Q2	Q3	Q4	∑	Q1	Q2	Q3	Q4	∑	Scrod	Market	Large	∑
1982	48	3848	48	866	6	7	6	6	25	4	3	7	4	18	0	2	1	2	5	134	348	792	266
1983	71	5241	67	1348	14	10	10	4	38	4	10	6	2	22	1	3	5	2	11	106	294	318	197
1984	55	3925	55	1224	7	5	6	7	25	4	3	5	6	18	1	6	3	2	12	85	319	245	193
1985	69	5426	66	1546	5	6	7	5	23	8	6	7	4	25	7	5	3	6	21	95	229	132	155
1986	53	3970	51	1160	5	5	6	3	19	5	6	8	2	21	1	5	4	3	13	124	242	170	182
1987	43	3184	42	939	4	4	3	4	15	5	5	3	5	18	4	2	3	1	10	83	224	225	175
1988	34	2669	33	741	4	3	4	4	15	1	5	3	5	14	1	2	2	0	5	147	271	391	234
1989	32	2668	32	714	3	3	3	3	12	4	1	5	4	14	2	2	1	1	6	209	430	311	325
1990	39	2982	38	789	3	7	3	5	18	4	7	4	3	18	0	2	1	0	3	300	378	966	387
1991	56	4519	56	1152	2	10	4	3	19	5	11	11	3	30	0	3	3	1	7	250	313	519	318
1992	51	4086	51	1002	2	8	6	3	19	6	7	7	3	23	3	1	1	4	9	104	232	375	214
1993	23	1753	23	447	3	3	3	1	10	1	2	4	1	8	1	1	2	1	5	177	453	527	360
1994	30	2696	33	665	0	2	2	4	8	1	4	4	6	15	0	2	3	2	7	180	284	272	263
1995	31	2568	32	662	4	2	2	4	12	2	7	1	2	12	0	5	0	2	7	133	300	202	219
1996	77	7027	71	1483	6	5	7	9	27	7	9	10	12	38	1	3	3	5	12	62	116	79	93
1997	78	6657	74	1521	7	10	3	9	29	11	9	9	7	36	1	8	2	2	13	37	91	71	69
1998	46	4205	46	912	4	7	0	3	14	8	9	9	3	29	0	0	2	1	3	53	81	321	90
1999	15	1305	16	350	6	0	1	0	7	4	2	0	0	6	2	0	0	0	2	36	144	245	109
2000	62	4881	62	1490	11	5	3	4	23	11	14	5	8	38	0	0	0	1	1	14	62	1131	61
2001	113	7326	105	2436	4	4	4	7	19	7	9	8	15	39	3	16	18	18	55	18	58	32	39
2002	137	5999	138	2800	4	4	0	2	10	16	5	8	4	33	53	9	15	17	94	17	64	19	30
2003	191	9043	234	5820	6	1	13	0	20	13	10	24	4	51	49	34	28	9	120	8	37	16	22
2004	201	10383	156	3375	11	9	6	20	46	16	20	15	14	65	35	19	11	25	90	2	24	22	19

Source: 1982-1985 from Serchuk and Wigley (1986); 1986-2004 from NEFSC files.

Table F4. Estimated number (000's) and weight (metric tons, live) of Atlantic cod caught by marine recreational fishermen from the Gulf of Maine stock, 1979 - 2004.[1]

Year		Total Cod Caught No. of Cod (000's)	Total Cod Caught Wt. of Cod (mt)		Total Cod Retained (excluding those caught and released) No. of Cod (000's)	Wt. of Cod (mt)	Sample Mean Weight (kg)	Number Measured	Percent of Total Landings
1979		2698	3466		not estimated		| ------- not estimated ------ |		
1980		2254	6860		not estimated		| ------- not estimated ------ |		
1981		2933	5944		2738	5549	1.595	380	30.7
1982		1833	2138		1736	2025	1.554	377	13.0
1983		1455	1388		1237	1180	1.568	882	7.8
1984		1098	1705		905	1405	1.497	596	11.5
1985		1671	1964		1471	1729	1.263	295	13.9
1986		1114	967		993	862	2.871	75	8.2
1987		2625	2317		2054	1813	1.680	320	19.4
1988		1487	2114		1300	1848	1.497	407	18.8
1989		1769	2690		1193	1814	1.824	404	14.9
1990		1725	3882		1247	2806	1.838	206	15.6
1991		1770	3635		1419	2914	1.987	370	14.1
1992		585	1154		332	655	2.725	922	5.7
1993		1564	2378		772	1174	1.799	290	12.4
1994	VTR P/C	1599	3129	VTR P/C	651	1274	1.756	477	13.9
1995	393	1486	2156	247	632	917	1.736	928	11.9
1996	278	906	2348	174	395	1025	1.920	959	12.5
1997	208	585	1245	123	166	353	2.222	458	6.1
1998	299	782	3278	119	257	1077	2.416	508	20.6
1999	226	842	2642	143	284	891	3.054	117	35.3
2000	241	1615	4562	160	555	1567	2.337	89	29.6
2001		1880	6828		778	2826	2.692	68	39.0
2002		1421	4704		409	1354	3.885	70	24.8
2003		1389	7771		468	2619	4.017	300	39.4
2004		1041	3467		372	1239	2.954	493	24.6

[1] **1981-2004 from Revised Marine Recreational Fishery Statistics Survey database expanded catch estimates.**

2 VTR P/C are estimates of the number of cod caught and retained derived from VTR records of Part/Charter vessels.

3 **1994-2001 catches were re-estimated using a revised port stratification scheme to better reflect sampling allocation.**

Table F5a. Total (commercial and recreational)landings at age (thousands of fish; metric tons) of Atlantic cod from the Gulf of Maine stock (NAFO Division 5Y), 1982 - 2004. (Input data for Virtual Population Analysis)

Year	Age 1	2	3	4	5	6	7+	Total
			Total Landings at Age in Numbers (000's)					
1982	88	1995	2350	1386	717	75	242	6853
1983	14	1337	2896	1184	685	448	169	6733
1984	24	813	1572	1636	469	205	142	4861
1985	49	989	2111	1122	665	133	137	5206
1986	26	208	2750	929	275	197	190	4575
1987	41	907	1418	1525	330	79	97	4397
1988	6	520	2140	1149	434	51	34	4334
1989	5	530	2284	1698	485	91	61	5154
1990	7	294	4195	2373	488	167	105	7629
1991	5	447	1349	4948	946	151	85	7931
1992	-	350	600	526	2184	218	86	3962
1993	1	152	1998	787	140	481	39	3597
1994	1	49	1488	1258	319	74	88	3277
1995	-	287	1233	1348	206	14	34	3123
1996	-	89	716	1955	368	45	10	3184
1997	-	61	498	469	893	72	8	2000
1998	-	112	505	627	182	214	11	1652
1999[1]	1	16	580	550	270	81	109	1606
2000[2]	-	194	540	856	198	97	23	1908
2001[3]	-	121	1065	643	375	102	84	2389
2002[4]	-	2	276	863	334	214	135	1824
2003[5]	-	14	111	430	786	240	189	1768
2004[6]	-	1	303	245	402	273	153	1376
			Total Landings at Age in Weight (Tons)					
1982	50	2151	3735	3719	3392	494	2738	16279
1983	6	1421	4664	2891	2568	2691	1680	15921
1984	12	820	2551	4412	1710	1192	1462	12169
1985	18	1007	3442	3121	2929	725	1327	12549
1986	11	213	4946	2679	1252	1186	2225	12512
1987	13	917	2185	4752	1564	547	998	10976
1988	1	513	3764	2736	2204	321	363	9902
1989	3	628	3922	4979	1861	386	726	12575
1990	1	299	6941	5414	2046	1266	1424	17391
1991	1	507	2045	12204	3807	1093	944	20601
1992	-	536	1149	1432	6684	1080	911	11793
1993	1	172	3650	1903	594	2927	428	9675
1994	-	70	2730	3845	1055	450	871	9020
1995	-	466	2261	3575	1036	100	455	7894
1996	-	147	1486	4555	1318	336	110	7951
1997	-	105	1097	1388	2804	326	70	5790
1998	-	151	1063	1833	748	877	109	4780
1999[1]	-	19	1052	1511	1117	468	840	5008
2000[2]	-	290	1222	2937	867	552	158	6025
2001[3]	-	218	2580	2089	1812	663	663	8019
2002[4]	-	3	659	2838	1348	1262	1139	7195
2003[5]	-	27	267	1322	3190	1275	1643	7406
2004[6]	-	2	730	816	1530	1472	1338	5898

1. Includes 2,500 mt of estimated discards.
2. Includes 1,000 mt of estimated discards.
3. Includes 1,500 mt of estimated discards.
4. Includes 1,500 mt of estimated discards.
5. Includes 1,000 mt of estimated discards.
6. Includes 1,000 mt of estimated discards.

Table F5b. Mean weight (kg) and mean length (cm) at age of total landings (commercial and recreational) of Atlantic cod from the Gulf of Maine stock (NAFO Division 5Y), 1982 - 2004. (Input data for Virtual Population Analysis)

	Age							
Year	1	2	3	4	5	6	7+	Average
			Total Landings Mean Weight (kg) at Age					
1982	0.568	1.078	1.589	2.683	4.731	6.587	11.314	2.375
1983	0.429	1.063	1.610	2.442	3.749	6.007	9.941	2.365
1984	0.500	1.009	1.623	2.697	3.646	5.815	10.296	2.503
1985	0.367	1.018	1.621	2.782	4.405	5.451	9.686	2.410
1986	0.423	1.024	1.799	2.884	4.553	6.020	11.711	2.735
1987	0.317	1.011	1.541	3.116	4.739	6.924	10.289	2.496
1988	0.167	0.987	1.759	2.381	5.078	6.294	10.676	2.285
1989	0.600	1.185	1.717	2.932	3.837	4.242	11.902	2.440
1990	0.143	1.017	1.655	2.282	4.193	7.581	13.562	2.280
1991	0.171	1.134	1.516	2.466	4.024	7.238	11.106	2.598
1992	0.390	1.531	1.915	2.722	3.060	5.000	10.593	2.977
1993	0.390	1.132	1.627	2.418	4.243	6.085	10.974	2.690
1994	0.390	1.429	1.835	3.056	3.307	6.081	9.898	2.753
1995	0.390	1.624	1.834	2.652	5.029	7.143	13.687	2.528
1996	0.390	1.662	2.075	2.330	3.582	7.412	10.657	2.497
1997	0.390	1.736	2.203	2.959	3.140	4.553	8.738	2.895
1998	0.625	1.348	2.105	2.923	4.110	4.098	9.528	2.893
1999	0.346	1.188	1.814	2.744	4.143	5.758	7.706	3.118
2000	0.390	1.498	2.261	3.432	4.385	5.691	6.994	3.158
2001	0.390	1.804	2.422	3.251	4.833	6.496	7.891	3.357
2002	0.390	1.360	2.389	3.289	4.041	5.888	8.427	3.944
2003	0.390	1.968	2.409	3.075	4.060	5.313	8.676	4.190
2004	0.390	1.525	2.406	3.336	3.803	5.390	8.749	4.285
			Total Landings Mean Length (cm) at Age					
1982	37.1	46.6	52.7	62.6	76.5	85.6	101.4	57.4
1983	33.5	46.6	53.1	61.0	70.5	82.5	95.6	58.0
1984	28.5	45.5	53.3	63.1	69.5	81.2	98.1	59.3
1985	32.0	45.4	53.3	64.1	74.5	79.9	96.6	58.5
1986	33.7	45.1	55.3	64.6	75.0	82.4	105.9	61.1
1987	26.4	45.1	52.1	66.4	76.2	86.4	98.4	58.8
1988	26.2	45.0	54.7	60.6	78.1	83.2	100.5	58.1
1989	38.4	48.5	54.6	65.1	71.2	77.5	103.1	60.0
1990	23.7	46.2	54.1	60.0	73.2	89.7	108.9	58.3
1991	24.9	47.5	51.9	61.3	71.8	88.1	100.7	61.1
1992	31.3	52.9	56.4	62.9	65.5	76.9	100.1	64.1
1993	38.0	47.4	55.9	60.8	73.5	83.2	101.7	61.4
1994	30.8	53.3	57.1	66.0	67.3	82.2	97.3	63.3
1995	30.8	54.4	57.3	63.2	77.9	88.6	107.0	61.9
1996	30.8	52.8	58.4	61.2	69.7	88.8	103.0	62.1
1997	30.8	54.6	59.3	65.2	66.5	75.0	104.5	64.2
1998	30.8	50.7	58.6	65.0	73.0	73.7	96.0	64.1
1999	30.8	51.1	56.3	63.7	71.4	80.5	91.7	65.7
2000	30.8	52.3	59.3	68.3	74.3	81.5	86.9	65.6
2001	30.8	55.1	61.0	67.0	77.0	85.2	90.6	66.9
2002	30.8	51.4	60.8	67.7	72.0	82.1	91.2	70.7
2003	30.8	57.9	61.1	65.9	72.1	79.0	92.5	72.1
2004	30.8	53.4	61.2	68.0	70.7	79.2	93.3	72.4

Table F6. Standardized stratified mean catch per tow in numbers and weight (kg) for Atlantic cod from NEFSC offshore spring and autumn research vessel bottom trawl surveys in the Gulf of Maine (NEFSC strata 01260-01300 and 01360-01400), 1963 - 2005 [a,b,c].

	Spring		Autumn	
Year	no/tow	wt/tow (kg)	no/tow	wt/tow (kg)
1963	No Survey Conducted		5.914	17.95
1964	No Survey Conducted		4.015	22.799
1965	No Survey Conducted		4.5	12.005
1966	No Survey Conducted		3.784	12.916
1967	No Survey Conducted		2.56	9.225
1968	5.583	18.195	4.374	19.437
1969	3.247	13.194	2.758	15.368
1970	2.191	11.077	4.905	16.442
1971	1.429	6.996	4.361	16.527
1972	2.057	8.029	9.301	12.988
1973	7.525	18.807	4.452	8.758
1974	2.902	7.418	4.328	8.959
1975	2.512	6.039	6.143	8.619
1976	2.782	7.556	2.148	6.74
1977	3.872	8.541	3.073	10.199
1978	2.05	7.697	5.773	12.899
1979	3.993	8.363	3.142	13.927
1980	2.154	6.232	7.034	14.202
1981	4.831	10.65	2.349	7.533
1982	3.763	8.616	7.768	15.919
1983	3.912	10.962	2.786	8.416
1984	3.667	6.143	2.449	8.735
1985	2.517	7.645	2.821	8.264
1986	1.957	3.476	1.95	4.715
1987	1.083	1.976	2.996	3.394
1988	3.127	3.603	5.903	6.616
1989	2.112	2.424	4.553	4.535
1990	2.362	3.076	2.986	4.912
1991	2.393	2.891	1.252	2.781
1992	2.435	8.626	1.433	2.448
1993	2.507	5.875	1.232	1.002
1994	1.271	2.427	2.13	2.737
1995	1.93	2.431	2.008	3.665
1996	2.465	5.427	1.327	2.351
1997	2.192	5.615	0.872	1.872
1998	1.71	4.18	0.843	1.5
1999	2.301	5.089	1.807	3.505
2000	3.083	3.211	2.604	4.652
2001	2.147	6.216	1.98	7.325
2002	3.724	10.933	5.328	24.659
2003	3.677	9.495	2.529	5.993
2004	0.981	2.414	3.53	4.90
2005	1.765	2.703		

[a] **Indices in all years have been recalculated and may differ slightly from those reported previously (e.g., Mayo *et al.* 2002) due to a better accounting of vessel effects in years when Albatross IV and Delaware II were used to conduct a portion of the same survey (e.g. 1979 and 1987).**

[b] **Spring surveys during 1973-1981 were conducted with a '41 Yankee' trawl; in all other years, spring surveys were conducted with a '36 Yankee' trawl. No adjustments have been made to the catch per tow data for these differences.**

[c] **During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in the standardization (NEFSC 1991).**

[d] **In the Gulf of Maine, spring and autumn surveys were conducted primarily by R/V ALBATROSS IV. During several periods since 1979, however, surveys were conducted either entirely or in part by R/V DELAWARE II. Adjustments have been made to the R/V DELAWARE II catch per tow data to standardize these to R/V ALBATROSS IV equivalents. Conversion coefficients of 0.79 (number) and 0.67 (weight) were used in the standardization (NEFSC 1991).**

Table F7 Standardized [for both door and gear changes] stratified mean number per tow at age and standardized stratified mean weight (kg) per tow of Atlantic cod in NEFSC offshore spring research vessel bottom trawl surveys in the Gulf of Maine (Strata 26-30 and 36-40), 1968-2005. [a,b]

Year	Age Group															Totals				Standardized
[c,d,e]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	0+	4+	5+	6+	Mean Wt/tow (Kg)
1968	0.128	0.613	1.234	1.407	0.846	0.538	0.207	0.129	0.111	0.059	0.165	-	-	-	-	5.438	2.056	1.211	0.673	18.20
1969	0.000	0.000	0.036	0.307	0.880	0.807	0.633	0.256	0.144	0.089	0.101	-	-	-	-	3.253	2.909	2.030	1.223	13.19
1970	0.000	0.159	0.124	0.053	0.091	0.271	0.465	0.611	0.094	0.059	0.098	0.100	0.042	0.012	0.012	2.191	1.855	1.764	1.494	11.08
1971	0.000	0.026	0.151	0.105	0.286	0.048	0.084	0.300	0.206	0.154	0.058	0.013	0.000	0.000	0.000	1.429	1.148	0.862	0.814	7.00
1972	0.000	0.371	0.135	0.521	0.195	0.181	0.044	0.124	0.093	0.229	0.056	0.056	0.034	0.000	0.017	2.057	1.030	0.835	0.653	8.03
1973	0.000	0.035	4.250	0.890	0.632	0.348	0.194	0.096	0.221	0.261	0.198	0.075	0.106	0.132	0.088	7.525	2.350	1.718	1.370	18.81
1974	0.000	0.475	0.103	1.503	0.172	0.235	0.075	0.028	0.057	0.033	0.045	0.043	0.081	0.000	0.051	2.902	0.820	0.648	0.413	7.42
1975	0.006	0.096	0.686	0.131	1.105	0.269	0.079	0.000	0.006	0.018	0.028	0.026	0.062	0.000	0.000	2.512	1.593	0.488	0.219	6.04
1976	0.000	0.051	0.265	1.104	0.137	0.902	0.090	0.095	0.027	0.000	0.011	0.000	0.074	0.027	0.000	2.782	1.362	1.225	0.323	7.56
1977	0.000	0.025	0.297	0.553	1.925	0.111	0.831	0.011	0.083	0.000	0.000	0.000	0.000	0.000	0.038	3.872	2.998	1.073	0.962	8.54
1978	0.000	0.048	0.110	0.308	0.351	0.744	0.095	0.252	0.013	0.107	0.000	0.022	0.000	0.000	0.000	2.050	1.584	1.233	0.488	7.70
1979	0.044	0.484	1.630	0.219	0.449	0.299	0.587	0.102	0.112	0.013	0.031	0.000	0.000	0.000	0.025	3.993	1.617	1.168	0.869	8.36
1980	0.070	0.037	0.423	0.492	0.138	0.238	0.304	0.317	0.000	0.122	0.014	0.000	0.000	0.000	0.000	2.155	1.133	0.994	0.756	6.23
1981	0.000	1.075	0.644	0.841	1.342	0.331	0.264	0.116	0.121	0.100	0.000	0.000	0.000	0.000	0.000	4.832	2.272	0.930	0.600	10.65
1982	0.014	0.359	1.007	0.476	0.655	0.988	0.087	0.112	0.000	0.026	0.039	0.000	0.000	0.000	0.000	3.763	1.907	1.251	0.264	8.62
1983	0.013	0.632	0.949	0.997	0.465	0.404	0.212	0.068	0.016	0.071	0.018	0.008	0.030	0.000	0.030	3.912	1.322	0.857	0.453	10.96
1984	0.000	0.151	1.312	1.023	0.823	0.212	0.047	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.667	1.182	0.359	0.147	6.14
1985	0.000	0.029	0.231	0.662	0.663	0.662	0.103	0.091	0.052	0.000	0.026	0.000	0.000	0.000	0.000	2.517	1.596	0.933	0.272	7.65
1986	0.000	0.537	0.248	0.754	0.237	0.091	0.035	0.038	0.000	0.000	0.000	0.000	0.018	0.000	0.000	1.957	0.419	0.182	0.090	3.48
1987	0.000	0.030	0.460	0.199	0.231	0.074	0.000	0.066	0.008	0.000	0.000	0.000	0.000	0.000	0.015	1.083	0.394	0.163	0.088	1.98
1988	0.029	0.717	0.923	0.823	0.218	0.254	0.092	0.065	0.000	0.007	0.000	0.000	0.000	0.000	0.000	3.127	0.635	0.417	0.163	3.60
1989	0.000	0.017	0.605	0.723	0.600	0.091	0.063	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.112	0.768	0.168	0.077	2.42
1990	0.000	0.000	0.208	1.365	0.637	0.102	0.032	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.362	0.789	0.152	0.050	3.08
1991	0.000	0.038	0.068	0.234	1.717	0.299	0.020	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.393	2.054	0.337	0.038	2.89
1992	0.000	0.050	0.226	0.242	0.282	1.328	0.226	0.069	0.000	0.012	0.000	0.000	0.000	0.000	0.000	2.435	1.917	1.635	0.307	8.63
1993	0.000	0.201	0.497	0.799	0.334	0.091	0.484	0.055	0.023	0.000	0.000	0.023	0.000	0.000	0.000	2.507	1.010	0.676	0.585	5.88
1994	0.000	0.015	0.316	0.388	0.215	0.094	0.049	0.127	0.027	0.022	0.018	0.000	0.000	0.000	0.000	1.271	0.553	0.338	0.244	2.43
1995	0.000	0.050	0.179	1.116	0.372	0.145	0.028	0.000	0.011	0.000	0.000	0.000	0.000	0.028	0.000	1.930	0.585	0.213	0.068	2.43
1996	0.000	0.057	0.022	0.593	1.331	0.403	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.465	1.793	0.463	0.059	5.43
1997	0.000	0.159	0.132	0.399	0.264	0.876	0.242	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.192	1.502	1.238	0.362	5.62
1998	0.000	0.018	0.224	0.330	0.517	0.142	0.421	0.023	0.037	0.000	0.000	0.000	0.000	0.000	0.000	1.710	1.139	0.622	0.481	4.18
1999	0.000	0.166	0.344	0.713	0.345	0.315	0.134	0.273	0.000	0.000	0.000	0.000	0.000	0.011	0.000	2.301	1.078	0.733	0.418	5.09
2000	0.026	1.184	0.725	0.439	0.457	0.107	0.101	0.024	0.022	0.000	0.000	0.000	0.000	0.000	0.000	3.083	0.710	0.253	0.146	3.21
2001	0.000	0.029	0.323	0.716	0.497	0.354	0.064	0.098	0.055	0.000	0.011	0.000	0.000	0.000	0.000	2.146	1.078	0.581	0.227	6.22
2002	0.000	0.340	0.045	0.524	1.601	0.614	0.362	0.164	0.057	0.016	0.000	0.000	0.000	0.000	0.000	3.724	2.814	1.213	0.598	10.93
2003	0.000	0.069	0.831	0.063	0.708	1.089	0.395	0.321	0.103	0.073	0.027	0.000	0.000	0.000	0.000	3.677	2.715	2.007	0.918	9.50
2004	0.000	0.136	0.045	0.221	0.118	0.191	0.232	0.014	0.014	0.010	0.000	0.000	0.000	0.000	0.000	0.981	0.579	0.461	0.270	2.41
2005	0.000	0.020	0.726	0.101	0.608	0.015	0.145	0.130	0.014	0.000	0.000	0.000	0.000	0.000	0.000	1.765	0.917	0.309	0.294	2.70

[a] Indices from 1970-2001 have been recalculated and may differ slightly from those reported previously (Mayo *et al.* 2002) due to slight modifications to the age-length keys and a better accounting of vessel effects in 1979 and 1987.

[b] Spring catch per tow at age indices for 1968-1969 were obtained by applying combined 1970-1981 age-length keys to stratified mean catch per tow at length distributions from each survey. Calculations were carried out only to age 10+.

[c] Spring surveys during 1973-1981 were accomplished with a '41 Yankee' trawl; in all other years, spring surveys were accomplished with a '36 Yankee' trawl. No adjustments have been made to the catch per tow data for these differences.

[d] During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in this standardization (NESFC 1991).

[e] In the Gulf of Maine, spring surveys during 1980-1982, 1989-1991, 1994 and 2003, were conducted aboard R/V DELAWARE II; in all other years, the surveys were conducted aboard R/V ALBATROSS IV except in 1979 and 1987 when both vessels were deployed on portions of the survey. Adjustments have been made to the R/V DELAWARE II catch per tow data to standardize these to R/V ALBATROSS IV equivalents. Conversion coefficients of 0.79 (numbers) and 0.67 (weight) were used in this standardization (NEFSC 1991).

Table F8. Standardized [for both door and gear changes] stratified mean number per tow at age and standardized stratified mean weight (kg) per tow of Atlantic cod in NEFSC offshore autumn research vessel bottom trawl surveys in the Gulf of Maine (Strata 26-30 and 36-40), 1963-2004. [a,b]

Year	Age Group															Totals				Standardized
[c,d]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	0+	3+	4+	5+	Mean Wt/tow (Kg)
1963	0.050	0.649	1.349	1.253	0.849	0.579	0.537	0.300	0.183	0.095	0.075	-	-	-	-	5.917	3.869	2.616	1.767	17.95
1964	0.000	0.092	0.122	0.417	0.856	0.853	0.783	0.373	0.237	0.114	0.101	-	-	-	-	4.003	3.789	3.318	2.462	22.80
1965	0.002	0.850	0.880	0.824	0.750	0.496	0.374	0.170	0.080	0.044	0.025	-	-	-	-	4.494	2.763	1.939	1.189	12.01
1966	0.170	0.204	0.640	0.697	0.718	0.558	0.441	0.192	0.078	0.048	0.036	-	-	-	-	3.783	2.769	2.072	1.354	12.92
1967	0.012	0.129	0.215	0.574	0.671	0.384	0.268	0.162	0.070	0.041	0.034	-	-	-	-	2.562	2.204	1.630	0.959	9.23
1968	0.012	0.036	0.179	0.719	1.256	0.973	0.627	0.261	0.156	0.072	0.095	-	-	-	-	4.387	4.159	3.440	2.184	19.44
1969	0.016	0.059	0.123	0.354	0.630	0.552	0.466	0.220	0.145	0.129	0.062	-	-	-	-	2.758	2.560	2.206	1.576	15.37
1970	0.802	0.883	0.260	0.538	0.329	0.486	0.425	0.811	0.132	0.094	0.036	0.037	0.073	0.000	0.000	4.905	2.960	2.422	2.093	16.44
1971	1.319	0.179	0.276	0.219	0.578	0.478	0.455	0.236	0.298	0.163	0.066	0.034	0.061	0.000	0.000	4.361	2.588	2.368	1.790	16.53
1972	0.031	5.578	1.215	1.528	0.233	0.090	0.140	0.070	0.138	0.262	0.000	0.000	0.000	0.000	0.016	9.301	2.477	0.949	0.716	12.99
1973	0.638	0.329	2.170	0.139	0.507	0.213	0.077	0.027	0.051	0.183	0.102	0.000	0.000	0.016	0.000	4.452	1.315	1.176	0.669	8.76
1974	0.283	1.134	0.266	1.876	0.167	0.274	0.051	0.046	0.036	0.033	0.033	0.098	0.000	0.000	0.033	4.328	2.646	0.770	0.603	8.96
1975	0.047	0.177	3.045	0.138	2.333	0.259	0.109	0.017	0.006	0.000	0.000	0.006	0.006	0.000	0.000	6.143	2.874	2.736	0.403	8.62
1976	0.000	0.230	0.221	0.633	0.077	0.773	0.052	0.132	0.000	0.000	0.031	0.000	0.000	0.000	0.000	2.148	1.697	1.064	0.988	6.74
1977	0.000	0.042	0.416	0.465	1.157	0.114	0.629	0.044	0.090	0.022	0.032	0.000	0.044	0.019	0.000	3.073	2.615	2.150	0.994	10.20
1978	0.248	1.373	0.378	1.135	0.658	1.426	0.109	0.310	0.005	0.083	0.007	0.013	0.000	0.028	0.000	5.773	3.773	2.638	1.980	12.90
1979	0.002	0.381	0.588	0.145	0.708	0.337	0.688	0.044	0.181	0.000	0.053	0.000	0.000	0.000	0.018	3.142	2.172	2.027	1.319	13.93
1980	0.027	1.321	2.520	1.780	0.492	0.194	0.360	0.207	0.036	0.025	0.000	0.036	0.000	0.014	0.022	7.034	3.165	1.385	0.894	14.20
1981	0.010	0.618	0.419	0.539	0.405	0.121	0.076	0.029	0.090	0.000	0.043	0.000	0.000	0.000	0.000	2.349	1.302	0.763	0.358	7.53
1982	0.000	0.843	3.353	2.275	1.089	0.209	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.769	3.573	1.298	0.209	15.92
1983	0.000	0.317	0.916	0.828	0.197	0.227	0.210	0.000	0.000	0.000	0.027	0.028	0.037	0.000	0.000	2.786	1.553	0.726	0.529	8.42
1984	0.022	0.432	0.426	0.631	0.387	0.214	0.163	0.079	0.000	0.030	0.000	0.000	0.030	0.035	0.000	2.449	1.569	0.938	0.551	8.74
1985	0.121	0.526	0.957	0.609	0.248	0.182	0.075	0.000	0.034	0.021	0.010	0.000	0.010	0.000	0.029	2.821	1.218	0.609	0.361	8.26
1986	0.000	0.392	0.401	0.657	0.342	0.073	0.041	0.000	0.011	0.034	0.000	0.000	0.000	0.000	0.000	1.950	1.157	0.501	0.159	4.72
1987	0.128	0.578	1.380	0.592	0.243	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.996	0.910	0.318	0.075	3.39
1988	0.000	1.938	2.313	0.990	0.443	0.099	0.065	0.033	0.011	0.011	0.000	0.000	0.000	0.000	0.000	5.903	1.652	0.662	0.219	6.62
1989	0.000	0.150	2.407	1.502	0.293	0.161	0.033	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	4.553	1.997	0.495	0.202	4.54
1990	0.006	0.045	0.187	1.829	0.598	0.259	0.052	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.986	2.748	0.919	0.321	4.91
1991	0.009	0.144	0.139	0.223	0.633	0.081	0.000	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.252	0.960	0.737	0.104	2.78
1992	0.059	0.291	0.446	0.140	0.036	0.350	0.104	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.433	0.638	0.498	0.462	2.45
1993	0.043	0.198	0.568	0.360	0.034	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.232	0.424	0.064	0.030	1.00
1994	0.032	0.207	0.883	0.826	0.085	0.051	0.000	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.130	1.008	0.182	0.096	2.74
1995	0.008	0.068	0.285	1.228	0.325	0.082	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.008	1.647	0.419	0.093	3.67
1996	0.029	0.124	0.383	0.188	0.542	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.327	0.792	0.604	0.062	2.35
1997	0.000	0.297	0.086	0.177	0.173	0.140	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.872	0.490	0.313	0.140	1.87
1998	0.050	0.097	0.320	0.115	0.192	0.039	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.843	0.376	0.262	0.069	1.50
1999	0.025	0.431	0.367	0.586	0.243	0.132	0.016	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.807	0.984	0.398	0.155	3.51
2000	0.008	0.533	0.984	0.394	0.507	0.134	0.010	0.000	0.011	0.023	0.000	0.000	0.000	0.000	0.000	2.604	1.079	0.686	0.178	4.65
2001	0.018	0.034	0.141	0.752	0.469	0.337	0.122	0.084	0.000	0.023	0.000	0.000	0.000	0.000	0.000	1.980	1.788	1.035	0.566	7.33
2002	0.000	0.269	0.081	0.364	2.797	1.096	0.627	0.051	0.043	0.000	0.000	0.000	0.000	0.000	0.000	5.328	4.979	4.615	1.818	24.66
2003	0.542	0.455	0.198	0.185	0.529	0.450	0.073	0.077	0.000	0.011	0.000	0.011	0.000	0.000	0.000	2.529	1.335	1.150	0.622	5.99
2004	1.380	0.651	0.168	0.581	0.231	0.253	0.168	0.068	0.011	0.010	0.011	0.000	0.000	0.000	0.000	3.533	1.334	0.753	0.522	4.90

[a] Indices from 1970-2001 have been recalculated and may differ slightly from those reported previously (Mayo *et al.* 2002) due to slight modifications to the age-length keys and a better accounting of vessel effects in 1979.

[b] Autumn catch per tow at age indices for 1963-1969 were obtained by applying combined 1970-1981 age-length keys to stratified mean catch per tow at length distributions from each survey. Calculations were carried out only to age 10+.

[c] During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in this standardization (NEFSC 1991).

[d] In the Gulf of Maine, autumn surveys during 1977-1978, 1980, 1989-1991 and 1993 were conducted aboard R/V DELAWARE II; in all other years, the surveys were conducted aboard R/V ALBATROSS IV except in 1979 when both vessels were deployed on portions of the survey. Adjustments have been made to the R/V DELAWARE II catch per tow data to standardize these to R/V ALBATROSS IV equivalents. Conversion coefficients of 0.79 (numbers) and 0.67 (weight) were used in this standardization (NEFSC 1991).

Table F9 Stratified mean catch per tow in numbers and weight (kg) of Atlantic cod in State of Massachusetts inshore spring and autumn bottom trawl surveys in territorial waters adjacent to the Gulf of Maine (Mass. Regions 4-5), 1978 - 2005. [a]

	Age Group											Totals				Stratified Mean Weight/tow (kg)
Year	0	1	2	3	4	5	6	7	8	9	10+	0+	1+	2+	3+	
Spring																
1978	21.965	12.784	4.162	4.572	0.872	1.028	0.000	0.000	0.023	0.000	0.000	45.406	23.441	10.657	6.495	12.16
1979	56.393	36.630	2.581	1.533	4.659	1.995	0.183	0.000	0.000	0.000	0.069	104.043	47.650	11.020	8.439	20.53
1980	8.156	50.311	12.679	0.971	0.745	0.737	0.080	0.214	0.000	0.025	0.000	73.918	65.762	15.451	2.772	17.71
1981	19.753	24.794	23.884	3.122	1.279	0.041	0.146	0.022	0.022	0.000	0.000	73.063	53.310	28.516	4.632	21.79
1982	1.489	16.235	7.060	3.418	1.147	0.232	0.011	0.057	0.045	0.000	0.000	29.694	28.205	11.970	4.910	13.42
1983	0.453	27.703	18.572	5.331	0.501	1.221	0.142	0.022	0.000	0.000	0.000	53.945	53.492	25.789	7.217	19.77
1984	0.206	2.896	5.408	2.271	0.865	0.138	0.162	0.000	0.000	0.000	0.000	11.946	11.740	8.844	3.436	8.63
1985	0.793	2.711	3.822	2.794	0.692	0.000	0.000	0.000	0.000	0.000	0.000	10.812	10.019	7.308	3.486	6.42
1986	0.957	19.960	3.222	0.887	0.426	0.090	0.019	0.000	0.000	0.000	0.000	25.561	24.604	4.644	1.422	7.77
1987	0.659	8.590	6.997	2.268	0.257	0.147	0.048	0.000	0.000	0.087	0.000	19.053	18.394	9.804	2.807	9.59
1988	1.595	11.841	11.356	2.511	1.370	0.000	0.039	0.000	0.000	0.000	0.000	28.712	27.117	15.276	3.920	9.66
1989	0.157	20.679	25.260	6.580	0.458	0.106	0.124	0.000	0.000	0.000	0.000	53.364	53.207	32.528	7.268	18.26
1990	4.10	6.33	6.89	17.77	2.64	0.18	0.05	0.02	0.000	0.000	0.000	37.980	33.88	27.55	20.66	19.51
1991	0.32	5.88	3.56	2.54	5.03	0.36	0.000	0.000	0.000	0.000	0.000	17.69	17.37	11.49	7.93	11.37
1992	1.36	6.42	6.35	3.58	0.65	1.37	0.12	0.04	0.00	0.00	0.00	19.88	18.53	12.11	5.76	10.10
1993	69.03	3.40	7.76	3.60	1.45	0.05	0.30	0.00	0.00	0.00	0.00	85.59	16.56	13.16	5.40	7.63
1994	3.90	4.45	5.67	2.46	0.52	0.23	0.03	0.06	0.00	0.03	0.00	17.35	13.45	9.00	3.33	4.83
1995	9.84	6.41	1.36	3.89	1.20	0.09	0.00	0.00	0.00	0.00	0.00	22.79	12.95	6.54	5.18	4.49
1996	6.39	1.37	0.65	1.15	2.00	0.38	0.00	0.00	0.00	0.00	0.00	11.96	5.57	4.20	3.55	4.06
1997	10.40	3.66	1.25	1.05	0.22	0.50	0.03	0.00	0.00	0.00	0.00	17.09	6.69	3.03	1.78	2.97
1998	20.72	3.15	1.80	0.99	1.06	0.08	0.46	0.04	0.00	0.00	0.00	28.30	7.58	4.43	2.63	5.76
1999	116.22	14.36	3.57	3.46	1.20	1.08	0.06	0.22	0.04	0.00	0.00	140.08	23.84	9.48	5.91	14.19
2000	1.83	27.99	7.12	2.85	2.60	0.78	0.77	0.06	0.13	0.00	0.00	44.16	42.33	14.34	7.22	22.36
2001	19.00	0.08	2.78	4.81	3.63	1.86	0.41	0.16	0.00	0.00	0.00	32.74	13.74	13.66	10.88	22.33
2002	0.82	16.71	0.441	1.642	2.379	0.879	0.615	0.37	0.286	0.178	0.286	24.11	23.29	6.58	6.14	19.51
2003	801.27	6.247	9.338	0.366	1.714	1.638	0.365	0.20	0.018	0.000	0.000	821.16	19.89	13.64	4.30	12.32
2004	100.62	12.177	2.049	3.350	0.608	1.310	0.891	0.056	0.097	0.067	0.000	121.22	20.60	8.42	6.37	12.18
2005	145.59	3.236	9.363	0.675	2.575	0.230	1.313	0.474	0.077	0.000	0.000	163.53	17.94	14.70	5.34	13.05
Autumn																
1978	151.533	2.082	0.000	0.120	0.140	0.318	0.000	0.080	0.000	0.000	0.000	154.273	2.740	0.658	0.658	3.02
1979	4.933	3.430	0.042	0.000	0.026	0.000	0.000	0.000	0.000	0.000	0.000	8.431	3.498	0.068	0.026	0.99
1980	5.680	8.834	0.052	0.000	0.000	0.050	0.000	0.000	0.000	0.000	0.000	14.616	8.936	0.102	0.050	1.57
1981	2.018	5.652	7.290	0.729	0.000	0.000	0.000	0.000	0.000	0.000	0.000	15.689	13.671	8.019	0.729	6.65
1982	4.667	2.346	1.005	0.060	0.050	0.000	0.000	0.000	0.000	0.000	0.000	8.128	3.461	1.115	0.110	1.35
1983	1.308	0.651	0.100	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.072	0.764	0.113	0.013	0.18
1984	12.296	0.344	0.022	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.675	0.379	0.035	0.013	0.18
1985	2.832	0.419	0.018	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.279	0.447	0.028	0.010	0.09
1986	2.478	1.150	0.833	0.000	0.067	0.000	0.000	0.000	0.000	0.000	0.000	4.528	2.050	0.900	0.067	0.55
1987	389.584	2.386	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	391.990	2.406	0.020	0.000	0.45
1988	4.571	20.490	0.679	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.740	21.169	0.679	0.000	1.57
1989	2.971	2.700	0.350	0.210	0.185	0.000	0.000	0.000	0.000	0.000	0.000	6.416	3.445	0.745	0.395	1.27
1990	9.37	9.13	1.74	0.31	0.06	0.03	0.000	0.000	0.000	0.000	0.000	20.638	11.27	2.14	0.40	1.56
1991	4.65	4.20	0.81	0.03	0.05	0.01	0.00	0.00	0.00	0.00	0.00	9.74	5.09	0.89	0.08	0.80
1992	24.30	2.01	0.11	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	26.48	2.18	0.17	0.06	0.42
1993	49.92	3.32	0.61	0.33	0.00	0.00	0.01	0.00	0.00	0.00	0.00	54.21	4.29	0.97	0.36	1.97
1994	33.49	14.13	6.37	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.26	20.77	6.64	0.27	4.47
1995	2.56	0.64	0.54	0.79	0.02	0.00	0.00	0.00	0.00	0.00	0.00	4.55	1.99	1.35	0.81	0.74
1996	7.59	0.15	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	7.78	0.19	0.04	0.03	0.09
1997	2.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.04	0.02	0.00	0.00	0.02
1998	2.61	1.04	0.62	0.08	0.11	0.00	0.00	0.00	0.00	0.00	0.00	4.46	1.85	0.81	0.19	0.56
1999	6.34	0.98	0.28	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	7.65	1.31	0.33	0.05	0.43
2000	0.04	0.54	0.27	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.91	0.87	0.33	0.06	0.34
2001	44.52	0.06	0.30	0.15	0.09	0.09	0.00	0.00	0.00	0.01	0.00	45.22	0.70	0.64	0.34	1.00
2002	0.99	2.50	0.30	0.55	0.77	0.91	0.08	0.00	0.00	0.08	0.00	6.17	5.18	2.68	2.38	8.66
2003	112.79	3.66	0.33	0.12	0.47	0.15	0.02	0.00	0.00	0.00	0.00	117.54	4.75	1.09	0.76	3.13
2004	39.22	14.38	1.50	2.03	0.33	0.77	0.38	0.01	0.00	0.00	0.00	58.62	19.40	5.02	3.52	8.77

[a] Massachusetts sampling strata 25-36.

Table F10. Comparative Results from ADAPT/VPA runs incorporating data and software updates since the 2002 GARM.

	GARM/FACT	GARM/NFT	NewAges/NFT [1]	Rev. MRFSS/NFT 1	Rev. Indices/NFT	All Rev/NFT [1]
Terminal Year	2001	2001	2001	2001	2001	2001
RSS	139.865	140.169	139.992	140.117	139.346	139.219
N t+1 age 2 (cv)	463 (0.40)	463 (0.38)	463 (0.38)	466 (0.38)	523 (0.33)	526 (0.33)
N t+1 age 3 (cv)	3009 (0.26)	3007 (0.25)	3002 (0.25)	2990 (0.26)	3022 (0.25)	3004 (0.26)
N t+1 age 4 (cv)	4554 (0.25)	4551 (0.24)	4533 (0.24)	4531 (0.24)	4704 (0.24)	4685 (0.24)
N t+1 age 5 (cv)	1362 (0.28)	1211 (0.27)	1207 (0.27)	1221 (0.27)	1257 (0.26)	1267 (0.26)
N t+1 age 6 (cv)	437 (0.36)	492 (0.35)	492 (0.35)	496 (0.35)	506 (0.34)	510 (0.34)
F age 1	0	0	0	0	0	0
F age 2	0.02	0.0167	0.0179	0.0348	0.0178	0.0358
F age 3	0.18	0.1814	0.1811	0.1937	0.1752	0.1872
F age 4	0.37	0.4039	0.4039	0.3906	0.3906	0.3779
F age 5	0.57	0.519	0.5227	0.518	0.5109	0.51
F age 6	0.47	0.4614	0.4663	0.4543	0.4507	0.4439
F (ages 4-5)	0.47		0.46	0.46	0.45	0.44
SSB (mt)	22,040	21,937	24,328	24,228	25,003	24,801

1. Revised mean weights at age in 2000 and 2001

Table F11. Final VPA Results for Gulf of Maine Cod, 1982-2005

JAN-1 Population Numbers (000's)

AGE	1982	1983	1984	1985	1986
1	7769.	7539.	10464.	7004.	10162.
2	10891.	6281.	6160.	8545.	5690.
3	5359.	7112.	3933.	4307.	6101.
4	3026.	2262.	3202.	1797.	1616.
5	1796.	1223.	780.	1142.	456.
6	170.	822.	382.	214.	333.
7	548.	310.	264.	221.	321.
Total	29559.	25548.	25185.	23231.	24680.

AGE	1987	1988	1989	1990	1991
1	12538.	25205.	4301.	4031.	7056.
2	8296.	10228.	20630.	3517.	3294.
3	4471.	5972.	7904.	16411.	2613.
4	2507.	2377.	2953.	4404.	9640.
5	483.	673.	907.	881.	1459.
6	125.	97.	158.	303.	280.
7	153.	64.	106.	191.	158.
Total	28573.	44616.	36958.	29738.	24500.

AGE	1992	1993	1994	1995	1996
1	6658.	9625.	3516.	3688.	3507.
2	5773.	5451.	7879.	2878.	3020.
3	2292.	4410.	4325.	6407.	2096.
4	919.	1334.	1802.	2195.	4130.
5	3416.	276.	380.	337.	577.
6	338.	820.	100.	22.	90.
7	135.	67.	119.	54.	20.
Total	19530.	21982.	18121.	15581.	13439.

AGE	1997	1998	1999	2000	2001
1	5919.	5106.	7826.	4404.	1050.
2	2871.	4846.	4180.	6406.	3606.
3	2392.	2295.	3866.	3408.	5070.
4	1068.	1508.	1422.	2641.	2302.
5	1612.	450.	667.	667.	1388.
6	140.	512.	204.	302.	367.
7	16.	26.	275.	72.	302.
Total	14018.	14744.	18441.	17900.	14084.

AGE	2002	2003	2004	2005
1	7062.	3067.	22082.	6316.
2	860.	5782.	2511.	18079.
3	2843.	702.	4721.	2055.
4	3187.	2078.	474.	3591.
5	1303.	1828.	1312.	167.
6	797.	764.	786.	711.
7	503.	602.	358.	499.
Total	16554.	14824.	32244.	31417.

Table 11 (continued).

Fishing Mortality Calculated

AGE	1982	1983	1984	1985	1986
1	0.0126	0.0021	0.0025	0.0078	0.0028
2	0.2262	0.2682	0.1577	0.1369	0.0412
3	0.6628	0.5979	0.5830	0.7801	0.6894
4	0.7057	0.8642	0.8315	1.1709	1.0083
5	0.5819	0.9646	1.0915	1.0322	1.0968
6	0.6578	0.8983	0.8774	1.1147	1.0271
7	0.6578	0.8983	0.8774	1.1147	1.0271
Avg (4-5)	0.6438	0.9144	0.9615	1.1015	1.0525

AGE	1987	1988	1989	1990	1991
1	0.0036	0.0003	0.0013	0.0019	0.0008
2	0.1288	0.0578	0.0288	0.0969	0.1625
3	0.4316	0.5043	0.3847	0.3320	0.8451
4	1.1156	0.7639	1.0093	0.9050	0.8376
5	1.4077	1.2483	0.8945	0.9471	1.2611
6	1.1573	0.8524	0.9812	0.9119	0.8840
7	1.1573	0.8524	0.9812	0.9119	0.8840
Avg (4-5)	1.2616	1.0061	0.9519	0.9260	1.0493

AGE	1992	1993	1994	1995	1996
1	0.0000	0.0001	0.0003	0.0000	0.0000
2	0.0694	0.0313	0.0069	0.1168	0.0331
3	0.3415	0.6947	0.4784	0.2391	0.4740
4	1.0012	1.0559	1.4756	1.1357	0.7406
5	1.2263	0.8202	2.6326	1.1231	1.2196
6	1.1742	1.0113	1.6026	1.1340	0.7884
7	1.1742	1.0113	1.6026	1.1340	0.7884
Avg (4-5)	1.1138	0.9381	2.0541	1.1294	0.9801

AGE	1997	1998	1999	2000	2001
1	0.0000	0.0000	0.0001	0.0000	0.0000
2	0.0238	0.0259	0.0042	0.0340	0.0378
3	0.2615	0.2786	0.1813	0.1925	0.2642
4	0.6638	0.6156	0.5575	0.4435	0.3692
5	0.9472	0.5916	0.5932	0.3977	0.3548
6	0.8245	0.6100	0.5687	0.4341	0.3638
7	0.8245	0.6100	0.5687	0.4341	0.3638
Avg (4-5)	0.8055	0.6036	0.5753	0.4206	0.3620

AGE	2002	2003	2004
1	0.0000	0.0000	0.0000
2	0.0026	0.0027	0.0004
3	0.1135	0.1921	0.0736
4	0.3556	0.2597	0.8459
5	0.3332	0.6445	0.4134
6	0.3491	0.4217	0.6297
7	0.3491	0.4217	0.6297
Avg (4-5)	0.3444	0.4521	0.6297

Table 11 (continued).

JAN-1 Biomass (mt)

AGE	1982	1983	1984	1985	1986
1	3226.	2109.	3666.	1539.	2780.
2	9607.	4880.	4052.	6096.	3488.
3	6870.	9369.	5165.	5509.	8257.
4	6868.	4455.	6673.	3819.	3495.
5	7541.	3880.	2328.	3935.	1624.
6	948.	4381.	1782.	956.	1715.
7	6200.	3082.	2722.	2140.	3761.
Total	41259.	32155.	26390.	23994.	25120.

AGE	1987	1988	1989	1990	1991
1	2253.	1580.	1982.	205.	510.
2	5426.	5722.	9178.	2747.	1326.
3	5616.	7963.	10289.	22982.	3245.
4	5936.	4554.	6706.	8718.	19476.
5	1785.	2676.	2740.	3089.	4421.
6	700.	528.	734.	1637.	1541.
7	1576.	688.	1261.	2587.	1749.
Total	23292.	23711.	32891.	41966.	32269.

AGE	1992	1993	1994	1995	1996
1	1527.	1964.	673.	700.	649.
2	3195.	3624.	5885.	2291.	2425.
3	3378.	7375.	6234.	10372.	3848.
4	1867.	2870.	4259.	4842.	8537.
5	9383.	940.	1074.	1323.	1779.
6	1518.	3540.	506.	109.	549.
7	1427.	730.	1173.	726.	213.
Total	22294.	21043.	19804.	20362.	18000.

AGE	1997	1998	1999	2000	2001
1	1244.	2315.	1301.	800.	220.
2	2363.	3515.	3602.	4612.	3026.
3	4563.	4388.	6046.	5586.	9656.
4	2648.	3825.	3418.	6589.	6240.
5	4360.	1571.	2321.	2313.	5651.
6	564.	1836.	993.	1465.	1958.
7	136.	251.	2117.	500.	2384.
Total	15877.	17701.	19798.	21865.	29135.

AGE	2002	2003	2004	2005
1	1228.	606.	4361.	1197.
2	626.	5068.	1938.	14324.
3	5923.	1271.	10273.	4158.
4	9033.	5652.	1345.	10043.
5	4732.	6710.	4487.	596.
6	4253.	3549.	3676.	3472.
7	4228.	5223.	3128.	4295.
Total	30024.	28078.	29208.	38085.

Table 11 (Continued).

Spawning Stock Biomass (mt)

AGE	1982	1983	1984	1985	1986
1	218.	143.	248.	59.	108.
2	2327.	1174.	993.	2766.	1608.
3	3629.	5004.	2765.	4444.	6763.
4	5197.	3283.	4945.	3039.	2858.
5	6421.	3099.	1821.	3204.	1308.
6	822.	3648.	1489.	768.	1397.
7	5374.	2566.	2275.	1719.	3065.
Total	23987.	18916.	14536.	16000.	17107.

AGE	1987	1988	1989	1990	1991
1	87.	61.	77.	22.	54.
2	2465.	2631.	4241.	732.	350.
3	4802.	6727.	8867.	11778.	1527.
4	4767.	3878.	5481.	5874.	13270.
5	1365.	2102.	2283.	2373.	3223.
6	559.	443.	602.	1333.	1261.
7	1257.	578.	1036.	2150.	1460.
Total	15302.	16419.	22587.	24261.	21144.

AGE	1992	1993	1994	1995	1996
1	162.	209.	26.	27.	25.
2	855.	976.	2160.	826.	886.
3	1728.	3558.	4955.	8579.	3061.
4	1238.	1886.	3189.	3836.	7225.
5	6880.	737.	670.	1061.	1404.
6	1183.	2835.	375.	87.	465.
7	1135.	597.	869.	581.	180.
Total	13182.	10798.	12244.	14998.	13247.

AGE	1997	1998	1999	2000	2001
1	48.	90.	50.	31.	8.
2	865.	1287.	1323.	1685.	1105.
3	3760.	3606.	5050.	4656.	7954.
4	2270.	3306.	2983.	5859.	5619.
5	3601.	1377.	2033.	2094.	5152.
6	475.	1604.	873.	1318.	1782.
7	114.	219.	1862.	450.	2170.
Total	11134.	11487.	14174.	16094.	23791.

AGE	2002	2003	2004
1	173.	86.	616.
2	223.	1803.	690.
3	3738.	792.	6527.
4	7172.	4559.	984.
5	4330.	5828.	4051.
6	3881.	3200.	3201.
7	3858.	4709.	2724.
Total	23375.	20977.	18793.

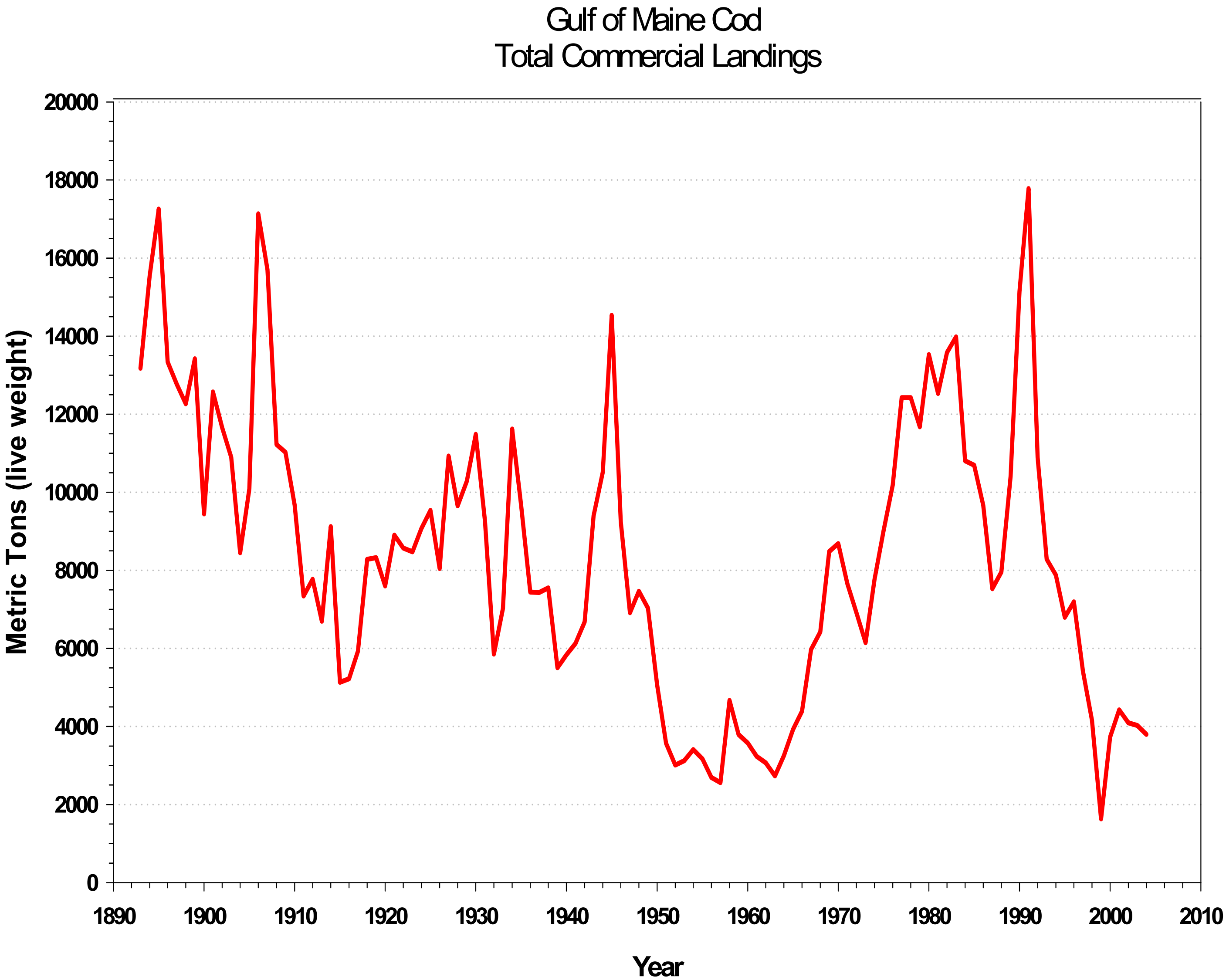


Figure F1. Total commercial landings of Gulf of Maine cod (NAFO Div. 5Y), 1893-2004.

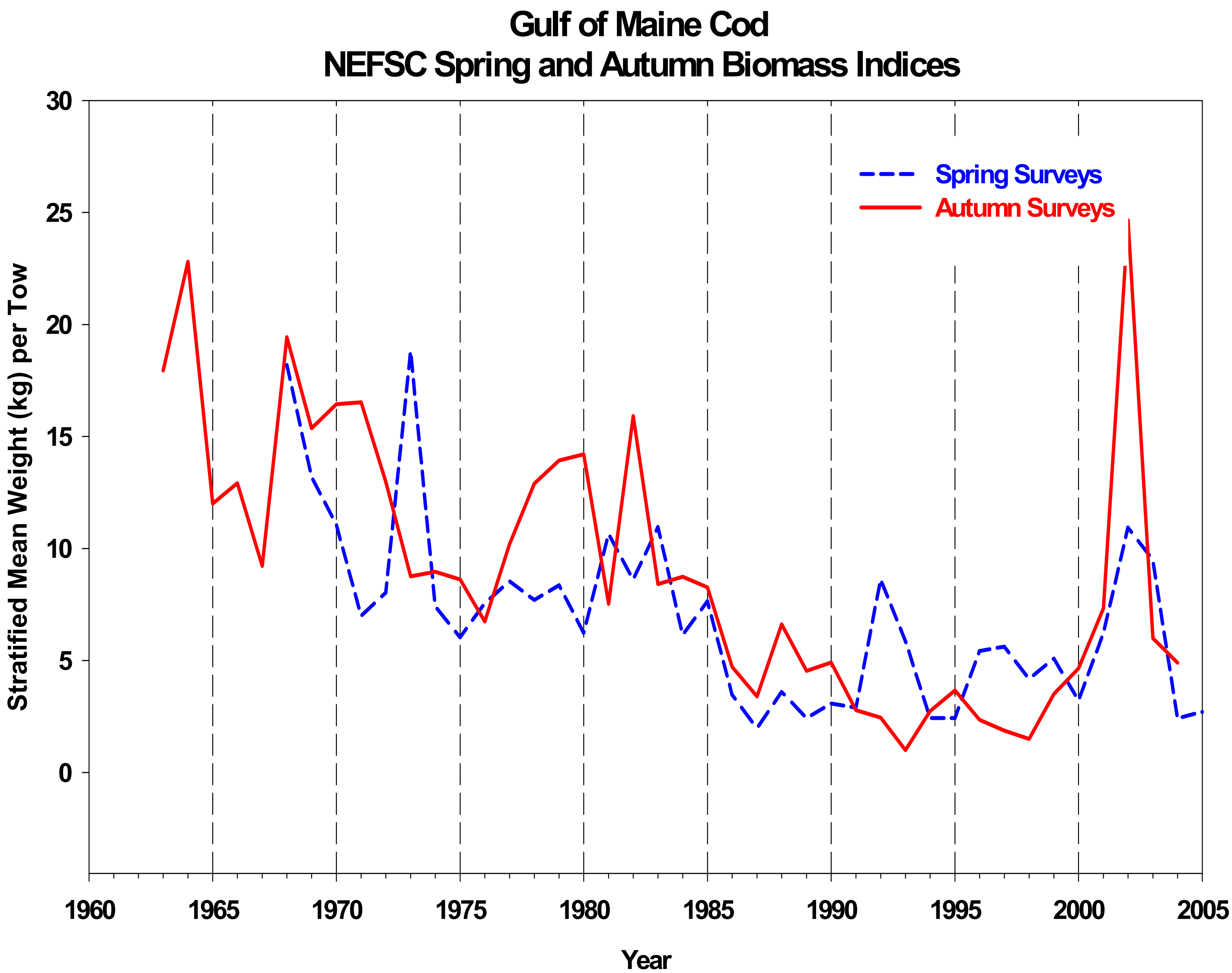
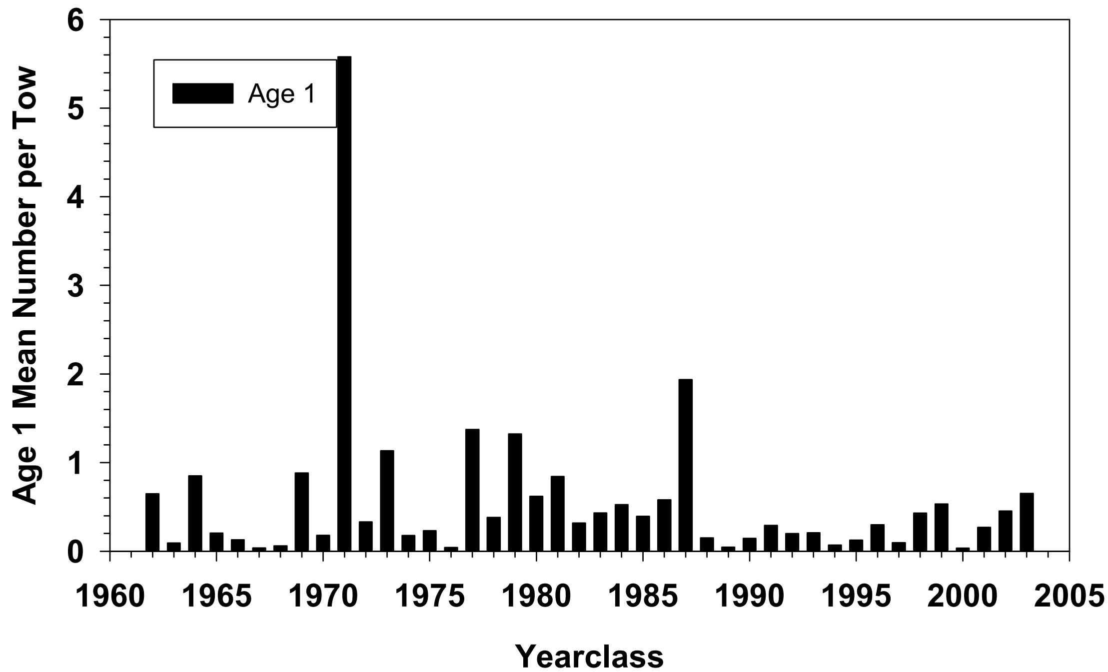


Figure F2. Biomass indices (stratified mean weight per tow) for Gulf of Maine cod from NEFSC autumn bottom trawl surveys.

NEFSC Autumn Survey: Yearclass Strength at Age 1



NEFSC Autumn Survey: Yearclass Strength at Age 2

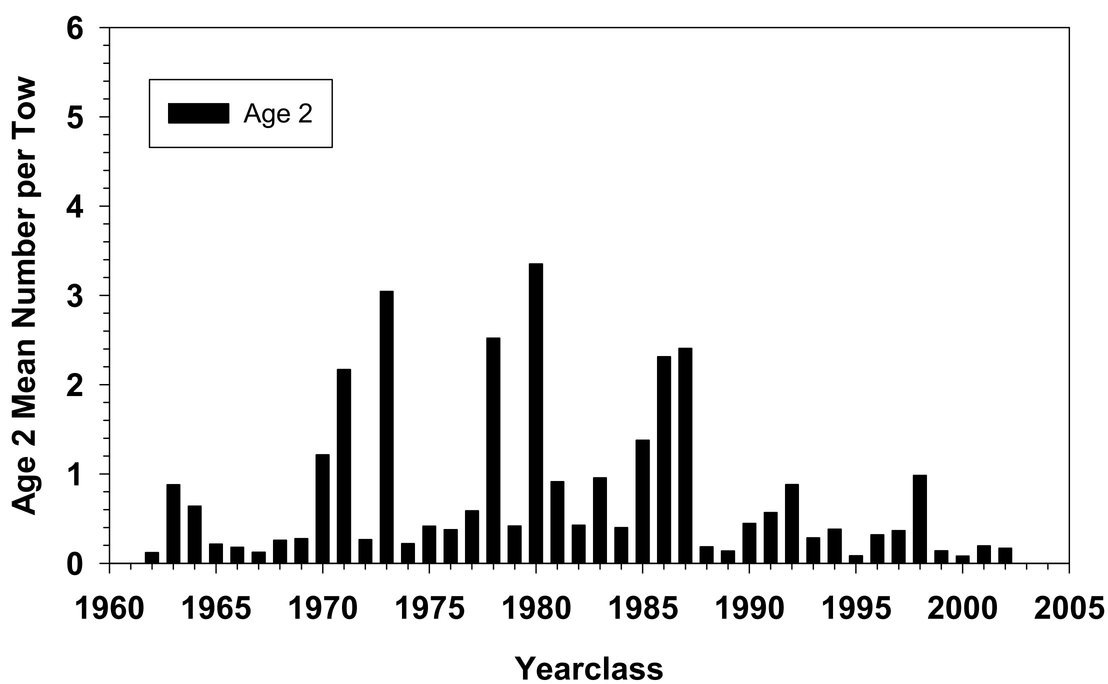
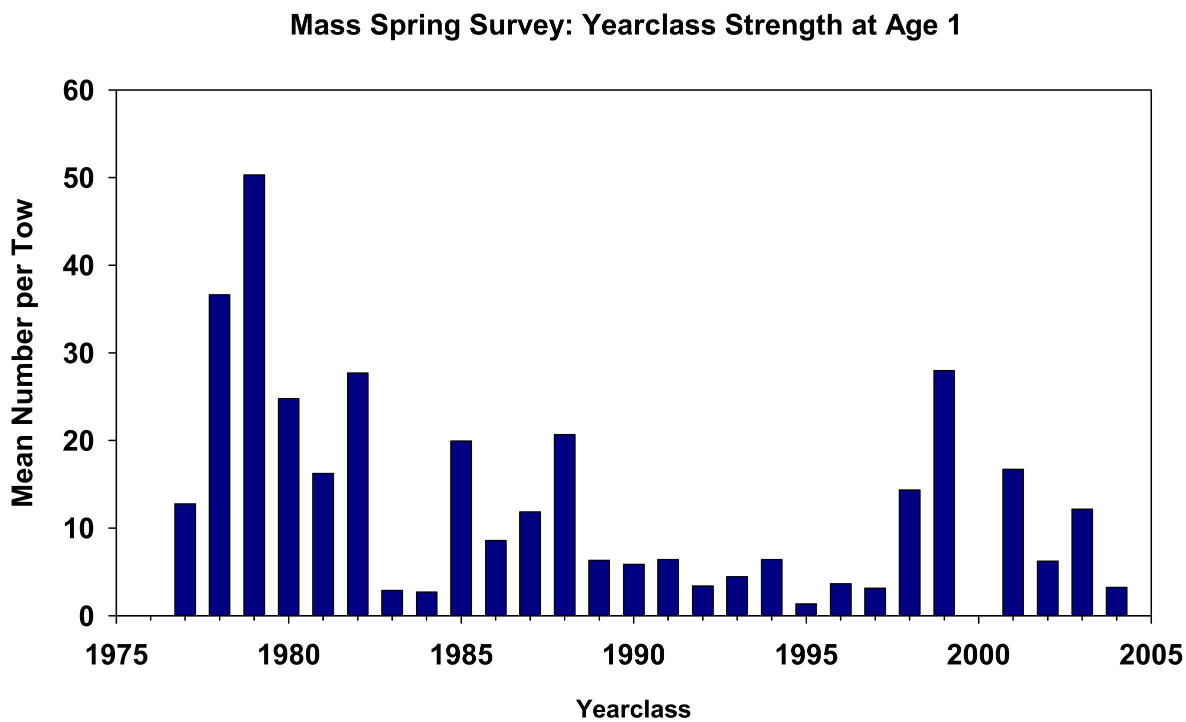


Figure F3. Recruitment indices at age 1 and 2 for Gulf of Maine cod from NEFSC autumn bottom trawl surveys.



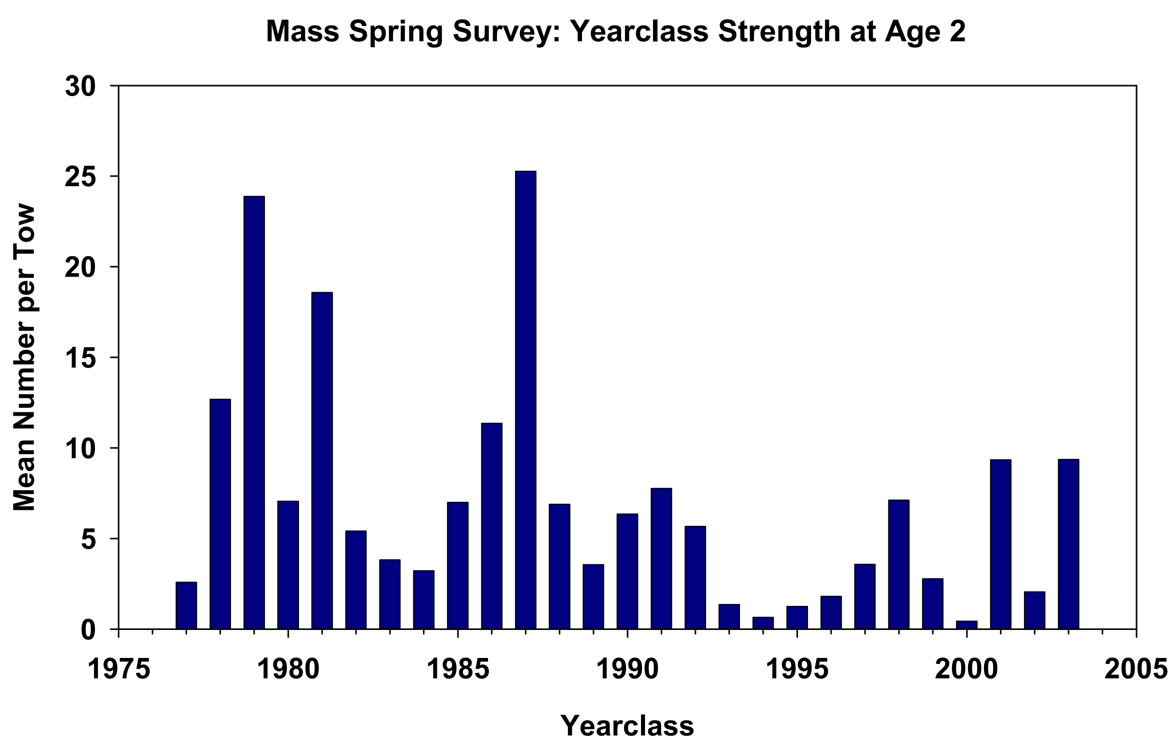
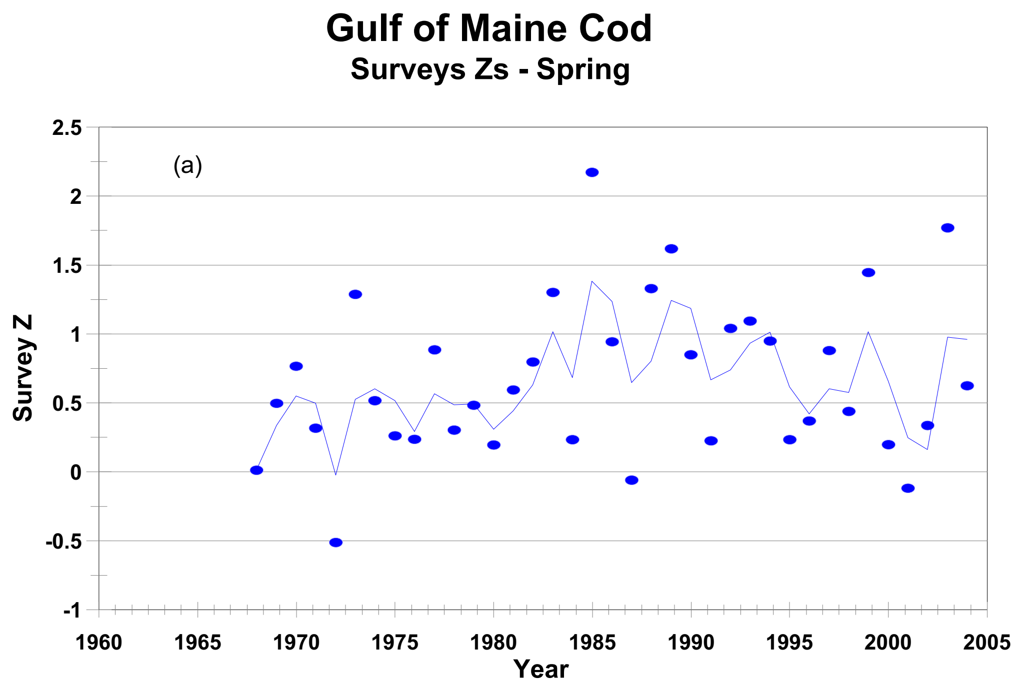


Figure F4. Recruitment indices at age 1 and 2 for Gulf of Maine cod from MA DMF autumn bottom trawl surveys.



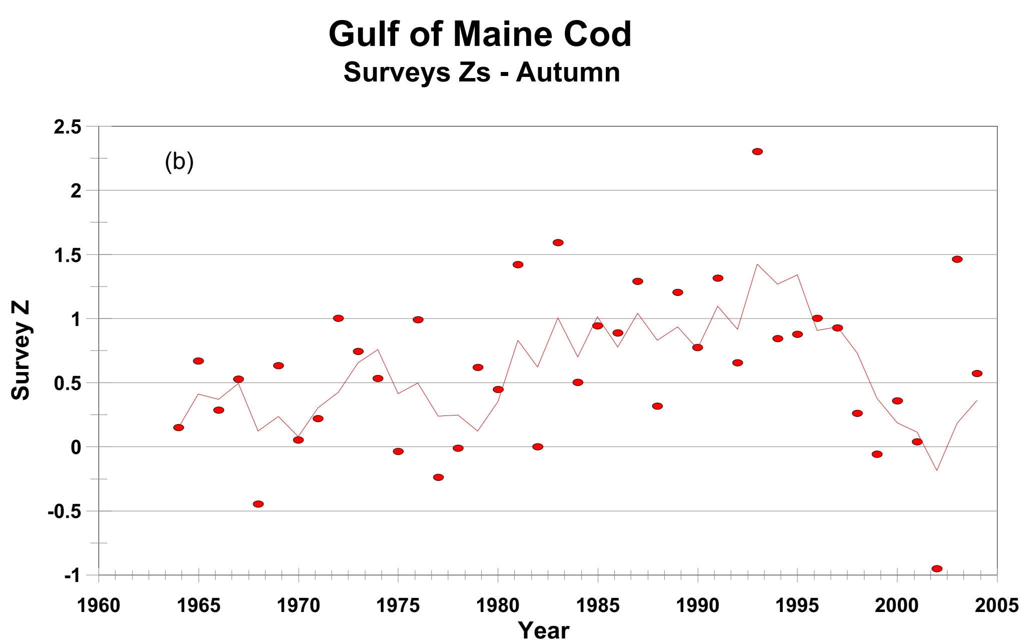


Figure F5. **Annual estimates of total instantaneous mortality (Z) for Gulf of Maine cod (points) and 3-year running average (line) from (a) NEFSC spring and (b) NEFSC autumn bottom trawl surveys.**

Gulf of Maine Cod Calculated VPA Residuals

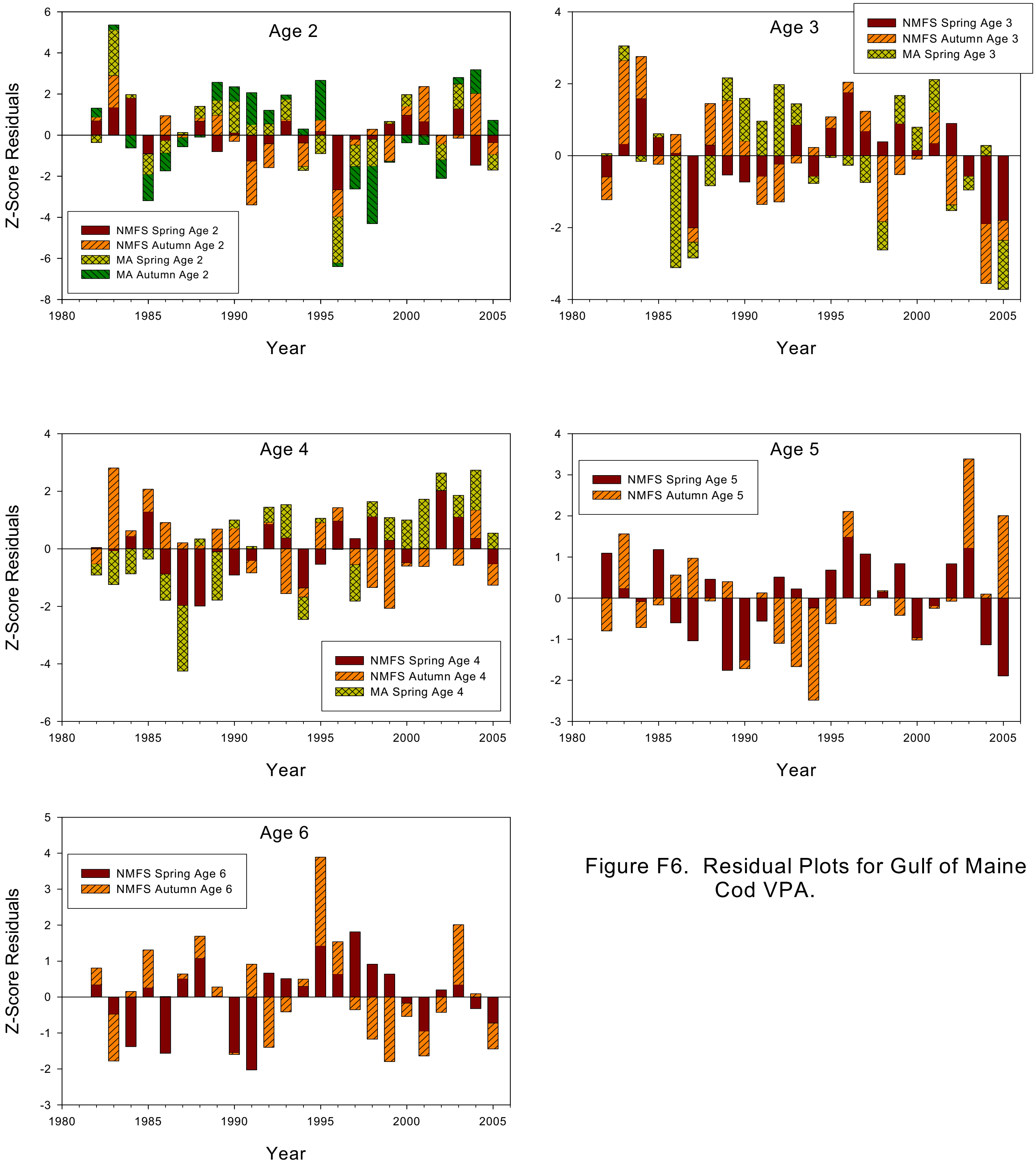


Figure F6. Residual Plots for Gulf of Maine Cod VPA.

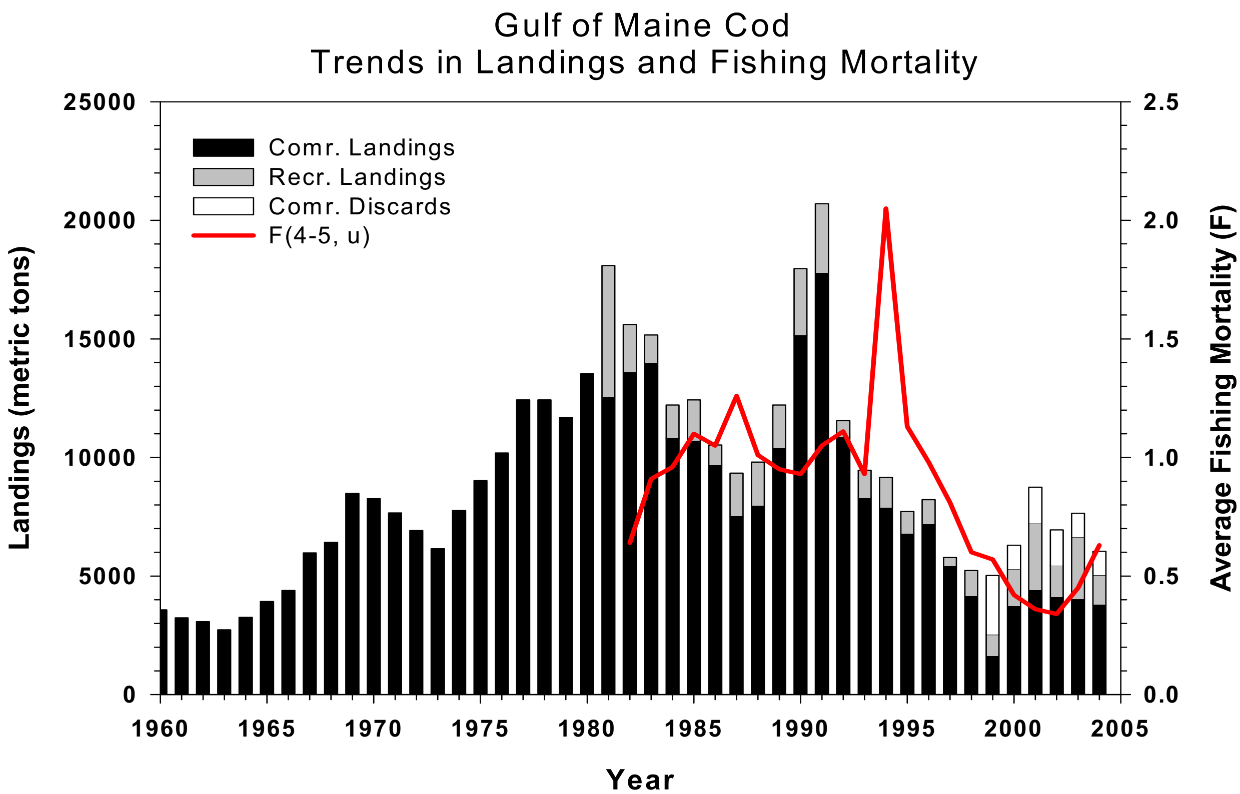


Figure F7. Trends in landings and fishing mortality for Gulf of Maine cod.

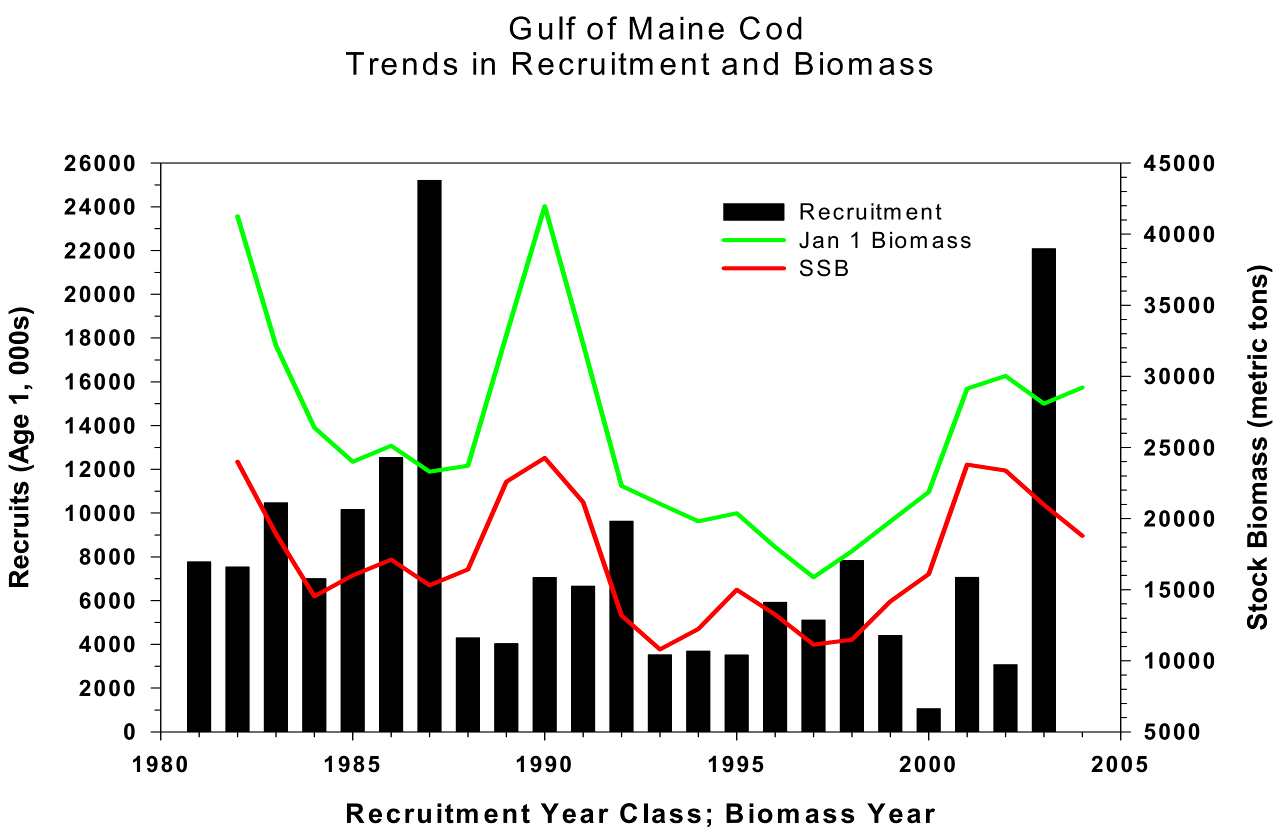
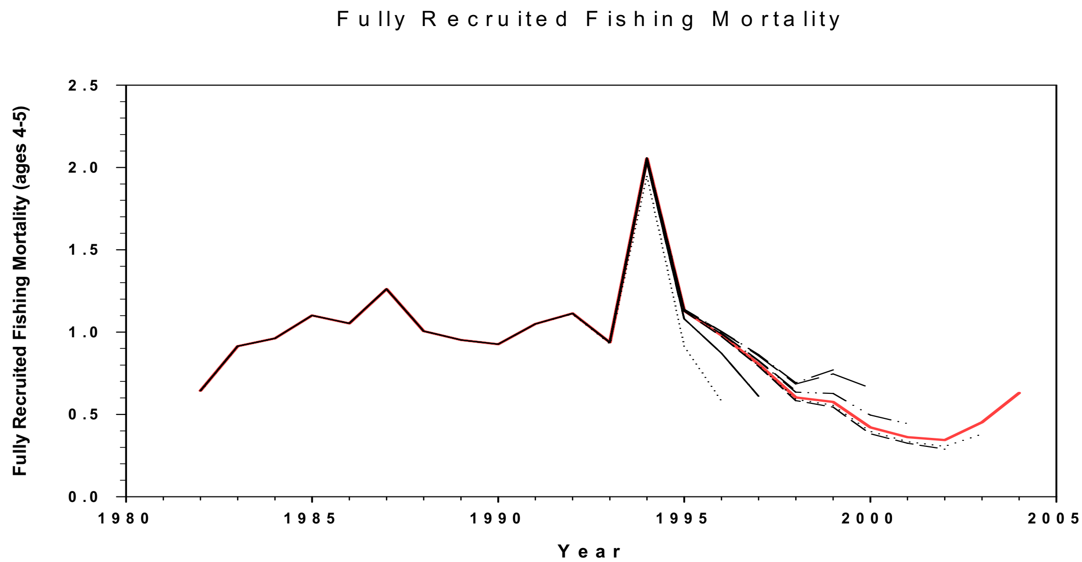


Figure F8. Trends in recruitment (age 1) and biomass for Gulf of Maine cod.



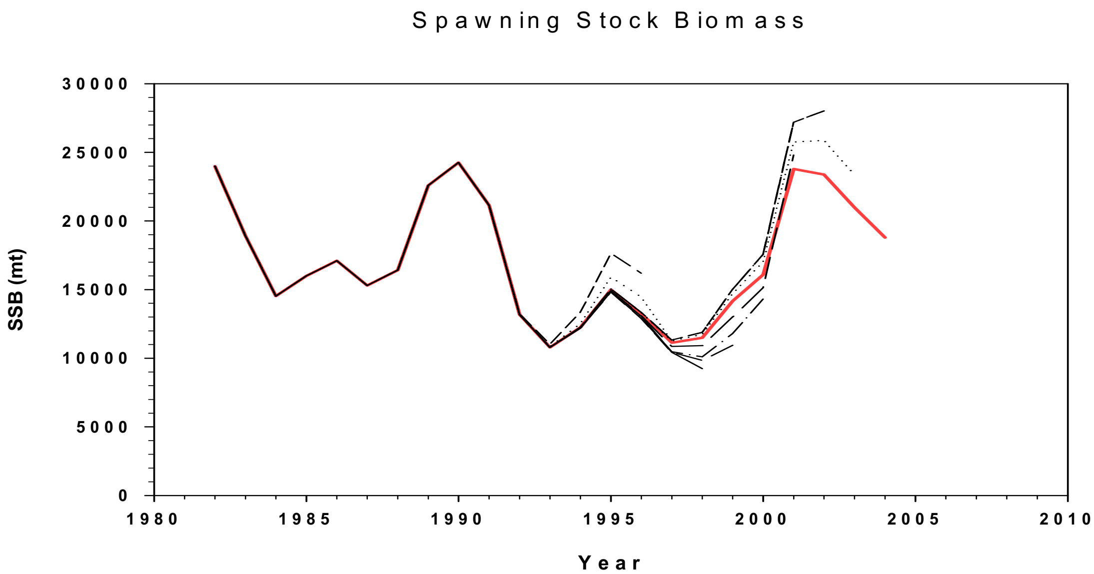
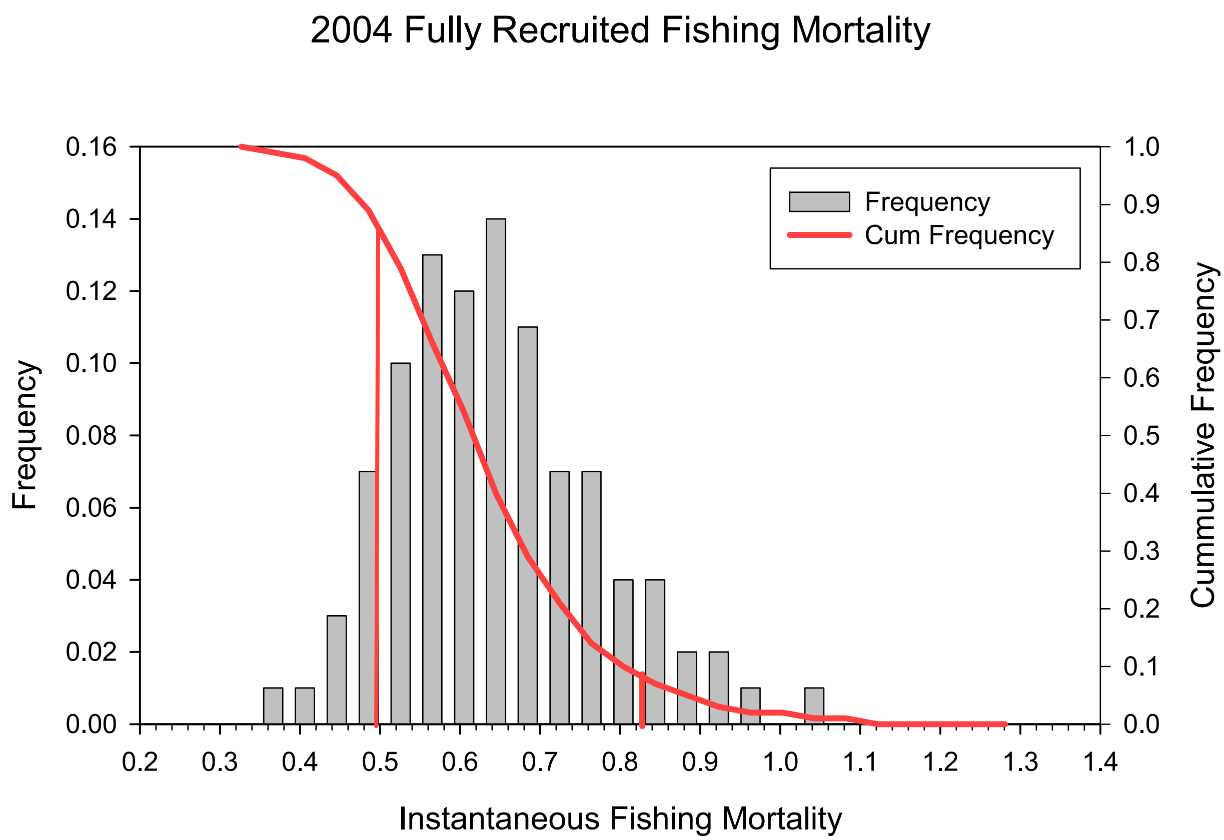


Figure F9. Retrospective analyses for Gulf of Maine Cod.



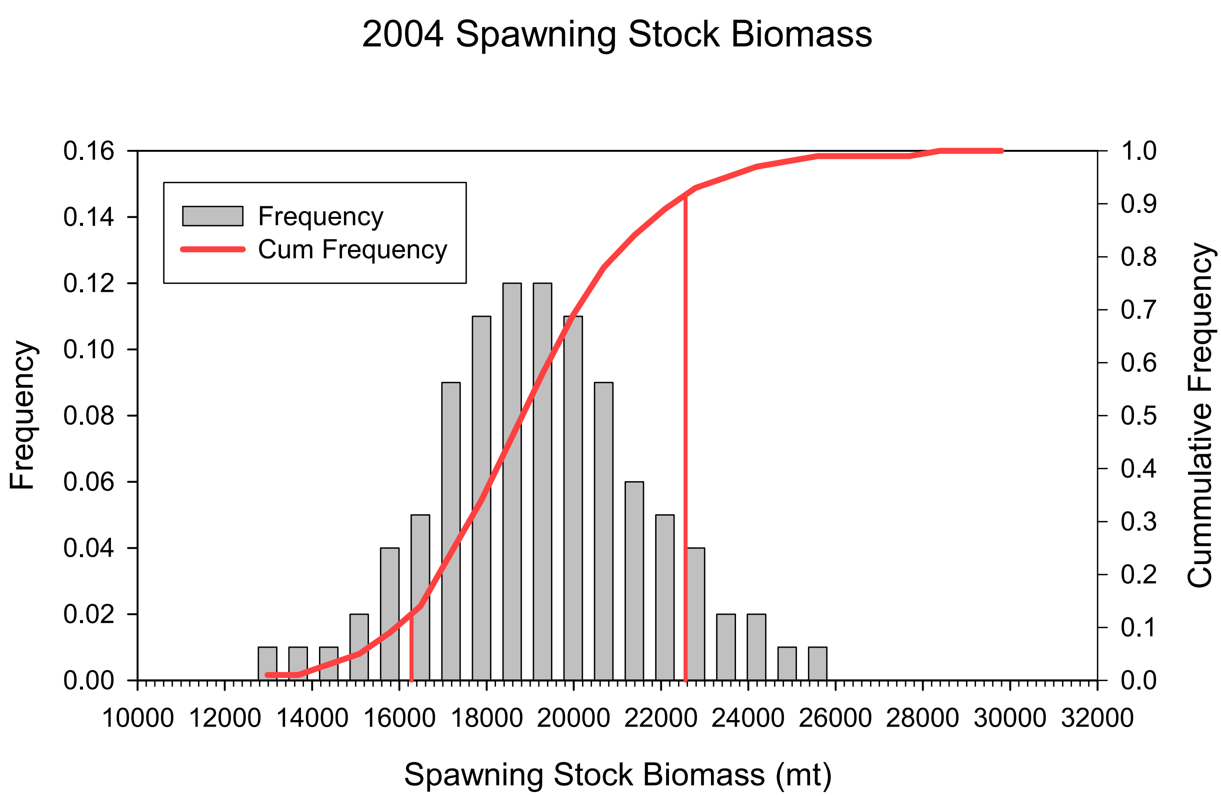
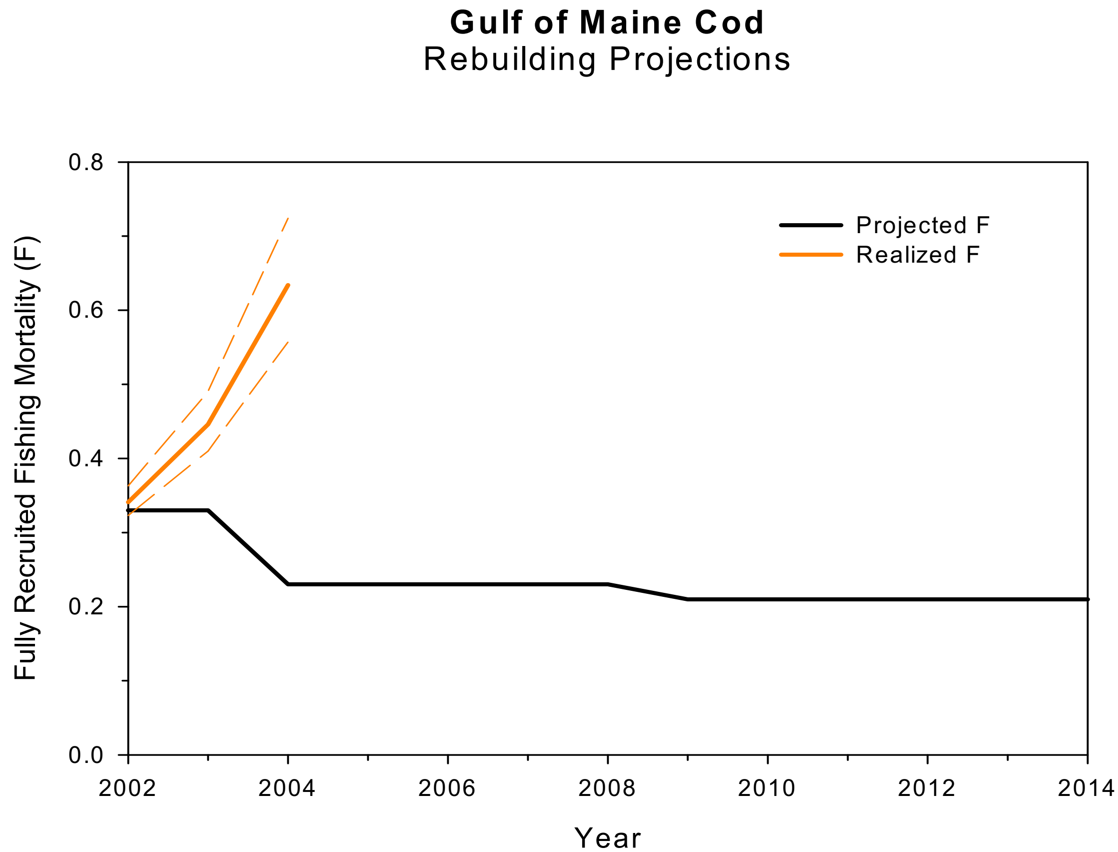


Figure F10. 2004 F and SSB bootstrap results for Gulf of Maine cod.



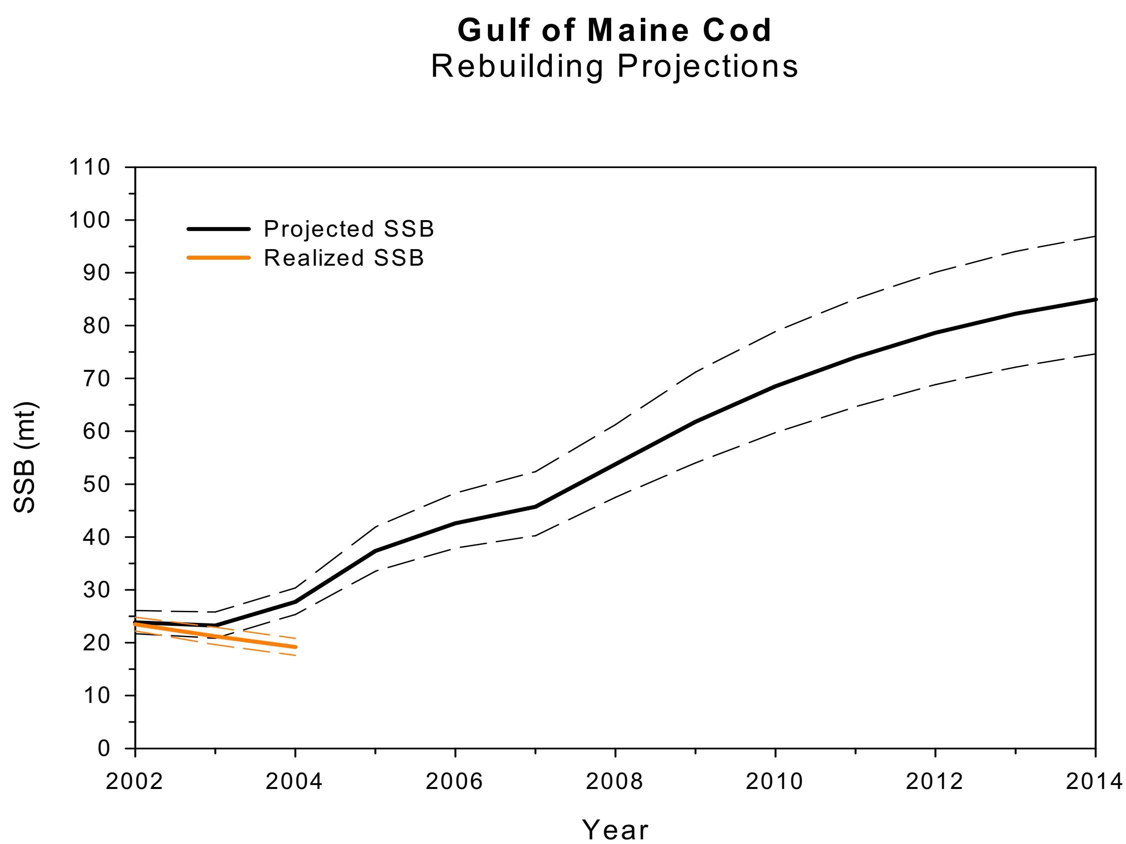


Figure F11. Comparisons between stock projections and recent and current state

Gulf of Maine Cod
Rebuilding Projections

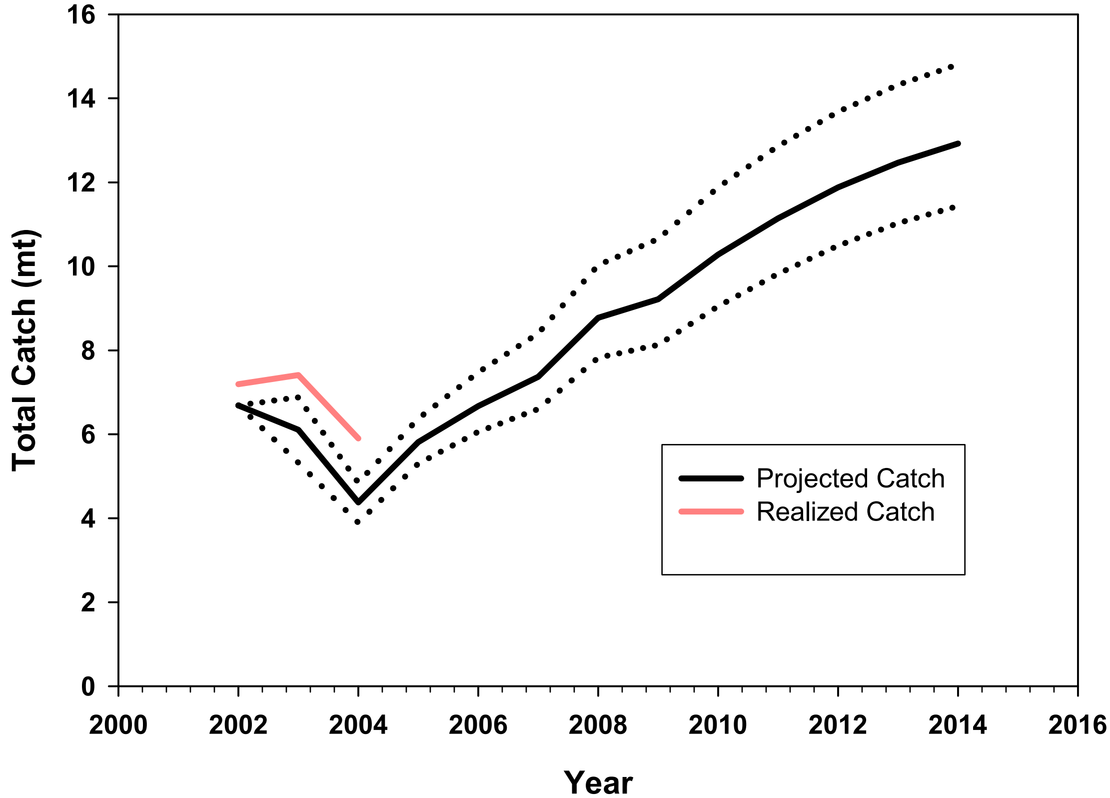


Figure F11 (Continued)

G. Witch Flounder by **S. Wigley and L. Col**

1.0 Background

Witch flounder, *Glyptocephalus cynoglossus*, are assessed as a unit stock from the Gulf of Maine southward. An analytical assessment was last conducted for this species in 2003 (Wigley et al. 2003) for SAW/SARC 37 (NEFSC 2003). The 2003 assessment indicated average fishing mortality (ages 8-9, unweighted) increased from 0.26 in 1982 to 0.67 in 1985, declined to 0.22 in 1992, increased to 1.13 in 1996, then declined to 0.41 in 2002. Spawning stock biomass declined from 16,897 tons in 1982 to about 3,800 tons in 1996 and then increased sharply to 18,296 mt in 2002. Since 1982, recruitment at age 3 has ranged from approximately 3 million fish (1984 year class) to 67.6 million fish (1997 year class) with a mean (1979 – 2000 year classes) of 19.6 million fish.

This report updates catch through 2004, survey indices through spring 2005, and estimates 2004 fishing mortality and spawning stock biomass for stock status determination.

2.0 Assessment Data

The Fishery

Significant proportions of the U.S. nominal catch have been taken from both the Georges Bank and Gulf of Maine regions. Canadian landings from both areas have been minor (not more than 68 mt annually). USA landings generally increased from the early 1960s, peaked in 1984 at 6,666 mt. Subsequently, landings declined and have fluctuated about 2,300 mt. In 2004, landings were 2,917 mt (Table G.1 and Figure G.1).

Sampling intensity of landings during 2003 and 2004 increased over recent years (Table G.2), however, as in previous years, it was necessary to pool some quarters for some market categories. To estimate landings at age and mean weights at age, quarter, semi-annual or annual age-length keys were applied to corresponding commercial landings length frequency data by market category.

Discard estimation

Discards-at-age were updated using the same estimation methods used in the 2003 assessment for the northern shrimp fishery and the large-mesh otter trawl fishery (Wigley et al 2003).

Discards from the northern shrimp fishery were estimated using two methods: when no observer data were available (1982-1988, 1998-2002), a regression of age 3 fish in the autumn NEFSC survey and observed discard rates were used to estimate ratios of discard weight to days fished (d/df) ratios. When observer was available (1989-1997, 2003-2004), d/df ratios were calculated by fishing zone (a surrogate for depth). To estimate discard weight, the mean discard ratio (weighted by days fished in each fishing zone) was expanded by the days fished in the northern shrimp fishery.

For 2003 and 2004, witch flounder discards in the northern shrimp fishery were estimated to be near zero. This is attributed to the short northern shrimp season and the shift in effort to near-shore waters, inshore of the witch flounder distribution

Witch flounder discarded in the northern shrimp fishery range in age from 0 to 6, with the majority at ages 1-3. The number of fish discarded in the shrimp fishery is small compare to the landings (Figure G.2).

The estimation of large-mesh otter trawl discards is based upon two methods. For 1982 to 1994, a method which filters survey length frequency data through a commercial gear retention ogive and a culling ogive was used and then a semi-annual ratio estimator of survey-filtered 'kept' index to semi-annual numbers landed was used to expand the estimated 'discard' survey index to numbers of fish discarded at length. For 1989 to 2004, discard weight to kept weight ratios (d/k) were calculated from observer data on a semi-annual basis. Total discard weight was derived by multiplying the d/k ratio by the commercial landings. Given the limited sample size (number of trips) prior to 1995, discards at age were estimated from 1995 onward. Observed discard length frequencies are used to estimate discarded fish at length. Semi-annual numbers of fished discarded were apportioned to age using the corresponding seasonal NEFSC survey age/length key. Witch flounder discarded in the large mesh otter trawl fishery range in age from 0 to 6, with the majority at ages 4 to 5. The number of fish discarded in the large-mesh otter trawl fishery is small compare to the landings (Figure G.2).

The total catch (landings + otter trawl discards + shrimp trawl discards) at age is presented in Table G.3 and Figure G.2. The age composition data reveal strong 1979- 1981 year classes; the 1989 and 1993 year classes also appear strong. The poor 1984 year class is also evident as well as a truncated age-structure since the early 1990's. As observed in recent years, the mean weights-at-age in the catch continue to decline (Figure G.3).

Research Vessel Survey Indices

The NEFSC bottom trawl survey indices generally declined from the early 1960s to record low levels in the late 1980s and early 1990s. Since then survey indices increased but have exhibited a declining trend since 2000 (Table G.4, Figure G.4a-b). Survey age compositions (mean number per tow at age)are presented in Table G.5. The survey mean weights and mean lengths at age show a similar decline as reported in the commercial landings. Survey maturity-at-age has remained stable in recent years.

3.0 Assessment Results

Since the last assessment, minor VPA software changes have occurred and additional age and length data have become available. These changes had only a minor impact on the SARC 37 assessment results (Table G.6). For the current assessment, the VPA formulation is the same as the 2003 assessment and uses catch (landings and discards) through 2004 and NEFSC spring and autumn survey indices through 2005 and 2004, respectively, to estimate stock sizes for ages 3 to 10. The VPA had a mean square residual of 0.81, the coefficients of variation (CVs) for estimated ages ranged between 27% and 65% (Table G.6), and the CVs for survey catchability coeffiecients (q) were consistent, ranging from 11% to 25%.

VPA results indicate average fishing mortality (ages 8-9, unweighted) increased from 0.26 in 1982 to 0.68 in 1985, declined to 0.22 in 1992, increased to 1.12 in 1996, then declined to 0.20 in 2004 (Tables G.7 and G.8, Figure G.5). Spawning stock biomass declined steadily from 16,897 mt in 1982 to 3,901 mt in 1996, and has increased to21,175 mt in 2004 (Tables G.7 and G.8, Figure G.6). Since 1982, recruitment at age 3 has ranged from approximately 3 million fish (1984 year class) to 45 million fish (1997 year class) with a mean of 15.5 million fish (median of 14 million; Table G.7, Figure G.6). The addition of the 2000 to 2002 year classes to the stock-recruit data continued the negative trend observed in this relationship in the previous assessment. The current age composition of the spawning stock is approaching the equilibrium age composition. However, given the recent poor year classes (2000-2002), spawning stock biomass will eventually decline as these poor classes enter the fishery (Figure G.6).

The retrospective analysis indicates that average F was underestimated in the late 1990s and early 2000s (Figure G.7a) and spawning stock biomass was consistently overestimated (Figure G.7b). The retrospective analysis indicated a pattern of relatively consistent estimates of the number of age 3 recruits, with the notable exception of the 1992, 1993 and 1996 year classes, which were considerably overestimated (Figure G.7c).

Bootstrap results suggest that the estimates of F and spawning stock biomass are relatively precise with CVs of 30% and 14%, respectively. The 80% confidence interval for F_{2004}=0.20 was 0.15 and 0.28, and for SSB_{2004} = 21,175 mt the 80% confidence interval was 18,192 mt and 26,121 mt.

4.0 Biological Reference Points

Based on yield and spawning stock biomass per recruit analyses and the arithmetic mean of the VPA age 3 recruitment (NEFSC 2003), the biological reference points are:

SSBmsy = 25,248 mt
Fmsy = F40% = 0.23
MSY = 4,375 mt.

The 2004 spawning stock biomass (21,175 mt) was above ½ SSBmsy (12,624 mt), the overfished threshold, and 2004 fishing mortality (0.20) was below Fmsy (0.23), the overfishing threshold; therefore, witch flounder was not overfished and overfishing was not occurring in 2004.

Amendment 13 Projections and current status

There is no formal rebuilding program required for witch flounder, thus there is not a rebuilding biomass trajectory. Amendment 13 is designed to end overfishing of witch flounder; a spawning stock biomass trajectory at Fmsy was conducted for Amendment 13. The spawning stock biomass estimates from this assessment are below what was projected for the Amendment 13. The fishing mortality estimated for 2004 is below the Fmsy used in the Amendment 13 projections (Figure G.8).

5.0 Panel Comments

The Panel discussed the adequacy of the age-length information used to estimate the commercial landings-at-age. There is now sufficient information for some of the years to develop estimates by quarter and market category, and given continued adequate sampling, this should be continued in the future. This may be important as the fishery has apparently shifted from peewees and smalls to smalls and mediums. There is some caution about simply using the number of samples as an indication about sample size. In the past, a sample normally consisted of about 100 fish. With potentially smaller catches, this criterion for sampling has been relaxed in order to get samples. Given that witch flounder is very slow growing, the pooling effect may not be as much of an issue.

There was some discussion of the apparent expansion in age structure of the discards beginning in 1995. It was suggested that this may be an artifact of the change in estimation method beginning in 1995. However, another expansion of the age structure was apparent in 2002 with the same method. Observed discards of large fish may be due to the inclusion of trips from other fisheries that do not require use of a DAS, although trips targeting *Loligo* were excluded.

The panel discussed the recent declines in mean weights. It is possible that fishing patterns have changed in relation to the distribution of the stock to areas that are less favorable for growth. The distribution of the fishery and survey should be investigated in the future.

The short term decline in size at maturity in the late 1980s was discussed. This short term decline coincided with very low biomass. It was not possible to examine the decline on an annual basis due to low sampling (sparse data).

The difference in current estimate of 2004 biomass compared to the estimate projected from the last assessment may be due to an increase in the estimate of realized F being higher than that used in the projections, lower recruitment than expected and a retrospective underestimate of SSB.

The Panel noted that the recent increase in SSB has been mostly driven by the good recruitment of the 1996-1998 year classes. If catches remain constant, SSB will eventually decline as the following poor year classes enter the fishery.

Projection Advice - The Panel recommended using an average of the mean weights from 2002-2004 for projections. The same years are suggested for the partial recruitment and maturity (5 year average of 2001-2005) vectors. Given the declining trend in recruitment, the panel recommended using the estimated value of the 2002 year class although it was an uncertain estimate. For 2006-2008, the panel suggested re-sampling just the 2000-2002 year classes (not the entire series). Given that witch flounder is long-lived and late maturing, the values of recruitment should not be influential in the projections.

6.0 Sources of Uncertainty

- Low frequency of samples across market category and quarter results in imprecise mean weights at age and estimates of numbers at age.

- Lack of data to support direct estimates of discards at age requires use of various surrogate survey-based methods.

- Retrospective patterns suggest that estimates of SSB may be overestimated (e.g. future assessments may have lower estimates of SSB).

- The research bottom trawl survey catches very few witch flounder; in most years, the stratified mean number per tow of witch flounder is less than 5 fish. Abundance of witch flounder in the late 1980s and early 1990's may have gone below levels that provide reliable estimates of trends in abundance and biomass

7.0 Acknowledgments

We thank all those who diligently collected data from the commercial fisheries (dock-side and at-sea) and the research vessel surveys. We thank J. Burnett for providing the age determinations used in the assessment. We thank all the members of the Groundfish Assessment Review Meeting for their review and helpful comments.

8.0 References

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Lange, A.M.T. and F.E. Lux. 1978. Review of the other flounder stocks (winter flounder, American plaice, witch flounder, and windowpane flounder) off the northeast United States. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 78-44, 53 pp.

NEFSC [Northeast Fisheries Science Center]. 2003. Report of the 37th Northeast Regional Stock Assessment Workshop (37th SAW), Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 03-16, 597 p.

Wigley, S.E., J. K.T. Brodziak, and L. Col. 2003. Assessment of the Gulf of Maine and Georges Bank witch flounder stock for 2003. Northeast Fish. Sci. Cent. Ref. Doc. 03-14, 186 p.

Table G.1. Witch flounder landings, discards and catch (metric tons, live) by country, 1937-2004 [1937-1959 provisional landings reported in Lange and Lux, 1978; 1960-1963 reported to ICNAF/NAFO (Burnett and Clark, 1983)].

	LANDINGS							
Year	USA Subarea 4, 5 & 6	USA Subarea 3	USA Total	CAN	Other	Total	USA Discards	USA Catch
1937			*5000*			*5000*		
1938			*3600*			*3600*		
1939			*3100*			*3100*		
1940			*3000*			*3000*		
1941			*2000*			*2000*		
1942			*1800*			*1800*		
1943			*1000*			*1000*		
1944			*1000*			*1000*		
1945			*1000*			*1000*		
1946			*1500*			*1500*		
1947			*1500*			*1500*		
1948			*1000*			*1000*		
1949			*3600*			*3600*		
1950			*3000*			*3000*		
1951			*2600*			*2600*		
1952			*3700*			*3700*		
1953			*4200*			*4200*		
1954			*4000*			*4000*		
1955			*2400*			*2400*		
1956			*2000*			*2000*		
1957			*1000*			*1000*		
1958			*1000*			*1000*		
1959			*1000*			*1000*		
1960	1255		1255			1255		
1961	1022		1022	2		1024		
1962	976		976	1		977		
1963	1226		1226	27	121	1374		
1964	1381		1381	37		1418		
1965	2140		2140	22	502	2664		
1966	2935		2935	68	311	3314		
1967	3370		3370	63	249	3682		
1968	2807		2807	56	191	3054		
1969	2542		2542		1310	3852		
1970	3112		3112	19	130	3261		
1971	3220		3220	35	2860	6115		
1972	2934		2934	13	2568	5515		
1973	2523		2523	10	629	3162		
1974	1839		1839	9	292	2140		
1975	2127		2127	13	217	2357		
1976	1871		1871	5	6	1882		
1977	2469		2469	11	13	2493		
1978	3501		3501	18	6	3525		
1979	2878		2878	17		2895		
1980	3128		3128	18	1	3147		
1981	3442		3442	7		3449		

Table G.1. continued.   Witch flounder landings, discards and catch (metric tons, live).

	LANDINGS							
Year	USA Subarea 4, 5 & 6	USA Subarea 3	USA Total	CAN	Other	Total	USA Discards	USA Catch
1982	4906		4906	9		4915	48	4954
1983	6000		6000	45		6045	162	6162
1984	6660		6660	15		6675	100	6760
1985	6130	255	6385	46		6431	61	6191
1986	4610	539	5149	67		5216	25	4635
1987	3450	346	3796	23		3819	47	3497
1988	3262	358	3620	45		3665	60	3322
1989	2068	297	2365	13		2378	133	2201
1990	1465	2	1467	12		1479	184	1649
1991	1777		1777	7		1784	95	1872
1992	2227		2227	7		2234	171	2398
1993	2601		2601	10		2611	376	2977
1994	2665		2665	34		2699	422	3087
1995	2209		2209	11		2220	193	2402
1996	2087		2087	10		2097	254	2341
1997	1771		1771	7		1778	300	2071
1998	1848		1848	10		1858	286	2134
1999	2121		2121	19		2140	213	2334
2000	2439		2439	53		2492	115	2554
2001	3019		3019	32		3051	224	3243
2002	3188		3188	34		3222	279	3467
2003	3124		3124	30		3154	381	3505
2004	2917		2917			2917	233	3150

Table G.2. Summary of USA commercial witch flounder landings (mt), number of length samples (n), number of fish measured (len) and number of age samples (age) by market category and quarter for all gear types, 1981 - 2004. The sampling ratio represents the amount of landings per length sample.

		Quarter 1			Quarter 2			Quarter 3			Quarter 4				Sampling
Year		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	All	Ratio
1981	mt	260	7	517	269	32	694	242	13	607	230	0	453	3324	
	n	.	.	.	.	1	1	.	1	.	1	.	1	5	
	len	.	.	.	.	101	103	.	89	.	105	.	100	498	
	age	.	.	.	.	.	26	.	25	.	25	.	25	101	
1982	mt	348	1	726	342	73	886	287	170	739	278	201	669	4720	
	n	5	2	6	1	2	2	2	2	6	3	4	2	37	128
	len	527	194	626	126	209	216	189	210	514	307	393	189	3700	
	age	128	55	150	30	55	50	50	50	150	81	105	50	954	
1983	mt	475	250	910	471	286	1037	298	154	758	257	169	613	5678	
	n	5	2	3	5	1	5	8	3	8	6	3	.	49	116
	len	680	232	265	685	96	520	1008	123	981	677	344	.	5611	
	age	135	30	55	131	16	125	152	0	159	180	75	.	1058	
1984	mt	462	322	1036	513	393	1000	403	248	653	429	286	586	6331	
	n	5	9	4	7	1	7	8	1	2	4	2	1	51	124
	len	804	1112	400	970	117	775	1045	106	191	615	243	91	6469	
	age	154	250	76	186	25	180	210	28	53	105	44	25	1336	
1985	mt	465	377	613	697	453	850	526	291	553	433	310	408	5976	
	n	12	1	2	5	4	7	7	7	6	8	2	4	65	92
	len	1530	105	229	657	426	698	795	800	684	824	264	349	7361	
	age	319	29	50	106	77	153	97	138	113	161	25	29	1297	
1986	mt	384	309	356	654	421	595	375	238	354	312	212	238	4448	
	n	6	3	5	5	4	5	4	3	4	5	3	2	49	90
	len	662	307	515	558	410	413	302	364	406	416	337	233	4923	
	age	123	60	89	106	97	129	63	75	100	87	75	52	1056	

Table G.2. continued.

Year		Quarter 1			Quarter 2			Quarter 3			Quarter 4			Sampling
		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	All	Ratio
1987	mt	349	211	228	432	317	387	296	203	247	298	203	202	3373	
	n	1	1	2	4	2	3	5	5	4	2	3	2	34	69
	len	85	145	200	323	228	316	354	583	400	204	261	178	3277	
	age	25	25	50	77	47	76	78	113	95	48	64	51	749	
1988	mt	424	304	271	436	393	389	184	176	208	140	140	131	3196	
	n	5	4	5	5	5	3	5	4	3	3	4	3	49	65
	len	335	407	465	344	544	429	396	359	295	229	402	356	4561	
	age	70	89	106	71	110	77	70	100	75	61	95	69	993	
1989	mt	230	174	148	255	264	251	98	145	156	85	107	103	2016	
	n	1	2	2	2	2	1	2	2	1	1	2	.	18	112
	len	94	201	222	230	236	27	150	206	100	125	202	.	1793	
	age	25	50	49	50	46	25	40	51	25	25	47	.	433	
1990	mt	113	125	107	147	168	147	100	119	129	84	79	85	1403	
	n	1	2	3	6	3	1	6	2	2	7	2	.	35	40
	len	134	199	199	335	296	100	349	247	145	381	201	.	2586	
	age	15	40	45	81	70	25	69	41	50	103	48	.	587	
1991	mt	71	56	58	219	151	167	192	142	184	168	108	121	1637	
	n	5	2	3	7	2	1	4	2	3	5	4	3	41	40
	len	262	224	401	537	239	125	212	165	249	300	410	274	3398	
	age	53	50	80	93	45	25	49	49	52	66	97	58	717	
1992	mt	180	86	82	466	163	174	205	115	138	212	97	116	2034	
	n	4	2	2	7	1	2	7	1	1	2	.	1	30	68
	len	259	241	185	501	125	235	477	121	117	129	.	46	2436	
	age	42	46	52	78	25	25	86	25	25	27	.	23	454	

Table G.2.

Year	Quarter 1			Quarter 2			Quarter 3			Quarter 4				Sampling
	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	All	Ratio
1993 mt	350	112	110	442	192	161	263	122	150	331	96	106	2435	
n	7	1	.	7	1	1	9	1	5	.	.	.	32	76
len	830	100	.	741	107	100	728	85	499	.	.	.	3190	
age	55	25	.	56	27	26	74	.	73	.	.	.	336	
1994 mt	403	143	98	505	183	154	390	122	117	383	91	80	2670	
n	.	.	.	3	5	6	5	5	1	5	3	4	37	72
len	.	.	.	560	532	749	356	648	105	342	368	407	4067	
age	.	.	.	59	104	134	44	113	26	56	60	82	678	
1995 mt	336	91	77	586	117	100	399	61	70	304	48	40	2212	
n	3	3	3	6	3	5	.	.	.	2	.	1	26	85
len	208	348	347	459	367	517	.	.	.	217	.	94	2557	
age	53	84	89	81	75	135	.	.	.	27	.	25	569	
1996 mt	313	57	36	545	86	60	458	56	44	363	42	28	2088	
n	5	2	3	5	2	1	5	4	4	5	3	3	42	50
len	504	218	292	331	240	127	494	464	468	343	277	348	4106	
age	59	45	78	53	50	26	59	86	101	60	70	69	756	
1997 mt	313	40	25	478	86	41	398	55	27	265	31	16	1775	
n	6	3	3	9	4	3	9	3	1	9	1	1	52	34
len	557	350	351	812	418	309	783	308	107	505	128	50	4678	
age	77	68	70	108	73	77	98	81	20	73	18	23	786	
1998 mt	372	39	19	587	79	31	380	40	20	239	26	14	1849	80
n	5	2	1	4	1	1	5	3	1	.	.	.	23	
len	339	206	128	238	88	135	484	186	100	.	.	.	1904	
age	45	50	19	30	.	29	47	22	.	.	.	.	242	
1999 mt	386	48	19	616	79	31	436	67	30	353	38	18	2121	51
n	3	.	.	4	.	.	17	2	3	11	1	.	41	
len	282	.	.	308	.	.	1110	201	306	775	109	.	3091	
age	15	.	.	62	.	.	143	.	32	91	16	.	359	

Table G.2. continued.

		Quarter 1			Quarter 2			Quarter 3			Quarter 4				Sampling
Year		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	All	Ratio
2000	mt	477	53	17	583	93	27	555	89	28	451	50	16	2439	21
	n	31	2	.	47	.	.	17	1	.	5	5	2	110	
	len	2253	91	.	2445	.	.	994	105	.	308	558	217	6971	
	age	393	10	.	463	.	.	224	20	.	67	92	51	1320	
2001	mt	583	71	17	824	99	30	699	98	28	507	50	13	3019	70
	n	8	4	2	3	3	2	8	2	3	5	3	.	43	
	len	744	422	134	237	352	159	594	209	213	313	232	.	3609	
	age	125	64	42	48	48	64	126	34	46	61	49	.	707	
2002	mt	740	79	18	774	103	26	849	114	29	400	45	9	3186	89
	n	5	1	2	3	5	3	5	2	3	3	2	2	35	
	len	363	121	107	212	518	209	389	150	194	262	226	115	2815	
	age	75	16	50	65	73	64	88	34	62	49	30	49	655	
2003	mt	603	70	17	684	108	30	865	125	36	533	43	10	3124	31
	n	4	6	6	10	5	10	11	6	16	7	7	13	101	
	len	324	423	162	881	482	433	943	531	552	654	632	525	6542	
	age	57	93	60	131	64	174	172	91	246	99	120	191	1498	
2004	mt	609	76	16	598	90	23	758	113	30	546	45	13	2917	26
	n	5	13	23	8	5	8	5	5	2	19	5	15	113	
	len	480	1244	1813	675	549	576	541	356	48	1838	420	83	8623	
	age	73	226	505	151	96	169	58	95	10	49	72	.	1504	

Table G.3. **Total USA commercial catch** [landings + shrimp trawl discards + large-mesh otter trawl discards using survey filter and FOP] in numbers, (thousands of fish), mean weight (kg) and mean length (cm) at age of witch flounder, 1982 - 2004.

	AGE											
Year	0	1	2	3	4	5	6	7	8	9	10	11+
				USA Commercial Catch in Numbers (1000's) at Age								
1982	0.03	0.06	1.72	190.49	1064.47	1207.67	1475.40	665.20	656.00	399.50	239.40	1578.40
1983	0.00	0.02	4.28	337.11	1346.17	1520.76	1575.12	1590.20	977.80	737.70	510.40	1675.50
1984	0.00	0.33	0.88	146.61	1466.31	2002.70	1739.59	1486.50	1497.50	696.70	375.10	1718.80
1985	0.00	0.34	3.47	123.58	1176.12	2118.21	1936.24	1524.90	1247.90	606.00	400.40	1359.20
1986	0.00	0.53	3.86	22.95	377.07	1516.79	2775.35	1566.90	834.90	412.70	222.80	758.20
1987	2.08	18.92	79.93	22.25	181.26	467.06	1280.06	1574.70	870.90	480.60	252.40	489.40
1988	0.42	14.66	130.29	600.27	139.91	264.30	658.27	1382.70	1154.10	401.50	266.70	597.50
1989	0.85	10.69	50.32	447.05	436.25	65.16	314.33	759.35	882.12	349.65	123.39	348.00
1990	1.46	6.29	95.30	343.93	634.14	1103.15	255.61	273.86	471.07	333.93	81.35	177.49
1991	3.06	17.90	23.26	441.77	405.76	863.74	575.43	235.77	244.55	292.11	313.56	257.77
1992	2.84	44.35	159.43	399.46	1255.56	859.20	935.96	716.98	201.64	177.88	120.04	377.01
1993	113.76	85.80	129.59	417.23	1807.30	1418.95	918.12	597.19	585.56	218.77	278.53	390.48
1994	8.06	1368.48	496.44	41.97	1001.80	2759.91	1287.99	826.85	196.69	539.15	113.49	324.29
1995	2.68	49.95	655.51	628.79	370.28	1041.23	1714.50	851.35	268.54	97.53	269.49	156.84
1996	5.21	32.68	50.83	121.89	524.44	1207.69	1362.86	1430.48	263.23	215.48	57.05	113.62
1997	8.68	74.91	102.92	135.29	1058.45	1015.95	1293.41	1019.07	593.77	84.55	49.79	70.08
1998	49.78	392.89	294.20	331.23	556.89	1063.74	1415.46	1611.62	371.44	142.05	15.54	70.30
1999	32.11	252.94	194.45	160.92	526.08	1095.77	1461.98	1201.10	765.34	252.52	31.57	54.36
2000	21.61	169.95	119.51	103.50	286.46	451.20	1168.80	1689.67	1009.04	558.09	93.13	234.60
2001	12.33	96.96	66.42	69.93	343.22	938.11	1088.86	1715.57	1455.26	632.43	427.38	309.51
2002	2.32	20.24	17.42	40.96	744.95	1226.69	1394.91	2141.29	1276.60	642.49	95.14	201.85
2003	0.00	2.40	11.21	50.07	391.72	1308.71	1743.54	1909.68	1565.83	749.60	435.29	348.74
2004	0.00	0.00	7.41	25.36	325.78	1078.47	1538.12	1500.94	1146.27	797.89	324.36	291.65

Table G.3. continued. **Total USA commercial catch** (landings + shrimp trawl discards + LM otter trawl discards).

	Age											
Year	0	1	2	3	4	5	6	7	8	9	10	11+
					USA Commerical Catch Mean Weight (kg) at Age							
1982	0.000	0.002	0.038	0.152	0.242	0.329	0.421	0.550	0.727	0.886	0.983	1.406
1983		0.009	0.038	0.149	0.202	0.270	0.409	0.518	0.613	0.795	0.977	1.357
1984		0.017	0.040	0.151	0.229	0.328	0.421	0.539	0.664	0.817	0.922	1.339
1985		0.017	0.023	0.128	0.237	0.305	0.429	0.565	0.691	0.842	0.964	1.326
1986		0.017	0.026	0.089	0.206	0.299	0.408	0.533	0.676	0.853	0.975	1.321
1987	0.006	0.015	0.033	0.081	0.191	0.298	0.433	0.561	0.686	0.828	0.980	1.303
1988	0.004	0.006	0.017	0.045	0.203	0.311	0.434	0.538	0.668	0.819	0.980	1.326
1989	0.009	0.012	0.034	0.122	0.170	0.321	0.425	0.574	0.682	0.818	0.968	1.358
1990	0.004	0.012	0.029	0.062	0.186	0.257	0.438	0.586	0.688	0.849	1.049	1.454
1991	0.004	0.014	0.035	0.062	0.199	0.344	0.420	0.578	0.702	0.836	0.974	1.420
1992	0.003	0.007	0.026	0.103	0.230	0.379	0.459	0.614	0.739	0.822	0.882	1.243
1993	0.003	0.009	0.027	0.122	0.202	0.318	0.432	0.535	0.666	0.882	1.023	1.335
1994	0.005	0.004	0.019	0.070	0.202	0.280	0.430	0.534	0.691	0.832	0.909	1.266
1995	0.005	0.007	0.024	0.051	0.158	0.328	0.435	0.561	0.690	0.910	0.974	1.243
1996	0.004	0.019	0.031	0.060	0.149	0.265	0.422	0.554	0.708	0.856	0.974	1.232
1997	0.004	0.023	0.033	0.070	0.189	0.274	0.376	0.495	0.627	0.868	1.037	1.293
1998	0.003	0.006	0.024	0.070	0.163	0.260	0.359	0.487	0.584	0.869	0.978	1.206
1999	0.003	0.006	0.024	0.068	0.217	0.291	0.400	0.514	0.584	0.627	0.917	0.872
2000	0.003	0.006	0.024	0.066	0.196	0.272	0.368	0.453	0.534	0.624	0.704	0.915
2001	0.003	0.006	0.023	0.089	0.176	0.256	0.362	0.464	0.550	0.645	0.647	0.840
2002	0.003	0.007	0.032	0.110	0.219	0.279	0.395	0.474	0.552	0.652	0.823	0.940
2003		0.008	0.039	0.070	0.157	0.243	0.320	0.420	0.503	0.565	0.620	0.809
2004			0.053	0.098	0.232	0.277	0.342	0.440	0.540	0.612	0.692	0.871
Mean												
1982-2004	0.004	0.010	0.030	0.091	0.198	0.295	0.406	0.526	0.642	0.787	0.911	1.203
2000-2004	0.003	0.007	0.034	0.086	0.196	0.265	0.357	0.450	0.536	0.619	0.697	0.875

Table G.4. Stratified mean number, weight (kg), length (cm), and individual weight (kg) per tow of witch flounder in NEFSC offshore spring and autumn bottom trawl surveys in Gulf of Maine-Georges Bank region (strata 22-30,36-40), 1963-2005.

	SPRING				AUTUMN			
Year	Number per tow	Weight per tow	Length per tow	Ave. wt. per tow	Number per tow	Weight per tow	Length per tow	Ave. wt. per tow
1963	-	-	-	-	5.52	3.46	39.7	0.627
1964	-	-	-	-	2.89	2.00	44.2	0.691
1965	-	-	-	-	3.94	2.27	40.6	0.577
1966	-	-	-	-	7.80	4.56	41.2	0.584
1967	-	-	-	-	3.01	2.02	43.7	0.673
1968	4.83	3.35	42.3	0.695	4.82	3.49	44.8	0.724
1969	3.74	2.53	45.3	0.676	5.81	4.40	43.5	0.757
1970	6.39	4.49	44.7	0.702	4.89	3.71	45.0	0.760
1971	2.70	2.04	46.5	0.756	4.32	2.95	42.1	0.683
1972	5.35	4.01	45.8	0.749	3.24	2.42	43.9	0.747
1973	8.20	6.21	44.8	0.758	3.18	2.05	43.6	0.646
1974	6.23	3.62	39.3	0.581	2.38	1.58	41.0	0.666
1975	3.72	2.75	43.9	0.739	1.66	1.03	39.8	0.621
1976	5.50	3.70	42.3	0.673	1.34	0.94	41.9	0.699
1977	4.20	1.96	37.2	0.467	5.06	3.38	42.0	0.669
1978	3.87	2.56	41.7	0.662	4.04	2.94	42.8	0.727
1979	2.91	1.71	38.2	0.587	1.94	1.62	45.2	0.838
1980	8.46	3.89	36.0	0.460	2.62	2.04	43.7	0.777
1981	8.14	4.05	38.0	0.497	3.66	2.19	40.4	0.600
1982	3.64	1.87	37.2	0.513	0.99	0.83	44.7	0.842
1983	6.41	2.74	36.3	0.427	4.72	2.12	36.7	0.448
1984	3.00	1.66	39.9	0.554	4.37	2.34	39.7	0.534
1985	5.18	2.75	40.3	0.531	2.76	1.59	41.9	0.577
1986	2.07	1.35	44.1	0.650	1.59	1.09	43.3	0.683
1987	1.01	0.65	43.4	0.646	0.48	0.37	43.9	0.774
1988	1.43	0.85	42.3	0.590	1.38	0.57	35.2	0.414
1989	1.95	0.74	35.8	0.382	0.89	0.38	31.4	0.423
1990	0.63	0.24	35.2	0.378	2.00	0.40	24.7	0.200
1991	1.68	0.57	31.5	0.341	2.08	0.54	29.2	0.258
1992	1.26	0.48	34.8	0.383	0.94	0.24	29.5	0.254
1993	1.47	0.36	30.3	0.245	5.15	0.54	17.0	0.105
1994	3.13	0.53	27.4	0.170	2.21	0.42	24.9	0.191
1995	1.88	0.47	30.6	0.248	4.74	0.62	25.7	0.132
1996	1.36	0.28	30.5	0.204	5.38	1.02	29.7	0.189
1997	2.22	0.43	31.0	0.195	5.11	0.77	24.9	0.150
1998	4.27	0.77	29.0	0.179	3.70	0.47	24.2	0.127
1999	3.15	0.48	28.1	0.153	5.92	0.88	26.3	0.148
2000	3.45	0.52	27.3	0.151	6.63	1.11	27.1	0.167
2001	4.41	0.75	29.5	0.171	7.94	1.71	32.3	0.216
2002	8.10	1.62	31.4	0.199	4.31	1.06	33.2	0.247
2003	5.20	1.30	34.2	0.250	2.66	0.79	35.4	0.298
2004	3.80	1.08	35.5	0.285	3.82	1.03	33.3	0.271
2005	3.36	0.89	34.6	0.264				

Note: No significant differences in catchability were found for witch flounder between BMV and polyvalent doors, no significant differences were found between research vessels, therefore no adjustment have been made (Byrne and Forrester, MS 1991). Spring surveys during 1973-1981 were accomplished with a 41 Yankee trawl; in all other years, a 36 Yankee trawl was used. No adjustments have been made.

Table G.5. Stratified mean number per tow at age of witch flounder in NEFSC bottom trawl spring and autumn surveys (Strata 22-30, 36-40), 1980 - 2005.

	AGE														
SPRING	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14+**	**Total**
1980	0.000	0.060	0.230	0.950	1.520	0.720	1.200	1.020	0.380	0.400	0.310	0.300	0.120	0.160	1.100	8.460
1981	0.000	0.000	0.050	0.820	0.930	2.000	1.020	0.760	0.670	0.420	0.130	0.200	0.240	0.220	0.900	8.400
1982	0.000	0.044	0.042	0.610	0.484	0.377	0.237	0.609	0.362	0.093	0.259	0.175	0.026	0.033	0.292	3.642
1983	0.000	0.000	0.071	0.531	1.262	1.293	0.541	0.716	0.632	0.475	0.214	0.166	0.075	0.054	0.376	6.407
1984	0.000	0.000	0.103	0.012	0.307	0.778	0.401	0.310	0.202	0.196	0.115	0.173	0.117	0.023	0.266	3.001
1985	0.000	0.000	0.000	0.017	0.459	1.057	1.199	0.908	0.412	0.148	0.149	0.044	0.072	0.027	0.691	5.182
1986	0.000	0.000	0.000	0.000	0.044	0.240	0.529	0.412	0.172	0.194	0.079	0.038	0.063	0.055	0.248	2.073
1987	0.000	0.000	0.000	0.000	0.059	0.114	0.133	0.259	0.185	0.009	0.061	0.023	0.000	0.000	0.163	1.007
1988	0.000	0.023	0.023	0.062	0.000	0.072	0.300	0.379	0.239	0.137	0.086	0.084	0.029	0.000	0.000	1.434
1989	0.000	0.023	0.013	0.036	1.004	0.105	0.073	0.081	0.327	0.081	0.015	0.056	0.056	0.019	0.056	1.945
1990	0.000	0.008	0.000	0.038	0.091	0.319	0.000	0.042	0.009	0.050	0.018	0.009	0.011	0.000	0.030	0.626
1991	0.000	0.042	0.000	0.781	0.108	0.087	0.209	0.033	0.101	0.083	0.138	0.018	0.022	0.000	0.064	1.684
1992	0.000	0.054	0.009	0.187	0.373	0.085	0.111	0.152	0.045	0.149	0.015	0.016	0.046	0.000	0.019	1.260
1993	0.000	0.149	0.112	0.137	0.472	0.320	0.058	0.085	0.000	0.015	0.015	0.000	0.068	0.000	0.037	1.469
1994	0.000	0.107	0.698	0.541	0.644	0.810	0.164	0.027	0.028	0.070	0.008	0.000	0.000	0.016	0.016	3.129
1995	0.000	0.041	0.120	0.581	0.316	0.179	0.312	0.116	0.110	0.042	0.000	0.038	0.028	0.000	0.000	1.883
1996	0.000	0.017	0.036	0.244	0.394	0.346	0.218	0.073	0.000	0.000	0.000	0.032	0.000	0.000	0.000	1.359
1997	0.000	0.072	0.066	0.152	0.693	0.617	0.437	0.084	0.083	0.014	0.000	0.000	0.000	0.000	0.000	2.219
1998	0.000	0.112	1.079	0.712	0.388	0.798	0.713	0.214	0.154	0.076	0.000	0.000	0.000	0.028	0.000	4.274
1999	0.000	0.106	0.376	0.974	0.797	0.482	0.164	0.182	0.031	0.014	0.023	0.000	0.000	0.000	0.000	3.149
2000	0.000	0.007	0.250	1.194	0.692	0.660	0.239	0.253	0.116	0.000	0.035	0.000	0.000	0.000	0.000	3.446
2001	0.000	0.105	0.099	0.713	1.476	1.020	0.401	0.293	0.163	0.113	0.028	0.000	0.000	0.000	0.000	4.409
2002	0.000	0.023	0.060	0.897	2.627	2.263	0.822	0.683	0.351	0.192	0.103	0.014	0.000	0.029	0.037	8.101
2003	0.000	0.000	0.000	0.150	0.808	1.646	1.017	0.869	0.387	0.197	0.046	0.060	0.000	0.016	0.009	5.204
2004	0.000	0.009	0.060	0.074	0.428	0.648	0.809	0.883	0.368	0.158	0.161	0.135	0.000	0.000	0.067	3.799
2005	0.000	0.011	0.160	0.146	0.220	0.737	0.760	0.574	0.383	0.245	0.086	0.018	0.000	0.021	0.000	3.362

Table G.5. continued. Stratified mean number per tow at age of witch flounder in NEFSC bottom trawl spring and autumn surveys (Strata 22-30, 36-40), 1980-2004.

	AGE														
AUTUMN	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14+**	**Total**
1980	0.040	0.000	0.020	0.000	0.200	0.260	0.280	0.360	0.170	0.150	0.270	0.040	0.160	0.120	0.570	2.620
1981	0.030	0.070	0.030	0.240	0.440	0.610	0.460	0.270	0.260	0.180	0.210	0.170	0.040	0.130	0.480	3.660
1982	0.020	0.000	0.000	0.058	0.013	0.027	0.076	0.241	0.132	0.015	0.027	0.032	0.009	0.039	0.301	0.991
1983	0.000	0.008	0.011	0.507	1.596	0.758	0.548	0.444	0.084	0.137	0.073	0.114	0.025	0.000	0.415	4.718
1984	0.000	0.000	0.000	0.093	0.943	0.991	0.605	0.535	0.310	0.149	0.126	0.073	0.041	0.132	0.375	4.373
1985	0.000	0.000	0.009	0.059	0.076	0.610	0.684	0.482	0.270	0.103	0.122	0.029	0.015	0.089	0.217	2.763
1986	0.009	0.000	0.000	0.000	0.051	0.266	0.353	0.309	0.160	0.112	0.009	0.010	0.021	0.052	0.237	1.590
1987	0.000	0.000	0.023	0.000	0.011	0.023	0.046	0.192	0.071	0.000	0.009	0.000	0.000	0.023	0.085	0.482
1988	0.000	0.007	0.000	0.725	0.055	0.012	0.036	0.215	0.048	0.046	0.045	0.079	0.011	0.043	0.055	1.376
1989	0.174	0.018	0.018	0.082	0.301	0.009	0.021	0.017	0.084	0.078	0.024	0.000	0.026	0.000	0.037	0.888
1990	0.481	0.088	0.137	0.380	0.507	0.219	0.024	0.023	0.023	0.025	0.000	0.000	0.009	0.055	0.034	2.005
1991	0.224	0.021	0.177	0.661	0.329	0.290	0.145	0.067	0.059	0.030	0.052	0.028	0.000	0.000	0.000	2.083
1992	0.097	0.029	0.109	0.259	0.224	0.054	0.061	0.000	0.000	0.019	0.009	0.019	0.000	0.019	0.042	0.940
1993	2.541	0.672	0.154	0.544	0.777	0.219	0.058	0.022	0.081	0.000	0.019	0.042	0.000	0.011	0.014	5.154
1994	0.432	0.156	0.287	0.532	0.165	0.395	0.037	0.106	0.000	0.043	0.009	0.000	0.005	0.000	0.042	2.209
1995	0.512	0.203	0.764	1.624	0.858	0.472	0.229	0.000	0.000	0.011	0.054	0.000	0.000	0.000	0.009	4.736
1996	0.232	0.092	0.261	0.785	1.988	1.386	0.441	0.066	0.065	0.037	0.000	0.033	0.000	0.000	0.000	5.384
1997	0.892	0.339	0.979	0.522	0.871	0.770	0.383	0.329	0.000	0.000	0.000	0.000	0.020	0.000	0.000	5.105
1998	0.639	0.082	0.520	1.363	0.465	0.303	0.165	0.110	0.043	0.012	0.000	0.000	0.000	0.000	0.000	3.701
1999	0.323	0.521	1.178	1.514	1.044	0.600	0.364	0.275	0.050	0.037	0.009	0.000	0.000	0.000	0.000	5.915
2000	0.943	0.096	0.719	1.408	1.746	0.674	0.589	0.229	0.152	0.049	0.000	0.000	0.026	0.000	0.000	6.630
2001	0.000	0.039	0.210	0.952	3.156	1.886	0.813	0.612	0.159	0.058	0.056	0.000	0.000	0.000	0.000	7.940
2002	0.000	0.000	0.275	0.431	1.475	0.997	0.532	0.331	0.148	0.071	0.000	0.046	0.005	0.000	0.000	4.311
2003	0.018	0.000	0.038	0.075	0.307	0.580	0.770	0.315	0.129	0.222	0.083	0.021	0.046	0.019	0.038	2.660
2004	0.276	0.072	0.014	0.086	0.453	0.987	0.826	0.498	0.355	0.054	0.105	0.072	0.000	0.000	0.019	3.816

Table G.6. Parameter estimates (with associated statistics) and estimates of terminal F from ADAPT VPA formulations for witch flounder; stock sizes in '000s.

Notes:	SARC 37	Re-Run of SARC 37	Revised CAA (age and length)		GARM 2005 BASE RUN
Software	NFTv2011	NFTv222	NFTv222/231		NFT 231
CAA	1982-2002 3-11+	1982-2002 3-11+	1982-2002 3-11+		1982-2004 3-11+
Est.Ages	3-10	3-10	3-10		3-10
NMFS-s	3-11+	3-11+	3-11+		3-11+
NMFS-a	3-11+	3-11+	3-11+		3-11+
M.S.R.	.791	.791	.793		.811
N3 (cv)	19,759 (.64)	19,759 (.64)	19,752 (.64)		3,902 (.65)
N4 (cv)	25,441 (.45)	25,441 (.45)	25,432 (.45)		4,053 (.46)
N5 (cv)	42,739 (.37)	42,739 (.37)	42,727 (.37)		9,206 (.39)
N6 (cv)	41,657 (.33)	41,657 (.33)	41,640 (.33)		14,614 (.35)
N7 (cv)	21,203 (.31)	21,203 (.31)	21,204 (.31)		19,943 (.32)
N8 (cv)	10,370 (.32)	10,370 (.32)	10,362 (.32)		17,315 (.30)
N9 (cv)	3,903 (.33)	3,903 (.33)	3,931 (.33)		8,815 (.27)
N10 (cv)	791 (.45)	791 (.45)	792 (.45)		2,245 (.37)
Age 3 in T+1 ('000s)	19,760	19,760	19,752		3,902
F 1	-	-	-		-
F 2	-	-	-		-
F 3	0.0015	0.0015	0.0015		0.0058
F 4	0.0161	0.0161	0.0160		0.0323
F 5	0.0268	0.0268	0.0269		0.0661
F 6	0.0595	0.0595	0.0591		0.0690
F 7	0.1741	0.1741	0.1748		0.0772
F 8	0.2648	0.2648	0.2622		0.1136
F 9	0.5526	0.5526	0.5570		0.2838
F10	0.4087	0.4087	0.4096		0.1987
F11+	0.4087	0.4087	0.4096		0.1987
Ave F 7-9	-	-	-		-
Ave F 8-9	0.4087	0.4087	0.4096		0.1987
SSB ('000 mt)	18,296	18,369	18,370		21,175

Table G.7. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality and spawning stock biomass (mt) for witch flounder estimated from virtual population analysis, 1982-2004.

Age	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
3	15405	17701	16343	7652	5417	3002	9745	6215	6673	8835	14374	9743
4	12175	13082	14923	13931	6471	4641	2563	7831	4935	5425	7195	12002
5	9563	9493	10014	11487	10901	5221	3827	2077	6336	3661	4294	5032
6	7830	7114	6765	6769	7929	7980	4061	3049	1727	4434	2354	2902
7	4289	5375	4668	4217	4039	4267	5685	2887	2333	1250	3284	1164
8	2752	3077	3160	2647	2224	2034	2222	3616	1784	1755	858	2164
9	2102	1763	1746	1344	1132	1146	950	854	2298	1100	1284	552
10	1101	1440	839	862	599	594	544	448	413	1669	677	941
11+	7260	4728	3844	2926	2040	1151	1218	1263	900	1372	2128	1319
Total	62477	63773	62302	51835	40752	30036	30815	28240	27399	29501	36448	35819

Age	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
3	14268	12680	18854	19931	19769	32280	44865	41852	25021	12889	4737	3902
4	7999	12242	10332	16114	17029	16708	27634	38520	35957	21498	11047	4054
5	8658	5958	10193	8407	12890	14141	13893	23519	32836	30258	18141	9207
6	3022	4908	4166	7656	6296	10109	11157	11540	19374	27126	24831	14615
7	1651	1416	2644	2329	5394	4111	7349	8521	8925	15384	21733	19948
8	454	662	440	964	1067	3156	2431	4765	5749	5704	11474	17316
9	1322	210	323	137	286	576	2010	1164	2759	3769	3465	8815
10	274	642	91	81	41	116	264	1215	422	1781	2551	2245
11+	783	373	181	114	185	200	665	880	895	1427	1738	3027
Total	38431	39091	47224	55733	62957	81397	110268	131976	131938	119836	99717	83129

Table G.7. continued.

Fishing Mortality

Age	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
3	0.013	0.021	0.010	0.018	0.005	0.008	0.069	0.081	0.057	0.055	0.030	0.047
4	0.099	0.117	0.112	0.095	0.065	0.043	0.061	0.062	0.149	0.084	0.208	0.177
5	0.146	0.189	0.242	0.221	0.162	0.101	0.077	0.034	0.207	0.292	0.242	0.360
6	0.226	0.271	0.323	0.366	0.470	0.189	0.191	0.117	0.173	0.150	0.554	0.414
7	0.182	0.381	0.417	0.490	0.536	0.502	0.302	0.331	0.135	0.226	0.267	0.792
8	0.295	0.416	0.705	0.700	0.514	0.612	0.807	0.303	0.333	0.162	0.291	0.343
9	0.228	0.593	0.556	0.657	0.495	0.595	0.601	0.576	0.170	0.335	0.161	0.551
10	0.266	0.477	0.650	0.685	0.507	0.606	0.741	0.350	0.238	0.225	0.211	0.382
11+	0.266	0.477	0.650	0.685	0.507	0.606	0.741	0.350	0.238	0.225	0.211	0.382

Age	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
3	0.003	0.055	0.007	0.007	0.018	0.005	0.002	0.002	0.002	0.004	0.006
4	0.145	0.033	0.056	0.073	0.036	0.034	0.011	0.010	0.023	0.020	0.032
5	0.418	0.208	0.136	0.139	0.093	0.087	0.036	0.044	0.041	0.048	0.066
6	0.608	0.468	0.431	0.200	0.276	0.169	0.120	0.107	0.081	0.072	0.069
7	0.764	1.020	0.859	0.630	0.386	0.376	0.283	0.244	0.298	0.143	0.077
8	0.622	0.569	1.013	1.064	0.466	0.301	0.587	0.396	0.272	0.349	0.114
9	0.573	0.686	1.234	1.063	0.754	0.631	0.353	0.865	0.288	0.240	0.284
10	0.585	0.596	1.100	1.064	0.520	0.346	0.474	0.473	0.277	0.304	0.199
11+	0.585	0.596	1.100	1.064	0.520	0.346	0.474	0.473	0.277	0.304	0.199

Table G.7 continued.

Spawning Stock Biomass (mt)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	20	21	39	8	6	18	69	71	18	19	62	36
4	107	132	185	127	91	216	191	238	156	104	145	230
5	376	458	580	684	1020	881	746	360	587	336	464	437
6	1115	1241	1243	1584	1916	2472	1298	965	454	887	582	695
7	1543	1883	1715	1720	1636	1794	2495	1303	999	496	1370	424
8	1634	1544	1559	1388	1218	1072	1148	2010	1003	1004	500	1211
9	1632	1172	1088	878	780	757	628	559	1641	754	917	393
10	949	1207	628	666	487	479	422	367	358	1411	548	789
11+	9521	5781	4505	3374	2414	1323	1392	1578	1227	1830	2491	1612
Total	16898	13439	11542	10428	9569	9012	8389	7451	6444	6842	7079	5827

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	26	11	12	9	31	62	106	161	135	29	21
4	156	162	113	115	247	300	464	646	681	412	205
5	637	606	896	599	1069	1096	1081	1782	2252	2230	1204
6	630	1205	1153	1845	1305	2072	2059	2047	3376	4526	4003
7	585	543	1053	906	1921	1407	2359	2605	2708	4771	6278
8	231	353	226	464	502	1499	1048	1977	2468	2358	4811
9	864	145	197	88	180	303	1082	559	1489	1914	1734
10	217	510	70	62	34	95	156	689	283	1039	1490
11+	876	410	181	120	200	160	549	666	783	1070	1429
Total	4222	3946	3899	4209	5489	6995	8903	11132	14177	18349	21175

Table G.8. Summary of witch flounder catch (mt), spawning stock biomass (mt), fully recruited fishing mortality, recruitment (age 3, thousands of fish) and the year class.

	Year	Catch (mt)	SSB (mt)	Ave F 8-9	Recruits Age 3	Year Class
	1982	4954	16897	0.262	15.405	1979
	1983	6159	13439	0.505	17.701	1980
	1984	6759	11542	0.631	16.343	1981
	1985	6192	10429	0.679	7.652	1982
	1986	4636	9568	0.504	5.417	1983
	1987	3494	9012	0.603	3.002	1984
	1988	3320	8389	0.704	9.745	1985
	1989	2199	7451	0.440	6.215	1986
	1990	1645	6443	0.251	6.673	1987
	1991	1870	6841	0.249	8.835	1988
	1992	2395	7079	0.226	14.374	1989
	1993	2973	5827	0.447	9.743	1990
	1994	3073	4222	0.597	14.268	1991
	1995	2386	3945	0.627	12.680	1992
	1996	2338	3901	1.123	18.854	1993
	1997	2065	4208	1.063	19.931	1994
	1998	2124	5489	0.610	19.769	1995
	1999	2327	6994	0.466	32.280	1996
	2000	2550	8904	0.470	44.865	1997
	2001	3241	11132	0.631	41.852	1998
	2002	3467	14175	0.280	25.021	1999
	2003	3506	18349	0.294	12.889	2000
	2004	3149	21175	0.199	4.737	2001
	2005				3.902	2002
min		1645	3901	0.199	3.002	
max		6759	21175	1.123	44.865	
mean		3340.087	9365.6957	0.516	15.506	
Geomean					12.266	
Median					14.268	

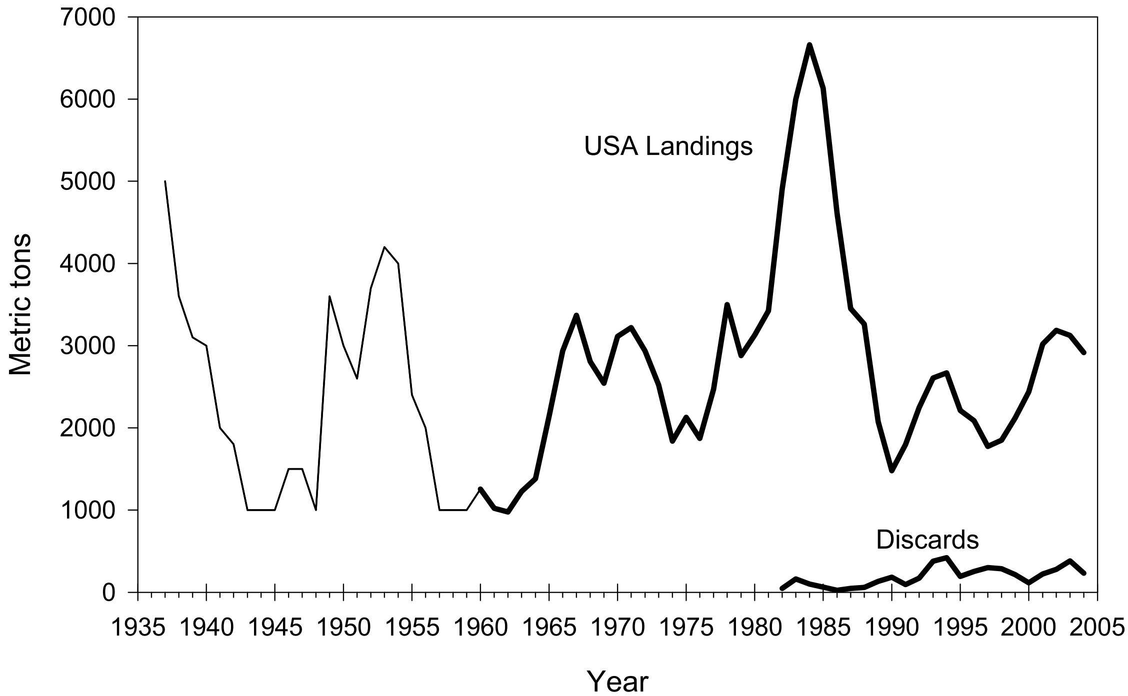

Figure G.1. Historical USA witch flounder landings (mt), excluding USA landings from the Grand Banks in the mid-1980's. The thin line represents provisional landings data taken from Lange and Lux (1978). Discards are from the northern shrimp and large-mesh otter trawl fisheries.

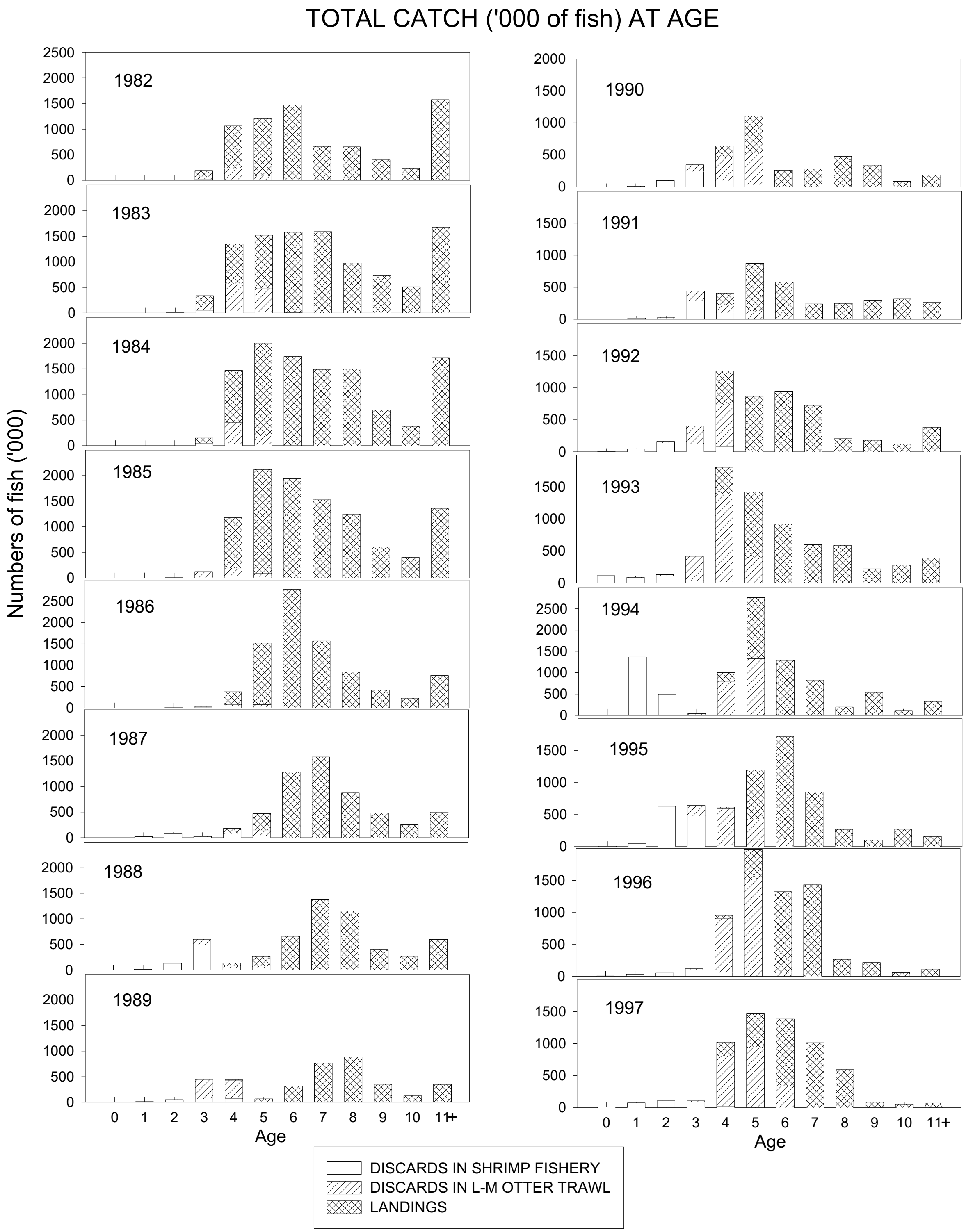

Figure G.2. Number of witch flounder ('000 of fish) at age in the total catch, by fishery, 1982-2004. Open bar represents discards in the shrimp fishery, diagonal bar represents discards in large-mesh fishery and hatched bar represents landings.

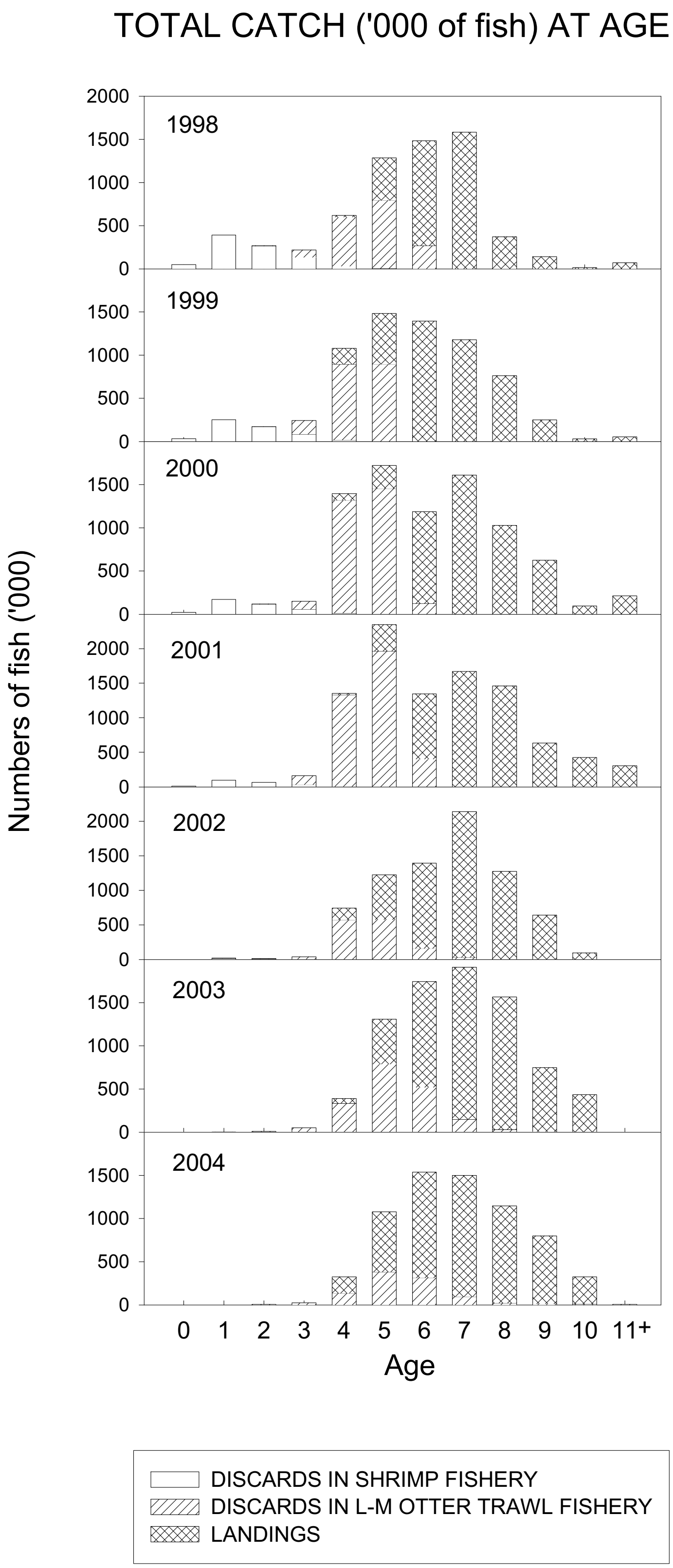

Figure G.2 continued.

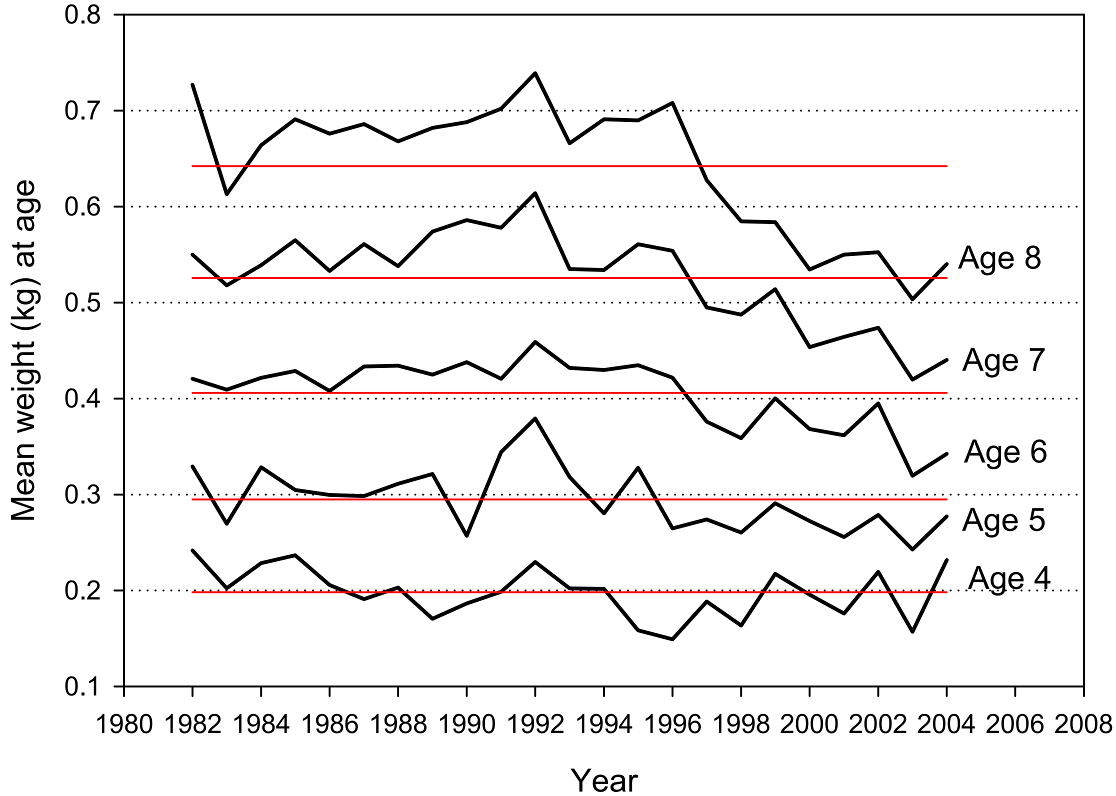

Figure G.3. Witch flounder mean weights at age in the catch, 1982 – 2004.

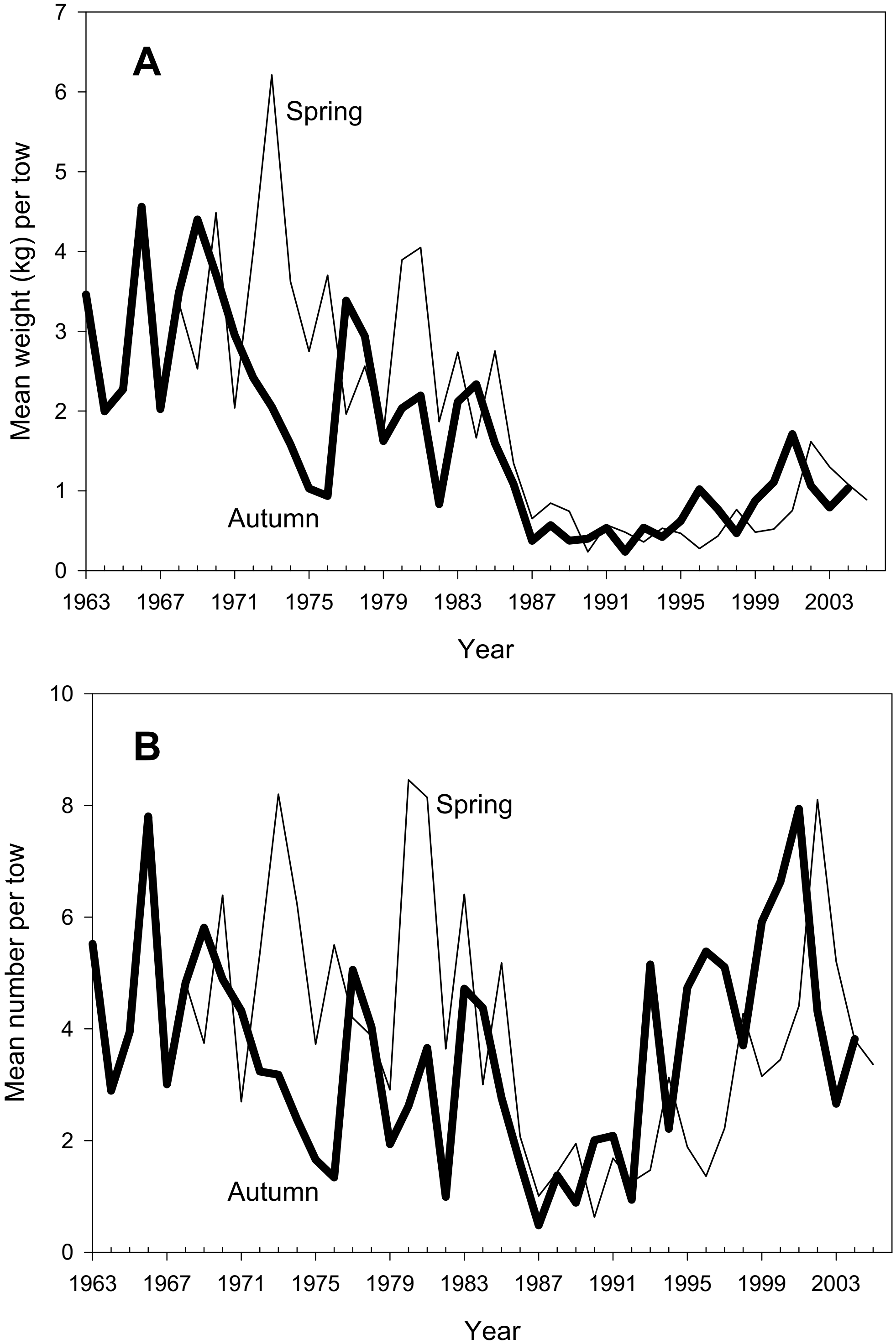

Figure G.4. Stratified mean weight (kg) per tow (A) and mean number per tow (B) of witch flounder in the NEFSC spring and autumn bottom trawl surveys, 1963-2005.

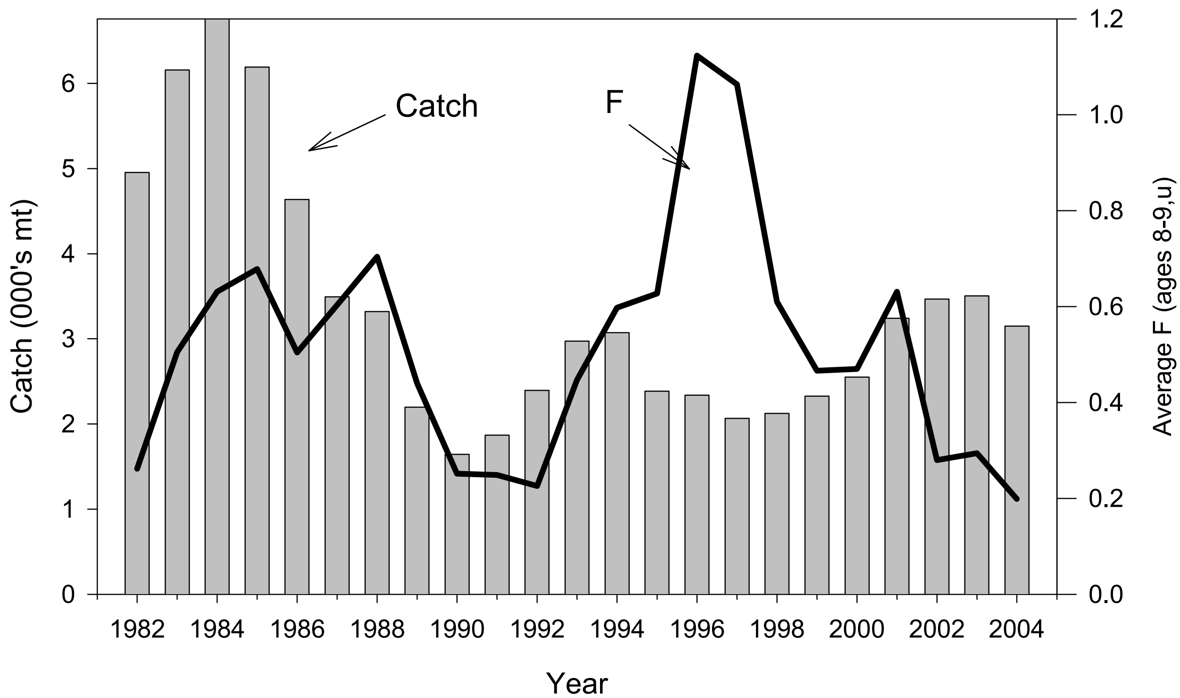

Figure G.5. Trends in total catch and fishing mortality for witch flounder, 1982-2004.

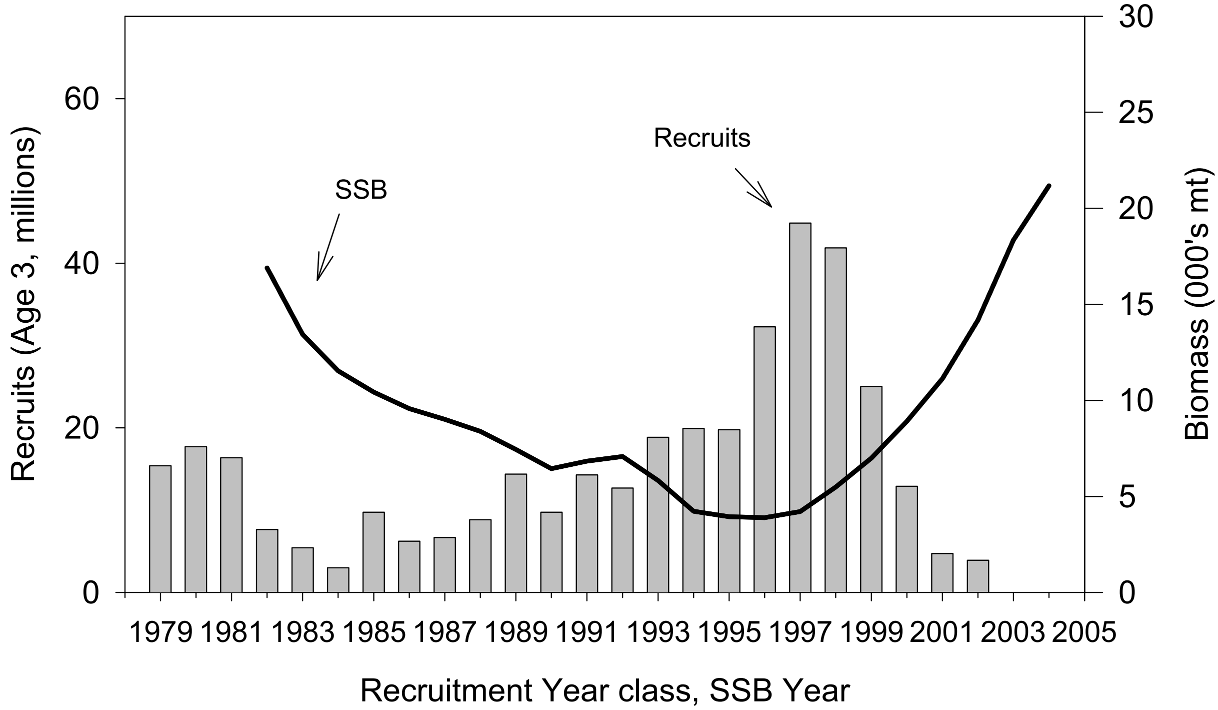

Figure G.6. Trends in spawning stock biomass and recruitment (age 3) for witch flounder; 1982 – 2004.

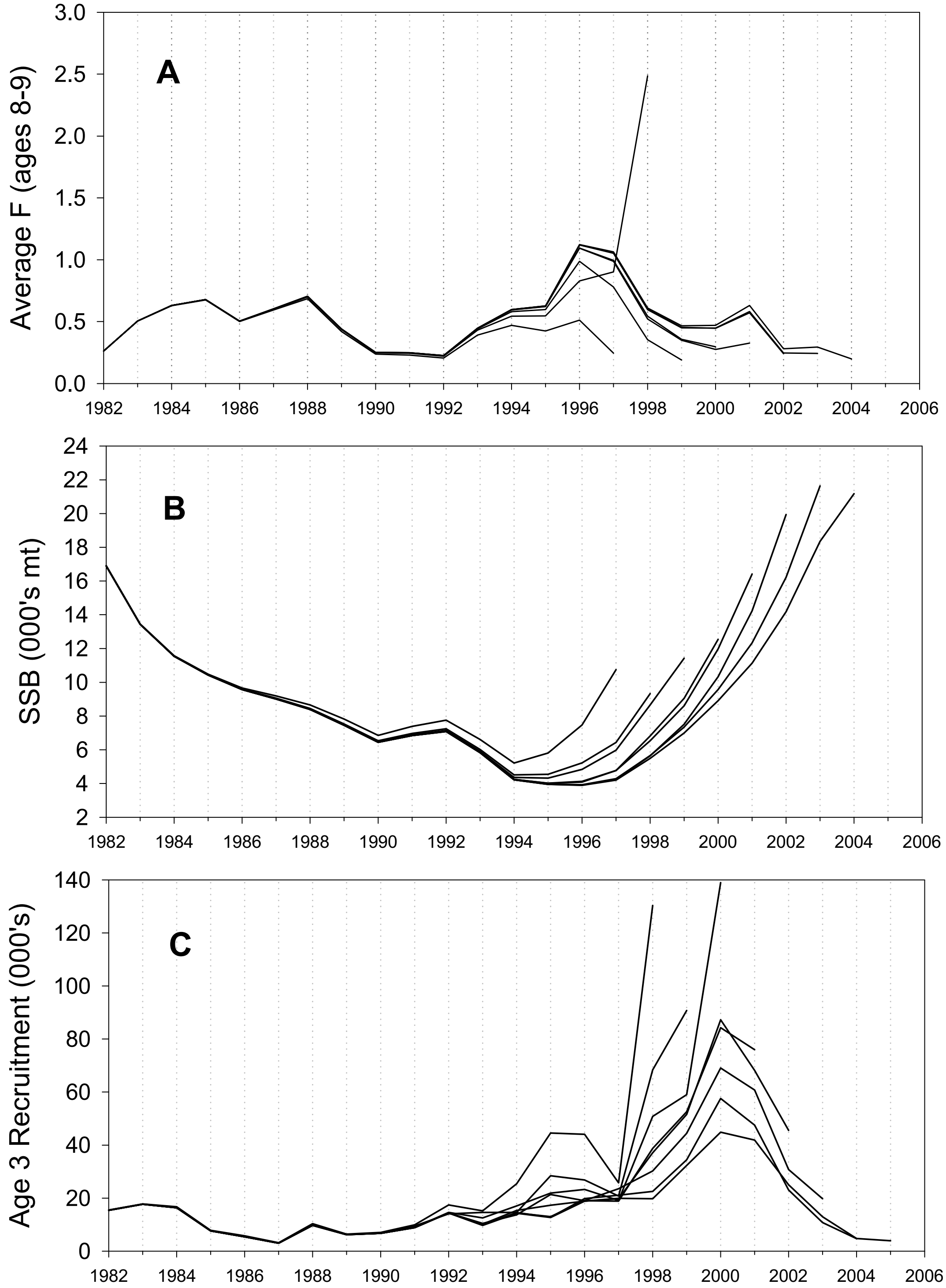

Figure G.7. Retrospective analysis results of fishing mortality(A), spawning stock biomass (B), and age 3 recruitment (C) for witch flounder.

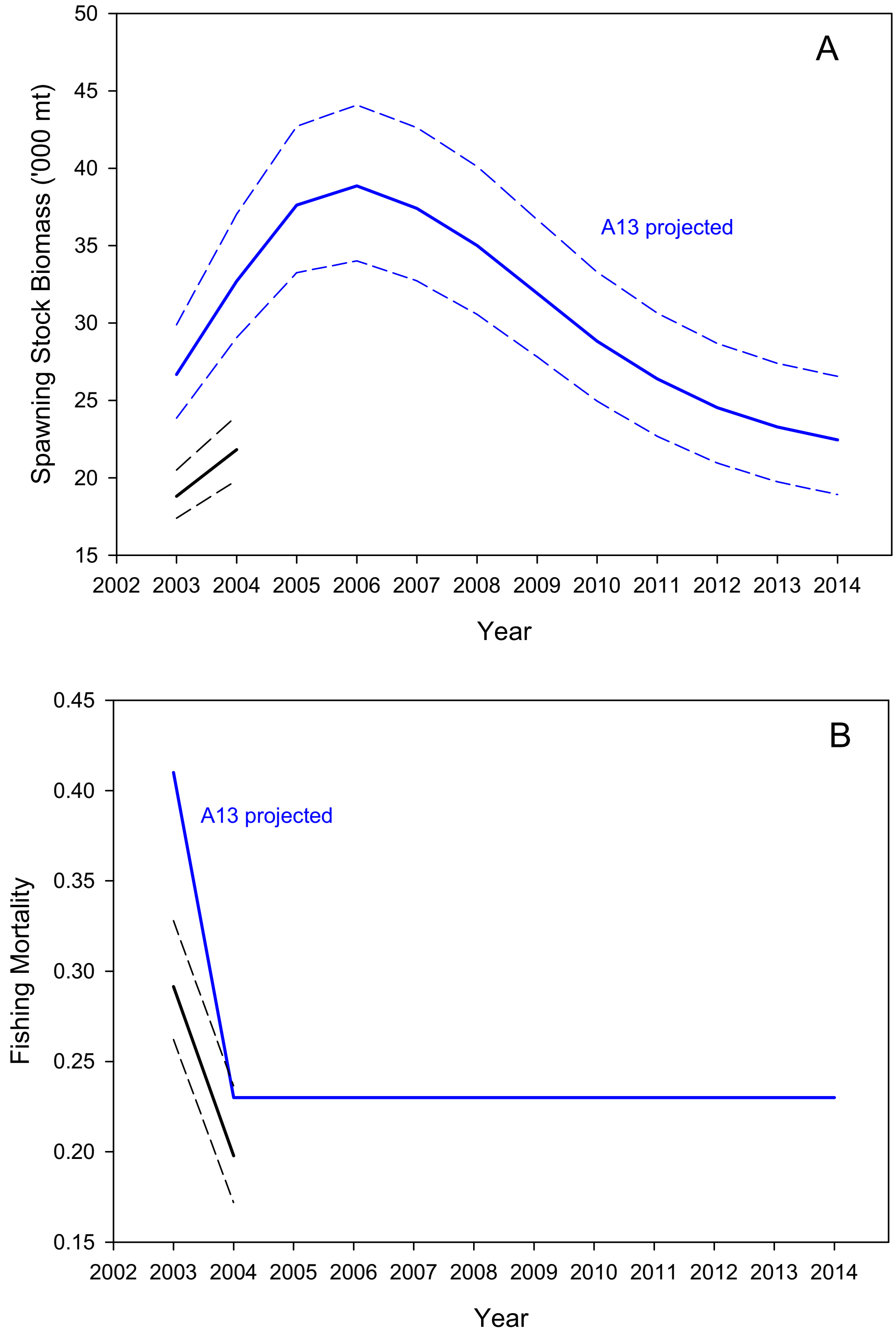

Figure G.8 . Comparisons of Amendment 13 projected and 2004 assessment estimates of witch flounder spawning stock biomass (A) and fishing mortality (B), 2003 - 2014. Solid lines represent the median values and dash lines represent the 25 and 75 percentiles.

H. Gulf of Maine/Georges Bank American Plaice by L. O'Brien, J. Burnett, and L. Col

1.0 Background

This stock was last assessed in 2002 (O'Brien et al. 2002) and reviewed by the Groundfish Assessment Review Meeting (Northeast Fisheries Science Center 2002).

Landings in 2001 were 4,479 mt and fully recruited F (ages 5-8, u) in 2001 was estimated to be 0.43, a 30% increase from 2000. Spawning stock biomass was 13,822 mt in 2001, a decrease of 3% from 2000. The 1998 and 2001 year classes were above average and the 2000 year class was the lowest in the time series.

2.0 Fishery

Total commercial landings of Gulf of Maine-Georges Bank American plaice were 1,711 mt in 2004, a 31% decrease from 2003 and a 51% decrease from 2002 (Table H1, Figure H1). USA landings account for about 98% of the landings in recent years (2002-2004) and Canada accounts for the remainder. The otter trawl fleet accounts for more than 95% of the landings and the fishery is prosecuted primarily during the 2nd and 3rd calendar quarter of the year. The highest proportion of landings are in the small market category. The number of samples obtained for characterizing the catch at age were adequate during 2002-2004, however, landings had to be pooled by half-year in 2002 for the medium market category (Table H2). The total catch at age (Table H3,Figure 2) includes estimates of discarded fish from both the Northern shrimp fishery and the large mesh fishery and landings from the commercial fishery.

Discarding of small fish occurs in the northern shrimp fishery during the 1st and 4th calendar quarter, and year-round by the large mesh fishery. Discarded catch in the Northern shrimp fishery is estimated directly from sea-sampled trips (1989-1997) and indirectly using survey data (1980-1988,1998-2004). Discards in the large mesh fishery are also estimated based on survey data. During 2002-2004 discards in the shrimp fishery accounted for about 0.8% of the total catch (in numbers) and discards in the large mesh fishery account for about 23% of the total catch (in weight).

3.0 Research Surveys

The NEFSC survey indices of abundance and biomass have generally been increasing during 1988-2000. The most recent spring and autumn indices, however, both indicate a decreasing trend (Table H4, Figure H3 and H4) during 2000-2005. Recruitment indices of age 1 fish from NEFSC autumn surveys indicate that both the 1997 and 1998 year classes are above average and the 2001 year class is just about average (Fig. H5a). The 1997 and 1998 year classes are just below average in the autumn Massachusetts state survey, however the 2003 is above average (Fig H5b) .

4.0 Assessment

Input data and Analyses

The current assessment is an update assessment and employs the same ADAPT formulation as in the 2002 assessment (O'Brien *et al.* 2002). Catch at age has been updated with 2002, 2003, and 2004 landings, and discards have been estimated for the Northern shrimp fishery and the large mesh fishery. Research survey indices have been estimated for the spring NEFSC (ages 1-8) and MADMF (ages 1-5) surveys and the autumn NEFSC (ages1-6) and MADMF (ages 1-5) surveys for 2002-2004 (Table H5a-d). The ADAPT calibration method (Parrack 1986), (Gavaris 1988) , (Conser and J.E. Powers. 1990) was used to derive estimates of instantaneous fishing mortality and beginning year stock sizes in 2004. A conditional non-parametric bootstrap procedure (Efron 1982) was used to evaluate the precision of fishing mortality, spawning stock biomass, and mean biomass estimates. A retrospective analysis was performed for terminal year fishing mortality, spawning stock biomass, and age 1 recruitment.

Assessment results

Fully recruited fishing mortality (age 5-8) was estimated at 0.15 in 2004 (Table H6, Figure H6). Spawning stock biomass in 2004 was estimated at 14,149 mt, a 16% decrease from 2001 and a 10% decrease from 2003 (Table H6, Figure H7). Recruitment of the 2001 year class (32.4 million age 1 fish) is estimated to be similar to the above average 1998 year class (35.7 million age 1 fish). The 2003 (54.8 million age 1 fish) and 2004 (66.7 million age 1 fish) year classes are well above the long term average (33.1 million age 1 fish) (Table H6, Figure H7).

VPA Diagnostics

Stock size estimates for ages 1-8 were well estimated with CVs ranging from 0.16 to 0.44. The distribution of F estimates from the bootstrap analysis ranged from 0.12 to 0.20 with an 80% probability that F in 2004 was between 0.14 and 0.17. The distribution of SSB estimates from the bootstrap analysis ranged from 12,000 mt to 18,000 mt with an 80% probability that SSB in 2000 was between 13,000 mt to 16,000 mt.

The retrospective analysis indicates a pattern in the estimate of F and SSB with this model formulation (Figure H8). The terminal year estimates of fishing mortality exhibit a pattern of overestimating F before 2003, whereas, SSB has a pattern of underestimation before 2003. The terminal year estimates of recruits are underestimated prior to 2002 and overestimated after 2002. These patterns are very different from the previous assessment (O'Brien et al. 2002) in which there was not a strong retrospective pattern .

5.0 Biological Reference Points

Biological reference points were established for Gulf of Maine -Georges Bank American plaice based on yield per recruit analyses using $F_{40\%}$ as a proxy for F_{MSY} (NEFSC 2002) as:

MSY= 4,900 mt
SSB_{MSY} = 28,600 mt and
F_{MSY}= 0.166

In 2004, spawning stock biomass was estimated at 14,149 mt, about 49% of the target SSB_{MSY}. The stock is considered to be overfished, although the upper 80% confidence interval includes biomass >50% SSB_{MSY}. Overfishing is not occurring on this stock since F_{2004}= 0.15 < F_{MSY}, although the upper 80% confidence interval about F_{2004} is above F_{MSY}.

6.0 Summary

American plaice in the Gulf of Maine-Georges Bank region are overfished but overfishing is not occurring. Estimates of F and SSB are similar to the A13 projection trajectories for 2002-2004 (Figure H9). Fishing mortality on this stock has declined during 2001-2004. Spawning stock biomass increased during 1995 to 2000 to 16,815 mt and has since decreased to 14,149 mt in 2004. The 1998 and 2001 year classes are just above average, whereas the 2000 year class is the lowest on record. The 2003 and 2004 year classes are well above average. The NEFSC survey biomass indices show a declining trend during 2002-2005, however, the 2001 and 2003 and 2004 year classes appear to be at or near the long term average.

7.0 Sources of Uncertainty

Lack of direct estimates of discards from sea sampled trips for large mesh fishery and shrimp fishery.

8.0 Panel Discussion

The Panel noted that discards from the northern shrimp fishery and the large-mesh otter trawl fishery estimated using survey-based methods are likely to be more uncertain than those estimated directly from Observer data. While the survey-based methods are consistent with previous American plaice assessments, direct estimates based on observer data are desirable.

The Panel discussed the number of fish estimated at age 1 in 2004 (68 million fish) and noted that there is some uncertainty associated with this estimate (bootstrap CV 93%). The high CV, coupled with the retrospective pattern of overestimating recruits, indicate that future assessments may estimate a lower value for this year class.

The Panel noted the retrospective analysis indicated a weak pattern where F was overestimated, spawning stock biomass was underestimated and estimates of Age 1 were underestimated prior to 2002 and overestimated after 2002.

Projection Advice - Given the declining trend in mean weights at age, the Panel agreed that the average of the three most recent years (2002 - 2004) of mean weights at age should be used for short-term projections. Additionally, a ‘smoothed’ partial recruitment vector based on 2002 -

2004 and the most recent maturity stanza (2003 - 2005) should be used. Although Age 1 in 2004 (2003 year class) is poorly estimated, this year class will not be influential on the short-term projected estimates of spawning stock biomass, and so the Panel agreed to retain the estimated value. The Panel agreed that re-sampling from the entire recruitment series should be used in the short-term projections.

9.0 References

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Table H1. Commerical landings (metric tons, live weight) of American plaice from the Gulf of Maine, Georges Bank, Southern New England and the Mid-Atlantic, 1960-2004.

Year	Gulf of Maine			Georges Bank					Southern New England				Mid - Atlantic			Grand Total		
	USA	Can	Total	USA	Can	USSR	Other	Total	USA	USSR	Other	Total	USA	Other	Total	USA	Other	Total
1960	620	1	621	689	-	-	-	689	-	-	-	0	-	-	0	1309	1	1310
1961	692	-	692	830	-	-	-	830	-	-	-	0	-	-	0	1522	0	1522
1962	694	-	694	1233	44	-	-	1277	-	-	-	0	-	-	0	1927	44	1971
1963	693	-	693	1489	127	24	-	1640	-	-	-	0	-	-	0	2182	151	2333
1964	811	-	811	2800	177	-	11	2988	-	-	-	0	-	-	0	3611	188	3799
1965	967	-	967	2376	180	112	-	2668	-	-	-	0	-	-	0	3343	292	3635
1966	955	2	957	2388	242	279	1	2910	-	-	-	0	-	-	0	3343	524	3867
1967	1066	6	1072	2166	203	1018	10	3397	-	-	-	0	4	-	4	3236	1237	4473
1968	904	5	909	1695	173	193	5	2066	637	145	-	782	18	2	20	3254	523	3777
1969	1059	7	1066	1738	71	63	17	1889	505	349	-	854	130	-	130	3432	507	3939
1970	895	-	895	1603	92	927	658	3280	88	18	40	146	8	-	8	2594	1735	4329
1971	648	5	653	1511	38	228	296	2071	11	112	206	329	6	2	8	2176	887	3063
1972	569	-	569	1222	22	358	-	1602	3	71	-	74	-	-	0	1794	451	2245
1973	687	-	687	910	38	289	-	1237	5	158	-	163	-	-	0	1602	485	2087
1974	945	2	947	1039	27	16	2	1084	92	4	-	96	-	-	0	2076	51	2127
1975	1507	-	1507	913	25	148	-	1086	3	-	-	3	-	-	0	2423	173	2596
1976	2550	-	2550	948	24	3	-	975	10	-	-	10	1	-	1	3509	27	3536
1977	5647	-	5647	1408	35	50	-	1493	6	78	-	84	7	-	7	7068	163	7231
1978	7287	30	7317	2193	77	-	-	2270	15	-	-	15	8	-	8	9503	107	9610
1979	8835	-	8835	2478	23	-	-	2501	13	-	7	20	4	-	4	11330	30	11360
1980	11139	-	11139	2399	43	-	5	2447	10	-	-	10	1	-	1	13549	48	13597
1981	10327	1	10328	2482	15	-	2	2499	26	-	2	28	46	-	46	12881	20	12901
1982	11147	-	11147	3935	27	-	1	3963	35	-	2	37	9	-	9	15126	30	15156
1983	9142	7	9149	3955	30	-	-	3985	40	-	-	40	4	-	4	13141	37	13178
1984	6833	2	6835	3277	6	-	-	3283	17	-	-	17	7	-	7	10134	8	10142
1985	4766	1	4767	2249	40	-	-	2289	12	-	-	12	2	-	2	7029	41	7070
1986	3319	-	3319	1146	34	-	-	1180	4	-	-	4	3	-	3	4472	34	4506
1987	2766	-	2766	1032	48	-	-	1080	2	-	-	2	1	-	1	3801	48	3849
1988	2271	-	2271	1097	108	-	-	1205	13	-	-	13	1	-	1	3382	108	3490
1989	1646	-	1646	703	68	-	-	771	1	-	-	1	3	-	3	2353	68	2421
1990	1802	-	1802	639	52	-	-	690	2	-	-	2	2	-	2	2445	52	2497
1991	2936	-	2936	1310	26	-	-	1310	15	-	-	15	0	-	0	4261	26	4287
1992	4564	-	4566	1838	3	-	-	1838	10	-	-	10	4	-	4	6416	3	6419
1993	3865	-	3865	1838	-	-	-	1838	11	-	-	11	4	-	4	5718	-	5718
1994	***3357***	-	3431	***1683***	30	-	-	1562	***22***	-	-	22	***4***	-	4	5066	30	5096
1995	***3105***	-	3126	***1505***	2	-	-	1486	***15***	-	-	15	***20***	-	20	4645	2	4647
1996	***2912***	-	2922	***1430***	2	-	-	1423	***40***	-	-	40	***15***	-	15	4396	2	4398
1997	***2312***	-	2396	***1576***	65	-	-	1560	***23***	-	-	23	***26***	-	26	3937	65	4002
1998	***2234***	-	2234	***1385***	20	-	-	1405	***23***	-	-	23	***20***	-	20	3663	20	3683
1999	***1718***	-	1718	***1384***	123	-	-	1507	***11***	-	-	11	***21***	-	21	3134	123	3257
2000	***2497***	-	2497	***1687***	143	-	-	1830	***10***	-	-	10	***19***	-	19	4213	143	4356
2001	***2602***	-	2602	***1814***	46	-	-	1860	***7***	-	-	7	***10***	-	10	4433	46	4479
2002	***1987***	-	1987	***1413***	98	-	-	1510	***6***	-	-	6	***10***	-	10	3416	97.549	3514
2003	***1480***	-	1480	***934.1***	57	-	-	991.3	***10***	-	-	10	***6***	-	6	2430	57.17	2487
2004	***1041***	-	1041	***654***	3	-	-	656.8	***4***	-	-	4	***9***	-	9	1708	2.825	1711

* 1994-2004 data are provisional and spatially distributed based on proportions of landings recorded by area in the VTR database

Table H2. Sampling of commercial American plaice landings, by market category, for the Gulf of Maine and Georges Bank areas (NAFO Division 5Y and 5Z), 1985-2004. Outline indicates samples pooled to estimate landings at age.

		Small				Medium				Large				Number of tons landed / sample		
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Sm.	Med.	Lrg.
1985	GB	2	4	14	3	---	2	2	2	---	3	7	1			
	GM	2	5	5	5	3	1	9	5	1	10	6	5			
	total	4	9	19	8	3	3	11	7	1	13	13	6	49	55	116
1986	GB	3	6	5	3	2	4	3	2	1	4	3	2			
	GM	9	5	3	5	3	4	5	1	10	10	7	4			
	total	12	11	8	8	5	8	8	3	11	14	10	6	33	35	56
1987	GB	4	5	5	1	---	2	3	2	2	4	4	1			
	GM	2	6	5	3	1	5	2	3	3	3	6	5			
	total	6	11	10	4	1	7	5	5	5	7	10	6	39	40	63
1988	GB	3	7	4	2	1	3	4	2	4	5	2	4			
	GM	4	7	4	5	6	6	4	3	6	5	3	2			
	total	7	14	8	7	7	9	8	5	10	10	5	6	34	21	40
1989	GB	2	5	5	---	1	1	6	1	5	3	3	---			
	GM	1	3	3	3	1	---	4	3	2	1	---	1			
	total	3	8	8	3	2	1	10	4	7	4	3	1	35	29	63
1990	GB	---	5	6	---	2	1	2	2	---	2	5	---			
	GM	5	5	3	3	1	6	3	5	1	5	3	5			
	total	5	10	9	3	3	7	5	7	1	7	8	5	33	26	42
1991	GB	---	3	1	---	3	1	1	---	3	3	2	---			
	GM	5	3	7	6	3	1	4	3	---	1	5	2			
	total	5	6	8	6	6	2	5	3	3	4	7	2	78	67	67
1992	GB	---	4	1	---	---	1	1	---	---	2	2	1			
	GM	1	5	2	2	1	4	3	2	2	2	3	2			
	total	1	9	3	2	1	5	4	2	2	4	5	3	168	143	155
1993	GB	---	2	1	1	---	1	---	---	---	3	2	1			
	GM	2	4	4	1	---	2	2	---	---	1	2	---			
	total	2	6	5	2	0	3	2	0	0	4	4	1	133	260	253
1994	GB	---	---	---	---	---	---	1	1	---	1	---	1			
	GM	---	2	5	3	---	4	3	3	---	2	3	3			
	total	0	2	5	3	0	4	4	4	0	3	3	4	205	97	181
1995	GB	1	---	---	---	1	---	---	---	1	---	---	---			
	GM	1	3	---	2	---	2	---	---	---	2	---	1			
	total	2	3	0	2	1	2	0	0	1	2	0	1	323	336	332
1996	GB	---	2	2	1	---	1	4	---	---	2	1	1			
	GM	2	3	2	1	2	1	3	5	3	1	4	2			
	total	2	5	4	2	2	2	7	5	3	3	5	3	189	53	75
1997	GB	2	4	2	3	---	2	3	1	---	2	---	---			
	GM	4	4	3	1	2	3	3	---	1	5	3	2			
	total	6	8	5	4	2	5	6	1	1	7	3	2	82	77	69
1998	GB	1	4	1	---	2	1	1	1	1	1	1	1			
	GM	2	3	1	1	6	3	7	7	2	2	2	2			
	total	3	7	2	1	8	4	8	8	3	3	3	3	111	41	87

Table H2 continued . Sampling of commercial American plaice landings, by market category, for the Gulf of Maine and Georges Bank areas (NAFO Division 5Y and 5Z), 1985-2004. Outline indicates samples pooled to estimate landings at age.

		Small				Medium				Large				Number of tons landed / sample		
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Sm.	Med.	Lrg.
1999	GB	4	4	---	1	5	2	1	---	---	4	1	---			
	GM	6	8	6	9	7	4	5	7	1	6	3	2			
	total	10	12	6	10	12	6	6	7	1	10	4	2	31	29	61
	GB	14	11	3	1	1	2	---	1	2	2	2	2			
2000	GM	15	29	4	1	2	6	3	---	---	4	1	3			
	total	29	40	7	2	3	8	3	1	2	6	3	5	21	85	78
	GB	4	2	1	2	---	2	2	4	---	3	2	1			
2001	GM	5	5	4	---	3	3	2	2	4	2	1	4			
	total	9	7	5	2	3	5	4	6	4	5	3	5	76	70	81
	GB	1	2	2	1	2	1	2	---	4	3	2	---			
2002	GM	2	3	2	3	2	1	3	---	1	3	3	2			
	total	3	5	4	4	4	2	5	0	5	6	5	2	93	85	54
	GB	---	3	---	---	1	---	---	1	---	3	2	---			
2003	GM	3	8	6	6	2	6	6	6	6	10	11	6			
	total	3	11	6	6	3	6	6	7	6	13	13	6	41	33	16
	GB	1	1	1	4	2	---	2	4	1	---	3	1			
2004	GM	5	3	7	2	2	6	4	2	11	12	2	6			
	total	6	4	8	6	4	6	6	6	12	12	5	7	33	22	12

Table H3. Catch at age (thousands of fish; metric tons) and mean weight (kg), of commercial landings, and large mesh and northern shrimp fishery discards of American plaice, ages 1-9+, from Gulf of Maine - Georges Bank, and South, 1980-2004.

Year	0	1	2	3	4	5	6	7	8	9+	Total
					Catch in Numbers (000's) at Age						
1980	0	5	99	1072	2672	3939	3933	3632	1185	3369	19906
1981	0	5	982	2192	5055	5337	3648	2401	1582	1706	22907
1982	0	10	603	3348	4574	4503	3599	3297	2038	2710	24681
1983	0	15	663	1478	5177	4918	3913	2270	1272	2062	21768
1984	0	3	370	991	2422	6031	3244	1936	580	1350	16927
1985	0	65	158	1217	1336	2405	2872	2228	1081	887	12250
1986	0	59	639	738	2284	1700	1476	1307	631	460	9295
1987	0	38	590	1840	1439	2282	1337	895	543	309	9274
1988	0	314	786	1840	1833	1597	1444	553	270	321	8957
1989	0	132	1653	1831	1125	829	536	753	471	411	7740
1990	0	68	676	3389	2664	1369	531	291	349	450	9787
1991	0	13	323	1001	4410	3403	1123	321	164	402	11161
1992	0	37	231	1083	2222	6810	2724	819	198	342	14467
1993	0	107	426	2032	4141	3583	3139	1403	265	563	15658
1994	1	288	506	623	2627	4459	1703	1288	608	688	12791
1995	1	518	1488	2285	6503	4826	2001	654	584	315	19174
1996	0	195	936	1418	4443	2958	1471	549	250	224	12444
1997	0	158	1375	803	2739	3919	1701	718	230	335	11978
1998	0	37	63	281	883	2607	2476	1044	320	272	7983
1999	0	4	202	205	985	1713	2073	1273	463	261	7180
2000	0	3	316	659	1265	1960	2460	1797	554	221	9235
2001	0	0	85	505	1355	2460	2168	1606	905	410	9494
2002	0	1	4	81	1611	2694	2116	1435	626	678	9246
2003	0	0	30	54	570	1823	1675	790	537	574	6051
2004	0	0	6	41	291	997	1309	576	375	375	3970
					Catch at Age (mt)						
1980	0	0	8	165	715	1611	2571	3009	1232	5132	14442
1981	0	0	106	370	1598	2360	2837	2125	1547	2243	13186
1982	0	0	69	768	1323	1884	2028	3165	2320	4010	15567
1983	0	1	20	211	1827	2542	2612	1872	1334	3118	13536
1984	0	0	17	160	735	3159	2046	1720	689	2236	10761
1985	0	1	9	102	279	796	1534	1887	1263	1435	7306
1986	0	1	27	102	523	652	867	1101	741	782	4796
1987	0	0	27	241	337	934	815	799	637	521	4312
1988	0	5	36	293	521	716	927	486	333	522	3839
1989	0	2	68	247	309	370	303	554	403	632	2888
1990	0	1	39	469	707	623	339	240	338	608	3364
1991	0	0	17	120	1458	1696	797	308	191	594	5182
1992	0	1	15	173	701	3304	1956	776	238	554	7717
1993	0	2	33	430	1259	1556	1852	1313	327	927	7699
1994	0	4	14	121	863	1866	961	984	659	1244	6715
1995	0	6	40	464	2091	2178	1238	534	653	490	7695
1996	0	3	35	155	1503	1403	937	495	294	371	5196
1997	0	2	29	89	865	1577	1030	536	219	525	4872
1998	0	1	2	46	248	968	1281	840	330	676	4391
1999	0	0	4	41	319	715	1110	894	407	366	3856
2000	0	0	9	137	388	842	1319	1326	554	279	4854
2001	0	0	2	60	406	1022	1132	1106	760	465	4952
2002	0	0	0	14	494	1024	1021	771	443	729	4496
2003	0	0	1	12	189	704	812	504	430	581	3232
2004	0	0	0	4	99	384	619	359	289	379	2132

Table H3 continued — Catch at age (thousands of fish; metric tons) and mean weight (kg), of commercial landings, large mesh and northern shrimp fishery discards of American plaice, ages 1-9+, from Gulf of Maine - Georges Bank, and South, 1980-2004.

Year	0	1	2	3	4	5	6	7	8	9+	Average
					Mean Weight at age (kg)						
1980	0.000	0.030	0.076	0.154	0.267	0.409	0.653	0.829	1.039	1.523	0.725
1981	0.000	0.032	0.108	0.168	0.316	0.442	0.778	0.885	0.978	1.315	0.576
1982	0.000	0.018	0.115	0.230	0.290	0.418	0.564	0.960	1.138	1.479	0.631
1983	0.002	0.013	0.033	0.185	0.378	0.530	0.670	0.823	1.042	1.479	0.630
1984	0.000	0.004	0.045	0.161	0.303	0.524	0.630	0.888	1.187	1.657	0.636
1985	0.000	0.018	0.058	0.084	0.209	0.331	0.534	0.847	1.167	1.618	0.596
1986	0.001	0.016	0.042	0.138	0.229	0.384	0.587	0.842	1.174	1.702	0.516
1987	0.000	0.013	0.046	0.131	0.234	0.409	0.609	0.892	1.173	1.688	0.465
1988	0.000	0.016	0.046	0.159	0.284	0.449	0.641	0.880	1.231	1.630	0.429
1989	0.000	0.012	0.041	0.135	0.275	0.446	0.566	0.736	0.857	1.537	0.373
1990	0.000	0.021	0.058	0.138	0.265	0.455	0.639	0.824	0.968	1.352	0.344
1991	0.000	0.015	0.053	0.120	0.330	0.498	0.710	0.960	1.161	1.479	0.464
1992	0.000	0.028	0.065	0.159	0.315	0.485	0.717	0.948	1.202	1.617	0.533
1993	0.000	0.016	0.078	0.212	0.304	0.434	0.590	0.936	1.234	1.647	0.492
1994	0.001	0.014	0.028	0.194	0.328	0.418	0.564	0.763	1.083	1.807	0.525
1995	0.001	0.012	0.027	0.203	0.322	0.453	0.646	0.909	1.166	1.399	0.407
1996	0.000	0.014	0.038	0.110	0.338	0.474	0.637	0.902	1.172	1.657	0.418
1997	0.000	0.014	0.021	0.111	0.316	0.402	0.605	0.746	0.951	1.565	0.407
1998	0.001	0.013	0.030	0.165	0.281	0.371	0.518	0.805	1.031	2.482	0.550
1999	0.000	0.008	0.018	0.198	0.324	0.417	0.535	0.702	0.879	1.401	0.537
2000	0.000	0.013	0.029	0.208	0.307	0.429	0.536	0.738	1.000	1.258	0.526
2001	0.000	0.000	0.018	0.119	0.300	0.416	0.522	0.689	0.839	1.133	0.522
2002	0.000	0.000	0.029	0.174	0.307	0.380	0.482	0.537	0.707	1.075	0.486
2003	0.000	0.000	0.022	0.216	0.332	0.386	0.485	0.639	0.802	1.011	0.534
2004	0.000	0.000	0.011	0.092	0.340	0.385	0.473	0.622	0.771	1.011	0.537
1980-2004	0.001	0.016	0.045	0.159	0.300	0.430	0.596	0.812	1.038	1.501	0.514
2000-2004	0.000	0.003	0.022	0.162	0.317	0.399	0.500	0.645	0.824	1.098	0.521

Table H4. Standardized stratified mean number and mean weight per tow (kg) of American plaice in NEFSC spring and autumn bottom trawl surveys in the Gulf of Maine - Georges Bank area, 1963 -2005 (Offshore strata 26-30,36-40,13-25)

	SPRING		**AUTUMN**	
Year	Number	Weight	Number	Weight
1963	-	-	14.17	5.87
1964	-	-	8.20	2.84
1965	-	-	11.95	3.80
1966	-	-	17.78	4.90
1967	-	-	11.05	2.69
1968	11.36	3.40	8.61	2.91
1969	8.59	2.68	7.51	2.36
1970	5.43	1.81	6.46	2.01
1971	3.80	1.26	7.47	1.96
1972	4.28	1.32	7.44	1.60
1973	7.18	1.85	6.19	1.94
1974	8.34	1.94	6.89	1.42
1975	5.78	1.72	8.12	2.43
1976	11.85	3.37	9.98	2.99
1977	14.57	5.11	11.80	3.52
1978	10.61	3.82	15.13	4.66
1979	9.23	3.62	9.96	4.00
1980	18.34	4.78	14.24	5.12
1981	18.75	5.88	13.04	5.62
1982	11.61	3.80	5.88	2.49
1983	16.94	4.60	9.34	3.45
1984	4.10	1.42	7.12	2.02
1985	4.94	1.88	6.95	2.00
1986	3.09	0.92	5.61	1.56
1987	3.50	0.81	4.38	1.09
1988	3.58	0.84	9.69	1.46
1989	4.81	0.75	9.21	1.17
1990	5.09	0.75	15.46	2.90
1991	5.91	1.05	7.71	1.56
1992	4.11	1.36	6.31	1.78
1993	5.29	1.39	11.89	2.39
1994	4.89	0.85	18.07	2.67
1995	9.43	1.94	11.84	2.58
1996	7.83	1.69	7.58	2.23
1997	7.62	1.62	6.27	1.94
1998	4.52	1.11	9.29	2.22
1999	4.18	1.20	11.03	2.57
2000	9.96	2.30	12.23	2.80
2001	10.65	2.19	10.40	2.63
2002	6.70	1.76	9.69	2.24
2003	4.17	0.87	9.29	2.27
2004	8.16	1.35	5.42	0.96
2005	5.02	0.83		

Table H5a. Standardized stratified mean number per tow by age and mean weight per tow (kg) of American plaice in NEFSC spring and autumn research bottom trawl surveys in the Gulf of Maine and Georges Bank area (offshore strata 13-30,36-40) , 1980-2005.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	no/tow	wt/tow
Spring																	
1980	0	0.45	3.69	4.55	3.05	2.93	1.61	1.14	0.26	0.31	0.23	0.04	0.04	0.03	0.006	18.34	4.78
1981	0	0.13	3.43	4.21	3.46	2.61	1.69	1.41	0.77	0.4	0.32	0.07	0.09	0.07	0.09	18.75	5.88
1982	0	0.03	1.05	1.79	3.17	2.13	1.33	0.92	0.5	0.35	0.19	0.07	0.02	0.05	0.01	11.61	3.80
1983	0	0.2	3.68	3.33	4.48	2.64	1.18	0.58	0.32	0.15	0.15	0.11	0.05	0.02	0.04	16.93	4.60
1984	0	0.01	0.35	0.56	0.9	1.29	0.58	0.22	0.1	0.01	0.02	0.01	0.01	0	0.04	4.10	1.42
1985	0	0.03	0.32	0.98	0.86	0.73	0.86	0.46	0.42	0.12	0.07	0.04	0.02	0.02	0.02	4.95	1.88
1986	0	0.01	0.46	0.34	1.01	0.59	0.29	0.21	0.1	0.04	0.04	0	0	0	0	3.09	0.92
1987	0	0.09	0.61	0.99	0.69	0.51	0.25	0.17	0.07	0.03	0.03	0.03	0.01	0	0	3.48	0.81
1988	0	0.2	0.99	0.84	0.76	0.31	0.23	0.12	0.01	0.09	0.01	0.01	0	0	0	3.57	0.84
1989	0	0.05	1.59	1.27	0.86	0.49	0.29	0.16	0.03	0.07	0.01	0.01	0	0	0	4.83	0.75
1990	0	0	0.57	2.65	1.02	0.54	0.17	0.06	0.04	0.05	0	0	0	0	0	5.10	0.75
1991	0	0.03	0.71	1.63	2.33	0.92	0.15	0.07	0.04	0.02	0	0.02	0	0	0.01	5.93	1.05
1992	0	0.06	0.34	1.15	0.88	1.07	0.43	0.11	0.04	0.02	0.01	0	0.01	0	0	4.12	1.36
1993	0	0.33	0.84	1.16	1.58	0.61	0.45	0.17	0.08	0.02	0.01	0.02	0.03	0	0	5.30	1.39
1994	0	0.03	1.43	1.14	1.12	0.75	0.23	0.1	0.03	0.01	0	0.01	0.01	0.01	0.01	4.88	0.85
1995	0	0.03	1.97	3.21	2.3	1.11	0.44	0.22	0.03	0.04	0.03	0.01	0.02	0.01	0.01	9.43	1.94
1996	0	0.02	0.47	1.94	3.3	1.31	0.53	0.2	0.05	0.02	0	0	0	0	0	7.84	1.69
1997	0	0.01	0.85	1.66	2.52	2.05	0.39	0.09	0.01	0	0.01	0	0.02	0	0	7.61	1.62
1998	0	0.06	0.19	1.02	1.12	1.22	0.68	0.16	0.06	0.01	0.01	0.003	0.01	0	0	4.54	1.11
1999	0	0.08	0.41	0.52	1.13	0.79	0.64	0.41	0.17	0.02	0.02	0	0	0	0	4.19	1.20
2000	0	0.03	1.91	2.48	2.22	1.6	0.86	0.6	0.15	0.07	0.02	0.003	0.01	0	0	9.95	2.30
2001	0	0	0.708	3.67	3.37	1.45	0.75	0.37	0.17	0.09	0.05	0.02	0	0	0	10.65	2.19
2002	0.00	0.10	0.35	0.98	2.35	1.66	0.51	0.33	0.20	0.14	0.07	0.01	0.00	0.00	0.00	6.70	1.76
2003	0.00	0.04	0.76	0.27	0.70	1.24	0.64	0.22	0.10	0.09	0.04	0.03	0.01	0.02	0.00	4.17	0.87
2004	0	0.36	0.87	2.03	1.79	1.33	1.14	0.34	0.10	0.18	0	0.01	0.02	0	0	8.16	1.35
2005	0	0.20	0.78	1.04	1.23	0.91	0.50	0.24	0.12	0	0.02	0	0	0	0	5.02	0.831

Table H5b. Standardized stratified mean number per tow by age and mean weight per tow (kg) of American plaice in NEFSC spring and autumn research bottom trawl surveys in the Gulf of Maine and Georges Bank area (offshore strata 13-30,36-40) , 1980-2005.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	no/tow	wt/tow
Autumn																	
1980	0	1.58	2.23	2.72	2.84	1.53	1.02	0.93	0.57	0.3	0.19	0.11	0.04	0.09	0.09	14.24	5.12
1981	0.003	0.44	2.64	2.16	2.48	2.16	1.44	0.59	0.53	0.06	0.16	0.15	0.02	0.02	0.16	13.04	5.62
1982	0	0.2	0.91	1.65	1.27	0.57	0.48	0.3	0.17	0.19	0.08	0.03	0	0	0.02	5.87	2.49
1983	0.06	0.5	1.01	2.02	2.92	1.36	0.68	0.34	0.17	0.1	0.03	0.05	0.06	0.01	0.03	9.34	3.45
1984	0.02	0.22	2.24	1.56	1.21	1.07	0.51	0.12	0.1	0	0.03	0.01	0.02	0	0.01	7.12	2.02
1985	0.02	0.91	0.83	2.64	1.05	0.79	0.41	0.19	0.05	0.03	0.02	0	0	0.01	0	6.95	2
1986	0.1	0.51	1.46	0.87	1.43	0.47	0.42	0.16	0.11	0.04	0.01	0.02	0.01	0	0	5.61	1.56
1987	0.01	0.53	1.27	0.99	0.43	0.69	0.25	0.1	0.04	0.04	0.01	0.02	0	0	0	4.38	1.09
1988	0	2.84	2.97	2.39	0.78	0.47	0.1	0.07	0	0.03	0	0.02	0	0	0	9.67	1.46
1989	0.05	0.48	4.45	2.86	0.98	0.19	0.1	0.02	0.02	0.02	0.02	0	0.01	0.02	0	9.22	1.17
1990	0.01	1.71	2.26	7.49	2.89	0.59	0.25	0.12	0.07	0.02	0.02	0.01	0.01	0.01	0	15.46	2.9
1991	0.01	0.47	2.47	2.02	1.59	0.73	0.29	0.04	0.06	0	0.01	0	0	0	0.01	7.70	1.56
1992	0.02	0.65	1.23	1.85	1.28	0.78	0.3	0.07	0.05	0.03	0.02	0	0.02	0	0	6.30	1.78
1993	0.01	1.7	2.34	3.47	2.28	1.05	0.8	0.11	0.04	0.04	0.04	0	0	0	0	11.88	2.39
1994	0.04	3.83	7.53	2.81	1.71	1.3	0.4	0.25	0.13	0.01	0.03	0.02	0	0	0	18.06	2.67
1995	0.01	0.5	3.8	3.82	2.5	0.9	0.22	0.04	0.03	0	0	0	0.02	0	0	11.84	2.58
1996	0.01	0.54	0.81	2	2.74	0.93	0.39	0.07	0.04	0.03	0	0	0.02	0	0.02	7.60	2.23
1997	0.01	0.36	1.06	1.55	1.86	1.04	0.32	0.04	0.01	0.01	0	0	0	0	0.02	6.28	1.94
1998	0.01	1.73	0.6	1.88	2.01	1.78	1.08	0.12	0.05	0.01	0.01	0	0.01	0	0	9.29	2.22
1999	0.02	2	2.2	2.05	2.13	1.6	0.81	0.2	0.03	0	0	0	0	0	0	11.04	2.57
2000	0.03	0.47	2.9	3.91	2.28	1.35	0.75	0.33	0.14	0.03	0.03	0	0	0	0	12.22	2.79
2001	0.02	0.4	1.22	3.31	2.64	1.46	0.53	0.41	0.2	0.17	0.02	0	0.01	0	0	10.39	2.63
2002	0.05	1.00	0.77	1.30	3.36	1.73	0.53	0.39	0.29	0.17	0.06	0.02	0.02	0.00	0.00	9.69	2.241
2003	0.03	0.70	2.26	1.26	1.76	1.74	0.88	0.35	0.13	0.06	0.08	0.01	0.00	0.03	0.00	9.29	2.269
2004	0.01	0.70	0.96	1.19	0.98	0.73	0.50	0.19	0.09	0.03	0.00	0.02	0.00	0.00	0.00	5.416	0.964
Average																	
1980-2004	0.03	1.00	2.10	2.39	1.90	1.08	0.54	0.22	0.13	0.07	0.05	0.04	0.02	0.03	0.05		

Table H5c. Stratified mean number per tow by age of American plaice in Massachusetts State spring and autumn bottom trawl surveys in Massachusetts Bay and Cape Cod Bay (Regions 4+5), 1982-2005.

	Age												Total
Year	0	1	2	3	4	5	6	7	8	9	10	11	#/tow
Spring													
1982	0.00	7.18	49.25	33.35	17.14	5.00	2.42	1.12	0.26	0.15	0.03	0.07	115.97
1983	0.00	1.93	18.76	22.42	21.46	10.22	2.37	0.73	0.20	0.19	0.06	0.10	78.44
1984	0.00	2.15	27.44	21.32	10.57	4.64	1.21	0.18	0.09	0.01	0.03	0.07	67.71
1985	0.00	21.56	17.16	24.22	9.50	3.77	2.24	0.65	0.76	0.12	0.04	0.03	80.05
1986	0.00	27.06	110.27	26.91	14.43	2.84	0.61	0.05	0.08	0.06	0.00	0.16	182.47
1987	0.00	34.36	17.26	15.79	3.90	1.76	0.51	0.10	0.02	0.00	0.00	0.00	73.70
1988	0.00	81.47	63.57	17.85	8.72	1.54	0.47	0.09	0.00	0.00	0.00	0.00	173.71
1989	0.00	8.07	127.26	44.97	11.99	3.03	1.31	0.20	0.03	0.03	0.00	0.05	196.94
1990	0.00	7.73	25.37	56.71	16.48	3.43	0.53	0.11	0.10	0.13	0.00	0.00	110.59
1991	0.00	2.10	19.98	34.77	18.98	3.24	0.18	0.07	0.01	0.00	0.00	0.00	79.33
1992	0.00	8.20	11.06	33.98	14.99	7.42	1.11	0.45	0.00	0.00	0.00	0.00	77.21
1993	0.00	11.60	18.98	16.08	9.16	3.45	0.81	0.04	0.02	0.00	0.00	0.00	60.14
1994	0.00	11.60	52.57	22.12	7.13	3.88	1.03	0.31	0.00	0.00	0.00	0.00	98.64
1995	0.00	0.54	34.65	49.64	10.32	3.16	0.62	0.17	0.03	0.05	0.02	0.00	99.20
1996	0.00	2.29	4.14	14.92	31.39	6.33	1.01	0.77	0.01	0.00	0.00	0.00	60.86
1997	0.00	1.55	7.96	13.95	17.24	12.21	2.41	0.21	0.00	0.00	0.00	0.00	55.52
1998	0.00	2.83	4.33	11.45	7.53	8.93	3.95	0.49	0.00	0.03	0.00	0.00	39.54
1999	0.00	1.35	11.65	11.65	15.11	7.57	3.96	1.62	0.35	0.01	0.00	0.00	53.27
2000	0.00	3.45	56.51	34.86	19.98	13.29	4.95	3.64	0.17	0.03	0.00	0.00	136.88
2001	0.00	0.07	4.75	23.71	17.03	4.74	2.18	0.95	0.48	0.15	0.10	0.03	54.19
2002	0.00	6.26	4.15	10.77	18.59	5.93	1.49	0.78	0.38	0.21	0.07	0.00	48.63
2003	0.00	5.15	44.88	12.38	18.27	17.82	4.37	0.95	1.64	0.25	0.01	0.28	106.02
2004	0.00	16.50	11.84	33.91	13.07	5.67	3.67	0.88	0.18	0.19	0.06	0.00	85.95
2005	0.00	7.52	20.18	22.93	8.24	4.80	1.98	0.94	0.37	0.00	0.00	0.00	66.98

Table H5d. Stratified mean number per tow by age of American plaice in Massachusetts State spring and autumn bottom trawl surveys in Massachusetts Bay and Cape Cod Bay (Regions 4+5), 1982-2005.

					Age							Total
Year	0	1	2	3	4	5	6	7	8	9	10	11	#/tow
Autumn													
1982	0.17	13.24	15.46	10.22	5.11	1.14	0.56	0.14	0.05	0.05	0.01	0.08	46.23
1983	1.29	52.17	18.98	10.02	8.30	1.39	0.32	0.15	0.05	0.06	0.00	0.01	92.74
1984	0.11	3.14	13.24	4.27	1.83	0.77	0.24	0.04	0.05	0.00	0.00	0.00	23.69
1985	0.00	60.97	9.45	14.21	1.56	0.14	0.03	0.02	0.00	0.00	0.00	0.00	86.38
1986	0.23	41.27	40.08	12.07	5.30	0.39	0.13	0.01	0.00	0.00	0.00	0.00	99.48
1987	0.24	46.36	14.60	3.00	0.52	0.23	0.07	0.01	0.04	0.00	0.00	0.00	65.07
1988	0.00	85.63	41.28	13.98	1.34	0.45	0.08	0.00	0.00	0.00	0.00	0.00	142.76
1989	0.03	57.56	122.25	31.03	2.33	0.13	0.01	0.01	0.00	0.00	0.00	0.00	213.35
1990	0.08	31.99	14.20	20.12	3.93	0.21	0.03	0.00	0.00	0.00	0.00	0.00	70.56
1991	0.04	24.07	90.36	40.05	11.51	1.17	0.14	0.00	0.00	0.00	0.00	0.00	167.34
1992	0.00	46.33	12.99	29.79	11.04	1.38	0.00	0.00	0.12	0.00	0.00	0.00	101.66
1993	0.00	76.21	36.80	17.59	6.85	1.71	0.69	0.00	0.00	0.00	0.00	0.00	139.84
1994	0.00	36.71	79.31	10.76	2.91	1.56	0.23	0.14	0.00	0.00	0.00	0.00	131.62
1995	0.00	11.84	44.22	24.93	4.21	0.91	0.08	0	0.00	0.00	0.00	0.00	86.19
1996	0.09	16.25	19.25	27.55	13.96	1.39	0.28	0	0.00	0.00	0.00	0.00	78.78
1997	0.00	13.61	28.08	17.91	10.29	1.46	0.19	0.01	0.00	0.00	0.00	0.00	71.55
1998	0.16	34.56	6.12	13.80	7.10	3.76	0.62	0.01	0.00	0.00	0.00	0.00	66.13
1999	0.00	29.23	32.57	20.61	10.58	2.85	1.2	0.41	0.00	0.00	0.00	0.00	97.45
2000	0.03	6.26	25.67	19.42	6.01	2.99	1.07	0.35	0.03	0.02	0.00	0.00	61.85
2001	0.00	3.01	14.71	30.81	9.07	2.67	0.26	0.36	0.15	0.02	0.00	0.00	61.06
2002	0.17	39.31	9.37	11.78	14.88	3.72	0.78	0.41	0.28	0.10	0.02	0.00	80.87
2003	0	23.98	33.08	14.24	7.58	4.00	0.39	0.58	0.07	0.04	0.01	0.00	83.98
2004	0	60.02	19.1	9.96	6.31	2.74	1.03	0.18	0.08	0.04	0	0.04	99.5

Table H6. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), spawning stock biomass (mt), and percent mature of Gulf of Maine-Georges Bank American plaice, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1980-2004.

Stock Numbers (Jan 1) in thousands

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	52643	25124	21947	25126	13190	14389	18443	36839	53337	27202	33128	33767	41054
2	42223	43096	20565	17960	20558	10796	11722	15046	30126	43385	22152	27061	27634
3	35918	34480	34395	16292	14104	16497	8697	9019	11785	23954	34025	17525	21863
4	24233	28437	26246	25131	12001	10651	12405	6452	5719	7984	17955	24791	13442
5	21552	17423	18708	17350	15891	7634	7511	8089	3981	3023	5519	12290	16307
6	17203	14082	9435	11243	9755	7554	4074	4612	4558	1814	1725	3280	6983
7	11091	10526	8228	4469	5664	5051	3586	2000	2566	2425	1000	932	1670
8	5103	5794	6445	3753	1605	2886	2119	1753	828	1601	1304	555	472
9+	14502	6249	8573	6085	3732	2368	1542	997	982	1400	1680	1357	815
Total	224467	185211	154544	127408	96501	77826	70099	84807	113881	112788	118489	121559	130241

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	45554	44726	32749	34281	30102	31529	35722	18407	11698	32350	23492	54802	68708
2	33578	37200	36358	26344	27891	24502	25780	29243	15068	9578	26485	19233	44868
3	22416	27106	29999	28421	20721	21591	20004	20924	23656	12259	7838	21658	15741
4	16920	16515	21629	22493	21986	16239	17423	16192	16535	18912	9964	6369	17695
5	8995	10106	11144	11824	14396	15523	12496	13373	12113	12312	14026	7642	4951
6	7189	4123	4239	4758	7004	8240	10350	8681	9176	7692	7642	9834	5355
7	3252	3045	1835	1660	2564	4196	4506	6598	4882	5550	4383	4741	6867
8	626	1394	1328	911	862	1450	2491	2537	3776	2544	3245	2874	3360
9+	1330	1577	716	814	1258	1234	1403	1014	1710	2754	3471	2912	4065
Total	139861	145791	139997	131506	126785	124504	130175	116969	98612	103950	100546	130065	171611

Fishing Mortality

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
2	0.00	0.03	0.03	0.04	0.02	0.02	0.06	0.04	0.03	0.04	0.03	0.01	0.01
3	0.03	0.07	0.11	0.11	0.08	0.09	0.10	0.26	0.19	0.09	0.12	0.07	0.06
4	0.13	0.22	0.21	0.26	0.25	0.15	0.23	0.28	0.44	0.17	0.18	0.22	0.20
5	0.23	0.41	0.31	0.38	0.54	0.43	0.29	0.37	0.59	0.36	0.32	0.37	0.62
6	0.29	0.34	0.55	0.49	0.46	0.55	0.51	0.39	0.43	0.40	0.42	0.48	0.56
7	0.45	0.29	0.58	0.82	0.47	0.67	0.52	0.68	0.27	0.42	0.39	0.48	0.78
8	0.29	0.36	0.43	0.46	0.50	0.53	0.40	0.41	0.44	0.39	0.35	0.39	0.61
9+	0.29	0.36	0.43	0.46	0.50	0.53	0.40	0.41	0.44	0.39	0.35	0.39	0.61
Total	0.32	0.35	0.47	0.54	0.49	0.54	0.43	0.46	0.43	0.39	0.37	0.43	0.64

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.00	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.01	0.02	0.05	0.04	0.06	0.00	0.01	0.01	0.01	0.00	0.00	0.00
3	0.11	0.03	0.09	0.06	0.04	0.01	0.01	0.04	0.02	0.01	0.01	0.00
4	0.32	0.19	0.40	0.25	0.15	0.06	0.06	0.09	0.09	0.10	0.07	0.05
5	0.58	0.67	0.65	0.32	0.36	0.21	0.16	0.18	0.25	0.28	0.16	0.16
6	0.66	0.61	0.74	0.42	0.31	0.40	0.25	0.38	0.30	0.36	0.28	0.16
7	0.65	0.63	0.50	0.45	0.37	0.32	0.37	0.36	0.45	0.34	0.22	0.14
8	0.62	0.65	0.65	0.36	0.35	0.28	0.23	0.27	0.31	0.31	0.20	0.15
9+	0.62	0.65	0.65	0.36	0.35	0.28	0.23	0.27	0.31	0.31	0.20	0.15
Total	0.63	0.64	0.64	0.39	0.35	0.30	0.25	0.30	0.33	0.32	0.21	0.15

Table H6. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), spawning stock biomass (mt), and percent mature of Gulf of Maine-Georges Bank American plaice, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1980-2004.

SSB at start of spawning season

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	24	12	8	5	0	5	12	17	0	0	0	0	0
2	164	185	94	33	38	12	72	92	14	21	11	17	16
3	874	873	1203	529	230	227	397	328	155	299	402	233	320
4	2408	2938	2716	3437	1320	931	1283	853	611	989	2007	3097	1536
5	4539	4056	4729	4653	4640	1633	1789	2037	996	879	1611	3644	4997
6	7937	6459	3635	4662	4447	3085	1488	1907	1973	780	782	1559	3413
7	7052	6937	5727	2310	3617	2910	2010	1161	1670	1426	590	616	1072
8	4185	4540	5533	3180	1330	2449	1821	1494	738	1200	960	468	414
9+	19518	7152	10845	7623	5187	3194	2262	1443	1362	1857	1981	1731	1076
Total	46701	33152	34489	26430	20808	14446	11136	9332	7521	7451	8344	11365	12845

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0	0	0	0	0	0	0	0	0	0	0	0
2	15	7	7	5	4	14	11	13	7	5	8	4
3	293	378	253	174	152	217	263	217	236	117	82	130
4	1963	2368	2789	3161	2254	1638	2300	2264	2340	2046	1322	956
5	2572	2725	3264	3810	4338	4419	3593	4174	3555	3394	4108	2325
6	3071	1649	1725	2168	3267	3201	4079	3519	3791	2963	2883	3803
7	2156	1660	1103	1076	1533	2570	2354	3606	2521	2569	2189	2389
8	552	1135	1011	817	697	1128	1882	1888	2618	1561	1927	1847
9+	1785	2305	809	1173	1718	2719	1766	1133	1707	2603	3175	2695
Total	12405	12229	10960	12385	13963	15907	16248	16815	16776	15258	15694	14149

Percent mature (females)

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	3	3	3	3	3	3	7	7	0	0	0	0	0
2	8	8	8	8	8	8	24	24	2	2	2	2	2
3	24	24	24	24	24	24	55	55	17	17	17	17	17
4	52	52	52	52	52	52	83	83	65	65	65	65	65
5	79	79	79	79	79	79	95	95	94	94	94	94	94
6	93	93	93	93	93	93	99	99	99	99	99	99	99
7	98	98	98	98	98	98	100	100	100	100	100	100	100
8	100	100	100	100	100	100	100	100	100	100	100	100	100

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0	0	0	0	0	0	0	0	0	0	0	0
2	1	1	1	1	1	3	3	3	3	3	2	2
3	12	12	12	12	12	18	18	18	18	18	14	14
4	60	60	60	60	60	61	61	61	61	61	59	59
5	94	94	94	94	94	92	92	92	92	92	93	93
6	99	99	99	99	99	99	99	99	99	99	99	99
7	100	100	100	100	100	100	100	100	100	100	1	1
8	100	100	100	100	100	100	100	100	100	100	1	1

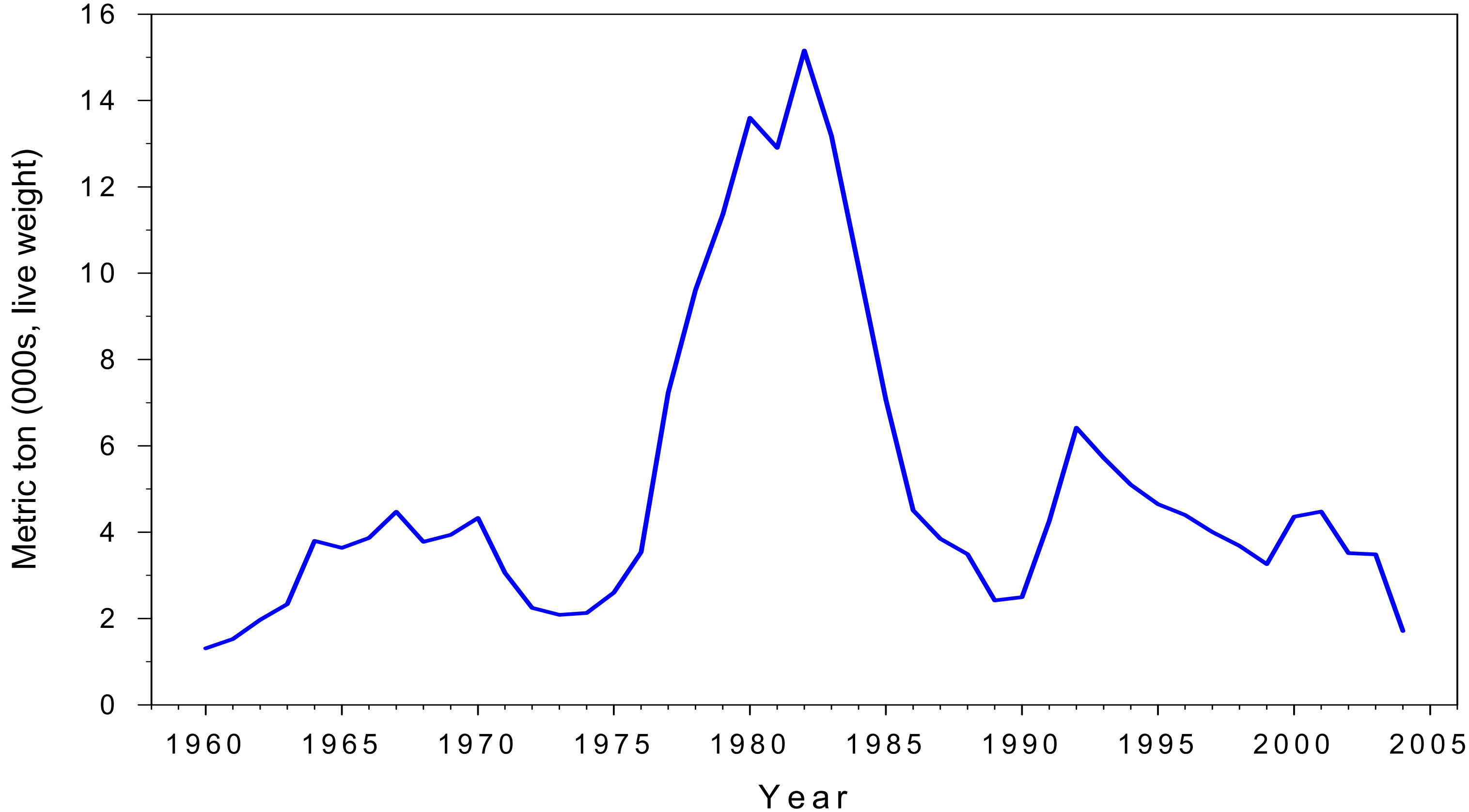


Figure H1. Total commecial landings of Gulf of Maine-Georges Bank American plaice (Division 5Z and 6), 1960-2004.

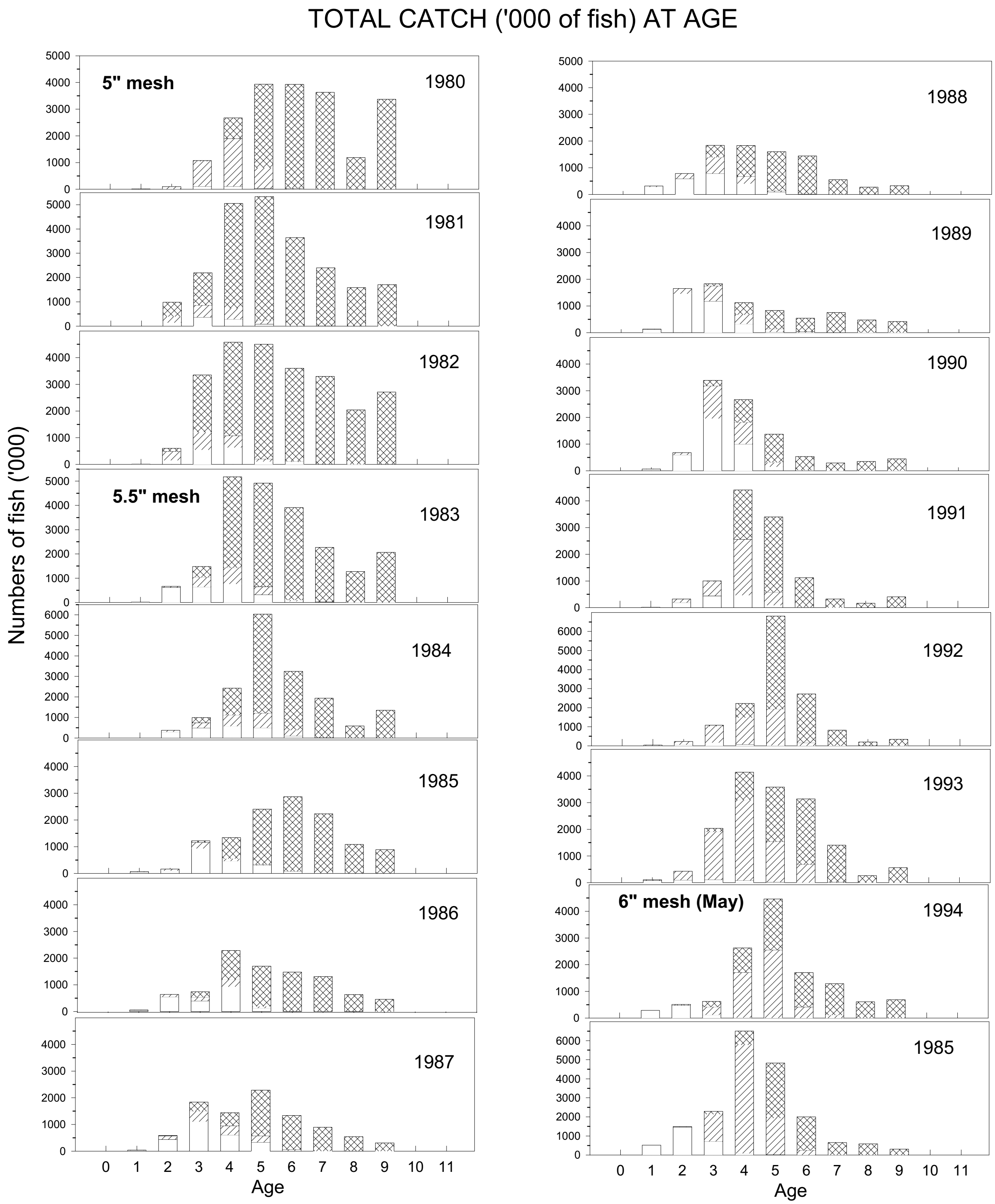


Figure H2. Number of American plaice ('000 of fish) at age in the total catch (discards from shrimp and large mesh fisheries, and landings), 1980 - 2004.

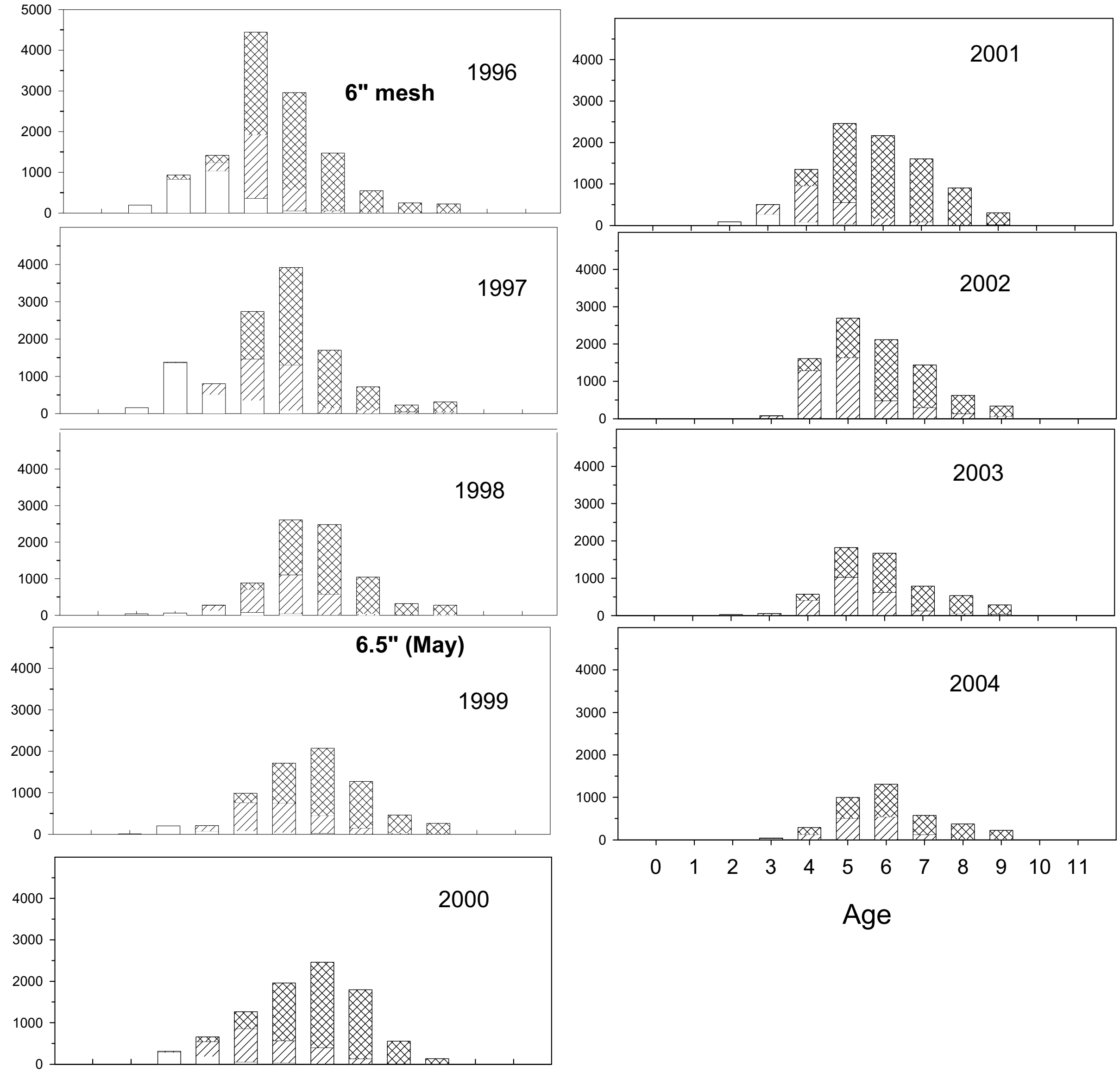


Figure H2 continued. Number of American plaice ('000 of fish) at age in the total catch (discards from the shrimp and large mesh fisheries, and landings), 1980-2004.

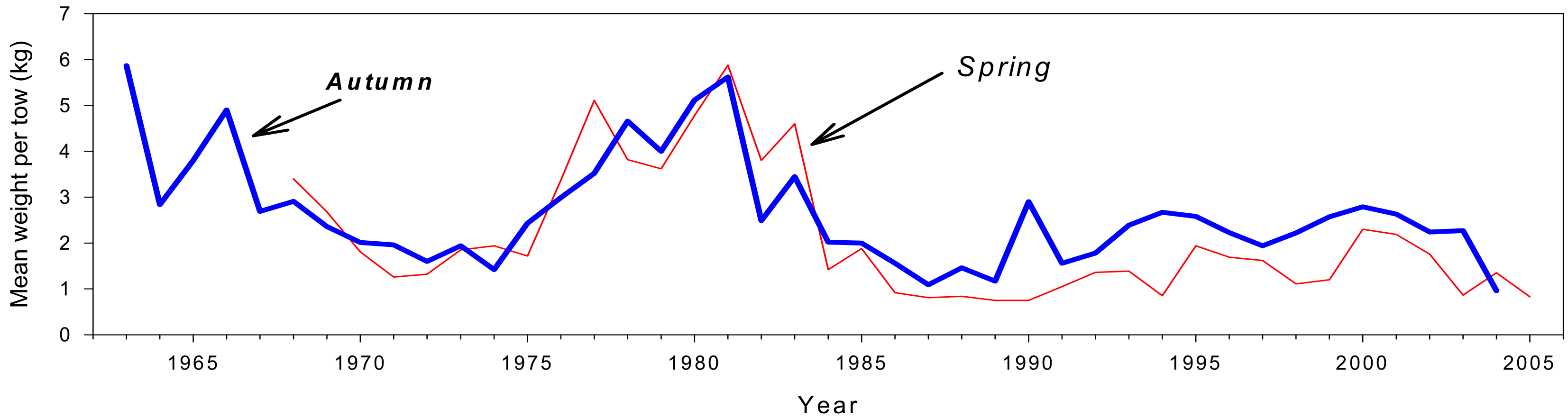


Figure H3. Standardized stratified mean weight per tow (kg) of American plaice in NEFSC spring and autumn research vessel bottom trawl survey in the Gulf of Maine-Georges Bank region, 1963-2005.

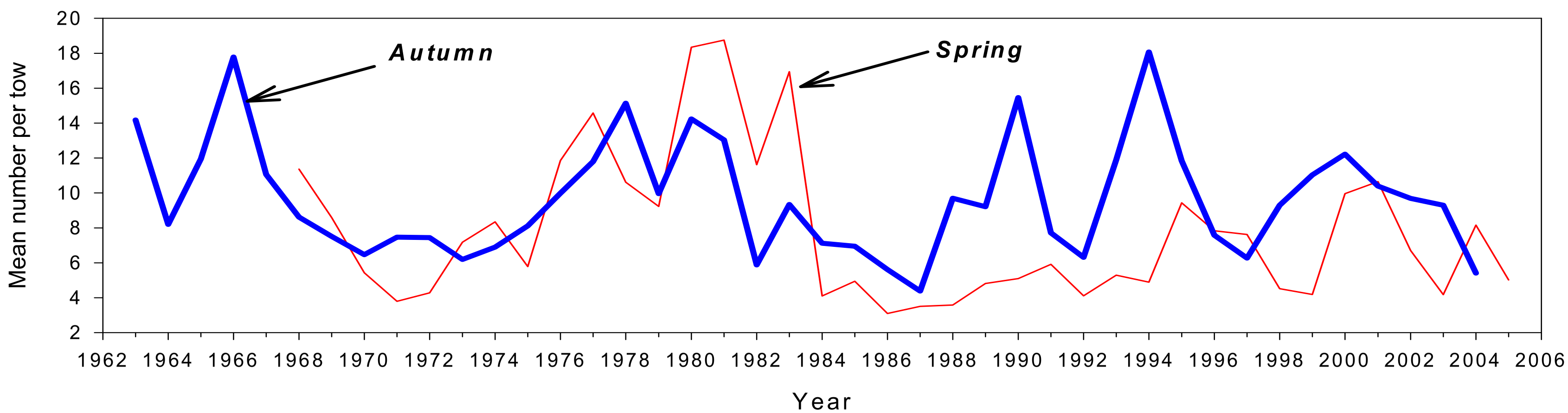


Figure H4. Standardized stratified mean number per tow (kg) of American plaice in NEFSC spring and autumn research vessel bottom trawl survey in the Gulf of Maine-Georges Bank region, 1963-2005.

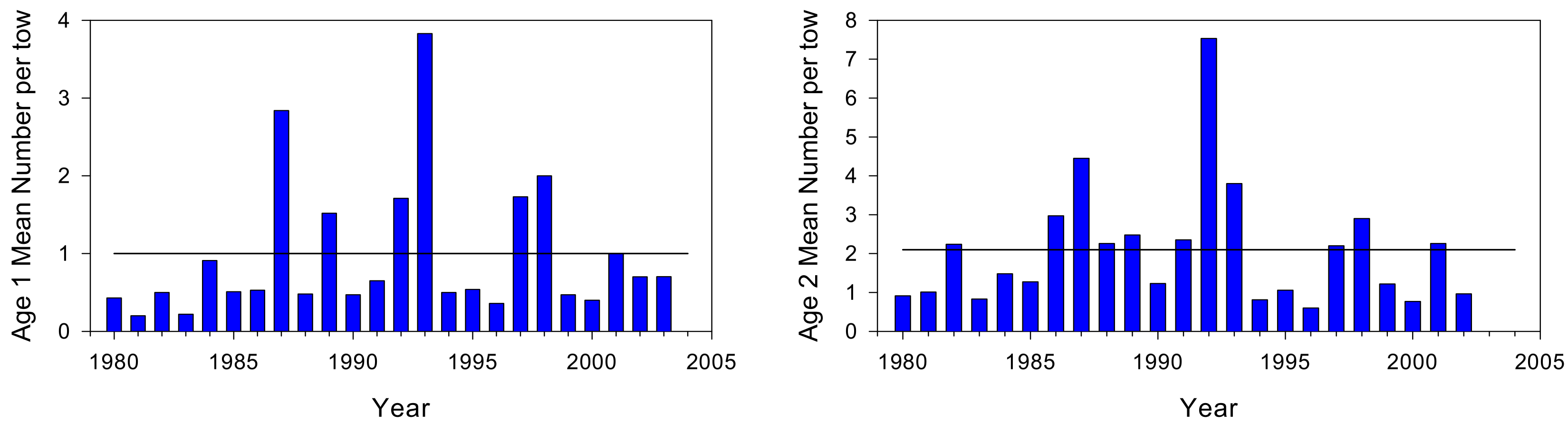


Figure H5a. Relative year class strength of age 1 and age 2 Gulf of Maine-George Bank American plaice from standardized catch (number) per tow indices from NEFSC autumn research vessel bottom trwl surveys, 1980-2004.

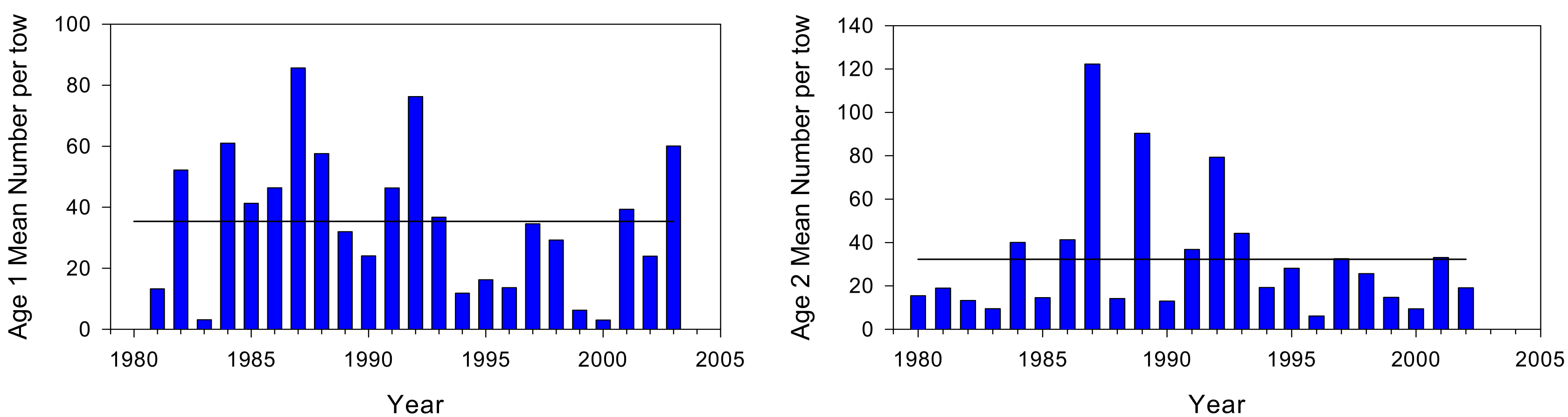


Figure H5b. Relative year class strength of age 1 and age 2 Gulf of Maine-George Bank American plaice from standardized catch (number) per tow indices from MADMF autumn research vessel bottom trwl surveys, 1980-2004.

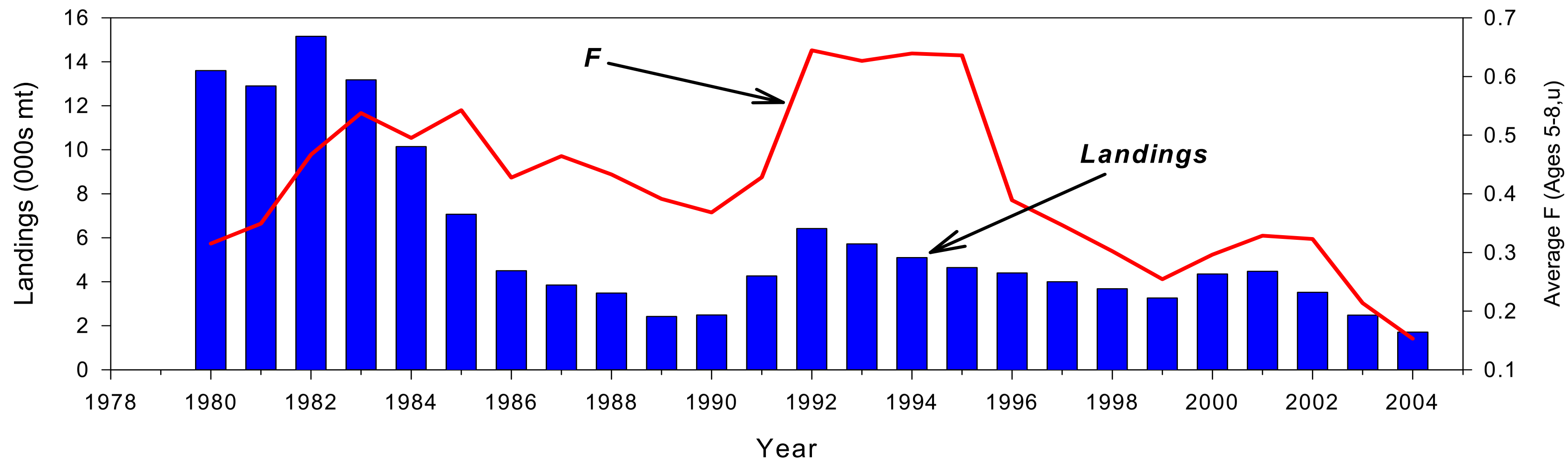


Figure H6. Trends in total commercial landings and fishing mortality for Gulf of Maine-Georges Bank American plaice, 1980-2004.

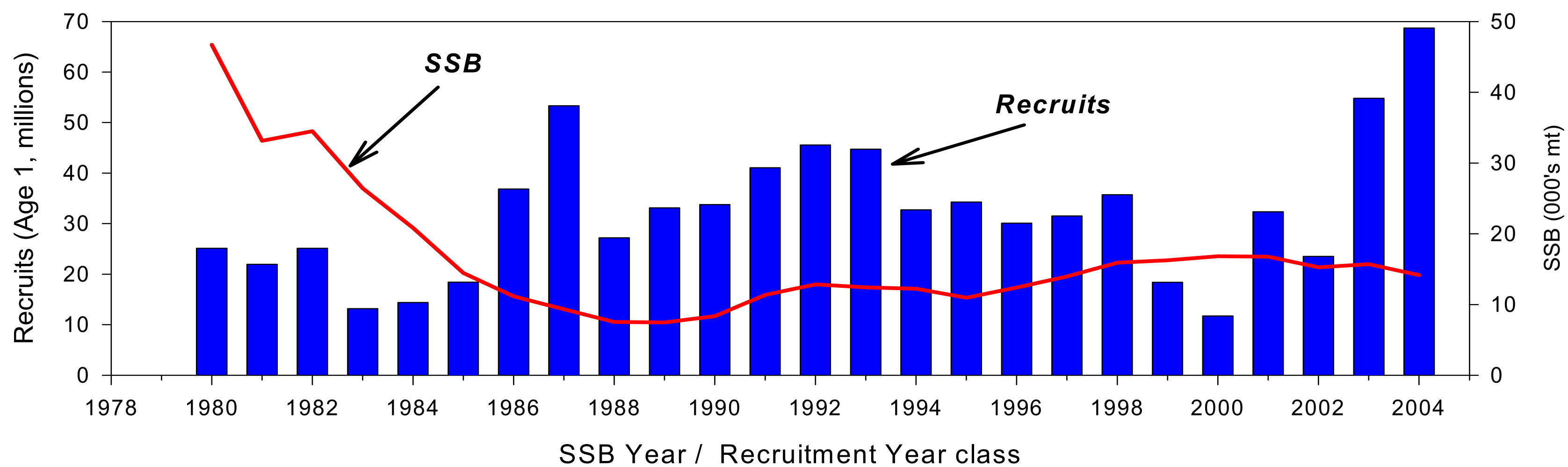


Figure H7. Trends in recruitment and spawning stock biomass for Gulf of Maine-Georges Bank American plaice, 1980-2004.

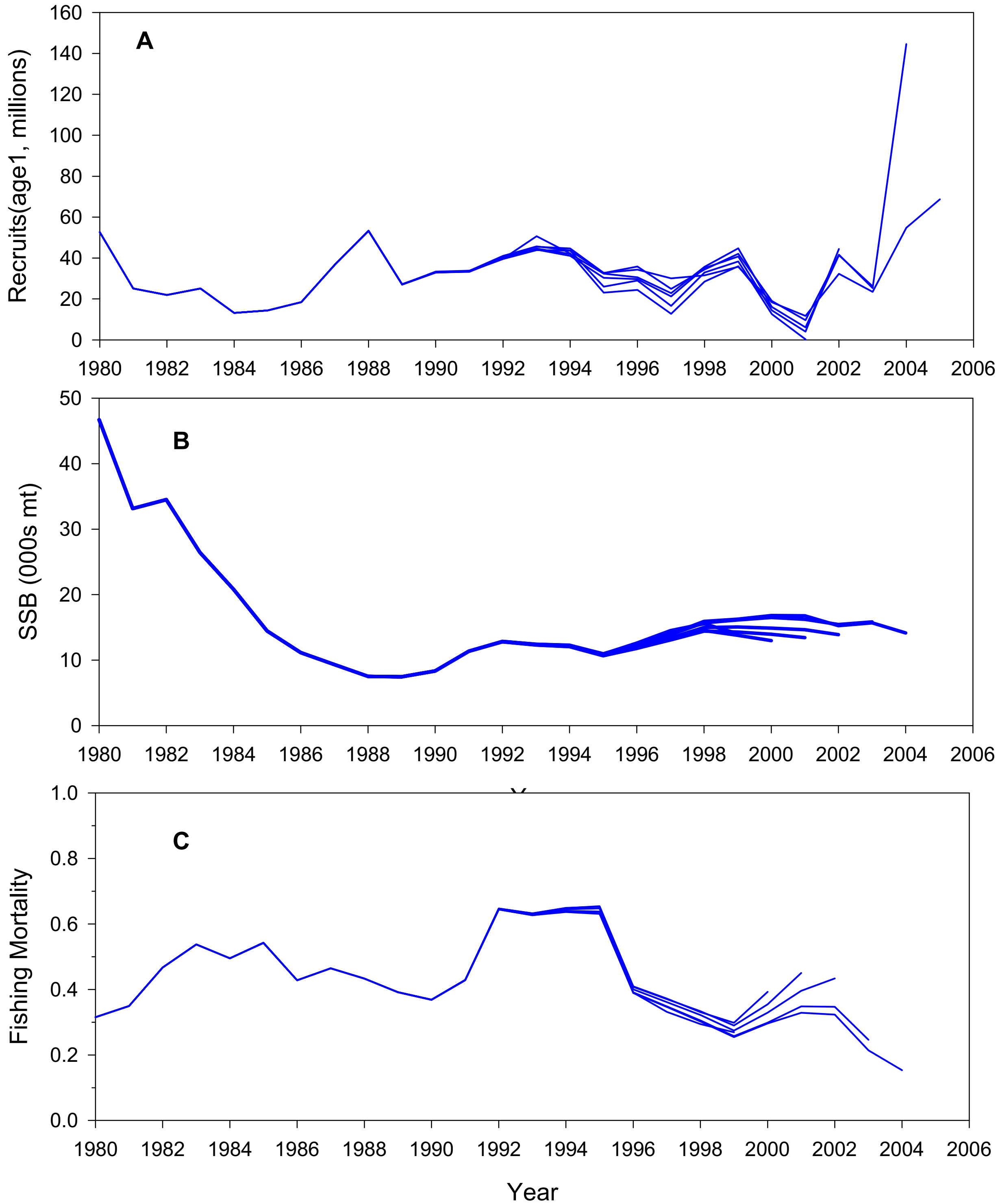
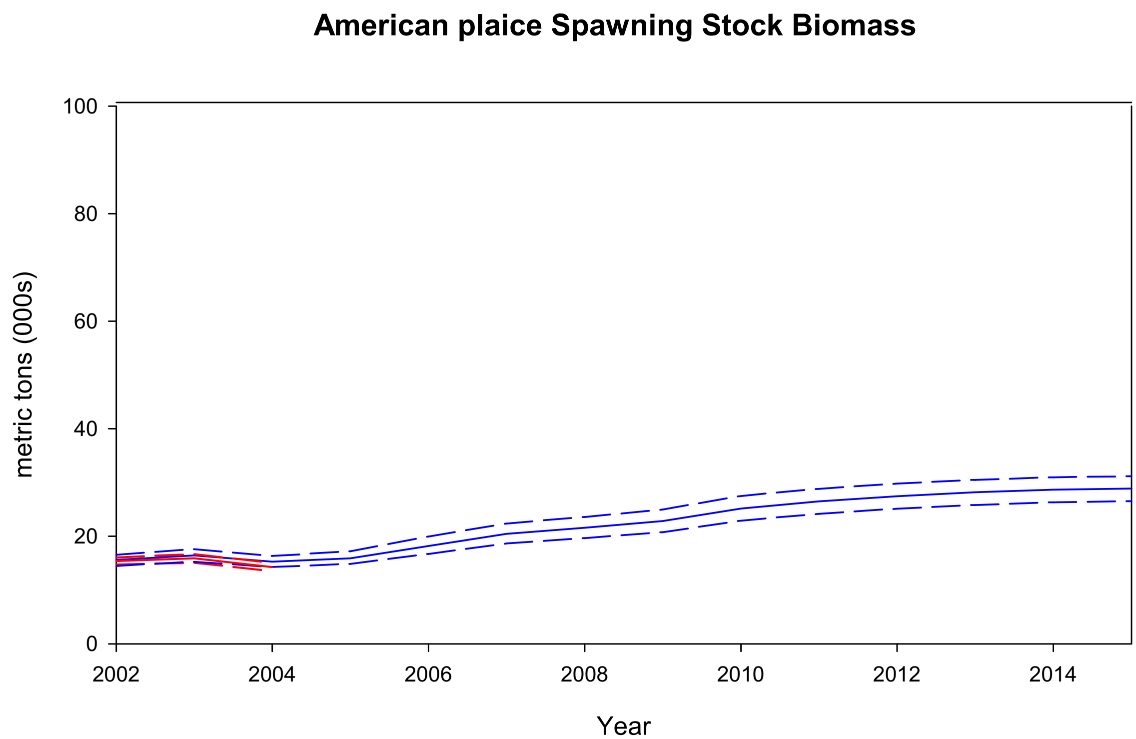


Figure H8. Retrospective analysis of Gulf of Maine-Georges Bank American plaice recruits at age 1 (A), spawning stock biomass (B), and fishing mortality (C, average F, ages 5-8, unweighted) based on the final ADAPT VPA formulation, 2004-1994.



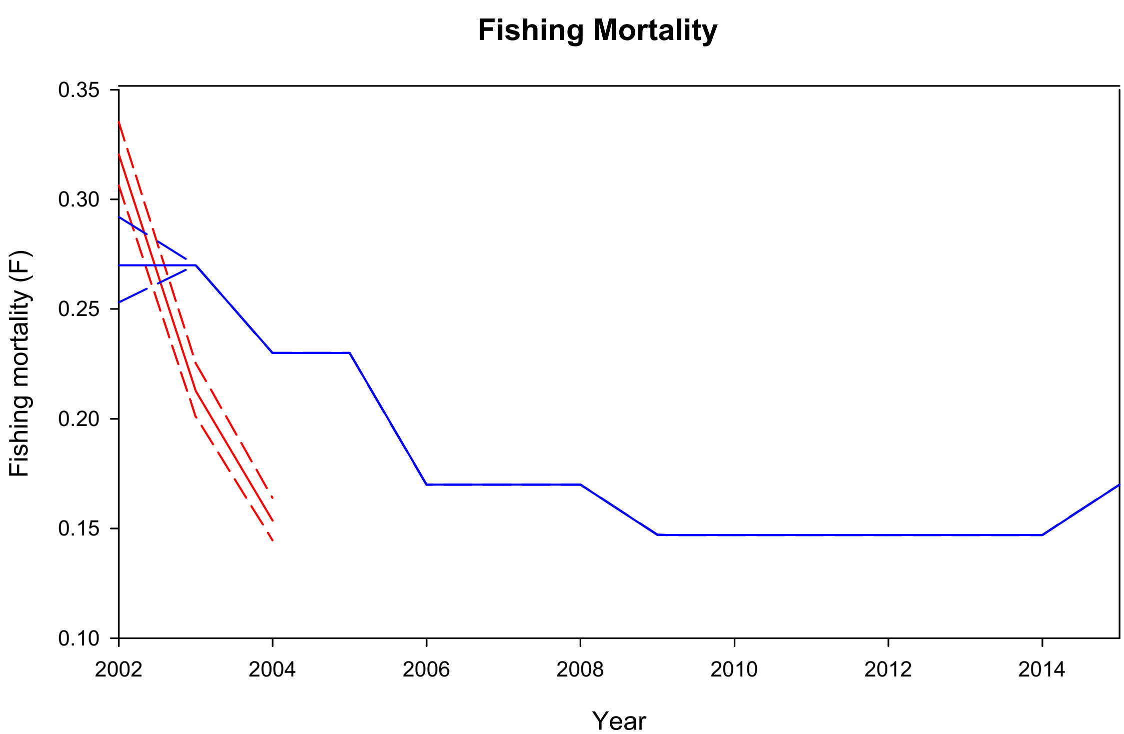


Figure H9. Comparison of A13 projections and current assessment bootstrap estimates of spawning stock biomass (SSB) and fishing mortality (F) , 2002-2004 for American plaice.

I. Gulf of Maine Winter Flounder by P. Nitschke

1.0 Background

The current assessment for Gulf of Maine winter flounder is an update of the SARC 36 VPA assessment that included catch through 2001 (NEFSC 2002). The SARC 36 assessment concluded that the stock is not overfished and overfishing is not occurring. Spawning stock biomass was estimated to be at 5,900 mt and fully recruited F = 0.14 in 2001. SSB at Bmsy was estimated to be at 4,100 mt and Fmsy = 0.43.

2.0 Fishery

Commercial landings were near 1,000 mt from 1964 to the mid 1970s. Thereafter commercial landings increased to a peaked of 2,793 mt in 1982, and then steadily declined to a record low of 253 mt in 1999. Landings have remained near 500 mt since 2000 (Table I1, Figure I1). The primary gear used was the otter trawl from 1964-1985 that accounted for an average of 95% of the landings. Otter trawl accounted for an average of 75% of the landings from 1986- 2001 with an increase in the proportion of the landings coming from gillnets (average of 20% from 1986-2001). Since 2001 the gillnet proportion has decreased slightly with an average of 15% of the landings (Figure I2). Since 1999 around 95% percent of the landings are taken in Massachusetts from statistical area 514 (Figure I3).

Recreational landings reached a peak in 1981 with 2,554 mt but declined substantially thereafter (Table I2, Figure I4). Landings have been less than 100 mt since 1995, with the lowest estimated landings in 2004 of 18 mt. Only one fish was measured in the second half of 2004. Lengths from the second half of 2003 were used for characterizing the length distribution to estimate the landed weight in the second half of 2004.

In the commercial fishery, annual sampling intensity varied from 4 to 310 mt landed per sample during 1982-2004. Overall sampling intensity was adequate, however temporal and market category coverage in some year was poor (Table I3). Samples were pooled by halfyear when possible. In 1982 mediums were pooled with unclassified by halfyear, in 1985 and 1995 smalls were pooled with mediums, the large sample from 1998 was also used to characterize 1999, in 2001 large samples were used to characterize 1999, and both 2001 and 2003 were used to supplement the 28 lengths taken in 2002. Sampling coverage may have been poor but length frequency samples appeared relatively constant over time and there was a substantial amount of overlap between market categories which help justify the pooling used in the assessment. Lengths of kept fish from observer data were used to supplement length data of unclassified fish. Lengths taken from gillnet trips in the observer data were used to characterize the gillnet proportion of the landings (Table I4).

Discards were estimated for the large mesh trawl (1982-2004), gillnet (1986-2004), and northern shrimp fishery (1982-2004) (Table I5 and I6). The survey method was used in estimating both the discard and proportion discards at length for the large mesh trawl fishery from 1982-1993

(Mayo et al. 1992). VTR large mesh otter trawl discards to landings ratios were applied to corresponding commercial fishery landings to estimate discards in weight from 1994 to 2004. The Fishery Observer length frequency samples were judged inadequate to characterize the proportion discarded at length from 1982 to 2000 for the large mesh trawl fishery and the length proportion from the survey method was used to characterize the size distribution of discarded fish. Observer length sampling increased in 2001 and were used to characterize the large mesh trawl discards from 2001 to 2004. The Fishery Observer sum discarded to landing ratios were used for estimating gillnet discard rates. Observer sum discarded to days fished ratios were used of the northern shrimp fishery since landing of winter flounder in the shrimp fishery is prohibited. The observer length frequency data for gillnet and the northern shrimp fishery were used to characterize the proportion discarded at length. The sample proportion at length, converted to weight, was used to convert the discard estimate in weight to numbers at length. As in the southern New England stock (NEFSC 1999), a 50% mortality rate was applied to all commercial discard data (Howell et al., 1992). Numbers at ages were determined using NEFSC/MDMF spring and NEFSC fall survey age-length keys (Table I5).

A discard mortality of 15% was assumed for recreational discards (B2 category from MRFSS data), as assumed in Howell et al. (1992). Discard losses peaked in 1982 at 140,000 fish. Discards have since declined reaching a low in 2004 of 3,000 fish (Table I2, Figure I4). Since 1997, irregular sampling of the recreational fisheries by state fisheries agencies has indicated that the discard is usually of fish below the minimum landing size of 12 inches (30 cm). For 1982-2004, the recreational discard has been assumed to have the same length frequency as the catch in the MDMF survey below the legal size and above an assumed hookable fish size (13 cm). The recreational discard for 1982-2001 is aged using NEFSC/MDMF spring and NEFSC fall survey age-length keys.

A summary of how the catch at age was constructed can be seen in Table I7. Decreases in the catch at age components are shown in Table I8 and Figure I5 and I6. Mean weights at age and the total catch at age are given in Tables I9 and I10 and Figures I7 and I8.

3.0 Research Surveys

Mean number per tow indices for the NEFSC and the Massachusetts Division of Marine Fisheries (MDMF) spring and fall time series are presented in Table I11 and Figures I9 through I12. All of the indices generally show a decrease in the population in the late 1980s from a high in the early 1980s with low abundance remaining through the early 1990s. All of the indices show signs of increase abundance starting in 1998 and 1999. Since 2001 the indices indicate a decrease in abundance. Age data for the MDMF fall survey are not available. The NEFSC fall ages where used to age the MDMF fall index.

The Seabrook Nuclear Power Plant in New Hampshire has conducted a monthly bottom trawl survey since 1985. The monthly survey was broken down to a spring and fall survey. No survey was conducted in 1993. This survey also shows an increase in the number of fish in the late 1990s (Figure I13). The MDMF spring survey was used to age the Spring Seabrook index. The

2004 Seabrook index is not available. The Seabrook fall index is not used in for tuning due to a lack of sampling in more recent years at one of the three stations because of the presences of lobster gear.

The MDMF and Seabrook survey catch a greater proportion of smaller fish than the NEFSC surveys. The two MDMF surveys and the Seabrook spring survey show strong recruitment in 2004 and 2005 (Figures I14 through I18).

4.0 Assessment Results

Abundance indices at age were available from several research surveys: NEFSC spring bottom trawl ages 1-8+, NEFSC fall ages 1-8+ (advanced to tune January 1 abundance of ages 2-8+), 1-5, Massachusetts spring ages 1-8+, Massachusetts fall ages 0-8+ (advanced to tune January 1 abundance of ages 1-8+), and Seabrook spring trawl survey ages 1-8+. SARC 36 assessment survey indices were selected for inclusion in VPA tuning based on consideration of the partial variance in a VPA trial run including all indices, residual error patterns from the various trail runs, and on the significance of the correlation among indices and with VPA abundance estimates from the trail run including all indices. The 2001 VPA assessment was done using the NEFSC Woods Hole Fisheries Assessment Compilation Toolbox (FACT) version 1.5 of the ADAPT VPA. Comparison of the FACT version to the new NOAA Fisheries Toolbox (NFT v2.3) VPA with a terminal year 2001 did not produce large changes in overall VPA results. However the change in software did result in a decrease in the terminal year +1 population estimate for 8+ from 1.1 to 0.2 million and increase in the cv for the 8+ abundance from 0.17 to 0.6 (Table I12). The same VPA configuration used in the SARC 36 2001 assessment was used for the updated assessment. Patterns in the residual plots did not change greatly from the SARC 36 assessment (Figure I19). Three additional runs with different configurations were looked at for sensitivity of the VPA results (no estimation of age 8+ abundance, all indices included, and indices with the highest partial variance excluded). Results from the three different VPA configurations did not vary greatly. However, the run which excluded the indices with the highest partial variance did result in higher recruitment in the terminal + 1 year (increase from 17.6 to 31.5 million).

During 1982-1995, fishing mortality (fully recruited F, ages 5-6) has varied between 0.5 (1983) and 2.1 (1995). Fishing mortality declined to a range of 0.3-0.6 during 1999-2001. Fishing mortality has declined to 0.13 in 2004 (Table I13, Figure I20). Accounting for the uncertainty of the 2004 estimate, the 80% confidence interval for F in 2004 ranged from 0.11 to 0.16 (Figure I21). Fishing mortality in 2004 was estimated at 30 percent of Fmsy (0.43). Spawning stock biomass (SSB) declined from 4,776 mt in 1982 to a record low of 529 mt in 1996. SSB has increased since 1995 to 3,436 mt in 2004 (Table I13, Figure I22). The 80% confidence interval for SSB in 2004 ranged between 2,899 and 4,048 mt (Figure I21). SSB in 2004 was estimated at 84 percent of Bmsy (Figure I23). Recruitment declined continuously from 11.6 million age-1 fish in 1982 to 2.5 million in 1993. Recruitment then increased to 6.1 million in 2003 (Figure I22). Record high recruitment was estimated for 2004 and 2005 (15.0 and 17.6 million retrospectively).

A retrospective analysis of the VPA was conducted back to a terminal catch year 2000 (Figure I24). The Gulf of Maine winter flounder VPA exhibits a severe retrospective pattern in F and a large overestimation of SSB since 2000. Fishing mortality in the 2001 SARC 36 assessment was estimated to be 0.14 and 2001 SSB at 5,900 mt. The updated assessment estimates F in 2001 at 0.58 and 2001 SSB at 1,739 mt. Estimated 1995 to 2001 recruitment in the updated assessment has also declined from the SARC 36 assessment.

Patterns in the survey residuals were observed for all ages in the VPA fit. Positive residuals are seen at the beginning of the time series whereas large negative residuals are present in the fully recruited ages in 2004 and 2005. The VPA could not fit the decline in the fully recruited ages in the surveys at the end of the time series when the catch is low. However it appears recruitment in inshore surveys (MDMF spring/fall and Seabrook spring) has increased in 2004 and 2005. The NEFSC spring, NEFSC fall, MADMF spring, and MADMF fall biomass indices generally increase from 1999-2000 and are consistent with trend in biomass estimated from the VPA over the same period. Since 2000, spring biomass indices have declined although the VPA biomass has increased. The NEFSC fall biomass index did not decline until 2004. The age distribution in NEFSC and MADMF survey indices has expanded during the 1999-2002. However, in recent years, older fish have declined in the MADMF spring survey. A similar expansion is seen in the catch at age.

Recreational landings have remained low despite perceived increases in stock size. However, recreational effort on this stock is also low. Survey indices and current distribution of landings indicated that the stock's distribution is truncated. The increase in survey biomass is concentrated in the Cape Cod area and commercial landings are concentrated in area 514. NEFSC survey indices from offshore strata located north of New Hampshire do not show the recovery seen in strata found in waters south of New Hampshire. Currently, landings are predominately from statistical area 514 (95% of total landings). Landings from statistical areas (513, 512, 511) that contributed substantial landings during the mid-1980s have been low during recent years. Overall, the condition of the stock appears to have improved since the late 1990s.

4.0 Sources of uncertainty

1) Landings data for 1994 and later years are derived by proration and are considered provisional.

2) The lack of survey coverage in inshore New Hampshire and Maine where winter flounder are abundant is a source of uncertainty. Low number of tows taken per strata in inshore Massachusetts strata in the NEFSC survey is a source of variability in the index.

3) The use of NEFSC fall survey ages to age the MDMF fall index.

4) Length frequency sampling coverage of the commercial fishery has been poor in some years.

5) Observer sampling intensity of the commercial large mesh and shrimp fishery were low in some years.

6) The Gulf of Maine winter flounder VPA exhibits a severe retrospective pattern of underestimation of F and overestimation of SSB.

5.0 GARM comments

The current assessment model exhibits a severe retrospective pattern of underestimation of recent F and overestimation of recent SSB. The previous assessment indicated that the stock was rebuilt and overfishing was not occurring. The updated assessment indicates that the stock was overfished and overfishing was occurring in 2001. The updated assessment indicates that the stock was not overfished and overfishing was not occurring in 2004. However, if the current retrospective pattern persists then current fishing mortality may be above the Fmsy reference point and SSB may be below one half Bmsy. Given this uncertainty, the GARM recommends against conducting short-term projections. The GARM recommends exploring the use of a forward projecting statistical catch at age model for the next stock assessment.

In addition to the severe retrospective pattern, diagnostics indicate poor fit in the VPA. Age 1 estimate has a high CV (60%) with 19% bias. The VPA has a pattern of negative residuals in recent years and this pattern is most pronounced on age 5, 6, and 7 tuning indices. Poor length frequency sampling of the commercial landings and low observer sampling intensity in the large mesh and shrimp fishery in some years contributes to uncertainty in the catch at age. Survey coverage in inshore Maine and New Hampshire waters, an area where winter flounder catches occurred historically, is poor.

6.0 Summary

The Gulf of Maine winter flounder stock is not overfished and overfishing is not occurring. Spawning stock biomass was estimated at 43 percent above Bmsy in the SARC 36 assessment but has dropped below Bmsy (83% of Bmsy) in the updated assessment due to a large retrospective pattern in the updated VPA. The very large retrospective pattern in fishing mortality, spawning stock biomass, and recruitment results in high uncertainty in current estimates of fishing mortality and spawning stock biomass in the updated VPA assessment. VPA results are too uncertain as a basis for performing projections. Surveys show decreases in abundance of fully recruited ages since the 2001 assessment. However in general all the surveys show some expansion of the age structure since the late 80s and early 90s. The MDMF and Seabrook surveys also show recruitment increasing in 2004 and 2005.

References

Howell, P., A. Howe, M. Gibson and S. Ayvasian. 1992. Fishery management plan for inshore stocks of winter flounder. Atlantic States Marine Fisheries Commission. Fisheries Management Report No. 21. May, 1992.

Mayo, R.K., L. O'Brien, and N. Buxton. 1992. Discard estimates of American plaice, *Hippoglossoides platessoides*, in the Gulf of Maine northern shrimp fishery and the Gulf of Maine-Georges Bank large-mesh otter trawl fishery. SAW 14 Res. Doc. 14/3. 40 pp.

NEFSC. 2003 Report of the 36th Northeast Regional Stock Assessment Workshop (36th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Ref. Doc 03-06. February 2003.

Table I1. Winter flounder commercial landings (metric tons) for Gulf of Maine stock (U.S. statistical reporting areas 512 to 515). Landings from 1964-1981 is taken from SARC 21, 1982-1993 is re-estimated from the wodets data, 1994-2003 is estimated using prorated dealer and VTR data, and 2004 is estimated using prorated dealer electronic reported and VTR data.

Year	metric tons	Year	metric tons
1964	1,081	1990	1,116
1965	665	1991	1,008
1966	785	1992	825
1967	803	1993	611
1968	864	1994	552
1969	975	1995	796
1970	1,092	1996	600
1971	1,113	1997	618
1972	1,085	1998	637
1973	1,080	1999	253
1974	885	2000	382
1975	1,181	2001	588
1976	1,465	2002	631
1977	2,161	2003	680
1978	2,194	2004	477
1979	2,021		
1980	2,437		
1981	2,406		
1982	2,793		
1983	2,096		
1984	1,699		
1985	1,582		
1986	1,188		
1987	1,140		
1988	1,250		
1989	1,253		

Table I2. Estimated number (000's) and weight (mt) of winter flounder caught, landed, and discarded in the recreational fishery, Gulf of Maine stock. * uses 2003 & 2004 2nd half lengths to estimate weight landed due to limited length sampling in 2004.

	Number (000's)				Metric tons
	Catch A+B1+B2	Landed A+B1	Released B2	15% Release Mortality	Landed A+B1
1981	6,200	5,433	767	115	2,554
1982	8,207	7,274	933	140	1,876
1983	2,169	1,988	181	27	868
1984	2,477	2,285	191	29	1,300
1985	3,694	3,220	474	71	1,896
1986	946	691	255	38	523
1987	3,070	2,391	679	102	1,809
1988	953	841	111	17	345
1989	1,971	1,678	294	44	620
1990	786	652	134	20	370
1991	213	154	59	9	91
1992	186	137	48	7	90
1993	396	249	147	22	140
1994	232	145	87	13	83
1995	150	82	68	10	39
1996	184	98	86	13	56
1997	192	64	129	19	43
1998	109	65	44	7	30
1999	115	67	48	7	34
2000	177	75	102	15	42
2001	172	72	100	15	43
2002	100	61	39	6	43
2003	85	51	34	5	32
2004	49	29	20	3	*18

Table I3. Number of lengths, samples, and metric tons per sample for Gulf of Maine winter flounder. Number of samples and calculations of metric tons per samples does not include observer data or gillnet landings from 1990-2004. * = redistributed according to market category and halfyear proportions. Bold numbers have additional lengths from observer trawl data but are not included in the number of samples.

		Number of lengths.						Number of samples					mt/samples				
year	Qtr	lg	sm	med	un	total		Lg	sm	med	un	total	lg	Sm	med	un	total
1982	1				296		1				3						
	2	102	101		159		2	1	1		1		838	453		46	
	3	84	81		106		3	1	1		1						
	4					929	4					9	396	691		231	310
1983	1	80		99			1	1		1							
	2	300	100		407		2	3	1		4		120	510		53	
	3	108	388				3	1	3								
	4	107	956		106	2651	4	1	8		1	24	125	44	64	95	87
1984	1	201	209				1	2	2								
	2	237	294		221		2	3	2		2		74	95			
	3		123				3		1								
	4	126	690	100		2201	4	1	5	1		19	189	67	114	124	89
1985	1	273	565				1	3	3								
	2	392	170				2	3	2				54				
	3	105					3	1									
	4	116			80	1701	4	1			1	14	87		182	176	113
1986	1				266		1				3						
	2	237	109	109			2	3	1	1				242	126	48	
	3		111	86			3		1	1							
	4		389	107	89	1503	4		5	1	1	17	113	37	31	56	70
1987	1				113		1				1						
	2						2										
	3		95				3		1								
	4	47	156	272		683	4	1	2	3		8	257	137	75	249	143
1988	1		258	311			1		3	3							
	2	102		395*			2	1		4*				108	23		
	3						3										
	4		169	107*		1342	4		2	1*		14	340	164	96		89
1989	1				100		1				1						
	2	113		91	**134**		2	1		1					168		
	3		95	120	**32**		3		1	1							
	4			100		785	4			1		6	313	435	42	254	209
1990	1	328	301				1	3	4								
	2				102		2				1		64	48			
	3						3										
	4	117	197	97		1142	4	1	2	1		12	83	90	138	118	75

Table I3. Continued.

		Number of lengths.					Number of samples					mt/samples				
Year	qtr	lg	Sm	med	un	total	lg	sm	med	un	total	lg	sm	med	un	total
1991	1	100	51	105	101		1	1	1	1						
	2	88	203	100	**42**		1	2	1			92	72			
	3		95					1								
	4	236	254			1375	3	3			15	32	47	95	115	65
1992	1	110			**107**		1									
	2	136	100	93			2	1	1			47	119	84		
	3															
	4	57	74	253		930	1	1	3		10	75	134	19		67
1993	1	100					1									
	2			288					3			83		16		
	3		55		**91**			1								
	4	80		157	**51**	822	1		2		8	47	177	30		59
1994	1															
	2		71	92	102			1	1	1				75		
	3															
	4	94		235		594	1		3		7	112	143	15	60	62
1995	1	101		175	**63**		1		2							
	2			299					3					37		
	3			414					4							
	4				**609**	1661					10	134		42		55
1996	1		77					1								
	2		231					2					44			
	3		355	252				2	3							
	4	84	440	86	**112**	1637	1	5	1		15	80	16	18		29
1997	1		204					2								
	2		127	75*				2	1*				28	66		
	3		220	218				2	3							
	4	307	502	56*		1709	4	8	1*		23	25	11	14		19
1998	1		148	79				2	1							
	2		151	201*				3	2*				34	29		
	3		583					7								
	4	69	163	110*		1504	1	2	1*		19	65	14	30		25
		↑					↑									
1999	1			104					1							
	2			171					2							
	3		28					1								
	4		52		**408**	763		1			5		26	10		34

Table I3. Continued.

Number of lengths.							Number of samples						mt/samples				
Year	qtr	lg	Sm	med	un	total		lg	sm	med	un	total	lg	sm	med	un	total
2000	1		866	143	**480**		1		12	2							
	2		3441	51	**554**		2		45	1				1			
	3		102		**50**		3		2								
	4		114		**26**	5827	4		2			64		12	13		4
		↓															
2001	1			187	**172**		1			2							
	2	99	157	189	**630**		2	1	2	3				38	10		
	3		100	52	**399**		3		1	1							
	4		154	198	**1307**	3644	4		2	2		14	26	22	26		33
		↑															
2002	1		74	173	**641**		1		2	2	2						
	2	28	433		**32**		2	1	5					7	25	54	
	3		530	73	**1519**		3		8	1	2						
	4		389	60	**1215**	5167	4		5	1		29	33	15	28	49	20
		↓															
2003	1		578		**1538**		1		7		2						
	2		298	41	**996**		2		5	1	1			9		43	
	3	166	452	69	**473**		3	5	12	1	4						
	4	142	195		**447**	5395	4	7	4		3	52	2	7	20	21	11
2004	1	19	181	86	**1052**		1	2	6	1	4						
	2	72	222		**788**		2	1	4		2			6		15	
	3		566		**908**		3		8		2						
	4	7	123		**2146**	6170	4	4	2		2	38	16	7	47	5	10

Table I4. Number of kept observer lengths, trips, and gillnet metric tons landed per 100 lengths sampled for Gulf of Maine winter flounder.

year	half	lengths	trips	gillnet landings	Mt/100 lengths
1990	1	539	90	184	
	2	78	1	29	
		617	91	214	35
1991	1	126	6	81	
	2	30	8	13	
		156	14	94	60
1992	1	1950	39	134	
	2	172	25	26	
		2122	64	160	8
1993	1	2004	63	96	
	2	375	20	42	
		2379	83	138	6
1994	1	330	22	101	
	2	206	10	15	
		536	32	115	21
1995	1	1116	20	217	
	2	306	23	35	
		1422	43	253	18
1996	1	1275	26	146	
	2	118	17	19	
		1393	43	164	12
1997	1	793	18	139	
	2	42	4	27	
		835	22	166	20
1998	1	1162	19	141	
	2	431	8	32	
		1593	27	173	11
1999	1	747	5	78	
	2	526	12	7	
		1273	17	85	7
2000	1	911	8	85	
	2	261	4	15	
		1172	12	100	9
2001	1	862	15	129	
	2	42	2	23	
		904	17	152	17
2002	1	237	13	33	
	2	693	31	12	
		930	44	44	5
2003	1	1704	42	80	
	2	3052	50	45	
		4756	92	126	3
2004	1	2256	59	58	
	2	4645	164	24	
		6901	223	82	1

Table 15. Gulf of Maine winter flounder discard ratios and number of trips/tows in the observer and VTR data for the large mesh, small mesh and gillnet fishery. Bold numbers indicate the data used in the VPA assessment.

		Large Mesh Otter Trawl					Small Mesh Otter Trawl					Gillnet				
Year	Half-year	# trips	#tows	SS ratio	VTR trips	VTR ratio	# trips	#tows	SS ratio	VTR trips	VTR ratio	# trips	#tows	SS ratio	VTR trips	VTR ratio
1989	Jan-Jun	15	44	0.130			2	3	0.200							
	Jul-Dec	7	16	0.071			10	25	0.290			26	62	**0.084**		
1990	Jan-Jun	5	6	0.167								50	164	**0.166**		
	Jul-Dec	6	14	0.287			2	3	0.333			33	63	**0.223**		
1991	Jan-Jun	8	25	0.072			4	14	0.029			73	164	**0.164**		
	Jul-Dec	23	103	0.055			8	18	1.152			321	618	**0.142**		
1992	Jan-Jun	21	48	0.098			1	1	0.000			257	617	**0.130**		
	Jul-Dec	6	22	0.039			3	11	0.068			224	397	**0.114**		
1993	Jan-Jun	1	1	0.600								196	576	**0.150**		
	Jul-Dec	4	12	0.080			3	10	0.153			97	198	**0.107**		
1994	Jan-Jun	1	1	0.000	445	**0.053**				23	0.151	43	101	**0.174**	249	0.229
	Jul-Dec				1422	**0.062**				524	0.092	15	35	**0.103**	648	0.091
1995	Jan-Jun	4	15	1.101	2417	**0.048**				229	0.217	18	54	**0.285**	907	0.150
	Jul-Dec	3	52	0.011	1149	**0.037**	22	57		123	0.322	19	52	**0.201**	548	0.388
1996	Jan-Jun	2	5	0.068	2196	**0.044**	1	1		60	0.254	17	62	**0.128**	589	0.159
	Jul-Dec	2	19	0.013	1227	**0.035**	26	93	3.344	219	1.807	18	39	**0.066**	364	0.553
1997	Jan-Jun	3	13	0.231	1700	**0.034**	1	4	0.218	22	0.064	18	56	**0.245**	470	0.112
	Jul-Dec				887	**0.023**				149	0.136	10	22	**0.272**	291	0.087
1998	Jan-Jun	5	16	0.233	1809	**0.046**				17	0.046	27	87	**0.109**	543	0.144
	Jul-Dec				939	**0.030**				129	0.024	35	66	**0.049**	329	0.117
1999	Jan-Jun				942	**0.038**				15	0.034	14	41	**0.141**	285	0.136
	Jul-Dec	15	35	0.015	1148	**0.038**	13	35		123	0.516	23	60	**0.100**	359	0.090
2000	Jan-Jun	35	78	0.041	1240	**0.060**	7	10	0.123	28	0.192	27	74	**0.137**	378	0.094
	Jul-Dec	6	8	0.000	1418	**0.032**	6	13	0.170	52	0.165	18	39	**0.098**	472	0.088
2001	Jan-Jun	27	61	0.970	1278	**0.029**				3	0.054	14	27	**0.061**	351	0.096
	Jul-Dec	61	144	0.036	1281	**0.044**	2	3	0.000	105	0.060	10	21	**0.109**	523	0.107
2002	Jan-Jun	19	52	0.062	986	**0.028**	1	1	0.000	2	0.156	15	37	**0.022**	192	0.075
	Jul-Dec	104	222	0.081	1483	**0.052**	20	59	3.875	88	0.023	38	86	**0.037**	400	0.134
2003	Jan-Jun	84	247	0.050	870	**0.061**	1	1	0.200			69	209	**0.037**	290	0.037
	Jul-Dec	91	193	0.089	1575	**0.061**	5	14	0.304	19	0.280	113	282	**0.014**	541	0.075
2004	Jan-Jun	47	115	0.061	801	**0.047**	5	14	0.023	23	0.501	101	303	**0.051**	240	0.068
	Jul-Dec	161	404	0.076	1332	**0.046**	22	51	1.578	55	0.051	318	816	**0.035**	470	0.049

Table I6. Gulf of Maine winter flounder estimated discard ratios in the shrimp fishery (total discard kg / total days fished estimated from NEFSC and MA Observer data by shrimp season). Ratio for 1982-1988 is the average ratio from 1989-1992. Total shrimp fishery days fished estimated by Wigley et al 1999 and estimated discards are also shown. A 50% mortality is used for estimating dead discards. Dotted line indicates the introduction of the Nordmore grate. * uses the average ratio between 2001 and 2003 due to the lack of sampling.

Year	trips	tows	ratio	Shrimp df	discard wt (kg)	dead discards (kg)
1982			*22.225*	970.1	21,560	10,780
1983			*22.225*	1156.9	25,712	12,856
1984			*22.225*	1754.0	38,983	19,491
1985			*22.225*	2081.4	46,259	23,129
1986			*22.225*	2395.1	53,231	26,615
1987			*22.225*	3708.2	82,414	41,207
1988			*22.225*	2815.2	62,568	31,284
1989	12	24	13.361	2839.5	37,939	18,969
1990	25	53	24.070	3204.6	77,136	38,568
1991	38	94	27.720	2587.7	71,730	35,865
1992	72	225	23.749	2313.3	54,938	27,469
1993	63	178	10.730	1902.2	20,411	10,206
1994	63	183	7.320	1982.3	14,511	7,256
1995	58	136	7.382	3375.7	24,918	12,459
1996	40	92	6.290	3242.9	20,398	10,199
1997	21	55	12.511	3661.2	45,804	22,902
1998	3	6	10.559	2204.0	23,273	11,636
1999	4	5	5.645	1217.4	6,872	3,436
2000	4	10	10.927	792.9	8,664	4,332
2001	4	6	9.466	673.4	6,375	3,187
2002	1	2	*9.912	245.5	2,433	1,217
2003	18	36	10.358	531.9	5,509	2,755
2004	11	47	9.571	243.2	2,328	1,164

Table I7. Gulf of Maine winter flounder catch at age component summary.

Catch at age component	years	halfyear	length data	age data
trawl and other commercial landings	82-04	mix	commercial and observer (unclassified)	commercial
gillnet commercial landings	90-04	whole year	observer (kept)	commercial
recreational landings	82-04	halfyear	MRFSS	combine NEFSC and MA DMF ages by halfyear
recreational discards	82-04	halfyear	spr & fall MA DMF	combine NEFSC and MA DMF ages by halfyear
large mesh trawl discards (survey)	82-93	whole year	survey method (spr & fall MA DMF)	combine NEFSC spr & fall survey
large mesh trawl discards (vtr/survey)	94-04	whole year	survey method (94-00) observer (01-04)	combine NEFSC spr & fall survey
gillnet discards	86-04	whole year	observer (discards)	combine spr NEFSC and MA DMF ages
shrimp discards	82-04	shrimp season	observer (discards)	combine spr NEFSC and MA DMF ages

Table I8. Gulf of Maine winter flounder composition of the catch by number.

	Landings		Discards				
year	recreational	commercial	recreational	gillnet	lg mesh	shrimp	Total
1982	7,274	5,282	140	0	1,397	96	14,188
1983	1,988	3,842	27	0	428	120	6,406
1984	2,285	3,992	29	0	249	174	6,729
1985	3,220	2,965	71	0	340	197	6,793
1986	691	2,055	38	41	253	240	3,318
1987	2,391	2,086	102	34	308	346	5,266
1988	841	2,210	17	40	406	262	3,775
1989	1,678	2,329	44	21	321	227	4,620
1990	652	1,922	20	70	315	214	3,193
1991	154	1,799	9	26	315	257	2,559
1992	137	1,567	7	36	216	256	2,220
1993	249	1,384	22	36	45	127	1,863
1994	145	1,116	13	36	49	116	1,475
1995	82	1,609	10	85	42	134	1,963
1996	98	1,224	13	35	31	123	1,524
1997	64	1,198	19	70	23	257	1,630
1998	65	1,166	7	29	33	123	1,423
1999	67	437	7	9	11	39	571
2000	75	516	15	22	20	54	701
2001	72	1,047	15	16	26	40	1,215
2002	61	1,072	6	2	51	13	1,205
2003	51	1,128	5	4	69	30	1,288
2004	29	710	3	5	41	13	802

Table I9. Gulf of Maine winter flounder mean weight at age (kg) from age 1 to 8+.

year	1	2	3	4	5	6	7	8+
1982	0.081	0.223	0.375	0.487	0.595	0.802	0.943	2.037
1983	0.115	0.252	0.357	0.502	0.644	0.795	0.946	1.164
1984	0.059	0.257	0.305	0.400	0.543	0.708	0.855	1.115
1985	0.041	0.169	0.311	0.447	0.584	0.809	0.927	1.122
1986	0.045	0.291	0.408	0.510	0.664	0.813	1.005	1.221
1987	0.034	0.240	0.390	0.527	0.690	0.858	1.070	1.284
1988	0.034	0.376	0.421	0.487	0.648	0.753	1.022	1.204
1989	0.036	0.197	0.412	0.570	0.623	0.989	1.175	1.397
1990	0.040	0.271	0.398	0.538	0.631	0.778	1.003	1.247
1991	0.048	0.256	0.429	0.563	0.609	0.722	0.771	0.965
1992	0.031	0.229	0.405	0.539	0.638	0.799	1.064	1.468
1993	0.031	0.226	0.380	0.454	0.658	0.680	1.148	1.453
1994	0.029	0.096	0.379	0.481	0.637	0.790	1.128	1.052
1995	0.043	0.127	0.345	0.431	0.552	0.651	0.929	1.186
1996	0.029	0.279	0.437	0.520	0.593	0.768	0.851	1.381
1997	0.043	0.191	0.415	0.514	0.630	0.802	0.798	0.859
1998	0.036	0.170	0.384	0.471	0.594	0.749	0.984	1.814
1999	0.035	0.088	0.391	0.490	0.559	0.713	0.907	1.062
2000	0.039	0.108	0.345	0.470	0.549	0.676	0.869	1.187
2001	0.033	0.085	0.318	0.456	0.544	0.687	0.847	1.050
2002	0.038	0.165	0.409	0.491	0.583	0.688	0.855	1.280
2003	0.035	0.149	0.367	0.481	0.567	0.698	0.891	1.317
2004	0.033	0.185	0.363	0.486	0.614	0.754	0.947	1.559

Table I10. Gulf of Maine winter flounder numbers at age (000's) from age 1 to 8+.

year	1	2	3	4	5	6	7	8+
1982	118	2,909	5,274	3,487	1,402	617	276	104
1983	146	941	1,970	1,839	857	362	158	133
1984	36	949	2,097	1,907	856	348	312	225
1985	54	320	1,617	2,124	1,925	398	218	136
1986	83	557	936	852	373	353	102	62
1987	78	553	2,031	1,224	794	311	138	136
1988	52	507	1,215	1,179	361	248	123	89
1989	56	439	1,480	1,545	793	218	51	38
1990	39	366	997	1,037	509	170	48	29
1991	43	405	995	674	232	116	55	40
1992	52	436	802	615	208	67	24	16
1993	46	220	725	647	147	66	9	3
1994	33	98	477	638	166	44	14	5
1995	43	95	367	749	488	174	27	18
1996	57	174	758	413	83	23	8	9
1997	37	279	605	519	139	32	9	11
1998	44	100	283	511	335	109	36	5
1999	18	23	70	188	162	71	24	16
2000	23	33	97	251	206	62	18	11
2001	19	23	61	349	438	206	82	37
2002	6	29	135	374	402	182	54	23
2003	11	45	159	349	386	219	73	45
2004	6	30	88	245	189	143	51	51

Table I11. NEFSC and MDMF survey indices of abundance for Gulf of Maine winter flounder. Indices are stratified mean number and mean weight (kg) per tow. NEFSC indices are for inshore strata (58,59,60,61,65,66) and offshore strata (26,27,38,39,40). NEFSC indices are calculated with trawl door conversion factors where appropriate. MA DMF uses strata 25-36.

	NEFSC spring		NEFSC fall		MDMF spring		MDMF fall	
Year	number	weight	number	weight	number	weight	number	Weight
1978					86.805	18.373	43.360	9.887
1979	9.063	3.218	6.003	2.602	64.952	14.407	119.506	28.978
1980	11.284	4.447	13.141	6.553	66.231	17.494	74.684	15.940
1981	13.051	3.946	4.179	3.029	100.569	28.370	47.342	13.228
1982	7.670	3.022	4.201	1.924	60.719	14.687	106.053	23.635
1983	12.367	5.653	10.304	3.519	108.508	27.233	88.143	15.772
1984	5.155	1.979	7.732	3.106	66.271	15.977	35.956	10.817
1985	3.469	1.418	7.638	2.324	48.651	13.594	44.564	7.381
1986	2.343	0.998	2.502	0.938	62.356	14.724	41.914	6.603
1987	5.609	1.503	1.605	0.488	83.171	17.648	50.426	7.227
1988	6.897	1.649	3.000	1.031	52.733	10.617	33.063	7.173
1989	3.717	1.316	6.402	2.013	63.595	13.317	33.983	7.462
1990	5.415	2.252	3.527	1.177	74.131	12.966	67.874	13.452
1991	4.517	1.436	7.035	1.467	49.265	11.587	88.777	15.473
1992	3.933	1.160	10.447	3.096	74.146	13.938	77.350	13.471
1993	1.556	0.353	7.559	1.859	80.133	12.390	92.476	14.996
1994	3.481	0.891	4.870	1.319	71.710	10.036	67.351	13.560
1995	12.185	3.149	4.765	1.446	87.848	14.560	84.768	17.250
1996	2.736	0.732	10.099	3.116	77.249	12.823	74.295	13.031
1997	2.806	0.664	10.008	2.950	95.918	14.796	74.347	14.316
1998	2.001	0.528	3.218	0.987	91.466	15.756	93.889	14.934
1999	6.510	1.982	10.921	3.269	77.941	14.198	117.648	22.672
2000	10.383	2.885	12.705	5.065	169.291	35.453	101.633	25.693
2001	5.242	1.666	8.786	3.131	90.153	23.891	80.978	18.367
2002	12.066	3.693	10.691	4.003	87.376	21.404	68.024	18.401
2003	7.839	2.543	10.182	4.312	85.355	17.693	89.367	16.803
2004	3.879	1.097	2.763	0.868	81.299	12.215	112.014	16.194
2005	6.920	2.056			100.819	13.744		

Table I12. Comparative Results from ADAPT/VPA runs incorporating data and software updates since SARC 36.

	SARC/FACT	GARM/NFT	update/NFT	no 8+/NFT	all indices/NFT	limited indices/NFT
Terminal Year	2001	2001	2005	2005	2005	2005
Indices Excluded	N_F2, N_F8 M_F6, M_F7 M_F8, S_S8	N_F2, N_F8 M_F6, M_F7 M_F8, S_S8	N_F2, N_F8 M_F6, M_F7 M_F8, S_S8	N_F2, N_F8 M_F6, M_F7 M_F8, S_S8	none	N_S1, N_F2, N_F6 N_F7, N_F8, M_F6 M_F7, M_F8
Number	33	33	33	33	39	31
RSS	419.74	423.94	618.83	637.24	894.51	523.01
N t+1 age 1 (cv)	6.3 (0.50)	6.2 (0.49)	17.6 (0.55)	17.1 (0.55)	17.4 (0.61)	31.5 (0.64)
N t+1 age 2 (cv)	6.0 (0.33)	6.0 (0.32)	12.3 (0.36)	12.0 (0.36)	10.1 (0.37)	11.2 (0.37)
N t+1 age 3 (cv)	5.0 (0.25)	4.9 (0.25)	4.0 (0.28)	3.9 (0.27)	4.0 (0.29)	4.1 (0.28)
N t+1 age 4 (cv)	5.4 (0.21)	5.4 (0.21)	2.4 (0.24)	2.3 (0.24)	2.5 (0.26)	2.3 (0.24)
N t+1 age 5 (cv)	3.6 (0.20)	3.6 (0.20)	1.4 (0.24)	1.3 (0.24)	1.4 (0.26)	1.4 (0.23)
N t+1 age 6 (cv)	2.0 (0.21)	2.7 (0.18)	1.2 (0.23)	0.9 (0.24)	1.1 (0.24)	1.2 (0.23)
N t+1 age 7 (cv)	1.6 (0.19)	2.0 (0.16)	1.0 (0.22)	0.7 (0.24)	1.0 (0.22)	1.0 (0.22)
N t+1 age 8 (cv)	1.1 (0.17)	0.2 (0.60)	<0.1 (0.69)	- (-)	0.1 (0.53)	< 0.1 (0.64)
F age 1	0	0	0	0	0	0
F age 2	0	0	0.01	0.01	0.01	0.01
F age 3	0.01	0.01	0.03	0.03	0.03	0.03
F age 4	0.08	0.08	0.15	0.15	0.15	0.15
F age 5	0.17	0.13	0.13	0.16	0.14	0.13
F age 6	0.1	0.09	0.12	0.16	0.12	0.12
F age 7	0.06	0.11	0.12	0.16	0.13	0.12
F (ages 5-6)	0.14	0.11	0.13	0.16	0.13	0.12
SSB (mt)	5,866	5,866	3,436	2,838	3,388	3,542

Table I13. VPA estimation results for Gulf of Maine winter flounder, 1982-2004.
Jan-1 Population Numbers

AGE	1982	1983	1984	1985	1986	1987
1	11634	8679	6193	9162	7576	6031
2	14256	9418	6974	5038	7453	6128
3	10961	9055	6863	4855	3836	5599
4	6122	4268	5642	3737	2525	2299
5	3038	1912	1850	2910	1171	1303
6	1170	1236	800	751	678	624
7	575	408	687	344	260	241
8	217	344	495	214	158	237
Total	47973	35319	29503	27011	23657	22463

AGE	1988	1989	1990	1991	1992	1993
1	4422	3984	4162	4408	3116	2524
2	4867	3573	3211	3372	3570	2504
3	4518	3528	2530	2299	2396	2530
4	2765	2608	1565	1179	993	1243
5	792	1210	763	363	366	267
6	362	326	288	174	92	115
7	234	77	74	85	40	16
8	169	58	45	62	27	5
Total	18130	15364	12638	11943	10600	9205

AGE	1994	1995	1996	1997	1998	1999
1	3705	3590	3024	3566	4116	5573
2	2025	3004	2900	2424	2886	3330
3	1852	1570	2374	2217	1733	2272
4	1421	1088	955	1263	1272	1164
5	441	593	228	413	570	584
6	88	212	59	113	214	169
7	35	33	22	28	64	78
8	13	22	24	34	9	52
Total	9580	10111	9586	10058	10864	13223

AGE	2000	2001	2002	2003	2004	2005
1	4675	3857	4595	6084	15017	17607
2	4546	3807	3141	3757	4971	12289
3	2706	3692	3096	2545	3035	4043
4	1797	2128	2968	2413	1940	2405
5	784	1245	1428	2093	1661	1368
6	333	457	627	808	1366	1190
7	75	217	190	350	465	990
8	46	98	81	216	467	27
Total	14962	15501	16126	18266	28923	39919

Table I13. Continued.
Fishing Mortality Calculated

AGE	1982	1983	1984	1985	1986	1987
1	0.0113	0.0187	0.0064	0.0065	0.0122	0.0144
2	0.2539	0.1166	0.1622	0.0726	0.0859	0.1047
3	0.7432	0.2731	0.4078	0.4537	0.3117	0.5056
4	0.9639	0.6357	0.4622	0.9606	0.4612	0.8652
5	0.6997	0.6717	0.7022	1.2562	0.4292	1.08
6	0.8529	0.3874	0.6445	0.8599	0.8356	0.7826
7	0.74	0.5503	0.6845	1.1612	0.5599	0.9737
8	0.74	0.5503	0.6845	1.1612	0.5599	0.9737

AGE	1988	1989	1990	1991	1992	1993
1	0.0131	0.0156	0.0104	0.0108	0.0186	0.0203
2	0.1218	0.1453	0.1341	0.1418	0.1443	0.1018
3	0.3495	0.6129	0.5635	0.6396	0.4565	0.3771
4	0.6266	1.0292	1.2602	0.9696	1.1121	0.8361
5	0.6871	1.2343	1.2768	1.1751	0.9601	0.9106
6	1.3427	1.2797	1.0216	1.2717	1.5386	0.9795
7	0.8506	1.2438	1.2001	1.2054	1.0523	0.9308
8	0.8506	1.2438	1.2001	1.2054	1.0523	0.9308

AGE	1994	1995	1996	1997	1998	1999
1	0.0099	0.0133	0.021	0.0115	0.0119	0.0036
2	0.0548	0.0355	0.0684	0.1355	0.039	0.0076
3	0.3322	0.2966	0.4305	0.3556	0.1979	0.0346
4	0.6734	1.3603	0.6386	0.5956	0.578	0.1955
5	0.5305	2.109	0.5066	0.4597	1.015	0.3625
6	0.7858	2.0816	0.5562	0.373	0.8115	0.6131
7	0.5687	2.1017	0.5166	0.4405	0.9553	0.4136
8	0.5687	2.1017	0.5166	0.4405	0.9553	0.4136

AGE	2000	2001	2002	2003	2004
1	0.0054	0.0054	0.0014	0.002	0.0004
2	0.008	0.0067	0.0102	0.0133	0.0067
3	0.0403	0.0184	0.0493	0.0713	0.0325
4	0.1668	0.1989	0.1493	0.1733	0.1496
5	0.3401	0.486	0.3692	0.2265	0.1338
6	0.229	0.6772	0.3829	0.3528	0.1224
7	0.3056	0.5338	0.3734	0.2601	0.1281
8	0.3056	0.5338	0.3734	0.2601	0.1281

Table I13. Continued.

Average Fishing Mortality For Ages 5-6

Year	Average F	N weighted	Biomass wtd	Catch Wtd
1982	0.7763	0.7423	0.7542	0.7465
1983	0.5295	0.5601	0.5458	0.5872
1984	0.6734	0.6848	0.6816	0.6856
1985	1.0581	1.1750	1.1526	1.1883
1986	0.6324	0.5783	0.6010	0.6268
1987	0.9313	0.9837	0.9673	0.9963
1988	1.0149	0.8928	0.9236	0.9540
1989	1.2570	1.2440	1.2471	1.2441
1990	1.1492	1.2068	1.1990	1.2129
1991	1.2234	1.2064	1.2100	1.2073
1992	1.2493	1.0761	1.0909	1.1010
1993	0.9450	0.9313	0.9328	0.9319
1994	0.6581	0.5730	0.5844	0.5840
1995	2.0953	2.1018	2.1005	2.1018
1996	0.5314	0.5168	0.5190	0.5174
1997	0.4163	0.4411	0.4382	0.4435
1998	0.9132	0.9595	0.9504	0.9650
1999	0.4878	0.4188	0.4298	0.4389
2000	0.2845	0.3070	0.3029	0.3144
2001	0.5816	0.5373	0.5449	0.5472
2002	0.3761	0.3734	0.3739	0.3735
2003	0.2897	0.2617	0.2667	0.2722
2004	0.1281	0.1287	0.1282	0.1289

Table I13. Continued.

Spawning Stock Biomass

AGE	1982	1983	1984	1985	1986	1987
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	449	363	261	187	142	253
4	1669	1293	1554	887	733	703
5	1250	861	771	977	545	561
6	664	734	437	382	361	369
7	396	295	454	198	194	168
8	349	332	443	171	160	227
Total	4776	3877	3920	2802	2134	2281

AGE	1988	1989	1990	1991	1992	1993
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	200	181	94	102	105	103
4	843	808	440	358	296	354
5	371	466	316	147	164	121
6	178	181	148	81	42	56
7	168	51	52	46	26	12
8	157	56	39	42	29	6
Total	1917	1743	1090	777	660	652

AGE	1994	1995	1996	1997	1998	1999
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	76	40	77	105	68	88
4	420	256	282	422	398	394
5	198	172	97	200	233	260
6	50	77	32	67	114	90
7	26	16	13	18	42	55
8	11	15	28	25	12	47
Total	780	576	529	838	867	934

AGE	2000	2001	2002	2003	2004
1	0	0	0	0	0
2	0	0	0	0	0
3	71	103	88	98	110
4	605	658	926	852	654
5	356	531	638	993	830
6	184	225	331	448	823
7	52	137	126	244	347
8	48	85	90	254	671
Total	1315	1739	2199	2890	3436

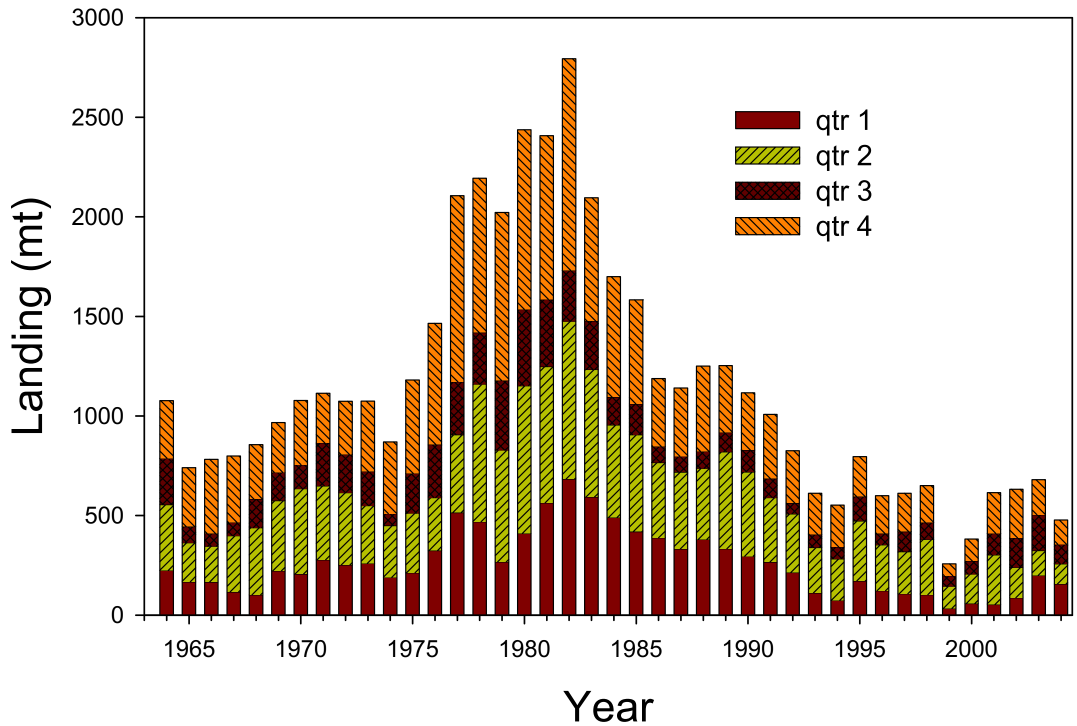


Figure I1. Gulf of Maine winter flounder landings by quarter from 1964-2004.

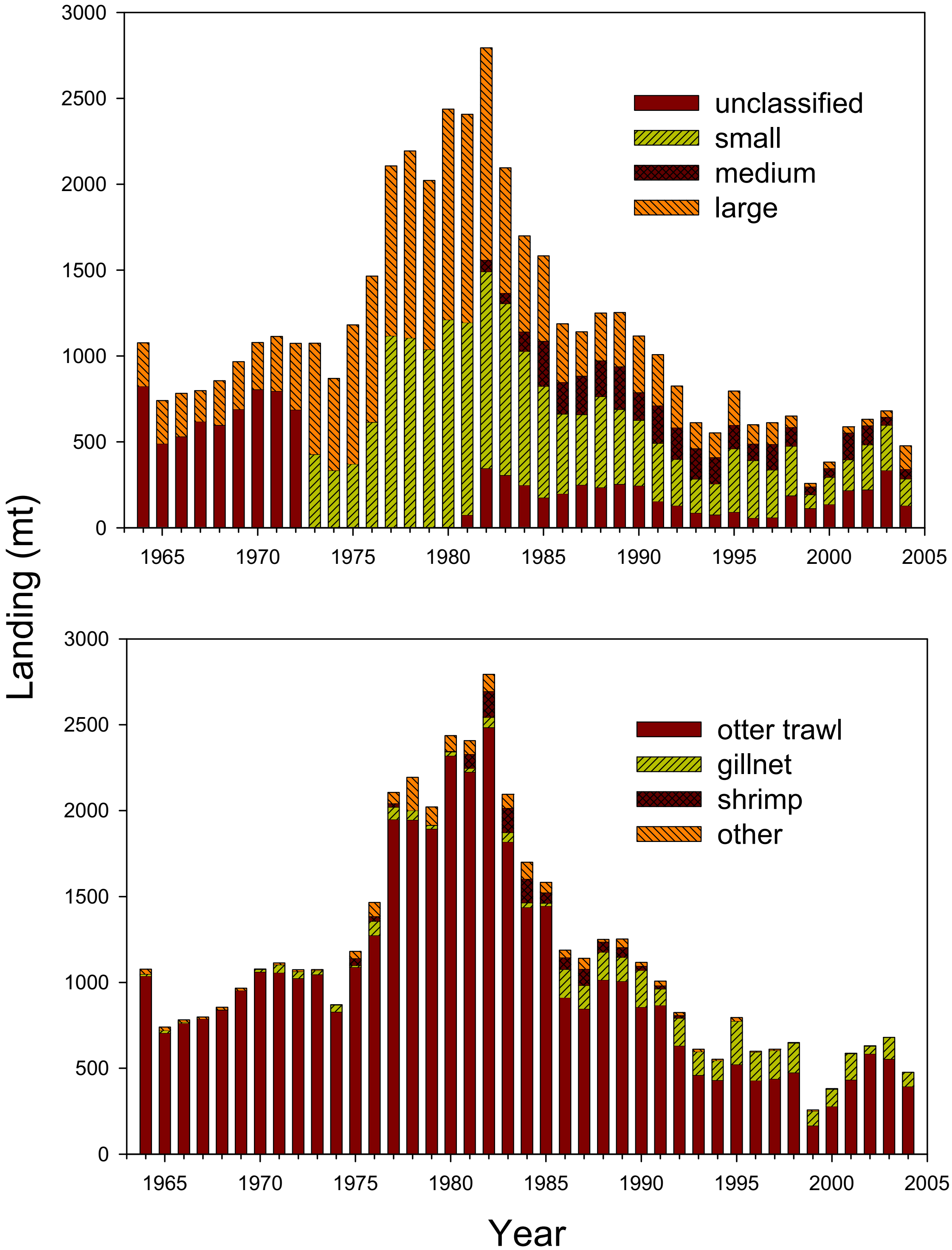


Figure I2. Gulf of Maine winter flounder landings in metric tons by market category (top panel) and gear (bottom panel).

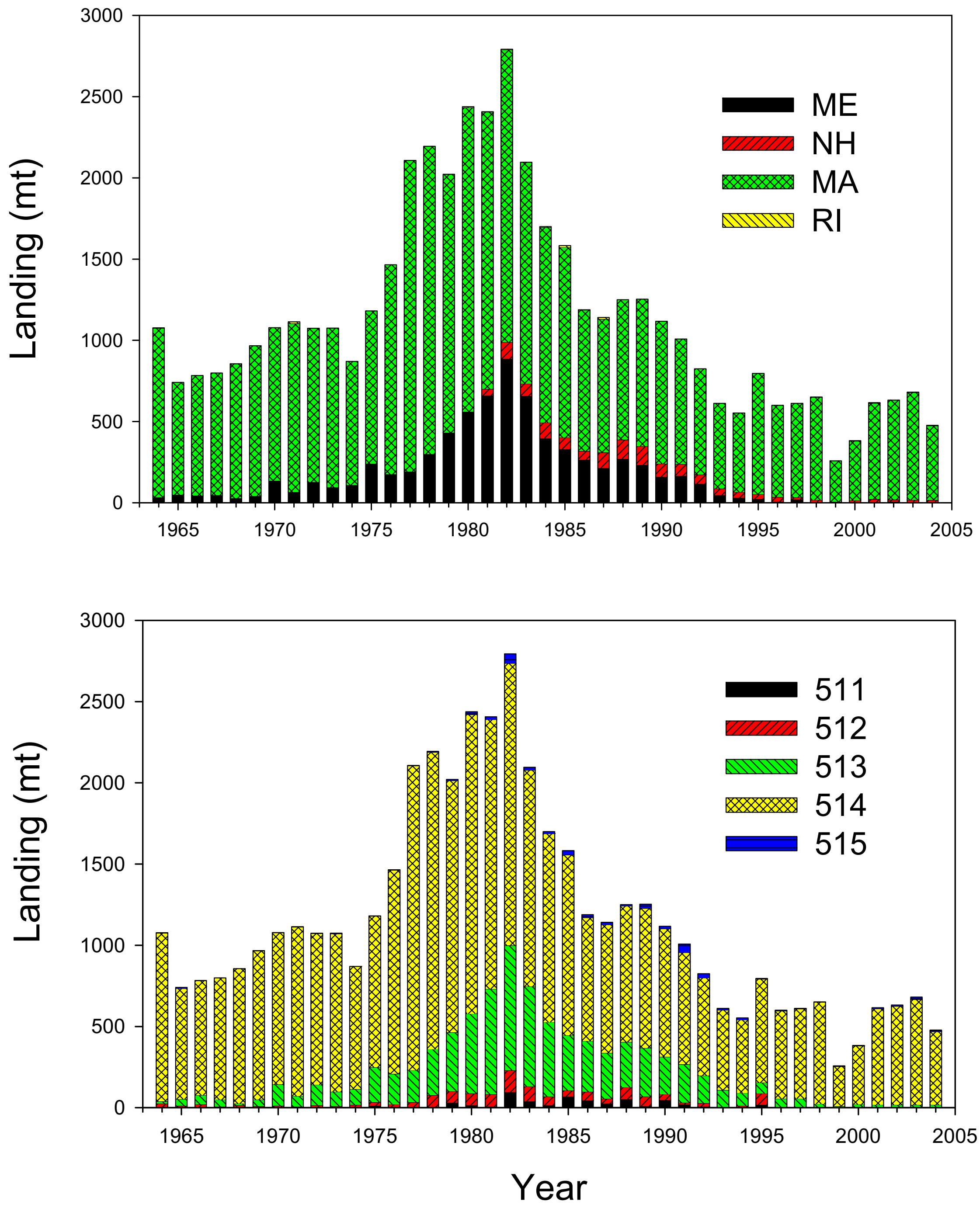


Figure I3. Gulf of Maine winter flounder landings by state (top panel) and statistical area (bottom panel) from 1964-2004.

Gulf of Maine Winter Flounder Recreational landings and b2 Catch

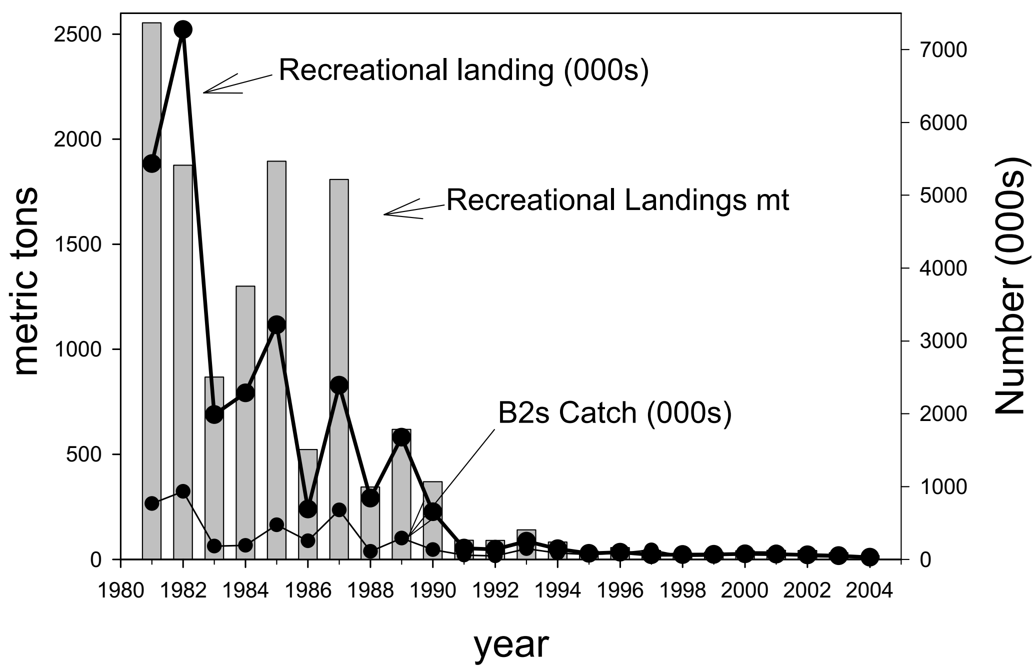


Figure I4. Recreational landings in numbers and metric tons for Gulf of Maine winter flounder. B2 catch in numbers is also shown.

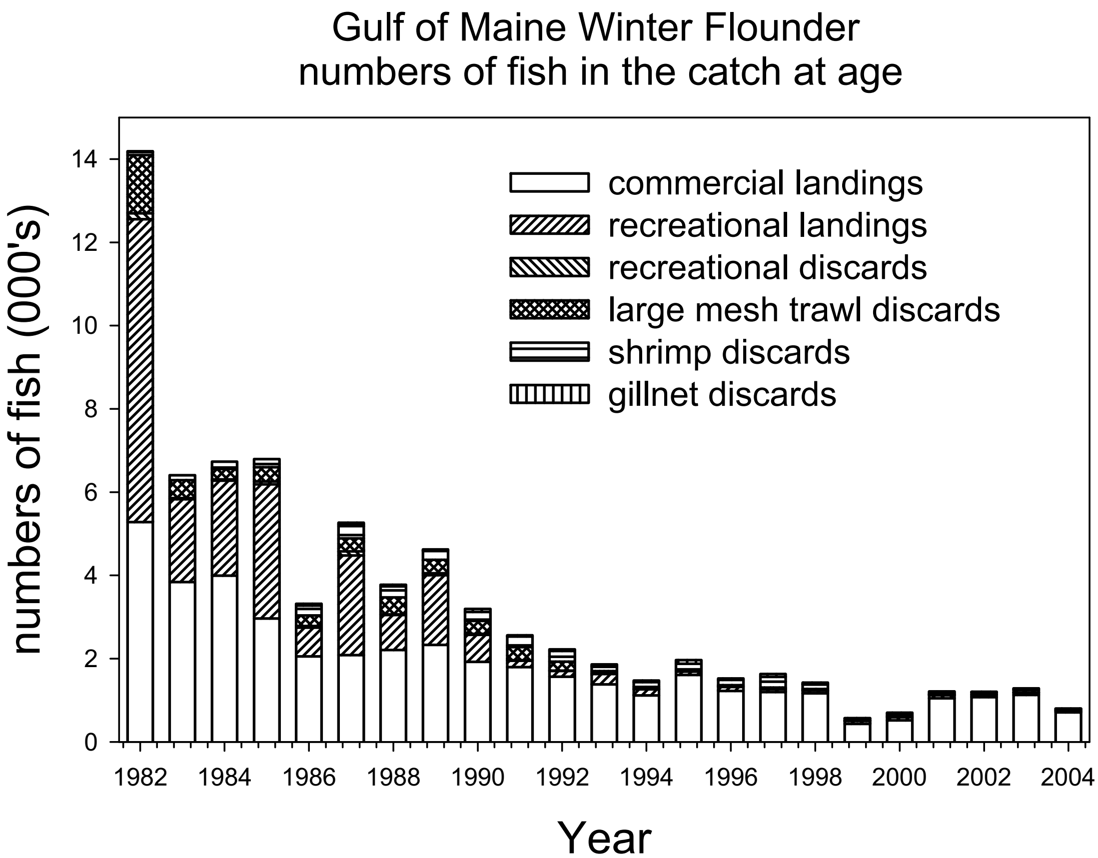


Figure I5. Gulf of Maine winter flounder catch composition in numbers.

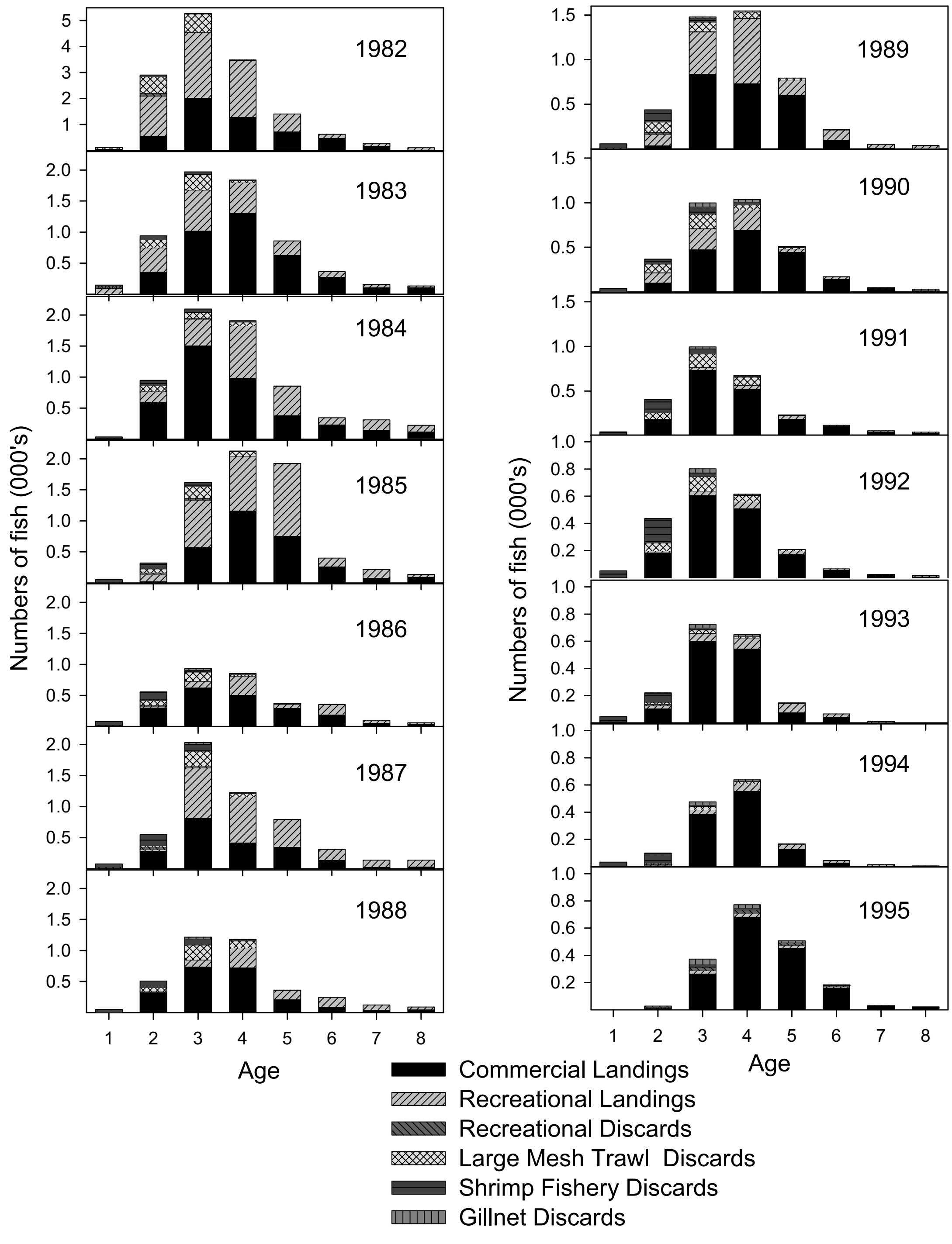


Figure I6. Gulf of Maine winter flounder catch at age composition from 1982-2004.

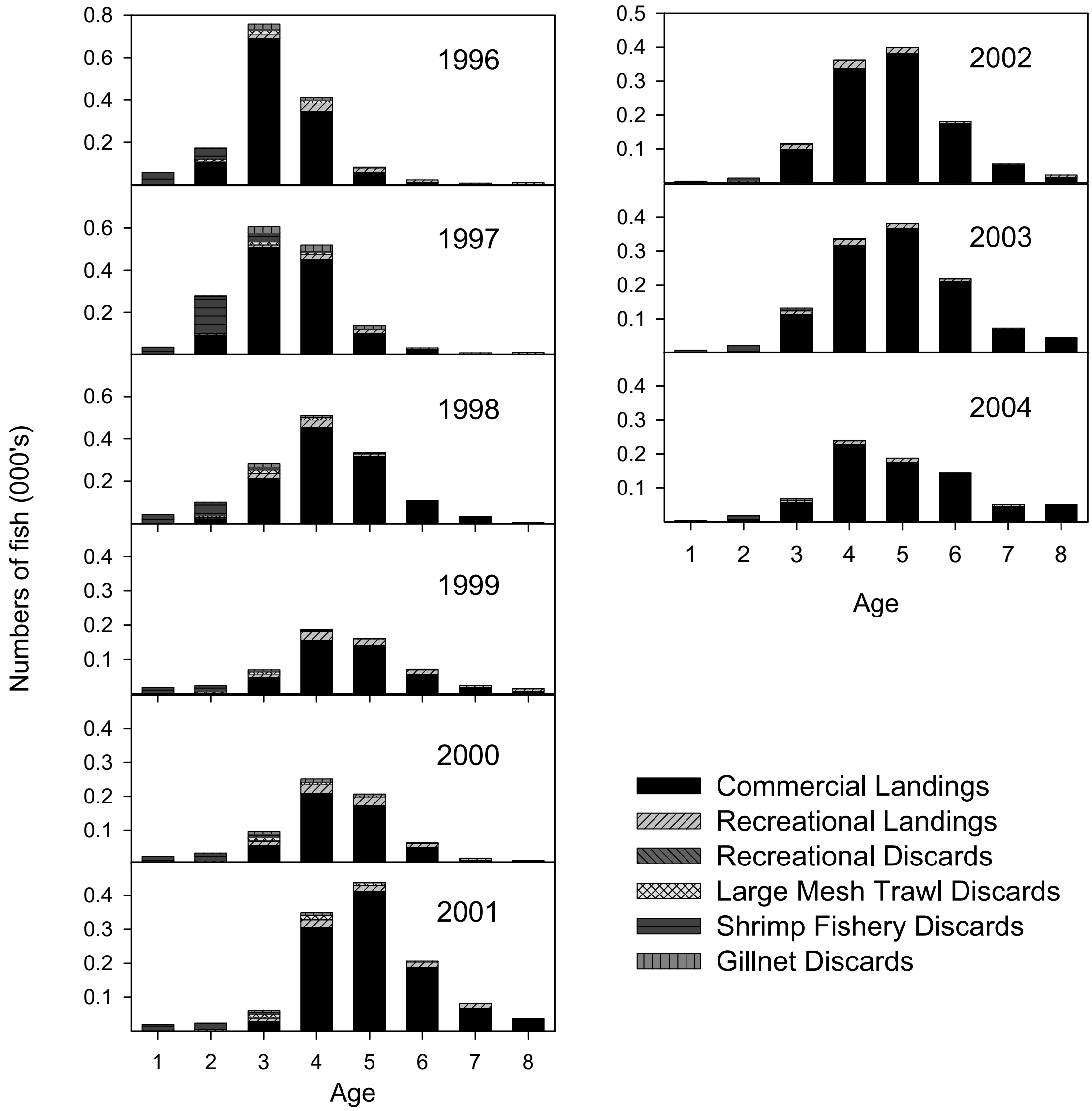


Figure I6. Continued.

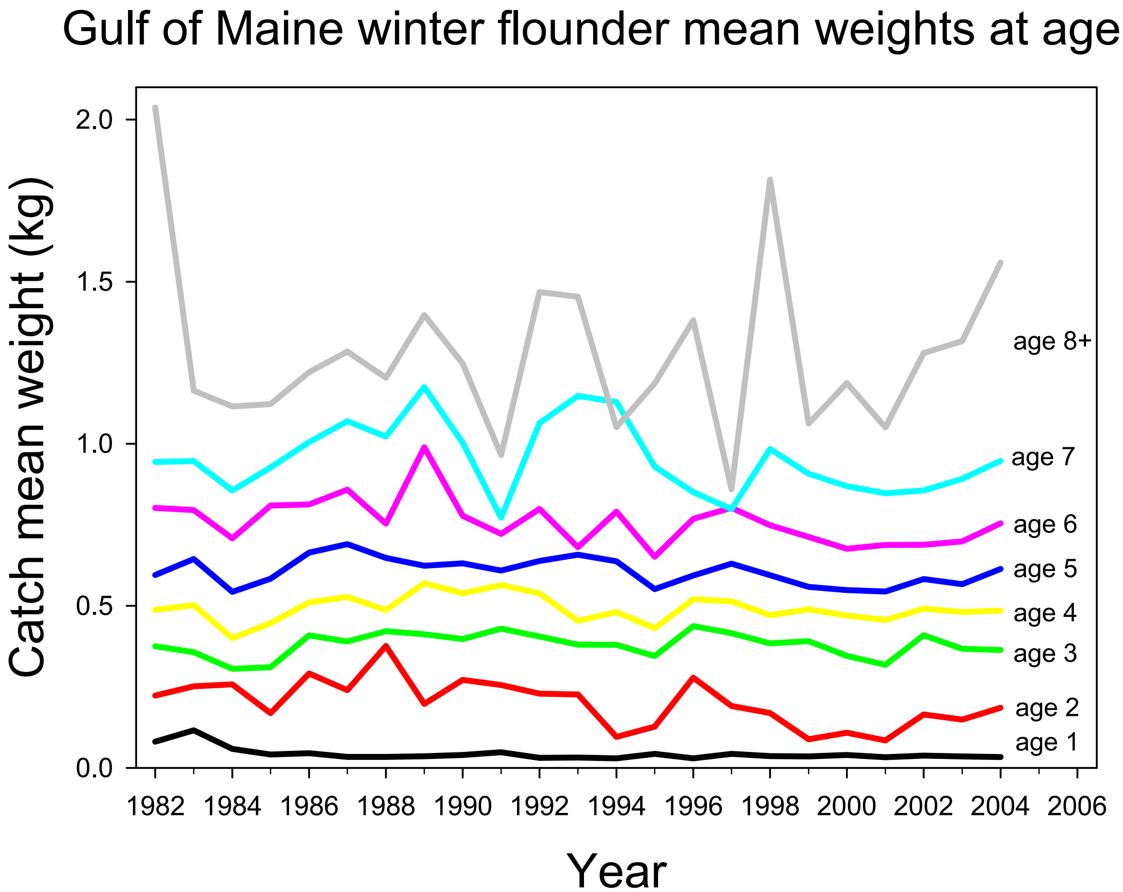


Figure I7. Gulf of Maine winter flounder catch mean weights at age.

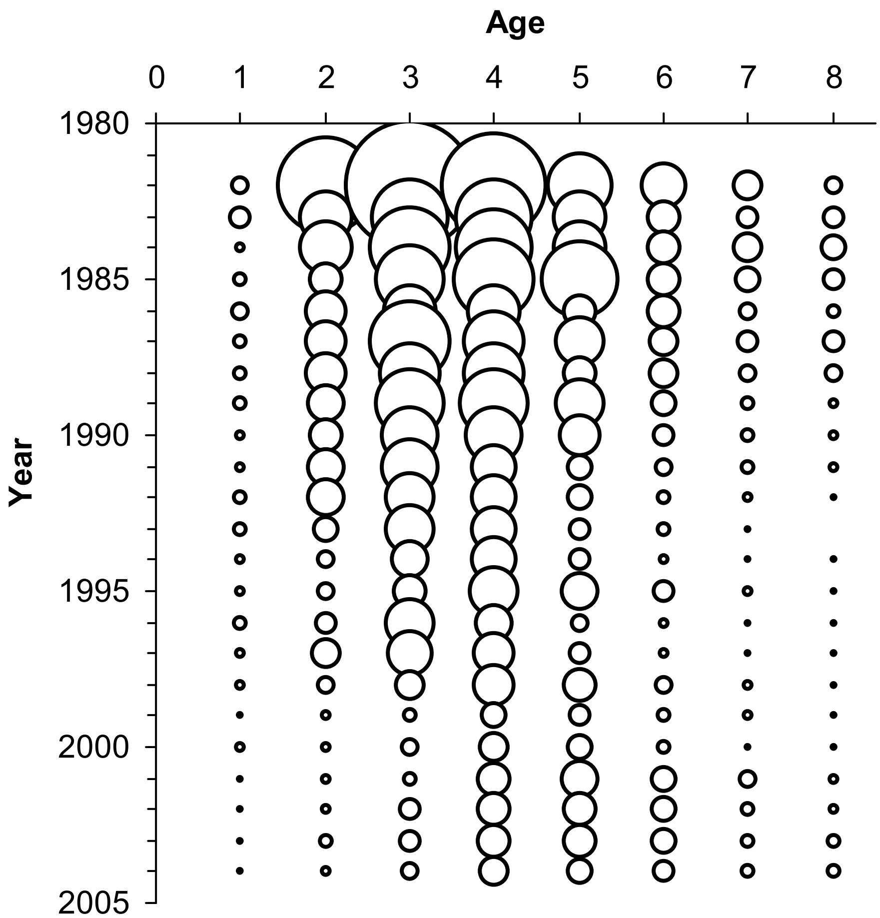


Figure I8. Gulf of Maine winter flounder bubble plot of the catch at age.

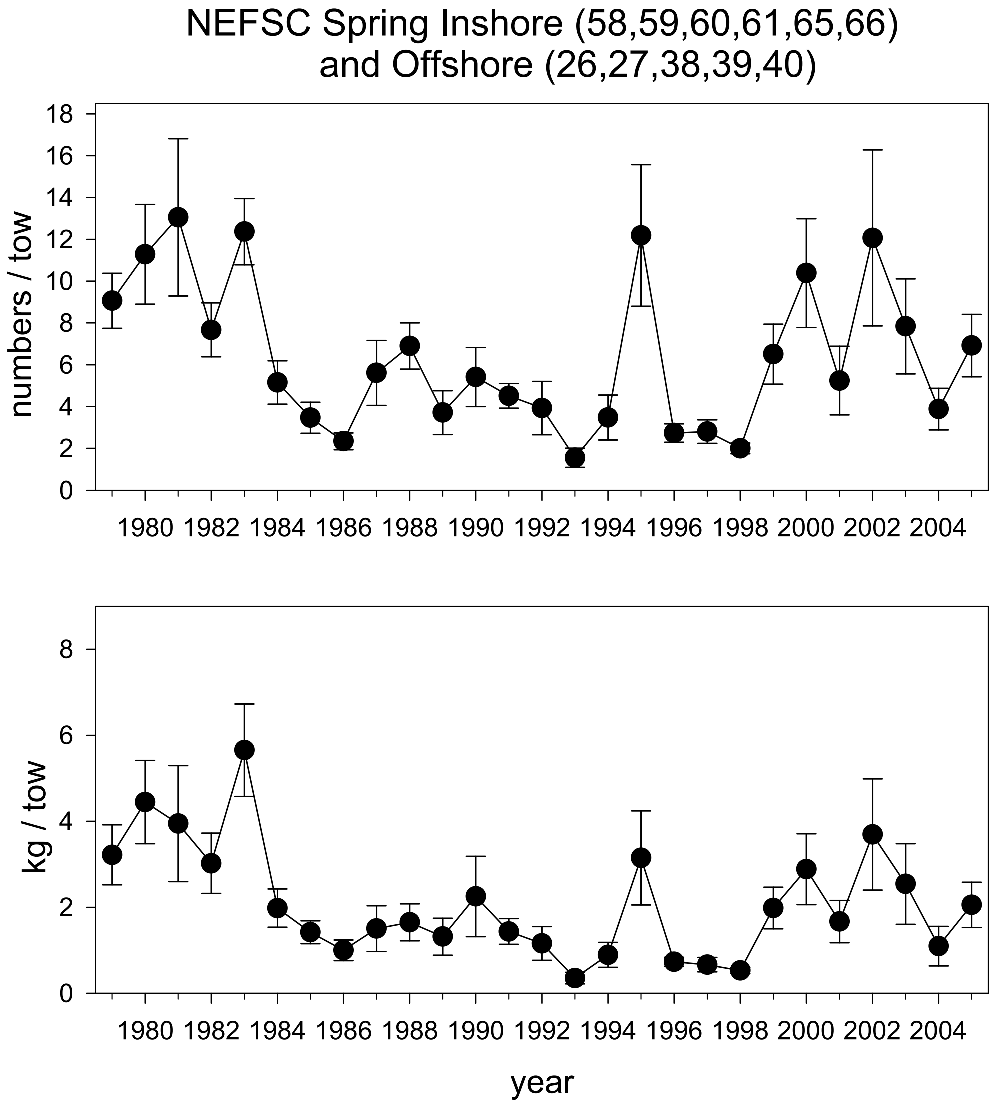


Figure I9. NEFSC Spring survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder. Trawl door conversion factors are use where appropriate.

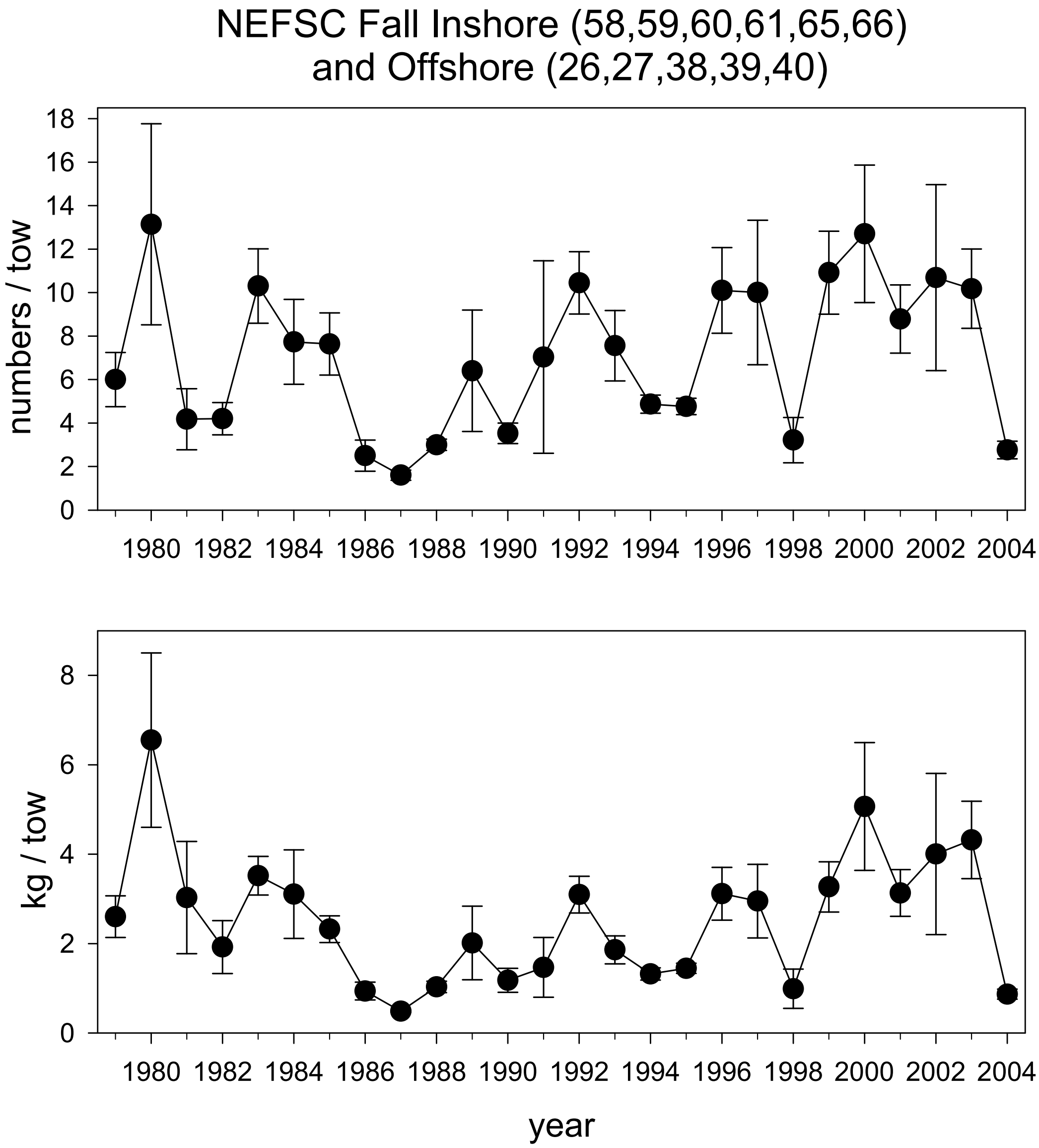


Figure I10. NEFSC Fall survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder. Trawl door conversion factors are use where appropriate.

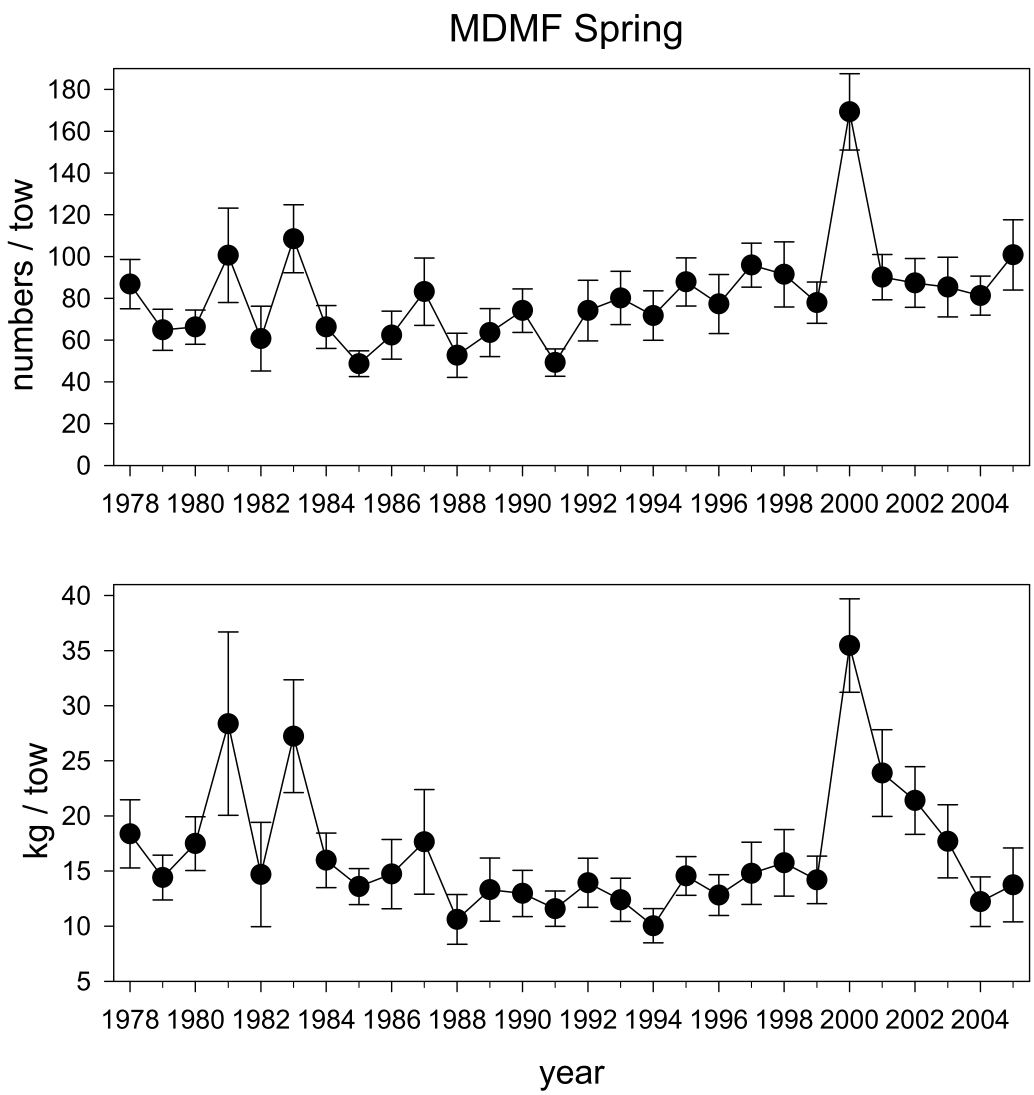


Figure I11. Massachusetts Division of Marine Fisheries (MDMF) Spring survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder.

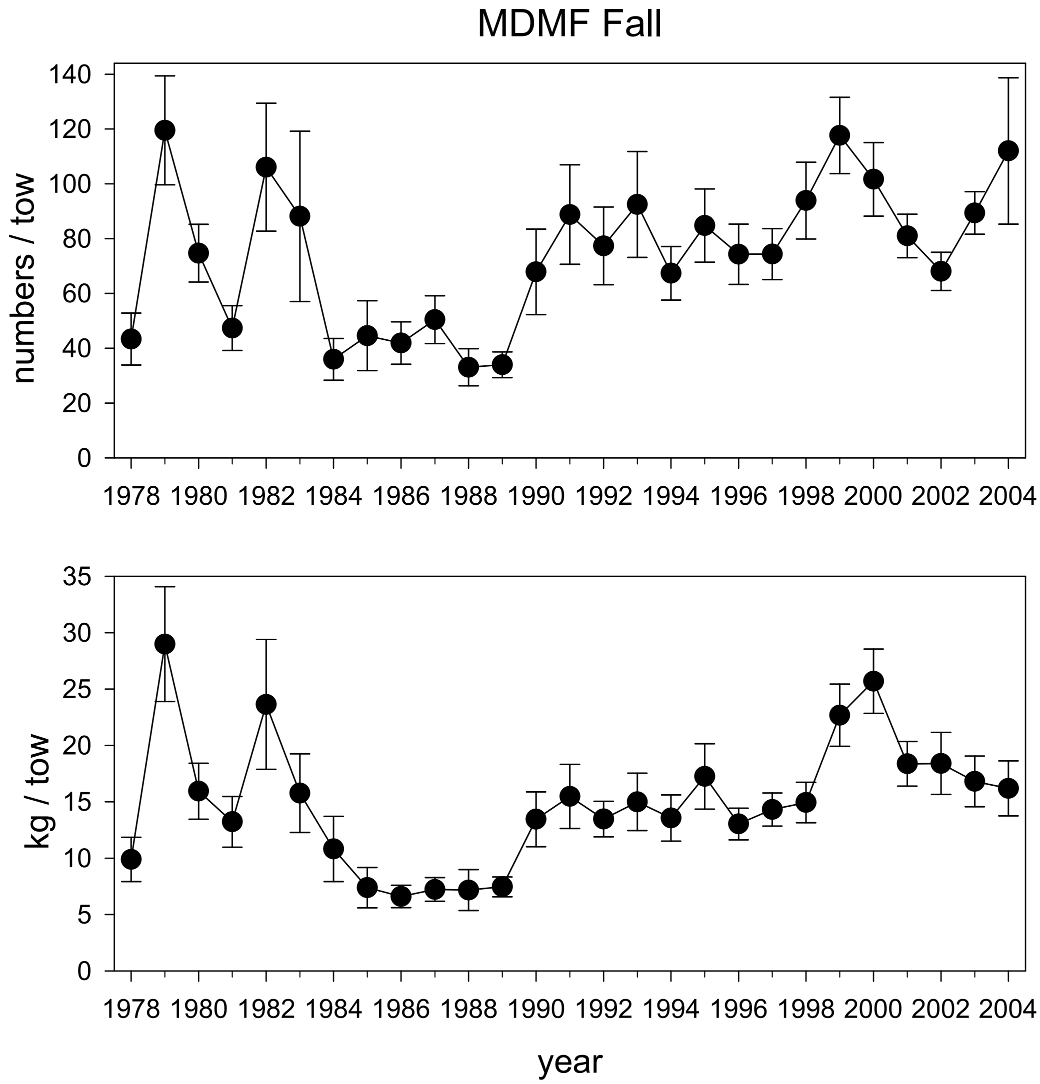


Figure I12. Massachusetts Division of Marine Fisheries (MDMF) Fall survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder.

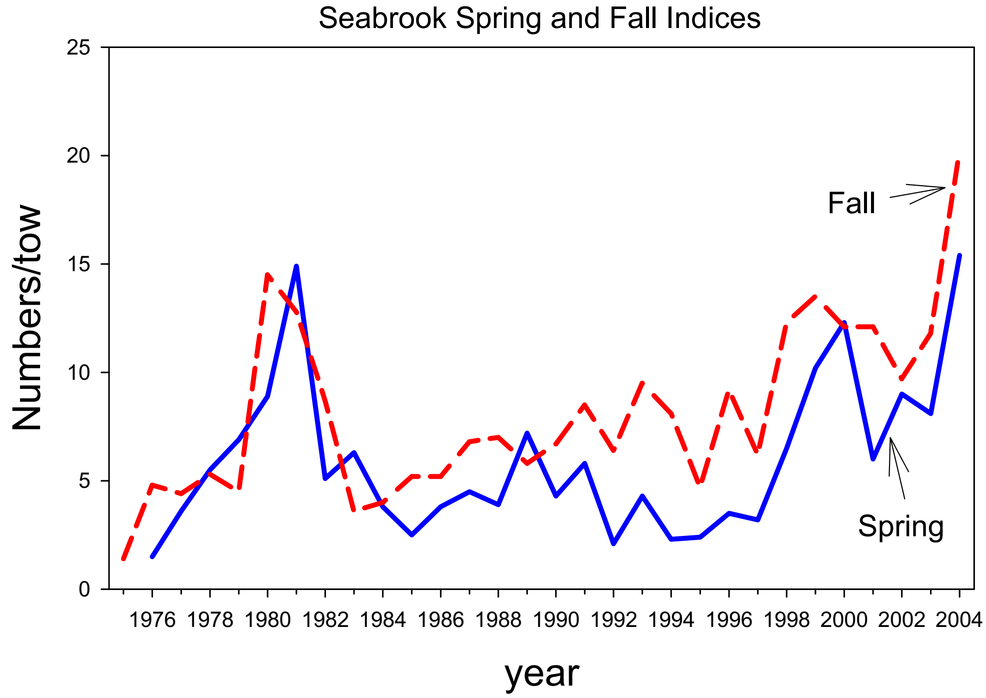


Figure I13. Seabrook Nuclear Power Plant in New Hampshire Spring and Fall survey mean numbers per tow for Gulf of Maine winter flounder. No length data exists from 1975 through 1984 and for 1993. The spring index is used in tunning the VPA.

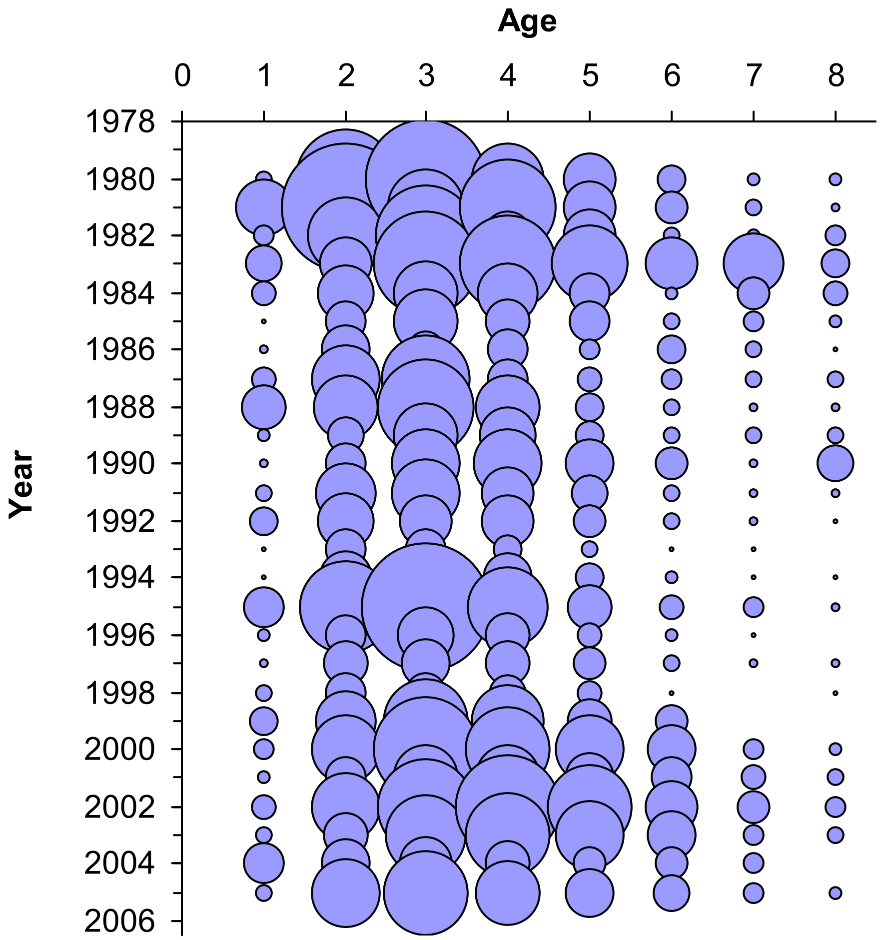


Figure I14. NEFSC Spring bubble plot by age.

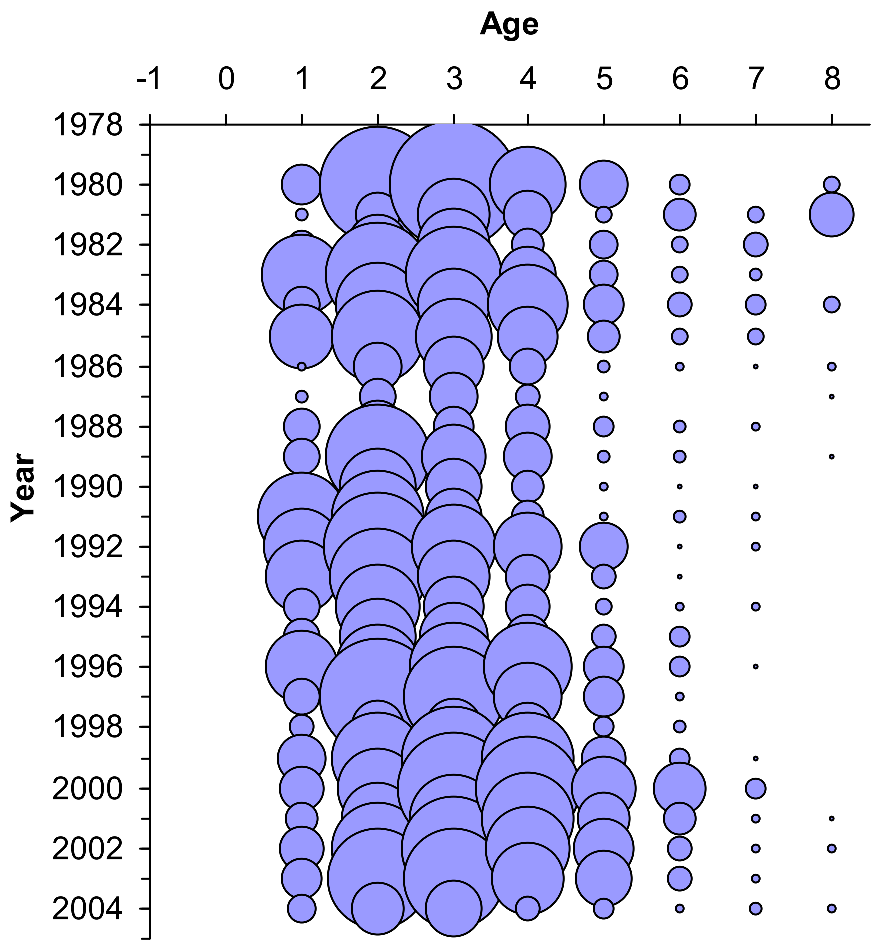


Figure I15. NEFSC Fall bubble plot by age.

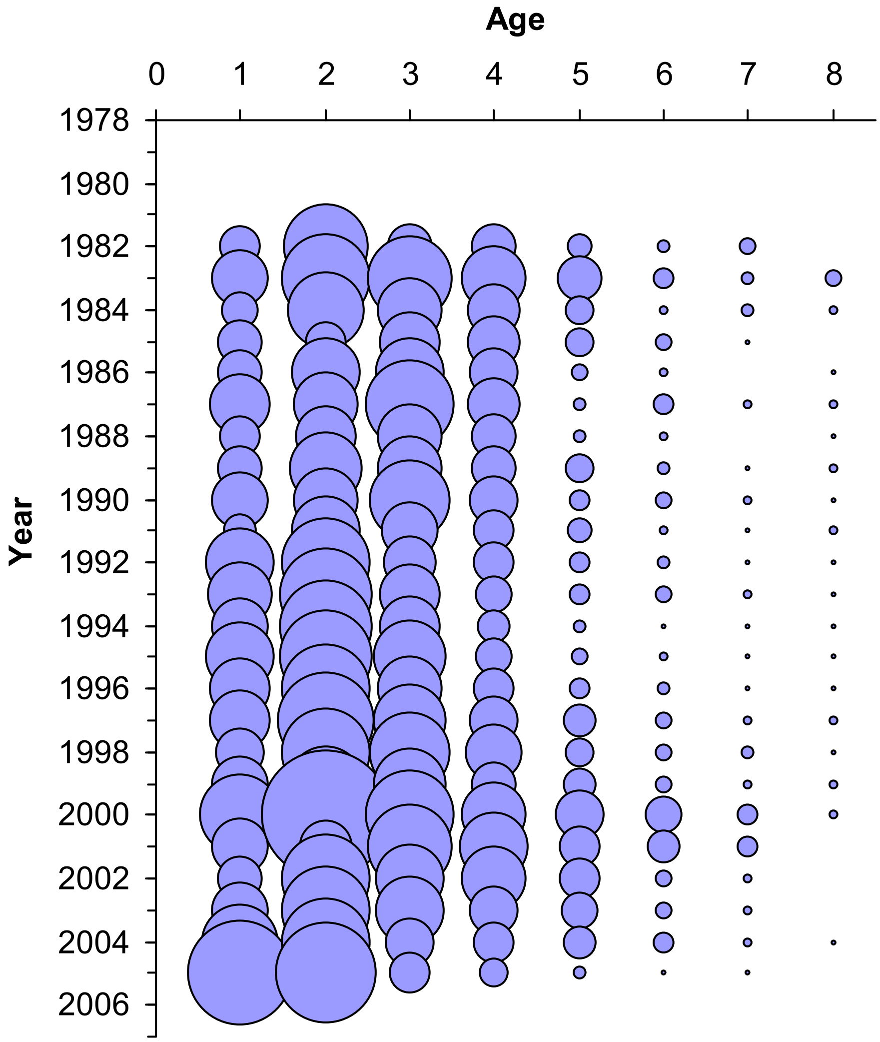


Figure I16. MDMF spring bubble plot by age.

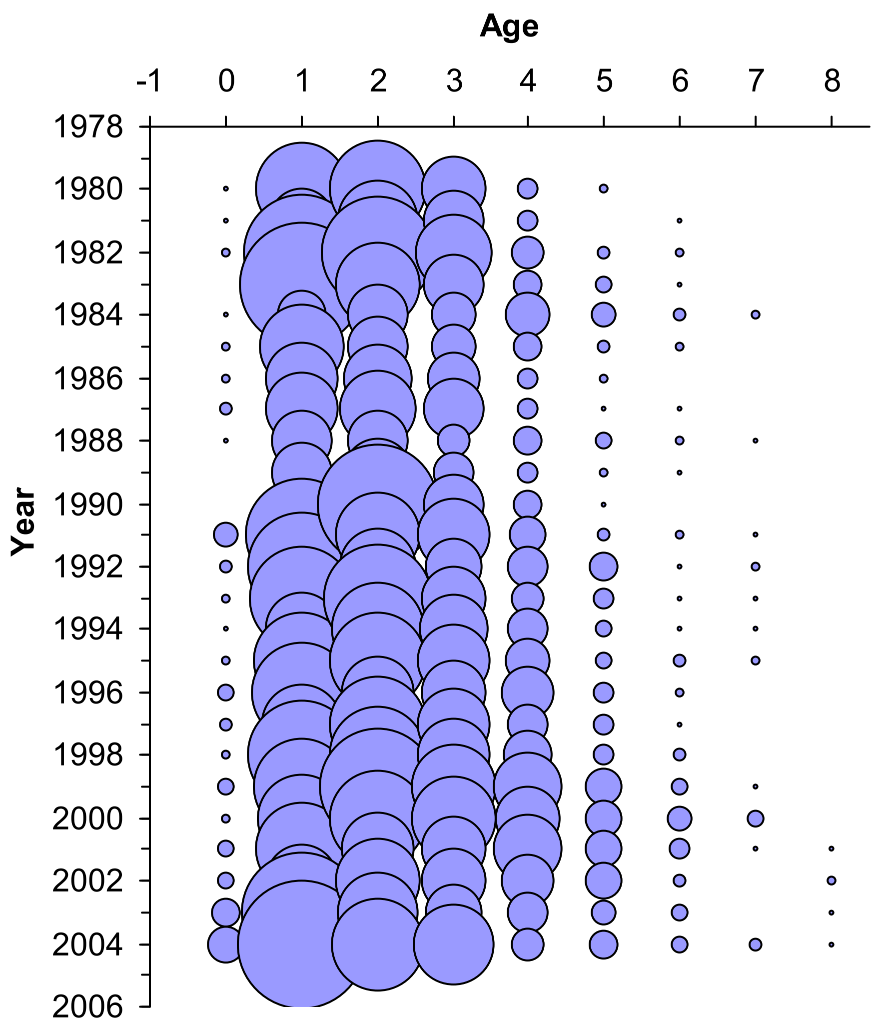


Figure I17. MDMF Fall bubble plot by age.

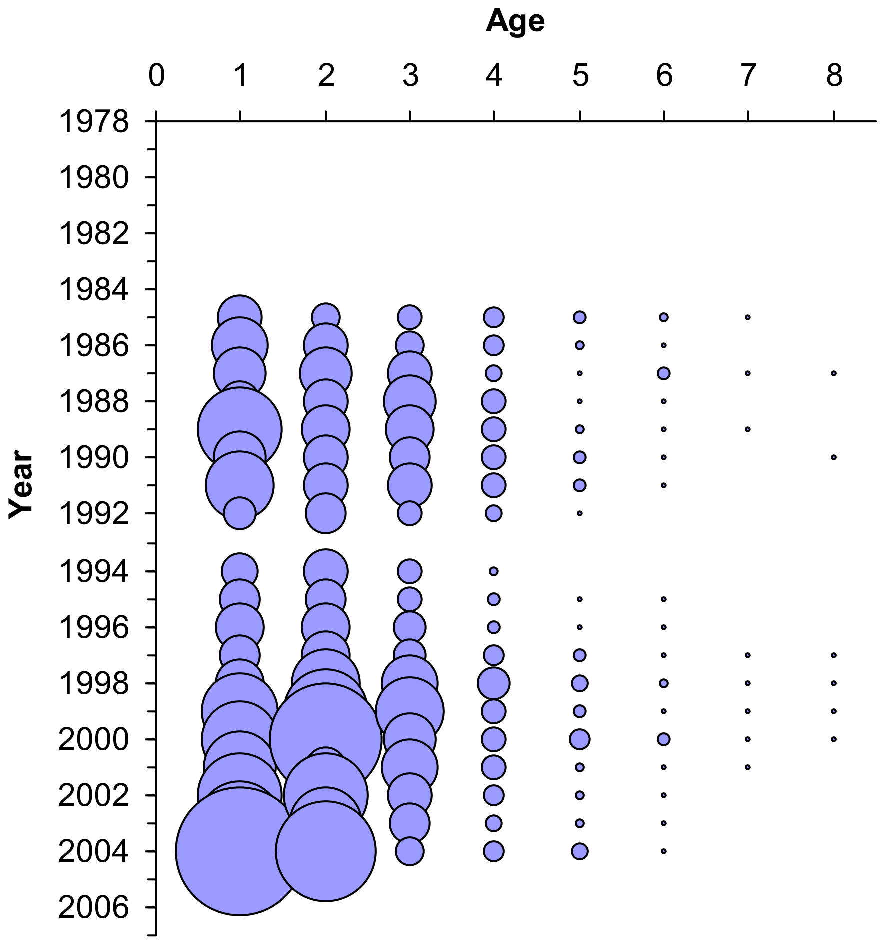


Figure I18. Seabrook Spring bubble plot by age.

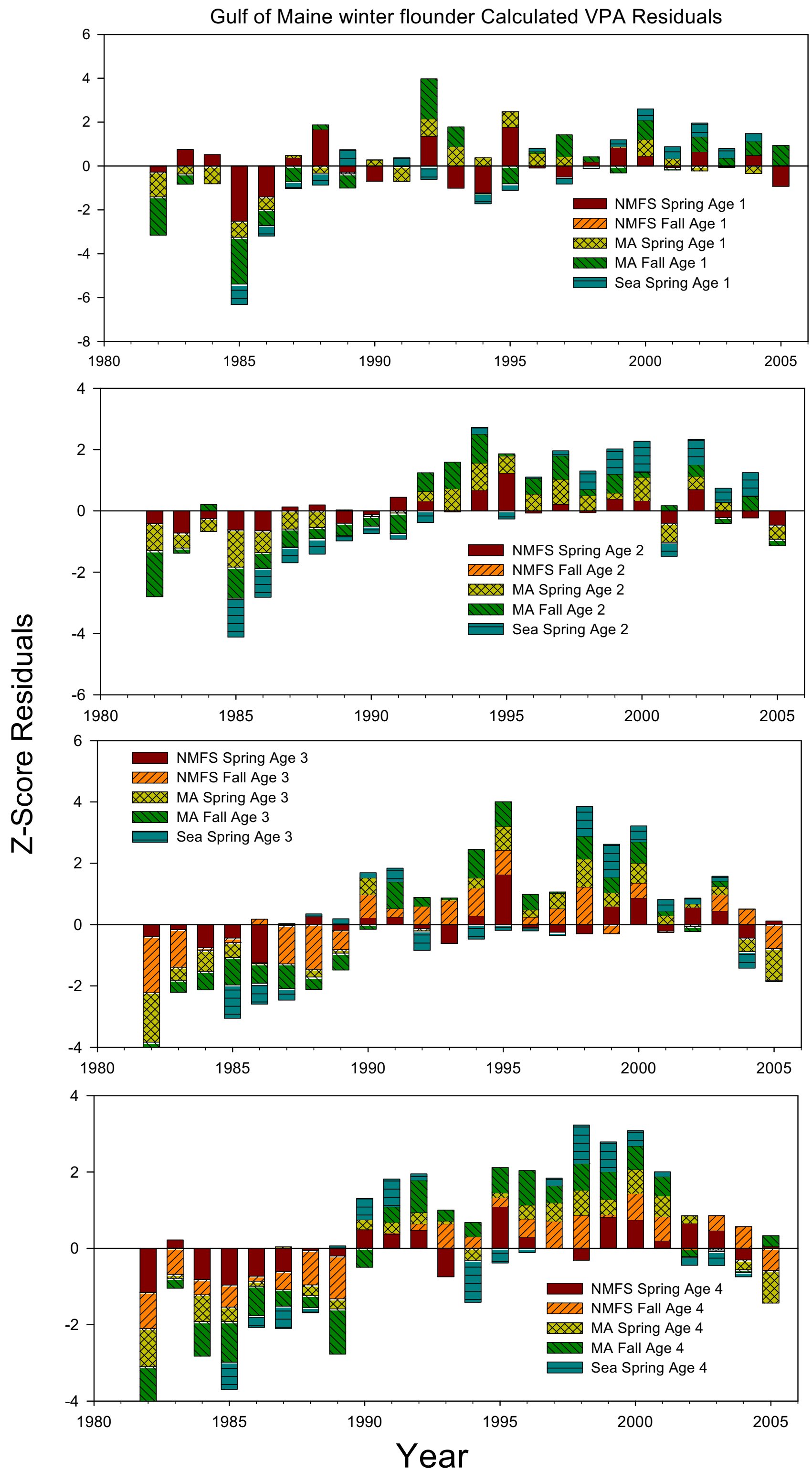


Figure I19. Gulf of Maine winter flounder VPA residual plots.

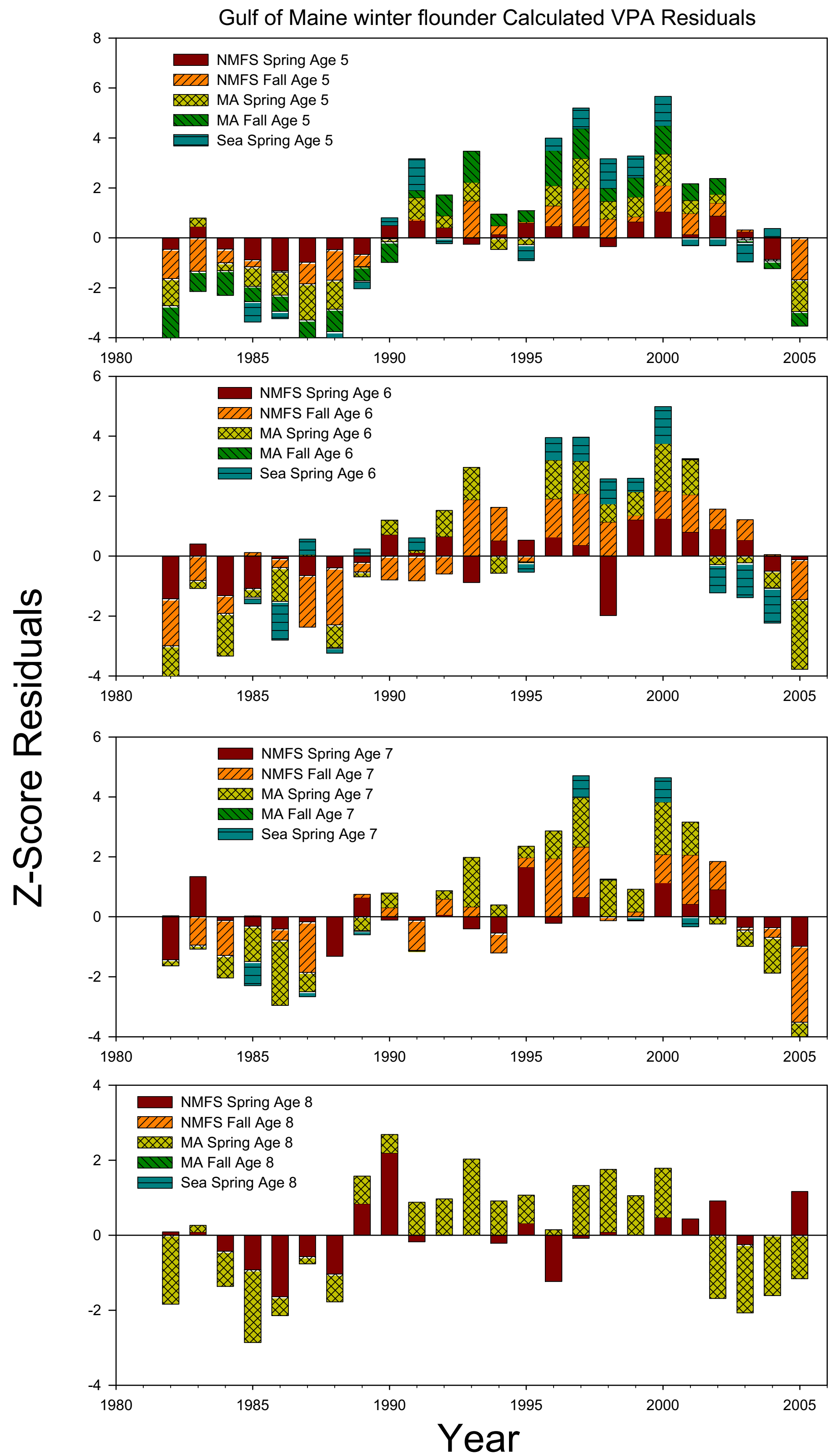


Figure I19. Continued.

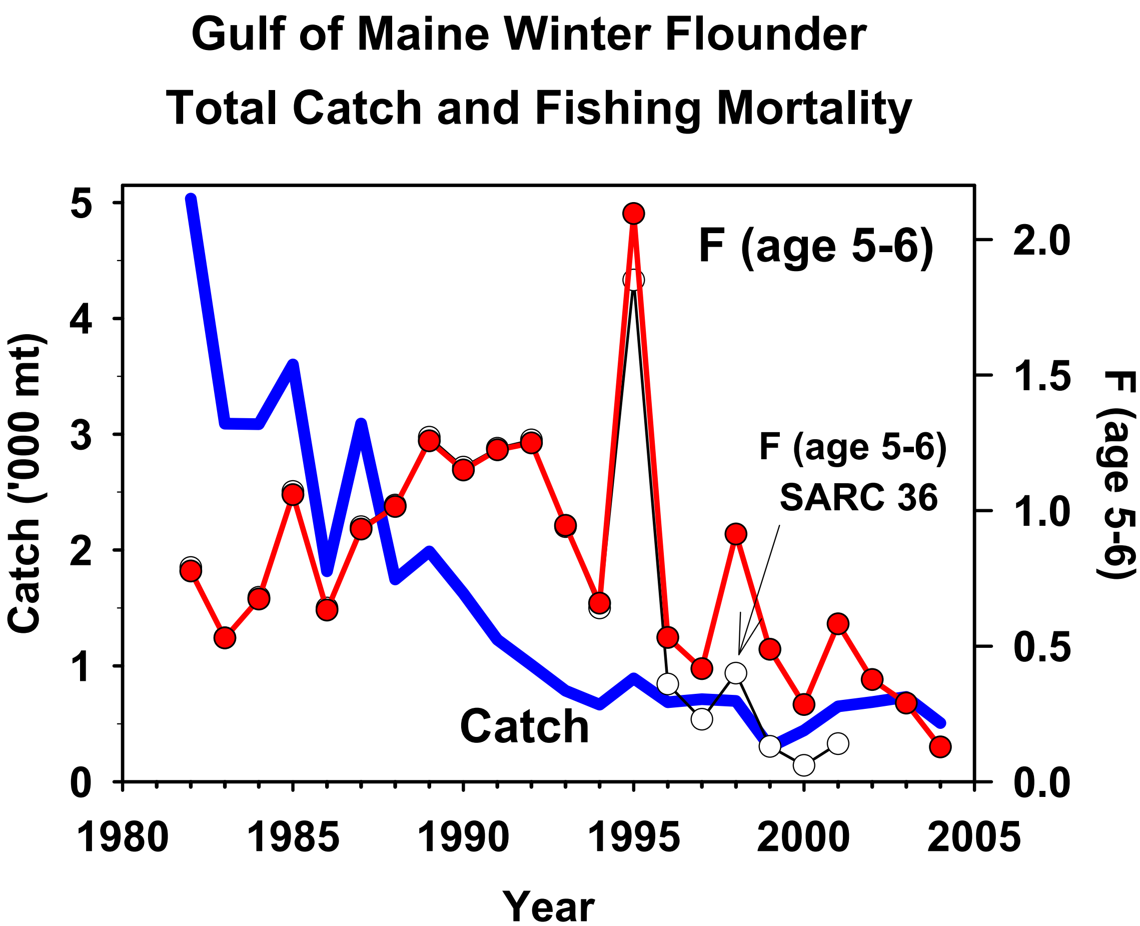


Figure I20. Total catch (landings and discards, thousands of metric tons) and fishing mortality rate (F, ages 5-6, unweighted) for Gulf of Maine winter flounder.

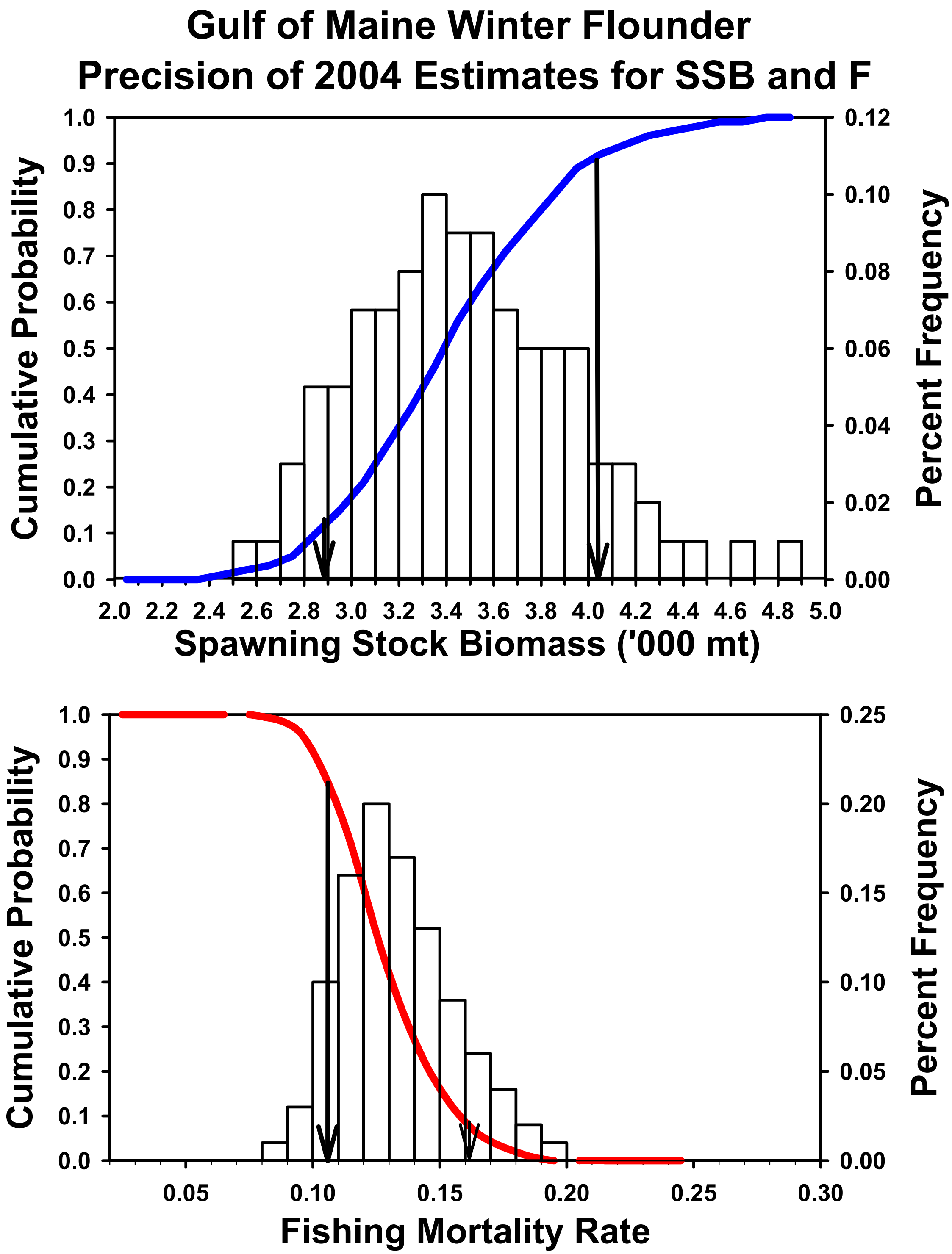


Figure I21. Precision of estimates of spawning stock biomass ('000 mt) and fishing mortality rate (F, ages 5-6, unweighted) in 2004 for Gulf of Maine winter flounder. Vertical bars display the range of the bootstrap estimates and the probability of individual values in the range. The solid curve gives the probability of SSB that is less or fishing mortality that is greater than any value along the X axis.

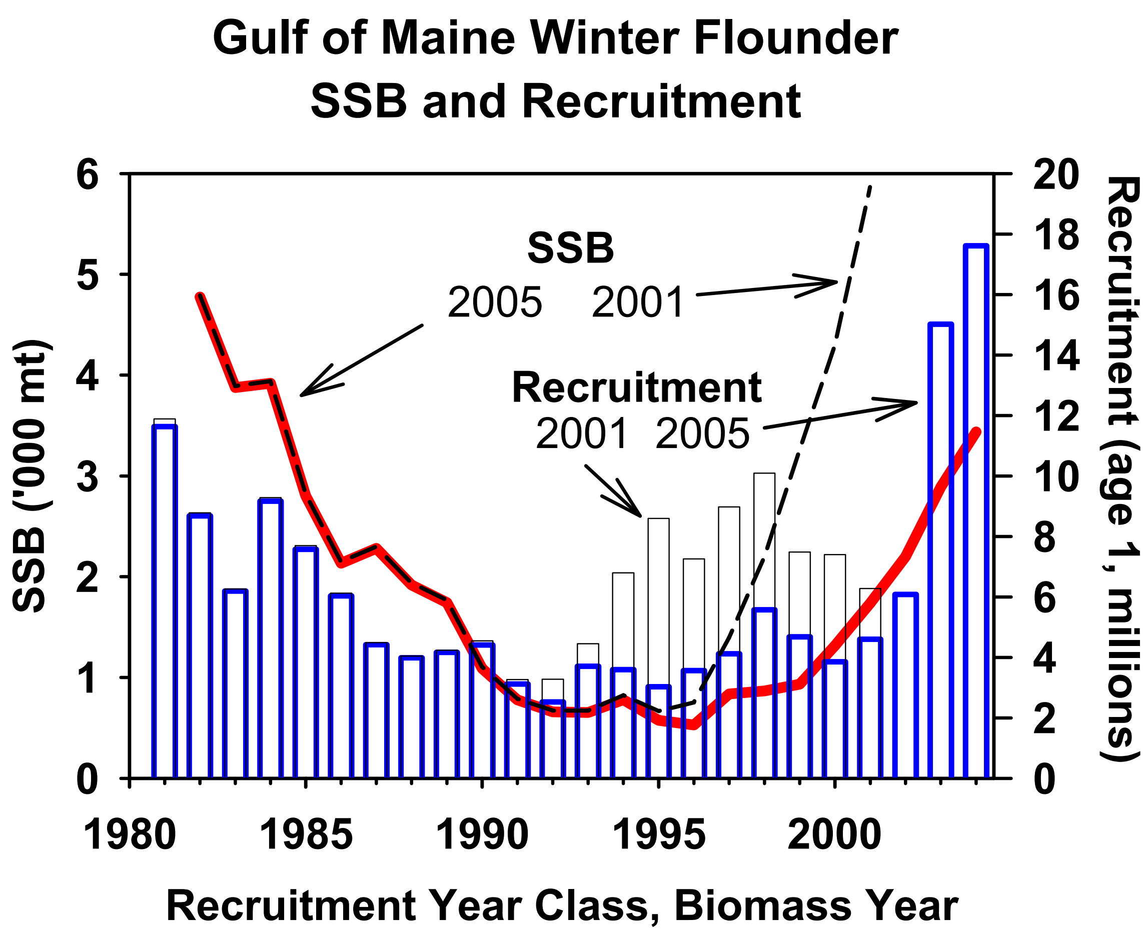


Figure I22. Updated VPA and SARC 36 (2001) spawning stock biomass (SSB, '000 mt) and recruitment (millions of fish at age-1) for Gulf of Maine winter flounder.

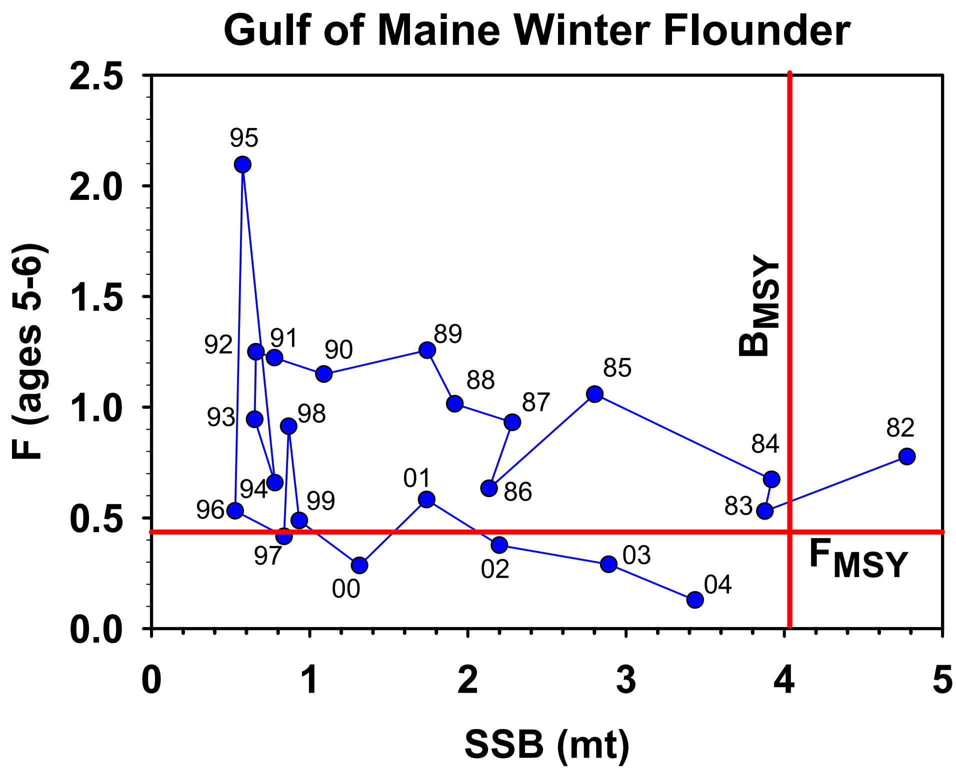


Figure I23. SSB and F (ages 5-6) for Gulf of Maine winter flounder. Biological references points calculated from the Beverton-Holt model in SARC 36 are also shown.

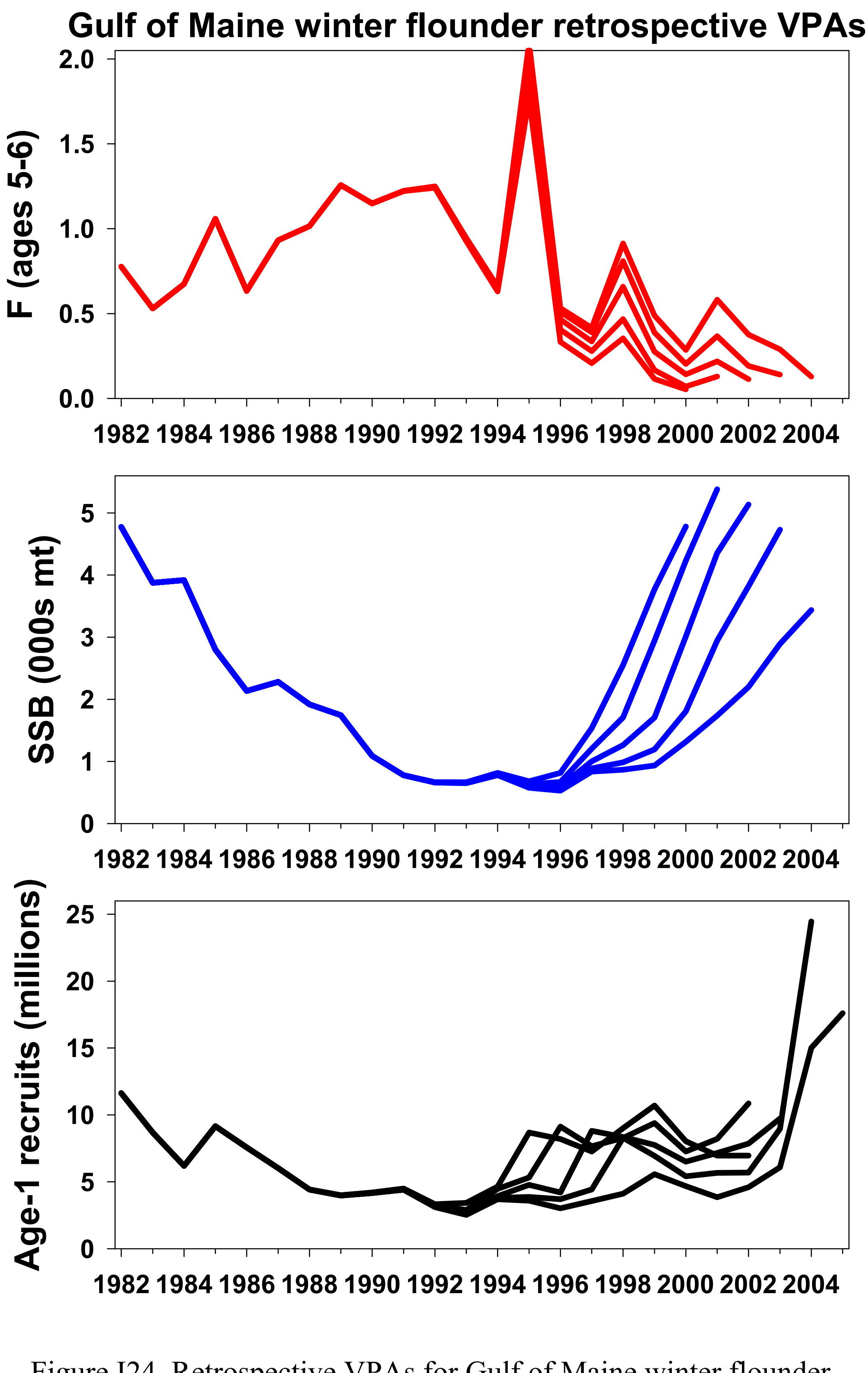


Figure I24. Retrospective VPAs for Gulf of Maine winter flounder.

J. Southern New England/Mid-Atlantic (SNE/MA) winter flounder by **M. Terceiro**

1.0 Background

The current assessment of the SNE/MA stock complex of winter flounder is an update of the previous assessment completed in 2002 at SAW 36 (NEFSC 2003). The SAW 36 assessment included catch through 2001, research survey abundance indices through 2002, and catch at age analyzed by Virtual Population Analysis (VPA) for 1981-2001. Current biological reference points are based on stock-recruitment modeling conducted by the 2002 Working Group on Re-estimation of Biological Reference points for New England Groundfish (NEFSC 2002), which indicated that F_{MSY} = 0.32, SSB_{MSY} = 30,100 mt, and MSY = 10,600 mt. The SAW 36 assessment concluded that the stock complex was overfished and that overfishing was occurring. Spawning stock biomass (SSB) in 2001 was estimated to be 7,600 mt, about 25% of SSB_{MSY} = 30,100 mt. The fully recruited fishing mortality rate in 2001 was estimated to be F = 0.51, about 60% above F_{MSY} = 0.32. The current assessment updates landings and discard estimates, research survey abundance indices, and analytical models through 2004-2005, as applicable.

2.0 2005 Assessment

The Fishery

After reaching an historical peak of 11,977 metric tons (mt) in 1966, then declining through the 1970s, total U.S. commercial landings again peaked at 11,176 mt in 1981, and then steadily declined to 2,159 mt in 1994. Commercial landings then increased to 4,410 mt in 2001 before falling a record low of 1,458 mt in 2004 (Table J1, Figure J1). The primary gear in the fishery is the otter trawl which accounts for an average of 98% of landings since 1989. Scallop dredges, handlines, pound nets, fyke nets, and gill nets account for the remaining 2% of total landings.

Recreational landings reached a peak in 1984 of 5,772 mt but declined substantially thereafter (Table J2, Figure J1). Landings have been less than 1,000 mt since 1991, with the lowest estimated landings in 2004 of 206 mt. The principal mode of fishing is private/rental boats, with most recreational landings occurring during January to June.

Length samples of winter flounder are available from both the commercial and recreational landings. In the commercial fishery, annual sampling intensity varied from 28 to 264 mt landed per 100 lengths measured during 1981-2004 (Table J3). Since 1997, port sampling has been adequate to develop the commercial fishery landings at age on a half-year, market category basis across all statistical areas.

In the recreational fishery, annual sampling intensity varied from 28 to 231 mt landed per 100 lengths measured during 1981-2004. Ages were determined using NEFSC survey spring and fall age-length keys.

For the SNE/MA stock complex of winter flounder, commercial Vessel Trip Reports (VTR) provide the most reliable data from which to estimate commercial fishery discards. VTR trawl gear fishery discards to landings ratios on a half-year basis were applied to corresponding commercial fishery landings to estimate discards in weight (Table J4, Figure J1). The NEFSC Fishery Observer length frequency samples were judged adequate to directly characterize the proportion discarded at length. A discard mortality rate of 50% (Howell et al., 1992) was applied to trawl discards to produce the number of fish discarded dead at length. Samples at length are generally applied on an annual basis due to low sample sizes. Ages were determined using NEFSC survey spring and fall age-length keys.

A discard mortality of 15% was assumed for recreational discards (B2 category from MRFSS data), as assumed in Howell et al. (1992). Discard losses peaked in 1984-1985 at 0.7 million fish. Discards have since declined and reached a low in 2004 of 15,000 fish (Table J4). Since 1997, irregular sampling of the recreational fisheries by state fisheries agencies has indicated that the discard is usually of fish below the minimum landing size of 12 inches (30 cm). For 2002-2004, discard length samples from the NYDEC sampling of the recreational party-boat fishery and from the CTDEP Volunteer Angling Survey (VAS) have been used to better characterize the recreational fishery discard. Ages were determined using NEFSC survey spring and fall age-length keys.

Input data and analyses

The Virtual Population Analysis (VPA) was calibrated using the NOAA Fisheries Toolbox (NFT) ADAPT VPA version 2.3. Total fishery catch at age and mean weight at age matrices used as input to the VPA are presented in Tables J5-J6. Abundance indices at age for use in VPA calibration were available from several research surveys: NEFSC spring trawl ages 1-7+, NEFSC fall trawl ages 1-5 (advanced to tune January 1 abundance of ages 2-6), NEFSC winter trawl ages 1-5, Massachusetts spring trawl ages 1-7+, Rhode Island fall seine age 0 (advanced to tune age-1), Rhode Island spring trawl ages 1-7+, Connecticut spring trawl ages 1-7+, New York trawl age 0 (advanced to tune age-1) and age-1, Massachusetts summer seine index of age-0 (advanced to tune age-1), Delaware juvenile trawl age-0 (advanced to tune age-1), New Jersey Ocean trawl ages 1-7+, and New Jersey River trawl ages 1-7+. Survey indices were selected for inclusion in VPA calibration based on consideration of the partial variance in an initial VPA trial run including all indices, residual error patterns from the various trail runs, and on the significance of the correlation among indices and with VPA abundance estimates from the initial trial run. A conditional non-parametric bootstrap procedure (Efron 1982) was used to evaluate the precision of fishing mortality and SSB. A retrospective analysis was performed for terminal year fishing mortality (F), SSB and age-1 recruitment.

3.0 Assessment results

Research surveys

Mean weight per tow and number per tow indices for the NEFSC spring, fall, and winter time series are presented in Table J7. Indices declined from the beginning of the time series in the

1960s to a low point in the early to mid-1970s, then increased to a peak by the early 1980s. Following several years of high indices, abundance once again declined to below the low levels of the 1970s. NEFSC survey indices reached near- or record low levels for the time series in the late 1980s-1990s. Indices from the three survey series generally increased during 1993-1998/1999, but have since declined again (Figure J2).

Several state survey indices were available to characterize the abundance of SNE/MA winter flounder. The Massachusetts Division of Marine Fisheries (MADMF) spring and fall survey, Rhode Island Division of Fish and Wildlife (RIDFW) spring and fall survey, Connecticut Department of Environmental Protection (CTDEP) Long Island Sound Trawl Survey, and the New Jersey Division of Fish, Game and Wildlife (NJDFW) ocean survey trends are summarized in Tables J8-J9 and Figure J2. The numerous state recruitment surveys (MADMF, RIDFW, CTDEP, New York Department of Environmental Conservation (NYDEC), NJDFW, Delaware Division of Fish and Wildlife (DEDFW)) are summarized in Table J10 and Figure J3.

Virtual Population Analysis

During 1981-1993, fishing mortality (fully recruited F, ages 4-5) varied between 0.4 (1982) and 1.4 (1988), and was as high as 1.3 as recently as 1997. Fishing mortality has been in the range of 0.9-0.4 during 2001-2004 (Table J11, Figure J4). SSB declined from 14,792 mt in 1983 to a record low of 2,651 mt in 1994. SSB increased to 5,012 mt in 2001, before declining again to 3,938 mt in 2004 (Table J11, Figure J5). Recruitment declined continuously from 62.9 million age-1 fish in 1981 to 7.8 million in 1992. Recruitment then averaged 14.7 million fish during 1993-2001, below the VPA time series average of 21.9 million. The 2002 year class is estimated to be the smallest on record, at only 4.4 million fish. The 2003 year class of 21.6 million is estimated to be of about average size, and the largest to recruit to the stock since 1989 (Table J11, Figure J5).

VPA diagnostics

The same VPA calibration configuration as used in the SAW 36 assessment (NEFSC 2003) was retained for this update. Changes in the software version of the VPA (from the previous FACT v1.5 to the current NFT v2.3) and updates to the 2001 catch at age had very little effect on the estimates. (Table J12). The precision of the 2005 stock size at age, F at age in 2004, and SSB in 2004 from VPA was evaluated using bootstrap techniques (Efron 1982). Five hundred bootstrap iterations were realized in which errors (differences between predicted and observed survey values) were resampled. Bootstrap estimates of stock size at age indicate low bias (<8%) for ages 1-6, but relatively high bias for age 7+ (20%). Bootstrap standard errors provide stock size CVs ranging from 20% at age 3 and age 5 to 107% at age 7+. Bootstrapped estimates of SSB indicate a CV of 11%, with low bias (bootstrap mean estimate of SSB of 3,977 mt compared with VPA estimate of 3,938 mt). There is an 80% probability that spawning stock in 2004 was between 3,451 mt and 4,562 mt. The bootstrap estimates of standard error associated with fishing mortality rates at age indicate moderate precision. Coefficients of variation for F estimates ranged from 17% at age 4 to 33% at age 5. There is an 80% probability that fully recruited F for ages 4-5 in 2004 was between 0.32 and 0.49.

A retrospective analysis of the VPA was conducted back to a terminal catch year of 1995 (Figure J6). The SNE/MA winter flounder VPA exhibits a severe retrospective pattern of underestimation of F and overestimation of SSB during the late 1990s and into 2001. The most likely cause of this pattern is the underestimation of the total catch. The pattern has been less severe since the terminal year 2001. The retrospective pattern for SSB has been a tendency for overestimation since 1991. The overestimation of SSB was most severe for the 1997 and 1998 terminal years. The retrospective estimation of age-1 recruits indicated a tendency for overestimation during 1993-2001.

4.0 Biological reference points

The Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish (NEFSC 2002) re-estimated the biological reference points for SNE/MA winter flounder in 2002 using yield and SSB per recruit analyses (Thompson and Bell 1934) and Beverton-Holt stock-recruitment models (Beverton and Holt 1957, Brodziak et al. 2001, Mace and Doonan 1988) based on the SARC 28 assessment (NEFSC 1999). The yield and SSB per recruit analyses indicated that $F_{40\%}$ = 0.21 and $F_{0.1}$ = 0.25. The stock-recruitment model indicated that MSY = 10,600 mt, F_{MSY} = 0.32, and B_{MSY} = 30,100 mt.

Amendment 13 projected target F, SSB and landings were forecast to be $F_{2004} = F_{MSY}$ = 0.32, SSB_{2004} = 6,855 mt, and catch in 2004 = 2,804 mt. Relative to these reference points and projected targets, F_{2004} = 0.38 is estimated to be 19% above F_{MSY} = 0.32 (Figure J7). SSB_{2004} = 3,938 mt is about 13% of B_{MSY} and 57% of the Amendment 13 projected SSB_{2004} (Figure J7). Total fishery catch in 2004 was 1,699 mt, 61% of the Amendment 13 projection. (Figure J7).

5.0 GARM comments

The Panel noted the large decrease in the 2004 landings and an estimate of fishing mortality for 2004 that is higher than projected in 2003. It was noted that the projections of SSB were not realized because the starting biomass was lower due to the retrospective pattern in the VPA and poor recruitment. The Panel suggested plotting the start point (2002) on the projection plots to show difference in the starting conditions in the previous projection and the updated assessment.

Projection Advice - Projections of future stock status should consider mean weights and partial recruitment patterns estimated for the most recent 3 years in the assessment (2002-2004) to reflect current conditions in the stock and fishery. Future levels of recruitment should be estimated from the stock-recruitment relationship provided in NEFSC (2002).

6.0 Sources of uncertainty

1) Landings data for 1994 and later years are derived by proration using Vessel Trip Reports (VTRs) and are considered provisional.

2) Commercial fishery discard estimates are based on rates provided by fishermen in the VTRs, due to inadequate Fishery Observer sampling for most of the assessment time series. Sampling levels have increased significantly since 2001 and observer data may now be adequate to provide reliable estimates of discard rates.
3) The SNE/MA winter flounder VPA exhibits a severe retrospective pattern of underestimation of F and overestimation of SSB during the late 1990s and into 2001.

7.0 Summary

The Southern New England/Mid-Atlantic (SNE/MA) winter flounder stock complex is overfished and overfishing is occurring. Fishing mortality (F) in 2004 was estimated to be 0.38 (exploitation rate = 29%), about 19% above F_{MSY} = 0.32. There is an 80% chance that the F in 2004 was between 0.32 and 0.49. The SNE/MA winter flounder VPA exhibits a severe retrospective pattern of underestimation of F and overestimation of SSB during the late 1990s and into 2001. SSB in 2004 was estimated to be 3,938 mt, about 13% of B_{MSY} = 30,100 mt. There is an 80% chance that the SSB in 2004 was between 3,451 mt and 4,562 mt. The retrospective pattern for SSB has been a tendency for overestimation since 1991. The 2002 year class is estimated to be the smallest on record, at only 4.4 million fish. The 2003 year class of 21.6 million is estimated to be of about average size, and the largest to recruit to the stock since 1989. The retrospective estimation of recruitment indicated a tendency for overestimation during 1993-2001.

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Table J1. Winter flounder commercial landings (metric tons) for Southern New England/Mid-Atlantic stock complex area (U.S. statistical reporting areas 521, 526, divisions 53, 61-63) as reported by NEFSC weighout, dealer, state bulletin and general canvas data.

Year	Metric tons
1964	7,474
1965	8,678
1966	11,977
1967	9,478
1968	7,070
1969	8,107
1970	8,603
1971	7,367
1972	5,190
1973	5,573
1974	4,259
1975	3,982
1976	3,265
1977	4,413
1978	6,327
1979	6,543
1980	10,627
1981	11,176
1982	9,438
1983	8,659
1984	8,882
1985	7,052
1986	4,929
1987	5,172
1988	4,312
1989	3,670
1990	4,232
1991	4,823
1992	3,816
1993	3,010
1994	2,159
1995	2,634
1996	2,781
1997	3,441
1998	3,208
1999	3,444

Table J1 continued.

Year	Metric tons
2000	3,800
2001	4,687
2002	3,136
2003	2,427
2004	1,458

Table J2. Estimated number (000's) and weight (mt) of winter flounder caught, landed, and discarded in the recreational fishery, Southern New England/Mid-Atlantic stock complex.

Year	Catch A+B1+B2 (N; '000)	Landed A+B1 (N; '000)	Released B2 (N; '000)	15% Release Mortality (N; '000)	Landed A+B1 (mt)
1981	11006	8089	2916	437	3050
1982	10665	8392	2273	341	2457
1983	11010	8365	2645	397	2524
1984	17723	12756	4967	745	5772
1985	18056	13297	4759	714	5198
1986	9368	6995	2374	356	2940
1987	9213	6900	2313	347	3141
1988	10134	7358	2775	416	3423
1989	5919	3682	2236	335	1802
1990	3827	2486	1340	201	1063
1991	4325	2795	1530	230	1214
1992	1360	806	555	83	393
1993	2211	1180	1031	155	543
1994	1829	1209	620	93	598
1995	1850	1390	461	69	661
1996	2679	1554	1125	169	689
1997	1901	1207	694	104	621
1998	1008	584	425	64	290
1998	1071	658	412	62	320
2000	2043	1346	697	105	831
2001	1421	892	529	79	546
2002	706	408	298	45	224
2003	740	557	182	27	316
2004	448	350	98	15	206

Table J3. The total number of commercial lengths sampled by market category for Southern New England/Mid-Atlantic winter flounder. The landings (mt) and metric tons per 100 lengths are also shown.

	Number of Lengths						
Year	Uclass	Small	Medium	Large	Total	Landings (mt)	mt/100 lengths
1981	1,904	1,542	-	784	4,230	11,176	264
1982	513	2,425	657	2,201	5,796	9,438	163
1983	927	1,790	1,044	1,840	5,601	8,659	155
1984	551	1,171	637	1,338	3,697	8,882	240
1985	716	2,632	1,663	1,396	6,407	7,052	110
1986	799	2,206	1,024	1,091	5,120	4,929	96
1987	99	2,524	670	1,978	5,271	5,172	98
1988	269	1,731	958	1,250	4,208	4,312	102
1989	106	1,224	1,220	975	3,525	3,670	104
1990	102	1,473	1,180	1,333	4,088	4,232	104
1991	-	1,220	921	917	3,058	4,823	158
1992	402	1,343	1,259	1,159	4,163	3,816	92
1993	62	1,249	401	642	2,354	3,010	128
1994	142	1,092	816	543	2,593	2,159	83
1995	79	1,182	290	325	1,876	2,634	140
1996	480	854	521	109	1,964	2,781	142
1997	201	1,327	1,176	1,301	4,005	3,441	86
1998	942	899	1,325	415	3,581	3,208	90
1999	2,381	798	607	821	4,607	3,444	75
2000	1,653	942	2,893	965	6,453	3,800	59
2001	658	897	2,203	2,284	6,042	4,687	78
2002	688	2,532	1,099	1,581	5,900	3,136	53
2003	901	1,236	881	1,660	4,678	2,427	52
2004	412	2,311	563	1,889	5,175	1,458	28

Table J4. Total winter flounder recreational and commercial catch for the Southern New England/Mid-Atlantic stock complex in weight (mt) and numbers (000s).

Year	Commercial Landings		Commercial Discards		Recreational Landings		Recreational Discards		Total Catch		% Discards/Total	
	mt	000s	Mt	000s	mt	000s	mt	000s	mt	000s	mt	000s
1981	11,176	20,705	1,343	5,123	3,050	8,089	88	437	15,657	34,354	9.1	16.2
1982	9,438	19,016	1,149	4,271	2,457	8,392	66	341	13,110	32,020	9.3	14.4
1983	8,659	16,312	1,311	5,251	2,524	8,365	125	399	12,619	30,327	11.4	18.6
1984	8,882	17,116	986	3,936	5,772	12,756	148	745	15,788	34,553	7.2	13.5
1985	7,052	14,211	1,534	4,531	5,198	13,297	230	714	14,014	32,753	12.6	16.0
1986	4,929	9,460	1,273	4,902	2,940	6,994	66	356	9,208	21,712	14.5	24.2
1987	5,172	10,524	950	3,545	3,141	6,899	61	347	9,324	21,315	10.8	18.3
1988	4,312	8,377	904	3,728	3,423	7,359	69	416	8,708	19,880	11.2	20.8
1989	3,670	7,888	1,404	5,761	1,802	3,684	49	335	6,925	17,668	21.0	34.5
1990	4,232	7,202	673	2,567	1,063	2,485	31	201	5,999	12,455	11.7	22.2
1991	4,823	9,063	784	2,701	1,214	2,794	51	230	6,872	14,788	12.2	19.8
1992	3,816	6,759	511	1,811	393	802	15	83	4,735	9,455	11.1	20.0
1993	3,010	5,336	457	1,580	543	1,180	31	155	4,041	8,251	12.1	21.0
1994	2,159	1,948	304	344	598	1,210	34	93	3,095	3,595	10.9	12.2
1995	2,634	2,321	121	107	661	1,390	23	69	3,439	3,887	4.2	4.5
1996	2,781	2,372	173	149	689	1,555	64	168	3,707	4,244	6.4	7.5
1997	3,441	5,834	267	1,200	618	1,204	26	85	4,352	8,323	6.7	15.4

Table J4 continued.

Year	Commercial Landings		Commercial Discards		Recreational Landings		Recreational Discards		Total Catch		% Discards/Total	
	mt	000s	Mt	000s	mt	000s	mt	000s	mt	000s	mt	000s
1998	3,208	6,224	456	1,503	290	584	13	64	3,967	8,375	11.8	18.7
1999	3,444	7,356	329	1,074	320	658	14	62	4,107	9,150	8.4	12.4
2000	3,800	6,590	148	534	831	1,346	30	105	4,809	8,575	3.7	7.5
2001	4,687	8,087	86	268	546	892	18	79	5,337	9,326	1.9	3.7
2002	3,136	4,834	109	319	224	408	12	45	3,481	5,606	3.5	6.5
2003	2,427	3,697	266	648	316	557	1	27	3,010	4,929	8.9	13.7
2004	1,458	2,190	34	91	206	350	1	15	1,699	2,646	2.1	4.0

Table J5. Total fishery catch at age used as input to Virtual Population Analysis (VPA) for the Southern New England/Mid-Atlantic winter flounder stock complex.

Year	Age						
	1	2	3	4	5	6	7+
1981	1362	14089	14352	3593	665	182	111
1982	587	14257	12421	3730	610	213	202
1983	617	7241	13308	6126	1794	696	545
1984	501	11575	14093	4928	1776	876	804
1985	277	7366	12836	6054	2953	1843	1424
1986	215	6327	9102	4216	1053	442	357
1987	73	5268	8999	3091	2703	755	426
1988	84	3941	9402	3964	1207	979	303
1989	463	5246	7176	3503	849	222	209
1990	36	2109	6275	2931	767	196	141
1991	53	3027	7140	3344	858	251	115
1992	25	1503	4457	2581	674	162	53
1993	274	2062	3329	1728	585	157	116
1994	61	1097	1152	713	311	162	99
1995	24	195	1862	889	415	291	211
1996	32	886	1450	1107	343	258	168
1997	385	2135	3300	1811	540	106	46
1998	50	2132	3663	1797	511	90	131
1999	66	2746	4008	1744	458	97	32
2000	69	1442	3500	2455	862	180	67
2001	21	2093	3765	2284	841	220	102
2002	20	570	1992	1742	886	282	115
2003	112	810	2020	1222	440	216	109
2004	16	296	898	797	309	187	142

Table J6. Total fishery mean weights at age used as input to Virtual Population Analysis (VPA) for the Southern New England/Mid-Atlantic winter flounder stock complex.

Year	Age						
	1	2	3	4	5	6	7+
1981	0.130	0.276	0.478	0.802	1.065	1.243	1.202
1982	0.090	0.261	0.438	0.694	1.048	1.253	1.837
1983	0.195	0.237	0.353	0.516	0.774	1.046	1.552
1984	0.146	0.258	0.366	0.542	0.693	0.913	1.282
1985	0.111	0.282	0.364	0.482	0.522	0.467	0.613
1986	0.129	0.292	0.398	0.480	0.685	0.879	0.961
1987	0.046	0.287	0.384	0.551	0.475	0.564	0.853
1988	0.039	0.279	0.351	0.508	0.634	0.517	0.827
1989	0.118	0.258	0.378	0.508	0.660	0.716	1.073
1990	0.082	0.295	0.394	0.525	0.672	0.808	0.990
1991	0.093	0.317	0.420	0.534	0.603	0.823	1.168
1992	0.079	0.287	0.427	0.599	0.802	0.945	1.395
1993	0.169	0.334	0.460	0.592	0.689	0.878	1.167
1994	0.156	0.347	0.448	0.597	0.741	0.692	0.818
1995	0.167	0.323	0.449	0.578	0.714	0.763	0.780
1996	0.193	0.407	0.507	0.569	0.705	0.826	0.853
1997	0.093	0.369	0.510	0.659	0.806	1.071	1.511
1998	0.202	0.332	0.438	0.580	0.665	0.892	1.241
1999	0.079	0.314	0.435	0.562	0.782	0.951	1.317
2000	0.100	0.396	0.484	0.613	0.738	0.915	1.144
2001	0.102	0.423	0.507	0.638	0.798	1.053	1.261
2002	0.127	0.356	0.493	0.636	0.799	1.036	1.341
2003	0.168	0.408	0.520	0.675	0.895	1.093	1.227
2004	0.106	0.390	0.540	0.609	0.788	0.953	1.267

Table J7. Winter flounder NEFSC survey index stratified mean number and mean weight (kg) per tow for the Southern New England/Mid-Atlantic stock complex. Spring and fall strata set (offshore 1-12, 25, 69-76 ; inshore 1-29, 45-56); winter strata set (offshore 1-2, 5-6,9-10,69,73).

	Spring				Fall			
Year	Number	N(CV)	Weight	W(CV)	Number	N(CV)	Weight	W(CV)
1963					8.554	33.2	3.284	41.4
1964					13.673	22.1	4.894	19.4
1965					15.537	32.5	4.435	28.7
1966					9.843	31.5	3.275	27.3
1967					9.109	20.6	2.745	18.7
1968	2.444	26.7	0.734	37.2	8.105	21.0	2.190	18.7
1969	5.640	34.3	3.414	53.7	6.841	34.9	1.939	29.7
1970	2.729	30.9	1.326	35.6	5.110	36.1	2.375	47.8
1971	2.035	32.9	0.756	36.2	3.861	17.5	1.231	19.1
1972	1.865	28.1	0.656	32.1	7.687	39.4	3.053	44.6
1973	7.458	19.9	2.013	20.6	2.691	26.9	0.775	25.8
1974	3.362	21.9	1.043	19.3	2.032	31.1	0.822	29.4
1975	1.135	22.6	0.354	20.8	2.196	20.3	0.688	22.1
1976	3.085	16.3	0.804	17.2	2.376	32.2	1.251	42.9
1977	4.209	17.2	1.189	18.6	4.722	22.5	1.735	25.2
1978	6.695	11.1	1.758	13.3	3.743	17.6	1.430	22.6
1979	2.966	16.8	1.069	25.0	10.058	18.4	2.606	15.4
1980	15.250	17.5	3.551	13.6	9.964	31.0	3.216	29.5
1981	18.234	20.9	4.762	16.9	10.206	20.3	3.110	19.9
1982	6.986	20.1	1.918	15.8	4.927	22.8	1.683	25.9
1983	6.262	18.4	2.469	28.0	8.757	37.6	2.690	31.7
1984	5.524	19.0	2.072	28.4	2.681	21.1	0.887	21.0
1985	5.360	17.4	1.983	16.5	2.727	21.5	0.991	21.5
1986	2.266	23.9	0.766	23.4	1.538	21.9	0.487	19.1
1987	1.763	21.3	0.568	17.9	1.167	28.9	0.419	37.8
1988	2.126	19.6	0.730	19.3	1.246	22.4	0.530	27.5
1989	2.485	33.5	0.582	29.6	1.435	40.7	0.341	30.4
1990	1.992	36.8	0.472	33.1	1.979	29.6	0.546	25.8
1991	2.473	15.6	0.692	14.7	1.950	23.6	0.708	25.6

Table J7 continued.

Year	Spring Number	N(CV)	Weight	W(CV)	Fall Number	N(CV)	Weight	W(CV)	Winter Number	N(CV)	Weight	W(CV)
1992	1.579	23.4	0.435	22.1	2.963	32.4	0.829	31.8	3.680	27.3	0.928	26.0
1993	0.961	19.1	0.219	14.8	1.382	25.0	0.392	25.9	2.590	29.4	0.456	21.5
1994	1.510	26.4	0.329	21.9	4.134	24.8	1.482	27.3	3.797	30.8	1.183	35.5
1995	2.097	23.4	0.592	19.1	2.253	20.7	0.626	17.3	2.221	26.1	0.697	29.1
1996	1.517	14.3	0.428	15.2	3.186	39.8	1.063	45.3	3.778	28.4	0.734	25.2
1997	1.436	22.1	0.399	20.0	7.893	32.6	2.583	26.7	3.906	19.7	1.043	21.6
1998	2.774	20.6	0.845	22.1	6.597	13.6	2.232	9.9	7.169	21.6	1.830	24.1
1999	4.171	16.2	1.245	16.4	3.596	17.0	1.549	16.5	10.328	31.8	3.100	32.3
2000	3.172	26.6	1.123	31.9	6.168	25.5	2.143	26.2	5.571	32.9	1.525	29.5
2001	1.568	14.3	0.581	13.3	4.877	28.1	2.030	28.5	3.096	31.6	0.873	29.0
2002	2.043	15.7	0.782	16.3	8.858	18.9	3.637	19.8	2.901	27.7	1.188	38.3
2003	0.767	11.8	0.267	11.1	3.209	24.2	1.568	27.5	2.199	42.1	0.782	42.0
2004	1.243	27.1	0.442	30.6	3.357	27.6	0.882	27.0	4.336	35.2	0.881	44.4
2005	0.928	28.8	0.306	30.0					4.045	30.4	1.143	26.0

NOTE: 1968-1972 spring index does not include inshore strata ; 1963-1971 fall index does not include inshore strata. All indices calculated with trawl door conversion factors where appropriate. Winter trawl survey began in 1992.

Table J8. SNE/MA winter flounder mean weight per tow for annual state surveys.

Year	MADMF Spring	RIDFW Spring	RIDFW Fall	CTDEP	NJDFW Ocean (April)
1978	18.12				
1979	18.17	7.72	7.24		
1980	15.18	13.57	4.88		
1981	15.77	12.13	2.12		
1982	14.82	5.23	1.30		
1983	19.67	9.52	2.28		
1984	14.68	8.43	3.38	15.68	
1985	11.60	5.93	3.01	13.91	
1986	10.36	6.47	3.12	10.33	
1987	9.57	8.14	2.25	11.76	
1988	6.64	6.02	1.45	18.28	
1989	8.46	3.09	0.79	22.62	5.86
1990	5.38	3.07	0.71	29.01	4.78
1991	2.91	7.38	0.18	24.59	5.32
1992	7.99	0.95	0.42	12.29	2.48
1993	8.16	0.22	0.50	10.26	3.87
1994	12.59	1.67	0.33	12.20	3.25
1995	7.98	6.04	0.89	7.72	8.06
1996	9.78	4.45	0.91	20.41	3.73
1997	10.02	4.57	0.64	15.53	6.52
1998	7.99	5.00	0.32	14.66	4.17
1999	4.44	3.66	0.57	10.29	6.83
2000	6.52	4.52	0.56	12.63	5.24
2001	3.73	3.56	0.28	14.02	6.36
2002	1.91	3.29	0.28	10.83	8.80
2003	5.50	1.56	0.68	8.87	5.81
2004	2.87	1.85	0.53	6.11	5.45
2005	3.56				

Table J9. SNE/MA winter flounder mean number per tow for annual state surveys.

Year	MADMF Spring	RIDFW Spring	RIDFW Fall	CTDEP	NYDEC Peconic Bay	NJDFW Ocean (April)
1978	51.62					
1979	53.78	83.76				
1980	38.94	63.10				
1981	46.12	87.97	25.21			
1982	40.23	31.39	18.55			
1983	56.84	58.97	17.29			
1984	37.36	41.64	19.02	111.96		
1985	38.38	34.97	21.44	83.58	4.87	
1986	36.27	41.02	31.28	63.65		
1987	37.85	56.21	20.90	79.92	6.07	
1988	27.91	34.44	10.64	137.59	4.31	
1989	24.41	20.88	7.17	148.19	17.02	25.60
1990	25.86	20.33	8.83	223.09	12.22	17.47
1991	10.66	41.95	1.77	150.20	21.50	22.17
1992	28.83	4.40	10.60	61.39	79.11	9.88
1993	46.96	2.92	6.65	63.60	31.20	20.13
1994	48.55	10.25	2.21	84.44	22.09	14.16
1995	37.84	32.19	7.00	50.12	8.15	30.04
1996	30.18	20.67	7.79	110.62	19.24	9.60
1997	39.31	22.28	5.48	71.31	10.99	36.24
1998	34.63	19.22	2.02	72.91	7.20	18.05
1999	25.11	13.45	2.80	41.35	10.96	17.84
2000	26.23	16.32	2.58	45.41	2.61	10.13
2001	16.00	12.49	2.10	54.50	7.99	13.83
2002	6.74	11.56	1.45	43.71	0.43	22.72
2003	19.38	5.56	5.21	27.84	1.40	12.55
2004	10.70	11.16	4.40	20.46	5.99	5.45
2005	25.85					

Table J10. State survey indices (stratified mean number per tow or haul) for young-of-year winter flounder in Southern New England/Mid-Atlantic stock complex.

Year	CTDEP	RIDFW Seine	DEDFW	MADMF Seine	NYDEC
1975				0.30	
1976				0.32	
1977				0.60	
1978				0.34	
1979				0.49	
1980				0.40	
1981				0.32	
1982				0.37	
1983				0.23	
1984				0.32	
1985				0.34	1.52
1986		29.00	0.17	0.32	
1987		11.60	0.09	0.27	2.65
1988	15.50	8.90	0.02	0.18	1.45
1989	1.90	18.90	0.29	0.42	11.15
1990	3.10	22.10	0.63	0.33	8.53
1991	5.80	12.00	0.03	0.27	14.60
1992	13.70	33.20	0.27	0.29	76.87
1993	6.00	5.50	0.04	0.07	16.99
1994	16.60	2.60	0.31	0.15	14.84
1995	12.50	5.30	0.10	0.16	4.04
1996	19.20	2.80	0.04	0.22	16.25
1997	7.47	4.40	0.10	0.39	4.42
1998	9.38	2.50	0.13	0.16	3.11
1999	8.70	14.60	0.07	0.19	7.49
2000	4.30	52.90	0.08	0.33	0.90
2001	1.30	12.90	0.06	0.21	2.31
2002	3.06	18.50	0.01	0.10	0.07
2003	8.10	31.20	0.28	0.18	0.86
2004	10.96	18.90	0.20	0.10	0.50
2005				0.08	

Table J11. Virtual Population Analysis estimation results for SNE/MA winter flounder, 1981-2004.

JAN-1 Population Numbers

AGE	1981	1982	1983	1984	1985
1	62859.	52020.	56503.	35617.	34615.
2	52566.	50232.	42060.	45703.	28708.
3	27768.	30289.	28226.	27884.	26945.
4	7146.	9748.	13560.	11068.	10077.
5	1468.	2600.	4606.	5559.	4603.
6	363.	600.	1577.	2148.	2944.
7	221.	569.	1235.	1971.	2275.
Total	152391.	146059.	147766.	129950.	110167.

AGE	1986	1987	1988	1989	1990
1	32795.	25973.	26725.	23109.	17359.
2	28090.	26656.	21199.	21805.	18501.
3	16839.	17273.	17057.	13790.	13106.
4	10446.	5551.	6000.	5458.	4797.
5	2773.	4738.	1748.	1325.	1299.
6	1096.	1317.	1433.	339.	317.
7	886.	743.	444.	319.	228.
Total	92924.	82251.	74605.	66145.	55607.

AGE	1991	1992	1993	1994	1995
1	11345.	7797.	8817.	8171.	12297.
2	14180.	9241.	6361.	6971.	6635.
3	13239.	8871.	6206.	3342.	4714.
4	5052.	4379.	3230.	2069.	1694.
5	1276.	1111.	1250.	1081.	1048.
6	369.	268.	299.	494.	604.
7	169.	88.	221.	302.	438.
Total	45631.	31753.	26383.	22429.	27430.

AGE	1996	1997	1998	1999	2000
1	15730.	18403.	17662.	14718.	10800.
2	10046.	12850.	14719.	14416.	11990.
3	5255.	7424.	8588.	10121.	9318.
4	2175.	2991.	3092.	3717.	4660.
5	582.	779.	810.	905.	1465.
6	483.	167.	149.	201.	327.
7	314.	72.	217.	66.	122.
Total	34587.	42685.	45238.	44144.	38682.

Table J11 continued

JAN-1 Population Numbers

AGE	2001	2002	2003	2004	2005
1	9853.	5681.	4417.	21590.	10624.
2	8780.	8048.	4633.	3515.	17662.
3	8512.	5294.	6073.	3061.	2610.
4	4462.	3562.	2532.	3144.	1693.
5	1594.	1586.	1340.	967.	1853.
6	420.	544.	497.	699.	512.
7	195.	222.	251.	490.	152.
Total	33814.	24938.	19744.	33467.	35106.

Table J11 continued

Fishing Mortality Calculated

AGE	1981	1982	1983	1984	1985
1	0.0242	0.0125	0.0121	0.0157	0.0089
2	0.3513	0.3764	0.2111	0.3284	0.3335
3	0.8468	0.6037	0.7362	0.8178	0.7476
4	0.8112	0.5497	0.6917	0.6774	1.0905
5	0.6945	0.3002	0.5629	0.4356	1.2346
6	0.7903	0.4917	0.6575	0.5899	1.1335
7	0.7903	0.4917	0.6575	0.5899	1.1335

AGE	1986	1987	1988	1989	1990
1	0.0073	0.0031	0.0035	0.0224	0.0023
2	0.2863	0.2464	0.2300	0.3091	0.1347
3	0.9098	0.8575	0.9395	0.8559	0.7532
4	0.5907	0.9557	1.3101	1.2356	1.1246
5	0.5442	0.9957	1.4411	1.2311	1.0574
6	0.5808	0.9739	1.3382	1.2347	1.1099
7	0.5808	0.9739	1.3382	1.2347	1.1099

AGE	1991	1992	1993	1994	1995
1	0.0052	0.0035	0.0349	0.0083	0.0022
2	0.2691	0.1982	0.4436	0.1911	0.0330
3	0.9064	0.8103	0.8986	0.4796	0.5736
4	1.3150	1.0539	0.8947	0.4795	0.8675
5	1.3600	1.1109	0.7285	0.3827	0.5753
6	1.3239	1.0652	0.8455	0.4452	0.7455
7	1.3239	1.0652	0.8455	0.4452	0.7455

AGE	1996	1997	1998	1999	2000
1	0.0023	0.0234	0.0031	0.0050	0.0071
2	0.1025	0.2029	0.1745	0.2364	0.1426
3	0.3637	0.6759	0.6374	0.5756	0.5364
4	0.8266	1.1063	1.0281	0.7309	0.8728
5	1.0522	1.4522	1.1947	0.8187	1.0502
6	0.8702	1.1686	1.0605	0.7475	0.9124
7	0.8702	1.1686	1.0605	0.7475	0.9124

AGE	2001	2002	2003	2004
1	0.0024	0.0039	0.0284	0.0008
2	0.3058	0.0815	0.2147	0.0977
3	0.6711	0.5376	0.4582	0.3919
4	0.8341	0.7775	0.7622	0.3287
5	0.8749	0.9603	0.4507	0.4354
6	0.8447	0.8304	0.6431	0.3820
7	0.8447	0.8304	0.6431	0.3820

Table J11 continued

Average Fishing Mortality For Ages 4-5

Year	Average F	N Weighted	Biomass Wtd	Catch Wtd
1981	0.7528	0.7913	0.7851	0.7929
1982	0.4249	0.4972	0.4753	0.5146
1983	0.6273	0.6591	0.6474	0.6625
1984	0.5565	0.5966	0.5789	0.6133
1985	1.1625	1.1356	1.1433	1.1377
1986	0.5675	0.5809	0.5783	0.5814
1987	0.9757	0.9741	0.9743	0.9744
1988	1.3756	1.3396	1.3468	1.3407
1989	1.2333	1.2347	1.2344	1.2347
1990	1.0910	1.1103	1.1070	1.1107
1991	1.3375	1.3240	1.3256	1.3242
1992	1.0824	1.0655	1.0681	1.0657
1993	0.8116	0.8483	0.8397	0.8527
1994	0.4311	0.4463	0.4410	0.4501
1995	0.7214	0.7558	0.7382	0.7745
1996	0.9394	0.8743	0.8836	0.8800
1997	1.2792	1.1778	1.1872	1.1857
1998	1.1114	1.0627	1.0684	1.0650
1999	0.7748	0.7481	0.7527	0.7491
2000	0.9615	0.9152	0.9227	0.9189
2001	0.8545	0.8448	0.8467	0.8451
2002	0.8689	0.8338	0.8431	0.8391
2003	0.6064	0.6544	0.6348	0.6797
2004	0.3820	0.3538	0.3591	0.3585

Table J11 continued

Spawning Stock Biomass

AGE	1981	1982	1983	1984	1985
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	4735.	4753.	3765.	3551.	3621.
4	3891.	4592.	5124.	3859.	3106.
5	1205.	2157.	2898.	2927.	1838.
6	342.	604.	1391.	1542.	1283.
7	218.	910.	1614.	2158.	1068.
Total	10392.	13015.	14792.	14037.	10916.

AGE	1986	1987	1988	1989	1990
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	2395.	2482.	2285.	1921.	1830.
4	3541.	1960.	1861.	1643.	1558.
5	1373.	1781.	744.	576.	590.
6	635.	647.	522.	171.	178.
7	728.	501.	270.	257.	174.
Total	8672.	7371.	5682.	4569.	4330.

AGE	1991	1992	1993	1994	1995
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	1980.	1413.	959.	598.	845.
4	1626.	1624.	1239.	899.	661.
5	525.	559.	667.	637.	586.
6	203.	157.	204.	300.	376.
7	146.	95.	209.	217.	283.
Total	4479.	3848.	3279.	2651.	2751.

AGE	1996	1997	1998	1999	2000
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	1007.	1505.	1548.	1746.	1661.
4	851.	1265.	1250.	1454.	1845.
5	289.	379.	406.	497.	735.
6	299.	110.	98.	132.	221.
7	217.	83.	210.	72.	111.
Total	2663.	3341.	3511.	3902.	4574.

Table J11 continued

Spawning Stock Biomass

AGE	2001	2002	2003	2004
1	0.	0.	0.	0.
2	0.	0.	0.	0.
3	1698.	1106.	1214.	676.
4	1915.	1580.	1145.	1512.
5	899.	898.	888.	621.
6	300.	403.	392.	575.
7	199.	242.	260.	553.
Total	5012.	4229.	3899.	3938.

Table J12. Comparative results for 2001/2002 from ADAPT/VPA runs incorporating data and software updates since SAW 36: SNE/MA winter flounder.

Run	SAW 36 FACT v1.5	SAW 36 NFT v2.0	SAW 36 NFT v2.3	SAW 36 NFT v2.3 Update 2001 CAA
Terminal Year	2001	2001	2001	2001
RSS	353.8	356.9	356.9	356.9
N_{t+1} age 1	5,665	5,658	5,658	5,665
N_{t+1} age 2	15,553	15,536	15,536	15,549
N_{t+1} age 3	6,671	6,661	6,661	6,604
N_{t+1} age 4	2,912	2,904	2,904	2,871
N_{t+1} age 5	2,179	2,610	2,610	2,557
N_{t+1} age 6	1,602	1,864	1,864	1,824
N_{t+1} age 7+	1,057	703	703	703
F age 1	0.00	0.00	0.00	0.00
F age 2	0.24	0.24	0.24	0.25
F age 3	0.76	0.76	0.76	0.78
F age 4	0.65	0.56	0.56	0.59
F age 5	0.37	0.32	0.32	0.35
F age 6	0.23	0.44	0.44	0.47
F age 7+	0.23	0.44	0.44	0.47
F (ages 4-5)	0.51	0.44	0.44	0.47
SSB (mt)	7,643	7,514	7,514	7,521

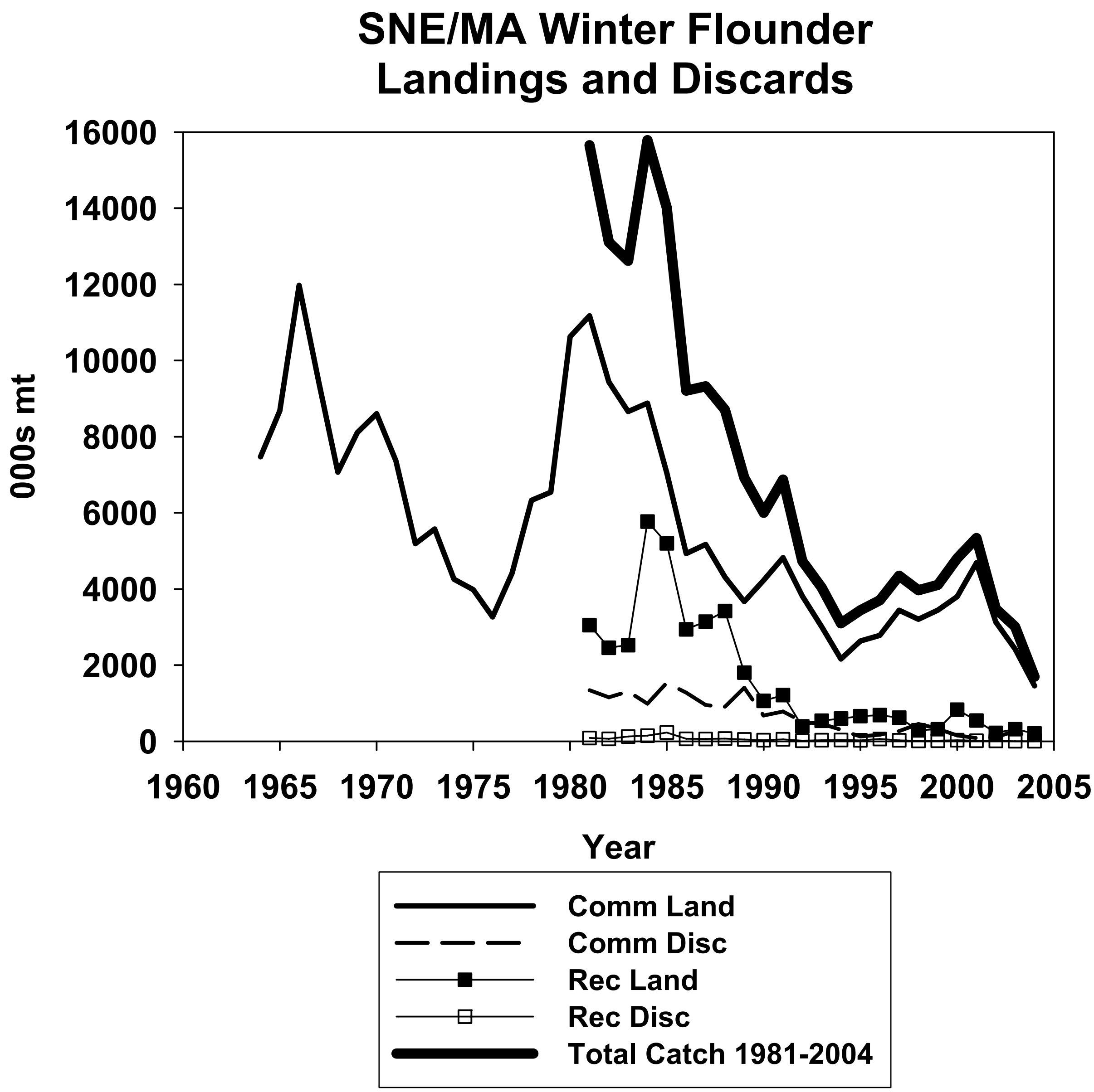

Figure J1. Commercial landings (1964-2004), commercial discards (1981-2004) recreational landings (1981-2004), recreational discards (1981-2004) and total fishery catch (1981-2004) for the SNE/MA winter flounder stock complex.

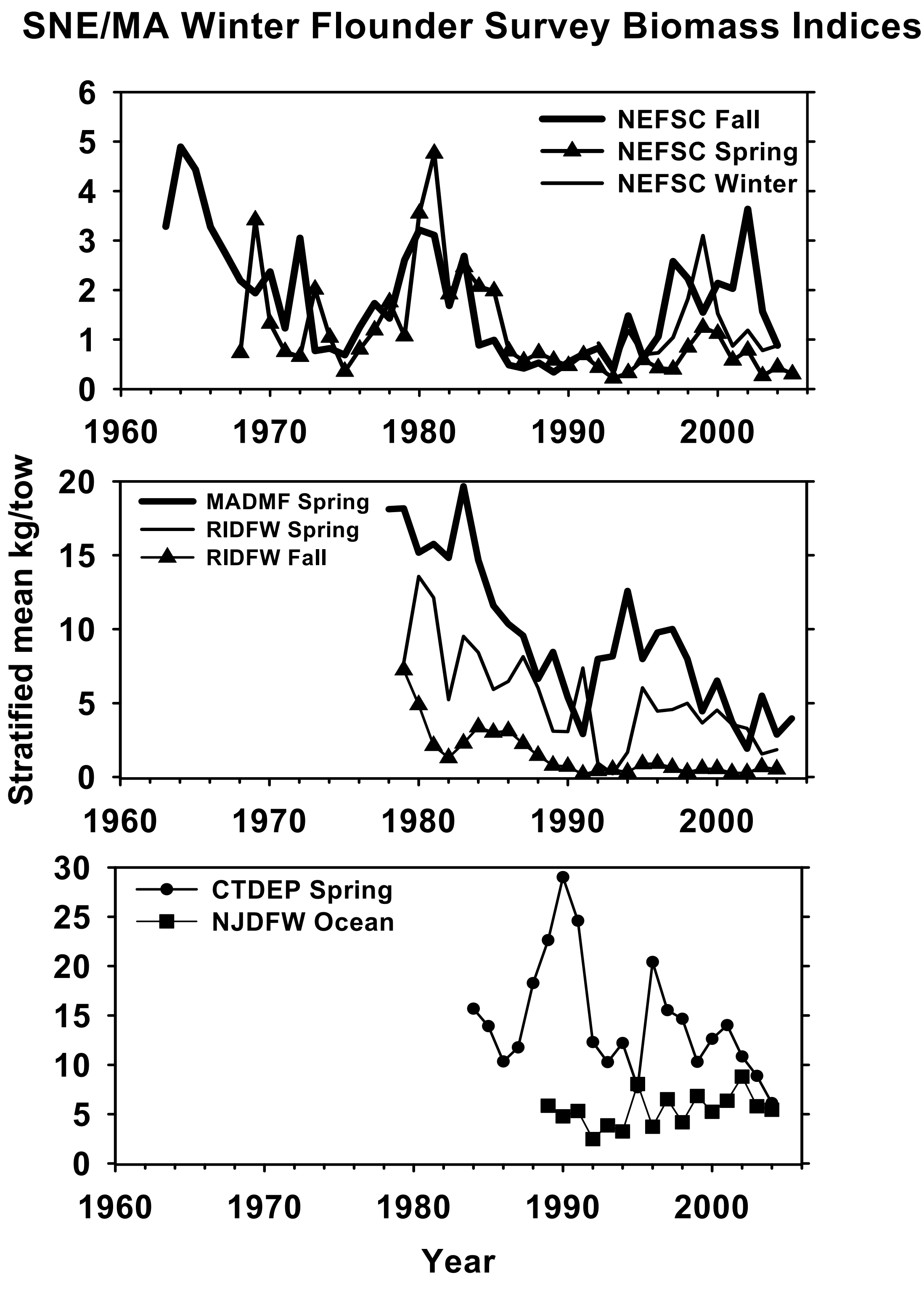

Figure J2. Trends in research survey biomass indices for SNE/MA winter flounder.

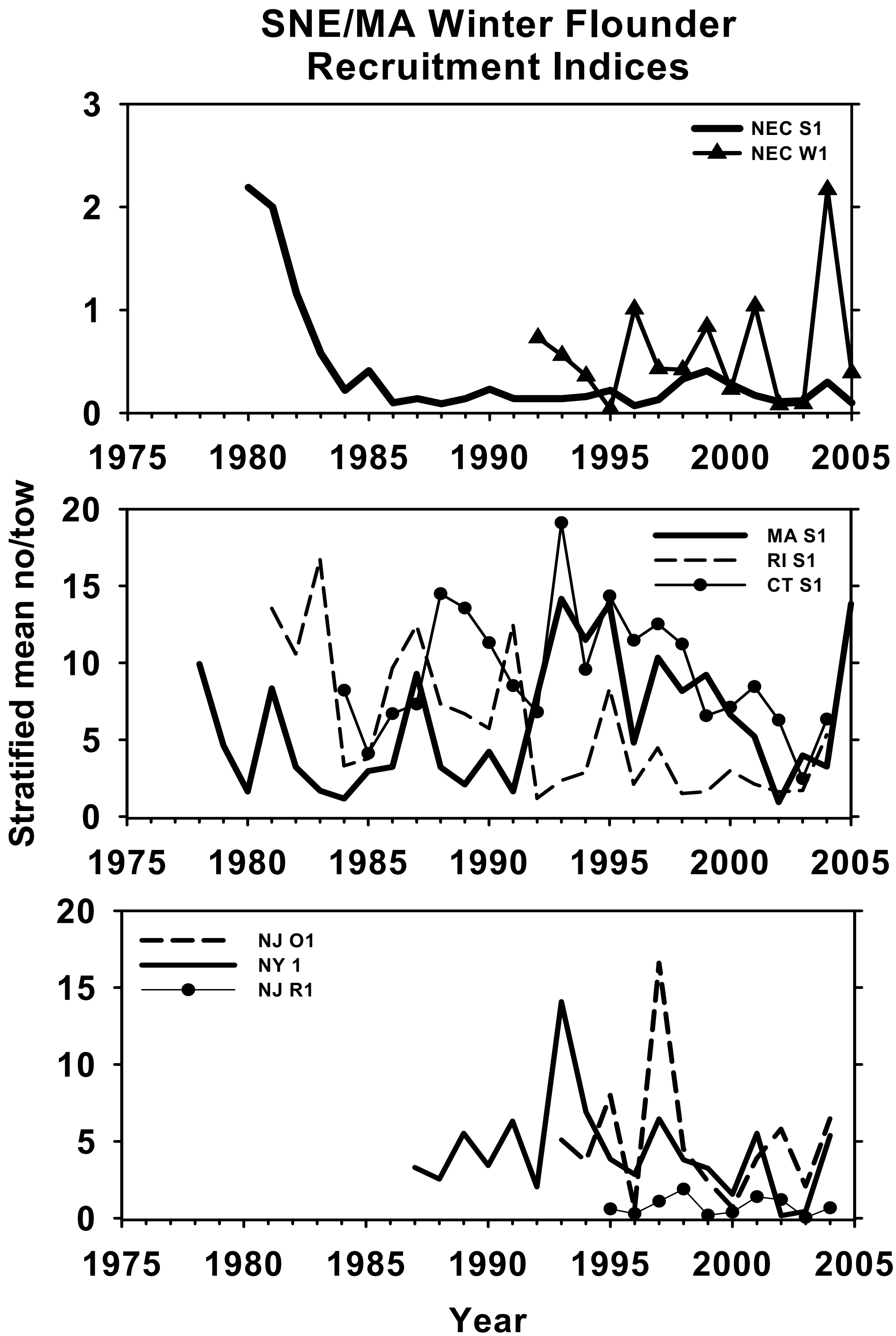

Figure J3. Trends in research survey recruitment indices for SNE/MA winter flounder. Includes spring survey age-1 indices and fall YOY indices.

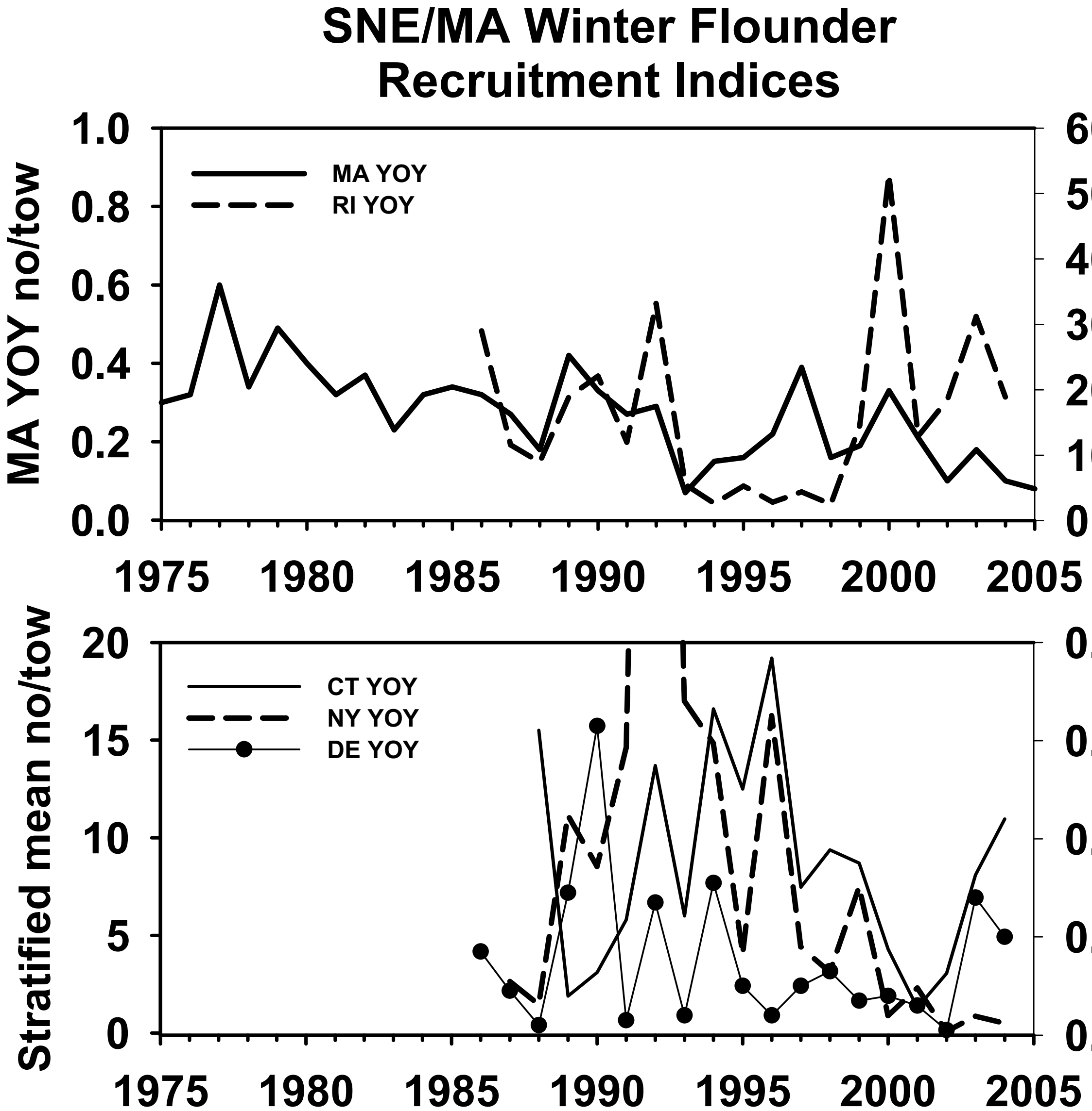

Figure J3 continued.

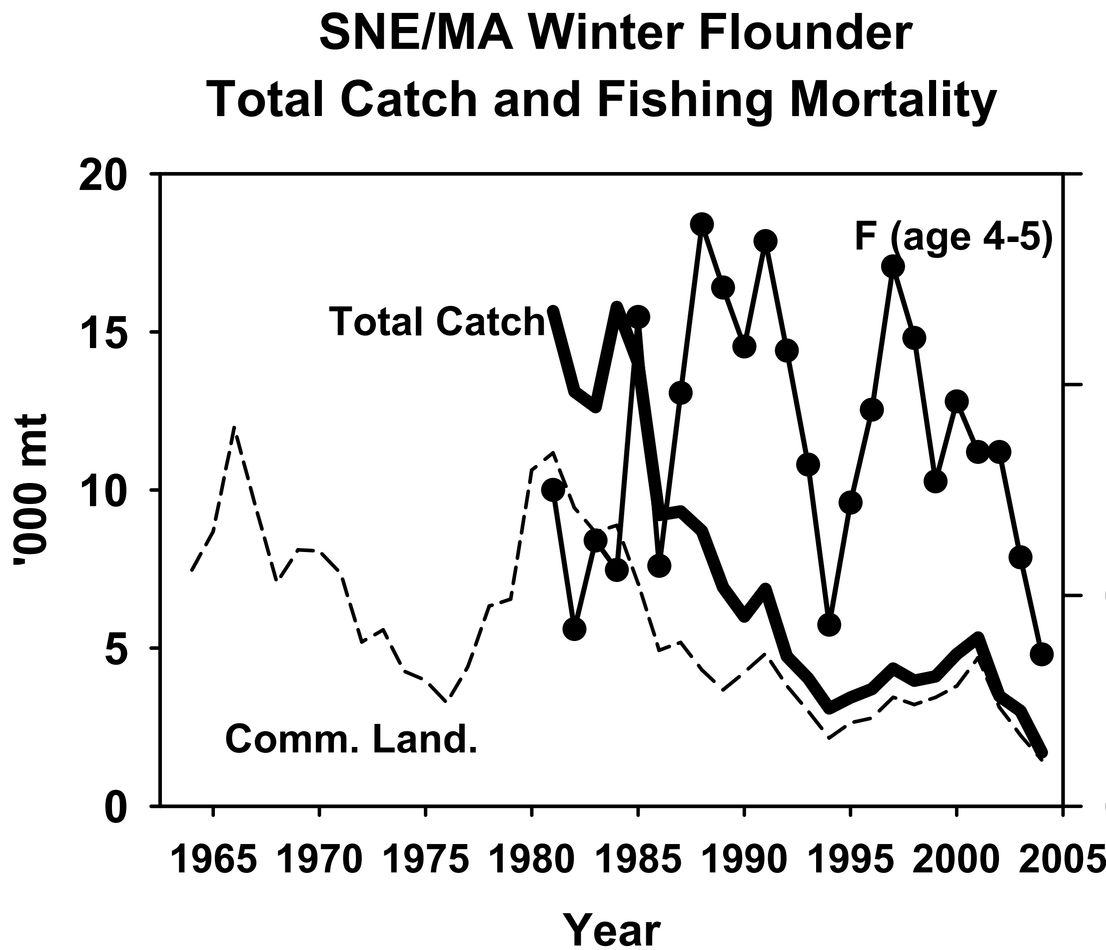

Figure J4. Total catch (landings and discards, '000 mt), commercial landings('000 mt), and fishing mortality rate (F, ages 4-5, unweighted) for SNE/MA winter flounder.

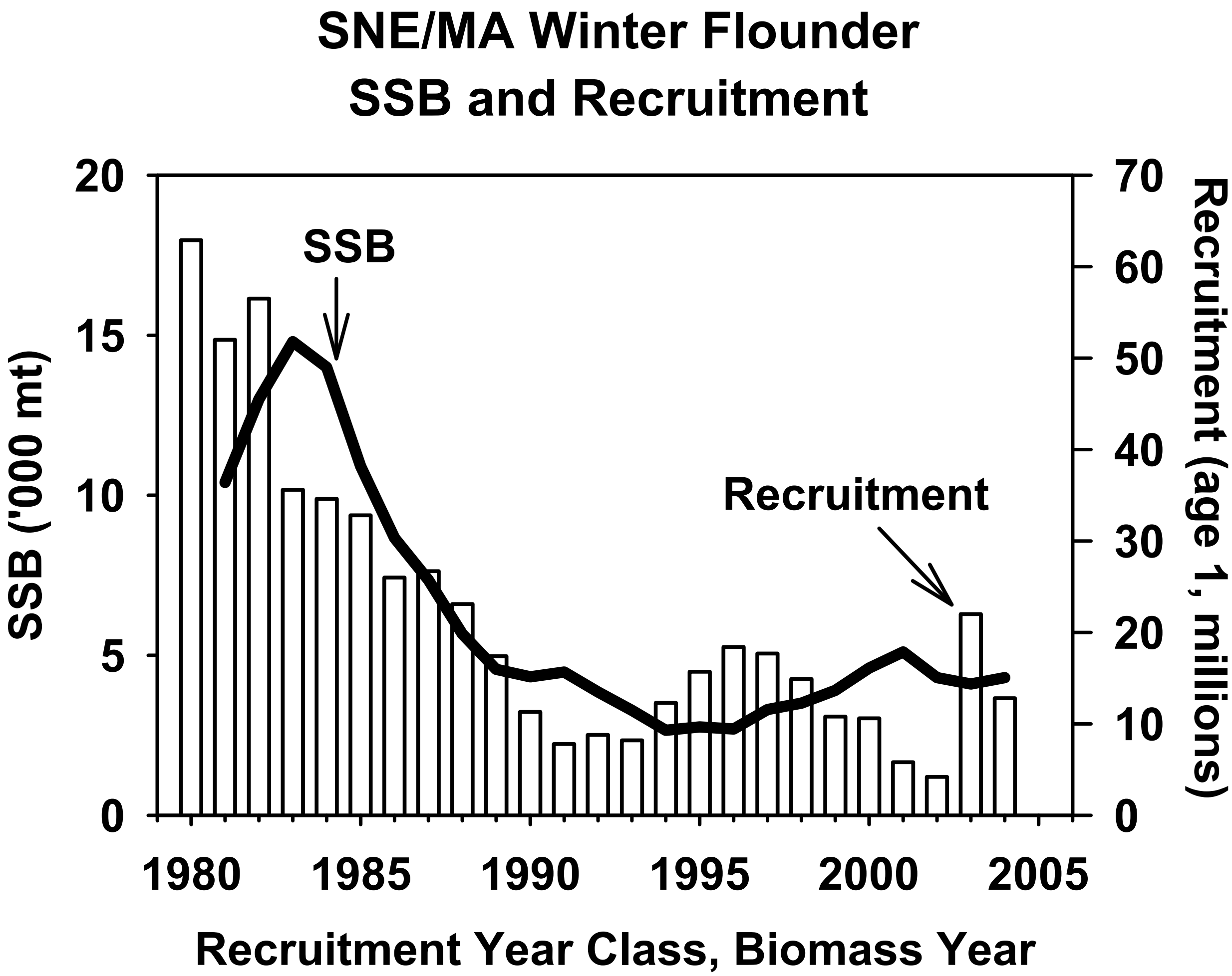

Figure J5. Spawning stock biomass (SSB, ages 3-7+, '000 mt) and recruitment (millions of fish at age-1) for SNE/MA winter flounder.

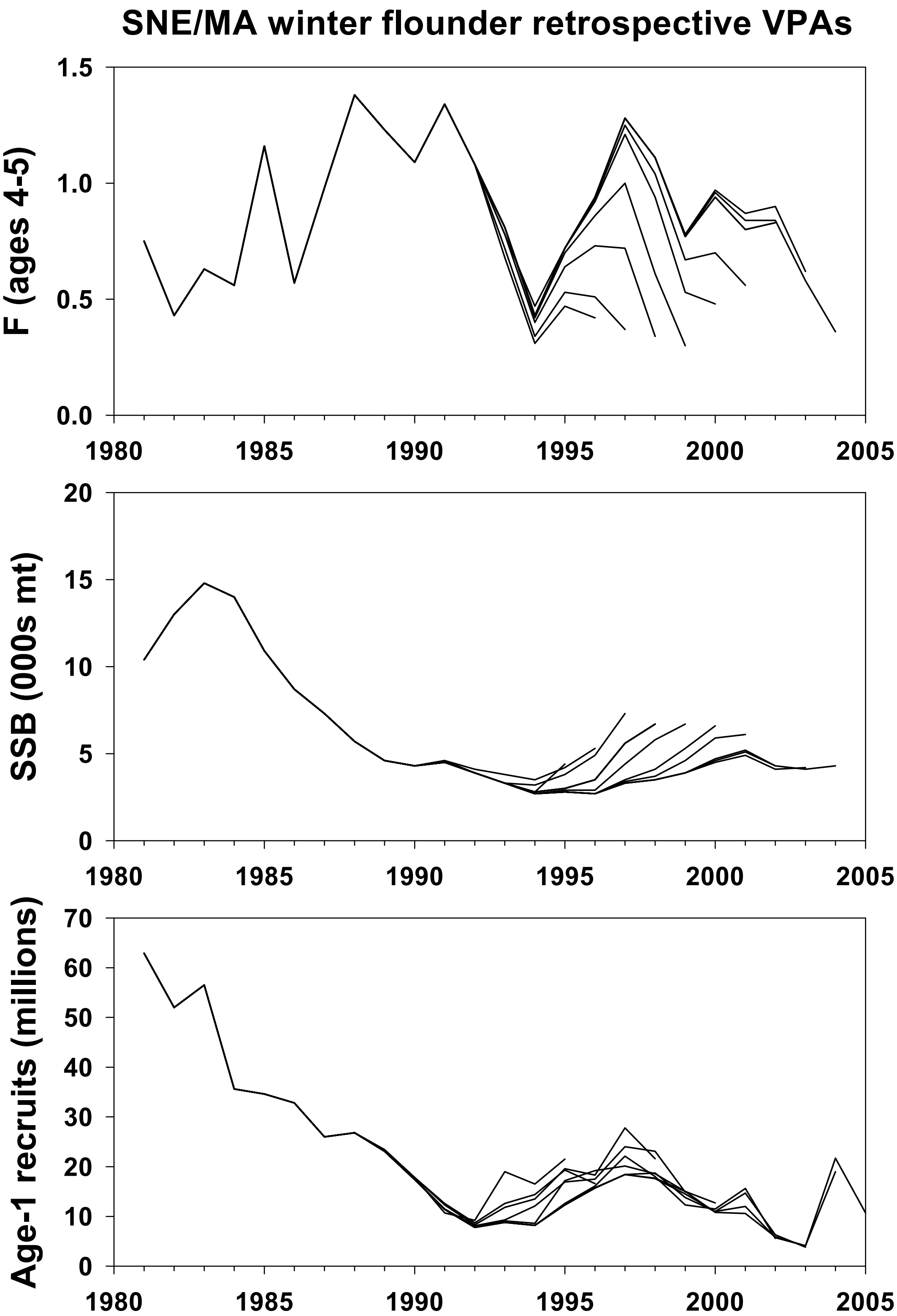

Figure J6. Retrospective VPAs for SNE/MA winter flounder.

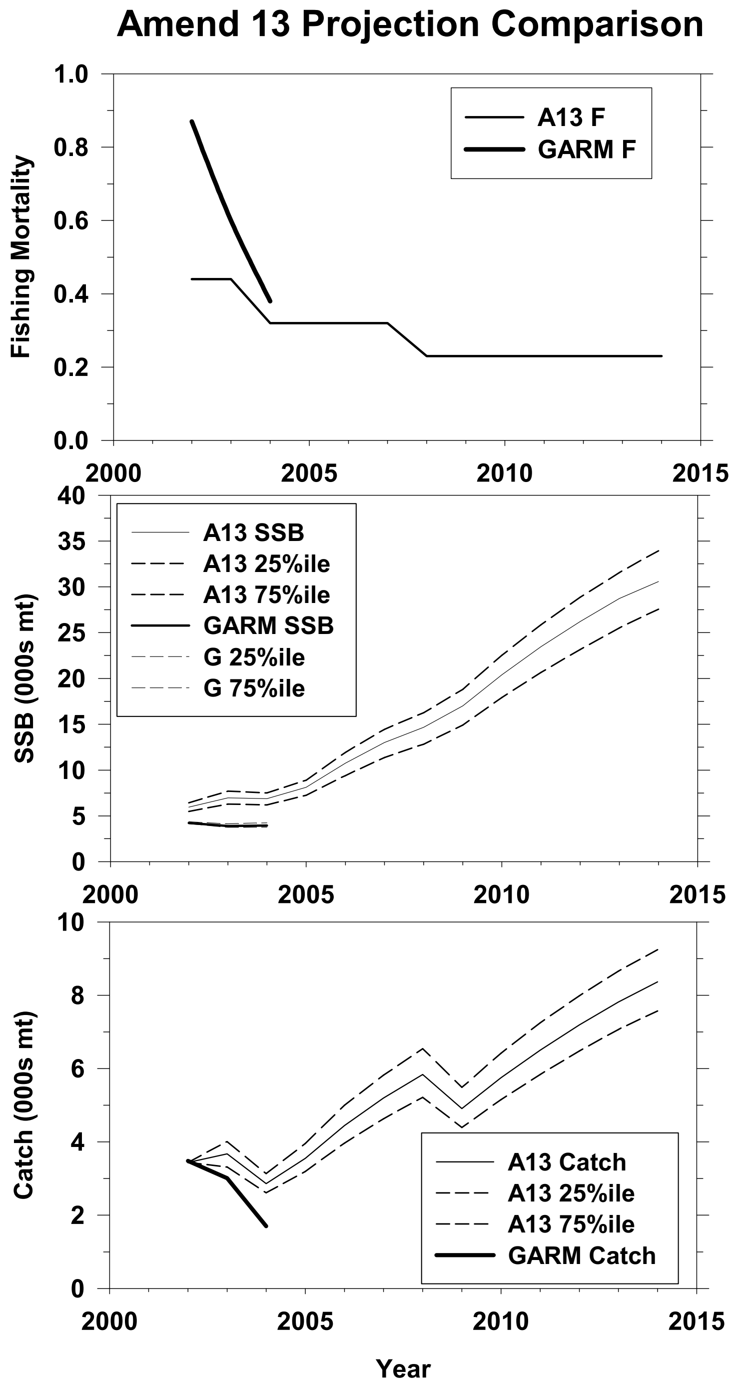

Figure J7. Comparison of Amendment 13 projections and current estimates.

K. Georges Bank Winter Flounder by **Lisa Hendrickson**

1.0 Background

The Georges Bank winter flounder stock was last assessed in October 2002 during a Groundfish Assessment Review Meeting (GARM) meeting (NEFSC 2002c). The assessment updated the SAW 34 (NEFSC 2002a) formulation of a biomass dynamics model known as ASPIC Prager 1995) that incorporated landings (1964-2001) and biomass indices from the NEFSC autumn (1963-2001) and spring (1968-2002) bottom trawl surveys. Model results indicated a reasonable fit to the input data with no strong retrospective pattern in the fishing mortality or biomass estimates. Fishing mortality rates were at or below F_{MSY} during 1995-2001. Average total biomass increased during 1994 through 2001 and was slightly above B_{MSY} in 2001. The 2001 estimates of fishing mortality rate (0.25) and total biomass (9,805 mt) indicated that the stock was not overfished and overfishing was not occurring in 2001.

After the 2002 GARM, the biological reference points adopted at SAW34 were re-examined and use of the absolute estimates of F_{MSY} and B_{MSY}, rather than survey-based equivalents, were recommended (NEFSC 2002b). In addition, medium term stochastic projections were generated using ASPIC software for 2002-2008 using bootstrap distributions of stock biomass in 2001 generated from the SAW 34 ASPIC model formulation and assuming F_{2002}=F_{2001} and $F_{2003\text{-}2008}$=F_{MSY}. Projected biomass was maintained at B_{MSY} throughout the projection time series with high probability. Projected catch increased to 3,000 mt and was also maintained throughout the projection time series.

2.0 Assessment Results

Stock status was assessed from the results of an updated run of the SAW 34 formulation of an ASPIC model, but version 5.10 (Prager 2004) of the ASPIC software was used rather than version 3.7.2 which was used in the 2002 assessment. The major software changes in ASPIC version 5.10 are estimation of the *K* parameter instead of *r*, a change in starting biomass parameterization from B_1/B_{MSY} to B_1/K, and model implementation using a continuous time step.

The new version of the ASPIC software was run using the input data input file from the 2002 GARM to determine the effect of the software changes on the assessment results. Similar results were obtained for the two model runs (Table K1), so the new version of the software was then run with the updated time series data that included the NEFSC survey biomass indices for autumn of 2002-2004 and spring of 2003-2005, as well as total landings for 2002-2004. Bias-corrected parameter estimates and 80% confidence intervals were computed from 500 bootstrap trials. Results from the updated model run showed a decrease in the bias-corrected catchabilities (*q*) of both the spring and autumn surveys. Bias-corrected estimates were lower for relative biomass (B_{2004}/B_{MSY}) and higher for relative fishing mortality (F_{2004}/F_{MSY}) in comparison to the 2001 estimates of these parameters.

2.1 <u>The Fishery</u>

Total commercial landings of Georges Bank winter flounder are predominately from U.S. fisheries, but also include landings from Canadian fisheries. Prior to 1978, USSR fleets also landed winter flounder from Georges Bank. After 1993, Canadian landings increased and reached a peak of 500 mt in 2001, comprising 25% of the total landings. Thereafter, Canadian landings declined to 200 mt in 2004.

Total landings peaked at 4,500 mt in 1972 then declined between 1984 and 1995 from 3,900 mt to 800 mt, respectively (Table K2 and Figure K1). Total landings have been increasing since 1995, and during 1999 to 2004, increased sharply from 1,000 to 3,100 mt, respectively.

Discarding of winter flounder occurs in the U.S. multi-species bottom trawl fishery and the scallop dredge fishery. However, data from the Observer Program (1989-2000) and Vessel Trip Report (1994-2000) databases were insufficient to produce reliable estimates of the magnitude or size and age composition of these discards (NEFSC 2002a).

2.2 Research Survey Indices

Relative biomass (stratified mean kg per tow) and abundance (stratified mean number per tow) indices from the NEFSC spring (April, 1968-2005) and autumn (October, 1963-2004) bottom trawl surveys (offshore strata 13-22), as well the Canadian spring bottom trawl surveys (February, 1987-2005), for strata 5Z1-Z4, are presented in Table K3. Biomass indices from all three surveys are presented in Figure K2. Canadian survey indices were not included in the current assessment because some winter flounder habitat on Georges Bank cannot be sampled by the survey gear and the inclusion of these indices in previous ASPIC model runs resulted in poor model fits (NEFSC 2002a). The spring survey indices were lagged back one year and used in the ASPIC model as an end-of-year index.

Despite considerable interannual variability, both series of NEFSC biomass indices indicate a declining trend during the 1980s and an increasing trend during the early 1990s through 2002. Thereafter, the spring biomass indices declined, and in 2004-2005, were at the low levels observed during the early 1990s. The autumn biomass indices also declined, but to a lesser extent. Biomass indices from the Canadian survey showed similar trends.

2.3 Biological Reference Points

ASPIC model estimates of relative total biomass (B_t/B_{MSY}) and fishing mortality rates (F_t/F_{MSY}) are more precisely estimated than the absolute values (Prager 1995). Therefore, bias-corrected estimates of annual total biomass (as of Jan. 1) and fishing mortality rates are presented in relative terms. In order to determine stock status, these ratios are compared to a biomass threshold (50% of B_{MSY}) of 0.5 and a fishing mortality rate threshold (F_{MSY}) of 1.0.

2.4 ASPIC Model Results and Stock Status

Relative fishing mortality rates increased rapidly after 1999 and were above 1.0 (= F_{MSY}) during 2000-2004 (Figure K3). During 2004, the relative fishing mortality rate was 1.86 (80% CL = 1.44, 3.23), nearly double the level of F_{MSY} (Table K4). Relative total biomass (as of January 1) gradually increased from the lowest level on record, in 1994 (0.23), to just above the B_{MSY} threshold in 2003 (0.56), but then declined during 2004 and 2005 (Figure K3). Relative biomass was 0.52 of B_{MSY} in 2004 (80% CL = 0.28, 0.76) then fell below the biomass threshold to 0.46 of

B_{MSY} in 2005 (80% CL = 0.22, 0.76). In 2004, relative biomass was just above the threshold limit and relative fishing mortality was well above $F_{MSY.}$ Therefore, in 2004, the stock was not overfished but overfishing was occurring.

A comparison of relative total biomass and fishing mortality rates from the updated assessment with those from the 2002 GARM indicated why a change in stock status occurred. The increasing biomass trend observed in the 2002 model results shifted to a declining trend after 2003 (Figure K4A) due to a decline in the survey biomass indices after 2002. After 2002, fishing mortality rates continued to increase, reaching levels well-above F_{MSY} (Figure K4B). These changes resulted in a divergence, after 1994, in biomass and fishing mortality rate estimates from the two assessments. Divergence was greatest during 2000-2002 when the 80% confidence intervals of the biomass estimates from the two assessments did not overlap (Figure K4A). Similarly, the confidence intervals for the 2001 and 2002 fishing mortality rate estimates did not overlap for the two times series. Bias-corrected estimates of absolute fishing mortality rates and January 1 total biomass are presented in Table K5.

Based on a comparison of the weighted mean square errors for each of the two survey time series, the fit for the updated model run was slightly poorer than the fit for the 2002 model run. However, in contrast to the 2002 model run, the updated run showed a retrospective pattern. Model runs for terminal years 1998-2004 suggested an underestimation of absolute fishing mortality rates and an overestimation of absolute average biomass during 2002-2004 (Figure K5).

Projections conducted for Amendment 13 included a constant fishing mortality scenario using the F_{MSY} estimate of 0.32 from SAW 34. Absolute total biomass estimates indicate a declining trend during 2002-2005, but are within the 80% confidence limits of the Amendment 13 projections of total biomass (Figure K6A). Unlike the projection scenario, fishing mortality rates increased during 2002-2004 (Figure K6B). During 2003 and 2004, realized landings were at the levels projected for Amendment 13 (Figure K6C).

3.0 Sources of Uncertainty

3.1 Exclusion of the discards from the U.S. otter trawl and scallop dredge fisheries results in an underestimation of fishery removals of the younger age classes (ages 0 to 3).

3.2 Current biomass levels estimated from the ASPIC model may not be reliable because recruitment is implicitly assumed to be a function of stock biomass.

3.3 U.S. landings after 1994 are based on prorations of preliminary logbook data. In 2004, a new method of reporting the landings was implemented whereby dealers rather than NMFS port agents entered the landings directly into the Weighout database.

3.4 There is some uncertainty about the accuracy of the Canadian landings because winter flounder are a bycatch species in the Canadian fisheries and a portion of the landings may be reported as unclassified flounders.

4.0 Research Recommendations

4.1 Include discards in future assessments.

4.2 Ensure that the survey indices and catch are composed of the same size fish.

5.0 Panel Discussion

The Panel discussed the consequence of the re-estimation of reference points in the updated assessment. The model estimates of F_{MSY} and B_{MSY} differ from those reported in SAW 34 and currently adopted. The terms of reference of the 2005 GARM do not include re-estimating reference points. Therefore, the Panel discussed whether it was consistent with the terms of reference to accept the ASPIC estimates of current stock status. However, because the estimation of K and MSY is intrinsic to the model fit, it is impossible to update the stock assessment without re-estimating the reference points. The Panel discussed several alternatives such as an alternative ASPIC run in which K and MSY were fixed at the values estimated from the 2002 GARM, comparing the new reference point estimates to the ASPIC model results from the 2002 GARM, and projecting from the 2002 GARM model using the actual catches. The model where MSY and K were fixed had a slightly poorer fit than the model which freely estimated the parameters. In addition, panelists noted that by imposing a constraint on F_{MSY} and B_{MSY} the model was not the same as that used in the last benchmark assessment. Accepting the results from constrained model would have conflicted with the terms of reference guidance that required the use of the same assessment method approved in the last benchmark assessment. The other two alternatives were considered scientifically invalid because the first method compares unrelated values while the second does not use all the data available. The Panel accepted the freely estimated model which is more pessimistic than the constrained model but has the same trend. The Panel decided to compare the ASPIC model results from the 2002 GARM with the updated model results by using the relative estimates of F and B instead of the absolute values (see comparison with bootstrap CI).

6.0 Literature Cited

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NEFSC [Northeast Fisheries Science Center]. 2002b. Final report of the working group on re-evaluation of biological reference points for New England groundfish. 231 p.

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Prager, M.H. 2004. User's manual for ASPIC: a stock production model incorporating covariates (ver.5). Beaufort Lab. Doc. BL-2004-01. 27 p.

Prager, M.H. 1995. User's manual for ASPIC: a stock production model incorporating covariates, program version 3.6x. Miami Lab. Doc. MIA-92/93-55. 25 p.

Table K1. Summary of results from ASPIC biomass dynamics models (SAW 34 configuration) utilized during the 2002 GARM and for an updated assessment of Georges Bank winter flounder. NA indicates these values are not estimated by the software version. All values are bias-correct using the methods defined by Prager (2004).

	GARM 2002, ASPIC v. 3.7.2 U.S. autumn survey, 1964-2001 U.S. spring survey, 1968-2002 Total landings, 1964-2001	Rerun GARM 2002, ASPIC v. 5.10 U.S. autumn survey, 1964-2001 U.S. spring survey, 1968-2002 Total landings, 1964-2001	Assessment update, ASPIC v. 5.10 U.S. autumn survey, 1964-2004 U.S. spring survey, 1968-2005 Total landings, 1964-2004
Total Objective Function	1.959	1.959	2.448
q (80% C.L.), U.S. Autumn Survey	0.265 (0.183, 0.330)	0.259 (0.184, 0.352)	0.225 (0.156, 0.331)
q (80% C.L.), U.S. Spring Survey	0.342 (0.246, 0.430)	0.329 (0.235, 0.453)	0.266 (0.184, 0.388)
r	0.65	0.67	0.55
K (mt)	18,200	17,491	20,273
$B_{2001 \text{ or } 2004}/B_{MSY}$ (as of Jan. 1)	1.06	1.04	0.52
$F_{2001 \text{ or } 2004}/F_{MSY}$	0.76	0.76	1.86
B_{2005}/B_{MSY} (as of Jan. 1)			0.46
B_{MSY}[1] (mt)	9,099	8,746	10,136
F_{MSY}	0.33	0.31	0.22
MSY (mt)	3,008	2,950	2,785

[1] GARM 2002 point estimates of F_{MSY}, B_{MSY} and MSY were not bias-corrected.

Table K2. Landings (mt) of Georges Bank winter flounder, by statistical area and country, during 1964-2004.

	522-525 561-562	5Ze[2] (521-526 and 541-562)		5Z (521-562)		
YEAR	USA[1]	CANADA	USSR	CANADA	USSR	TOTAL
1964	1,371			146		1,517
1965	1,176			199	312	1,687
1966	1,877			164	156	2,197
1967	1,917			83	349	2,349
1968	1,570	57	372			1,999
1969	2,167	116	235			2,518
1970	2,615	61	40			2,716
1971	3,092	62	1,029			4,183
1972	2,805	8	1,699			4,512
1973	2,269	14	693			2,976
1974	2,124	12	82			2,218
1975	2,409	13	515			2,937
1976	1,877	15	1			1,893
1977	3,572	15	7			3,594
1978	3,185	65				3,250
1979	3,045	19				3,064
1980	3,931	44				3,975
1981	3,993	19				4,012
1982	2,961	19				2,980
1983	3,894	14				3,908
1984	3,927	4				3,931
1985	2,151	12				2,163
1986	1,762	25				1,787
1987	2,637	32				2,669
1988	2,804	55				2,859
1989	1,880	11				1,891
1990	1,898	55				1,953
1991	1,814	14				1,828
1992	1,822	27				1,849
1993	1,662	21				1,683
1994	907	65				972
1995	706	54				760
1996	1,265	71				1,336

YEAR	522-525 561-562 USA[1]	5Ze[2] (521-526 and 541-562) CANADA	USSR	5Z (521-562) CANADA	USSR	TOTAL
1997	1,287	143				1,430
1998	1,243	93				1,336
1999	938	104				1,042
2000	1,677	161				1,838
2001	1,629	529				2,158
2002	2,110	244				2,354
2003	2,791	310				3,101
2004	2,931	191				3,122

[1] USA landings prior to 1985 include those from Statistical Areas 551 and 552 and landings during 1994-2004 were prorated from Vessel Trip Reports based on gear, month, and state.
[2] Includes landings from statistical areas 521 and 526, outside of the Georges Bank winter flounder stock area.

Table K3. Standardized, stratified relative abundance (mean number per tow) and biomass (mean kg per tow) indices for Georges Bank winter flounder caught in the U.S. spring and autumn and Canada spring research vessel bottom trawl surveys. U.S. offshore survey strata 13-22; Canadian survey strata (5Z1-5Z4). Trawl door standardization coefficients of 1.46 (numbers) and 1.39 (weight) were applied to indices from U.S. survey indices prior to 1985 to account for differences in catchability between different survey doors.

Year	**U.S. Spring Survey**		**U.S. Autumn Survey**		**Canada Spring Survey**	
	Number/tow	kg/tow	Number/tow	kg/tow	Number/tow	kg/tow
1963			1.20	1.82		
1964			1.30	1.82		
1965			2.15	2.05		
1966			5.16	5.66		
1967	*Initiated in 1968*		1.79	2.07		
1968	2.70	3.11	1.31	1.07		
1969	3.14	4.29	2.37	2.39		
1970	1.86	2.29	5.62	6.49		
1971	1.84	2.17	1.32	1.26		
1972	4.95	5.32	1.26	1.58		
1973	2.95	3.51	1.22	1.20		
1974	6.05	5.78	1.19	1.46		
1975	1.96	1.41	3.79	2.06		
1976	4.67	3.01	5.99	3.93		
1977	3.79	1.58	4.86	3.99		
1978	7.07	5.06	4.06	3.10		
1979	1.74	2.21	5.07	3.83		
1980	3.22	2.80	1.66	1.87		
1981	3.73	3.75	3.83	2.43		
1982	2.30	1.52	5.30	2.69		
1983	8.41	7.11	2.73	2.36		
1984	5.53	5.60	3.93	2.45		
1985	3.84	2.65	1.98	1.12		
1986	2.00	1.21	3.58	2.18	*Iinitiated in 1987*	
1987	2.80	1.25	0.76	0.89	1.24	1.74
1988	2.93	1.65	4.08	1.27	4.31	2.75
1989	1.30	0.76	1.56	1.05	4.05	1.95
1990	2.80	1.57	0.50	0.35	4.93	2.64
1991	2.40	1.32	0.27	0.14	1.98	1.38
1992	1.42	0.90	0.68	0.38	0.51	0.59
1993	1.02	0.57	1.17	0.66	3.53	1.76
1994	1.29	0.58	0.87	0.58	5.10	2.01
1995	2.61	1.49	2.36	1.34	5.63	1.96
1996	2.31	1.50	1.54	1.76	4.12	2.30

Year	U.S. Spring Survey		U.S. Autumn Survey		Canada Spring Survey	
	Number/tow	kg/tow	Number/tow	kg/tow	Number/tow	kg/tow
1997	1.61	1.19	1.74	1.53	4.58	3.09
1998	0.76	0.72	1.78	1.57	1.14	1.21
1999	3.83	3.48	1.54	1.76	1.25	1.89
2000	4.42	3.69	2.16	2.66	1.48	2.22
2001	1.29	1.22	2.45	2.51	2.28	2.54
2002	5.05	5.16	2.58	3.15	3.17	3.85
2003	1.22	1.34	1.94	2.24	1.09	1.31
2004	0.39	0.51	2.50	2.04	2.10	1.79
2005	1.09	0.87			1.19	1.23
Mean All Years	2.95	2.48	2.48	2.09	2.82	2.01

Table K4. Bias-corrected estimates of relative fishing mortality rates (F_t/F_{MSY}) and total biomass (B_t/B_{MSY}, as of Jan. 1), derived using an ASPIC biomass dynamics model, for Georges Bank winter flounder during 1964-2005.

Year	F_t/F_{MSY}	B_t/B_{MSY} (as of Jan. 1)
1964	0.85	0.48
1965	0.83	0.56
1966	0.98	0.64
1967	0.98	0.70
1968	0.77	0.75
1969	0.90	0.84
1970	0.94	0.89
1971	1.49	0.92
1972	1.79	0.85
1973	1.26	0.74
1974	0.91	0.74
1975	1.16	0.80
1976	0.71	0.80
1977	1.31	0.89
1978	1.23	0.85
1979	1.17	0.84
1980	1.59	0.84
1981	1.80	0.76
1982	1.44	0.68
1983	2.08	0.66
1984	2.56	0.56
1985	1.61	0.44
1986	1.30	0.44
1987	1.99	0.46
1988	2.47	0.42
1989	1.84	0.34
1990	2.01	0.33
1991	2.02	0.30
1992	2.24	0.28
1993	2.25	0.25
1994	1.28	0.23
1995	0.86	0.25
1996	1.32	0.31
1997	1.29	0.34
1998	1.09	0.37
1999	0.73	0.41
2000	1.13	0.49
2001	1.25	0.53
2002	1.31	0.55
2003	1.76	0.56
2004	1.86	0.52
2005		0.46

Table K5. Bias-corrected estimates of absolute fishing mortality rates and January 1 total biomass (000's mt), derived using an ASPIC biomass dynamics model, for Georges Bank winter flounder during 1964-2005.

Year	Fishing Mortality Rate	Jan. 1 Total Biomass (000's mt)
1964	0.19	5.886
1965	0.18	6.994
1966	0.22	8.147
1967	0.22	8.941
1968	0.17	9.659
1969	0.21	10.816
1970	0.21	11.502
1971	0.34	11.992
1972	0.41	10.972
1973	0.29	9.496
1974	0.21	9.485
1975	0.26	10.267
1976	0.16	10.369
1977	0.30	11.570
1978	0.28	11.075
1979	0.27	10.897
1980	0.37	10.881
1981	0.41	9.885
1982	0.33	8.731
1983	0.47	8.502
1984	0.58	7.198
1985	0.36	5.562
1986	0.29	5.500
1987	0.45	5.846
1988	0.56	5.270
1989	0.41	4.286
1990	0.45	4.107
1991	0.45	3.789
1992	0.49	3.498
1993	0.49	3.075
1994	0.27	2.694
1995	0.19	3.033
1996	0.29	3.772
1997	0.28	4.119
1998	0.24	4.490
1999	0.16	5.105
2000	0.26	6.244
2001	0.28	6.791
2002	0.30	7.114
2003	0.40	7.297
2004	0.42	6.692
2005		6.385

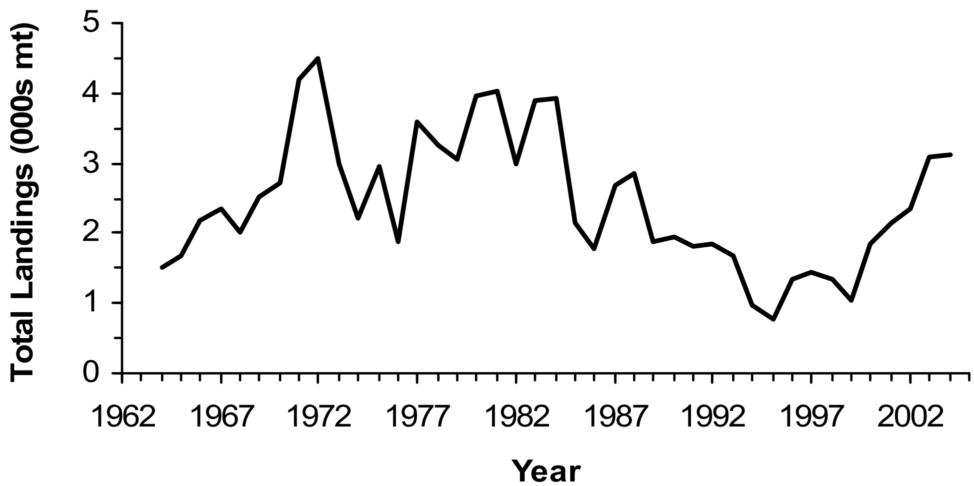

Figure K1. Total commercial landings of Georges Bank winter flounder during 1964-2004.

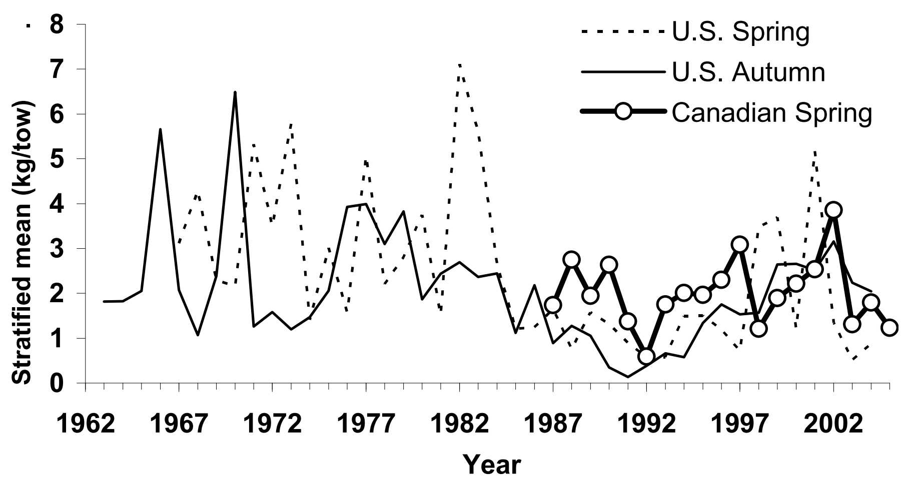

Figure K2. Relative biomass indices (stratified mean kg per tow) of Georges Bank winter flounder from NEFSC spring (1968-2005, lagged back one year) and autumn (1963-2004) bottom trawl surveys and the Canadian spring (1987-2005) bottom trawl survey.

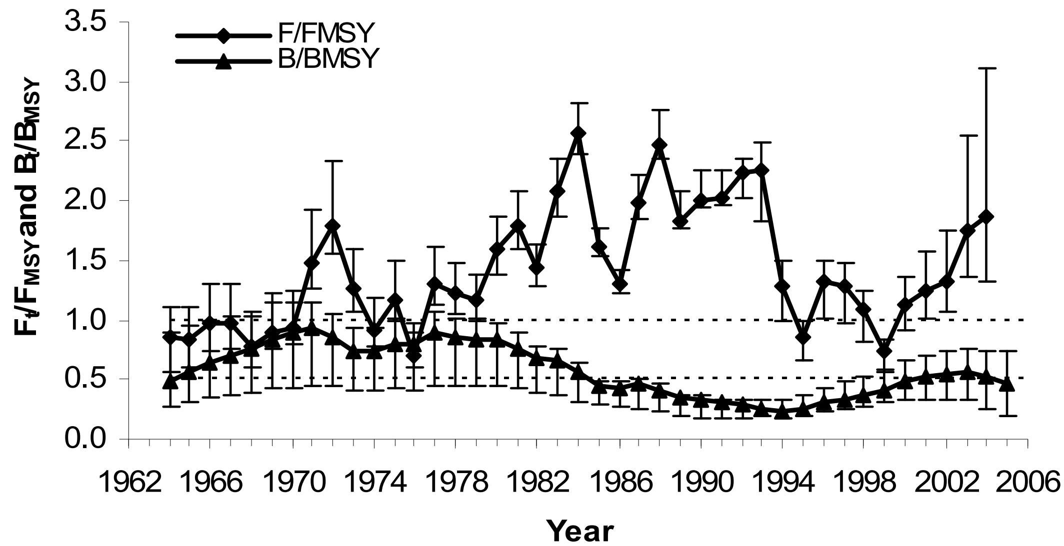

Figure K3. Trends in bias-corrected estimates of relative total biomass (B_t/B_{MSY} on Jan. 1) and relative fishing mortality rates (F_t/F_{MSY}), derived using an ASPIC biomass dynamics model, for Georges Bank winter flounder. Error bars represent bias-corrected 80% confidence intervals.

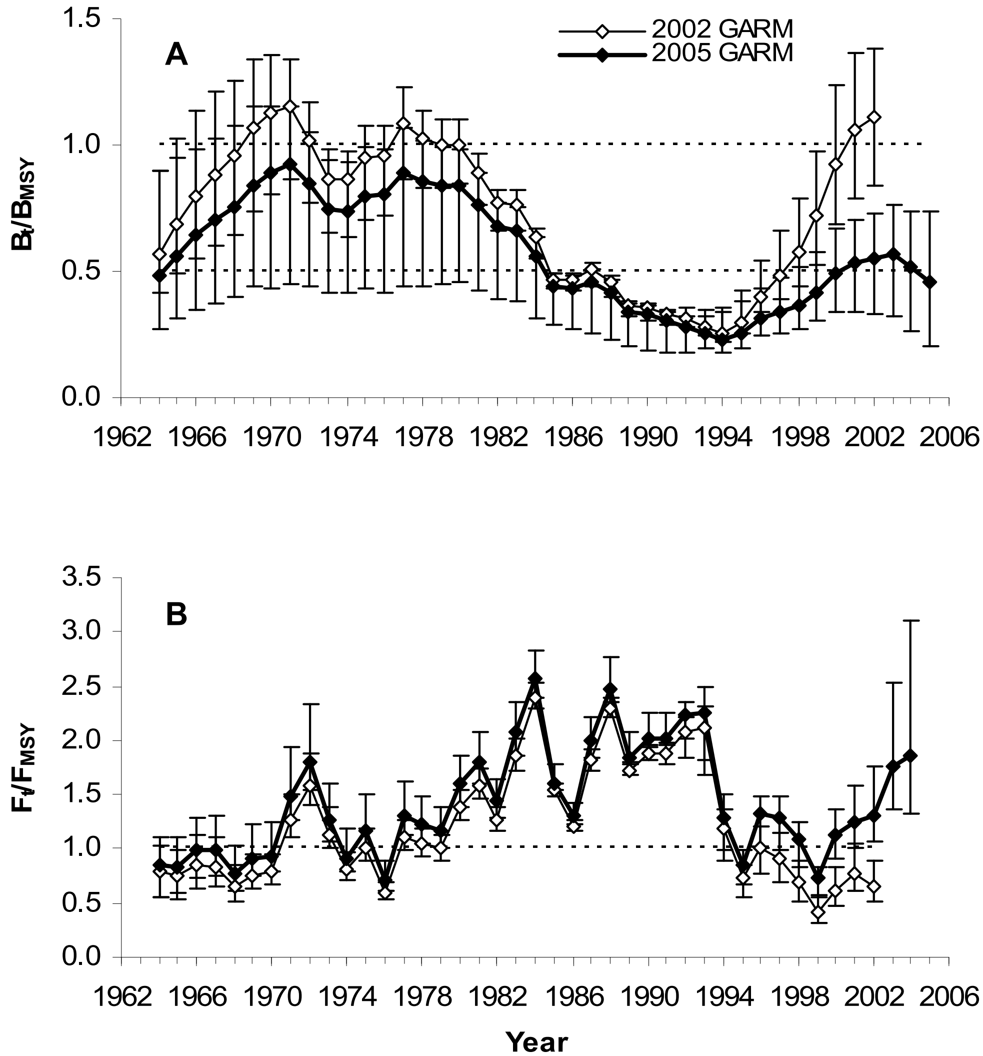

Figure K4. Bias-corrected estimates of (A) relative total biomass (B_t/B_{MSY} on Jan. 1), during 1964-2005, and (B) relative fishing mortality rates (F_t/F_{MSY}), during 1964-2004, for the 2002 and 2005 ASPIC model runs for Georges Bank winter flounder. Error bars represent bias-corrected 80% confidence intervals.

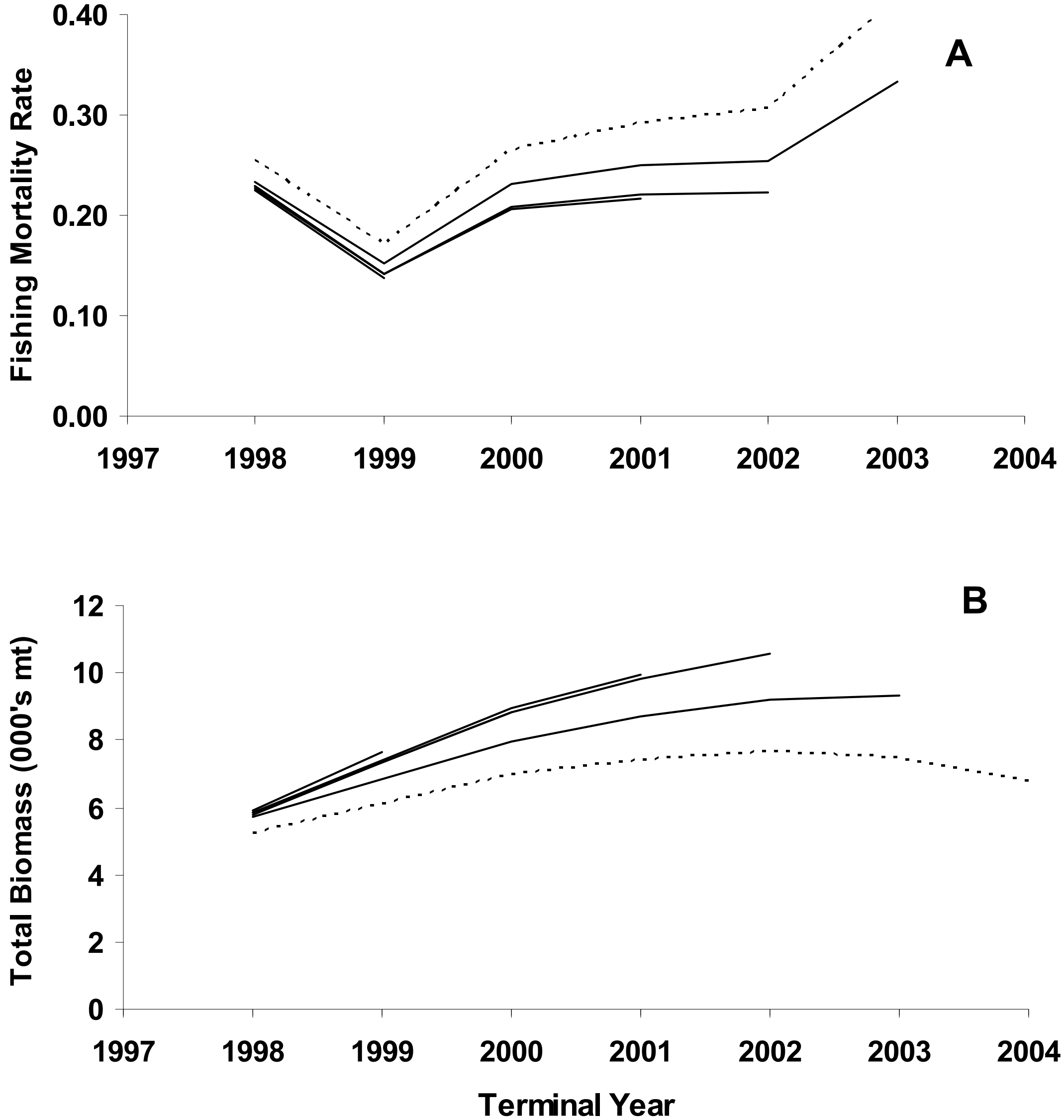

Figure K5. Retrospective patterns in absolute estimates of (A) fishing mortality rates and (B) average biomass, during terminal years 1995-2000, for an updated ASPIC biomass dynamics model for Georges Bank winter flounder, 1964-2004. Estimates of fishing mortality and stock biomass are not bias-corrected.

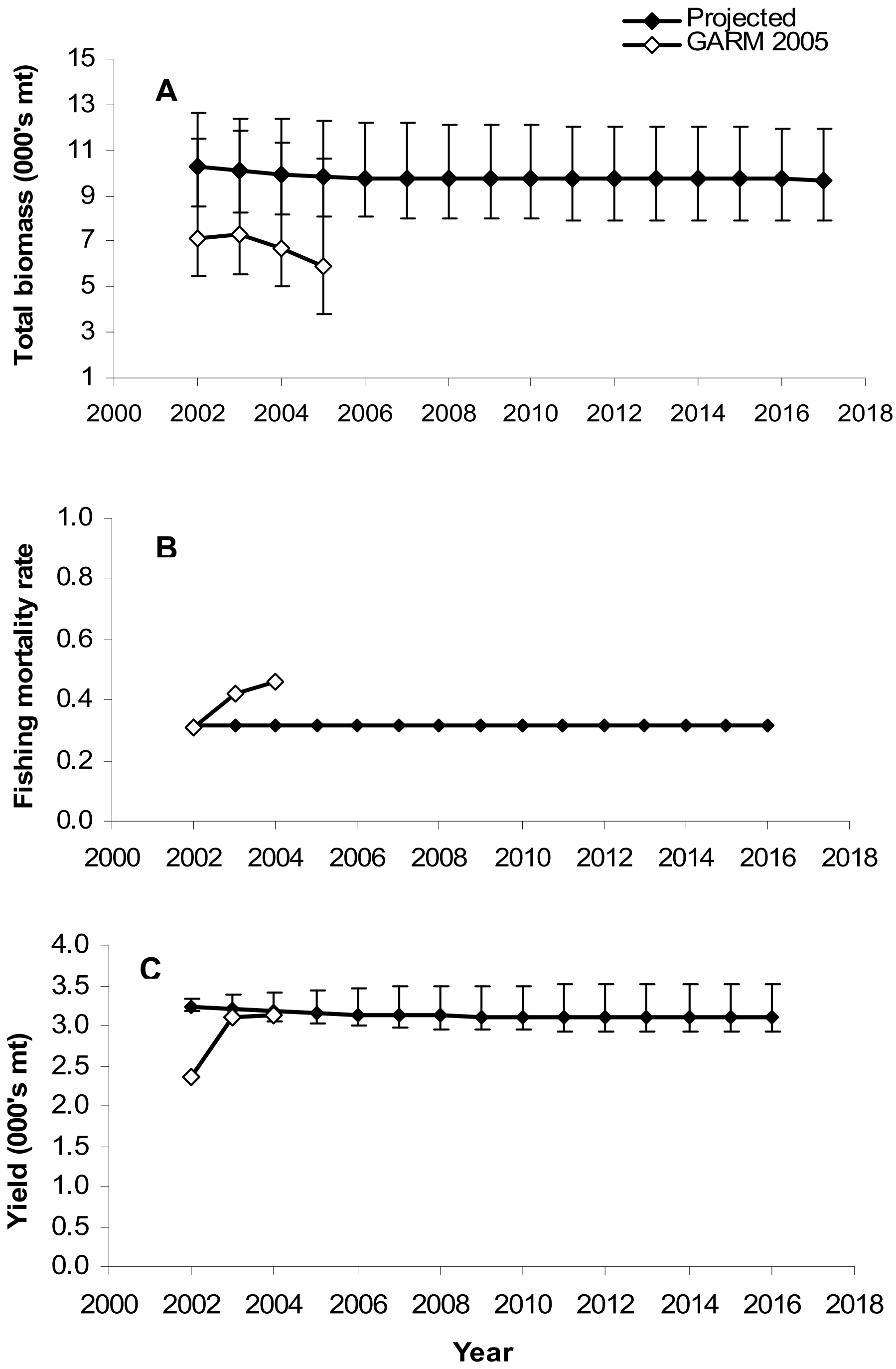

Figure K6. ASPIC-derived absolute estimates of (A) total biomass (as of Jan. 1) and (B) fishing mortality rates, and (C) actual landings, for Georges Bank winter flounder during 2002-2004, versus projected estimates, for Amendment 13, based on a constant F (=0.32) scenario. ASPIC-derived point estimates and 80% confidence limits are bias-corrected.

L. Georges Bank/Gulf of Maine White Hake by **K.A. Sosebee**

1.0 Background

This stock was last assessed and reviewed at the Groundfish Assessment Review Committee meeting in 2002 (NEFSC 2002a). The AIM method was used to develop reference points and to assess the status of the stock relative to these reference points (NEFSC 2002b). Landings and discards of fish greater than 60 cm, were used in the model as well as autumn survey indices of biomass. Relative fishing mortality in 2001 was estimated to be more than twice the value for F_{ref}. Biomass estimates were less than 1/2 B_{msy}. NEFSC spring and autumn research vessel bottom trawl survey indices had declined to near record low levels in 1999 but increased through 2002 due to a moderate 1998 year class.

2.0 The Fishery

United States commercial landings of white hake increased from a low of 2,225 mt in 1997 to 4,435 mt in 2003 (Table L1; Figure L1). Landings subsequently declined to 3,505 mt (-21%). Canadian landings declined to a time-series low of 90 mt. Discard estimates were derived for 2002-2004 using the same method as in the previous assessment (Table L2; Figure L1). Discards decreased to 176 mt overall. Only otter trawl discards are used in the assessment and they decreased to 83 mt (Table L2).

3.0 2005 Assessment

Landings-at-length were estimated annually using port samples collected from 2002-2004. The sampling intensity was good (Table L3) and the coverage adequate, except for unclassified. As in the previous assessment, the unclassified landings were small and were added at the end.

Discards-at-length were estimated annually using length samples collected from 2002 through 2004. The otter trawl sampling in the observer program was low (zero samples in the first half) in 2002 so length data were pooled for the year (Table L4).

The possible mis-identification of species is particularly a problem for the discards. To determine the potential extent of this problem, the data from the Observer Program were compared to the Dealer data for 2003. There were 474 trips in the Observer Database which identified red or white hake in the catch. Out of these trips, 111 reported all hake were discarded. From the remaining trips, 151 were able to be matched to the Dealer Database. Twelve trips differed in the species identification which is less than 10% of the trips.

The length compositions of both the landings and discards were broken out into fish <= 60 cm and fish > 60 cm. This length cutoff ensures that most of the fish > 60 cm are white hake since red hake seldom reach this size. For years prior to 1985, an average proportion of fish > 60 cm for 1985-2000 was used to split the landings into two parts (75% > 60 cm). All discards prior to 1989 were assumed to be <= 60 cm. The NEFSC surveys were also split into two parts as in the commercial length compositions. The AIM method using biomass estimates from the NEFSC autumn survey as well as catch of animals greater than 60 cm was used to estimate relative fishing mortality and biomass in 2004.

4.0 Assessment Results

NEFSC research vessel bottom trawl survey abundance and biomass indices for white hake remained relatively low through autumn 1999, increased through 2002/2003 and subsequently declined (Table L5; Figure L2). The rate of decline for the > 60 cm portion of the stock was apparently greater than that for the stock as a whole through 1999 (Table L6; Figure L3). The index increased through 2002 as the 1998 year class recruited into that size category. The catch of fish > 60 cm also increased through 2003 as this year class passed through (Table L7; Figure L3). Exploitation (catch/three year average of survey biomass) on the 60+ cm component has increased since the 1970s (Figure L4, Table L8).

Reference points for this stock were estimated at the previous GARM using the AIM model (NEFSC 2002a). The value for relative F to be used as a proxy for F_{msy} was estimated to be 0.55. This value was used along with the estimate of MSY (4,234 mt) from the last accepted ASPIC model to determine a value of 7.70 kg/tow for a B_{msy} proxy. The current value for biomass of 3.01 kg/tow, although an increase over the last assessment, remains below that of ½ B_{msy} and indicates that the stock is still overfished (Figure L4). Likewise, the relative F value of 1.18 is above F_{msy} indicating that overfishing is still occurring (Figure L4).

5.0 Comparison with Amendment 13 Projections

Although the stock of white hake is still overfished, stock size has increased slightly since 2002. The Amendment 13 projections used a phased in fishing mortality and projected stock size to be lower than estimated in 2003 and 2004 (Figure L5). Therefore the stock is above the anticipated biomass in 2004.

6.0 Panel Comments

Small white hake may be misidentified as red hake in the commercial catch. Unlike white hake, red hake seldom reach sizes of 60 cm or larger. To eliminate this potential source of confusion, in the assessment total length is used to separate the two species of fish, whereby fish larger than 60 cm are assumed to be white hake and only these fish are included. An analysis of Observer and Dealer landings data for 2003 indicated that misidentification of the species landed occurred in 10% of the trips.

The Panel expressed concern about omitting fish smaller than 60 cm from the assessment since during some years, these smaller fish constitute a large portion of the landings and survey biomass indices. As a result, the Panel recommended the examination of methods to incorporate fish less than 60 cm in future stock assessments.

6.0 Sources of Uncertainty

* Catch at age (and length) not well characterized due to possible mis-identification of species in the commercial and sea sampling data, low sampling of commercial landings in some years, and sparse discard data.

* Catchability of older ages in the survey.

* Only part of the population is represented in the current AIM model

7.0 References

NEFSC. 2002a. Assessment of 20 Northeast Groundfish Stocks through 2001. A Report of the Groundfish Assessment Review Meeting (GARM), Northeast Fisheries Science Center, Woods Hole, Massachusetts, October 8-11, 2002. NMFS/NEFSC, Woods Hole Laboratory Ref. Doc. 02-16.

NEFSC 2002b. Final Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish. NMFS/NEFSC, Woods Hole Laboratory Ref. Doc. 02-04.

Table L1. Total Landings (mt,live) of white hake by country from the Gulf of Maine to Cape Hatteras (NAFO Subareas 5 and 6), 1964-2004.

	Canada	USA	Other	Grand Total
1964	29	3016	0	3045
1965	0	2617	0	2617
1966	0	1563	0	1563
1967	16	1126	0	1142
1968	85	1210	0	1295
1969	34	1343	6	1383
1970	46	1807	280	2133
1971	100	2583	214	2897
1972	40	2946	159	3145
1973	117	3279	5	3401
1974	232	3773	0	4005
1975	146	3672	0	3818
1976	195	4104	0	4299
1977	170	4976	338	5484
1978	155	4869	29	5053
1979	251	4044	4	4299
1980	305	4746	2	5053
1981	454	5969	0	6423
1982	764	6179	2	6945
1983	810	6408	0	7218
1984	1013	6757	0	7770
1985	953	7353	0	8306
1986	956	6109	0	7065
1987	555	5818	0	6373
1988	534	4783	0	5317
1989	583	4548	0	5131
1990	547	4927	0	5474
1991	552	5607	0	6159
1992	1138	8444	0	9582
1993	1681	7466	0	9147
1994	955	4737	0	5692
1995	481	4333	0	4814
1996	372	3287	0	3659
1997	290	2225	0	2515
1998	228	2364	0	2592
1999	174	2624	0	2798
2000	224	2990	0	3214
2001	203	3482	0	3685
2002	158	3266	0	3424
2003	128	4435	0	4563
2004	90	3505	0	3595

Table L2. White hake discards (mt) by half year and gear type. Only Otter trawl discards are used in the assessment.

	Jan-June			July-Dec			total			
	trawl	shrimp	SGN	trawl	shrimp	SGN	trawl	shrimp	SGN	Total
1989	247	25	n/a	1804	18	50	2050	42	50	2143
1990	2114	9	11	2182	27	65	4297	37	76	4409
1991	111	20	14	1239	11	48	1350	31	62	1443
1992	350	14	29	364	<1	86	715	15	114	844
1993	42	n/a	41	561	n/a	63	603	n/a	104	707
1994	145	n/a	18	85	n/a	19	230	n/a	37	267
1995	33	n/a	9	101	n/a	45	134	n/a	54	188
1996	57	n/a	18	460	n/a	29	517	n/a	47	564
1997	89	n/a	15	133	n/a	15	222	n/a	31	253
1998	81	n/a	6	157	n/a	35	238	n/a	41	279
1999	24	n/a	16	2051	n/a	4	2076	n/a	19	2095
2000	187	n/a	6	93	n/a	32	280	n/a	38	318
2001	258	n/a	15	116	n/a	49	374	n/a	65	439
2002	40	n/a	154	68	n/a	80	108	n/a	234	342
2003	30	n/a	60	123	n/a	41	153	n/a	101	254
2004	39	n/a	77	44	n/a	17	83	n/a	94	176

Table L3. Summary of US commercial white hake landings (mt), number of length samples (n), and number of fish measured(#fish) by market category and quarter from the Gulf of Maine to the Mid-Atlantic (SA 464,465, 511-515,521-526,533-539,611-626) for all gear types, 1985-2004.

		small					medium					large					unclassified					All	Sampling Intensity mt/
Year		Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Q1	Q2	Q3	Q4	sum	Total	sample
1985	mt	129	162	235	167	694	63	78	181	124	446	237	433	1135	623	2428	367	737	1690	988	3782	7349	272
	N	-	2	4	3	9	-	-	-	-	-	-	5	5	3	13	-	1	3	1	5	27	
	#fish	-	233	323	317	873	-	-	-	-	-	-	632	519	271	1422	-	101	293	104	498	2793	
1986	mt	59	134	105	100	398	86	89	55	54	284	274	422	835	417	1948	455	752	1578	694	3478	6107	235
	N	1	3	2	1	7	1	1	-	2	4	1	3	2	1	7	2	2	3	1	8	26	
	#fish	102	263	215	101	681	94	122	-	229	445	122	315	248	96	781	215	206	292	106	819	2726	
1987	mt	98	300	641	576	1616	13	49	122	123	306	171	326	943	372	1813	262	482	1035	301	2080	5814	194
	N	-	2	4	5	11	-	2	1	1	4	-	1	6	3	10	2	1	1	1	5	30	
	#fish	-	240	291	507	1038	-	203	91	109	403	-	111	518	236	865	218	140	112	125	595	2901	
1988	mt	181	549	893	397	2020	26	82	262	120	489	136	330	695	325	1486	73	137	437	134	782	4776	165
	N	5	6	3	5	19	1	1	1	-	3	1	1	2	1	5	-	1	-	1	2	29	
	#fish	558	764	240	478	2040	100	92	105	-	297	112	121	214	85	532	-	100	-	41	141	3010	
1989	mt	149	221	404	358	1132	41	54	124	68	287	188	473	904	470	2035	33	190	774	96	1092	4547	350
	N	1	1	2	2	6	-	-	1	-	1	-	-	2	2	4	1	-	1	-	2	13	
	#fish	91	94	213	195	593	-	-	103	-	103	-	-	206	204	410	100	-	106	-	206	1312	
1990	mt	207	411	885	450	1953	43	108	303	171	625	167	300	596	320	1382	24	182	580	176	962	4922	234
	N	3	4	4	2	13	-	-	2	1	3	2	-	1	1	4	-	-	-	1	1	21	
	#fish	309	408	399	151	1267	-	-	302	99	401	214	-	101	103	418	-	-	-	101	101	2087	
1991	mt	150	366	1215	612	2342	88	160	381	129	758	126	241	533	338	1238	52	358	714	138	1262	5601	156
	N	2	5	6	4	17	1	1	3	1	6	4	1	1	4	10	-	2	1	-	3	36	
	#fish	151	471	485	244	1351	103	100	382	100	685	375	99	96	539	1109	-	207	94	-	301	3446	
1992	mt	424	626	1735	848	3633	102	202	766	358	1428	231	351	699	371	1651	60	280	1246	141	1727	8439	211
	N	4	4	8	3	19	1	4	3	3	11	-	2	3	2	7	1	-	2	-	3	40	
	#fish	329	432	655	240	1656	80	388	266	317	1051	-	194	325	297	816	97	-	237	-	334	3857	
1993	mt	331	502	453	214	1500	161	397	1117	461	2136	173	476	795	416	1860	94	463	975	433	1965	7462	191
	N	2	5	4	1	12	2	3	2	1	8	2	3	7	2	14	-	2	2	1	5	39	
	#fish	150	504	275	50	979	184	309	196	95	784	199	262	676	175	1312	-	214	196	97	507	3582	
1994	mt	63	82	116	56	317	154	374	593	265	1386	206	481	687	407	1782	193	352	457	251	1252	4737	144
	N	-	2	4	1	7	-	2	3	3	8	-	3	4	2	9	-	2	4	3	9	33	
	#fish	-	167	386	100	653	-	230	305	272	807	-	303	363	304	970	-	236	431	372	1039	3469	

Table L3.cont.

Year		small Q1	Q2	Q3	Q4	sum	medium Q1	Q2	Q3	Q4	sum	large Q1	Q2	Q3	Q4	sum	unclassified Q1	Q2	Q3	Q4	sum	All Total	Sampling Intensity mt/ sample
1995	mt	39	43	98	56	245	140	238	616	399	1393	197	398	595	374	1564	134	225	504	268	1130	4333	361
	N	-	1	1	1	3	-	2	2	1	5	-	2	-	1	3	-	1	-	-	1	12	
	#fish	-	107	97	105	309	-	191	222	111	524	-	221	-	103	324	-	100	-	-	100	1257	
1996	mt	23	34	80	43	181	96	207	531	269	1103	208	331	416	280	1234	110	152	339	169	769	3287	122
	N	-	-	-	-	-	1	-	4	4	9	-	2	4	5	11	1	1	3	2	7	27	
	#fish	-	-	-	-	-	101	-	435	541	1077	-	202	451	759	1412	127	72	326	220	745	3234	
1997	mt	31	58	124	83	295	76	113	369	193	751	146	146	438	335	1065	34	28	26	26	113	2225	32
	N	4	2	4	2	12	3	7	6	13	29	5	7	7	9	28	-	-	-	1	1	70	
	#fish	458	206	430	261	1355	276	694	564	1200	2734	541	720	678	896	2835	-	-	-	58	58	6982	
1998	mt	31	54	128	105	318	55	77	218	152	502	159	311	571	407	1449	28	23	34	14	100	2370	74
	N	1	2	1	1	5	3	-	3	2	8	7	2	8	1	18	-	-	1	-	1	32	
	#fish	53	220	120	59	452	327	-	402	305	1034	684	213	1311	110	2318	-	-	118	-	118	3922	
1999	mt	50	76	103	87	317	85	110	236	149	580	303	468	633	257	1661	11	14	25	16	66	2624	119
	N	-	-	1	-	1	1	1	3	4	9	1	6	2	3	12	-	-	-	-	-	22	
	#fish	-	-	119	-	119	111	102	315	313	841	166	665	202	327	1360	-	-	-	-	-	2320	
2000	mt	55	70	81	81	286	118	202	289	201	811	293	497	596	446	1833	14	15	20	12	60	2990	120
	N	4	-	-	1	5	5	1	5	4	15	1	1	-	3	5	-	-	-	-	-	25	
	#fish	428	-	-	123	551	527	106	573	450	1656	103	126	-	336	565	-	-	-	-	-	2772	
2001	mt	59	122	167	177	525	131	155	219	310	815	413	497	697	434	2041	10	22	57	12	101	3482	97
	N	2	3	2	2	9	2	1	2	2	7	3	4	7	6	20	-	-	-	-	-	36	
	# fish	231	329	213	224	997	221	100	235	215	771	328	456	797	660	2241	-	-	-	-	-	4009	
2002	mt	125	58	51	31	264	330	186	234	163	912	454	378	640	576	2047	7	14	15	6	43	3266	58
	N	-	2	1	11	14	6	4	4	7	21	7	4	7	3	21	-	-	-	-	-	56	
	# fish	-	154	103	968	1225	626	391	417	629	2063	768	372	665	335	2140	-	-	-	-	-	5428	
2003	mt	35	20	42	32	129	153	92	158	134	537	918	997	1066	743	3724	6	5	26	9	46	4435	46
	N	3	6	6	4	19	4	8	4	8	24	6	14	17	17	54	-	-	-	-	-	97	
	# fish	249	424	306	208	1187	355	768	387	796	2306	576	1369	1620	1665	5230	-	-	-	-	-	8723	
2004	mt	17	17	44	38	116	113	87	180	122	503	869	632	721	420	2642	5	53	98	88	245	3505	42
	N	2	3	-	7	12	5	5	2	6	18	20	14	5	15	54	-	-	-	-	-	84	
	# fish	83	162	-	445	690	383	456	211	579	1629	2062	1474	524	1213	5273	-	-	-	-	-	7592	

Table L4. Summary of Domestic Observer number of trips (trips) and number of length samples taken (len) by gear type, half year, and catch disposition, 1989-2004.

		Sink Gill Net						Otter Trawl						Grand	
		Half 1		Half 2		Total		Half 1		Half 2		Total		Total	
		Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc	Kept	Disc
1989	trips			14	1	14	1	4	10	3	19	7	29	21	30
	len			512	2	512	2	123	916	154	1734	277	2650	789	2652
1990	trips	6		8	1	14	1	3	4	1	5	4	9	18	10
	len	206		1197	32	1403	32	69	53	138	312	207	365	1610	397
1991	trips	20	1	89	7	109	8	2	1	3	2	5	3	114	11
	len	2526	135	9973	30	12499	165	53	180	413	45	466	225	12965	390
1992	trips	34	1	182	4	216	5	7	6	2	4	9	10	225	15
	len	1620	1	8473	4	10093	5	265	17	59	144	324	161	10417	166
1993	trips	26	1	129	10	155	11	8	20	5	2	13	22	168	33
	len	1276	1	4001	13	5277	14	681	333	658	44	1339	377	6616	391
1994	trips	10		81	3	91	3	12	37	8	7	20	44	111	47
	len	44		1835	12	1879	12	247	570	489	294	736	864	2615	876
1995	trips	9	1	117	7	126	8	12	49	9	10	21	59	147	67
	len	167	1	2638	30	2805	31	1111	1375	697	372	1808	1747	4613	1778
1996	trips	11	2	78	2	89	4	8	16	6	13	14	29	103	33
	len	70	13	826	3	896	16	284	526	331	381	615	907	1511	923
1997	trips	8		24	2	32	2	5	9	6	6	11	15	43	17
	len	85		427	4	512	4	117	93	110	64	227	157	739	161
1998	trips	8		31	1	39	1	3	2	1	1	4	3	43	4
	len	36		411	1	447	1	39	17	12	2	51	19	498	20
1999	trips	6		17	3	23	3	1		7	17	8	17	31	20
	len	79		218	20	297	20	23		113	287	136	287	433	307
2000	trips	7	2	5		12	2	7	5	15	10	22	15	34	17
	len	47	9	143		190	9	421	119	475	76	896	195	1086	204
2001	trips	1	1	6	1	7	2	1	1	4		5	1	12	3
	len	15	3	4501	2	4516	5	46	43	2217		2263	43	6779	48
2002	trips	1		10	1	11	1	4		35	15	39	15	50	16
	len	1		49	2	50	2	125		1050	189	1175	189	1225	191

2003	trips	8	2	38	6	46	8	55	14	57	16	112	30	158	38
	len	16	5	362	24	378	29	2353	83	2477	246	4830	329	5208	358
2004	trips	5	4	125	17	130	21	50	26	80	49	130	75	260	96
	len	28	6	1826	67	1854	73	1733	336	2147	733	3880	1069	5734	1142

Table L5. Stratified mean catch per tow in numbers and weight (kg) for white hake from NEFSC offshore spring and autumn research vessel bottom trawl surveys (strata 21-30,33-40), 1963-2005.

	Spring			Autumn		
Year	No/Tow	Wt/Tow	Mean Length(cm)	No/Tow	Wt/Tow	Mean Length (cm)
1963				5.00	6.31	46.2
1964				1.77	4.14	56.3
1965				4.39	6.86	50.4
1966				6.79	7.67	45.1
1967				3.92	3.64	42.6
1968	1.60	1.74	44.1	4.24	4.54	44.9
1969	3.76	5.09	46.3	9.24	13.09	46.8
1970	5.84	11.86	52.9	8.05	12.82	51.3
1971	3.31	5.14	51.3	10.38	12.10	43.6
1972	10.18	12.66	47.3	12.52	13.10	45.2
1973	9.24	12.22	49.9	9.05	13.46	51.7
1974	8.08	13.99	55.0	5.35	11.00	54.5
1975	9.32	11.22	44.7	5.28	7.23	48.5
1976	9.98	17.01	52.7	6.04	10.56	54.7
1977	6.13	11.01	55.5	9.78	13.74	47.8
1978	3.22	6.14	51.8	7.87	12.54	50.2
1979	5.26	4.97	43.0	5.62	10.31	53.1
1980	10.38	13.96	49.7	10.86	16.66	48.8
1981	17.09	19.92	45.9	8.70	12.16	49.9
1982	6.06	8.91	51.0	1.96	2.11	46.7
1983	3.23	3.12	43.7	8.22	10.79	48.8
1984	2.75	4.17	51.4	5.32	8.23	51.9
1985	4.33	5.38	48.5	9.37	9.74	42.9
1986	8.24	5.61	40.0	14.42	11.56	41.9
1987	7.15	6.44	45.3	7.59	9.62	49.2
1988	4.52	3.69	41.9	8.12	9.88	46.1
1989	3.65	3.22	43.0	11.76	9.23	40.5
1990	11.11	18.37	53.3	13.09	10.58	41.5
1991	8.42	6.14	41.6	13.22	12.20	44.6
1992	7.59	7.11	45.1	10.16	11.24	47.7
1993	7.93	6.84	45.1	11.35	11.66	45.2
1994	4.59	3.17	40.1	8.44	7.02	42.3
1995	4.38	4.02	44.1	9.54	8.20	40.8
1996	2.87	3.07	45.9	4.52	6.35	51.2
1997	1.88	0.89	38.4	4.69	4.55	41.5
1998	2.25	1.09	37.7	4.41	4.27	44.5
1999	3.32	2.97	44.6	5.68	3.44	36.3
2000	5.19	3.33	40.4	7.57	6.72	43.8
2001	4.81	5.18	48.4	5.74	7.97	52.7
2002	5.13	6.32	49.0	6.91	6.73	42.0
2003	5.16	5.73	46.5	4.58	4.91	44.6
2004	4.91	5.19	46.0	3.55	3.72	44.8
2005	3.78	5.52	48.8			

Table L6. NEFSC autumn and spring survey indices (kg/tow) by size group.

	Autumn		Spring	
Year	> 60 cm	<= 60 cm	> 60 cm	<= 60 cm
1964	3.25	0.89		
1965	4.60	2.26		
1966	4.00	3.67		
1967	1.77	1.85		
1968	2.20	2.34	0.98	0.76
1969	8.38	4.71	3.58	1.52
1970	7.76	5.07	9.12	2.74
1971	8.00	4.10	3.62	1.52
1972	7.04	6.05	8.95	3.71
1973	8.22	5.23	7.01	5.21
1974	8.19	2.80	10.34	3.65
1975	4.46	2.77	7.48	3.74
1976	6.83	3.73	12.90	4.10
1977	9.07	4.67	7.97	3.04
1978	8.46	4.08	4.97	1.17
1979	6.97	3.34	2.83	2.14
1980	11.60	5.06	8.73	5.23
1981	8.44	3.72	13.47	6.45
1982			6.15	2.76
1983	6.06	4.73	1.54	1.58
1984	5.05	3.18	2.68	1.49
1985	5.49	4.24	3.06	2.32
1986	4.38	7.18	2.29	3.32
1987	4.56	5.06	2.56	3.88
1988	5.41	4.48	1.90	1.80
1989	3.84	5.39	1.80	1.42
1990	3.79	6.79	12.14	6.22
1991	4.83	7.37	2.76	3.38
1992	4.14	7.10	2.30	4.81
1993	4.90	6.76	2.68	4.16
1994	2.46	4.56	1.23	1.94
1995	2.96	5.23	1.96	2.06
1996	3.34	3.01	1.77	1.30
1997	2.60	1.95	0.14	0.75
1998	1.64	2.64	0.26	0.84
1999	1.26	2.17	1.43	1.53
2000	2.91	3.81	1.08	2.26
2001	2.89	5.08	2.16	3.02
2002	4.30	2.43	4.21	2.12
2003	2.83	2.08	4.00	1.72
2004	1.90	1.82	3.15	2.04

Table L7. Commercial catch (mt) of white hake by size group.

	> 60 cm			<= 60 cm		
Year	Landings	Discards	Total	Landings	Discards	Total
1964	2284	0	2284	761	664	1425
1965	1963	0	1963	654	408	1062
1966	1173	0	1173	391	298	689
1967	857	0	857	286	288	574
1968	971	0	971	324	325	649
1969	1037	0	1037	346	370	716
1970	1600	0	1600	533	582	1115
1971	2173	0	2173	724	760	1484
1972	2359	0	2359	786	678	1464
1973	2551	0	2551	850	767	1617
1974	3004	0	3004	1001	731	1732
1975	2864	0	2864	954	536	1490
1976	3224	0	3224	1075	634	1709
1977	4113	0	4113	1371	914	2285
1978	3790	0	3790	1263	862	2125
1979	3224	0	3224	1075	813	1888
1980	3790	0	3790	1263	1049	2312
1981	4817	0	4817	1606	1372	2978
1982	5209	0	5209	1736	1525	3261
1983	5414	0	5414	1805	1923	3728
1984	5828	0	5828	1943	2037	3980
1985	6306	0	6306	1987	2176	4163
1986	6405	0	6405	654	1845	2499
1987	5025	0	5025	1353	1895	3248
1988	3295	0	3295	2041	1444	3485
1989	3944	0	3944	1186	2050	3236
1990	3156	0	3156	2330	4297	6627
1991	3824	0	3824	2347	1350	3697
1992	6147	0	6147	3434	715	4149
1993	5576	0	5576	3583	603	4186
1994	3985	55	4040	1706	177	1883
1995	2185	2	2187	2625	133	2758
1996	2850	0	2850	806	517	1323
1997	2248	75	2323	270	147	417
1998	2421	78	2499	173	160	333
1999	2530	565	3095	269	1509	1778
2000	2999	17	3016	215	263	478
2001	3093	107	3200	593	264	857
2002	2987	78	3065	440	29	469
2003	4438	6	4444	126	65	191
2004	3549	11	3560	86	72	157

Table L8. Three-year moving average of the NEFSC autumn survey index (> 60 cm kg/tow) and the relative F values used in AIM.

	Survey Index	Relative F
1965	3.92	0.50
1966	3.95	0.30
1967	3.46	0.25
1968	2.66	0.36
1969	4.12	0.25
1970	6.11	0.26
1971	8.05	0.27
1972	7.60	0.31
1973	7.75	0.33
1974	7.82	0.38
1975	6.96	0.41
1976	6.49	0.50
1977	6.79	0.61
1978	8.12	0.47
1979	8.17	0.39
1980	9.01	0.42
1981	9.00	0.54
1982	9.09	0.57
1983	7.25	0.75
1984	6.12	0.95
1985	5.53	1.14
1986	4.97	1.29
1987	4.81	1.04
1988	4.78	0.69
1989	4.60	0.86
1990	4.35	0.73
1991	4.15	0.92
1992	4.25	1.44
1993	4.63	1.21
1994	3.84	1.05
1995	3.44	0.64
1996	2.92	0.98
1997	2.97	0.78
1998	2.52	0.99
1999	1.83	1.69
2000	1.94	1.56
2001	2.35	1.36
2002	3.37	0.91
2003	3.34	1.33
2004	3.01	1.18

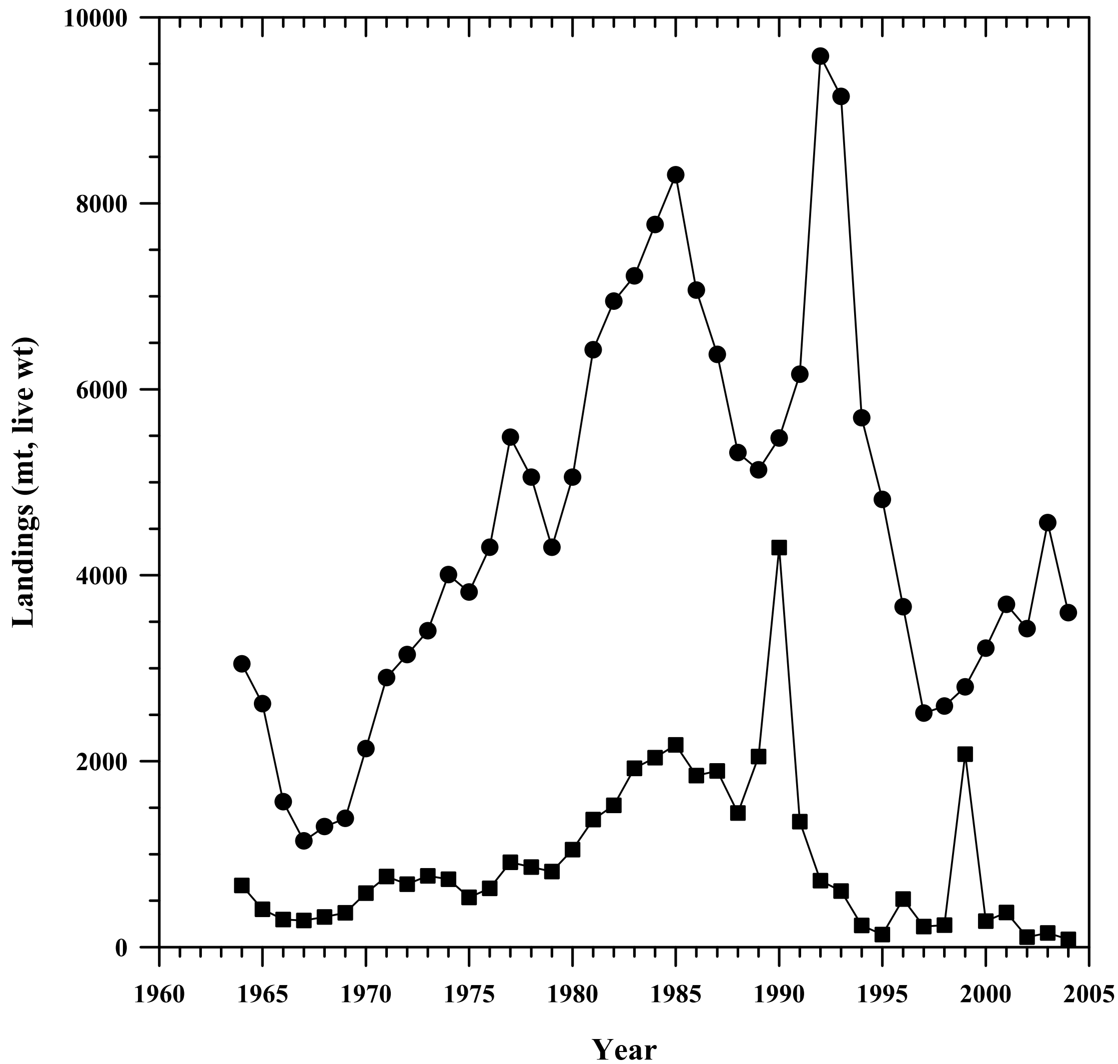

Figure L1. Total landings (circles) and discards (squares) of white hake from the Gulf of Maine to Mid-Atlantic region, 1964-2004.

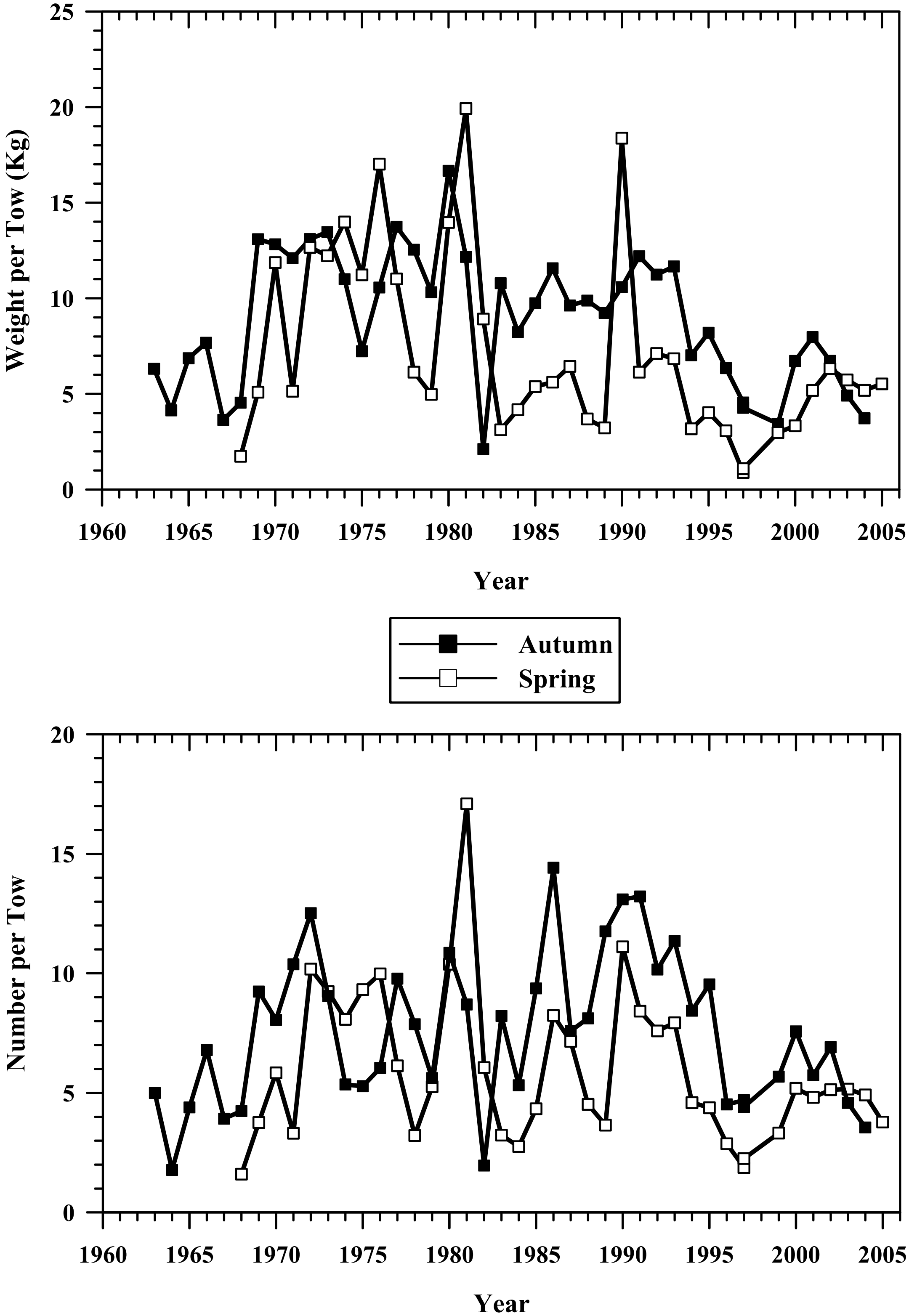

Figure L2. White hake indices of biomass (top panel) and abundance (bottom panel) from the NEFSC bottom trawl spring (solid line) and autumn (dashed line) surveys in the Gulf of Maine to Northern Georges Bank region (offshore strata 21-30, 33-40), 1963-2005.

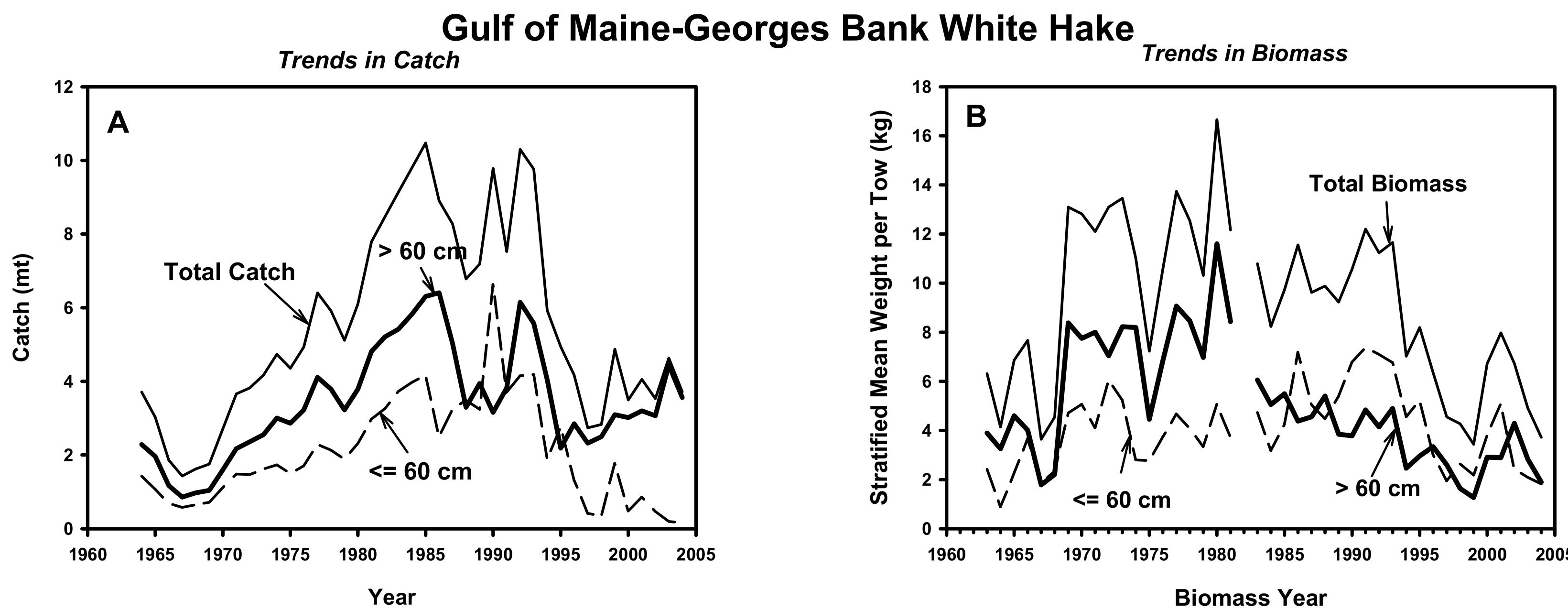

Figure L3. Trends in catch (Panel A) and survey indices of biomass (Panel B) by size class.

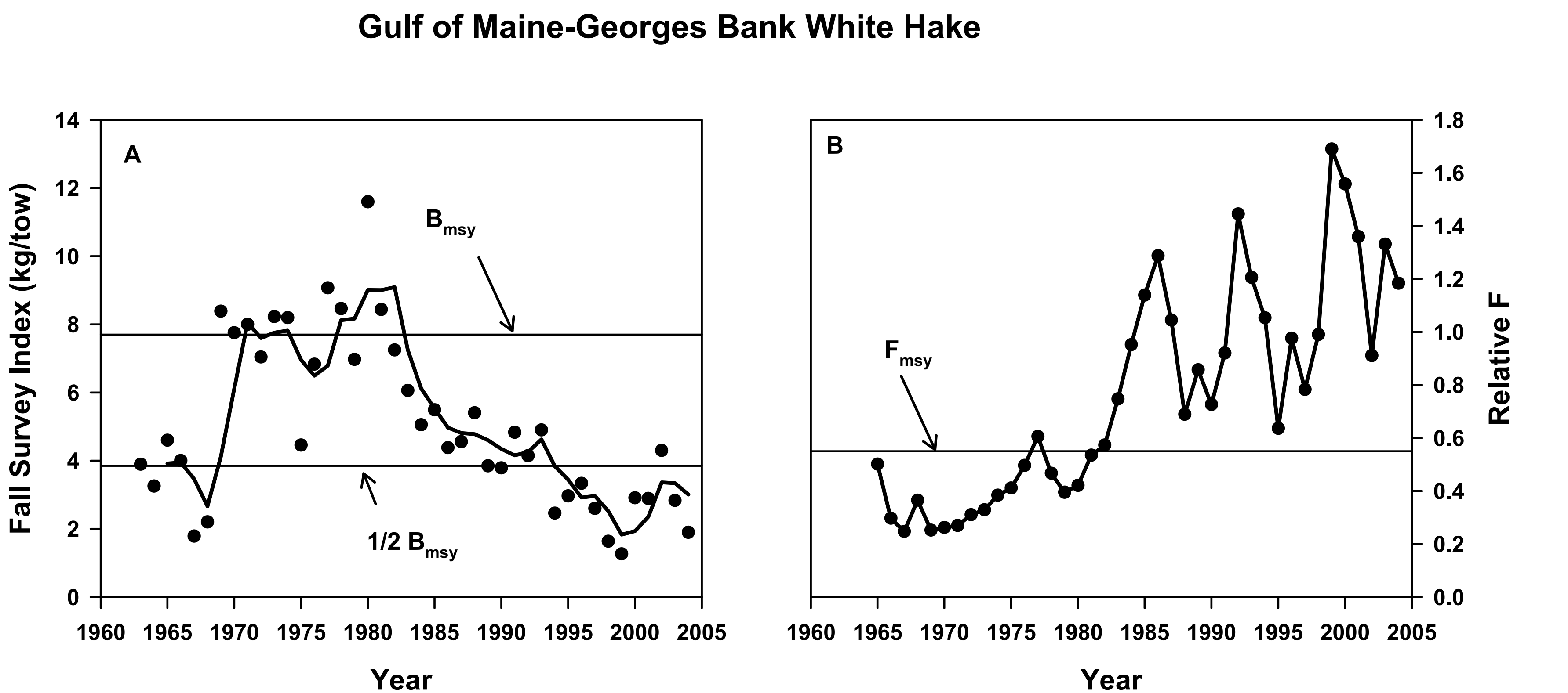

Figure L4. Trend in biomass (A) and trend in relative F (B).

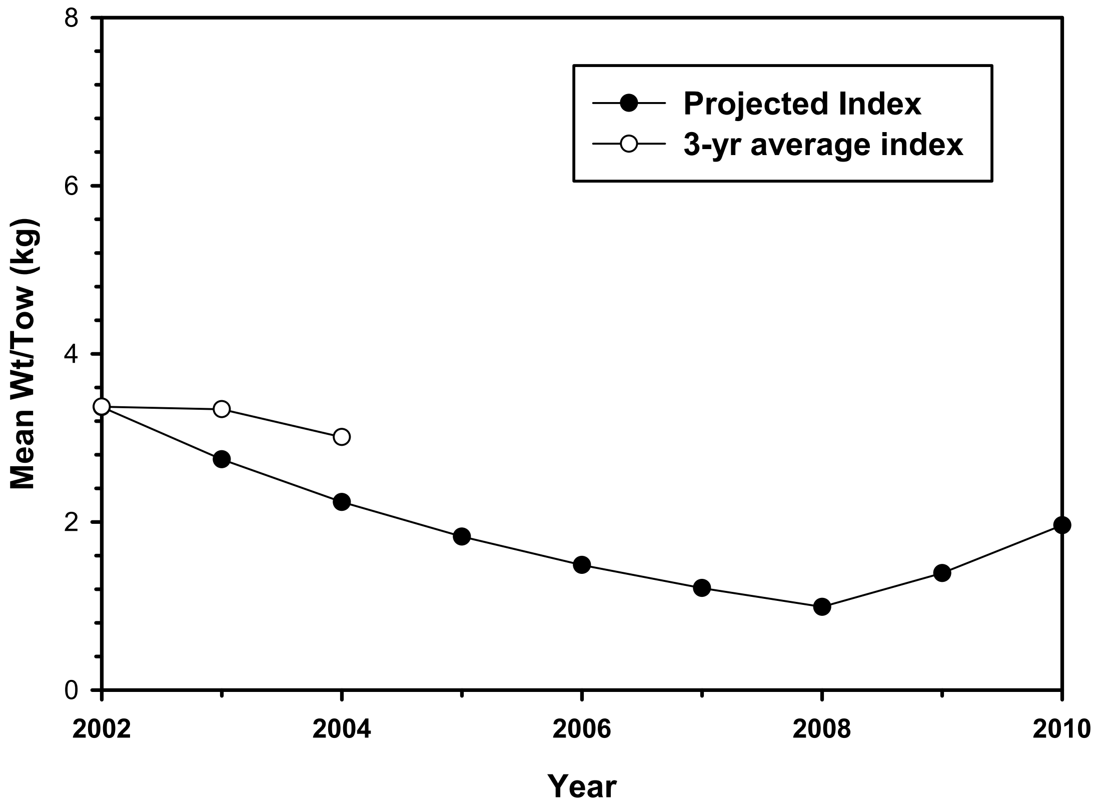

Figure L5. Amendment 13 projected indices for white hake through 2010 and realized indices through 2004.

M. Georges Bank/Gulf of Maine Pollock by **R.K. Mayo, L. Col and M. Traver**

1.0 Background

Pollock, *Pollachius virens* (L.) have traditionally been assessed as a unit stock from the Scotian Shelf (NAFO Divisions 4VWX) to Georges Bank, the Gulf of Maine and portions of the Mid-Atlantic region (Subareas 5 and 6). This stock was last assessed over its range *via* VPA at SAW 16 in 1993 (Mayo and Figuerido 1993, NEFSC 1993a, 1993b). At that time, spawning stock biomass had been declining since the mid-1980s, and was expected to reach its long-term average (144,000 mt). Fishing mortality was estimated to be 0.72 in 1992, above F20% (0.65) and well above Fmed (0.47). The stock was then considered to be fully exploited and at a medium biomass level.

The state of this stock was first evaluated *via* index assessment in 2000 (Mayo 2001). At that time, it was noted that biomass indices for the Gulf of Maine-Georges Bank portion of the stock, derived from NEFSC autumn bottom trawl surveys, had increased during the mid-1970s, declined sharply during the 1980s, but have been generally increasing since the mid-1990s. Indices derived from Canadian bottom trawl surveys, conducted on the Scotian Shelf, increased during the 1980s, but declined sharply during the early 1990s. The index assessment provided no basis with which to evaluate the state of the stock relative to the control rule as determined by the Overfishing Definition Review Panel (Anon. 1998).

An assessment of this stock over the major portion of its range (NAFO Divisions 4VWX and Subdivision 5Zc) has been conducted by Canada since 1989. The most recent full stock assessment was conducted in 1999 (Neilson et al. 1999) and the most recent update was performed in 2001. In 1999, it was noted that age 5+ population biomass reached a maximum in 1985 and then declined steadily to a minimum in 1995. Biomass had increased slightly after 1995 due to recruitment from the 1992 year class. Recent recruitment has been declining, and it was concluded that most indicators of stock status suggest that the resource remains depleted. The 2001 update indicated a further decline in the relative biomass indices and a reduction in the size structure of the population.

A Canadian Framework Assessment process was initiated in 2003 and continued through 2004 to develop a revised framework for assessing the state of the resource in Divs. 4VWX and Subdivision 5Zc. Based on these reviews it was concluded that pollock inhabiting the easternmost portions of the Scotian Shelf are sufficiently spatially isolated from those found in the most of Division 4X to warrant separate management units (Anon 2004, Neilson et al. 2004a). Given the low biomass currently found in the eastern management unit, the most recent evaluation of stock status (Neilson et al. 2004b) provides F and biomass estimates only for the western component inhabiting portions of Div. 4X and Subdivision 5Zc. This assessment indicated that fishing mortality (ages 4-9) declined to 0.28 in 2003, but remains high (1.0 or higher) on older fish (ages 6-9). Biomass (ages 2+) continues to rebuild, doubling since 1999, but remains low compared to the 1984 maximum.

In 2002, index-based biological reference points were developed for a portion of the pollock stock primarily under US management jurisdiction (Subareas 5 and 6), including a portion of eastern Georges Bank (Subdivision 5Zc) that is under Canadian management jurisdiction (NEFSC 2002). The most recent assessment of the resource inhabiting the area comprising this management unit was conducted in October, 2002 at the first Groundfish Assessment Update Meeting (GARM I). At that time it was determined that the index of current biomass was greater than ½ of the Bmsy proxy reference point and that the index of current F was below the Fmsy proxy reference point (Mayo and Col 2002).

2.0 The Fishery

2.1 Divisions 4VWX and Subareas 5&6

Nominal commercial catches from the Scotian Shelf, Gulf of Maine, and Georges Bank region increased from an annual average of 38,200 mt during 1972-76 to 68,800 mt in 1986 (Table M1, Figure M1). Canadian landings increased steadily from 24,700 mt in 1977 to an annual average of 43,900 mt during 1985-87, while U.S. landings increased from an average of 9,700 mt during 1973-77 to more than 19,000 mt annually from 1985-1987, peaking at 24,500 mt in 1986. Landings by distant-water fleets declined from an annual average of 9,800 mt during 1970-73 to less than 1,100 mt per year during 1981-88. Distant-water fleet landings increased to 3,300 mt in 1991, but have since declined to negligible levels. Over time, most of the distant water fleet catch has been taken by the USSR/Russian fleet on the Scotian Shelf (Table M1).

By 1996, USA and Canadian landings had declined to 2,963 mt and 9,145 mt, respectively, the lowest landings by either country in over 3 decades. Landings by distant water fleets fishing on the Scotian Shelf remained almost negligible. Since 1996, USA and Canadian landings have increased slightly but remain low relative to past levels. From 1999 to 2004, USA landings fluctuated between 4,111 and 4,600 mt, and Canadian landings ranged from 5,700 to 7,700 mt (Table M1).

Since 1984, the USA fishery has been restricted to areas of the Gulf of Maine and Georges Bank west of the line delimiting the USA and Canadian fishery zones. The Canadian fishery occurs primarily on the Scotian Shelf and additional landings are obtained from Georges Bank east of the line delimiting the USA and Canadian fishery zones. This fishery on the Scotian Shelf has shifted westward over time, and the contribution to the total catch from larger, mobile gear vessels has steadily diminished since 1981.

2.2 Subareas 5&6

The commercial fishery in Subareas 5&6 is dominated by United States vessels; additional catches are taken by Canada and, for a period primarily during the 1970s, by some distant water fleets. The total landings increased steadily from less than 10,000 mt during the 1960s to a maximum of over 26,000 mt in 1986 (Figure M2). Landings declined sharply during the late 1980s and have remained below 10,000 mt throughout most of the 1990s. Landings since 1999 have fluctuated between 5,000 and **7,000** mt.

3.0 Research Survey Indices

Indices of relative biomass (ln re-transformed), derived from NEFSC autumn research vessel bottom trawl surveys covering Georges Bank and the Gulf of Maine have varied considerably since 1963 (Table M2, Figure M2). Indices generally fluctuated between 2 and 5 kg per tow throughout most of the 1960s and 1970s, peaking at over 8 kg per tow during the mid-to-late 1970s, reflecting recruitment of several moderate-to strong year classes from the early 1970s. Strong year classes were also produced in 1979 and 1980, after which recruitment began to diminish during the 1980s.

Biomass indices declined rapidly during the early 1980s, and continued to decline steadily through the early 1990s, remaining below 1 kg per tow and reaching a minimum during the mid-1990s. Since then, biomass indices from the Gulf of Maine-Georges Bank region have generally increased, reaching 1.5 kg per tow in 1999 and have recently been fluctuating between 2 and 2.5 kg/tow (Table M2, Figure M2). On the Scotian Shelf, Canadian biomass indices, derived from commercial fishery catch rates, declined rapidly after 1985, following the recruitment of the 1979 year class. Apart from a sharp spike in 1996, Canadian survey indices continued to decline through 2000 but have increased slightly thereafter (Neilson et al. 2004b).

4.0 Assessment Results

4.1 Subareas 5&6

As evident from recent trends in total landings from Subareas 5 and 6 and NEFSC autumn biomass indices calculated for the Gulf of Maine-Georges Bank region, exploitation ratios (Subarea 5&6 landings/NEFSC autumn biomass index) peaked in the mid-to-late 1980s after which they steadily declined (Table M3, Figure M3). Biomass indices from the Gulf of Maine-Georges Bank region have been increasing throughout the late 1990s and now indicate that biomass may have returned to levels evident during the early 1980s.

Relative Exploitation Rate and Replacement Ratio Analyses

An index of relative exploitation (catch/survey biomass index) corresponding to a replacement ratio of 1.0 was developed by the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish (NEFSC 2002) for the portion of the unit stock of pollock primarily within the USA EEZ (NAFO Subareas 5&6) including a portion of eastern Georges Bank (Subdivision 5Zc) that is under Canadian management jurisdiction. Autumn NEFSC survey biomass indices from the Gulf of Maine and Georges Bank region from 1963 through 2001 were used to calculate the replacement ratios, defined as the biomass index in the current year divided by the average biomass indices from the previous 5 years. The biomass indices and total landings from the same region were used to compute the relative exploitation rates, defined as the catch in the current year divided by the 3 year average survey biomass index for the current year and the previous 2 years. These relative exploitation rates (or relative F) may be considered a proxy for F on that portion of the pollock stock considered in this analysis.
The relationship between replacement ratios and relative F was evaluated by a linear regression of the Log_e replacement ratio on Log_e relative F (NEFSC 2002) and the results were used to derive an estimate of relative F corresponding to a replacement ratio of 1.0. Results for pollock

were highly significant (NEFSC 2002), and the estimate of the relative replacement F (F rel rep) has a low standard error compared to the point estimate (5.88). The regression indicates that, on average, when the relative F is greater than 5.88, the stock is not likely to replace itself in the long-term.

Trends in 3 year average relative F (exploitation ratio) and replacement ratios are given in Figures M3 and M4, respectively and the values are listed in Table M3. Prior to the 1980s, a high proportion of the replacement ratios equaled or exceeded 1.0 (Figure M4). During the 1980s and early 1990s, most of the replacement ratios were less than 1.0, with ratios greater than 1.0 appearing again by the late 1990s as the biomass indices began to gradually increase from the very low levels of the mid-1990s.

The information displayed in Figure M5 also provide a means to derive a biomass index which relates to the replacement ratios. In this case, it is evident that most of the replacement ratios below 1.0 occurred during the 1980s when the biomass index was less than about 3.0 (Figure M5). During this period the relative F was also well above relative replacement F (Figure M6). This biomass index may be considered as the biomass proxy for Bmsy that corresponds to the relative F proxy for Fmsy.

5.0 Biological Reference Points

Since the relative F relates the catch directly to survey biomass, the catch corresponding to the Bmsy proxy can be estimated from the relative F and the biomass index of Bmsy. For pollock, this computes to 3.0 * 5.88 = 17.64, or 17,640 mt as a proxy for MSY. The following biological reference point proxies were obtained from an index-based model of replacement ratios (NEFSC 2002) derived from indices of relative exploitation (Table M3):

MSY	17,640 mt
B_{MSY}	3.00 kg/tow
F_{MSY}	5.88 (Relative F)

Since the mid-1990s, the NEFSC autumn survey biomass has been increasing towards the 3.0 kg/tow Bmsy proxy and and the replacement ratio has remained at or above 1.0. More recently, since 1999, the relative F has remained below the 5.88 Fmsy proxy.

6.0 Summary

In 2004, the 3-year average biomass index for pollock was 1.99, approximately 66% of the 3.00 Bmsy proxy an increase from the 2001 value of 1.601. Thus, current biomass is estimated to be between ½ Bmsy and Bmsy. In 2004, the 3-year average relative F was 3.51, approximately 60% of the 5.88 Fmsy proxy, a slight decrease from the 2001 value of 3.55. Thus, current F is estimated to be below Fmsy. Accordingly, in 2004 the stock was not overfished and overfishing was not occurring. Total landings in 2004 were 7,000 mt, a 23% increase from the 2001 value of 5,680 mt.

7.0 GARM Panel Comments

The Panel sought clarification on the use of the multi-year averages applied to the survey biomass indices in both replacement ratios and relative exploitation rates. It was explained that the 5 and 3-year average survey biomass index used for the replacement ratios and relative exploitation rates respectively were applied to smooth annual noise in the autumn survey biomass indices.

8.0 Sources of Uncertainty

- Survey indices for pollock exhibit considerable inter-annual variability

- Movement of pollock among the NAFO Divisions comprising the stock unit is likely to vary over time, contributing to the year effects noted in the surveys

9.0 References

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Table M1. Pollock landings (metric tons, live) from Divisions 4VWX and Subareas 5 and 6 by country, 1960-2001.

Year	Canada	USA	FRG	GDR	Japan	Spain	USSR	Cuba	Others	Total DWF	Total
1960	29470	10132	0	0	0	783	0	0	1	784	40386
1961	26323	10265	0	0	0	982	0	0	1	983	37571
1962	31721	7391	0	0	0	0	0	0	0	0	39112
1963	28999	6650	126	0	0	0	793	0	28	947	36596
1964	30007	6006	208	0	0	0	4603	0	429	5240	41253
1965	27316	5303	71	0	0	1361	2667	0	11	4110	36729
1966	18271	3791	0	0	0	2384	9865	0	12	12261	34323
1967	17567	3312	0	0	0	1779	644	0	15	2438	23317
1968	18062	3276	0	0	0	1128	372	0	7	1507	22845
1969	15968	3943	1188	2195	0	1515	227	0	7	5132	25043
1970	10753	3976	3233	4710	40	532	527	0	0	9042	23771
1971	11757	4890	633	6849	15	912	2216	0	3	10628	27275
1972	18022	5729	475	4816	8	616	3495	0	58	9468	33219
1973	26990	6303	1124	948	1570	3113	3092	0	36	9883	43176
1974	24975	8726	149	2	40	1500	2301	0	62	4054	37755
1975	26548	9318	236	95	0	708	2004	0	124	3167	39033
1976	23568	10863	994	24	0	303	1466	0	390	3177	37608
1977	24654	13056	368	0	1	2	182	0	53	606	38316
1978	26801	17714	0	0	110	0	502	141	39	792	45307
1979	29967	15541	7	0	19	0	1025	50	23	1124	46632
1980	35986	18280	0	0	81	0	950	32	99	1162	55428
1981	40270	18171	0	0	15	0	358	0	90	463	58904
1982	38029	14357	0	0	3	0	297	84	44	428	52814
1983	32749	13967	0	0	6	0	226	261	22	515	47231
1984	33465	17903	0	1	1	0	97	123	46	268	51636
1985	43300	19457	0	0	17	0	336	66	77	496	63253
1986	42845	24542	0	0	51	0	564	387	81	1083	68470
1987	45407	20353	0	0	82	0	314	343	28	767	66527
1988	41690	14960	0	0	1	0	1054	225	0	1280	57930
1989	41093	10553	0	0	1	0	1782	99	478	2360	54006
1990	36178	9645	0	0	0	0	1040	261	3	1304	47127
1991	37931	7950	0	0	38	0	1117	459	167	1781	47662
1992	32002	7183	0	0	72	0	1006	1015	9	2102	41287
1993	20253	5629	0	0	0	0	176	644	0	820	26702
1994	15240	3768	0	0	0	0	0	10	0	10	19018
1995	9781	3358	0	0	0	0	0	58	0	58	13197
1996	9145	2963	0	0	0	0	6	129	0	135	12243
1997	11927	4267	0	0	0	0	0	64	0	64	16258
1998	14371	5583	0	0	0	0	1	9	0	10	19964
1999	7737	4594	0	0	0	0	0	6	0	6	12337
2000	5676	4043	0	0	0	0	0	0	0	0	9719
2001	6306	4111	0	0	0	0	0	0	0	0	10417
2002	7090	3580	0	0	0	0	0	6	0	6	10670
2003	8090	4794	0	0	0	0	0	0	0	0	12884
2004	7000	5061	0	0	0	0	0	0	0	0	12061

1994-2004 USA Data Preliminary

Table M2. Stratified mean catch per tow in weight (kg) and numbers for Scotian Shelf, Gulf of Maine, and Georges Bank pollock in NEFSC offshore spring and autumn bottom trawl surveys[1], 1963-2005[3]. Indices for the total stock and the mature component are listed.

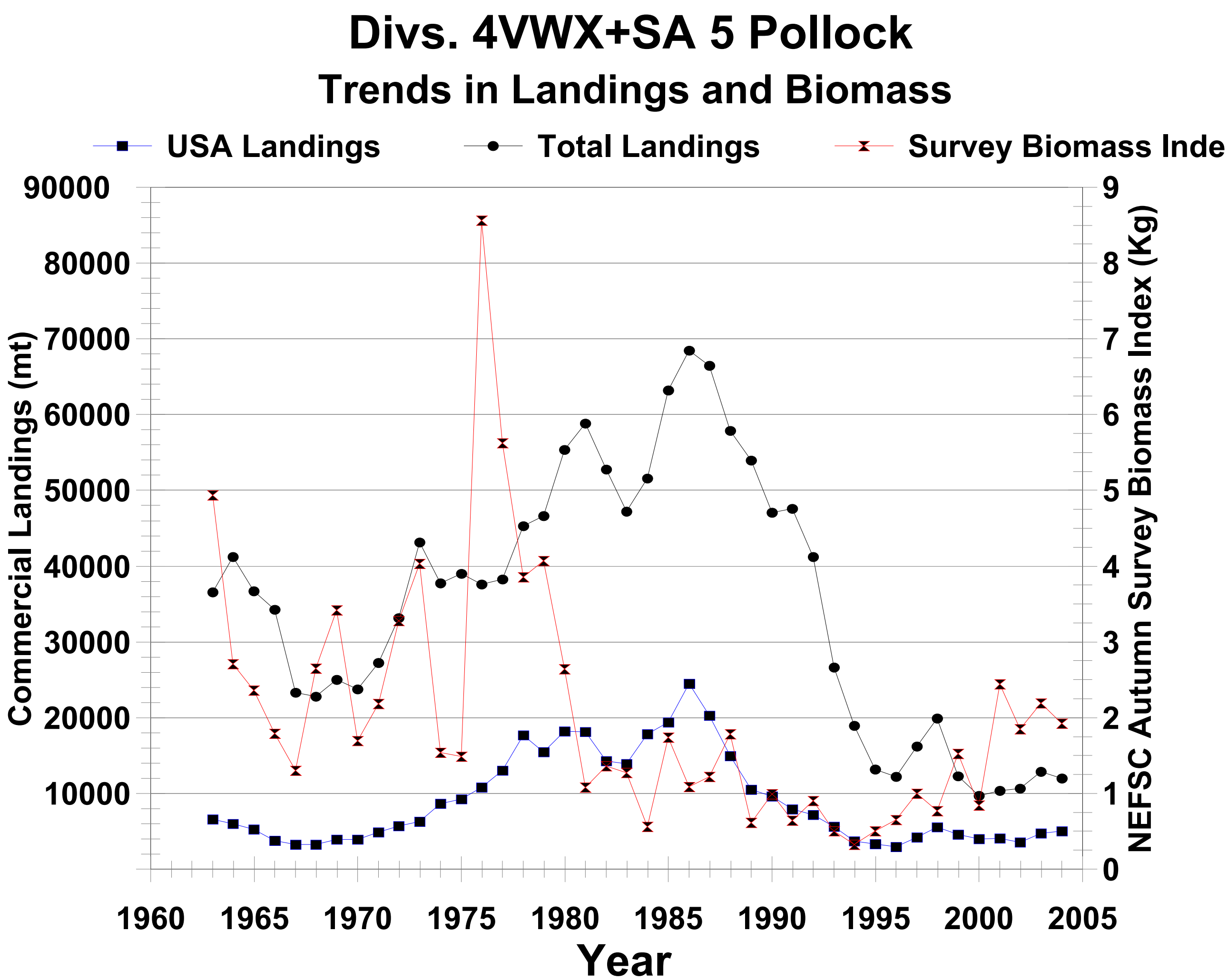
	NEFSC Spring Survey[2]								NEFSC Autumn Survey							
	Total Biomass		Mature Biomass		Total Numbers		Mature Numbers		Total Biomass		Mature Biomass		Total Numbers		Mature Numbers	
	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans	Linear	Re-trans
1963	-	-	-	-	-	-	-	-	5.502	4.939	5.164	4.636	1.401	1.289	1.113	1.024
1964	-	-	-	-	-	-	-	-	4.755	2.716	4.092	2.337	1.770	1.136	0.975	0.626
1965	-	-	-	-	-	-	-	-	2.977	2.362	2.657	2.108	0.903	0.847	0.555	0.521
1966	-	-	-	-	-	-	-	-	2.567	1.795	2.003	1.401	1.060	0.637	0.488	0.293
1967	-	-	-	-	-	-	-	-	1.973	1.310	1.809	1.201	0.560	0.478	0.391	0.334
1968	4.537	2.876	4.292	2.721	1.121	0.932	0.677	0.563	3.494	2.654	3.343	2.539	0.758	0.696	0.569	0.522
1969	2.723	2.584	2.404	2.281	1.157	1.014	0.519	0.455	7.208	3.424	6.994	3.322	1.395	0.884	1.248	0.791
1970	5.295	3.920	4.928	3.648	1.659	1.449	0.994	0.868	2.251	1.699	2.082	1.571	0.609	0.588	0.377	0.364
1971	3.474	2.831	3.266	2.661	0.973	0.897	0.593	0.547	4.365	2.189	3.833	1.922	1.201	0.778	0.612	0.396
1972	5.003	3.618	4.051	2.930	3.871	2.140	0.867	0.479	4.589	3.279	4.079	2.915	1.448	1.174	0.733	0.594
1973	4.927	3.835	3.508	2.731	4.329	1.710	1.018	0.402	4.683	4.037	4.382	3.778	1.267	1.106	0.865	0.755
1974	3.951	4.157	3.553	3.738	1.344	1.176	0.755	0.661	3.332	1.542	2.912	1.348	0.953	0.576	0.654	0.395
1975	5.919	5.580	5.409	5.099	1.621	1.298	1.014	0.812	2.087	1.494	1.905	1.364	0.718	0.493	0.381	0.262
1976	7.204	7.490	6.798	7.068	1.612	1.483	1.227	1.129	18.261	8.567	17.406	8.166	4.038	1.895	3.674	1.724
1977	3.591	3.295	3.205	2.941	1.717	1.318	0.882	0.677	9.376	5.628	8.789	5.276	2.272	1.303	1.739	0.997
1978	5.130	3.107	4.272	2.587	1.898	0.835	1.091	0.480	6.275	3.862	6.033	3.713	1.064	0.723	0.790	0.537
1979	4.585	3.750	4.348	3.556	1.036	0.939	0.785	0.712	4.770	4.074	4.504	3.847	0.865	0.719	0.718	0.597
1980	4.191	3.531	3.711	3.127	1.451	1.069	0.987	0.727	3.298	2.647	3.202	2.570	0.580	0.544	0.470	0.441
1981	5.749	5.391	5.415	5.078	1.395	1.221	0.989	0.866	2.683	1.083	2.178	0.879	1.033	0.341	0.672	0.222
1982	6.372	3.349	5.839	3.069	3.755	1.767	2.076	0.977	2.118	1.364	1.966	1.266	0.759	0.574	0.493	0.373
1983	1.592	1.018	1.533	0.980	0.897	0.662	0.251	0.185	2.989	1.274	2.834	1.208	0.976	0.579	0.479	0.284
1984	3.119	2.298	3.002	2.212	1.084	0.914	0.688	0.580	0.909	0.564	0.778	0.483	0.421	0.367	0.188	0.164
1985	29.132	8.446	26.404	7.655	14.587	2.725	12.014	2.244	2.114	1.742	1.875	1.545	1.080	0.708	0.454	0.298
1986	8.256	4.283	8.123	4.214	1.973	1.333	1.686	1.139	1.707	1.089	1.466	0.935	0.898	0.571	0.528	0.336
1987	2.778	1.870	2.510	1.690	1.616	0.738	0.599	0.274	2.035	1.223	1.924	1.156	0.597	0.506	0.383	0.325
1988	2.015	1.384	1.950	1.339	0.907	0.758	0.339	0.283	13.021	1.787	12.088	1.659	3.754	0.869	3.131	0.725
1989	5.216	2.156	5.041	2.084	1.998	1.024	1.577	0.808	1.223	0.619	0.723	0.366	1.883	0.771	0.461	0.189
1990	1.821	1.165	1.675	1.072	0.760	0.560	0.442	0.326	2.079	0.994	1.888	0.903	0.823	0.586	0.502	0.357
1991	5.051	2.797	4.738	2.624	2.303	1.399	1.762	1.070	1.055	0.649	0.851	0.524	0.728	0.535	0.409	0.301
1992	3.349	2.166	3.139	2.030	1.787	1.242	0.755	0.525	1.697	0.910	1.507	0.808	1.051	0.643	0.520	0.318
1993	1.602	1.248	1.358	1.058	1.648	1.163	0.534	0.377	0.769	0.505	0.570	0.374	1.043	0.567	0.195	0.106
1994	1.065	0.840	0.972	0.767	0.562	0.504	0.380	0.341	0.603	0.328	0.500	0.272	0.422	0.311	0.270	0.199
1995	3.716	1.307	2.659	0.935	3.432	0.820	1.984	0.474	1.017	0.504	0.787	0.390	0.840	0.465	0.516	0.286
1996	1.080	0.758	1.023	0.718	0.650	0.510	0.342	0.268	1.060	0.654	0.862	0.532	1.009	0.666	0.435	0.287
1997	4.573	2.060	3.866	1.742	3.369	1.802	1.693	0.906	1.512	1.003	1.095	0.726	1.766	0.921	0.611	0.319
1998	2.643	1.564	2.139	1.266	2.609	1.506	0.900	0.520	1.308	0.772	0.860	0.508	2.104	0.748	0.539	0.192
1999	1.069	0.862	0.745	0.601	2.165	1.022	0.419	0.198	3.099	1.532	2.595	1.283	2.414	1.394	1.161	0.670
2000	1.369	0.997	1.222	0.890	1.502	0.973	0.434	0.281	1.441	0.844	0.522	0.306	2.770	1.333	0.583	0.278
2001	2.029	1.275	1.854	1.165	1.693	1.272	0.728	0.547	3.567	2.448	3.067	2.105	2.385	1.811	1.361	1.033
2002	1.578	1.247	1.475	1.166	0.760	0.630	0.482	0.400	5.920	1.855	5.420	1.698	3.135	1.460	2.305	1.073
2003	0.890	0.667	0.731	0.548	1.439	0.734	0.242	0.123	7.951	2.197	6.348	1.754	7.363	2.043	4.790	1.329
2004	0.744	0.585	0.703	0.553	0.487	0.380	0.180	0.140	4.206	1.925	3.440	1.574	3.221	1.395	2.122	0.919
2005	5.700	2.426	5.537	2.357	2.046	1.258	1.612	0.991								

[1] NEFSC Strata 01130-01300, 01330-01340, 01360-01400.
[2] The "36 Yankee" trawl was used from 1970-1972, and 1982-2002; the "41 Yankee" trawl was used from 1973-1981.
No gear conversion factors are available to adjust for differences in fishing power.
[3] BMV oval doors were used from 1970-1984; since 1985 Portuguese polyvalent doors have been used. No door conversion factors were applied.
Surveys performed using *R/V Albatross IV* and *R/V Delaware II*; No vessel conversion factors were applied.

Table M3. Total commercial landings (mt), NEFSC autumn survey biomass index (kg/tow, LN retransformed), exploitation ratio (relative F) and replacement ratio For pollock in NAFO Subareas 5&6, 1963-2004.

	Landings	Mean Weight (kg) per Tow		Exploitation Ratio (Rel. F)		Replacement Ratio
	SA5&6	Annual	3-yr Avg	Annual	3-yr Avg	5-yr Avg
1963	6241	4.939		1.264		
1964	9008	2.716		3.317		
1965	9000	2.362	3.339	3.810	2.695	
1966	9847	1.795	2.291	5.486	4.298	
1967	8534	1.31	1.822	6.515	4.683	
1968	5222	2.654	1.920	1.968	2.720	1.011
1969	9822	3.424	2.463	2.869	3.988	1.580
1970	11976	1.699	2.592	7.049	4.620	0.736
1971	15203	2.189	2.437	6.945	6.238	1.006
1972	13013	3.279	2.389	3.969	5.447	1.454
1973	13076	4.037	3.168	3.239	4.127	1.524
1974	12393	1.542	2.953	8.037	4.197	0.527
1975	13871	1.494	2.358	9.284	5.883	0.586
1976	13382	8.567	3.868	1.562	3.460	3.416
1977	16273	5.628	5.230	2.891	3.112	1.487
1978	22305	3.862	6.019	5.776	3.706	0.908
1979	18452	4.074	4.521	4.529	4.081	0.966
1980	23539	2.647	3.528	8.893	6.673	0.560
1981	22068	1.083	2.601	20.377	8.483	0.219
1982	19466	1.364	1.698	14.271	11.464	0.394
1983	17816	1.274	1.240	13.984	14.364	0.489
1984	20633	0.564	1.067	36.583	19.331	0.270
1985	21069	1.742	1.193	12.095	17.656	1.256
1986	26507	1.089	1.132	24.341	23.423	0.903
1987	22347	1.223	1.351	18.272	16.537	1.014
1988	17304	1.787	1.366	9.683	12.665	1.516
1989	11903	0.619	1.210	19.229	9.840	0.483
1990	11201	0.994	1.133	11.269	9.883	0.769
1991	9600	0.649	0.754	14.792	12.732	0.568
1992	10225	0.91	0.851	11.236	12.015	0.863
1993	9873	0.505	0.688	19.550	14.350	0.509
1994	7099	0.328	0.581	21.643	12.219	0.446
1995	4362	0.504	0.446	8.655	9.788	0.744
1996	4164	0.654	0.495	6.367	8.406	1.129
1997	5483	1.003	0.720	5.467	7.612	1.729
1998	7441	0.772	0.810	9.639	9.190	1.289
1999	5591	1.532	1.102	3.649	5.072	2.349
2000	5240	0.844	1.049	6.209	4.994	0.945
2001	5680	2.448	1.608	2.320	3.532	2.547
2002	5170	1.855	1.716	2.787	3.013	1.406
2003	6215	2.197	2.167	2.829	2.868	1.474
2004	7000	1.925	1.992	3.636	3.513	1.084

Figure M1



Divs. 4VWX+SA 5 Pollock
Trends in Landings and Biomass
USA Landings
Total Landings
Survey Biomass Inde
Commercial Landings (mt)
NEFSC Autumn Survey Biomass Index (Kg)
Year
90000
80000
70000
60000
50000
40000
30000
20000
10000
9
8
7
6
5
4
3
2
1
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

Figure M2

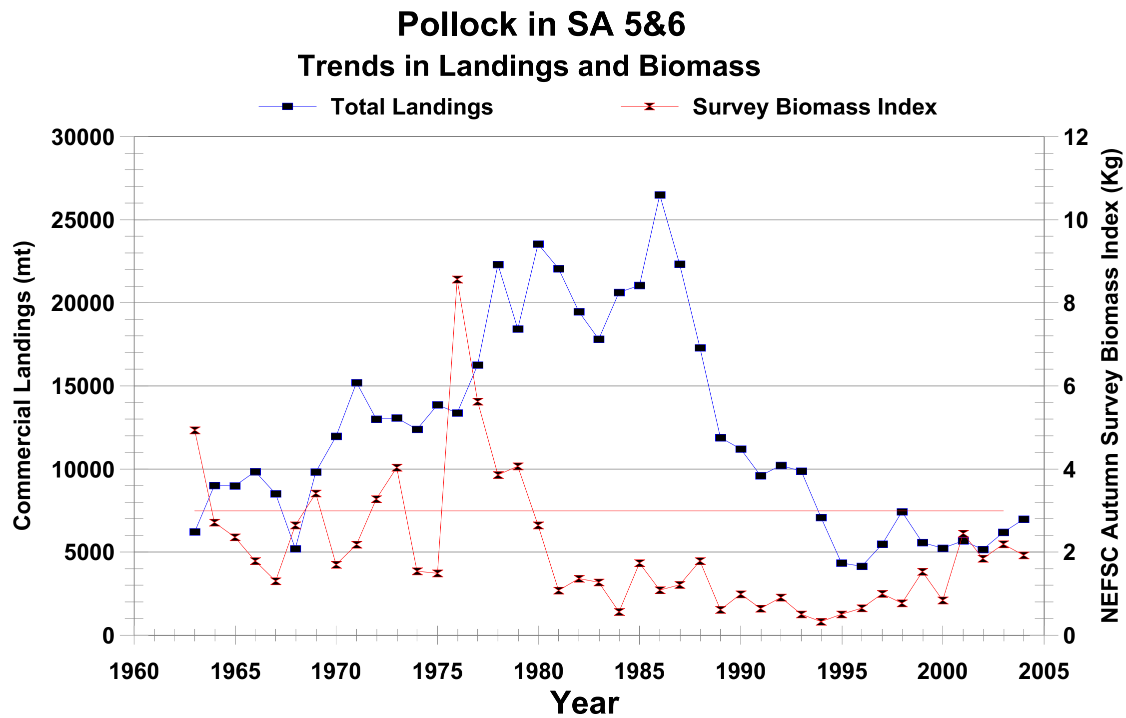


Figure M3

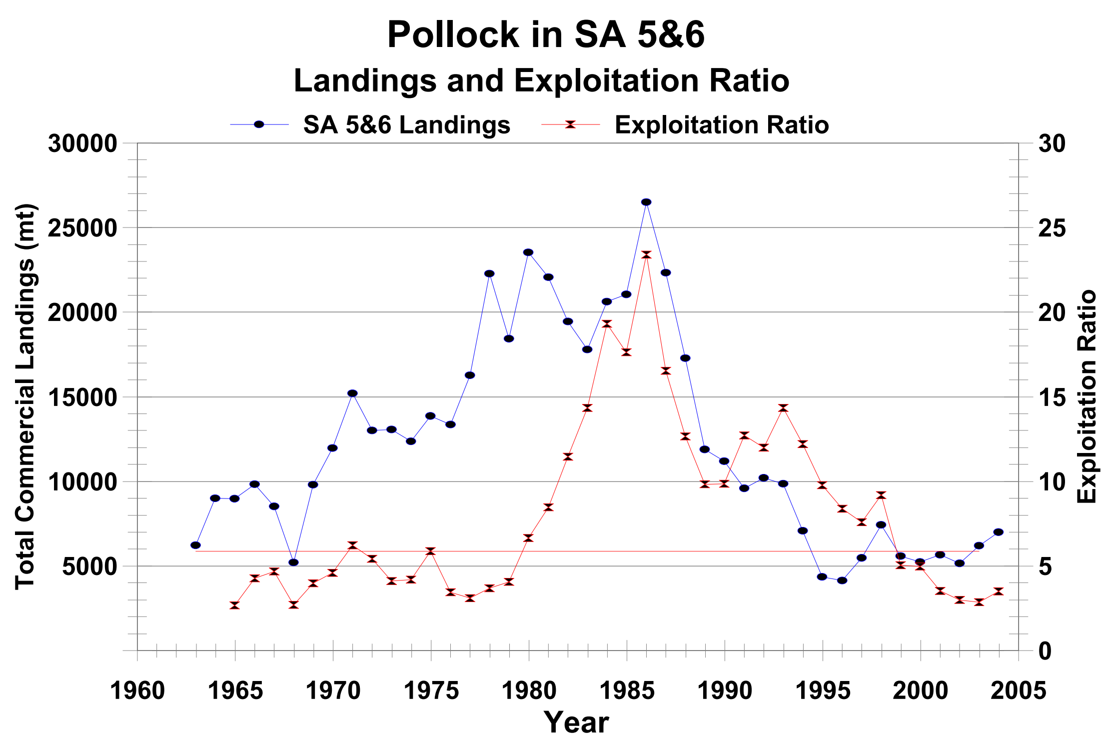


Figure M4

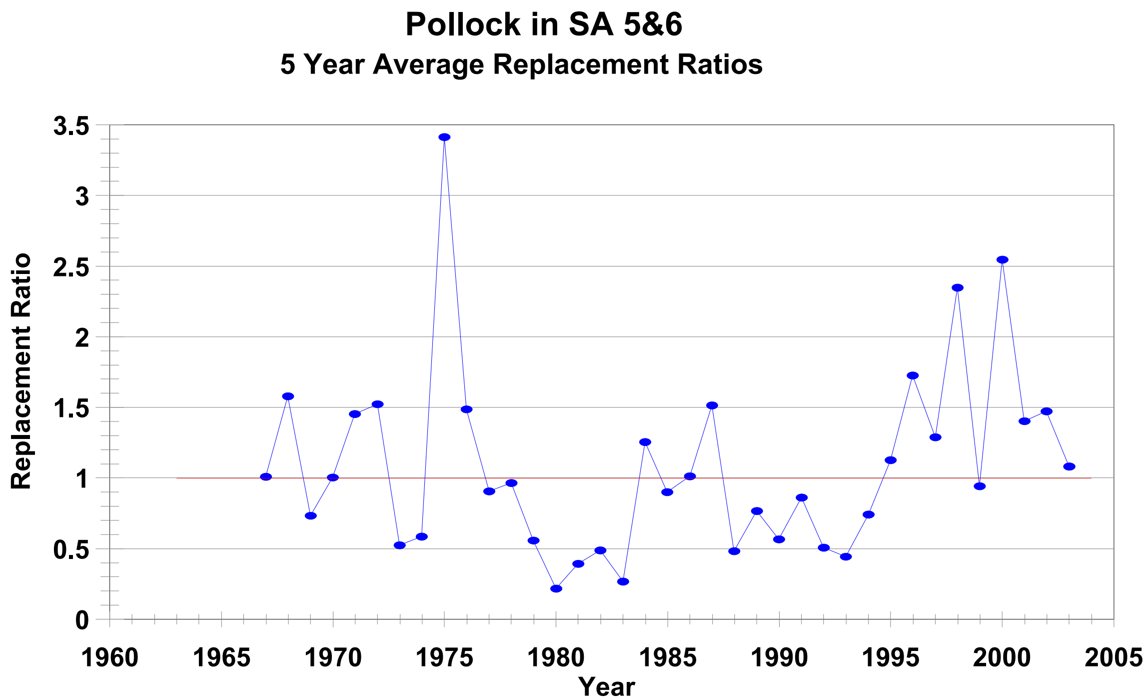


Figure M5

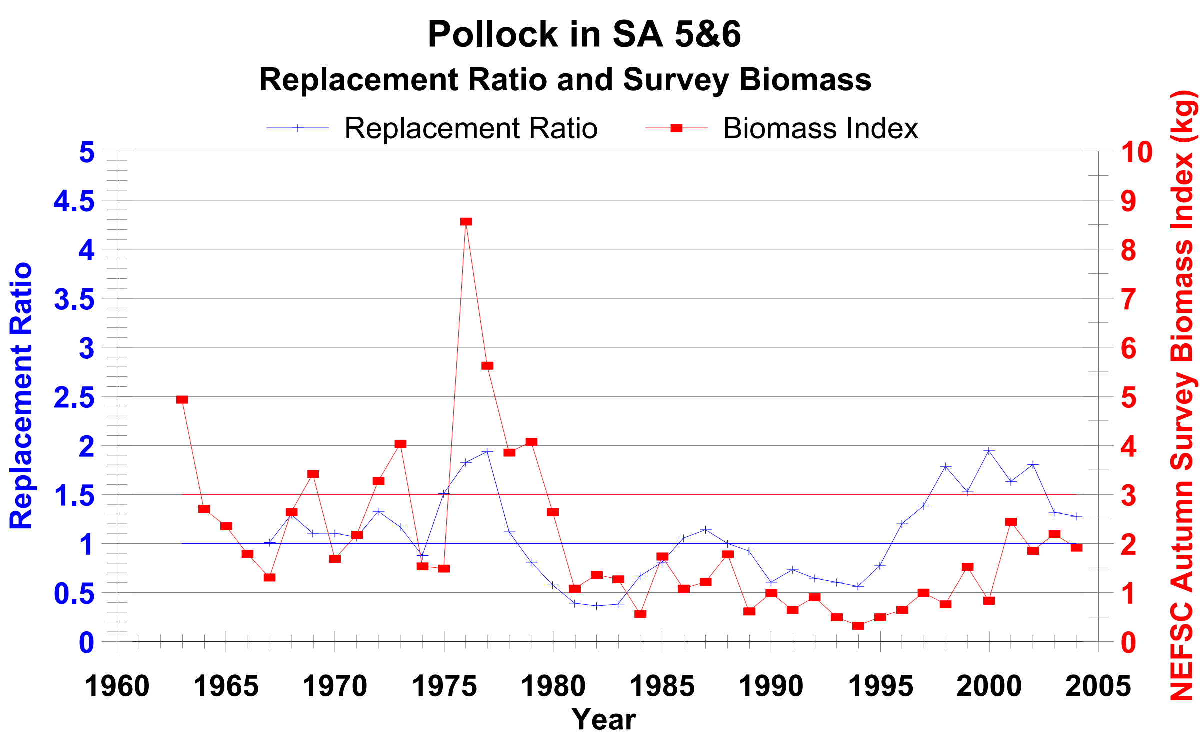
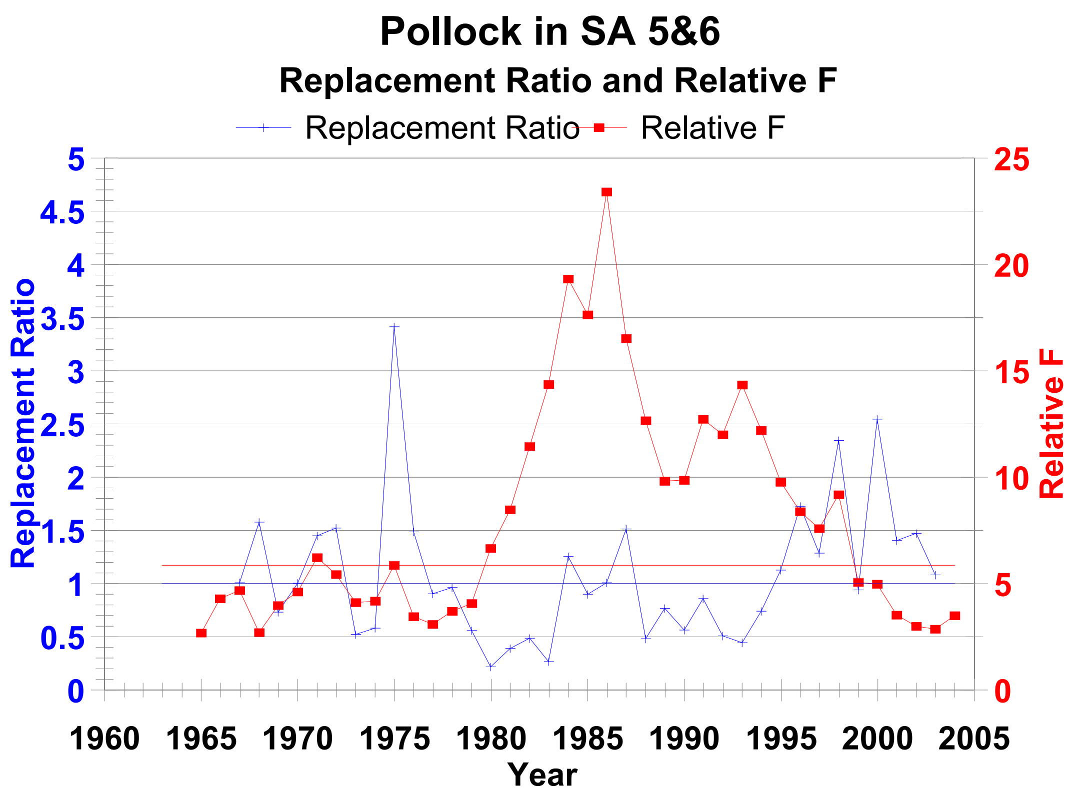


Figure M6



Pollock in SA 5&6
Replacement Ratio and Relative F
Replacement Ratio
Relative F
Replacement Ratio
Relative F
Year
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
5
10
15
20
25
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

N. Gulf of Maine/Georges Bank Acadian Redfish by **R.K. Mayo, J. Brodziak, M. Traver and L. Col**

1.0 Background

The most recent stock assessment of Acadian redfish in Subarea 5 was completed in 2001 (Mayo *et al.* 2002), and the results were reviewed at the 33rd Northeast Regional Stock Assessment Workshop in June, 2001 (NEFSC 2001a, 2001b). The assessment was based on several analyses including trends in catch/survey biomass exploitation ratios; a yield and biomass per recruit analysis; an age-structured dynamics model which incorporates information on the age composition of the landings, size and age composition of the population, and trends in relative abundance derived from commercial CPUE and research vessel survey biomass indices; and an age-aggregated biomass dynamics model. Surplus production estimates were derived from the age-structured dynamics model. Estimates of current biomass and fishing mortality relative to MSY-based reference points were also provided by the biomass dynamics model.

Based on the most recent assessment, redfish biomass has been increasing in recent years. The NEFSC autumn survey biomass index had increased substantially during the mid-1990s and had remained relatively high through 2000. The rapid increase in abundance and biomass was attributed to recruitment and growth of the 1992 and other early-1990s year classes. The state of this stock was reviewed at the 2002 Groundfish Assessment Review Meeting (Mayo and Col 2002) by examining trends in relative biomass and exploitation ratios based on the NEFSC autumn bottom trawl surveys. At that time exploitation ratios (catch/total survey biomass) suggested that fishing mortality has remained very low since the mid-1980s compared to previous periods. Estimates of fishing mortality derived from the age-structured dynamics model (Mayo *et al.* 2002) also indicated that then current fishing mortality (0.003) was low relative to past decades and less than 10% of F_{MSY}. Stock biomass in 2000 was then estimated to be 119,600 mt or about 33% of B_{MSY} due, in large part, to strong recruitment from the early 1990s

2.0 The Fishery

Exploitation of redfish has changed substantially since the 1930s. During the early development phase of the Gulf of Maine redfish fishery, USA landings increased rapidly to a peak level of about 56,000 mt in 1942 followed by a steep decline through the early 1950s (Table N1; Figure N1). Nominal catches then declined at a more gradual rate to less than 10,000 mt during the 1960s. During the 1970s, USA landings increased again, peaking at 16,000 mt in 1971 and again at 15,000 mt in 1979. During the1970s, additional catches by Canadian and distant water fleets increased the total redfish catch to a maximum of about 17,000 to 20,000 mt per year from 1970 through 1973; catches of redfish by these fleets declined to negligible levels after1976. Landings of redfish declined steadily throughout the1980s, remaining below 1,000 mt per year since1989, and at less than 500 mt per year since 1994. Total redfish landings in 2004 were 398 mt compared to 360 mt in 2003. Although population biomass has increased sharply since the mid-1990s, most of fish are below the retention size of the current otter trawl regulated minimum mesh size (6.5 in).

The redfish fishery in the Gulf of Maine has traditionally taken very low bycatch of other species. For example, over 70% of the redfish landed during 1964-1978 were taken on trips comprising over 85% redfish (Mayo 1980). Commercial catch per unit effort (CPUE) indices from these trips were considered representative of trends in stock biomass. These indices are available from the early 1940s through the late1980s but have since been discontinued (Table N1, Figure N2). These indices declined sharply during the 1940s and 1950 as the large accumulated virgin biomass was fished down. The CPUE indices increased during the 1960 following recruitment of several strong year classes from the 1950 (Mayo 1980) but have since shown a steady decline (Figure N2).

As a consequence of the relatively low landings of redfish after the mid 1980s, the level of biological sampling declined and is now extremely low (Table N2). Estimates of catch and mean weight at age were derived up to 1985 (Table N3), but these calculations have since been discontinued.

3.0 Research Survey Indices

Total Biomass Indices

Indices of relative biomass, derived from NEFSC spring (Table N4, Figure N3) and autumn (Table N5, Figure N4) research vessel bottom trawl surveys, although variable, exhibited a rather steady decline between 1963 and 1982. On average, the autumn biomass index appears to have declined by about 90% over a 20 year period. During this time, only two year classes of any significance were produced, 1971 and 1978. Between 1983 and 1993, the biomass index approximately doubled, reflecting the relatively low rate of removals by the fishery and the very slow growth rate of the species.

No substantial year classes were detected by the research vessel surveys until autumn 1995 when a substantial number of fish in the 15-19 cm range were noted, suggesting the possibility of above average reproduction in 1990 and/or 1991. This was followed by a very large increase in the abundance index in the autumn of 1996. The autumn biomass index has fluctuated between 20 and 65 kg per tow since then, a magnitude comparable to the period between 1963 and the mid-1970s. Indices from both surveys are used as relative biomass indices in the age-structured model.

Exploitable Biomass Indices

Indices of exploitable biomass (Table N6) were computed by adjusting the total biomass indices by length-specific retention rates obtained by first fitting mesh selectivity data to a logistic model. Selectivity studies are available for redfish for a range of mesh sizes from 60 to 134 mm (2.36 – 5.28 in) (Clark 1963, Clay 1979, McKone 1979 Nikeshin et al. 1981). As the regulated mesh size in the groundfish fishery increased to the present 6-6.5 inches, redfish retention rates declined. At present the portion of the total biomass stock that can be exploited is very small compared to the earlier periods.

Survey Age Composition

Age samples from the NEFSC autumn bottom trawl survey are available from 1975 through 2004. As illustrated in Figure Nx abundance estimates at age reveal a series of dominant year classes followed by periods of poor year classes between 1975 and the early 1990s. Several strong year classes began to appear in the early 1990s and additional year classes have continued to appear in the survey, the annual growth of these fish accounts for the sharp increases in the total biomass indices beginning in the mid-1990s. Both surveys provide age composition information for the age-structured model.

4.0 Assessment Results

The age structured model (RED) employed at the last peer review of this assessment in 2001 (SAW 33) was updated with NEFSC spring and autumn bottom trawl survey biomass indices and NEFSC autumn bottom trawl survey age compositions through 2004. A full description of the age-structured model is provided in Mayo *et al*. 2002.

The age-structured model is based on forward projection of population numbers at age. This modeling approach is based on the principle that population numbers through time are determined by recruitment and total mortality at age through time. The population numbers at age matrix $\mathbf{N}=(N_{y,a})_{YxA}$ has dimensions Y by A, where Y is the number of years in the assessment time horizon and A is the number of age classes modeled. The oldest age (A) comprises a plus-group consisting of all fish age-A and older. The time horizon for redfish is 1934-2004 (Y=71). The number of age classes is 26, representing ages 1 through 26+.

Input data to the model includes the total catch 1934-2004), commercial CPUE index (1942-1989), commercial catch at age (1969-1985), NEFSC spring and autumn total biomass indices and the autumn survey age composition (1975-1984).

Based on results from RED, fishing mortality in 2004 is estimated at 0.00239, a substantial decline from 2001. Spawning stock biomass increased from 124,400 mt in 2001 to 175,800 mt in 2004. The estimate of the 2000 spawning stock biomass based on the present assessment is within 5% of the estimate obtained from the 2001 assessment.

Sensitivity Analyses

The initial version of the age structured forward projection model (RED) was refined after 2001, and is now a component of the NOAA Fisheries Toolbox (NFT) stock assessment software named STATCAM. This version, while identical to RED in most approaches, provides for additional weighting of input data, depending on the length of the time series. Comparative runs of both models were conducted on data sets available at the previous peer review meeting (1934-2000) and at the present meeting (1934-2004) to determine whether differences in modeling approaches produced different estimates of spawning biomass and F.

While both models produce very similar estimates of spawning stock biomass and fishing mortality over time (Figures N6 and N7), the STATCAM model is generating a higher rate of increase in SSB during the past decade than the biomass produced by the original RED model. Although both models produce the same status determination for this stock, because the results from the original RED model were used to derive the biomass reference point, the update from this model is used for current status determination.

5.0 Biological Reference Points

Estimates of recruitment obtained from the age-structured biomass dynamics model reviewed at the 33rd SAW were used to imply the probable recruitment that could be produced by a rebuilt stock as described in NEFSC (2002). Recruitment estimates derived by the model from the1952-1999 year classes served as the basis for evaluating trends and patterns in recruitment. The stock-recruitment data suggest an increase in the frequency of larger year classes (> 50 million fish) at higher biomass levels. Therefore recruitment estimates corresponding to the upper quartile of the SSB range served as the basis for deriving mean and median recruitment estimates. In accordance with the recommendation of the Stock Assessment Review Committee of the 33rd SAW, the estimate of $F_{50\%}$ (0.04) is taken as a proxy for F_{MSY}. This fishing mortality rate produces 4.1073 kg of spawning stock biomass per recruit and 0.1429 kg of yield per recruit. The resulting mean recruitment of 57.63 million fish results in an SSB_{MSY} estimate of 236,700 mt when multiplied by the SSB per recruit, and an MSY estimate of 8,235 mt when multiplied by the yield per recruit.

Reference points derived from the non parametric approach are:

MSY	8,235mt
B_{MSY}	236,700 mt
F_{MSY}	$0.04 = F_{50\%}$ MSP

It was determined (NEFSC 2002) that the stock could not be rebuilt to B_{MSY} by 2009 even at F=0.0. Therefore, the rebuilding scenario invoked a 10 year plus 1 mean generation time (31 years for Acadian redfish) to achieve rebuilding. This results in an Frebuild = 0.013. Based on the results from the present assessment, F in 2004 (0.002) is below Fmsy (and Frebuild), and spawning stock biomass is above ½ Bmsy. Thus overfishing is not occurring and the stock is not in an overfished condition.

6.0 Summary

Spawning stock biomass in 2004 is estimated at 175,800 mt, 74% of Bmsy and F in 2004 is estimated at 0.002, well below Fmsy. Thus, the stock is not overfished and overfishing is not occurring.

7.0 GARM Panel Comments

Exploitable biomass was estimated based on approximate mesh size changes through time. Mesh selection ogives were generated for a set of 5 discrete time periods. These curves were used to estimate exploitable biomass using the NEFSC survey length frequency data. The Panel concluded that this analysis satisfied the research recommendation to evaluate the consequence of changing mesh size on exploitable redfish biomass.

The Panel reviewed results of the updated redfish model (RED) and an alternative statistical catch-at-age mode (STATCAM) applied to provide a sensitivity analysis. The Panel noted that the STATCAM and RED models produce similar results in terms of recent trends in biomass and fishing mortality but had some differences in estimates of the magnitude of strong year classes and survey selectivity. The Panel accepted the updated redfish model (RED).

8.0 Sources of Uncertainty

- The sharp increase in the survey biomass index in 1996 is inconsistent with the life history characteristics of this species.
- Given the pelagic diurnal movement and general distribution of redfish, swept area estimates of stock biomass derived from bottom trawl survey data will tend to under-estimate absolute stock size.

9.0 References

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Table N1. Nominal redfish catches (metric tons), actual and standardized catch per unit effort, and calculated standardized USA and total effort for the Gulf of Maine-Georges Bank redfish fishery.

	Nominal Catch (Metric tons)			USA Catch per Unit Effort (tons/day)		Calculated Standard Effort (days fished)	
Year	USA	Others	Total	Actual	Standard	USA	Total
1934	519		519				
1935	7549		7549				
1936	23162		23162				
1937	14823		14823				
1938	20640		20640				
1939	25406		25406				
1940	26762		26762				
1941	50796		50796				
1942	55892		55892	6.9	6.9	8100	8100
1943	48348		48348	6.7	6.7	7216	7216
1944	50439		50439	5.4	5.4	9341	9341
1945	37912		37912	4.5	4.5	8425	8425
1946	42423		42423	4.7	4.7	9026	9026
1947	40160		40160	4.9	4.9	8196	8196
1948	43631		43631	5.4	5.4	8080	8080
1949	30743		30743	3.3	3.3	9316	9316
1950	34307		34307	4.1	4.1	8368	8368
1951	30077		30077	4.1	4.1	7336	7336
1952	21377		21377	3.5	3.4	6287	6287
1953	16791		16791	3.8	3.6	4664	4664
1954	12988		12988	3.4	3.1	4190	4190
1955	13914		13914	4.5	4.0	3479	3479
1956	14388		14388	4.4	3.8	3786	3786
1957	18490		18490	4.3	3.6	5136	5136
1958	16043	4	16047	4.4	3.6	4456	4458
1959	15521		15521	4.3	3.5	4435	4435
1960	11373	2	11375	3.8	3.0	3791	3792
1961	14040	61	14101	4.6	3.5	4011	4029
1962	12541	1593	14134	5.4	4.0	3135	3534
1963	8871	1175	10046	4.1	3.0	2957	3349
1964	7812	501	8313	4.3	2.9	2694	2867
1965	6986	1071	8057	7.0	4.4	1588	1831
1966	7204	1365	8569	11.7	6.4	1126	1339
1967	10442	422	10864	12.4	5.6	1865	1940
1968	6578	199	6777	14.7	6.1	1078	1111
1969	12041	414	12455	11.4	4.9	2457	2542
1970	15534	1207	16741	9.0	4.0	3884	4185
1971	16267	3767	20034	7.0	3.2	5083	6261
1972	13157	5938	19095	5.7	2.9	4537	6584
1973	11954	5406	17360	5.3	2.9	4122	5986
1974	8677	1794	10471	5.0	2.6	3337	4027
1975	9075	1497	10572	4.0	2.2	4125	4805
1976	10131	565	10696	4.6	2.3	4405	4650
1977	13012	211	13223	4.9	2.5	5205	5289
1978	13991	92	14083	4.8	2.4	5830	5868
1979	14722	33	14755	3.6	1.9	7748	7766
1980	10085	98	10183	3.2	1.6	6303	6364
1981	7896	19	7915	2.7	1.4	5640	5654
1982	6735	168	6903	2.7	1.5	4490	4602
1983	5215	113	5328	2.1	1.2	4346	4440
1984	4722	71	4793	1.9	1.1	4293	4357
1985	4164	118	4282	1.4	0.9	4627	4758
1986	2790	139	2929	1.0	0.6	4650	4882
1987	1859	35	1894	1.1	0.7	2656	2706
1988	1076	101	1177	0.9	0.5	2152	2354
1989	628	9	637	1.1	0.6	1047	1062
1990	588	13	601	**	**		
1991	525		525	**	**		
1992	849		849	**	**		
1993	800		800	**	**		
1994*	440		440	**	**		
1995*	440		440	**	**		
1996*	322		322	**	**		
1997*	251		251	**	**		
1998*	320		320	**	**		
1999*	353		353	**	**		

Table N1 - continued

2000*	319	319	**	**
2001*	360	360	**	**
2002*	368	368	**	**
2003*	361	361	**	**
2004*	398	398	**	**

* Preliminary

** CPUE and effort not calculated due to sharp reduction in directed redfish trips

Table N2. Commercial length and age sampling summary for Gulf of Maine - Georges Bank Redfish, 1969-2000.

Year	Landings (tons)	Number of Samples	Number of tons/sample	Number of Length Measurements	Number of Ages Collected	Number of Ages Available
1969	12455	14	890	3,200	?	616
1970	16741	18	930	2,300	600	461
1971	20034	34	589	7,796	963	963
1972	19095	16	1193	5,085	?	1,066
1973	17360	23	755	6,246	1,120	1,027
1974	10471	34	308	7,945	2,170	1,011
1975	10572	27	392	6,761	2,912	1,147
1976	10696	24	446	8,094	3,700	1,028
1977	13223	31	427	8,495	3,688	863
1978	14083	30	469	5,493	2,352	1,012
1979	14755	35	422	8,975	3,866	1,122
1980	10183	21	485	4,858	2,210	1,110
1981	7915	21	377	3,718	1,718	851
1982	6903	27	256	4,216	1,734	849
1983	5328	31	172	5,100	2,416	995
1984	4793	26	184	4,603	2,275	1,018
1985	4282	37	116	5,775	2,962	1,464
1986	2929	38	77	6,063	3,102	N/A
1987	1894	29	65	4,633	2,290	N/A
1988	1177	21	56	2,487	1,258	N/A
1989	637	17	37	1,921	958	N/A
1990	601	12	51	1,338	692	N/A
1991	525	10	52	1,136	?225	N/A
1992	849	11	77	1,354	?	N/A
1993	800	5	160	528	?	N/A
1994	440	2	220	226	?	N/A
1995	440	3	147	303	?	N/A
1996	322	1	322	113	?	N/A
1997	251	3	84	343	?	N/A
1998	320	0	-	0	?	N/A
1999	353	1	353	111	?	N/A
2000	319	1	319	110	?	N/A

Table N3. Total catch at age and mean weights at age for Gulf of Maine - Georges Bank redfish, 1969-1985.

Year	Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26+
														Number landed (000s)												
1969	-	-	-	22	421	439	1008	6065	2513	6717	2660	3975	3287	2221	2820	1348	751	526	606	426	451	345	469	38	100	847
1970	-	-	-	-	146	4055	4048	1060	9692	3221	8351	2734	4702	2672	2302	3489	1778	1640	393	662	368	529	572	488	64	1743
1971	-	-	-	-	-	72	1941	4430	1536	7907	2767	6504	3088	4267	3680	2895	2206	2765	1347	1163	560	1048	559	282	138	2439
1972	-	-	-	-	-	-	933	3296	7401	1712	7580	2782	2884	1994	3531	2449	1205	1276	2245	734	1011	1172	718	538	1280	2874
1973	-	-	-	-	-	-	235	2463	7938	8391	2201	7337	2078	3100	2376	2024	1799	1380	864	933	411	590	426	295	289	1977
1974	-	-	308	105	-	17	8	174	1886	4724	2945	2435	1709	1115	1302	935	1454	910	640	661	589	730	271	285	250	1755
1975	-	-	4	695	72	11	-	30	124	1944	4360	2154	1932	1442	1009	1344	1360	1235	945	1116	608	887	492	294	298	1282
1976	-	-	-	196	8961	439	-	-	21	48	467	2706	3375	1702	1725	1388	1233	1166	1424	608	769	681	323	672	94	2011
1977	-	-	-	-	234	16747	311	-	-	-	81	2127	1262	4012	1823	2747	1466	1190	1064	461	706	541	117	571	1013	2157
1978	-	-	-	-	-	271	24569	215	-	34	33	182	1689	1484	2948	1748	1310	866	899	1283	895	734	500	192	530	2220
1979	-	-	-	-	25	205	849	23729	152	117	48	168	541	1228	1972	1299	1580	983	845	1008	798	594	532	538	427	2506
1980	-	-	-	-	-	132	175	1110	16900	208	44	46	217	491	830	1221	860	664	564	452	473	370	349	294	265	1308
1981	-	-	23	-	77	40	57	47	223	12380	84	22	-	44	317	364	1274	506	534	396	318	381	306	326	350	1540
1982	-	-	3	271	123	60	92	30	-	15	7268	56	32	21	128	185	582	452	840	324	501	484	301	134	104	2270
1983	-	-	-	11	1687	159	46	43	86	49	141	4959	58	106	64	42	85	319	270	551	169	224	314	195	131	1817
1984	-	-	46	11	51	6674	-	20	40	-	35	15	3571	-	44	49	34	92	210	166	324	215	144	157	162	1807
1985	-	-	27	146	33	31	3818	-	28	11	13	40	12	3202	-	25	11	101	116	260	230	187	197	142	107	1489
														Mean weight (kg)												
1969	.010	.020	.052	.113	.115	.142	.169	.195	.219	.260	.320	.339	.366	.404	.425	.473	.495	.457	.589	.497	.515	.594	.589	.705	.708	.591
1970	.010	.020	.052	.092	.172	.168	.170	.189	.221	.236	.290	.339	.356	.367	.340	.418	.427	.438	.523	.579	.505	.450	.464	.476	.345	.541
1971	.010	.020	.052	.092	.135	.172	.242	.244	.265	.304	.333	.369	.399	.437	.445	.468	.435	.449	.541	.553	.514	.544	.581	.481	.473	.540
1972	.010	.020	.052	.092	.135	.171	.197	.240	.257	.289	.334	.367	.399	.427	.451	.472	.490	.515	.509	.562	.581	.565	.604	.489	.560	.668
1973	.010	.020	.052	.092	.135	.171	.162	.213	.257	.281	.343	.341	.384	.402	.482	.454	.500	.492	.523	.525	.529	.641	.633	.568	.653	.620
1974	.010	.020	.064	.080	.135	.195	.150	.233	.270	.326	.331	.378	.399	.427	.449	.442	.503	.527	.540	.565	.525	.578	.585	.641	.633	.642
1975	.010	.020	.039	.098	.161	.221	.195	.383	.349	.317	.342	.394	.399	.420	.460	.469	.533	.527	.522	.550	.600	.547	.595	.607	.663	.662
1976	.010	.020	.052	.076	.135	.199	.195	.245	.345	.278	.296	.347	.395	.389	.405	.427	.511	.469	.542	.517	.518	.552	.645	.577	.628	.630
1977	.010	.020	.052	.092	.090	.173	.288	.245	.277	.297	.350	.413	.412	.408	.433	.454	.462	.534	.537	.610	.466	.595	.611	.544	.552	.605
1978	.010	.020	.052	.092	.135	.135	.209	.300	.277	.311	.383	.468	.402	.433	.423	.458	.551	.504	.526	.547	.523	.537	.633	.551	.606	.641
1979	.010	.020	.052	.092	.135	.200	.191	.251	.304	.295	.248	.402	.508	.472	.474	.564	.526	.543	.551	.617	.664	.597	.567	.605	.567	.647
1980	.010	.020	.052	.092	.135	.108	.175	.188	.283	.371	.421	.362	.424	.454	.506	.478	.499	.518	.554	.595	.647	.664	.629	.599	.681	.695
1981	.010	.020	.080	.092	.117	.150	.143	.195	.247	.318	.374	.466	.404	.532	.592	.543	.528	.499	.537	.550	.594	.617	.560	.633	.552	.650
1982	.010	.020	.052	.142	.203	.256	.242	.252	.277	.383	.395	.491	.563	.383	.544	.475	.540	.504	.564	.583	.592	.563	.621	.499	.535	.699
1983	.010	.020	.052	.107	.172	.198	.249	.329	.252	.368	.396	.425	.381	.471	.504	.595	.494	.579	.639	.580	.614	.647	.622	.630	.589	.682
1984	.010	.020	.110	.092	.206	.197	.195	.311	.252	.297	.333	.377	.403	.420	.497	.630	.569	.529	.519	.499	.610	.547	.568	.600	.517	.619
1985	.010	.020	.092	.146	.154	.177	.239	.245	.279	.345	.421	.362	.595	.443	.441	.591	.494	.545	.599	.552	.603	.635	.605	.699	.624	.692

Table N4 Spring NEFSC bottom trawl survey stratified mean catch per tow indices, average weights and average lengths of redfish in the Gulf of Maine - Georges Bank region.

Year	INSHORE 1 Stratified Mean Catch per Tow Number	kg	Avg. Wt. kg	Avg. Length cm	OFFSHORE 2 Stratified Mean Catch per Tow Number	kg	Avg. Wt. kg	Avg. Length cm	COMBINED 3 Stratified Mean Catch per Tow Number	kg
1968	7.9	1.2	0.152	17.9	51.7	19.8	0.383	26.4	45.2	17.0
1969	59.0	8.3	0.141	20.3	44.2	21.7	0.491	30.6	46.4	19.7
1970	29.7	9.3	0.313	24.4	59.1	20.6	0.349	26.4	54.7	18.9
1971	49.9	13.3	0.267	24.9	176.0	81.7	0.464	29.8	157.2	71.6
1972	23.8	4.6	0.193	18.6	114.7	51.3	0.447	28.9	101.2	44.4
1973	14.4	4.6	0.319	22.0	49.6	28.9	0.583	31.4	44.4	25.3
1974	25.7	6.1	0.237	19.7	35.8	21.0	0.587	31.5	34.3	18.8
1975	50.9	18.9	0.371	25.5	37.4	17.4	0.465	28.5	38.9	17.6
1976	45.9	6.4	0.139	19.8	65.1	29.6	0.455	29.2	62.2	26.2
1977	79.1	24.0	0.303	25.3	15.6	9.4	0.603	32.1	25.1	11.6
1978	33.7	10.4	0.309	25.0	22.3	12.5	0.561	30.2	24.0	12.2
1979	27.5	8.5	0.309	25.4	67.5	36.4	0.539	30.0	61.6	32.3
1980	8.5	2.2	0.259	25.3	33.5	23.5	0.701	32.4	29.8	20.3
1981	3.0	1.0	0.333	22.5	38.9	21.7	0.558	30.5	33.6	18.6
1982	5.0	1.4	0.280	24.7	19.0	10.8	0.568	30.1	16.9	9.4
1983	4.8	0.9	0.188	21.6	10.7	7.0	0.654	31.0	9.9	6.1
1984	5.4	1.6	0.296	25.1	4.9	2.9	0.592	30.2	5.0	2.7
1985	1.2	0.4	0.333	24.8	13.6	7.7	0.566	30.1	11.7	6.6
1986	9.5	5.4	0.568	29.9	4.5	2.8	0.622	31.4	5.3	3.2
1987	5.5	1.4	0.255	23.9	27.8	14.9	0.536	30.5	24.5	12.9
1988	11.7	2.6	0.222	23.0	7.5	3.4	0.453	28.4	8.1	3.3
1989	17.6	2.7	0.153	17.6	6.5	3.0	0.462	27.8	7.6	2.9
1990	0.8	0.2	0.250	23.1	14.4	8.0	0.556	30.2	12.3	6.8
1991	5.5	0.8	0.145	19.4	10.2	4.9	0.480	28.0	9.5	4.3
1992	77.0	15.8	0.205	23.4	31.0	9.8	0.316	26.1	37.9	10.7
1993	12.4	2.3	0.182	22.6	39.5	20.2	0.510	29.7	35.5	17.5
1994	16.6	2.5	0.152	19.6	16.1	4.2	0.259	24.2	16.1	3.9
1995	11.8	2.1	0.176	20.7	6.4	1.9	0.293	23.6	7.2	1.9
1996	16.4	2.2	0.137	20.1	30.9	13.6	0.439	27.9	28.7	11.9
1997	1235.2	175.8	0.142	20.7	33.3	9.3	0.278	24.6	212.0	34.0
1998	13.6	2.0	0.145	20.4	38.4	8.9	0.231	23.6	34.7	7.8
1999	50.8	6.3	0.125	19.9	80.5	21.2	0.264	24.4	76.1	19.0
2000	12.0	2.9	0.238	23.8	209.4	65.3	0.312	25.9	180.1	56.0
2001	103.8	16.7	0.161	21.6	101.2	41.7	0.412	28.7	101.6	40.0
2002	11.6	1.8	0.155	18.4	262.5	71.6	0.273	25.4	225.2	61.2
2003	28.1	2.8	0.100	17.5	123.3	38.7	0.314	26.4	109.1	33.3
2004	72.8	38.2	0.525	27.2	166.2	58.7	0.353	27.1	152.3	55.7
2005	7.7	1	0.130	17.6	169.4	54.2	0.320	26.3	145.3	46.3

1. Strata Set: 26, 27, 39, 40
2. Strata Set: 24, 28-30, 36-38
3. Strata Set: 24, 26-30, 36-40

Table N5 Autumn NEFSC bottom trawl survey stratified mean catch per tow indices, average weights and average lengths of redfish in the Gulf of Maine - Georges Bank region.

Year	INSHORE 1 Stratified Mean Catch per Tow Number	INSHORE 1 Stratified Mean Catch per Tow kg	INSHORE 1 Avg. Wt. kg	INSHORE 1 Avg. Length cm	OFFSHORE 2 Stratified Mean Catch per Tow Number	OFFSHORE 2 Stratified Mean Catch per Tow kg	OFFSHORE 2 Avg. Wt. kg	OFFSHORE 2 Avg. Length cm	COMBINED 3 Stratified Mean Catch per Tow Number	COMBINED 3 Stratified Mean Catch per Tow kg
1963	86.3	7.6	0.088	17.4	87.5	27.0	0.309	26.4	87.3	24.1
1964	81.3	13.5	0.166	20.2	122.3	61.8	0.505	30.8	116.3	54.6
1965	189.5	22.3	0.118	17.7	33.9	11.5	0.339	25.3	57.0	13.1
1966	172.8	17.0	0.098	16.2	77.8	31.2	0.401	27.4	91.9	29.1
1967	62.9	5.3	0.084	17.7	107.1	27.6	0.258	23.6	100.5	24.3
1968	41.1	4.7	0.114	18.3	161.3	46.6	0.289	25.1	143.4	40.4
1969	105.9	16.0	0.151	20.7	65.2	24.8	0.380	27.4	71.2	23.5
1970	18.2	2.8	0.154	20.3	107.2	38.2	0.356	26.3	94.0	32.9
1971	20.7	4.7	0.227	21.8	52.8	26.7	0.506	29.7	48.0	23.4
1972	36.4	6.6	0.181	20.8	58.9	27.8	0.472	29.2	55.6	24.6
1973	26.2	2.1	0.080	15.6	41.4	19.7	0.476	29.7	39.2	17.0
1974	44.4	4.7	0.106	18.0	49.0	27.6	0.563	30.1	48.3	24.2
1975	45.7	6.0	0.131	19.6	79.9	45.9	0.574	30.6	74.8	39.9
1976	11.6	2.5	0.216	22.6	31.9	17.5	0.549	30.2	28.9	15.3
1977	54.6	12.3	0.225	23.4	37.9	18.1	0.478	28.5	40.4	17.3
1978	20.4	5.5	0.270	24.6	49.5	23.4	0.473	29.0	45.2	20.7
1979	6.2	2.1	0.339	26.5	32.8	18.4	0.561	30.5	28.9	16.0
1980	20.6	6.2	0.301	24.6	20.6	13.8	0.670	31.8	20.6	12.6
1981	6.8	1.9	0.279	24.9	22.7	14.0	0.617	31.8	20.4	12.2
1982	28.2	4.6	0.163	21.2	5.6	3.2	0.571	31.5	9.0	3.4
1983	30.2	8.7	0.288	24.8	6.5	3.3	0.508	29.1	10.0	4.1
1984	7.7	3.2	0.416	27.9	7.8	4.1	0.526	29.0	7.8	3.9
1985	7.2	2.1	0.292	24.8	14.0	6.3	0.450	28.0	13.0	5.7
1986	67.6	15.3	0.226	23.3	18.8	6.7	0.356	26.1	26.1	8.0
1987	26.5	4.8	0.181	21.9	11.5	5.6	0.487	29.2	13.7	5.5
1988	18.5	5.1	0.276	21.9	11.4	6.5	0.570	29.1	12.4	6.3
1989	14.0	2.9	0.207	22.6	21.3	7.5	0.352	25.9	20.3	6.8
1990	57.6	14.5	0.252	23.8	31.7	11.7	0.369	26.7	35.5	12.2
1991	7.2	1.1	0.153	20.4	21.1	9.6	0.455	28.5	19.1	8.4
1992	7.8	1.2	0.147	20.0	24.9	9.3	0.374	27.3	22.4	8.1
1993	53.7	7.4	0.137	20.0	32.5	11.9	0.366	26.3	35.6	11.2
1994	31.5	5.4	0.171	21.7	19.0	6.0	0.317	25.0	20.9	5.9
1995	109.7	11.1	0.102	18.5	19.9	3.5	0.177	21.3	33.2	4.7
1996	53.8	9.1	0.169	21.5	189.9	34.4	0.181	21.9	169.6	30.6
1997	105.6	15.7	0.149	20.3	57.9	19.5	0.337	26.0	65.0	18.9
1998	48.7	10.7	0.219	20.4	128.9	35.4	0.275	23.6	117.0	31.7
1999	164.2	35.1	0.214	23.2	68.2	20.7	0.304	25.6	82.5	22.9
2000	133.3	21.8	0.164	21.6	99.4	26.9	0.271	24.8	104.4	26.2
2001	144.4	28.9	0.200	22.8	80.2	28.0	0.349	27.3	89.8	28.2
2002	217.7	31.6	0.145	20.7	179.5	43.7	0.243	24.4	185.2	41.9
2003	664.0	153.1	0.231	25.0	178.8	50.2	0.281	25.6	250.9	65.5
2004	61.2	7.0	0.114	15.3	138.8	41.8	0.301	25.6	127.3	36.6

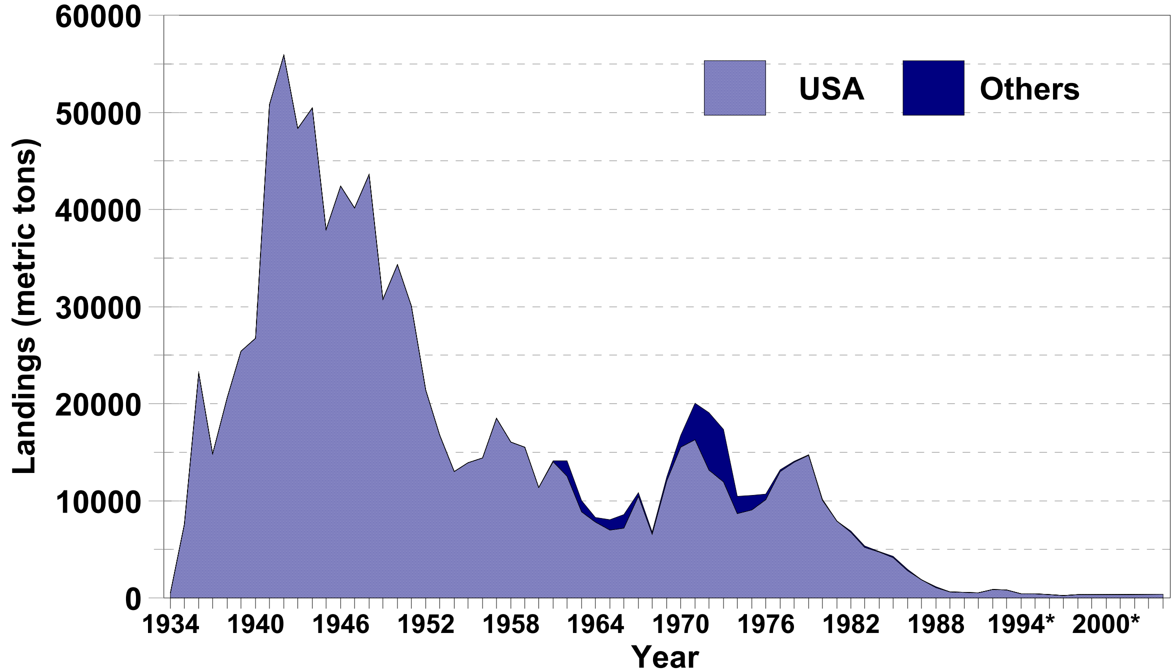
1. Strata Set: 26, 27, 39, 40
2. Strata Set: 24, 28-30, 36-38
3. Strata Set: 24, 26-30, 36-40

Table N6. Commercial landings (mt), NEFSC autumn survey biomass index (kg/tow), and index of exploitation for Gulf of Maine redfish.

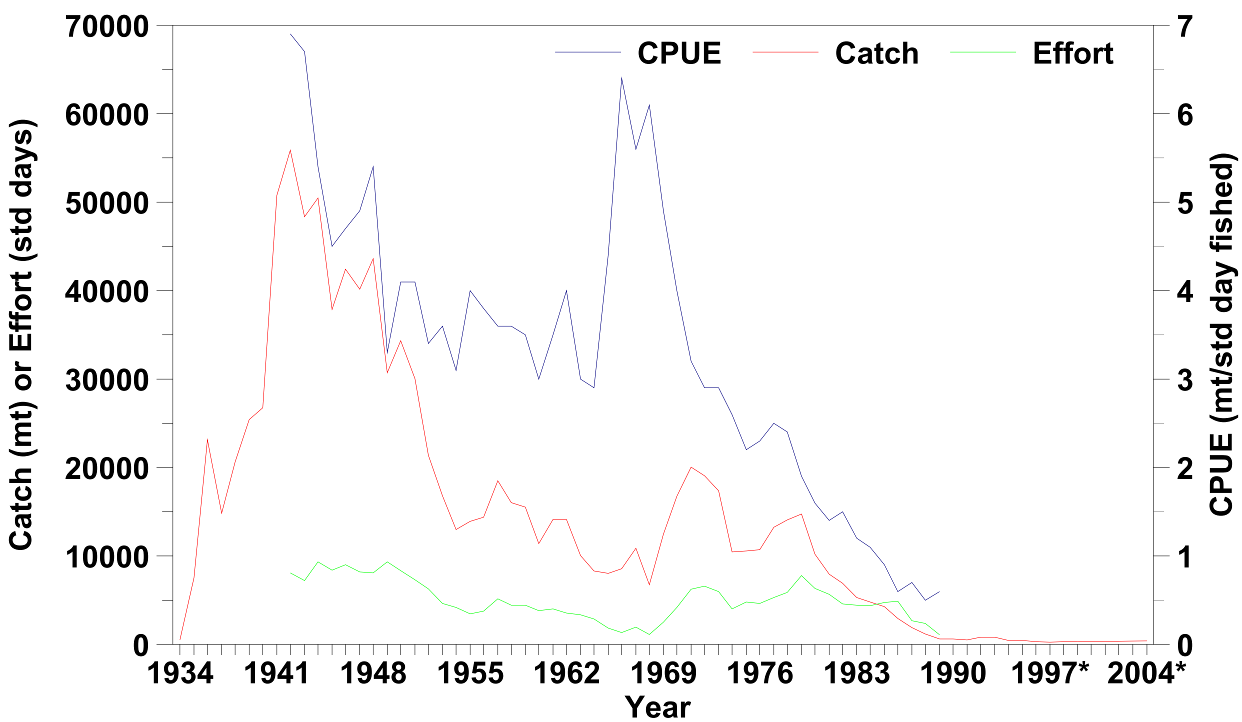
Year	Commercial landings (mt)	Biomass Index	Exploitation Ratio	Exp Biomass Index	Exploitation Ratio
1963	10046	24.1	0.0417	23.841	0.0421
1964	8313	54.6	0.0152	54.487	0.0153
1965	8057	13.1	0.0615	12.708	0.0634
1966	8569	29.1	0.0294	28.553	0.0300
1967	10864	24.3	0.0447	23.826	0.0456
1968	6777	40.4	0.0168	40.05	0.0169
1969	12455	23.5	0.0530	23.361	0.0533
1970	16741	32.9	0.0509	32.807	0.0510
1971	20034	23.4	0.0856	22.098	0.0907
1972	19095	24.6	0.0776	23.077	0.0827
1973	17360	17.0	0.1021	16.209	0.1071
1974	10471	24.2	0.0433	22.833	0.0459
1975	10572	39.9	0.0265	37.828	0.0279
1976	10696	15.3	0.0699	14.42	0.0742
1977	13223	17.3	0.0764	15.494	0.0853
1978	14083	20.7	0.0680	19.231	0.0732
1979	14755	16.0	0.0922	15.341	0.0962
1980	10183	12.6	0.0808	12.195	0.0835
1981	7915	12.2	0.0649	11.953	0.0662
1982	6903	3.4	0.2030	2.062	0.3348
1983	5328	4.1	0.1300	2.294	0.2323
1984	4793	3.9	0.1229	2.542	0.1886
1985	4282	5.7	0.0751	3.121	0.1372
1986	2929	8.0	0.0366	2.951	0.0993
1987	1894	5.5	0.0344	2.6	0.0728
1988	1177	6.3	0.0187	2.896	0.0406
1989	637	6.8	0.0094	2.676	0.0238
1990	601	12.2	0.0049	4.535	0.0133
1991	525	8.4	0.0063	3.521	0.0149
1992	849	8.1	0.0105	3.071	0.0276
1993	800	11.2	0.0071	3.742	0.0214
1994	440	5.9	0.0074	1.432	0.0307
1995	440	4.7	0.0095	0.566	0.0777
1996	322	30.6	0.0011	3.387	0.0095
1997	251	18.9	0.0013	4.393	0.0057
1998	320	31.7	0.0010	4.37	0.0073
1999	353	22.9	0.0015	3.753	0.0094
2000	319	26.2	0.0012	3.938	0.0081
2001	360	28.2	0.0013	5.554	0.0065
2002	368	41.9	0.0009	5.848	0.0063
2003	416	65.5	0.0006	11.688	0.0036
2004	398	36.6	0.0011	6.954	0.0057

Figure N1

Gulf of Maine-Georges Bank Redfish
Commercial Landings



Gulf of Maine - Georges Bank Redfish
Catch, Effort and CPUE



Redfish Stratified Mean Catch per Tow
NMFS Spring Bottom Trawl Survey

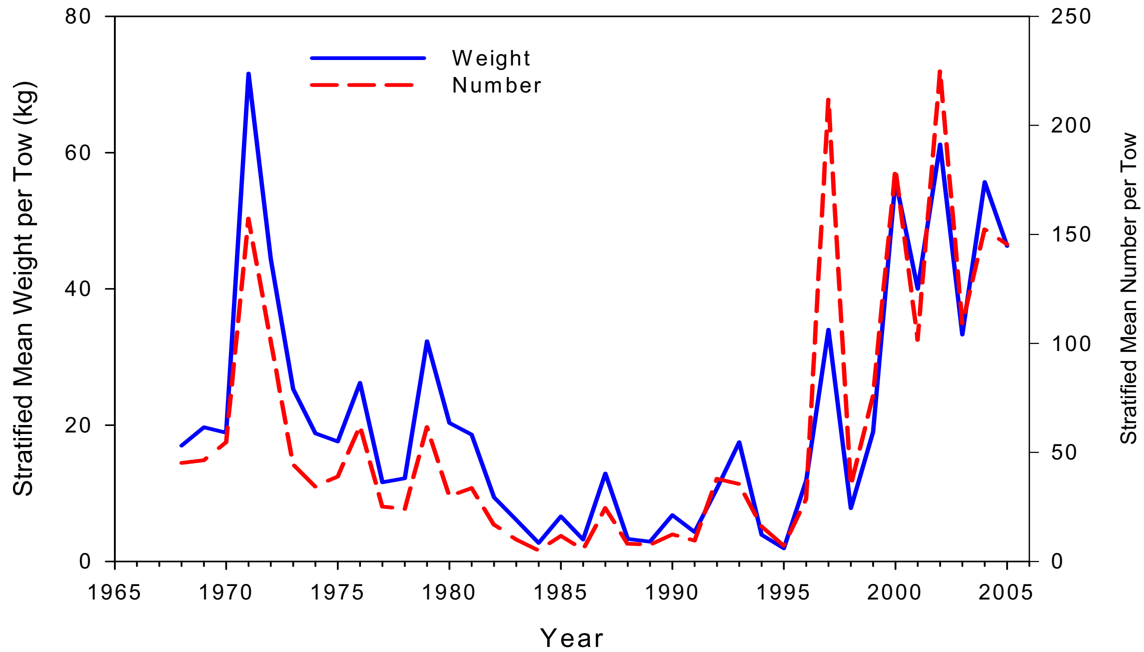
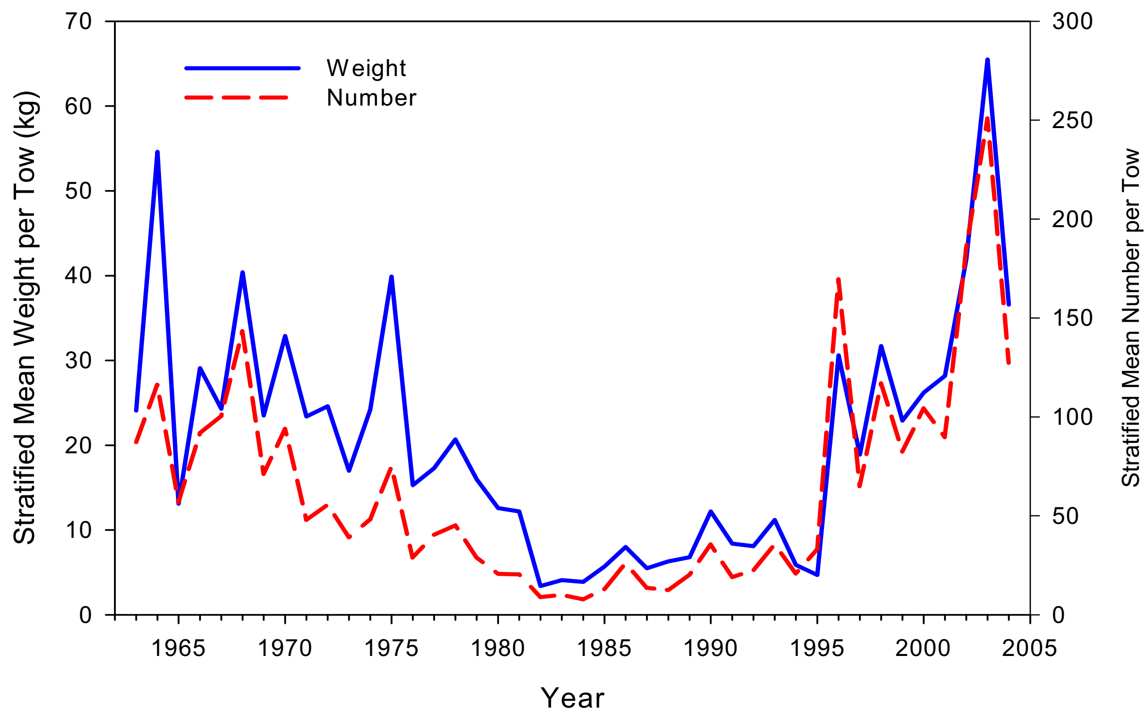


Figure N4

Redfish Stratified Mean Catch per Tow
NMFS Autumn Bottom Trawl Survey



Autumn Survey Redfish Age Composition

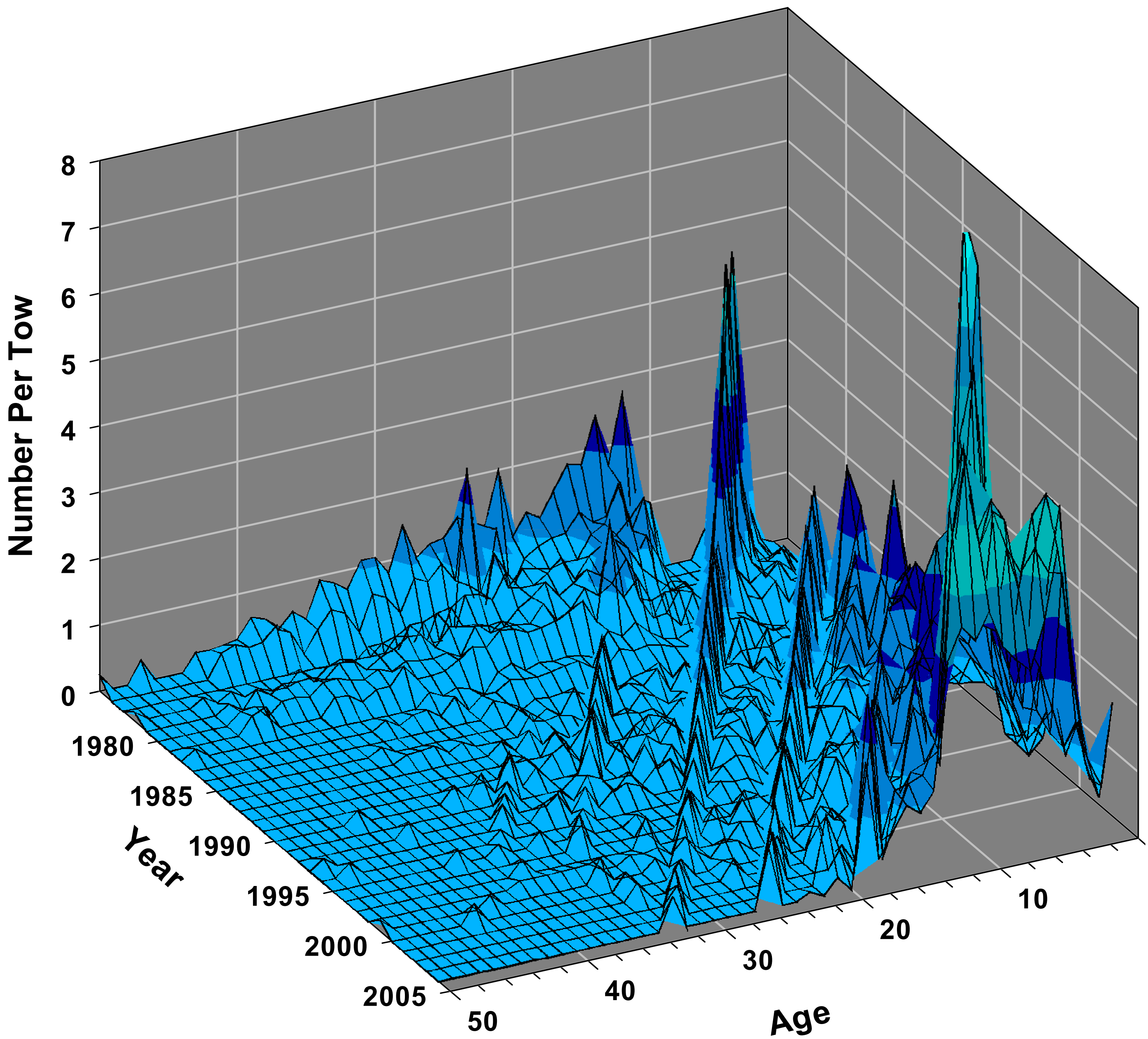


Figure N5

Figure N6

Redfish Red2000 and Stat2000 Models

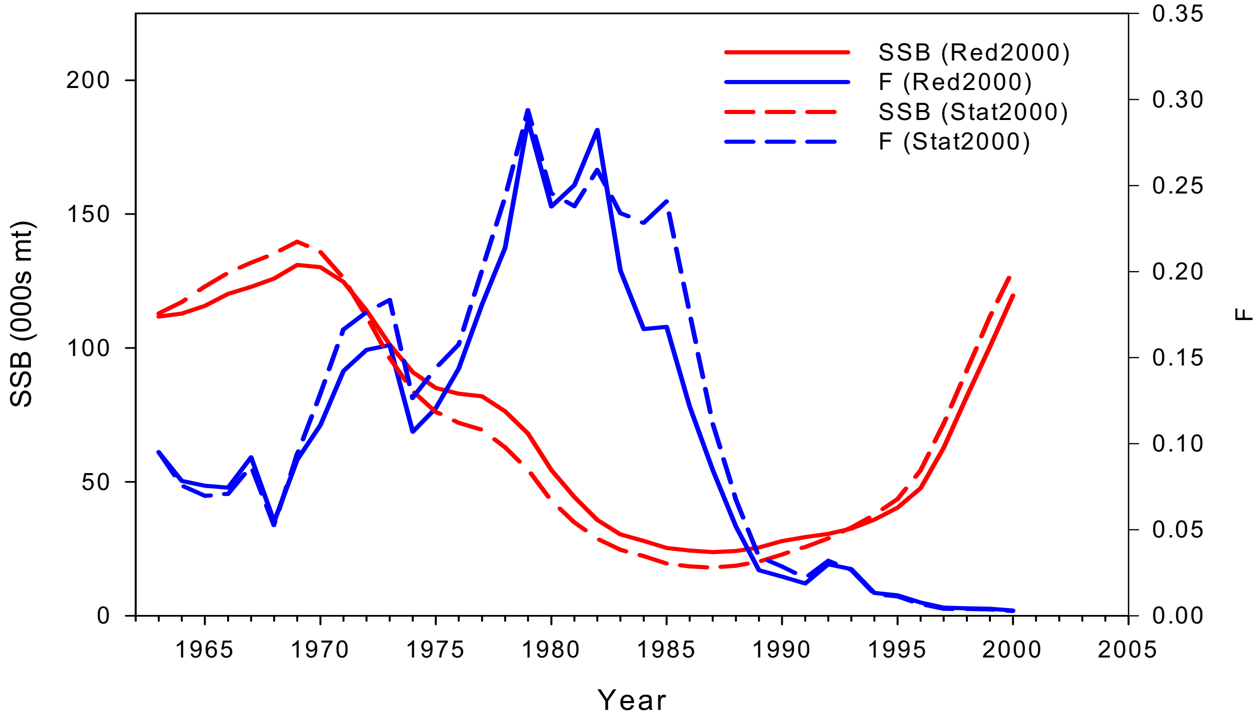


Figure N7

Redfish Red2005 and Stat2005 Models

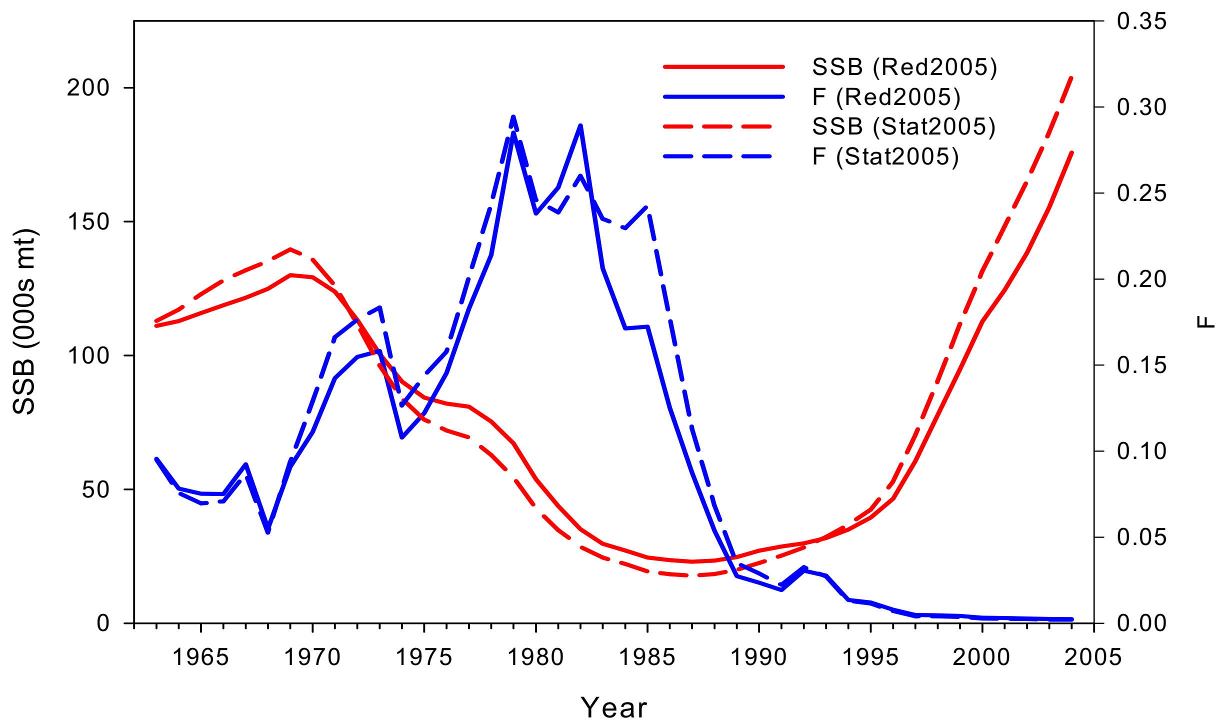
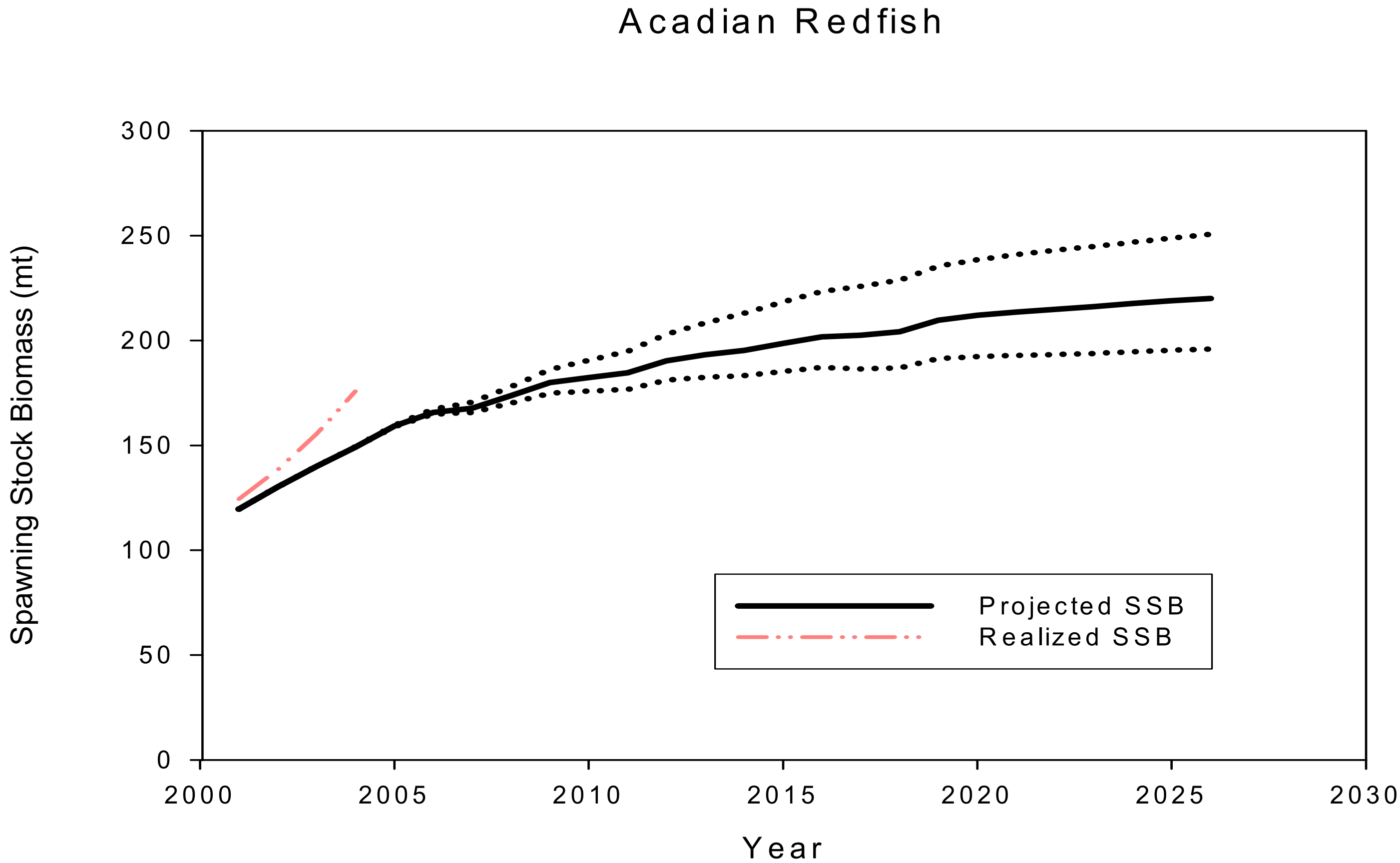
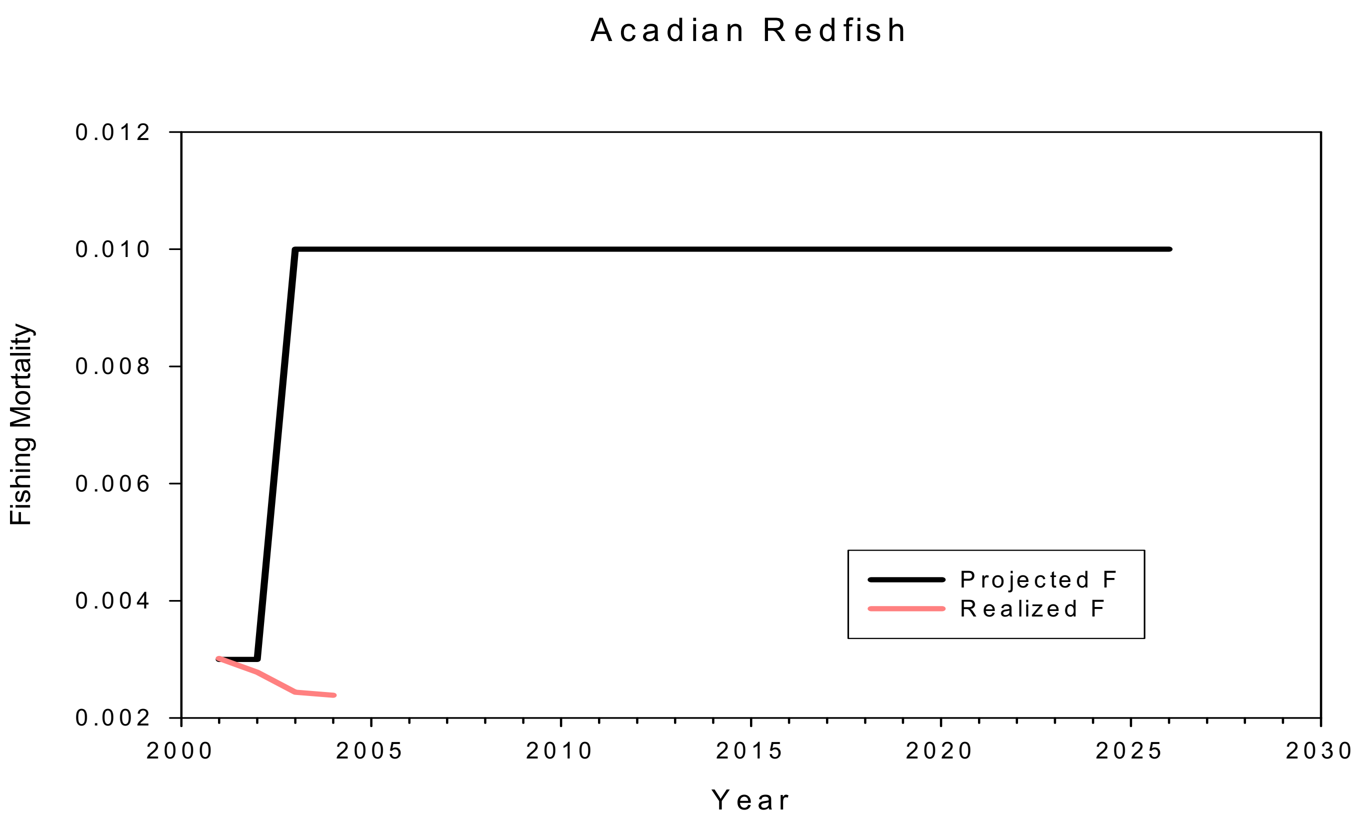


Figure N8


Acadian Redfish
Spawning Stock Biomass (mt)
300
250
200
150
100
50
0
2000
2005
2010
2015
2020
2025
2030
Year
Projected SSB
Realized SSB


Acadian Redfish
Fishing Mortality
0.012
0.010
0.008
0.006
0.004
0.002
2000
2005
2010
2015
2020
2025
2030
Year
Projected F
Realized F

O. Ocean Pout by **S. Wigley and L. Col**

1.0 Background

Ocean pout, *Macrozoarces americanus*, are assessed as a unit stock from Cape Cod Bay south to Delaware. An index assessment for this species was last reviewed at the 2002 Groundfish Assessment Review Meeting (NEFSC 2002a). At that time, the three year average spring biomass index (1999-2001 average = 2.46 kg/tow) was at the biomass threshold (½ Bmsy = 2.4 kg/tow) of the Bmsy proxy (1980-1991 median = 4.9 kg/tow). The relative exploitation ratio (0.007) indicated that fishing mortality was well below the F threshold (Fmsy proxy = 0.31). Ocean pout are included in the New England Fishery Management Council's Multispecies Fishery Management Plan and is one of twelve species listed in the "Large Mesh/Groundfish" group based on fish size and type of gear used to harvest the fish.

2.0 The Fishery

From 1964 to 1974, an industrial fishery developed for ocean pout, and nominal catches by the U.S. fleet averaged 4,700 mt (Table O.1, Figure O.1). Distant-water fleets began harvesting ocean pout in large quantities in 1966, and total nominal catches peaked at 27,000 mt in 1969. Foreign catches declined substantially afterward, and none have been reported since 1974. United States landings declined to an average of 600 mt annually during 1975 to 1983. Catches increased in 1984 and 1985 to 1,300 mt and 1,500 mt respectively, due to the development of a small directed fishery in Cape Cod Bay supplying the fresh fillet market. Landings have declined more or less continually since 1987. In recent years, landings from the southern New England/Mid-Atlantic area have continued to dominate the catch, reversing landing patterns observed in 1986-1987, when the Cape Cod Bay fishery was dominant. The shift in landings is attributed to the changes in management (gear/mesh) regulations. Total landings in 2004 were 5 mt, a record low in the time series (Table O.1, Figure O.1).

Dock-side sampling of commercial ocean pout landings began in 1984; landed ocean pout range between 40 and 90 cm, with most fish between 50 and 60 cm. In recent years, dock-side sampling has been sporadic.

3.0 Discard Estimation

The Vessel Trip Report (VTR, 1994-2004) and Northeast Fisheries Observer Program (NEFOP, 1989 – 2004) data were explored to estimate the magnitude of discarding in fisheries which may impact ocean pout.

Based on the VTR, landings and discards from the recreational fishery are minimal. The commercial VTRs indicate that discarding of ocean pout may have exceeded the reported landings 2004. [Note: the VTR program was implemented in May 1994 and ocean pout landings primarily occur in the late winter and early spring, therefore, the VTR values may not fully reflect all landings in 1994.]. Based on the VTRs, ocean pout discarding in the commercial fishery occurs primarily with otter trawl, longline, and lobster pot gears.

The primary reason reported in the NEFOP for ocean pout discards is "no market". Limited NEFOP data were available for gear types other than otter trawl gear. Two ratio estimators, discards to days fished (d/df) and discards to days absent (d/da), were used to estimate ocean pout discards in the otter trawl fishery by large (>=5.5 inch) and small (<5.5 inch) mesh groups and half year using the NEFOP data. These ratios were expanded by the days fished and days absent in the Dealer weighout data for 1989 – 1994 and estimated from the VTR data for 1994 – 2004 assuming that the VTR represent a near census of the commercial trips. The discard amounts derived from the two ratio estimators were different in the first part of the time series (1989 – 1993) but were similar during 1994 – 2004 (Table O.2). This may be attributed to: 1) the year-around closures coupled with reductions in days at sea, and 2) the change in data collection. Days absent is assumed to be a more stable metric over time. Using the d/da ratio, ocean pout discards range between 600 mt and 9,600 mt t during 1989 to 2004, roughly 3 to 109 times the landings (Table O.2, Figure O.2). Ocean pout discard data prior to the observer program are too sparse to estimate discards; consequently, ocean pout discards prior to 1989 have not been estimated.

4.0 Research Survey Indices

Commercial landings and the NEFSC spring research vessel survey biomass index followed similar trends during 1968 to 1975 (encompassing peak levels of foreign fishing and the domestic industrial fishery); both declined from very high values in 1968-1969 to lows of 300 mt and 1.3 kg per tow, respectively, in 1975 (Table O.3 and Figure O.1). Between 1975 and 1985, survey indices increased to record high levels, peaking in 1981 and 1985. Since 1985, survey catch per tow indices have generally declined, and are presently below than the long-term survey average (3.3 kg per tow); the 2004 and 2005 spring survey indices are 0.55 and 0.53 kg per tow, respectively, are the lowest values in the time series. Both NEFSC winter survey and the Massachusetts Division of Marine Fisheries inshore research vessel surveys confirm the declining trend observed in the NEFSC spring survey.

5.0 Exploitation Indices

Computing survey biomass indices of exploitable biomass for use in calculating exploitation ratio was explored. However, given no minimum fish size, no market demand, no mesh selection parameters, and limited commercial length frequency data, there was insufficient information to apply a selection ogive to the ocean pout survey length frequency data.

Exploitation ratios (landings/three year average survey biomass index) have declined sharply from a peak in 1973 to low levels in the early 1980s then increased slightly in the late-1980s, after which they declined to record low levels (Table O.4, Figure O.3). The 2004 exploitation index (0.003) was the lowest in the time series and well below the Fmsy proxy (0.31), derived as the MSY proxy (1,500 mt) divided by the Bmsy proxy. Although discards have been estimated for a portion of the time series, discards were not included in the exploitation ratio, and, as such, the exploitation ratios may be underestimated. The biological reference points were based on landings, not catch, therefore it is not be appropriate to incorporate discards into the relative exploitation analyses and use the current MSY control rule.

6.0 Assessment Results

The index assessment presented above reveals that landings, survey indices and exploitation ratios remain at, or near, record low levels and the annual estimates of discards exceed annual landings. The record-low survey biomass index has caused the stock status for ocean pout to change from the last assessment.

For ocean pout, the replacement ratio and relative F analyses were not informative upon which to base Bmsy, Fmsy, and MSY (NEFSC 2002). Thus, biological reference points for ocean pout remain based upon research vessel survey biomass trends and the exploitation history (Applegate et al. 1998). MSY was chosen to be 1,500 mt and the B-msy proxy was determined as the median survey index from 1980-1991 (4.9 kg/tow). Given these proxies, the threshold F-msy proxy is 0.31 (1.5/4.9). The minimum biomass threshold is ½ of the B-msy proxy (2.45 kg/tow). The MSY control rule states that a target F should be set to the F calculated to rebuild to Bmsy in 10 years when biomass is between ½ Bmsy and Bmsy. When stock size is less than the threshold biomass, the F will be established by the formal rebuilding program.

To evaluate stock conditions, the three year average of NEFSC spring survey indices and the exploitation ratio (2004 landings/ average of 2002, 2003, 2004 spring survey biomass indices) were used as proxies for biomass and fishing mortality, respectively. In 2004, the three year average survey index (1.78 kg/tow) indicates that biomass is below the minimum biomass threshold (2.45 kg/tow) and the exploitation ratio (0.003) indicates F is below the F threshold to allow for stock re-building. Thus, the ocean pout population appears to be overfished but overfishing did not occur in 2004.

An adaptive rebuilding trajectory is used in the formal rebuilding program for ocean pout in Amendment 13. The realized stock size (kg/tow) is below the stock size projected in Amendment 13 (Figure O.4) even though the relative exploitation rate has been below the Fmsy proxy used the rebuilding program.

7.0 Panel Comments

The Panel noted that exploitation has been low yet stock size has not increased. Discards are now estimated to be an important component of catch and the currently estimated level of discards may be sufficient to hinder recovery of the stock. The Panel also noted that low water temperatures may contribute to the low survey biomass indices in 2004-2005.

The Panel also noted the lack of strong recruitment since 1989 which may also contribute to the lack of recovery of the stock. It was suggested that the absence of a recovery may not be due solely to current fishing activity but rather a combination of past exploitation and low fecundity.

8.0 Research recommendations

- Explore methods to extend the catch series (landings and discards) back beyond 1989. Approaches could include applying the observed discard rate based on the 15 years of existing data to the pre-1989 data as well as investigating fleet specific characteristics of vessels targeting ocean pout.

- Until studies on discard mortality are available, explore the impacts of various discard mortality rates through sensitivity analyses.

9.0 Sources of Uncertainty

- Due to the lack of commercial length samples (one sample of 37 fish since 2004), the size composition of the commercial landings could not be characterized.

- Biological reference points are based on landings; landings, not catch, are used to derive exploitation ratios. Exploitation ratios may be underestimated.

10.0 Acknowledgements

We would like to recognize and thank all those who diligently collected data from the commercial fisheries (port and at-sea) and the research vessel surveys. We thank all the members of the Groundfish Assessment Review Meeting for their review and helpful comments.

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Table O.1. Commercial landings (mt, live) of ocean pout from the Gulf of Maine to the Mid-Atlantic region (NAFO Subareas 5 and 6), 1962-2004.

	USA				
Year	5	6	Total	Other	Total
1962	0	0	0	0	0
1963	20	0	20	0	20
1964	2123	0	2123	0	2123
1965	877	0	877	0	877
1966	7149	0	7149	6231	13380
1967	7090	0	7090	271	7361
1968	8373	364	8737	4324	13061
1969	5571	966	6537	20435	26972
1970	5851	426	6277	895	7172
1971	2678	1448	4126	1784	5910
1972	1927	358	2285	1066	3351
1973	2810	285	3095	2275	5370
1974	2790	459	3249	483	3732
1975	209	65	274	3	277
1976	341	337	678	0	678
1977	809	250	1059	0	1059
1978	715	320	1035	0	1035
1979	658	14	672	0	672
1980	339	11	350	0	350
1981	234	17	251	0	251
1982	317	4	321	0	321
1983	408	0	408	0	408
1984	1324	0	1324	0	1324
1985	1450	54	1504	0	1504
1986	801	1	802	0	802
1987	2111	74	2185	0	2185
1988	1765	46	1811	0	1811
1989	1308	6	1314	0	1314
1990	1299	13	1312	0	1312
1991	1361	63	1424	0	1424
1992	406	68	474	0	474
1993	217	15	232	0	232
1994	137	59	196	0	196
1995	51	14	65	0	65
1996	34.7	16.3	51.0	0	51
1997	7.6	25.4	33.0	0	33
1998	8.6	8.4	17.0	0	17
1999	8.9	9.1	18.0	0	18
2000	8.4	10.6	19.0	0	19
2001	8.4	9.2	17.6	0	18
2002	3.5	8.6	12.1	0	12
2003	18.1	7.4	25.6	0	26
2004	3.0	2.4	5.4	0	5

1994-2004 spatial patterns are based upon Vessel Trip Report data.

Table O.2 Ocean pout discards (mt) in the VTR and observer data [using discards to days absent ratio (via DA) and using a discards to days fished ratio (via DF)] and landings (mt) from the VTR, Dealer Weighout (WO), and the estimated landings using a kept weight to days absent ratio from observer data, and the ratio (%) of discards (via DA) to Dealer WO landings.

	DISCARDS			LANDINGS			
		OBSERVER					
YEAR	VTR	via DA	via DF	VTR	WO	Est. Kept	%
1989		7014.1	19438.5		1314.0	397.2	5.3
1990		8430.7	17852.3		1312.0	1072.5	6.4
1991		9589.2	20996.5		1424.0	2574.3	6.7
1992		1545.8	6027.2		474.0	334.6	3.3
1993		1550.4	4648.3		232.0	192.0	6.7
1994	21.7	1918.0	3016.8	16.8	196.0	12.2	9.8
1995	16.7	872.0	1261.3	61.5	65.0		13.4
1996	3.6	828.7	1271.3	48.5	51.0		16.2
1997	1.9	989.5	1288.1	20.8	33.0	48.0	30.0
1998	1.9	1000.3	1160.4	13.2	17.0		58.8
1999	3.9	5545.6	4036.0	13.6	18.0		308.1
2000	1.0	1031.1	1132.7	11.8	19.0		54.3
2001	2.2	1227.0	992.9	13.8	17.6	13.9	69.8
2002	4.1	1291.1	433.4	7	12.1	0.8	106.4
2003	2.3	810.5	331.6	18.3	25.6	5.3	31.7
2004	1.3	589.6	353.5	3.3	5.4	0.4	109.4
*1999		1023.2			18.0		56.8

Note: *1999 represents the imputed discard estimate using average of surrounding values.

Table O.3. Stratified mean catch per tow in weight and numbers, mean length and individual average fish weight of ocean pout in NEFSC spring surveys, in the Gulf of Maine-Mid-Atlantic region (strata 1-26, 73-76), 1968-2005.

Year	Mean weight (kg) per tow	Mean number per tow	Mean Length (cm)	Individual average weight (kg)
1968	5.366	6.766	51.1	0.793
1969	6.154	8.629	49.3	0.713
1970	5.180	6.133	51.9	0.845
1971	2.183	3.135	50.2	0.696
1972	4.453	5.090	51.6	0.875
1973	3.373	4.591	48.8	0.735
1974	1.479	2.310	47.0	0.640
1975	1.293	1.358	53.4	0.952
1976	1.400	2.440	46.5	0.574
1977	3.605	6.366	44.8	0.566
1978	3.371	11.831	31.6	0.285
1979	1.493	5.197	34.7	0.287
1980	5.729	11.837	42.6	0.484
1981	7.605	14.131	42.7	0.538
1982	4.743	8.690	44.0	0.546
1983	4.236	5.076	50.5	0.835
1984	5.540	7.275	50.0	0.762
1985	6.494	9.011	48.7	0.721
1986	6.345	6.995	53.0	0.907
1987	2.705	3.076	51.7	0.879
1988	3.244	5.405	45.0	0.600
1989	2.792	5.323	44.0	0.525
1990	5.074	6.369	50.3	0.797
1991	3.783	5.596	49.7	0.676
1992	2.257	2.639	52.9	0.855
1993	3.084	3.546	53.4	0.870
1994	2.309	2.639	54.3	0.875
1995	1.916	2.525	50.5	0.759
1996	2.058	3.127	47.6	0.658
1997	1.632	2.069	52.4	0.789
1998	1.733	2.957	46.1	0.586
1999	2.561	3.340	50.2	0.767
2000	2.016	3.113	48.2	0.648
2001	2.801	3.748	51.6	0.747
2002	2.026	2.809	51.3	0.721
2003	2.757	2.919	55.4	0.945
2004	0.547	0.673	50.8	0.812
2005	0.526	0.854	45.9	0.616

Table O.4. NEFSC Spring survey index (kg per tow), total landings ('000 mt), annual relative exploitation rate, 3 yr moving average of Spring survey biomass index, relative exploitation rate (landings / 3 yr average of spring survey biomass index) for ocean pout, 1970-2005.

					Control Rule
Year	NEFSC Spring Index kg/tow	Total Landings ('000)	Annual relative expliotation rate (land./spr index)	3 year moving average (kg/tow)	Relative Exploitation Rate (land./ 3yr avg spr index)
1968	5.366	13.0610	2.434		
1969	6.154	26.9720	4.383		
1970	5.180	7.1720	1.385	5.5667	1.288
1971	2.183	4.9100	2.249	4.5057	1.090
1972	4.453	3.3510	0.753	3.9387	0.851
1973	3.373	5.3700	1.592	3.3363	1.610
1974	1.479	3.7320	2.523	3.1017	1.203
1975	1.293	0.2770	0.214	2.0483	0.135
1976	1.400	0.6780	0.484	1.3907	0.488
1977	3.605	1.0590	0.294	2.0993	0.504
1978	3.371	1.0350	0.307	2.7920	0.371
1979	1.493	0.6720	0.450	2.8230	0.238
1980	5.729	0.3500	0.061	3.5310	0.099
1981	7.605	0.2510	0.033	4.9423	0.051
1982	4.743	0.3210	0.068	6.0257	0.053
1983	4.236	0.4080	0.096	5.5280	0.074
1984	5.540	1.3240	0.239	4.8397	0.274
1985	6.494	1.5040	0.232	5.4233	0.277
1986	6.345	0.8020	0.126	6.1263	0.131
1987	2.705	2.1850	0.808	5.1813	0.422
1988	3.244	1.8110	0.558	4.0980	0.442
1989	2.792	1.3060	0.468	2.9137	0.448
1990	5.074	1.3120	0.259	3.7033	0.354
1991	3.783	1.4240	0.376	3.8830	0.367
1992	2.257	0.4743	0.210	3.7047	0.128
1993	3.084	0.2321	0.075	3.0413	0.076
1994	2.309	0.1964	0.085	2.5500	0.077
1995	1.916	0.0654	0.034	2.4363	0.027
1996	2.058	0.0512	0.025	2.0943	0.024
1997	1.632	0.0336	0.021	1.8687	0.018
1998	1.733	0.0175	0.010	1.8077	0.010
1999	2.561	0.0170	0.007	1.9753	0.009
2000	2.016	0.0187	0.009	2.1033	0.009
2001	2.801	0.0175	0.006	2.4593	0.007
2002	2.026	0.0121	0.006	2.2810	0.005
2003	2.757	0.0256	0.009	2.5280	0.010
2004	0.547	0.0054	0.010	1.7767	0.003
2005	0.526			1.2766	
	1968 - 2004	1980-1991			
mean	3.387	1.0832			
median	2.801	4.9090			

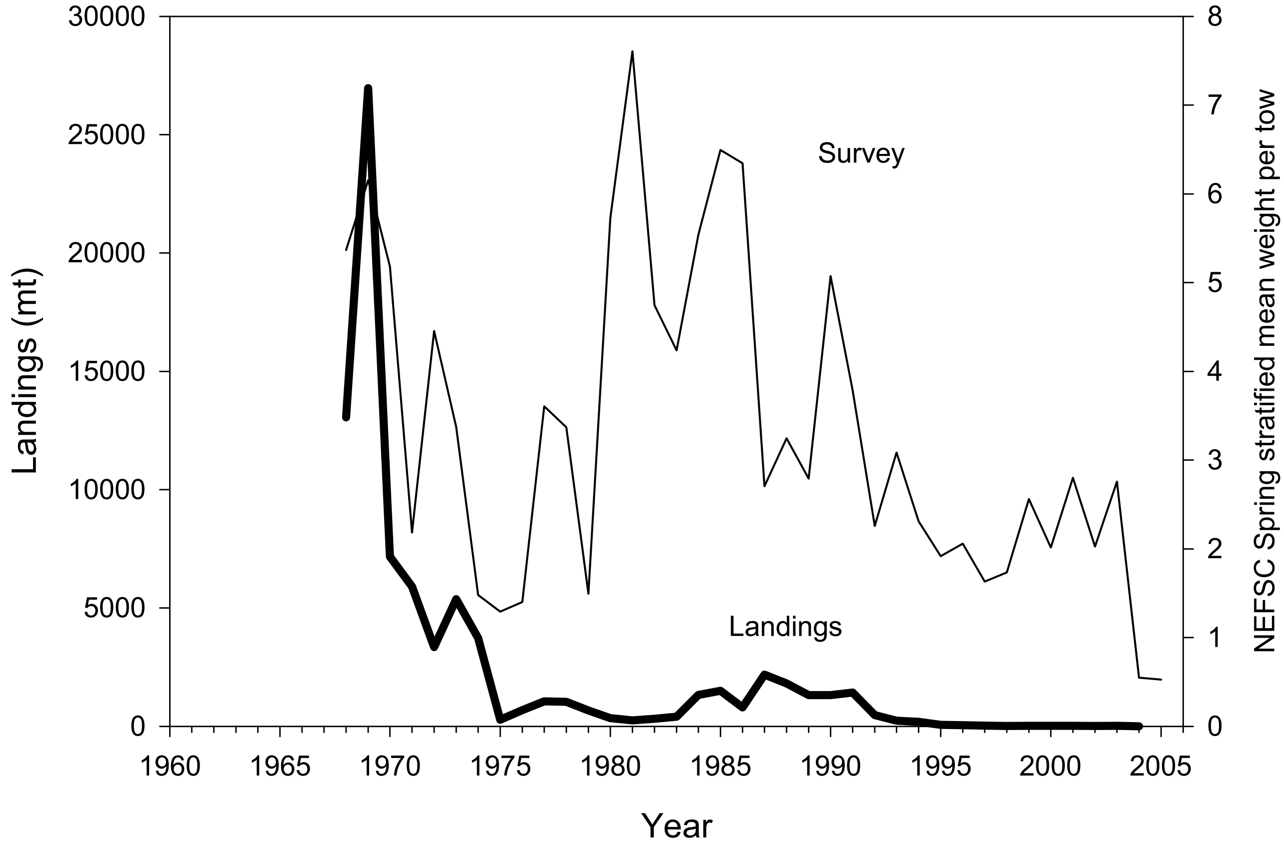

Figure O.1. Trends in landings (mt) and NEFSC spring survey biomass (kg/tow) for ocean pout.

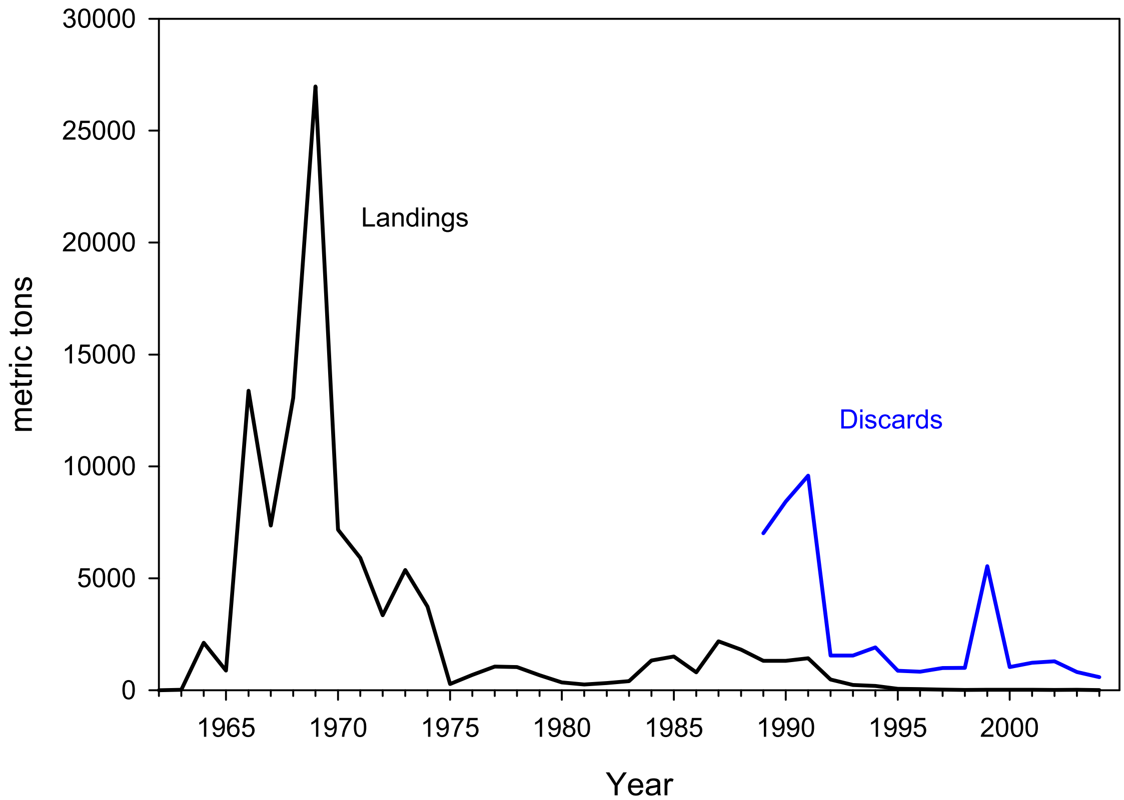

Figure O.2. Trends in landings (mt) and otter trawl discards for ocean pout [Note: 1999 value influenced by small sample size on first half –year of small mesh otter trawl fishery; the 1999 imputed discards equals 1023.2 mt].

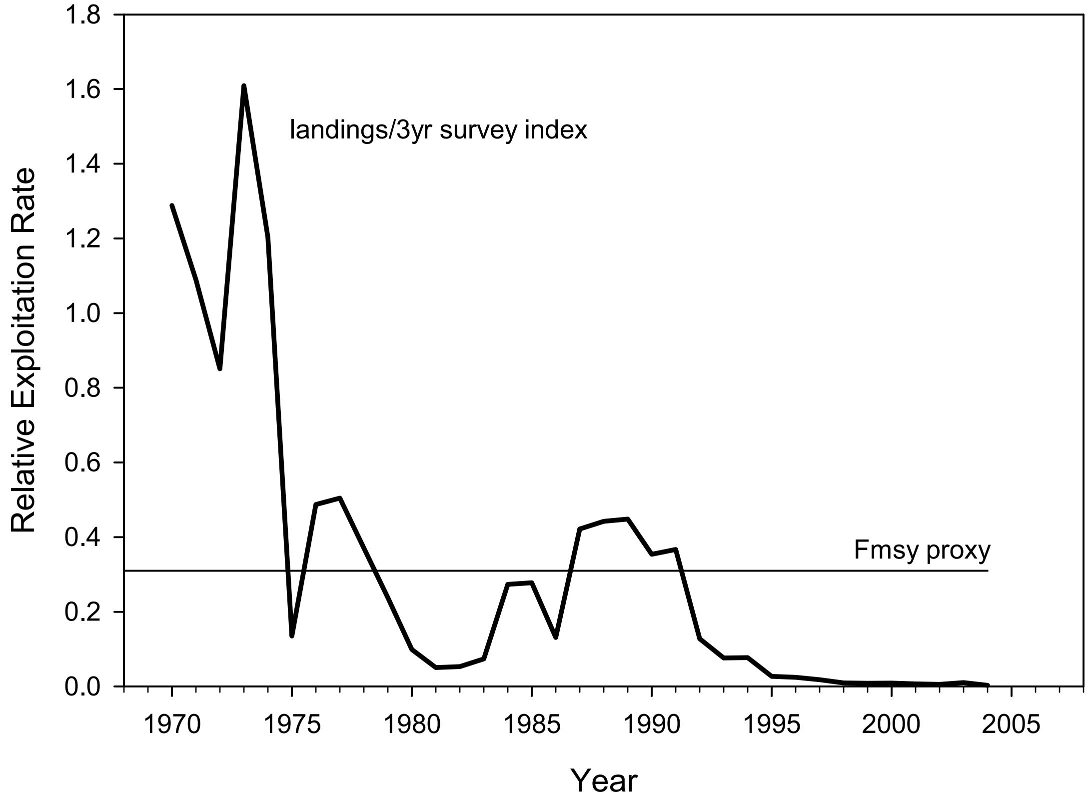

Figure O.3. Relative exploitation indices (landings/three year average of spring biomass index) for ocean pout, 1970 - 2004.

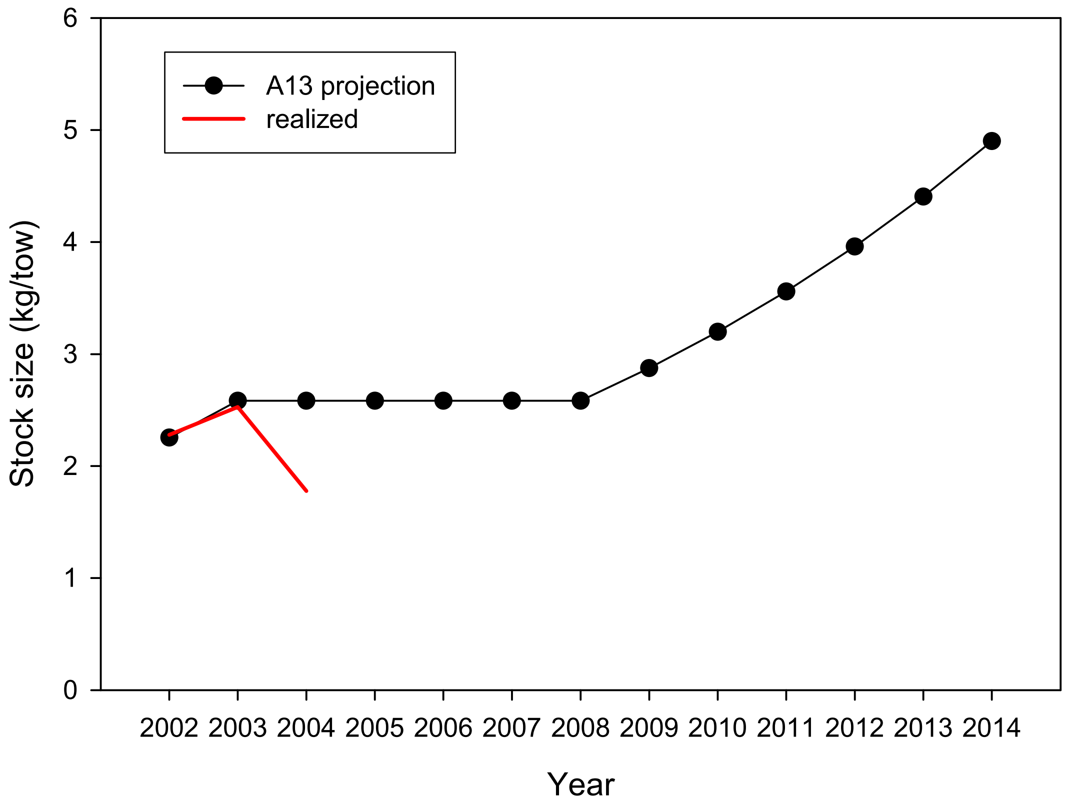

Figure O.4. Amendment 13 projected and realized size stock (kg/tow) for ocean pout in 2002, 2003 and 2004.

P. Gulf of Maine/Georges Bank Windowpane Flounder by Lisa Hendrickson

1.0 Background

No stock structure information is available. Therefore, a provisional arrangement has been adopted that recognizes two stock areas based on apparent differences in growth, sexual maturity, and abundance trends between windowpane flounder from Georges Bank and Southern New England. The proportion of total landings contributed by the Gulf of Maine is low, so windowpane flounder landings from Georges Bank are combined with those from the Gulf of Maine and the two regions are assessed as the Gulf of Maine-Georges Bank (GOM-GB) stock.

The GOM-GB windowpane flounder stock has never been formally assessed as part of the SAW/SARC process. The following index-based assessment represents an update of the assessment presented in October 2002 at the Groundfish Assessment Review Meeting (GARM) (NEFSC 2002a). Following the 2002 GARM, a re-evaluation of the overfishing definition was conducted and the status quo was recommended (NEFSC 2002b).

2.0 Assessment Results

2.1 The Fishery

Commercial landings of windowpane flounder were first recorded in 1975. During 1985-1998 more than 50% of the windowpane landings were from the GOM-GB stock. Since 2001, the trend has reversed and most of the windowpane landings have come from the SNE-MAB stock. Landings increased sharply between 1982 and 1985, from 400 to 2,100 mt, then ranged between 1,100 and 1,800 mt through 1990 (Table P1 and Figure P1). Following a 1991 record high of 2,900 mt, landings declined sharply to 300 mt in 1994. High landings during the early 1990's probably reflected an expansion of the fishery to offshore areas, as well as targeting of windowpane flounder as an alternative to depleted groundfish stocks. Landings declined from 700 mt in 1996 to about 50 mt in 1999 and have since been at the lowest levels recorded, ranging from 12 to 45 mt.

Discards of windowpane flounder have never been quantified and were not evaluated for this assessment update. Therefore, only the landings are included in the calculation of exploitation indices.

2.2 Research Survey Indices

Relative biomass indices, stratified mean weights (kg) per tow, of GOM-GB windowpane flounder from the NEFSC autumn bottom trawl surveys, conducted during 1963-2004, are presented in Table P1 and Figure P2. Survey biomass indices are highly variable and ranged between 0.16 and 1.56 kg per tow during 1972-1983. Following a time series peak of 2.14 kg per tow, in 1984, biomass indices declined rapidly to 0.17 kg per tow in 1991. Biomass indices increased again after 1991 and reached 1.66 kg per tow in 1998. However, the high 1998 index is primarily attributable to a large catch of windowpane at one station. Biomass declined in 1999 then remained fairly stable through 2004.

2.3 Biological Reference Points

Biological reference points for GOM-GB windowpane flounder were derived from survey-based proxies of biomass and exploitation rates and are based on an MSY estimate (1,000 mt) from an ASPIC model (NEFSC 2002b). The threshold F is defined as an F_{MSY} proxy (= 1.11) when the NEFSC autumn survey index is greater than 0.94 kg per tow (equal to a B_{MSY} proxy) and declines linearly to zero at 50% of the B_{MSY} proxy (= 0.47 kg/tow). The target exploitation index is defined as 60% of the F_{MSY} proxy (= 0.67) when the autumn survey index is greater than 0.94 kg/tow and declines linearly to zero at 0.47 kg/tow.

2.4 Relative Exploitation Rates and Stock Status

Relative exploitation rates (landings/NEFSC autumn survey biomass index) have been declining since reaching a peak in 1991 (Table P1 and Figure P3) and were below the F_{MSY} proxy (=1.11) during 1997-2004. The 2002-2004 autumn survey mean biomass index is 0.78 kg/tow and the 2002-2004 mean exploitation index (landings/NEFSC autumn survey biomass index) is 0.02 (Table P3 and Figure P2). Therefore, the stock was not overfished and overfishing was not occurring in 2004 (Figure P4).

During 2002-2004, autumn survey biomass indices declined and in 2003 and 2004 were below the levels projected in Amendment 13 (Figure P5).

3.0 Sources of Uncertainty

3.1 The influence of discards on the evaluation of current stock status relative to biological reference points is unclear.

4.0 Research Recommendations

4.1 Include discards in the estimated catch.

5.0 Panel Discussion

The Panel noted that discards are not included in the estimate of the relative exploitation index and recommends that future assessments attempt to estimate discards. In addition, the NMFS inshore survey strata are not used in the calculation of the trawl survey index and the Panel recommends that these be included in future assessments. If these recommendations are adopted, the reference points will need to be re-evaluated.

6.0 Literature Cited

NEFSC [Northeast Fisheries Science Center]. 2002a. Assessment of 20 northeast groundfish stocks through 2001: A report of the Groundfish Assessment Review Meeting (GARM), Northeast Fisheries Science Center, Woods Hole, Massachusetts, October 8-11, 2002. *Northeast Fish. Sci. Cent. Ref. Doc.* 02-16. 511 p.

NEFSC [Northeast Fisheries Science Center]. 2002b. Final report of the working group on re-evaluation of biological reference points for New England groundfish. 231 p.

Table P1. Landings (mt), NEFSC autumn survey biomass indices (stratified mean kg per tow, offshore strata 13-29 and 37-40), and exploitation indices (landings/autumn survey biomass index) for Gulf of Maine-Georges Bank windowpane flounder during 1963-2004. Landings include Statistical Areas beginning with 51 and 52, with the exception of 526, 530-539 and 541.

Year	Landings[1] (mt)	Biomass Indices (kg per tow)	Exploitation Indices (landings/biomass index)
1963		0.24	
1964		0.10	
1965		0.17	
1966		0.48	
1967		0.52	
1968		0.26	
1969		0.64	
1970		0.19	
1971		0.16	
1972		0.57	
1973		1.53	
1974		0.82	
1975	1,300	0.39	3.38
1976	1,516	1.17	1.30
1977	1,099	1.56	0.71
1978	923	1.15	0.80
1979	856	0.73	1.18
1980	408	0.63	0.65
1981	413	0.79	0.52
1982	411	0.49	0.83
1983	460	0.55	0.84
1984	743	2.14	0.35
1985	2,141	0.94	2.29
1986	1,842	1.11	1.67
1987	1,396	0.65	2.16
1988	1,377	0.65	2.12
1989	1,577	0.41	3.81
1990	1,078	1.13	0.96
1991	2,862	0.17	16.74
1992	1,519	0.38	4.01
1993	1,212	0.62	1.96
1994	300	0.31	0.97
1995	700	0.80	0.87
1996	700	0.50	1.40
1997	418	0.43	0.96
1998	396	1.66	0.24
1999	46	0.73	0.06
2000	142	0.73	0.20
2001	45	0.92	0.05
2002	12	0.89	0.01
2003	17	0.77	0.02
2004	25	0.68	0.04

[1] Landings from 1995-2004 were prorated based on Vessel Trip Reports.

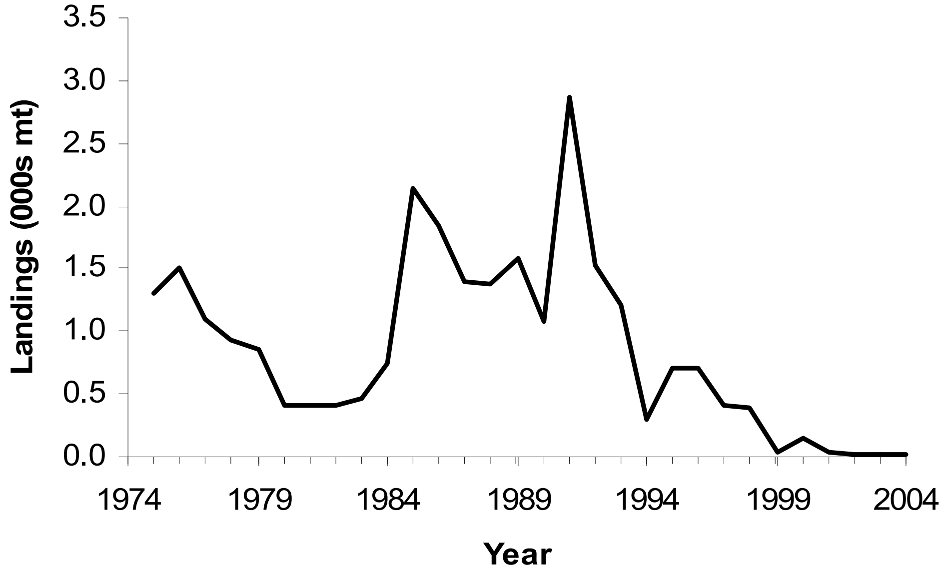

Figure P1. Commercial landings of Gulf of Maine-Georges Bank windowpane flounder during 1975-2004.

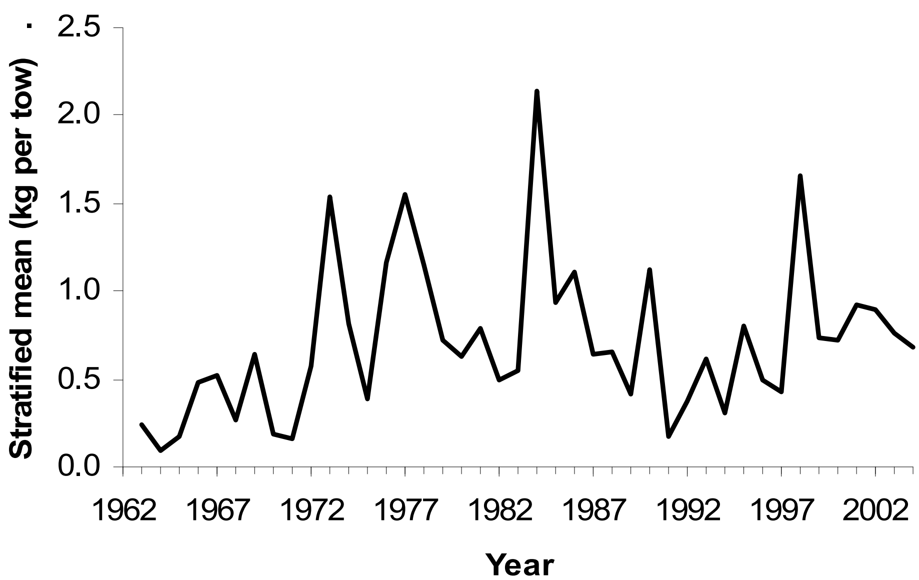

Figure P2. Relative biomass indices (stratified mean kg per tow) for Gulf of Maine-Georges Bank windowpane flounder from the NEFSC autumn bottom trawl surveys conducted during 1963-2004.

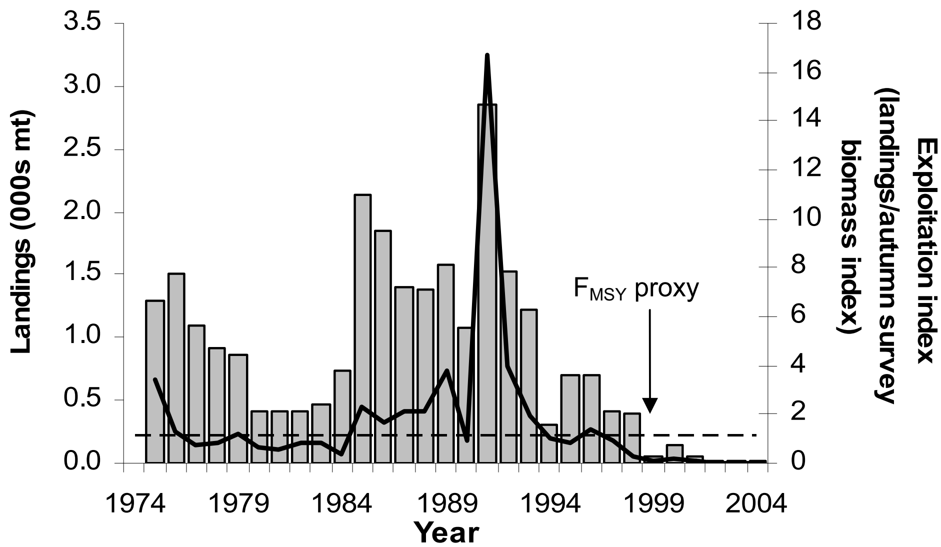

Figure P3. Relative exploitation indices (landings/autumn survey biomass indices) and landings (mt) of Gulf of Maine-Georges Bank windowpane flounder during 1975-2004.

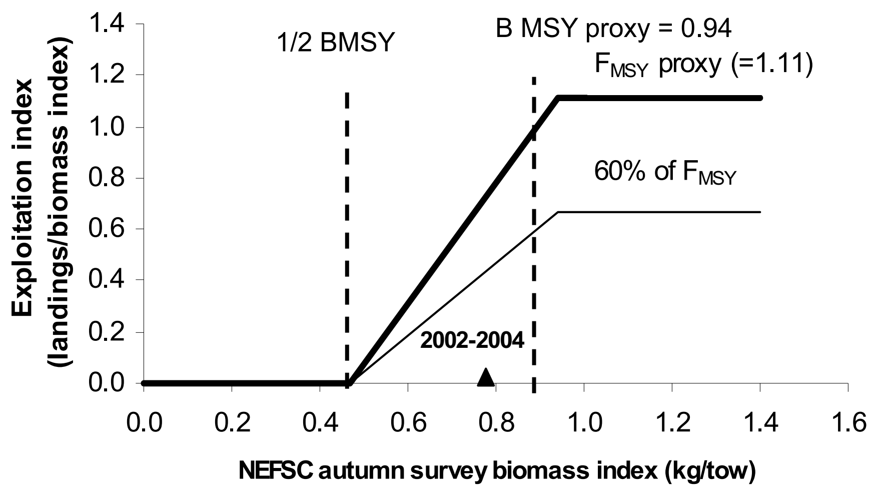

Figure P4. Harvest control rule for GOM-GB windowpane flounder based on survey equivalents of MSY-based reference points and the 2002-2004 means of the exploitation and biomass indices.

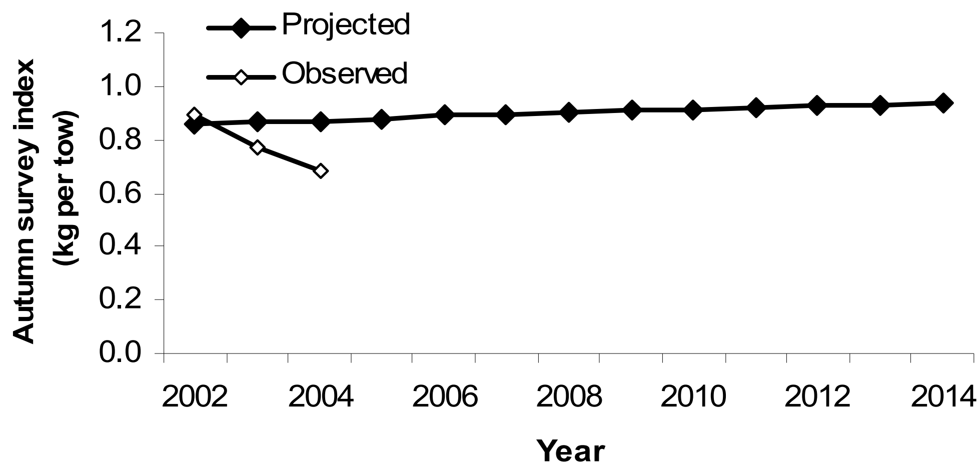

Figure P5. Observed autumn survey biomass indices, during 2002-2004, in relation to Amendment 13 projections of the survey biomass indices for GOM-GB windowpane flounder.

Q. Southern New England-Mid-Atlantic Bight Windowpane Flounder
by **Lisa Hendrickson**

1.0 Background

No stock structure information is available. Therefore, a provisional arrangement has been adopted that recognizes two stock areas based on apparent differences in growth, sexual maturity, and abundance trends between windowpane flounder from Georges Bank and Southern New England. The proportion of total landings contributed by the Mid-Atlantic area is low, so windowpane flounder landings from the Mid-Atlantic area are combined with those from Southern New England and the two regions are assessed as the southern New England and Mid-Atlantic Bight (SNE-MAB) stock.

The SNE-MAB windowpane flounder stock has never been formally assessed as part of the SAW/SARC process. The following index-based assessment represents an update of the assessment presented in October 2002 at the Groundfish Assessment Review Meeting (GARM) (NEFSC 2002a). Following the 2002 GARM, a re-evaluation of the overfishing definition was conducted and changes in the biological reference points were recommended (NEFSC 2002b).

2.0 Assessment Results

2.1 The Fishery

Commercial landings of windowpane flounder were first recorded in 1975. During 1985-1998 more than 50% of the windowpane landings were from the GOM-GB stock. Since 2001, the trend has reversed and most of the windowpane landings have come from the SNE-MAB stock. Landings ranged between 500 and 900 mt during 1975-1981, then increased sharply to a record high of 2,100 mt in 1985 (Table Q1 and Figure Q1). Thereafter, landings declined rapidly to 100 mt in 1995. During 1996-2000, landings stabilized at 100-200 mt, then declined to the lowest level on record in 2004 (44 mt).

Discards of windowpane flounder have never been quantified and were not evaluated for this assessment update. Therefore, only the landings are included in the calculation of exploitation indices.

2.2 Research Survey Indices

Relative biomass indices, stratified mean weight (kg) per tow, of SNE-MAB windowpane flounder from the NEFSC autumn bottom trawl surveys, conducted during 1963-2004, are presented in Table Q1 and Figure Q2. Biomass indices are highly variable, but indicate a declining trend 1963 and 1975, from a time series peak (1.99 kg per tow) to 0.14 kg per tow. Biomass indices then increased to 0.87 kg per tow in 1982, then declined to a record low in 1993 (0.03 kg per tow). During 1994-2004, biomass was fairly stable but at a very low level.

2.3 Biological Reference Points

Biological reference points for SNE-MAB windowpane flounder were derived from survey-based proxies of biomass and exploitation rates and are based on an MSY estimate (900 mt) from an ASPIC model. Biological reference points were subsequently revised based on a stock replacement ratio analysis, but target reference points were not revised (NEFSC 2002b). The threshold F is defined as an F_{MSY} proxy (= 0.98) when the NEFSC autumn survey index is greater than 0.92 kg per tow (equal to a B_{MSY} proxy) and declines linearly to zero at 50% of the B_{MSY} proxy (= 0.46 kg/tow).

2.4 Relative Exploitation Rates and Stock Status

Relative exploitation rates (landings/NEFSC autumn survey biomass index) declined sharply after reaching a peak in 1993 (Table Q1 and Figure Q3) and were at or below the F_{MSY} proxy (= 0.98) during 1994-2004. The 2002-2004 autumn survey mean biomass index is 0.19 kg/tow and the 2002-2004 mean exploitation index (landings/NEFSC autumn survey biomass index) is 0.37. Therefore, the stock was overfished but overfishing was not occurring in 2004 (Figure Q4).

Autumn survey biomass indices were at or near the levels projected in Amendment 13 during 2002 and 2003, but the observed biomass index was below the projected level in 2004 (Figure Q5).

3.0 Sources of Uncertainty

3.1 The influence of discards on the evaluation of current stock status relative to biological reference points is unclear.

4.0 Research Recommendations

4.1 Include discards in the estimated catch.

4.2 Investigate inclusion of the inshore strata in the NEFSC autumn survey time series.

5.0 Panel Discussion

The Panel noted that discards are not included in the estimate of the relative exploitation index and recommends that future assessments attempt to estimate discards. In addition, the NMFS inshore survey strata are not used in the calculation of the trawl survey index and the Panel recommends that these be included in future assessments. If these recommendations are adopted, the reference points will need to be re-evaluated.

6.0 Literature Cited

NEFSC [Northeast Fisheries Science Center]. 2002a. Assessment of 20 northeast groundfish stocks through 2001: A report of the Groundfish Assessment Review Meeting

(GARM), Northeast Fisheries Science Center, Woods Hole, Massachusetts, October 8-11, 2002. *Northeast Fish. Sci. Cent. Ref. Doc.* 02-16. 511 p.

NEFSC [Northeast Fisheries Science Center]. 2002b. Final report of the working group on re-evaluation of biological reference points for New England groundfish. 231 p.

Table Q1. Landings (mt), NEFSC autumn survey biomass indices (stratified mean kg per tow, offshore strata 1-12 and 61-76), and exploitation indices (landings/autumn survey biomass index) for Southern New England-Mid-Atlantic Bight windowpane flounder during 1963-2004. Landings include Statistical Areas beginning with 6, 526, 530-539 and 541.

Year	Landings[1] (mt)	Biomass Indices (kg per tow)	Exploitation Indices (landings/biomass index)
1963		1.99	
1964		0.87	
1965		0.78	
1966		1.11	
1967		0.81	
1968		0.90	
1969		0.37	
1970		0.31	
1971		0.40	
1972		0.57	
1973		0.58	
1974		0.26	
1975	681	0.14	4.76
1976	568	0.36	1.58
1977	647	0.54	1.21
1978	898	0.54	1.67
1979	633	0.76	0.83
1980	532	0.26	2.08
1981	883	0.52	1.70
1982	651	0.87	0.75
1983	798	0.37	2.17
1984	1,088	0.25	4.40
1985	2,065	0.62	3.34
1986	1,381	0.56	2.45
1987	887	0.44	2.02
1988	1,172	0.42	2.76
1989	1,121	0.09	12.18
1990	890	0.18	4.92
1991	817	0.41	2.02
1992	584	0.18	3.24
1993	469	0.03	15.14
1994	200	0.23	0.89
1995	100	0.20	0.50
1996	200	0.26	0.76
1997	107	0.13	0.84
1998	123	0.18	0.68
1999	116	0.12	1.00
2000	126	0.17	0.75
2001	128	0.34	0.38
2002	85	0.17	0.49
2003	47	0.30	0.16
2004	44	0.10	0.44

[1] Landings from 1995-2004 were prorated based on Vessel Trip Reports.

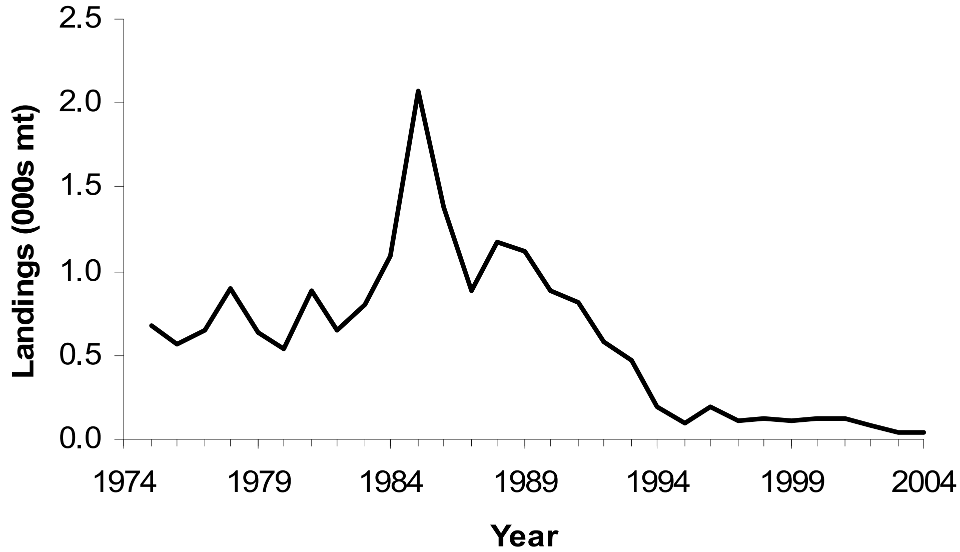

Figure Q1. Commercial landings of SNE-MAB windowpane flounder during 1975-2004.

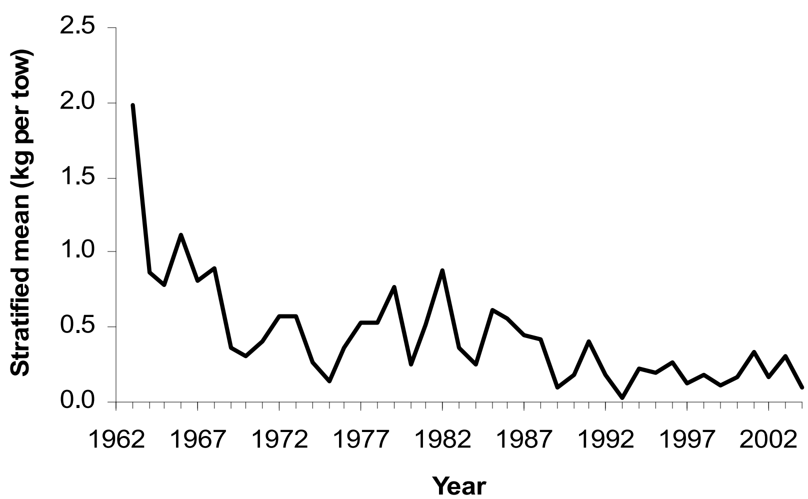

Figure Q2. Relative biomass indices (stratified mean kg per tow) for Southern New England-Mid-Atlantic Bight windowpane flounder from the NEFSC autumn bottom trawl surveys conducted during 1963-2004.

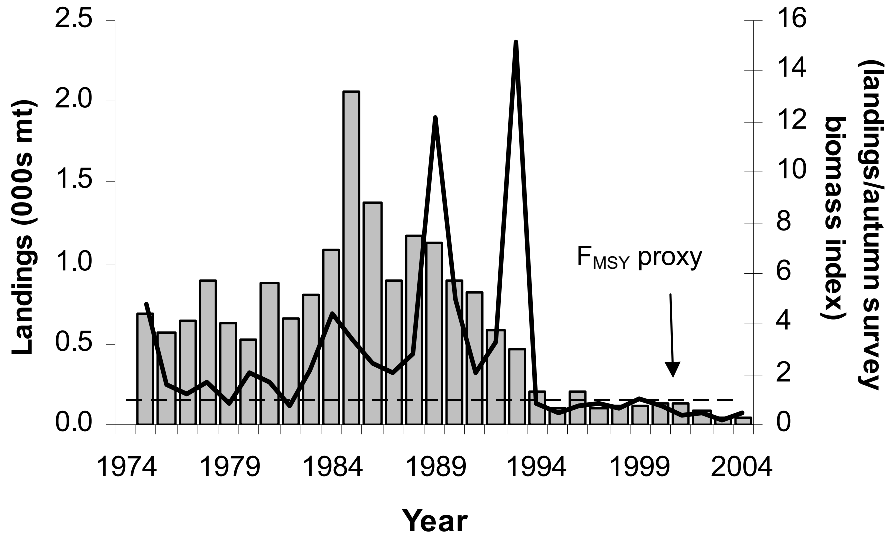

Figure Q3. Relative exploitation indices (landings/autumn survey biomass indices) and landings (mt) of Southern New England-Mid-Atlantic Bight windowpane flounder during 1975-2004.

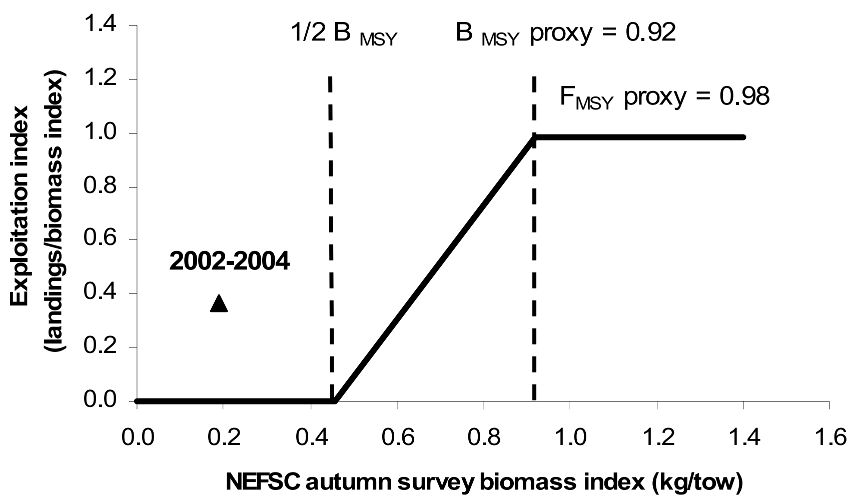

Figure Q4. Harvest control rule for SNE-MAB windowpane flounder based on survey equivalents of MSY-based reference points and the 2002-2004 means of the exploitation and biomass indices.

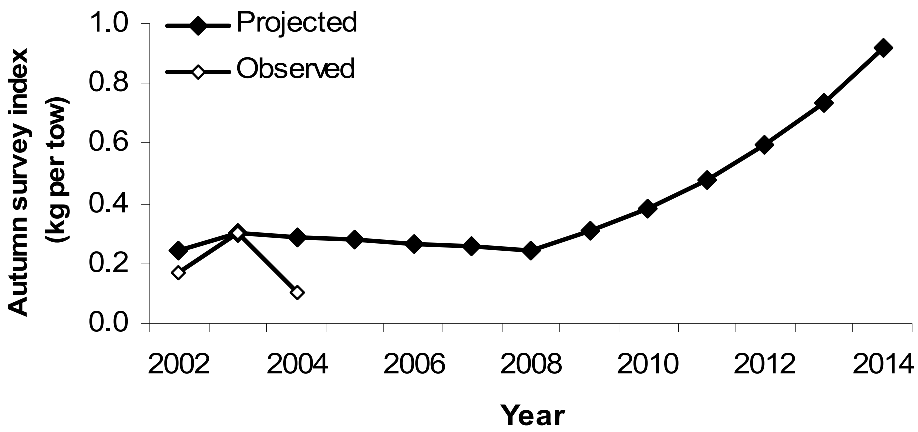

Figure Q5. Observed autumn survey biomass indices, during 2002-2004, in relation to Amendment 13 projections of the survey biomass indices for SNE-MAB windowpane flounder.

R. Gulf of Maine Haddock by **Jon Brodziak and Michele Traver**

1.0 Background

The Gulf of Maine haddock stock was last assessed at the Groundfish Assessment Review Meeting in 2002 (Brodziak and Thompson 2002). Based on the 2002 assessment, stock biomass was overfished in 2001 (B_{2001} was 47% of B_{MSY}) and was not experiencing overfishing (F_{2001} was 52% of F_{MSY}). In this report, we update the Gulf of Maine haddock assessment using fishery data for 2001-2004 and available survey data for 2001-2005. Updated survey biomass and exploitation rate indices are used for stock status determination.

2.0 Assessment for 2005

<u>2.1 2001-2004 Catches</u>
US commercial haddock landings were prorated into Georges Bank and Gulf of Maine stock components using a standard algorithm. Revised prorated Gulf of Maine haddock commercial landings totaled 1,196 mt in 2001, a 0.5% increase over the value reported in the last assessment. Total commercial landings of Gulf of Maine haddock increased from a low of 182 mt in 1995 to over 1,021 mt in 2004. Despite recent increases, commercial landings in 2004 were still less than half of the average annual landings during 1982-1991 (2,564 mt).

Recreational landings of Gulf of Maine haddock were extracted from MRFSS databases for 2001-2004 (Scott Steinback, NEFSC, Personal communication). Revised recreational landings in 2001 totaled 206 mt in 2001, a 1.5% increase over the value reported in the last assessment. Recreational landings have averaged 204 mt per year since 2000 (Figure R1).

<u>2.2 Survey Indices</u>
NEFSC spring survey indices were computed for 2002-2005 (Table B2, Figure B2) and NEFSC autumn survey indices were computed for 2002-2004 (Table B2, Figure B2) using standardized research survey data.

3.0 Assessment Results

<u>3.1 Index-Based Results</u>
An updated index-based assessment was conducted. The 3-year average of the NEFSC autumn survey biomass constituted the stock biomass index, except for 1963-1964 where one- and two-year averages were used (Table R3). Total commercial fishery landings were used for the catch time series (Table R3). Exploitation rate indices for stock status determination were computed as the annual catch divided by the 3-year average stock biomass index (Table R3, Figure R3). The exploitation rate index in 2004 was 0.18, an increase of 50% over the 2001 exploitation rate (0.12) and roughly 78% of the F_{MSY} proxy (0.23).

3.2 Sensitivity of Calculated Exploitation Index to Recreational Landings

Recreational landings of Gulf of Maine haddock have increased in recent years to average almost 20% of annual commercial landings. The sensitivity of the calculated exploitation rate index to the inclusion of recreational landings in the catch time series was evaluated (Table R4). Results indicate that the 2004 exploitation rate index calculated using total commercial and recreational landings was 0.22, about 20% above the index derived using only commercial landings and almost equal to the F_{MSY} proxy.

4.0 Sources of Uncertainty

- Proration of landings are based on preliminary logbook data and are subject to change.
- The amount of interchange between Gulf of Maine and Georges Bank haddock stocks is a source of uncertainty.

5.0 Summary Stock Status

5.1 Biological Reference Points

For Gulf of Maine haddock, the stock biomass index (B_{MSY}) and the proxy exploitation rate index (F_{MSY}) to produce MSY are B_{MSY} = 22.17 kg/tow and F_{MSY} = 0.23 (NEFSC 2002). The overfished threshold ($B_{THRESHOLD}$) for Gulf of Maine haddock is $B_{THRESHOLD}$ = ½ B_{MSY} = 11.08 kg/tow. The overfishing threshold ($F_{THRESHOLD}$) for Gulf of Maine haddock is $F_{THRESHOLD} = F_{MSY}$ = 0.23.

5.2 Stock Status in 2004

In 2004, the 3-year stock biomass index was 5.79 kg/tow (52% of $B_{THRESHOLD}$ and 26% of B_{MSY}) with a standard error of 1.06 kg/tow. Based on the biomass index, the Gulf of Maine haddock stock was overfished in 2004. In 2004, the exploitation rate index was 0.18 (78% of $F_{THRESHOLD}$). Therefore, overfishing was not occurring on the Gulf of Maine haddock stock in 2004.

5.3 Comparison with Projected Amendment 13 Rebuilding Trajectory

The projected Amendment 13 rebuilding trajectory for Gulf of Maine haddock was compared to the 3-year survey (B_{2004}) and exploitation rate (E_{2004}) indices in 2004. For this stock, an adaptive rebuilding plan was adopted in which $F_{REBUILD}=F_{MSY}=0.23$ during 2004-2008. The survey index on the rebuilding trajectory was projected to be $B_{REBUILD}$=21.43 kg in 2004. For comparison, the approximate 80% confidence interval for B_{2004} was (4.43, 7.15) kg and the $B_{REBUILD}$ in 2004 does not within the probable range of B_{2004}. For the exploitation rate index, the value of E_{2004}=0.18 was below the $F_{REBUILD}$ value for 2004. Overall, this suggests that current estimates of both stock biomass and exploitation rate are below the projected 2004 values on the adaptive rebuilding trajectory.

6.0 GARM Comments

The Panel discussed the recent increase in recreational landings, and its possible effects on the assessment. Recreational catch is regulated only by a minimum size restriction and has accounted for 15-20% of the total landings in recent years, but is not included in the assessment analyses.

The index-based assessment could be sensitive to the inclusion of these landings. The Panel recommended that recreational catch be included in future assessments.

A question was raised as to whether discards have been higher in the Gulf of Maine in recent years. Such a trend, in conjunction with the trend in recreational catches, could increase the exploitation rate index beyond what is accounted for in this model. The Panel's expectation is that discard rates probably have not increased, although effort may have increased due to fishing restrictions on Georges Bank. Furthermore, trip limits apply regardless of stock area, which suggests that these limits may not be as constraining in the Gulf of Maine as they are on Georges Bank. This may indicate a low discard rate in the Gulf of Maine.

The Panel noted that stock rebuilding is not occurring as rapidly as projected in 2003.

Research Recommendations

- Use an age-structured model.
- Include recreational catches with landings data.
- Recent exploitation indices and indices of abundance of the stock are similar to those seen in the 1970s and early 1980s. Investigate whether the current geographic distribution of the stock is also similar to those earlier periods.

7.0 References

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Table R1. Commercial landings (mt, live weight) of haddock from the Gulf of Maine (NAFO Division 5Y; U.S. statistical areas 511-515) from1956-2004.

Year	United States	Canada	USSR	Other	Total
1956	7278	29	0	0	7307
1957	6141	25	0	0	6166
1958	7082	285	0	0	7367
1959	4497	163	0	0	4660
1960	4541	383	0	0	4924
1961	5297	112	0	0	5409
1962	5003	107	0	0	5110
1963	4742	3	44	0	4789
1964	5383	70	0	0	5453
1965	4204	159	0	0	4363
1966	4579	1125	0	0	5704
1967	4907	589	0	0	5496
1968	3437	120	0	0	3557
1969	2423	59	0	231	2713
1970	1457	38	0	67	1562
1971	1194	85	0	27	1306
1972	909	23	4	0	936
1973	509	49	0	0	558
1974	622	198	0	9	829
1975	1180	79	0	4	1263
1976	1865	91	0	0	1956
1977	3296	26	0	0	3322
1978	4538	641	0	0	5179
1979	4622	257	0	0	4879
1980	7270	203	0	0	7473
1981	5726	513	0	0	6239
1982	5645	1278	0	0	6923
1983	5594	2003	0	0	7597
1984	2793	1245	0	0	4038
1985	2234	781	0	0	3015
1986	1443	225	0	0	1668
1987	829	0	0	0	829
1988	436	0	0	0	436
1989	264	0	0	0	264
1990	433	0	0	0	433
1991	431	0	0	0	431
1992	312	0	0	0	312
1993	193	0	0	0	193
*1994	329	0	0	0	329
*1995	182	0	0	0	182
*1996	1061	0	0	0	1061
*1997	613	0	0	0	613
*1998	1037	0	0	0	1037
*1999	913	0	0	0	913
*2000	774	0	0	0	774
*2001	1196	0	0	0	1196
*2002	1211	0	0	0	1211
*2003	1221	0	0	0	1221
*2004	1021	0	0	0	1021
Average 1956-2004	2712	224	1	7	2943
Average 1980-1999	1887	312			2199
Average 2000-2004	1084				1084

*U.S. landings from 1994-2004 are provisional.

Table R2. NEFSC spring and fall survey indices for Gulf of Maine haddock, 1963-2005.

Year	NEFSC Spring Number per Tow	Spring Number per Tow Stderr	NEFSC Spring Weight (kg) per Tow	Spring Weight per Tow Stderr	NEFSC Fall Number per Tow	Fall Number per Tow Stderr	NEFSC Fall Weight (kg) per Tow	Fall Weight per Tow Stderr
1963					69.55	20.46	50.70	8.36
1964					14.18	5.43	18.83	3.52
1965					17.43	6.34	17.64	4.00
1966					11.65	3.88	13.86	4.03
1967					12.19	3.09	16.85	4.44
1968	6.01	1.91	7.89	2.19	8.56	1.43	17.24	2.90
1969	3.78	0.81	7.38	1.87	5.45	1.37	12.85	3.05
1970	0.91	0.23	1.73	0.47	2.92	0.67	7.35	1.66
1971	0.88	0.44	2.52	1.20	2.88	1.01	8.14	2.86
1972	0.86	0.33	0.87	0.56	1.98	0.50	3.04	1.10
1973	1.20	0.35	1.60	0.65	4.17	0.91	8.58	2.90
1974	1.44	0.61	1.06	0.47	2.69	1.64	3.35	1.13
1975	2.77	0.81	3.48	1.65	4.54	1.24	6.81	2.26
1976	8.33	3.01	6.35	2.49	6.04	1.50	8.04	2.37
1977	6.80	2.30	6.73	2.80	8.30	2.88	8.75	2.62
1978	1.36	0.62	1.43	0.45	9.78	1.77	21.66	4.30
1979	3.33	0.69	3.95	0.93	6.17	1.30	15.57	3.52
1980	2.70	0.98	2.67	1.35	7.15	2.67	9.84	2.54
1981	4.41	0.96	3.55	0.85	4.46	0.88	10.87	2.64
1982	2.05	0.73	2.56	0.97	2.63	1.00	4.16	1.30
1983	3.68	1.68	3.57	1.72	2.60	0.82	5.22	1.61
1984	1.10	0.50	1.14	0.53	1.70	0.51	3.89	1.16
1985	1.77	0.74	1.88	0.62	4.08	1.78	6.15	1.99
1986	0.71	0.36	1.28	0.70	0.62	0.28	1.39	0.59
1987	0.09	0.04	0.06	0.04	1.04	0.35	2.65	0.75
1988	0.19	0.11	0.30	0.20	0.34	0.23	1.48	1.13
1989	0.08	0.07	0.12	0.11	0.28	0.12	0.63	0.33
1990	0.02	0.01	0.00	0.00	0.15	0.06	0.43	0.17
1991	0.07	0.04	0.07	0.05	0.14	0.09	0.12	0.09
1992	0.19	0.12	0.27	0.27	0.21	0.13	0.09	0.06
1993	0.45	0.23	0.20	0.16	0.87	0.71	0.47	0.45
1994	0.40	0.15	0.25	0.11	0.33	0.15	0.22	0.21
1995	0.81	0.41	0.35	0.17	0.98	0.60	1.10	0.50
1996	0.31	0.10	0.34	0.13	2.41	0.97	3.54	1.63
1997	1.94	0.85	1.22	0.69	2.69	1.07	2.42	0.75
1998	0.20	0.09	0.11	0.05	3.13	1.73	2.92	1.32
1999	4.27	1.87	1.11	0.44	6.73	2.12	4.91	1.25
2000	3.61	1.62	1.82	0.83	16.59	8.29	14.03	6.10
2001	2.36	1.55	3.22	2.31	9.96	2.92	11.98	3.33
2002	5.70	3.22	2.79	0.99	3.92	1.49	4.84	1.75
2003	3.19	0.87	3.91	1.20	4.73	1.15	5.36	1.37
2004	1.06	0.40	1.20	0.53	5.70	1.64	7.17	2.28
2005	0.86	0.38	0.97	0.51				
Average 1963-2005	2.10	0.79	2.10	0.82	6.47	2.08	8.22	2.15
Average 1980-1999	1.27	0.50	1.05	0.46	2.13	0.81	3.13	1.03
Average 2000-2005	2.80	1.34	2.32	1.06	8.18	3.10	8.68	2.96

Table R3. Exploitation rate index for Gulf of Maine haddock based on autumn NEFSC survey biomass index and annual commercial landings, 1963-2004.

Year	Commercial Landings	Survey Index	3-Year Average Survey Index	Exploitation Rate Index
1963	4.789	50.70	50.70	0.09
1964	5.453	18.83	34.76	0.16
1965	4.363	17.64	29.06	0.15
1966	5.704	13.86	16.78	0.34
1967	5.496	16.85	16.12	0.34
1968	3.557	15.48	15.40	0.23
1969	2.713	12.85	15.06	0.18
1970	1.562	7.35	11.90	0.13
1971	1.306	8.14	9.45	0.14
1972	0.936	3.04	6.18	0.15
1973	0.558	8.58	6.59	0.08
1974	0.829	3.35	4.99	0.17
1975	1.263	8.62	6.85	0.18
1976	1.956	8.04	6.67	0.29
1977	3.322	8.75	8.47	0.39
1978	5.179	20.93	12.57	0.41
1979	4.879	13.72	14.47	0.34
1980	7.473	9.84	14.83	0.50
1981	6.239	9.34	10.97	0.57
1982	6.923	4.16	7.78	0.89
1983	7.597	5.22	6.24	1.22
1984	4.038	3.89	4.43	0.91
1985	3.025	6.15	5.09	0.59
1986	1.668	1.39	3.81	0.44
1987	0.829	2.65	3.40	0.24
1988	0.436	1.48	1.84	0.24
1989	0.264	0.63	1.58	0.17
1990	0.433	0.43	0.85	0.51
1991	0.431	0.12	0.39	1.09
1992	0.312	0.09	0.21	1.46
1993	0.193	0.47	0.23	0.85
1994	0.329	0.22	0.26	1.27
1995	0.182	1.10	0.60	0.31
1996	1.061	3.54	1.62	0.66
1997	0.613	2.42	2.36	0.26
1998	1.037	2.92	2.96	0.35
1999	0.913	4.91	3.42	0.27
2000	0.774	14.03	7.29	0.11
2001	1.196	11.98	10.31	0.12
2002	1.211	4.84	10.28	0.12
2003	1.221	5.36	7.39	0.17
2004	1.021	7.17	5.79	0.18
Average 1963-2004	2.459	8.12	9.05	0.41
Average 1980-1999	2.200	3.05	3.64	0.64
Average 2000-2004	1.085	8.68	8.21	0.14

Table R4. Sensitivity analysis of the exploitation rate index for Gulf of Maine haddock using total commercial and recreational landings, 1963-2004

Year	Total Landings	Survey Index	3-Year Average Survey Index	Exploitation Rate Index
1963	4.789	50.70	50.70	0.09
1964	5.453	18.83	34.76	0.16
1965	4.363	17.64	29.06	0.15
1966	5.704	13.86	16.78	0.34
1967	5.496	16.85	16.12	0.34
1968	3.557	15.48	15.40	0.23
1969	2.713	12.85	15.06	0.18
1970	1.562	7.35	11.90	0.13
1971	1.306	8.14	9.45	0.14
1972	0.936	3.04	6.18	0.15
1973	0.558	8.58	6.59	0.08
1974	0.829	3.35	4.99	0.17
1975	1.263	8.62	6.85	0.18
1976	1.956	8.04	6.67	0.29
1977	3.322	8.75	8.47	0.39
1978	5.179	20.93	12.57	0.41
1979	4.879	13.72	14.47	0.34
1980	7.473	9.84	14.83	0.50
1981	6.239	9.34	10.97	0.57
1982	6.997	4.16	7.78	0.90
1983	7.634	5.22	6.24	1.22
1984	4.054	3.89	4.43	0.92
1985	3.024	6.15	5.09	0.59
1986	1.668	1.39	3.81	0.44
1987	0.856	2.65	3.40	0.25
1988	0.440	1.48	1.84	0.24
1989	0.282	0.63	1.58	0.18
1990	0.433	0.43	0.85	0.51
1991	0.431	0.12	0.39	1.09
1992	0.312	0.09	0.21	1.46
1993	0.193	0.47	0.23	0.85
1994	0.331	0.22	0.26	1.27
1995	0.347	1.10	0.60	0.58
1996	1.069	3.54	1.62	0.66
1997	0.657	2.42	2.36	0.28
1998	1.092	2.92	2.96	0.37
1999	0.941	4.91	3.42	0.28
2000	0.964	14.03	7.29	0.13
2001	1.402	11.98	10.31	0.14
2002	1.378	4.84	10.28	0.13
2003	1.429	5.36	7.39	0.19
2004	1.256	7.17	5.79	0.22

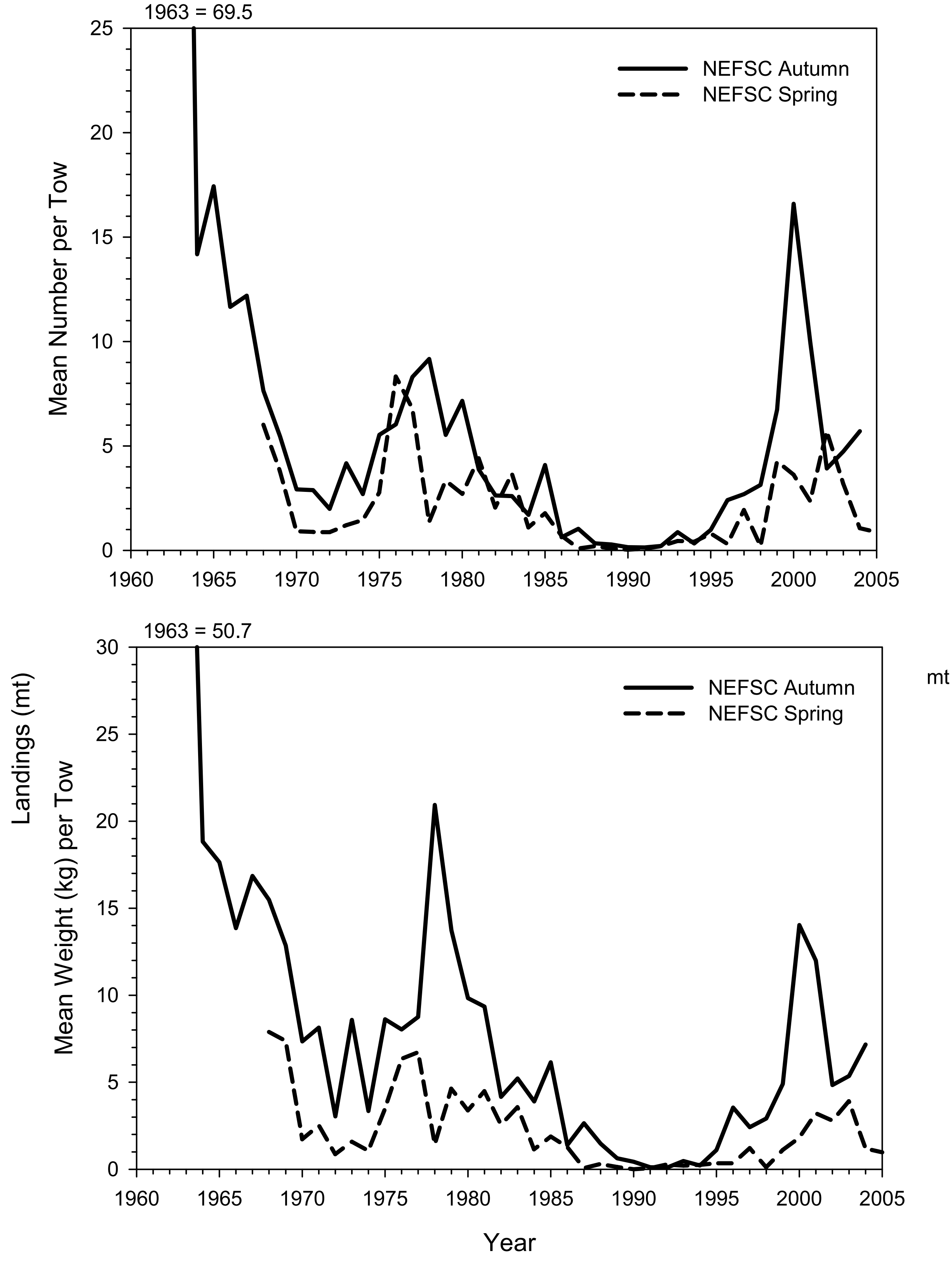
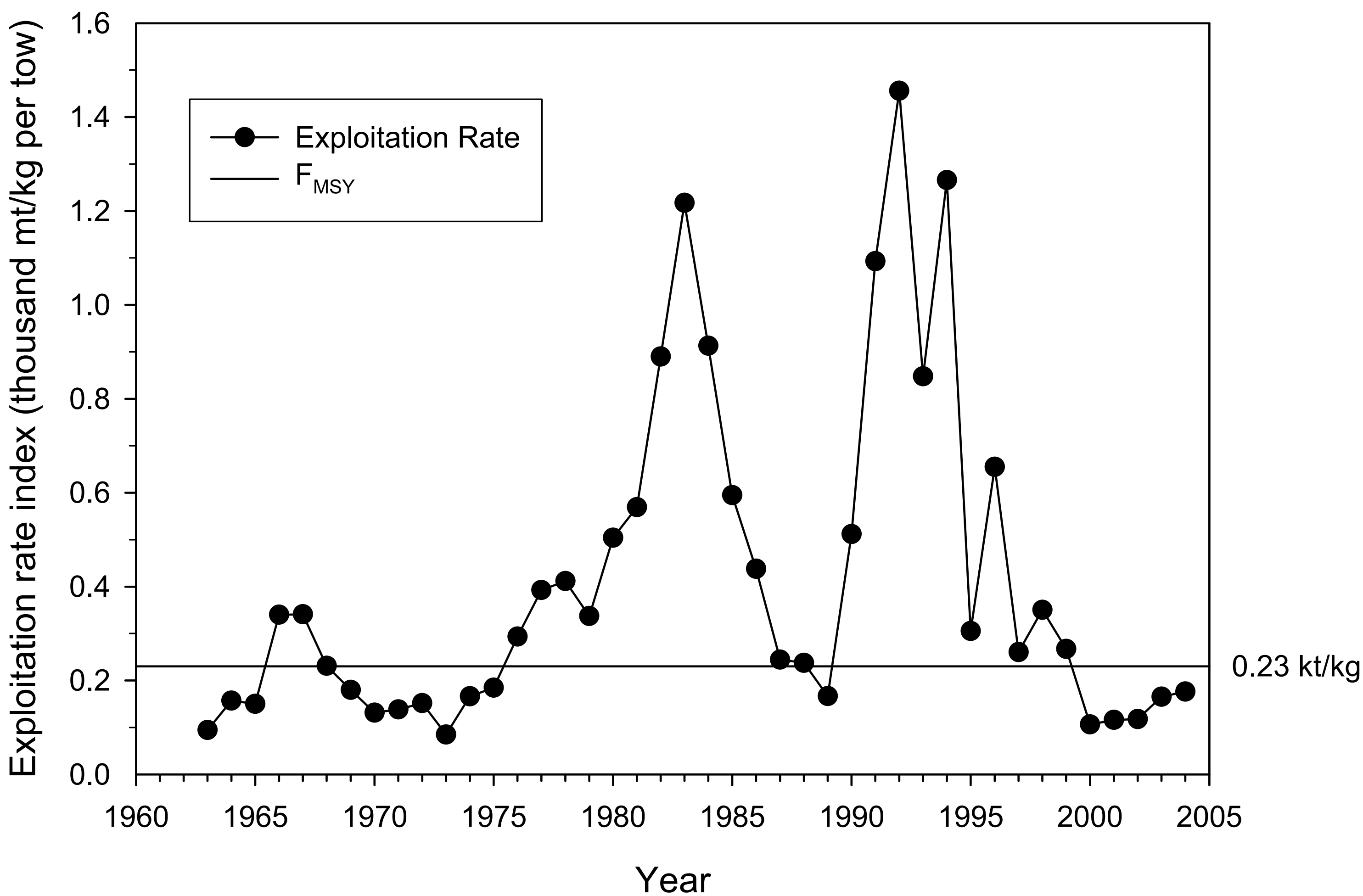


Figure R2. Northeast Fisheries Science Center research standardized and stratified survey abundance (mean number per tow; top panel) and biomass (kg per tow; bottom panel) indices for Gulf of Maine haddock from 1963-2002. U.S. survey includes strata 01260-01280 and 01360-01400.

Figure R3. Gulf of Maine haddock exploitation rate index, 1963-200



S. Atlantic halibut by **Jon Brodziak** and **Laurel Col**

1.0 Background

The Atlantic halibut (*Hippoglossus hippoglossus*) is distributed from Labrador to southern New England in the northwest Atlantic (Bigelow and Schroeder 1953). The Atlantic halibut stock within Gulf of Maine-Georges Bank waters (NAFO Subarea 5) has been exploited since the 1830s. The Gulf of Maine-Georges Bank Atlantic halibut stock was last assessed in 2002 (Brodziak 2002). Based on that assessment, the stock was overfished (B_{2001} was 7% of B_{MSY}) and it was unknown whether overfishing was occurring. In this report, we update the Atlantic halibut assessment using fishery data and available survey data for 2002-2004. Updated survey biomass indices are used for stock status determination.

2.0 Assessment for 2005

2.1 2001-2004 Catches

Records of Atlantic halibut landings from the Gulf of Maine and Georges Bank begin in 1893 (Table S1, Figure S1). Substantial landings occurred prior to this, however, as the halibut fishery declined in the late 1800s (Hennemuth and Rockwell 1987). Landings have decreased since the 1890s as components of the resource have been sequentially depleted. Annual landings averaged 662 mt during 1893-1940 and declined to an average of 144 mt during 1941-1976. During 1977-2000, landings averaged 89 mt per year. Total reported commercial landings of halibut increased from a record low of 17 mt in 2000 to 25 mt in 2004. Of the 2004 landings, 9 mt (36%) were landed by U.S. fishermen and 16 mt were landed by Canadian fishermen (Division 5Zc). Despite moderate recent increases, annual commercial landings averaged only 25 mt during 2001-2004, less than one-third of the average annual landings during 1977-2000.

2.2 Survey Indices

The NEFSC spring and fall bottom trawl surveys provide measures of the relative abundance of Atlantic halibut within the Gulf of Maine and Georges Bank region (offshore survey strata 13-30 and 36-40, Table S2). Both indices have high interannual variability since relatively few halibut are captured during these surveys; in some years, no halibut are caught. The survey indices suggest that relative abundance increased during the 1970s to early 1980s and subsequently declined in the 1990s. However, it is unknown whether abundance trends in the Gulf of Maine and Georges Bank region have been influenced by changes in the seasonal distribution and availability of Atlantic halibut. NEFSC spring survey indices were computed for 2002-2005 (Table S2) and NEFSC autumn survey indices were computed for 2002-2004 (Table S2, Figure S2) using standardized research survey data.

3.0 Assessment Results

3.1 Index-Based Results

An updated index-based assessment was conducted. The 5-year average of the NEFSC fall survey biomass constituted the stock biomass index, except for 1963-1967 where one- to four-year averages were sequentially used (Table S2 and Figure S3). Total commercial fishery landings were used for the catch time series (Table S1). Although no estimates of fishing mortality are available, exploitation rate indices (annual landings/5-year moving average of survey index) suggest that exploitation rates have probably been stable since the 1970s, and appear to have declined during the 1990s (Table S2). Thus, although the Atlantic halibut stock in the Gulf of Maine and Georges Bank region remains depleted, exploitation rates do not appear to have increased since the 1970s. The autumn exploitation rate index in 2004 was 0.09, an increase of about 28% over the 2000 exploitation rate (0.07), but still much lower than the rates observed during the 1970s-1980s.

4.0 Sources of Uncertainty

- Discarding and misreporting of Atlantic halibut landings is a potential source of uncertainty.
- Fishery-dependent information on the size and age composition of Atlantic halibut catches are limited, although an experimental fishery in the Gulf of Maine has provided some valuable data (Sigourney 2002).
- Stock structure of Atlantic halibut within the Gulf of Maine and Georges Bank region is uncertain. Wise and Jensen (1959) documented movements of tagged Atlantic halibut between Georges Bank and Browns Bank, but movement rates were not estimated in their study. Recently, one halibut released near Stonington, Maine in April 2000 during the Gulf of Maine experimental fishery was recaptured off Port au Basque, Newfoundland in May 2002 after growing from 32 to 40 inches in total length (Kohl Kanwit, Maine DMF, personal communication). To date, preliminary tag-recapture data from a Maine DMR tagging study indicate that about 23% of Atlantic halibut recaptures were reported in Canadian waters.
- The portion of the Atlantic halibut population within Gulf of Maine and Georges Bank region is a transboundary stock. Conservation measures for both USA and Canadian fisheries may be needed to rebuild this stock.

5.0 Summary Stock Status

5.1 Biological Reference Points

For Gulf of Maine-Georges Bank Atlantic halibut stock, the stock biomass index (B_{MSY}) to produce MSY is B_{MSY} = 5400 mt; there is currently no F_{MSY} proxy for this stock (NEFMC 1998, NEFSC 2002). The overfished threshold ($B_{THRESHOLD}$) for Gulf of Maine-Georges Bank Atlantic halibut is $B_{THRESHOLD}$ = ½ B_{MSY} = 2700 mt.

5.2 Stock Status in 2004

In 2004, the 5-year average stock biomass index was 288 (11% of $B_{THRESHOLD}$ and 5% of B_{MSY}). Based on the stock biomass index, the Gulf of Maine-Georges Bank Atlantic halibut stock was overfished in 2004. In 2004, no estimate of fishing mortality was available and overfishing status was unknown.

5.3 Comparison with Projected Amendment 13 Rebuilding Trajectory

There is no Amendment 13 rebuilding trajectory for Gulf of Maine-Georges Bank Atlantic halibut.

6.0 GARM Comments

The Panel noted that the magnitude of discards recorded by at sea observers in recent years has increased, although this increase may be a function of increased observer coverage. Most of the fish observed at sea in both the landings and discards appear to be below the median length of maturity (103 cm = 41 inches), especially for females. The current minimum retention size is 91 cm = 36 inches.

Gulf of Maine/ Georges Bank Atlantic halibut is a component of a larger transboundary stock. Tagging information indicates movement across the US-Canada border. US landings are a small fraction of the Canadian landings. Additional conservation measures for the USA and Canadian fisheries may promote rebuilding of this stock.

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Table S1. Reported landings (mt) of Atlantic halibut from the Gulf of Maine and Georges Bank, 1893-2004.

Year	USA	Canada	Other	Total	Year	USA	Canada	Other	Total
1893	634	0	0	634	1950	116	0	0	116
1894	843	0	0	843	1951	154	0	0	154
1895	4200	0	0	4200	1952	123	0	0	123
1896	4908	0	0	4908	1953	104	0	0	104
1897	733	0	0	733	1954	125	0	0	125
1898	564	0	0	564	1955	74	0	0	74
1899	407	0	0	407	1956	62	0	0	62
1900	311	0	0	311	1957	80	0	0	80
1901	287	0	0	287	1958	73	0	0	73
1902	367	0	0	367	1959	59	0	0	59
1903	502	0	0	502	1960	63	0	0	63
1904	332	0	0	332	1961	79	5	0	84
1905	580	0	0	580	1962	86	35	25	146
1906	542	0	0	542	1963	94	88	1	183
1907	447	0	0	447	1964	115	120	1	236
1908	891	0	0	891	1965	128	153	18	299
1909	193	0	0	193	1966	110	110	62	282
1910	329	0	0	329	1967	102	386	26	514
1911	389	0	0	389	1968	74	193	3	270
1912	460	0	0	460	1969	63	96	9	168
1913	402	0	0	402	1970	52	67	19	138
1914	329	0	0	329	1971	81	38	0	119
1915	336	0	0	336	1972	63	37	8	108
1916	478	0	0	478	1973	51	38	0	89
1917	293	0	0	293	1974	46	29	1	76
1918	375	0	0	375	1975	70	36	0	106
1919	496	0	0	496	1976	58	33	0	91
1920	896	0	0	896	1977	50	31	0	81
1921	689	0	0	689	1978	84	50	0	134
1922	694	0	0	694	1979	125	29	0	154
1923	508	0	0	508	1980	80	88	0	168
1924	616	0	0	616	1981	80	118	0	198
1925	843	0	0	843	1982	85	116	0	201
1926	944	0	0	944	1983	72	131	0	203
1927	831	0	0	831	1984	75	62	0	137
1928	781	0	0	781	1985	61	57	0	118
1929	570	0	0	570	1986	44	32	0	76
1930	716	0	0	716	1987	27	23	0	50
1931	511	0	0	511	1988	47	81	0	128
1932	443	0	0	443	1989	13	65	0	78
1933	279	0	0	279	1990	16	58	0	74
1934	192	0	0	192	1991	30	58	0	88
1935	292	0	0	292	1992	22	47	0	69
1936	374	0	0	374	1993	15	50	0	65
1937	187	0	0	187	1994	22	24	0	46
1938	146	0	0	146	1995	11	8	0	19
1939	124	0	0	124	1996	13	12	0	25
1940	497	0	0	497	1997	14	14	0	28
1941	145	0	0	145	1998	8	9	0	17
1942	250	0	0	250	1999	12	8	0	20
1943	76	0	0	76	2000	11	6	0	17
1944	77	0	0	77	2001	11	11	0	22
1945	55	0	0	55	2002	10	10	0	20
1946	124	0	0	124	2003	17	14	0	31
1947	196	0	0	196	2004	9	16	0	25
1948	156	0	0	156					
1949	157	0	0	157					

Table S2. Stratified swept-area biomass (mt) of Atlantic halibut from NEFSC spring and autumn surveys (offshore strata 13-30, 36-40) and exploitation rate indices calculated as annual landings divided by the 5-year moving average of swept-area biomass indices.

Year	Spring Swept-Area Index (mt)	5-Year Average Spring Swept-Area Index (mt)	Spring Explotiation Rate Index	Fall Swept-Area Index (mt)	5-Year Average Fall Swept-Area Index (mt)	Autumn Explotiation Rate Index
1963				282	282	0.65
1964				222	252	0.94
1965				106	204	1.47
1966				13	156	1.81
1967				30	131	3.93
1968	428	428	0.63	0	74	3.63
1969	783	606	0.28	1640	358	0.47
1970	349	520	0.27	0	337	0.41
1971	110	417	0.29	302	394	0.30
1972	17	337	0.32	60	400	0.27
1973	375	327	0.27	435	487	0.18
1974	372	244	0.31	46	169	0.45
1975	0	175	0.61	315	232	0.46
1976	2138	580	0.16	1255	422	0.22
1977	471	671	0.12	196	449	0.18
1978	541	704	0.19	976	558	0.24
1979	1185	867	0.18	133	575	0.27
1980	1869	1241	0.14	33	518	0.32
1981	219	857	0.23	1065	481	0.41
1982	272	817	0.25	382	518	0.39
1983	2028	1115	0.18	0	323	0.63
1984	73	892	0.15	412	378	0.36
1985	209	560	0.21	352	442	0.27
1986	0	516	0.15	1039	437	0.17
1987	953	653	0.08	110	382	0.13
1988	76	262	0.49	13	385	0.33
1989	0	248	0.32	219	347	0.23
1990	212	248	0.30	199	316	0.23
1991	206	289	0.30	807	270	0.33
1992	123	123	0.56	667	381	0.18
1993	20	112	0.58	153	409	0.16
1994	56	123	0.37	0	365	0.13
1995	17	84	0.23	219	369	0.05
1996	43	52	0.48	176	243	0.10
1997	209	69	0.41	578	225	0.12
1998	56	76	0.22	342	263	0.06
1999	793	224	0.09	50	273	0.07
2000	0	220	0.08	70	243	0.07
2001	544	321	0.07	823	372	0.06
2002	425	364	0.05	13	260	0.08
2003	176	388	0.08	163	224	0.14
2004	554	340	0.07	372	288	0.09
2005	83	356				

Figure S1. Atlantic halibut landings from the Gulf of Maine-Georges Bank region during 1893-2004.

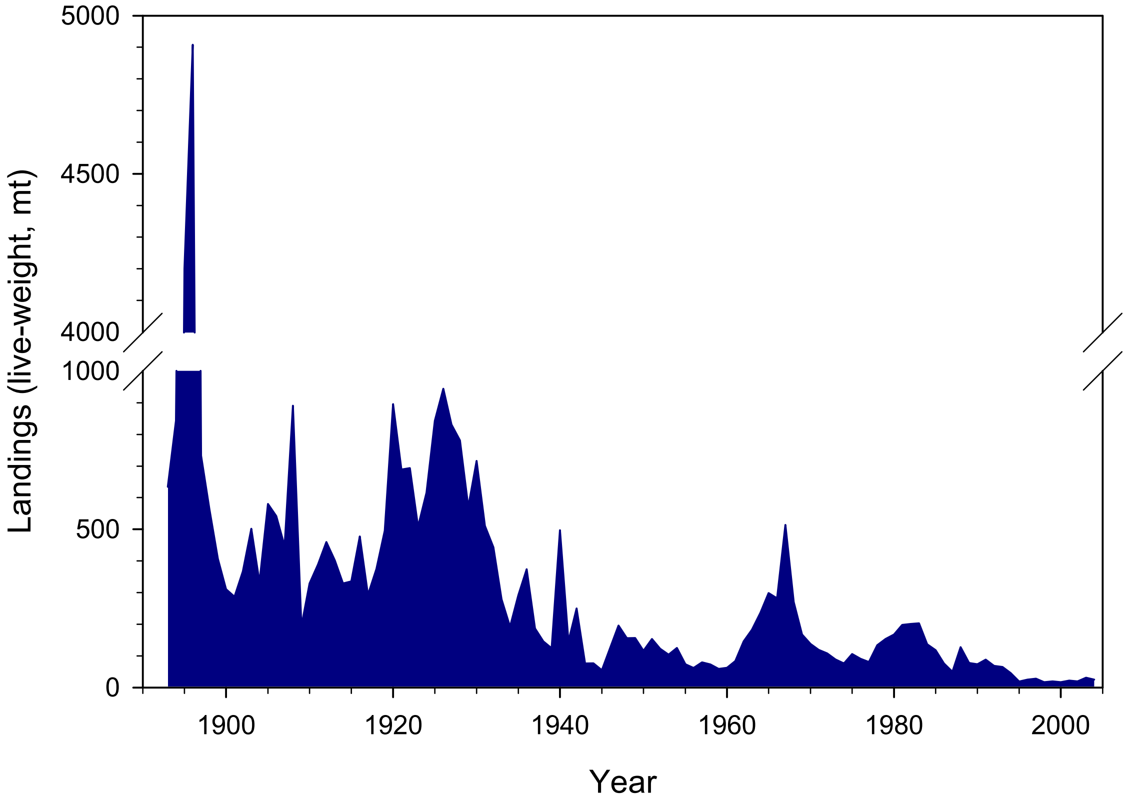


Figure S2. Trends in Atlantic halibut landings from the Gulf of Maine and Georges Bank in comparison to 5-year moving averages of spring and autumn survey indices, 1967-2005.

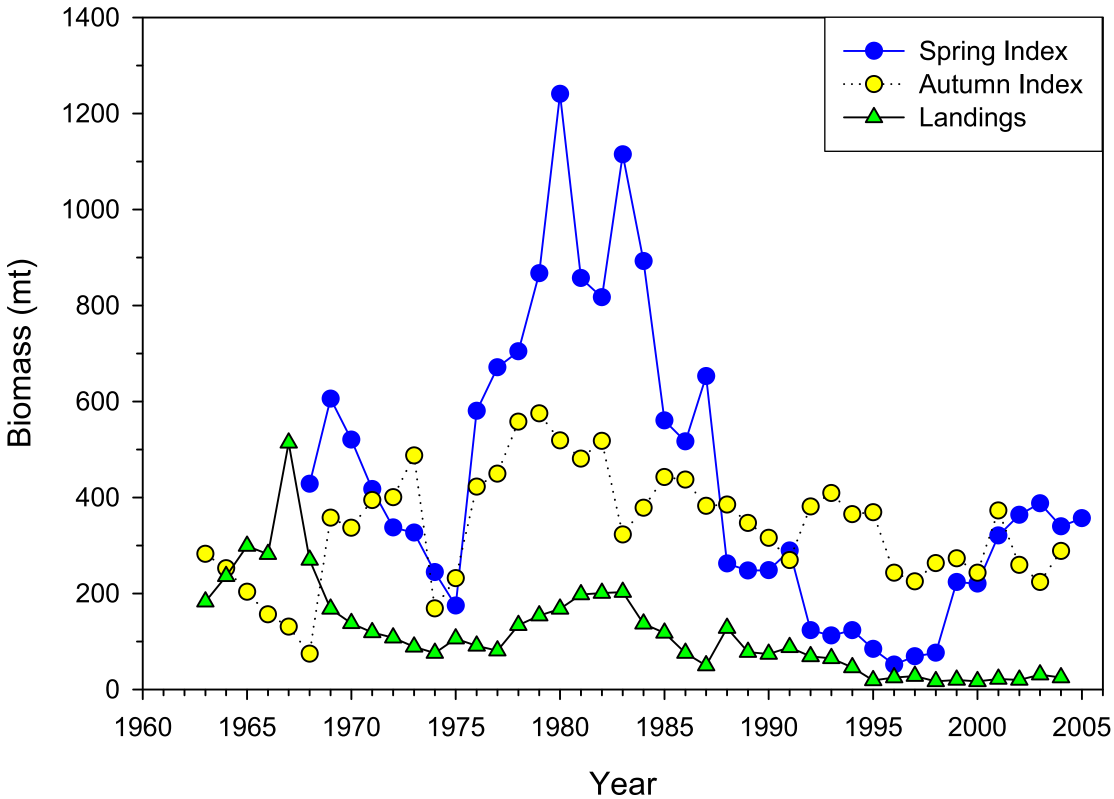
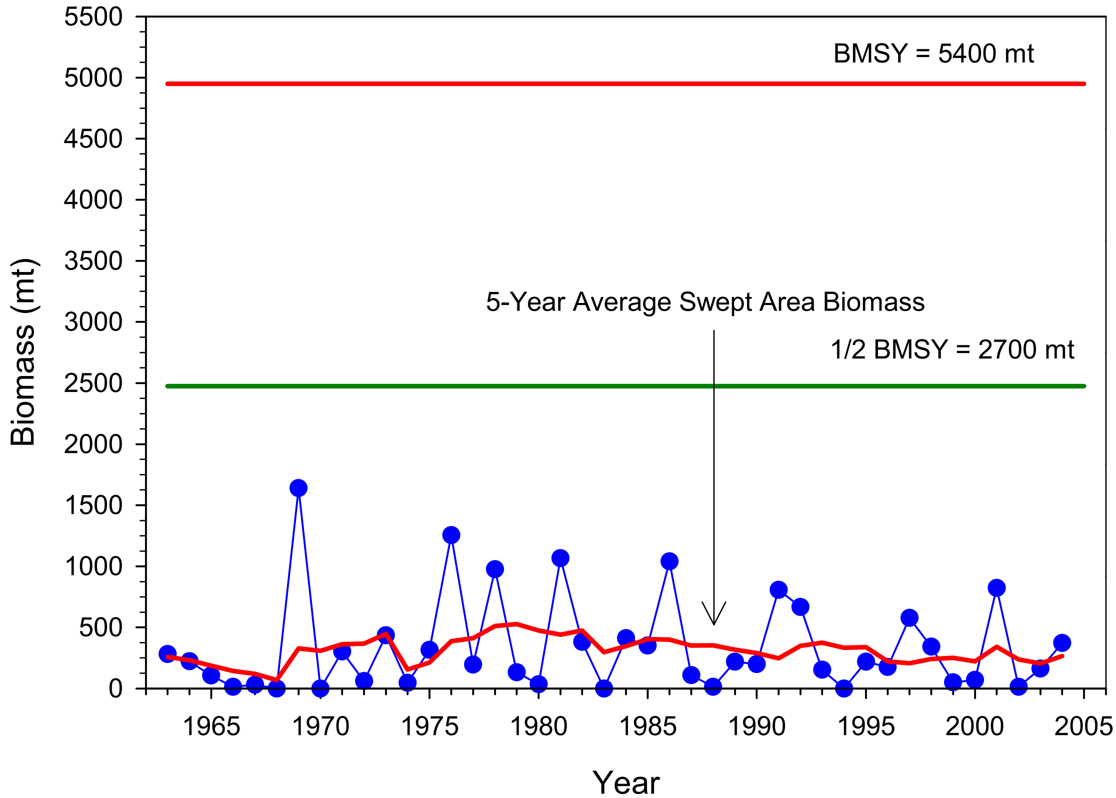


Figure S3. Trends in swept-area biomass indices (mt) of Atlantic halibut from NEFSC autumn bottom trawl surveys.



3.0 Summary

This section summarizes stock status in 2004 as determined by current assessments, and compares that to stock status in 2001 as determined both by the current assessments and those conducted by the 2002 GARM. For some stocks, the current assessments provide different estimates of 2001 biomass and fishing mortality than those reported by the 2002 GARM. These cases are noted.

Assessment information is based on the calendar year. For stocks that are assessed with age-based methods, biomass estimates are for SSB at the beginning of the spawning season. Since most groundfish stocks spawn in the spring or early summer, the assessments provide an estimate of biomass at the beginning of the implementation of Amendment 13 (implemented May 1, 2004) and do not reflect the impact of Amendment 13 measures. For most index-based stocks the biomass index proxy includes the 2004 fall trawl survey and thus reflects a few months of Amendment 13 measures. Fishing mortality estimates reflect eight months of Amendment 13 measures.

3.1 Current Stock Status

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 ½ 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 6 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 3.1 and 3.2. Stocks falling into each category are listed in Table 3.1. The number of stocks where biomass was below ½ B_{MSY} remained the same, 12 below and 6 at or above ½ 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 ½ B_{MSY} and F exceeded F_{MSY} declined from 9 in 2001 to 7 in 2004.

The current assessments indicate that Georges Bank yellowtail flounder, and Gulf of Maine and Georges Bank winter flounder were less than ½ BMSY in 2001, a change from status as reported by the 2002 GARM. Conversely, the current assessments indicate that plaice was above ½ BMSY in 2001, whereas the 2002 GARM reported that plaice was less than ½ BMSY.

Direct comparisons between the state of these stocks in 2001 and 2004 are also provided in Figures 3.3 and 3.4. 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 ½ 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.

Atlantic halibut is excluded from Table 3.1 and Figures 3.1 and 3.2 because F_{MSY} reference points have not been estimated. These stocks are also categorized according to the status as determined at the 2002 GARM. Comparisons between these two assessment results are problematic for some stocks because of changing stock definitions (Southern New England, Mid Atlantic, and Cape Cod yellowtail flounder), a change in the basis of the assessment (Gulf of Maine winter flounder), and a recommended change in the status determination criteria (Georges Bank winter flounder).

Table 3.1. 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	GB Cod	GB Cod	GB Cod
AND	GB YT	GB YT	
F > Fmsy	SNE/MA YT	SNE/MA YT	SNE YT and MA YT
	CC/GOM YT	CC/GOM YT	CC YT
	SNE/MA Winter	SNE/MA Winter	SNE/MA Winter
	W Hake	W Hake	W Hake
	GOM Cod	GOM Cod	GOM Cod
		Witch	
		GOM Winter	
			Plaice
Biomass < 1/2 Bmsy	GB Haddock	GB Haddock	GB Haddock
AND	GOM Haddock	GOM Haddock	GOM Haddock
F< Fmsy	So. Window	So. Window	So. Window
	Plaice		
	Pout		
Biomass > 1/2 Bmsy	GB Winter	GB Winter	
AND		Plaice	
F>Fmsy			Witch
Biomass > 1/2 Bmsy	Pollock	Pollock	Pollock
AND	Redfish	Redfish	Redfish
F< Fmsy	No. Window	No. Window	No. Window
		Pout	Pout
	GOM Winter		GOM Winter
			GB Winter
			GB YT
	Witch		

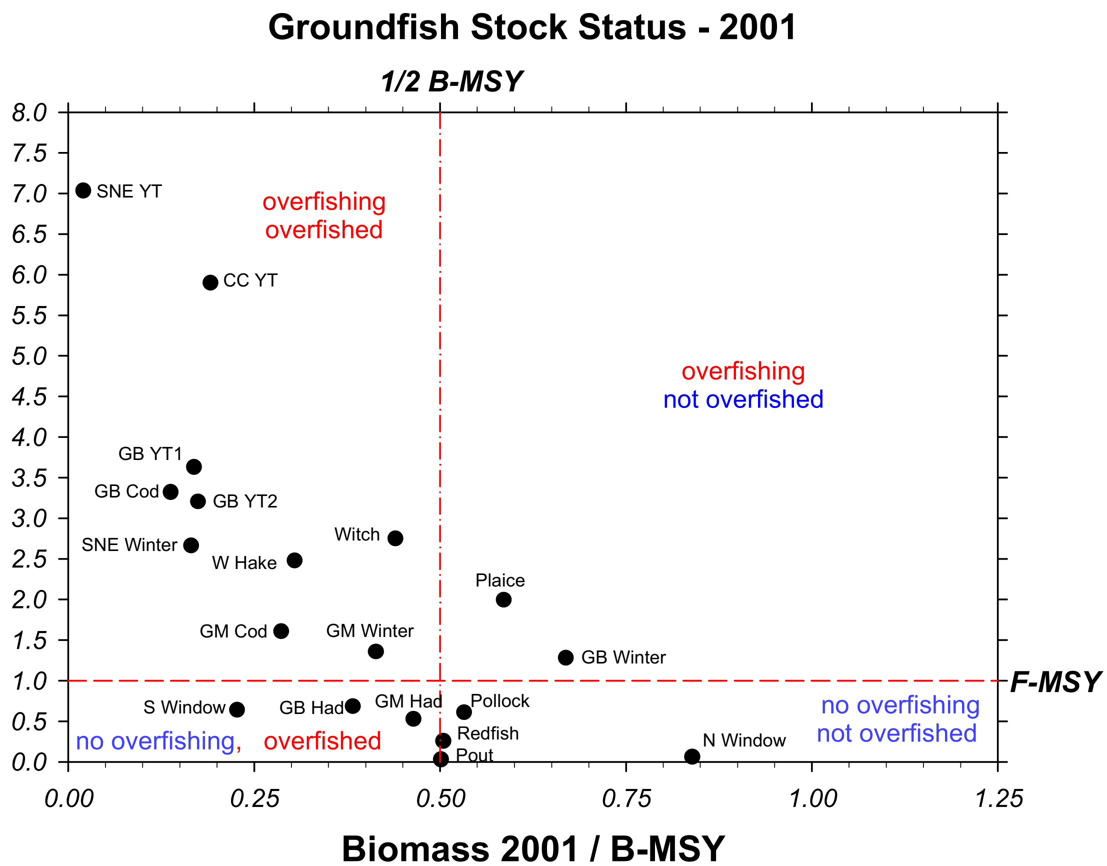


Figure 3.1. State of 18 groundfish stocks in 2001 with respect to F_{MSY} and B_{MSY} based on the current assessment.

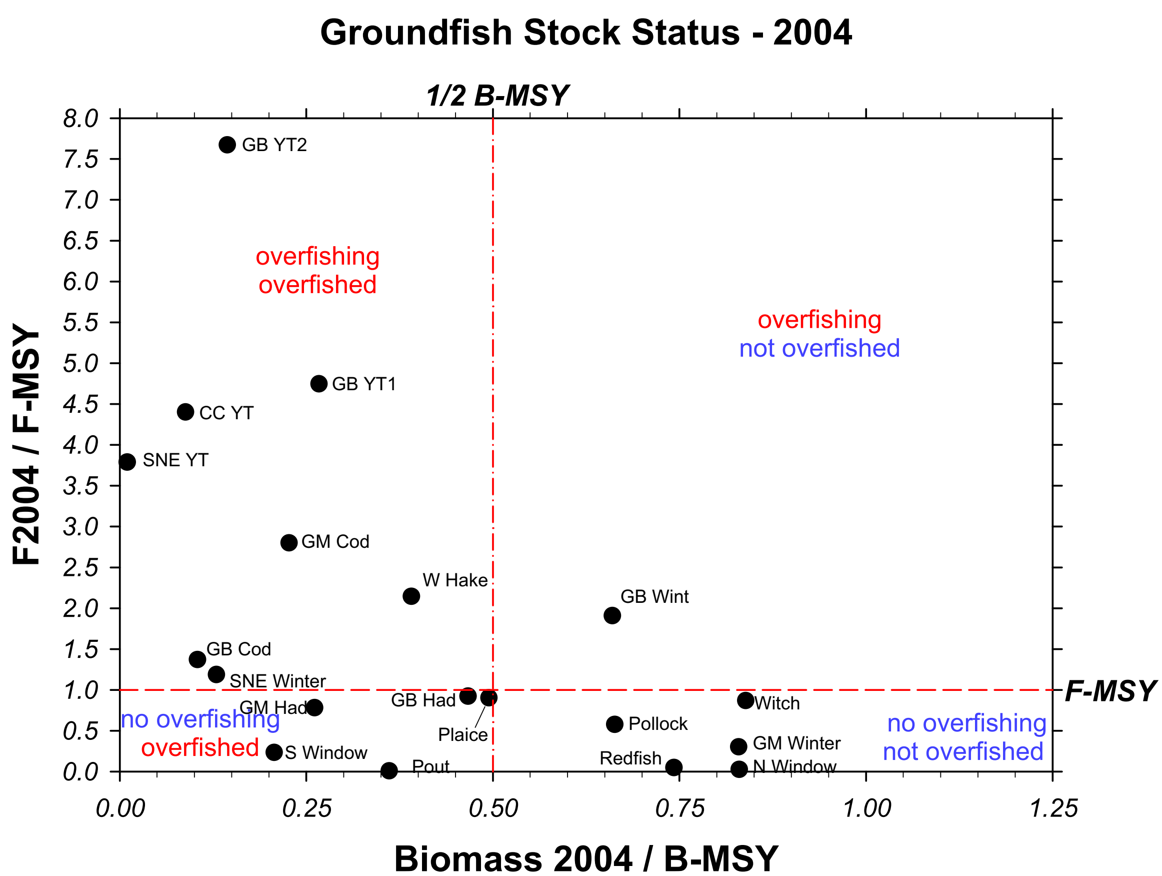


Figure 3.2. State of 18 groundfish stocks in 2004 with respect to F_{MSY} and B_{MSY}.

Figure 3.3. Comparisons between 2001 and 2004 F with respect to F_{MSY}, based on the current assessment.

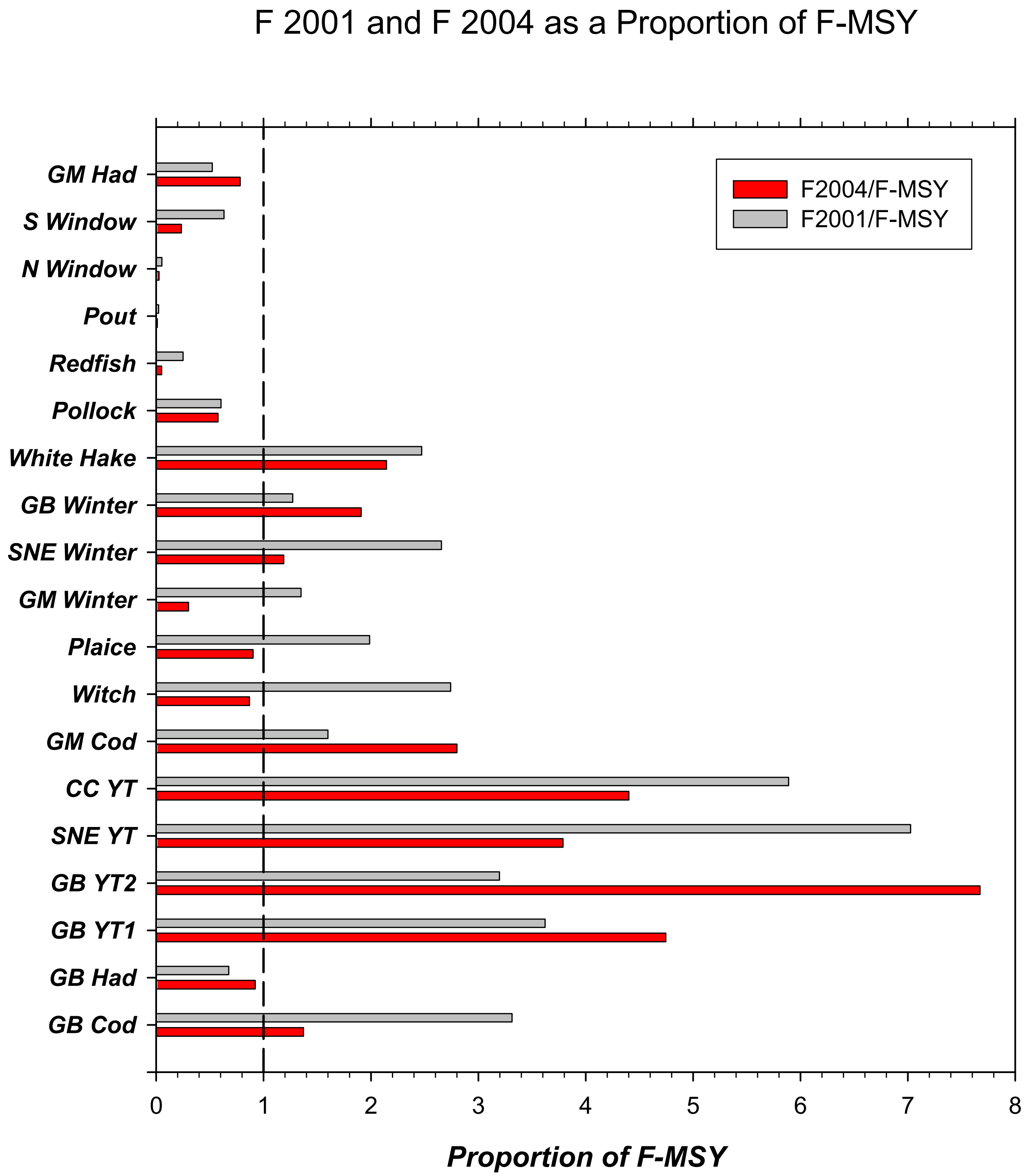
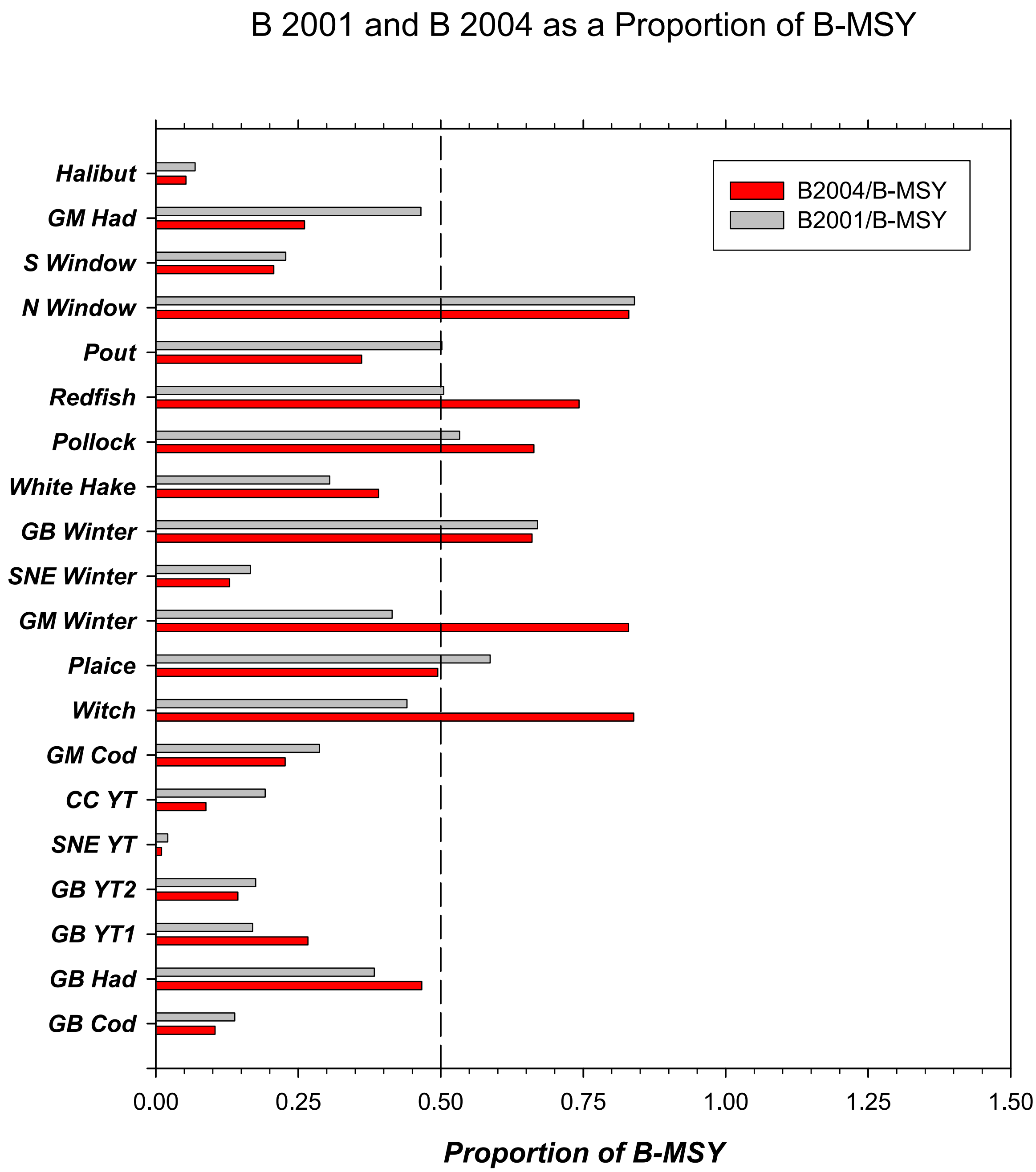


Figure 3.4. Comparisons between 2001 and 2004 stock biomass with respect to B_{MSY}, based on the current assessment.



3.2 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 3.5 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. The general patterns are described in this section and their implications for future yields and rebuilding trajectories are discussed. Possible causes for the apparent declines are 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". These stock weights represent the estimated average weight of a fish of age i at the beginning of the year (January 1). Data to estimate stock weights were derived from a number of sources including the fishery-independent surveys and the biological samples from the landings. For this source of data, the stock weights are derived from the average weights-at-age in the catch by extrapolation technique known as the Rivard (1982) method. This method can be biased if changes in the partial recruitment pattern of the fishery have occurred over time. 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 plus or minus 30% over the last decade. To illustrate the pattern of changes across species and years, for each stock and age combination, 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) and coded by color and symbol (black full circle =highest, black half circle= 4th quintile, black open circle=3rd quintile, red half circle=2nd quintile, and red full circle=1st quintile= smallest average size). Results in Figures 3.6 to 3.9 show a general pattern of smaller average sizes in the last 6 years with a predominance of observations falling into the first quintile (smallest) .

On Georges Bank, average sizes of both cod and haddock fall into the lowest quintile (Figure 3.6). 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 (Figure 3.8), 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 (Figure 3.8). Southern New England stocks of yellowtail flounder and winter flounder have average weights in the highest quintiles (Figure 3.9).

Changes in average weights at age have been noted in a number of stocks around the world. One of the most notable has been the Pacific halibut where changes have been ascribed to changes in oceanic productivity (Sullivan et al. 1999). Other possible explanations for the changes in average weights include density dependence, changes in fishery selectivity, and genetic selection. Regardless of the underlying causal mechanism(s), lower average weights-at-age will tend to retard progress to attaining spawning stock biomass targets and reduce total yields under any rebuilding strategy. Persistent changes in average weights-at-age may also change the estimates of biological reference points when they are re-evaluated in 2008. The GARM has recommended the use of the most recent average weights-at-age for projections (See relevant chapters in Section 2).

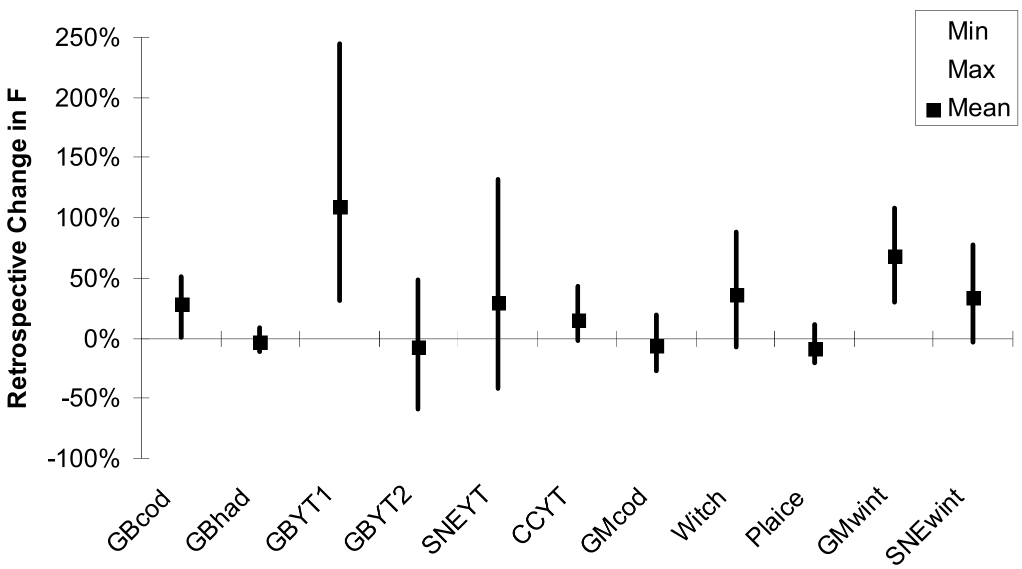
2004 Commercial Fishery Landings Data

Mandatory Dealer Electronic Reporting (DER) was implemented on May 1, 2004 as part of Amendment 13. All federal Dealers were required to submit trip information (vessel permit and hull numbers), species and market category weight and price information on a daily and/or weekly basis. The Dealers were not required to report the gear type used by the fishermen. Consequently, there was a high proportion of landings without gear type in the 2004 landings data. The gear information in 2004 Vessel Trip Report (VTR) data was used to augment the 2004 landings data Vessels which reported using a single gear type in the 2004 VTR were identified. The gear type associated with each vessel was then applied to all landings made by the vessel. Gear type is a necessary data element in the landings data because gear type is used as a stratification variable in the singlespecies proration algorithm to partition total species landings into stock landings.

Further work continues to augment gear type in the 2004 landings data by linking the Dealer and VTR databases on a trip-by-trip basis using the unique trip identification. 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. Landings from these trips cannot be directly identified without linking these data to other databases containing this information. Many stock assessments use a discard weight to kept weight (d/k) ratio and expand this ratio by the landings to estimate discards. Without the capability to separate trips participating in the SAPs and US/CAN Resource Sharing Area, landings data could not be partitioned appropriately to correspond to SAP-specific discard ratios derived from the Fisheries Observer Program.

As in previous years, 2004 State data and late Dealer data continue to enter the Commercial Fisheries Database System (CFDBS) throughout the months following the end of a calendar year. Thus, 2004 landings are subject to changes over time.

Figure 3.5. 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.



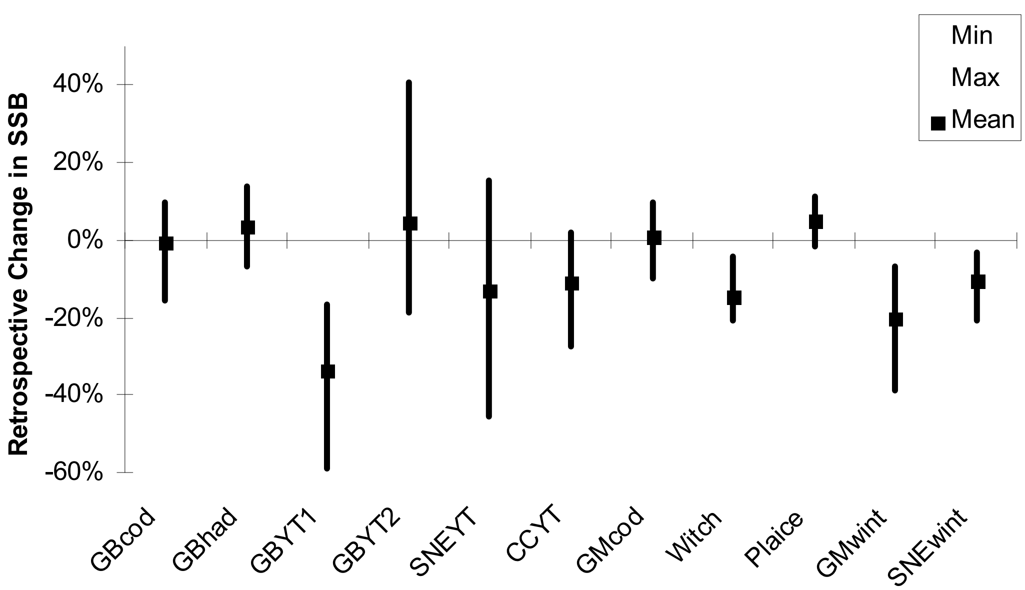
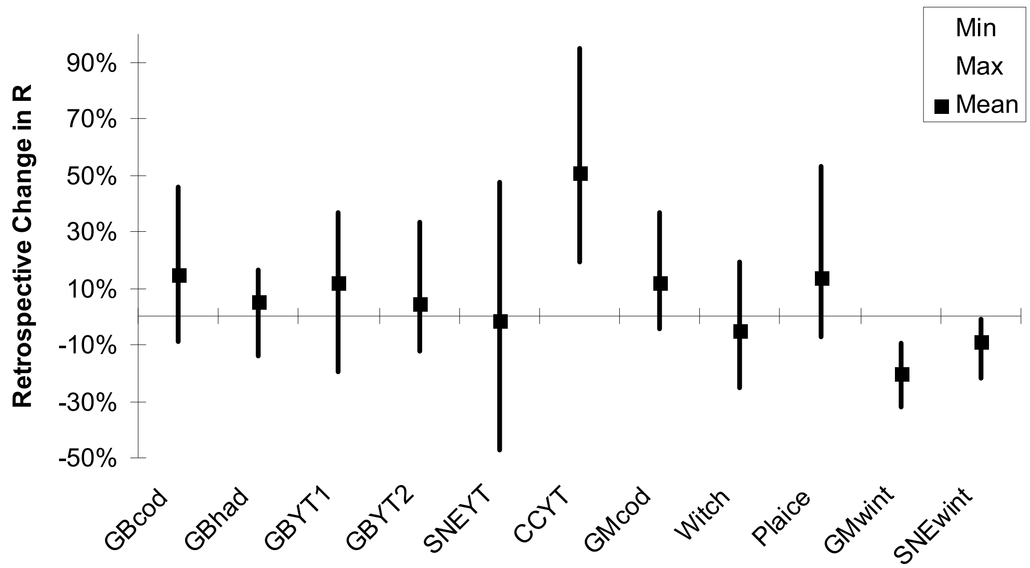


Figure 3.5 (continued).



<u>Projected vs. Realized Catches</u>

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 (Table 3.2). 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.

3.3 Recommendations

The GARM participants considered a number of generic recommendations for improving stock assessments and associated management advice: Estimation and inclusion of discards in the stock assessment models. Examine methods for deriving maturity ogives over time. Further examination of possible causes of the recent declines in mean weights at age. Numerous recommendations and comments pertaining to individual assessments are provided in the stock-specific chapters of the report.

3.4 Acknowledgements

The GARM participants extend their appreciation to Edgar Kleindinst for technical support and in particular the set up and maintenance of the local area network that provided for effective electronic file transfer among panel members. Colleen Close and Betty Holmes solved innumerable logistical difficulties. Additionally, the GARM appreciates the extraordinary efforts of the individuals involved in supplying information upon which these assessments and data summaries are based (e.g., aging information, research vessel survey abundance indices, port sampling and sea sampling, and landings data).

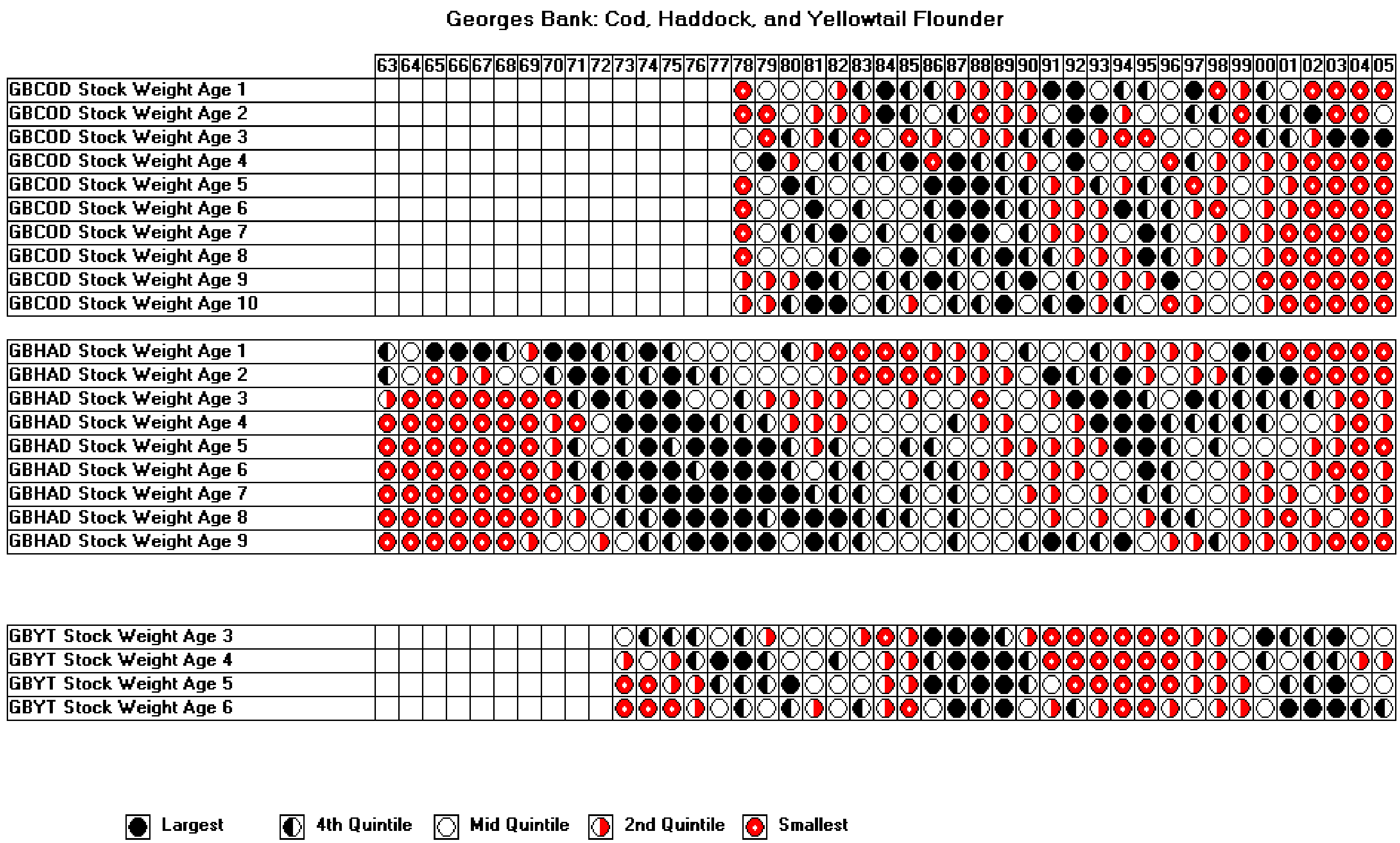


Fig. 3.6. Summary of relative changes in average stock weights-at-age for Georges Bank cod (GBCOD), haddock (GBHAD), and yellowtail flounder (GBYT).

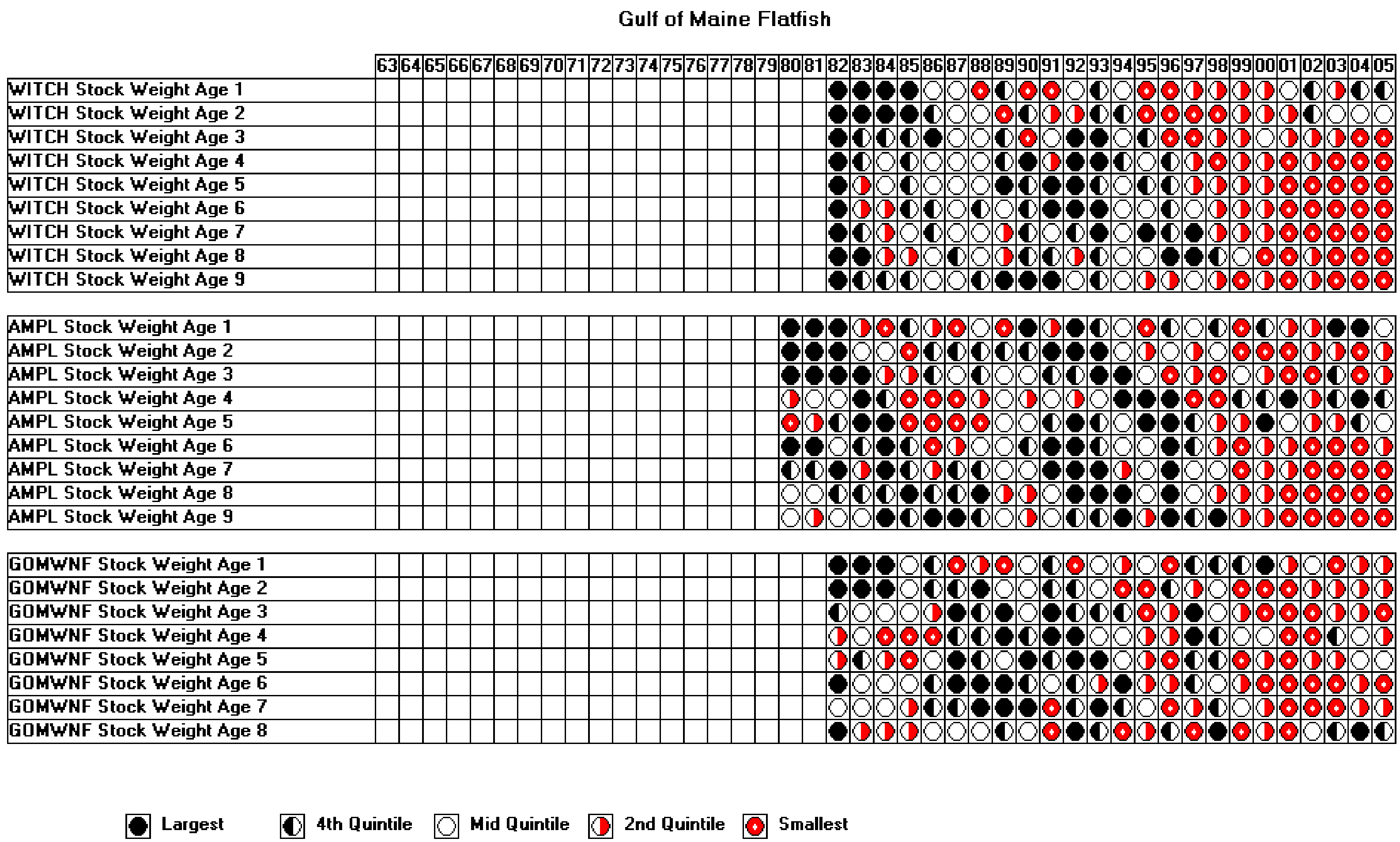


Fig 3.7. Summary of relative changes in average stock weights-at-age for Gulf of Maine flatfish: witch flounder (WITCH), American plaice (AMPL) and winter flounder (GOMWNF).

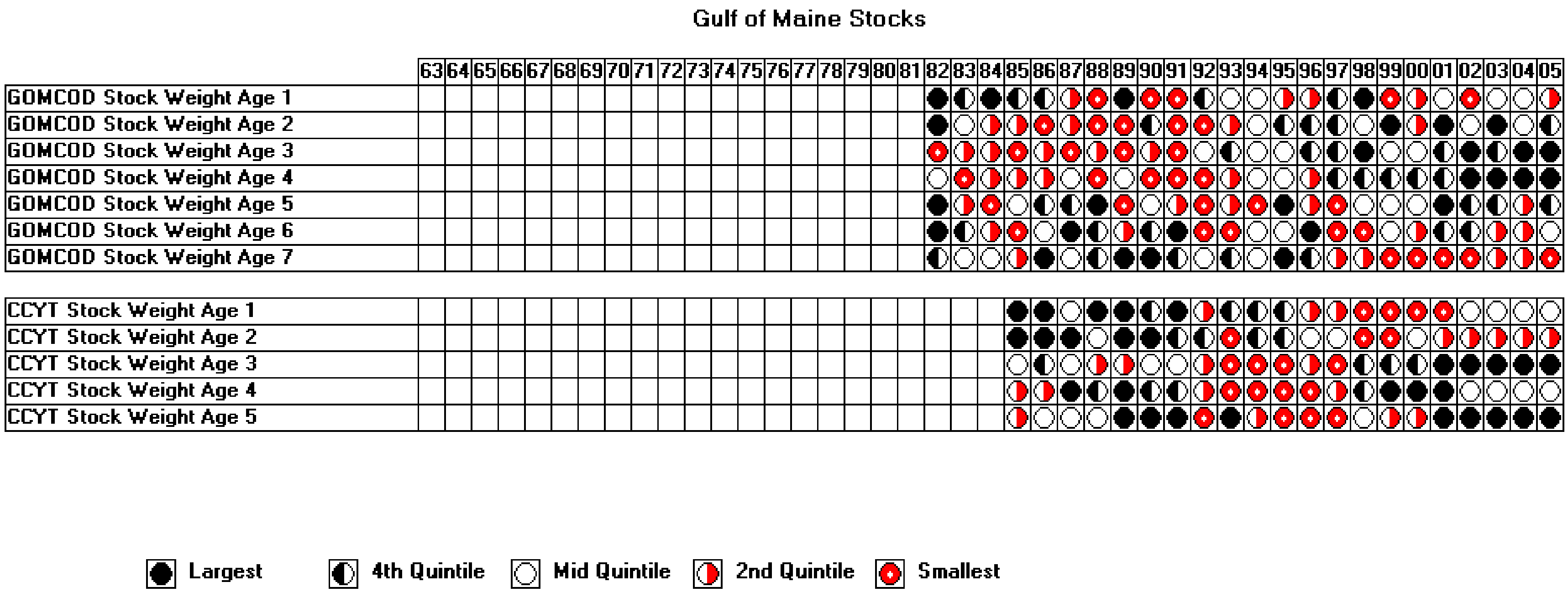


Figure. 3.8. Summary of relative changes in average stock weights-at-age for Gulf of Maine stocks: cod (GOMCOD) and yellowtail flounder (CCYT).

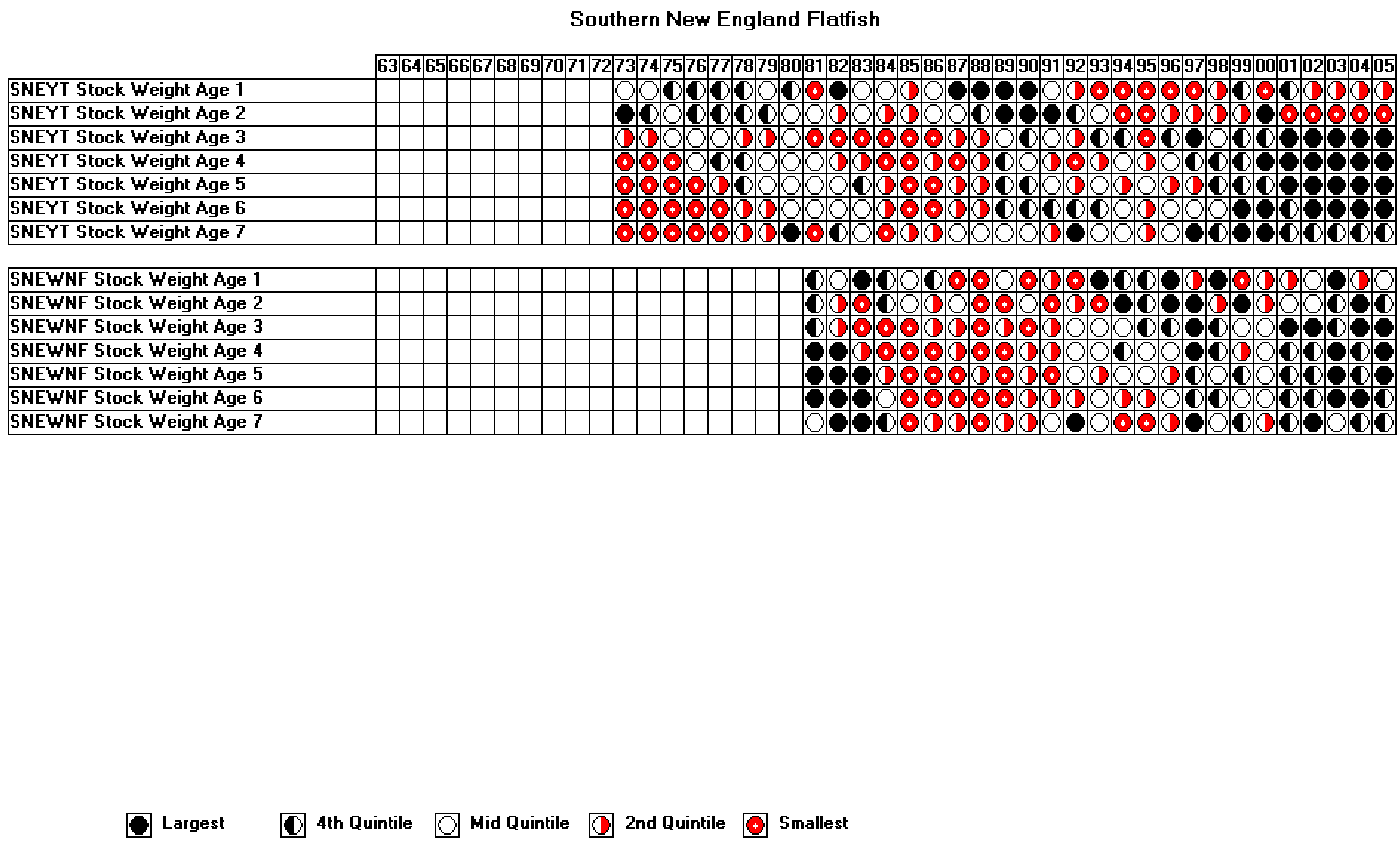


Figure. 3.9. Summary of relative changes in average stock weights-at-age for Southern New England stocks: yellowtail flounder (SNEYT) and winter flounder (SNEWNF).

Table 3.2. Projected and realized catches (mt) for 18 groundfish stocks, 2002-2004.

	2002		2003		2004	
	Projected	Actual	Projected	Actual	Projected	Actual
GB Cod	10,375	10,274	8,705	7,963	3,949	4,583
GB Haddock	12,859	12,994	19,492	12,576	27,145	17,584
GB Yellowtail	6,123	5,900	6,887	6,600	11,713	7,300
SNE/MA Yellowtail	828	880	859	500	707	300
CC/GOM Yellowtail Flounder	2,119	2,127	1,935	1,967	968	962
GOM Cod	6,684	7,195	6,876	7,406	4,850	5,898
Witch Flounder		3,222	6,254	3,154	5,174	2,917
American Plaice	4,023	4,496	4,393	3,232	3,695	2,132
GOM Winter Flounder	733	679	824	729	3,286	508
SNE/MA Winter Flounder	3,438	3,481	3,669	3,010	2,860	1,699
GB Winter Flounder	3,233	2,354	3,193	3,101	3,167	3,122
White Hake (> 60 cm)	3,460	3,065	2,821	4,444	2,300	3,560
Pollock	5,323	5,170	6,727	6,215	10,584	7,108
Redfish	428	368	1,524	361	1,632	398
Ocean Pout	16	12	19	26	77	5
GOM/GB Windowpane	239	12	267	17	534	25
SNE/MA Windowpane	113	85	143	47	266	44
GOM Haddock	1,110	1,211	2,061	1,221	4,831	1,021

3.5 References

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3.6 List of Appendices

Appendix I. Summary of Groundfish Management Measures, 2002-2004

Appendix II. Accuracy and Precision Exercises Associated with the 2005 GARM Production Ageing

Appendix I

Groundfish Assessment Review Meeting **15-19 August, 2005**

Summary of Groundfish Management Measures, 2002-2004

By

Tom Nies

New England Fishery Management Council

2001
January 9 – March 17 April 16 – April 30 Northern Shrimp season (61 days)
November 6: Daily haddock possession limit removed (maximum 50,000 lbs.-trip).
2002
February 15-March 11: Northern Shrimp season (25 days with days off)
May 1: Interim rule as a result of FW 33 lawsuit settlement agreement. Continuation of most measures from previous frameworks. DAS: 15 hour minimum charged for all trips over 3 hours Vessels limited to 25 percent of allocation May 1 through July 31, 2002 (only) Prohibition on front-loading DAS Minimum size: Cod 22 in. Gear: GOM Regulated Mesh Area (RMA): 6.5 in. diamond or square codend minimum, 6.5 inch mesh for trip gillnets, 6.5 inch mesh standup (roundfish) or 7 inch mesh tiedown (flatfish) for day gillnets. All areas: day gillnets limited to 50 standup/100 tiedown nets. *Hook gear*: de-hooking devices with spacing of less than six inches prohibited. Closures: WGOM year round closure extended (was to sunset May 1); Cashes Ledge Closed Area (year round); year round Cashes Ledge East and West closure added; add blocks 124/125 May, blocks 132/133 June, Recreational: Cod minimum size 23 in., GOM party/charter limited to 10 fish combined cod/haddock, all areas private recreational limited to 10 cod Possession limits: Remain the same. Haddock possession limit of 3,000 lbs.-DAS/30,000 lbs.-trip through September 30.
June 1: Revised interim rule Minimum size: Cod 19 in. Closures: Year-round Cashes Ledge east and west closures removed Gear: *Hook*: Requirement for six-inch spacing for de-hooking gear removed
July 4: Haddock daily limit suspended. Possession limit of 30,000 lbs.-trip until September 30, 50,000 lbs.-trip thereafter.
August 1: Emergency rule implementing FW 33 lawsuit settlement agreement. DAS: DAS allocation for each permit reduced 20 percent from maximum used FY 1996-2000 (est 71,218 allocated, including carry-over). DAS counted by the minute, except for day gillnet vessels (15 hour minimum). (This change reverted to DAS counting in effect in FY 2001). Prohibition on front-loading DAS clock. Minimum size: Cod 22 in. Gear: *Trawl:* GOM/GB RMAs: 6.5 in. diamond or square codend minimum; Southern New England RMA changed to 70W to 74W (vice 72-30W). 6.5 in. square, 7 in. diamond codend in SNE RMA. *Gillnet:* GOM: Trip gillnets – 6.5 in. mesh/150 nets; Day – 6.5 in./50 standup nets, 7 in./100 tiedown nets (prohibited March-June); GB – 6.5 in./50 nets, SNE – 6.5 in./75 nets; Mid-Atlantic: Trip – 5.5 in. diamond/6 in. square, Day – 5.5 in. diamond/6 in. square. *Hook*: no de-hookers with less than 6 in/. spacing, 12/0 circle hooks or larger; GOM: 2,000 rigged hooks, GB: 3,600 rigged hooks Closures: Add GB seasonal closure areas, May – Blocks 80, 81, 118, 119, 120 (south of 42-20N) Possession limits: *Yellowtail flounder*: SNE/MA: landing/possession of yellowtail flounder prohibited south of 40N. Mar 1 – May 31: 250 lbs./trip, June 1 – February 28: 500 lbs.-DAS/4,000 lbs. – trip. *Cod*: GOM: 500 lbs.-DAS/4,000 lbs./trip. Open access commercial permits limited to 200 lbs. regulated groundfish. Recreational: Cod/haddock: 23 in. minimum size. Party/charter: GOM RMA: April-November, 10 cod/haddock combined per person, Dec-Mar – 10 cod/haddock combined, no more than 5 cod per person per trip. Private: GOM RMA: December-March – 10 cod/haddock combined, no more than 5 cod.
2003
January 15-February 27: Northern Shrimp season (38 days with days off)
March 13: Haddock possession limit suspended until May 1.
May 1: Haddock possession limit of 3,000 lbs-DAS/30,000 lbs.-trip
May 1: Framework Adjustment 37

Modifications to whiting management measures: extension of Cultivator Shoal whiting fishery by one month (June 15-October 31), changes to default measures, minor changes to Cape Cod Bay Raised Footrope Trawl exemption area.
May 13: Haddock possession limit revised to 30,000 lbs./trip (no daily limit).
July 9: Framework Adjustment 38 Raised footrope trawl whiting fishery in the inshore GOM, July 1 – November 30 each year.
July 28: Final emergency rule implementing FW 33 lawsuit settlement agreement Recreational: Haddock, 21 in. minimum size. Party/charter: GOM: Apr-Nov, 10 cod per person, December-March, 5 cod per person. Private: GOM: December-March, 10 cod/haddock combined, no more than 5 cod. Other areas: 10 cod/haddock combined.
October 7: Haddock possession limit suspended for the remainder of the fishing year.
2004
January 19-March 12: Northern Shrimp season (40 days with days off)
May 1: Implementation of Amendment 13. Measures based on emergency rule and measures in effect prior to interim rule. DAS: DAS for each permit re-categorized. Category 1: 60% of maximum DAS used FY 1996-2001 in years that permit landed 5,000 pounds regulated groundfish (est. 43,000 allocated). Category B: 40% of maximum DAS used FY 1996-2001 in years that permit landed 5,000 pounds regulated groundfish; can only be used in specific programs. DAS leasing and transfer programs allow DAS exchanges between vessels under limited conditions. (200 lbs. of winter flounder can be retained by vessels fishing for fluke west of 72-30 W without using a DAS). Minimum Size: No change from emergency rule Gear**:** *Trawl*: No change from emergency rule. *Gillnet*: GOM/GB: Day-6.5 in./50 standup nets, no seasonal restriction on tie-down nets; Trip: 6.5 in. mesh/150 nets. SNE/MA: 6.5 in. in. mesh/75 nets. *Hook: GOM:* 2,000 hooks. *GB*: 3,600 hooks Closures: Same as emergency rule, with addition of habitat closed areas; all except Jeffrey Bank and NLCA habitat closed area are within existing year-round closed areas. Possession limits: *GOM cod*: 800 lbs-DAS/4,000 lbs.-trip. GB cod: 1,000 lbs.-DAS/10,000 lbs.-trip. *CC/GOM yellowtail flounder*: April, May, October, November - 250 lbs. trip, other months 750 lbs.-DAS/3,000 lbs-trip. *SNE/MA yellowtail flounder*: March –June, 250 lbs. trip, other months 750 lbs.-DAS/3,000 lbs-trip. *Haddock*: 3,000 lbs.-DAS/30,000 lbs.-trip. Special Management Programs: *US/Canada Area*: hard TAC on cod, haddock (SAs 561, 562), yellowtail flounder (SAs 522, 525, 561, 562). Cod possession limit: 500 lbs-DAS/5,000 lbs-trip. No DAS charged to/from SAs 561, 562. Exempted Fisheries: Northern Shrimp fishery area restriction removed; General Category scallop fishery exemption in SAs 537, 538, 539, and 613.
May 14: Haddock possession limit suspended for remainder of the fishing year.
June 1: CAII Yellowtail Flounder Special Access Program Access to CAII south of 41-30N by trawl vessels targeting yellowtail flounder. Limited to 320 trips (total), two trips per vessel per month, yellowtail flounder limited to 30,000 lbs./trip. Authorized use of Category B DAS.
June 23: Amendment 10 to the Atlantic Sea Scallop FMP. 10-in. square mesh twine top required for all scallop dredge vessels in all areas.
September 3: CAII Yellowtail Flounder SAP ends (no trips can begin after this date)
November 2: Framework Adjustment 39 (Scallop Framework Adjustment 16) Scallop dredge vessel access to portions of groundfish mortality CAII and NLCA in 2004, CAI and CAII in 2005, and CAI and NLCA in 2006. Season: June 15 through January 31. Possession limits: 1,000 lbs. regulated groundfish, no more than 100 lbs. cod. In NLCA, limited to 250 lbs.-trip yellowtail flounder in June. (Outside of access program, scallop vessels continue to be limited to 300 lbs. regulated groundfish per trip). Yellowtail flounder catch capped at 10 percent of target TAC for the stock.
October 1: Closure of SAs 561 and 562 to all fishing on a multispecies DAS. Prohibition on the possession of yellowtail flounder from SAs 522, 525, 561, 562.
November 19: Framework Adjustment 40A *Closed Area I Haddock SAP* Access to small area of CAI to target haddock using longlines. Limited to 1,000 mt haddock TAC. Season ends December 31.

Eastern US/CA Area Haddock SAP Pilot Program
Access to northern corner of CAII and adjacent area to target haddock using separator trawl. Season: May 1 through December 31. Authorized use of Category B DAS.
Category B (regular) DAS Pilot Program
Vessels can use Category B (regular) DAS to target healthy stocks. Catch (kept and discarded) limited to 100 lbs. of cod, American plaice, white hake, witch flounder, ocean pout, SNE/MA winter flounder and windowpane flounder, 25 lbs.-DAS/250 lbs.-trip of yellowtail flounder. Maximum of 1,000 DAS can be used in each of four quarters from November 1, 2004 through October 31, 2005.

Appendix II.

Groundfish Assessment Review Meeting **August 15–19, 2005**

Accuracy and Precision Exercises Associated with 2005 GARM Production Ageing

Accuracy and precision exercises associated with 2005 GARM production ageing

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1. 0. Introduction

In production ageing programs, age reader accuracy can be thought of as how often the "right" age is obtained, and precision as how often the "same" age is obtained (Campana 2001). Both measures are important components of a quality control monitoring program. For the 2005 Groundfish Assessment Review Meeting (GARM), exercises were undertaken to estimate the accuracy and/or precision of production ageing by the Fishery Biology Program for cod *Gadus morhua*, haddock *Melanogrammus aeglefinus*, yellowtail flounder *Limanda ferruginea*, witch flounder *Glyptocephalus cynoglossus*, American plaice *Hippoglossoides platessoides*, winter flounder *Pseudopleuronectes americanus*, and Acadian redfish *Sebastes fasciatus*.

2. 0. Methods

For all species, subsamples were selected to be re-aged to test age-reader accuracy or precision. Ageing accuracy is only presented for species that have reference collections already established, i.e. the Georges Bank stocks of cod and haddock. Precision data is presented for all species *versus* samples previously aged by the same reader. When re-ageing fish, the age reader had knowledge of the same data as during production ageing, i.e. fish length, date captured, and area captured. Except in the case of cod, where two people aged the species, all exercises combined stock areas for each species.

All exercises were 'one-shot' deals, and no attempts were made to improve results by repeated readings. There was also no attempt to revise the original production ages in cases where differences occurred. Results are presented in terms of percentage agreement, total coefficient of variation (CV), age bias plots, and age agreement matrices (Campana *et al*.1995, Campana 2001).

For Georges Bank cod, production ageing this year reverted to the previous age reader, who aged cod during the period 1984–2003. Following production ageing, age-reader accuracy was determined from a random subsample drawn from the NEFSC cod otolith reference collection. No precision estimates were attempted for this stock, due to time constraints.

For the Gulf of Maine cod stock, the current cod age reader completed precision exercises on two occasions. These were subsampled from U.S. commercial landings from the fourth quarter of 2003, and during all of 2004. A comparison between the two readers was also undertaken, with NEFSC 2004 autumn bottom trawl survey samples from the Gulf of Maine.

For haddock, age-reader precision was estimated on six occasions from second readings of random subsamples from each cruise (NEFSC 2004 autumn and 2005 spring bottom trawl surveys) and each quarter from U.S. commercial landings (2004). Following the completion of production ageing, age-reader accuracy was assessed by reading a random subsample from the NEFSC Georges Bank haddock otolith reference collection.

For yellowtail flounder, age-reader precision was estimated three times from second readings of random subsamples from 2004 Canadian landings, the Canadian 2005 bottom trawl survey, and a combination of recent U.S. samples (2004 autumn and 2005 spring bottom trawl surveys, plus 2004 commercial landings). These latter samples were also aged by a trainee who will soon assume yellowtail age-reader duties, following the recent retirement of the former age reader. The trainee worked with the former age reader during production ageing, and re-aged the same set of fish as the former reader.

For witch flounder, age-reader precision was estimated once from a combination of fish from both the NEFSC 2005 spring bottom trawl survey and Quarters 2 and 4 of 2004 U.S. commercial landings. Quarter 2 included fish from the large market category, while Quarter 4 was composed of both small and medium fish.

For American plaice, age-reader precision was estimated once from a combination of fish from both Quarter 1 of 2004 U.S. commercial landings and the NEFSC 2004 autumn bottom trawl survey.

For winter flounder, age-reader precision was estimated twice. One exercise used otoliths from NEFSC bottom trawl surveys, with equal numbers of Gulf of Maine fish from the 2004 autumn survey and Southern New England fish from the 2005 spring survey. The second exercise used scales from 2004 U.S. commercial landings, with Quarters 1 and 3 combined. In the commercial samples, Quarter 1 included Southern New England fish in both small and large market categories, and medium-sized Gulf of Maine fish. Quarter 3 was reversed in terms of stock areas and market categories.

For Acadian redfish, age-reader precision was estimated once from second readings of random subsamples from the NEFSC 2004 autumn bottom trawl survey.

3. 0. Results and Discussion

The total sample sizes associated with the accuracy and precision exercises were as follows: 106 (Georges Bank cod), 217 (Gulf of Maine cod), 500 (haddock), 367 (yellowtail), 122 (witch flounder), 161 (American plaice), 225 *(*winter flounder), and 142 (redfish). Results for cod are presented in Figures 1–4, haddock in Figures 5–11, yellowtail flounder in Figures 12–15, witch flounder in Figure 16, American plaice in Figure 17, winter flounder in Figures 18 and 19, and redfish in Figure 20. All results are summarized in Table 1.

The accuracy estimate for Georges Bank cod was high (91% agreement) and the total CV (1.5%) was low. There was a slight tendency toward overageing by one year in the test readings (Fig. 1), but no ages differed by more than one year. Even so, accuracy was virtually the same as that obtained last year (91% agreement and 1.9% CV, Sutherland *et* *al*. 2004, unpubl.), suggesting that the switch from the current to previous age reader was not problematic.

For the two Gulf of Maine cod exercises, precision levels of 86% and 94% agreement (total CVs of 2.7% and 0.8%, respectively) were attained (Figs. 2 and 3). While these values would seem to suggest an adequate level of consistency in age determinations, the age bias plots indicated that, for the first exercise (2003 Quarter 4 commercial samples; Fig. 2), the mean test age for Age 3 fish was significantly biased from the mean production age, necessitating remedial intervention. A comparison of ages performed by the two cod age readers resulted in 100% agreement (Fig. 4), indicating that the two age readers are consistent with each other in their age determinations.

For haddock, precision levels ranged between 91 and 98% agreement, with total CVs of 0.2–0.9%, between first and second readings (Figs. 5–10), indicating a high level of consistency in age determinations. No disagreement between readings was more than one year. This year's results showed an increase in precision from last year (median of 86% agreement and 2.0% CV, Sutherland *et al*. 2004, unpubl.). The relatively high accuracy estimate (94% agreement, 1.3% CV, Fig. 11) for samples from the Georges Bank reference collection, coupled with consistently high precision results, supports the conclusion that the haddock age reader, having just completed their second year of production ageing, has attained a reliable level of ageing capability.

For yellowtail flounder, precision levels were consistent between samples from the Canadian 2004 commercial landings and the Canadian 2005 spring survey (86 and 92% agreement and total CVs of 2.5 and 1.8%, respectively, Figs. 12–13). In the commercial samples, there was a slight tendency toward overageing in the second readings. The values obtained for U.S. samples, however, were less precise (71% agreement and 6.6% CV, Fig. 14), and revealed a bias towards underageing of older fish (age ≥4 years) in the second readings. Even so, no ages differed by more than one year. When the future age reader re-aged these same U. S. samples, similar precision levels were attained (73% agreement and 6.1% CV, Fig. 15), but no bias was apparent.

Observations of poor scale condition in yellowtail flounder from eastern Georges Bank, which began in 2002, have continued in these samples. The scales were characterized by actual holes and moderate to severe erosion of the anterior scale edges (illustrated in Sutherland *et al*. 2004, unpubl.). Causes for this condition remain are unknown, but this may help to explain the reduced precision observed with yellowtail samples.

For witch flounder, the precision level was 80% agreement, with a total CV of 1.6%, between first and second readings (Fig. 16). This indicates a moderate level of consistency in age determinations for this long-lived species.

For American plaice, a precision level of 86% agreement (total CV of 1.7%) was attained between first and second readings (Fig. 17), indicating a moderate level of consistency in age determinations.

For the two winter flounder exercises, precision levels of 94% and 79% agreement (total CVs of 1.6% and 2.8%, respectively) were attained (Figs. 18 and 19). Much greater precision was obtained with otoliths from the survey samples than with the scales routinely collected from commercial landings. Neither exercise revealed a bias, although there may have been an error in distinguishing ages 3 and 4 in the commercial production ages. This may be related to the lack of availability of sex data for commercial samples. Female winter flounder exhibit a strong check on their scales associated with the onset of maturation (about age 3), which cannot be distinguished from an annulus without data on fish sex.

For Acadian redfish, the precision level was 89% agreement, with a total CV of 1.0%, between first and second readings (Fig. 20), indicating a moderate level of consistency in age determinations for this long-lived species.

Acceptable levels of age determination accuracy and precision are highly influenced by species, age structure, and age reader experience. Even so, various ageing labs consider a total CV of under 5% to be acceptable for species of moderate longevity and ageing complexity (Campana 2001). Therefore, precision of recent age determinations appears to have been generally reliable for the GARM assessments. Completion of reference collections for additional species and continued training of new age readers are top priorities for the Fishery Biology Program in the coming year.

4.0 GARM Discussion

The GARM Panel suggested that tests of symmetry (Hoenig et al. 1995) may be a more appropriate method with which to evaluate age reader precision. For precision exercises presented above with age agreement less than 90%, Bowker's test of symmetry (Bowker 1948) was performed. Results are presented in Table 2. Only the exercise for 2003 Quarter 4 Gulf of Maine cod revealed a systematic difference between the two readings. Several exercises flagged as problematic from age bias plots or high CVs were not significantly asymmetrical. It appears that, for some data sets, the power of tests of symmetry may be low and sensitive to the degrees of freedom available in the analysis. However, the potential utility of the test as an additional diagnostic for age reader precision was accepted and will be routinely incorporated into the suite of precision evaluations conducted by the Fishery Biology Program.

5. 0. References

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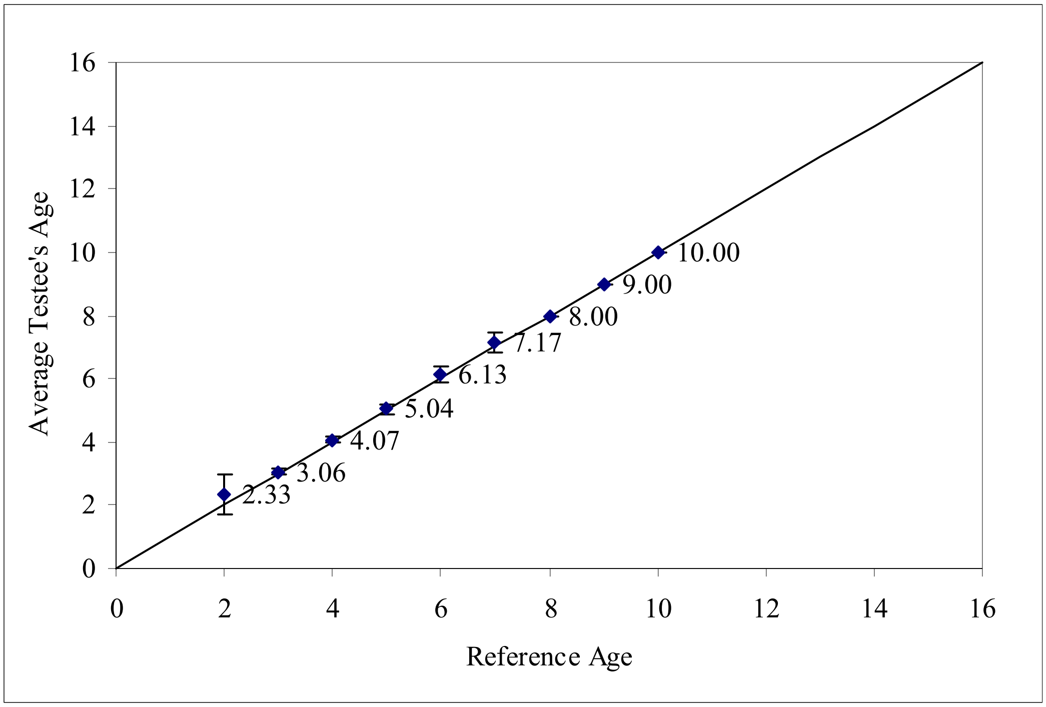
Table 1. Results of all ageing exercises, with list of associated figures. Maximum age is the highest age found among the production ages within each exercise.

Fig.	Species & Exercise Type	N	Agreement (%)	CV (%)	Max. Age
1	Cod Accuracy (GB)	106	90.6	1.53	10
2	Cod Precision (GOM)	105	85.7	2.68	7
3	Cod Precision (GOM)	112	93.8	0.75	12
4	Cod Comparison (GOM)	60	100.0	0.00	10
5	Haddock Precision	102	95.1	0.71	10
6	Haddock Precision	76	96.1	0.89	9
7	Haddock Precision	56	92.9	0.69	11
8	Haddock Precision	55	90.9	0.94	11
9	Haddock Precision	44	97.7	0.25	11
10	Haddock Precision	60	95.0	0.44	12
11	Haddock Accuracy	107	93.5	1.26	12
12	Yellowtail fldr Precision	167	86.2	2.52	9
13	Yellowtail fldr Precision	100	92.0	1.79	7
14	Yellowtail fldr Precision	100	71.0	6.64	7
15	Yellowtail fldr Precision (trainee)	100	73.0	6.11	7
16	Witch fldr Precision	122	80.3	1.55	23
17	American Plaice Precision	161	85.7	1.69	13
18	Winter fldr Precision (Otoliths)	110	93.6	1.59	9
19	Winter fldr Precision (Scales)	115	79.1	2.81	9
20	Redfish Precision	142	89.4	0.99	19
	Total	**2000**			
	Average		**89.1**	**1.79**	
	Median		**91.5**	**1.40**	

Table 2. Results of Bowker's test of symmetry for all precision exercises with age agreements of less than 90% (**bold** value indicates a systematic difference in the distribution of the two sets of ages).

Species	χ^2	d.f.	P-value
Cod (GOM)	11.50	4	**0.02**
Yellowtail (2004 Canadian fishery)	16.47	11	0.12
Yellowtail (US survey & fishery)	10.45	6	0.11
Yellowtail (Trainee)	2.20	5	0.82
Witch flounder	19.33	18	0.37
American plaice	8.00	10	0.63
Winter fldr (Scales)	11.20	7	0.13
Redfish	10.33	11	0.50

Figure 1. Results of Georges Bank cod age-reader accuracy exercise against randomly selected samples from the NEFSC cod reference collection. Error bars indicate 95% confidence intervals.

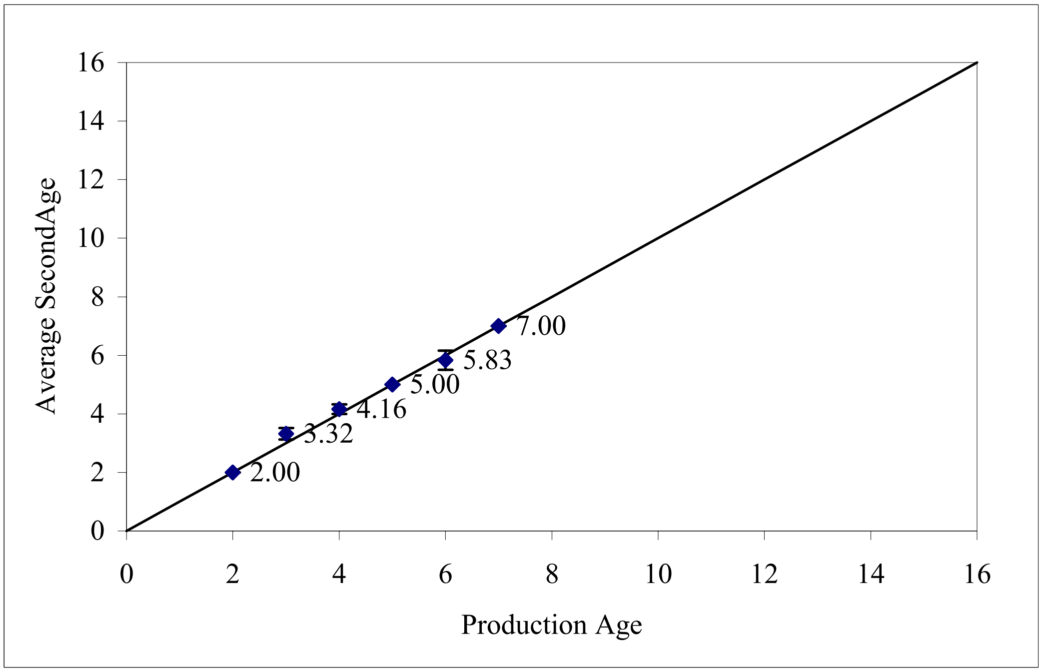


N Aged	106	CV	1.53
N Agreed	96		
Disagreed	10	%Agreement	90.6%

Testee's Age

Ref Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1														
2			2	1										3
3				31	2									33
4					26	2								28
5					1	21	2							24
6							7	1						8
7								5	1					6
8									1					1
9										2				2
10											1			1
11														
12														
Total			2	32	29	23	9	6	2	2	1			106

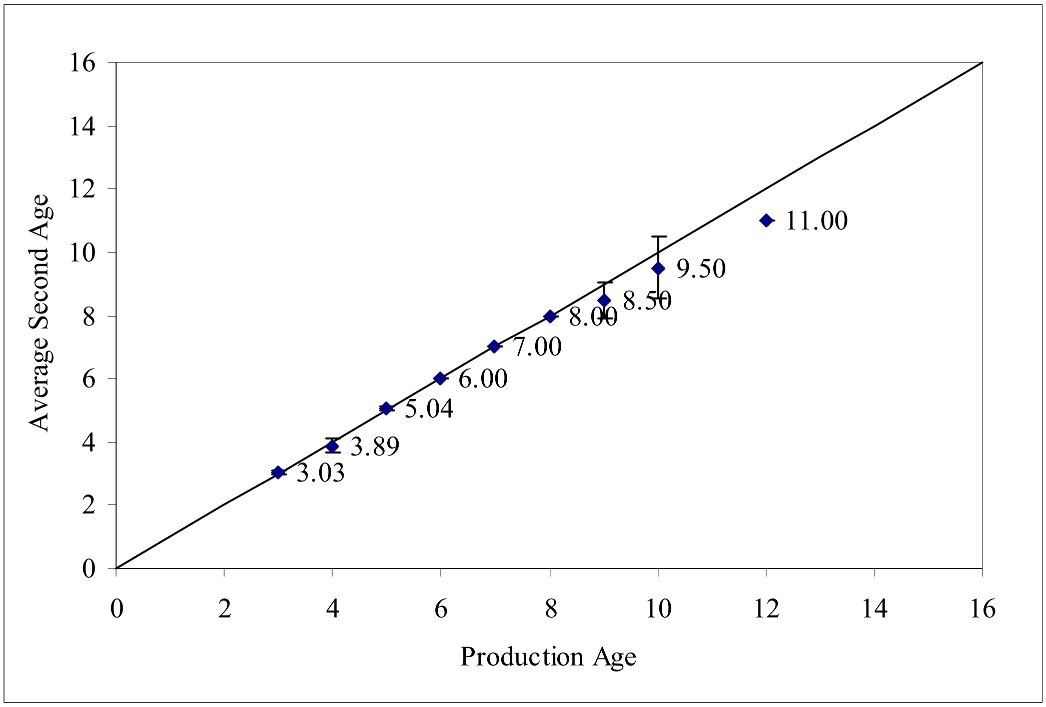
Figure 2. Results of Gulf of Maine cod age-reader precision exercise against randomly selected samples from Quarter 4 of 2003 U.S. commercial landings. Error bars indicate 95% confidence intervals.



N Aged	105	CV	2.68
N Agreed	90		
Disagreed	15	%Agreement	85.7%

Prod Age \ Second Age	0	1	2	3	4	5	6	7	8	9	10	Total
0												
1												
2			13									13
3				15	7							22
4				1	30	5	1					37
5						25						25
6						1	5					6
7								2				2
8												
9												
10												
Total			13	16	37	31	6	2				105

Figure 3. Results of Gulf of Maine cod age-reader precision exercise against randomly selected samples from Quarters 1–4 of 2004 U.S. commercial landings. Error bars indicate 95% confidence intervals.



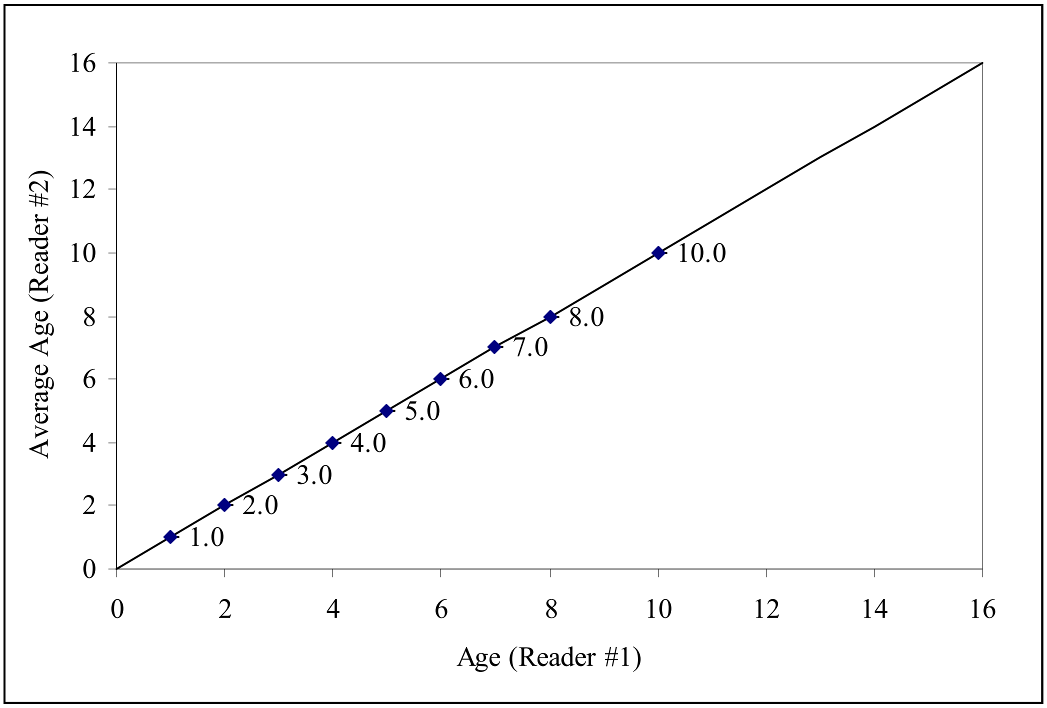
N Aged	112
N Agreed	105
Disagreed	7

CV	0.75
%Agreement	93.8%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1														
2														
3				28	1									29
4				1	8									9
5						27	1							28
6							23							23
7								7						7
8									9					9
9									2	2				4
10										1	1			2
11														
12												1		1
Total				29	9	27	24	7	11	3	1	1		112

Figure 4. Results of cod age-reader comparison exercise using randomly selected Gulf of Maine samples from the NEFSC 2004 autumn bottom trawl survey. The current age reader is listed here as Reader #1. Error bars indicate 95% confidence intervals.

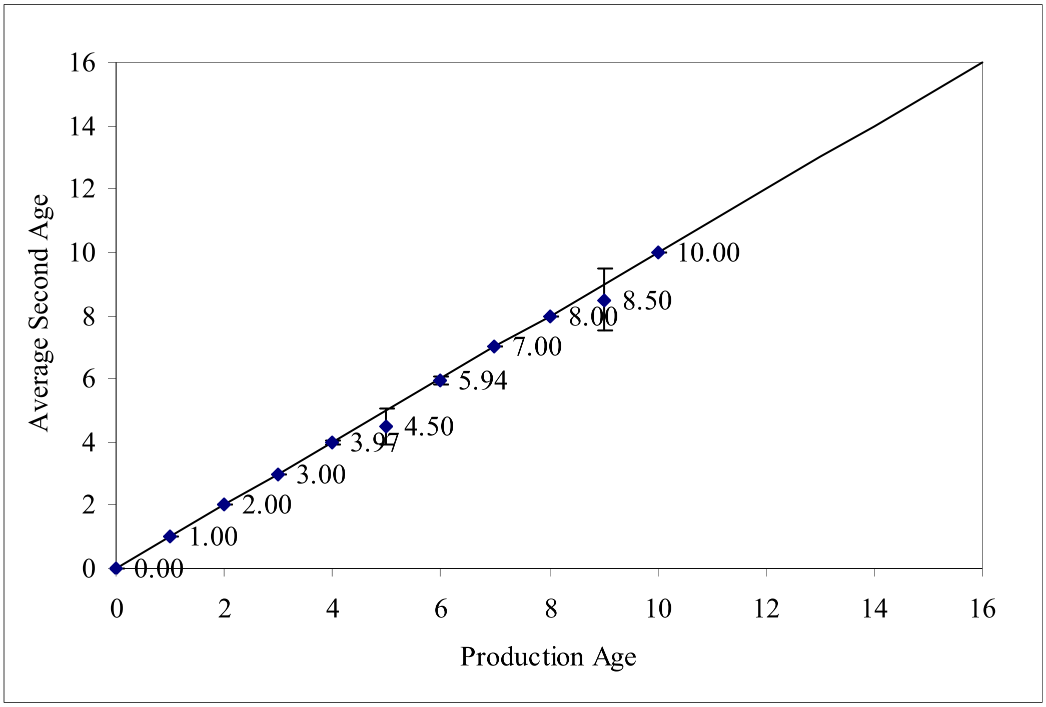


N Aged	60	CV	0.00
N Agreed	60		
Disagreed	0	%Agreement	100.0%

Age (Reader #1)

Reader #2	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1		11												11
2			2											2
3				12										12
4					10									10
5						13								13
6							8							8
7								2						2
8									1					1
9														
10											1			1
11														
12														
Total		11	2	12	10	13	8	2	1		1			60

Figure 5. Results of haddock age-reader precision exercise against randomly selected samples from the NEFSC 2004 autumn bottom trawl survey. Error bars indicate 95% confidence intervals.

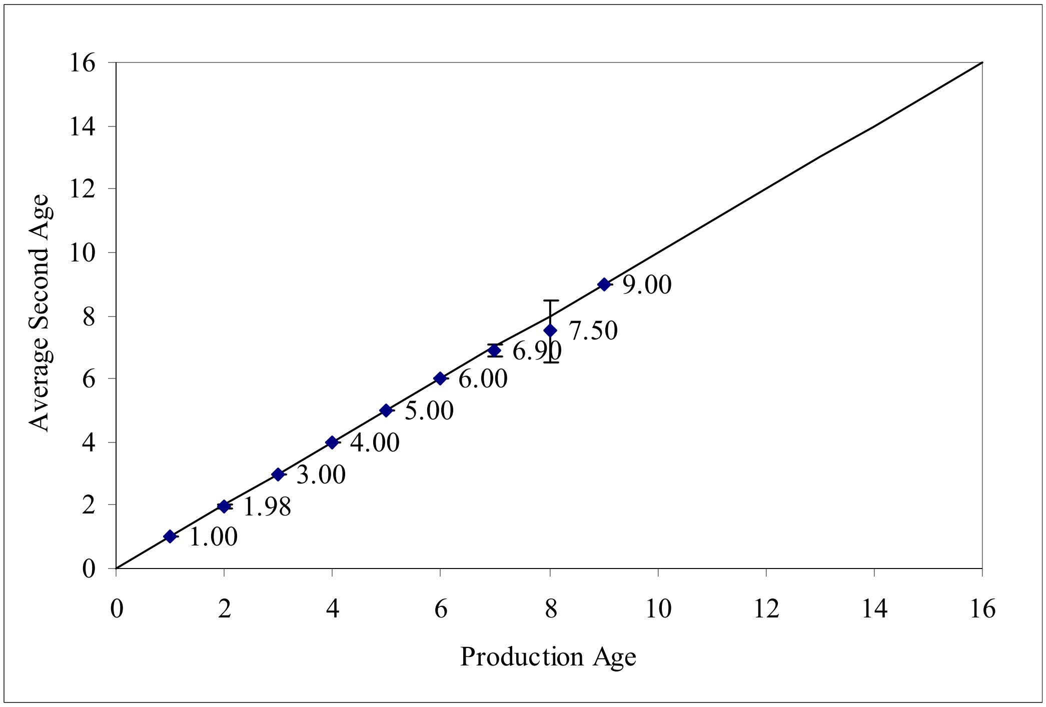


N Aged	102
N Agreed	97
Disagreed	5

CV	0.71
%Agreement	95.1%

Prod Age \ Second Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0	8													8
1		28												28
2			1											1
3				3										3
4				1	29									30
5					2	2								4
6						1	15							16
7								3						3
8									6					6
9									1	1				2
10											1			1
11														
12														
Total	8	28	1	4	31	3	15	3	7	1	1			102

Figure 6. Results of haddock age-reader precision exercise against randomly selected samples from the NEFSC 2005 spring bottom trawl survey. Error bars indicate 95% confidence intervals.

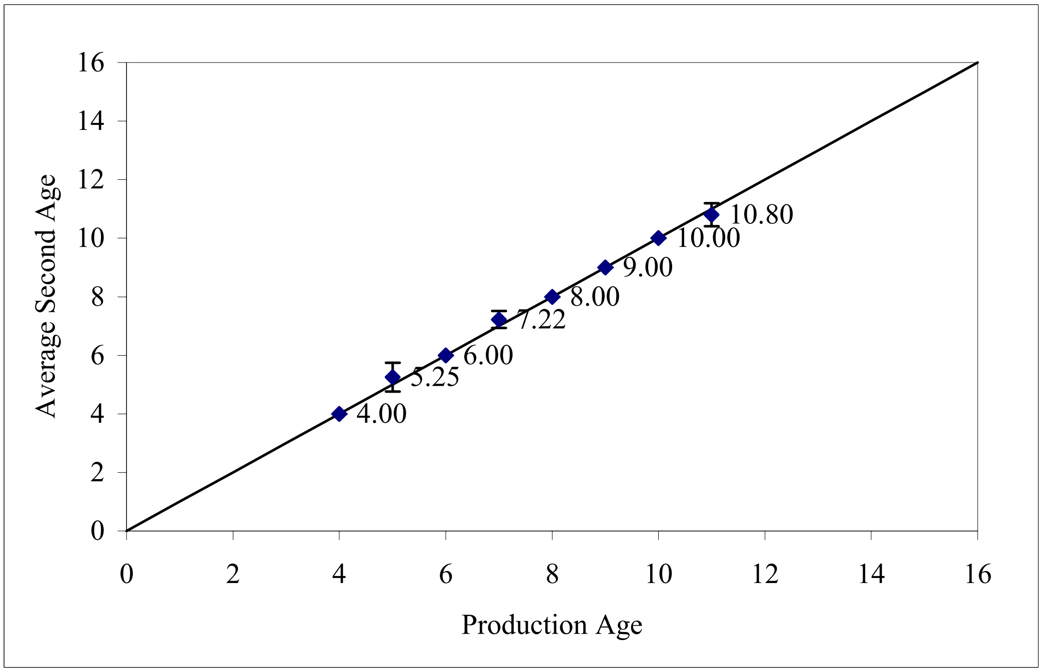


N Aged	76	CV	0.89
N Agreed	73		
Disagreed	3	%Agreement	96.1%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1		2												2
2		1	39											40
3				1										1
4					4									4
5						11								11
6							5							5
7							1	9						10
8								1	1					2
9										1				1
10														
11														
12														
Total		3	39	1	4	11	6	10	1	1				76

Figure 7. Results of haddock age-reader precision exercise against randomly selected samples from Quarter 1 of 2004 U.S. commercial landings. Error bars indicate 95% confidence intervals.

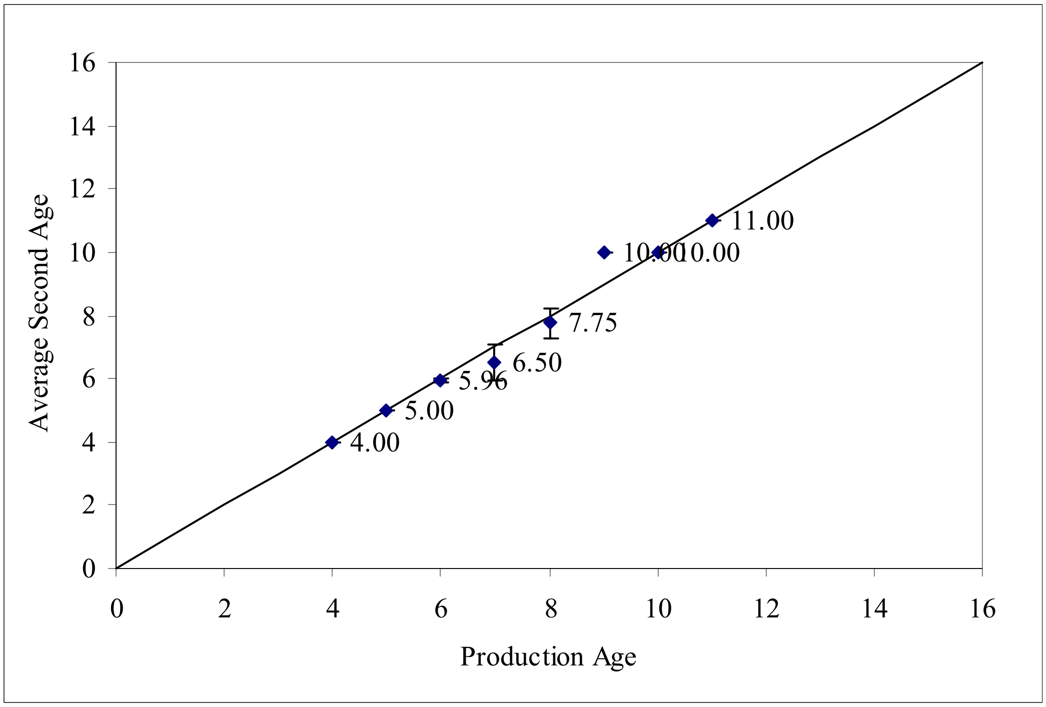


N Aged	56	CV	0.69
N Agreed	52		
Disagreed	4	%Agreement	92.9%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1														
2														
3														
4					4									4
5						3	1							4
6							22							22
7								7	2					9
8									7					7
9										2				2
10											3			3
11											1	4		5
12														
Total					4	3	23	7	9	2	4	4		56

Figure 8. Results of haddock age-reader precision exercise against randomly selected samples from Quarter 2 of 2004 U.S. commercial landings. Error bars indicate 95% confidence intervals.



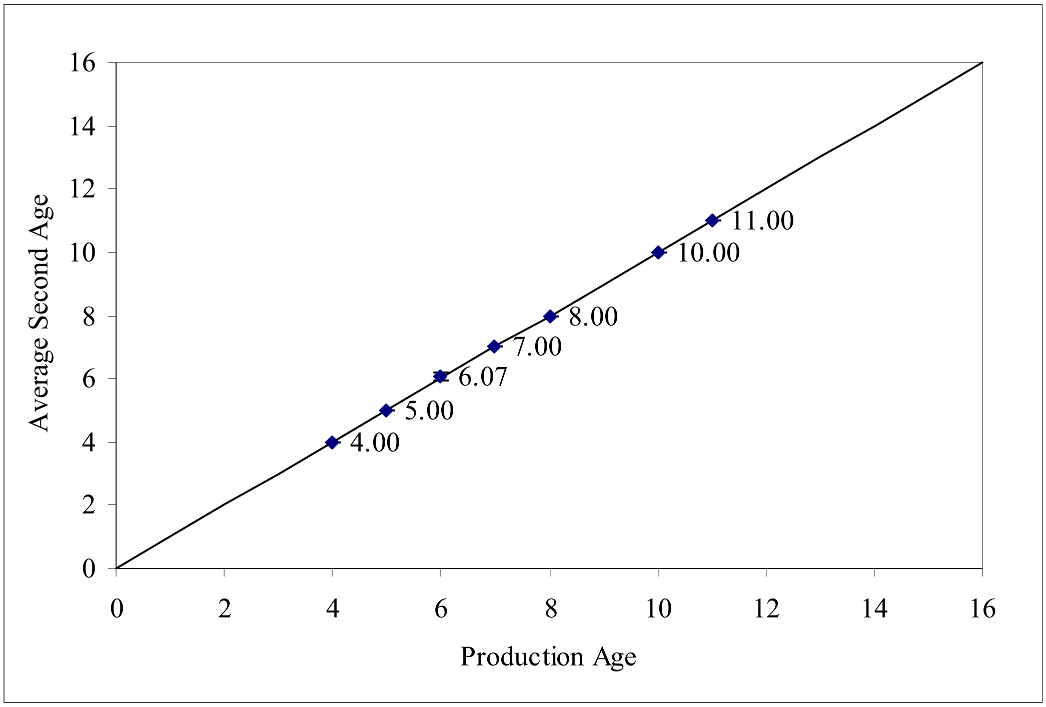
N Aged	55
N Agreed	50
Disagreed	5

CV	0.94
%Agreement	90.9%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1														
2														
3														
4					7									7
5						9								9
6						1	27							28
7							2	2						4
8								1	3					4
9											1			1
10											1			1
11												1		1
12														
Total					7	10	29	3	3		2	1		55

Figure 9. Results of haddock age-reader precision exercise against randomly selected samples from Quarter 3 of 2004 U.S. commercial landings. Error bars indicate 95% confidence intervals.



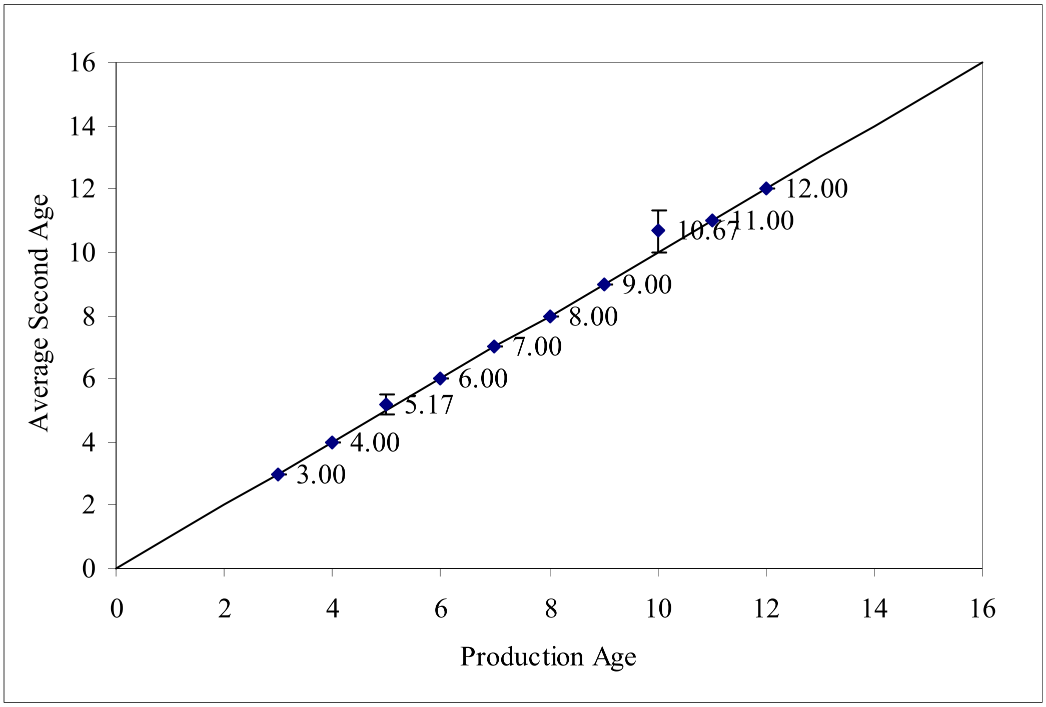
N Aged	44
N Agreed	43
Disagreed	1

CV	0.25
%Agreement	97.7%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1														
2														
3														
4					10									10
5						3								3
6							14	1						15
7								6						6
8									3					3
9														
10											4			4
11												3		3
12														
Total					10	3	14	7	3		4	3		44

Figure 10. Results of haddock age-reader precision exercise against randomly selected samples from Quarter 4 of 2004 U.S. commercial landings. Error bars indicate 95% confidence intervals.



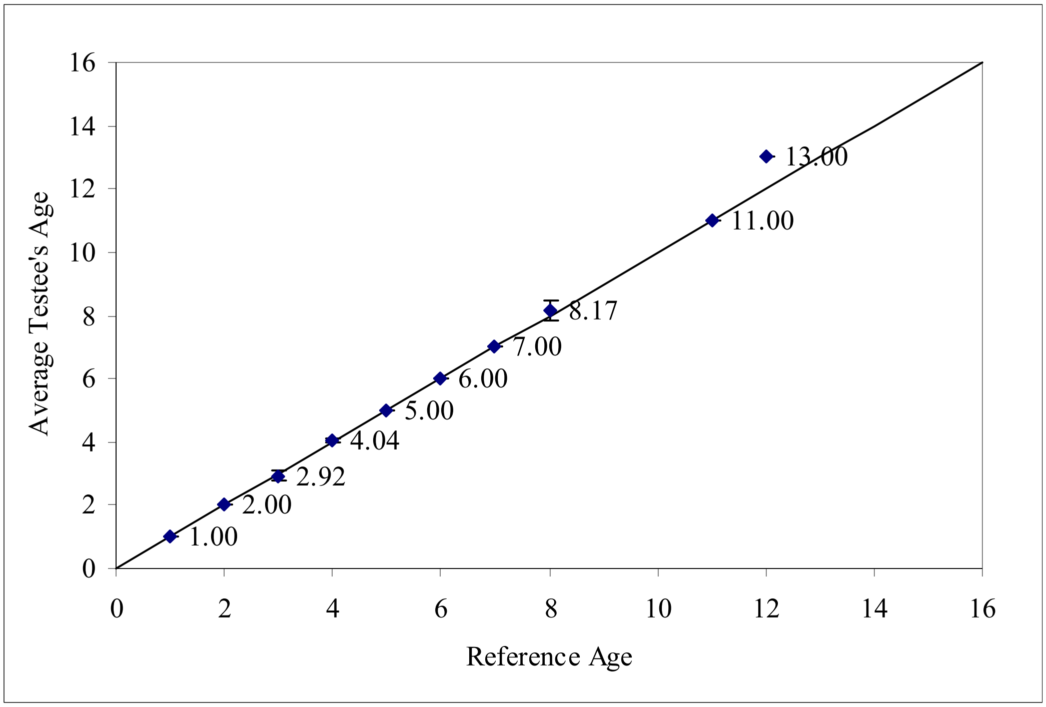
N Aged	60
N Agreed	57
Disagreed	3

CV	0.44
%Agreement	95.0%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1														
2														
3				1										1
4					17									17
5						5	1							6
6							24							24
7								3						3
8									2					2
9										2				2
10											1	2		3
11												1		1
12													1	1
Total				1	17	5	25	3	2	2	1	3	1	60

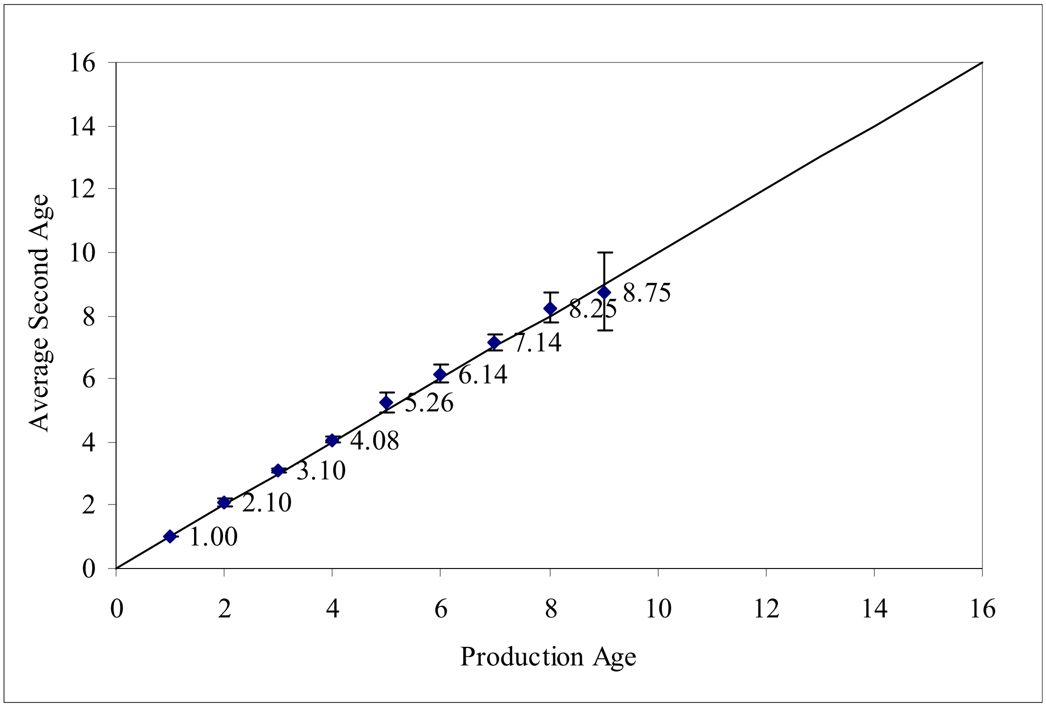
Figure 11. Results of haddock age-reader accuracy exercise against randomly selected samples from the NEFSC haddock reference collection. Error bars indicate 95% confidence intervals.



N Aged	107	CV	1.26
N Agreed	100		
Disagreed	7	%Agreement	93.5%

Ref Age	Testee's Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
0															
1		9													9
2			14												14
3			3	22	1										26
4					25	1									26
5						13									13
6							8								8
7								3							3
8									5	1					6
9															
10															
11												1			1
12														1	1
13															
Total		9	17	22	26	14	8	3	5	1		1		1	107

Figure 12. Results of yellowtail age-reader precision exercise against randomly selected samples from Canadian 2004 commercial landings. Error bars indicate 95% confidence intervals.

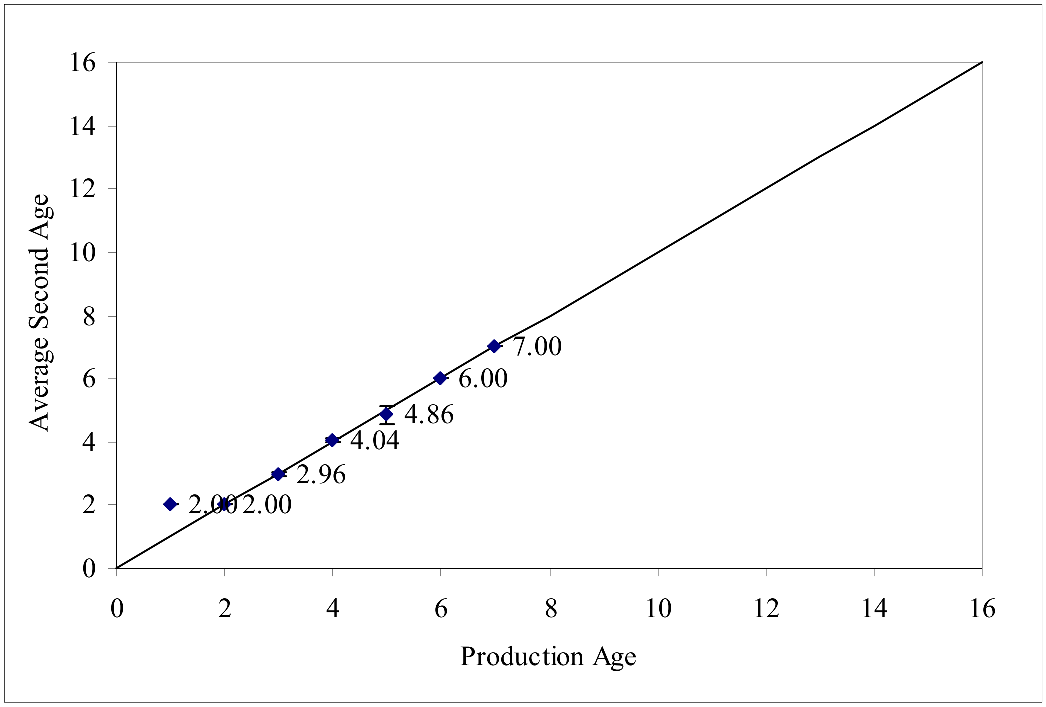


N Aged	167		CV	2.52
N Agreed	144			
Disagreed	23		%Agreement	86.2%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1		1												1
2			28	3										31
3				47	5									52
4				1	33	4								38
5					1	18	2	1	1					23
6							6	1						7
7								6	1					7
8									3	1				4
9								1		2	1			4
10														
11														
12														
Total		1	28	51	39	22	8	9	5	3	1			167

Figure 13. Results of yellowtail age-reader precision exercise against randomly selected samples from the Canadian 2005 bottom trawl survey. Error bars indicate 95% confidence intervals.

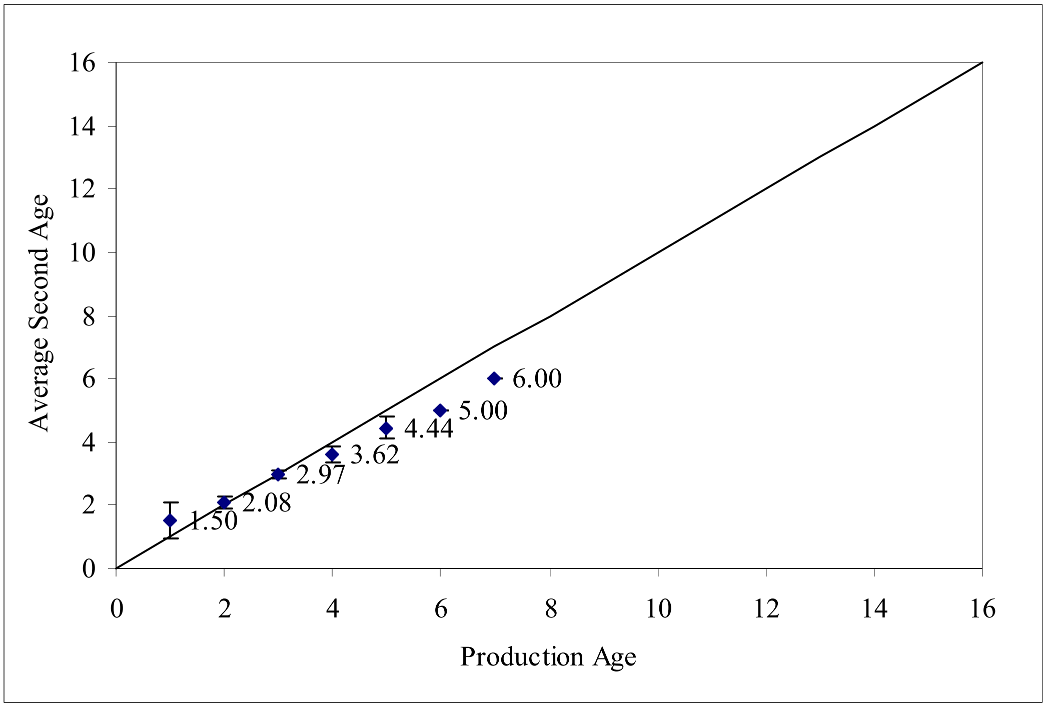


N Aged	100
N Agreed	92
Disagreed	8

CV	1.79
%Agreement	92.0%

Prod Age \ Second Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1			1											1
2			6											6
3			2	45										47
4					25	1								26
5					3	10	1							14
6							5							5
7								1						1
8														
9														
10														
11														
12														
Total			9	45	28	11	6	1						100

Figure 14. Results of yellowtail age-reader precision exercise against randomly selected samples from U.S. 2004 commercial landings, and NEFSC 2004 autumn and 2005 spring bottom trawl surveys. Error bars indicate 95% confidence intervals.

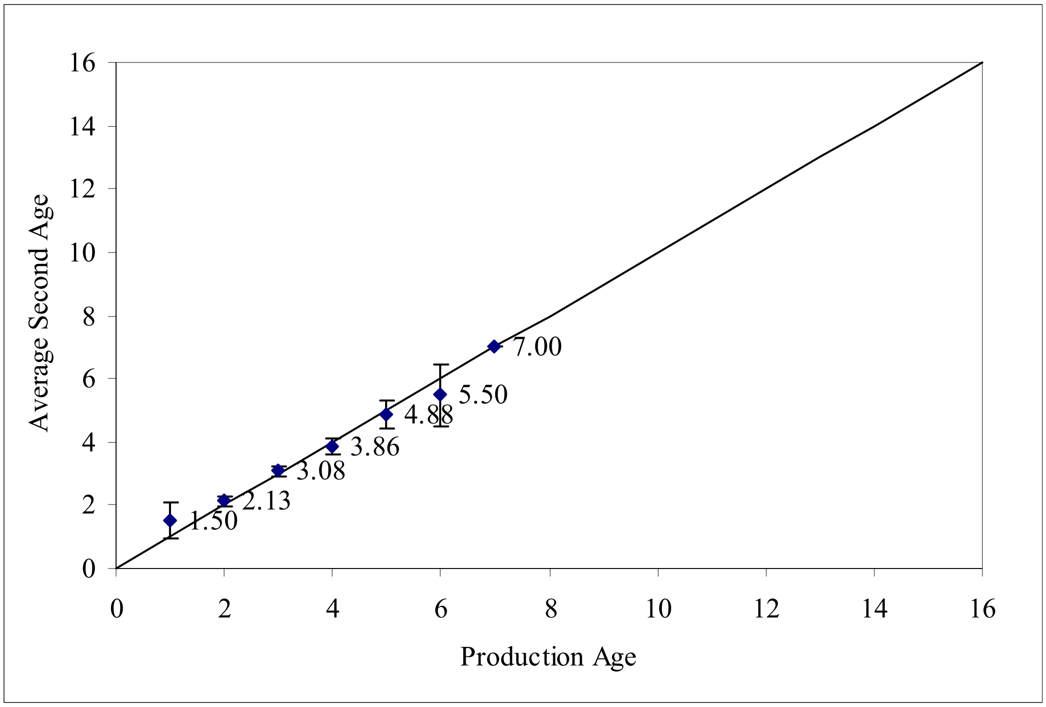


N Aged	100	CV	6.64
N Agreed	71		
Disagreed	29	%Agreement	71.0%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1		2	2											4
2		1	20	3										24
3			3	34	2									39
4				9	11	1								21
5					5	4								9
6						2								2
7							1							1
8														
9														
10														
11														
12														
Total		3	25	46	18	7	1							100

Figure 15. Results of trainee yellowtail age-reader precision exercise against randomly selected samples from U.S. 2004 commercial landings, and NEFSC 2004 autumn and 2005 spring bottom trawl surveys. Error bars indicate 95% confidence intervals.



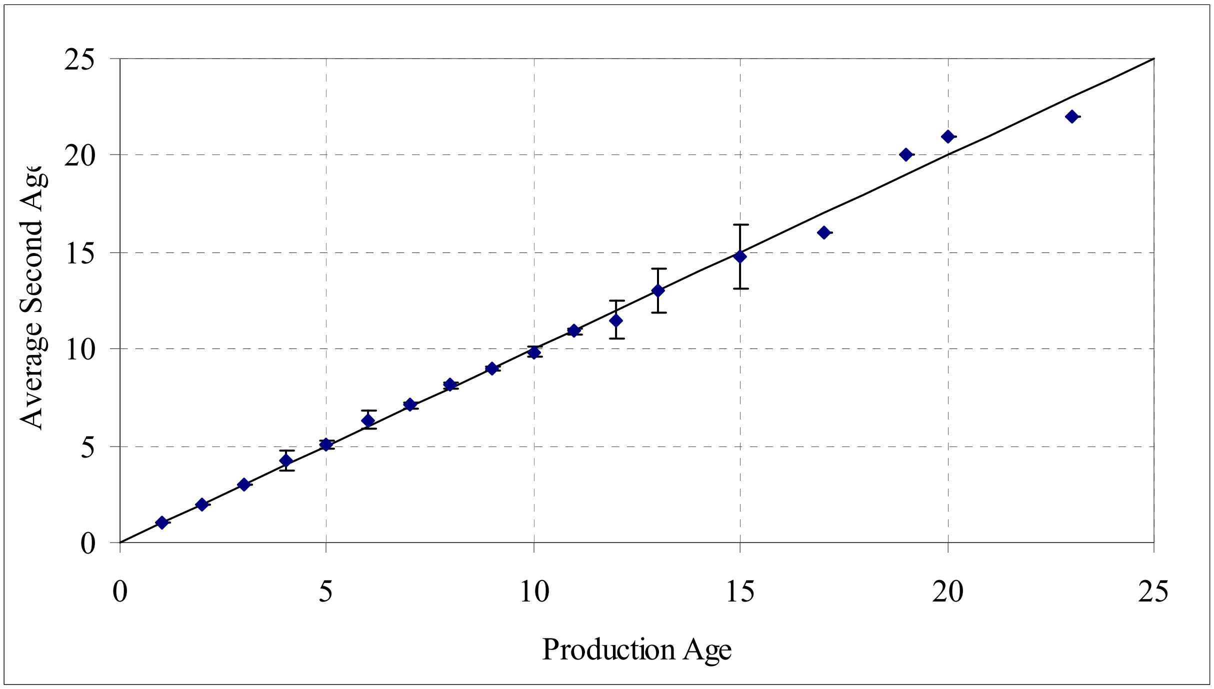
N Aged	100
N Agreed	73
Disagreed	27

CV	6.11
%Agreement	73.0%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1		2	2											4
2			20	3										23
3			3	31	6									40
4				6	13	3								22
5					2	5	1							8
6						1	1							2
7								1						1
8														
9														
10														
11														
12														
Total		2	25	40	21	9	2	1						100

Figure 16. Results of witch flounder age-reader precision exercise against samples from Quarters 2 and 4 of 2004 U.S. commercial landings (N=60) and the NEFSC 2005 spring bottom trawl survey (N=62). Error bars indicate 95% confidence intervals.



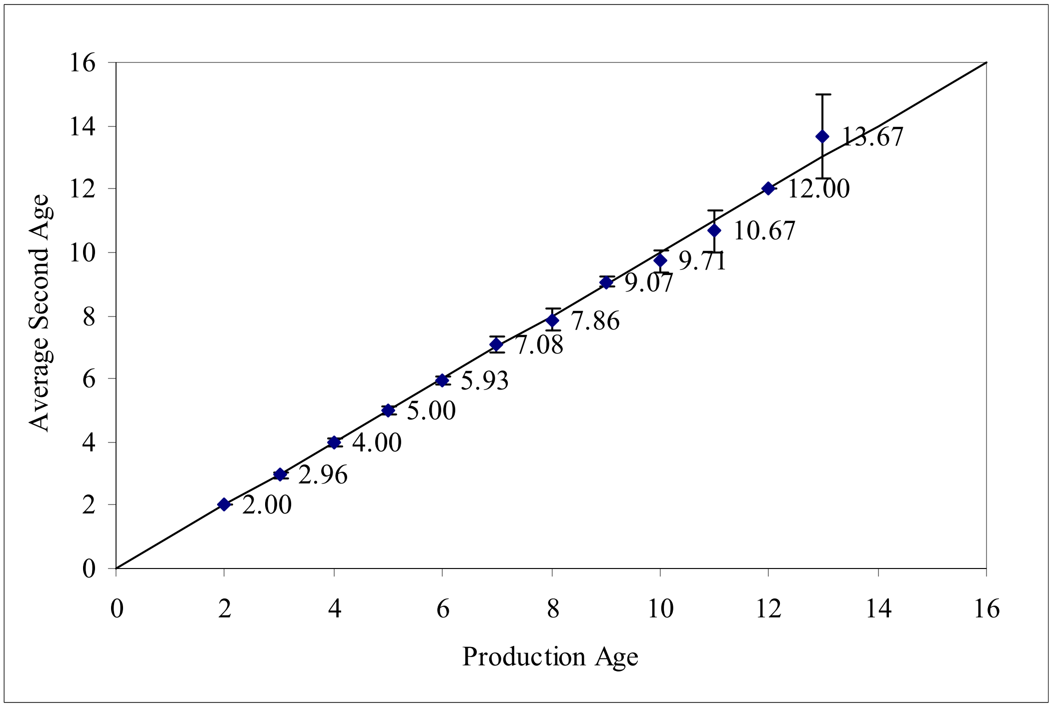
N Aged	122
N Agreed	98
Disagreed	24

CV	1.55
%Agreement	80.3%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
0																									
1		1																							1
2			6																						6
3				1																					1
4					3	1																			4
5						9	1																		10
6							7	1	1																9
7								11	1																12
8									13	2															15
9									1	22															23
10										3	10	1													14
11											1	12													13
12												1	1												2
13													1	1	1										3
14																									
15														1	1	1		1							4
16																									
17																	1								1
18																									
19																					2				2
20																						1			1
21																									
22																									
23																							1		1
Total		1	6	1	3	10	8	12	16	27	11	14	2	2	2	1	1	1			2	1	1		122

Figure 17. Results of American plaice age-reader precision exercise against samples from the Quarter 1 of 2004 U.S. commercial landings (N=82) and the NEFSC 2004 autumn bottom trawl survey (N=79). Error bars indicate 95% confidence intervals.



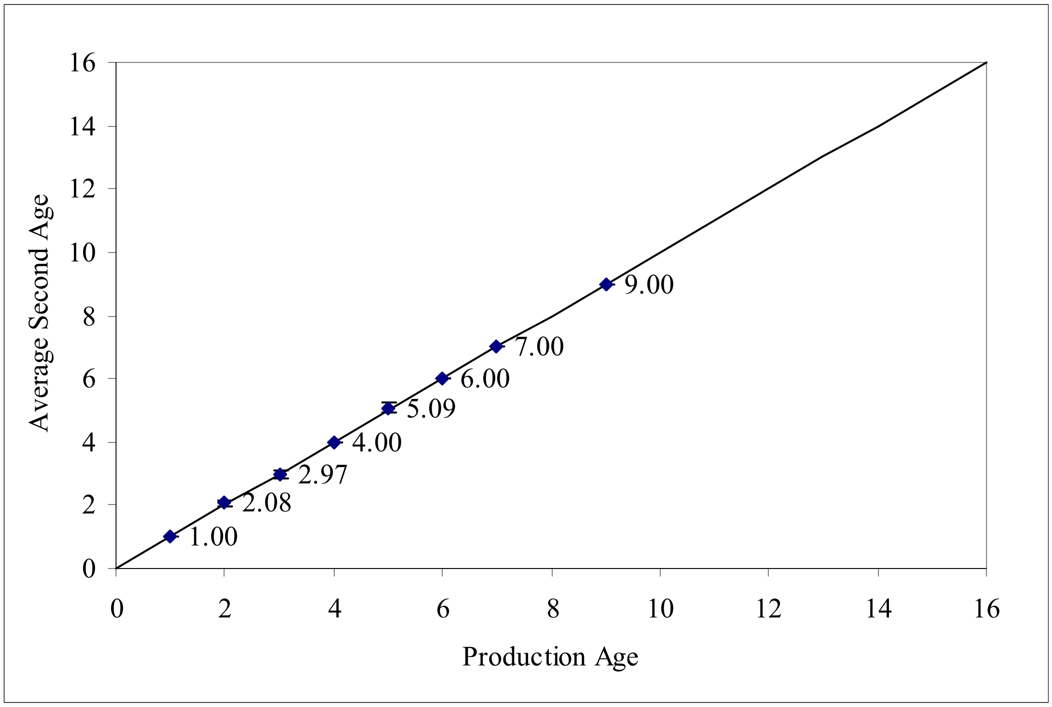
N Aged	161
N Agreed	138
Disagreed	23

CV	1.69
%Agreement	85.7%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
0																		
1																		
2			5															5
3			1	23														24
4				1	21	1												23
5					1	21	1											23
6						3	24	1										28
7							1	10	2									13
8								4	8	2								14
9										13	1							14
10										2	5							7
11										1		5						6
12													1					1
13														2		1		3
14																		
15																		
16																		
Total			6	24	22	25	26	15	10	18	6	5	1	2		1		161

Figure 18. Results of winter flounder age-reader precision exercise against otolith samples from the NEFSC 2004 autumn (N=55) and 2005 spring (N=55) bottom trawl surveys. Error bars indicate 95% confidence intervals.



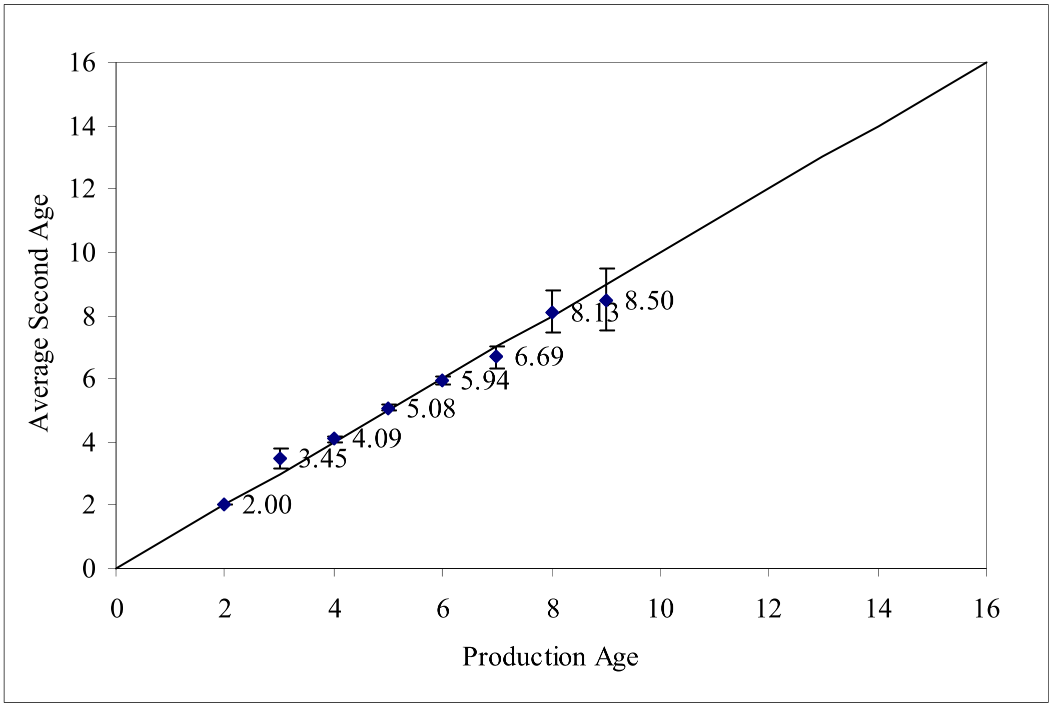
N Aged	110
N Agreed	103
Disagreed	7

CV	1.59
%Agreement	93.6%

Second Age

Prod Age	0	1	2	3	4	5	6	7	8	9	Total
0											
1		11									11
2			34	3							37
3			2	26	1						29
4					16						16
5						10	1				11
6							2				2
7								3			3
8											
9										1	1
Total		11	36	29	17	10	3	3		1	110

Figure 19. Results of winter flounder age-reader precision exercise against scale samples from Quarters 1 (N=55) and 3 (N=60) of 2004 U.S commercial landings. Error bars indicate 95% confidence intervals.

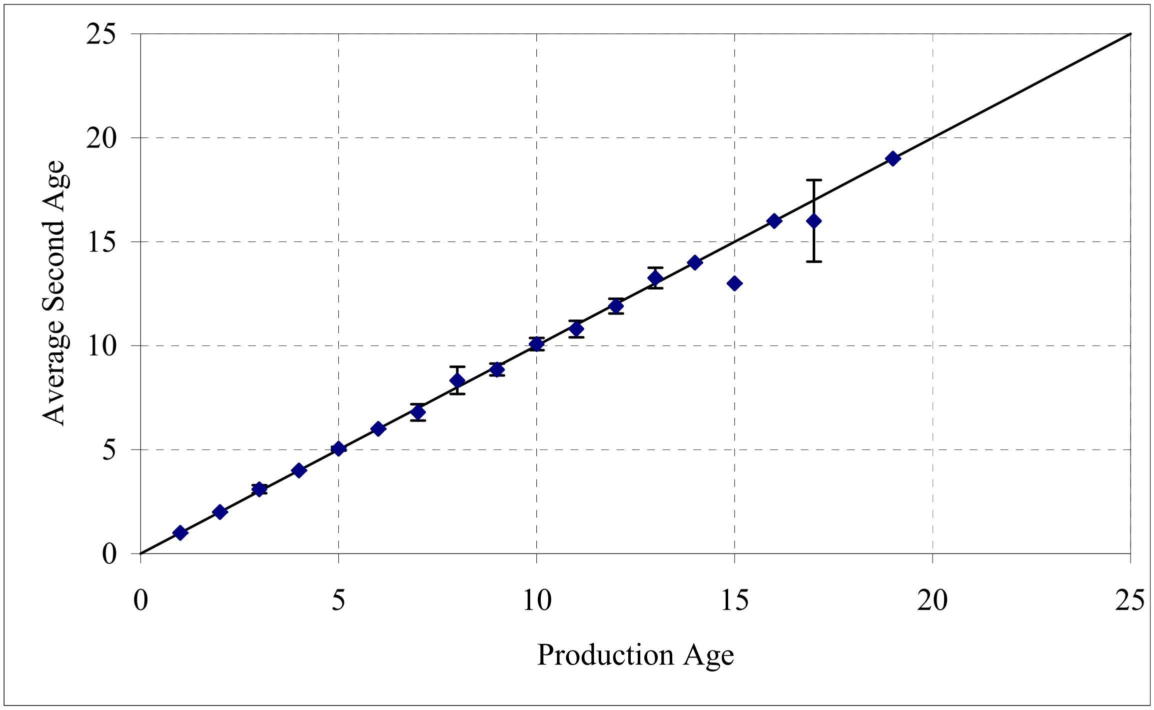


N Aged	115
N Agreed	91
Disagreed	24

CV	2.81
%Agreement	79.1%

	Second Age											
Prod Age	0	1	2	3	4	5	6	7	8	9	10	Total
0												
1												
2			1									1
3				6	5							11
4					21	2						23
5						23	2					25
6						3	28	1				32
7							5	7	1			13
8								2	4	1	1	8
9									1	1		2
10												
Total			1	6	26	28	35	10	6	2	1	115

Figure 20. Results of redfish age-reader precision exercise against randomly selected samples from the NEFSC 2004 autumn bottom trawl survey. Error bars indicate 95% confidence intervals.



N Aged	142
N Agreed	127
Disagreed	15

CV	0.99
%Agreement	89.4%

Second Age

Prod Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	23																			23
2		9																		9
3			9	1																10
4				11																11
5					20	1														21
6						12														12
7						1	4													5
8								2	1											3
9								1	6											7
10									1	9	2									12
11										1	4									5
12											2	7	1							10
13													3	1						4
14														1						1
15													1							1
16																1				1
17													1				3			4
18																				
19																			3	3
Total	23	9	9	12	20	14	4	3	8	10	8	7	6	2		1	3		3	142

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Publications and Reports of the Northeast Fisheries Science Center

The mission of NOAA's National Marine Fisheries Service (NMFS) is "stewardship of living marine resources for the benefit of the nation through their science-based conservation and management and promotion of the health of their environment." As the research arm of the NMFS's Northeast Region, the Northeast Fisheries Science Center (NEFSC) supports the NMFS mission by "conducting ecosystem-based research and assessments of living marine resources, with a focus on the Northeast Shelf, to promote the recovery and long-term sustainability of these resources and to generate social and economic opportunities and benefits from their use." Results of NEFSC research are largely reported in primary scientific media (*e.g.*, anonymously-peer-reviewed scientific journals). However, to assist itself in providing data, information, and advice to its constituents, the NEFSC occasionally releases its results in its own media. Currently, there are three such media:

NOAA Technical Memorandum NMFS-NE -- This series is issued irregularly. The series typically includes: data reports of long-term field or lab studies of important species or habitats; synthesis reports for important species or habitats; annual reports of overall assessment or monitoring programs; manuals describing program-wide surveying or experimental techniques; literature surveys of important species or habitat topics; proceedings and collected papers of scientific meetings; and indexed and/or annotated bibliographies. All issues receive internal scientific review and most issues receive technical and copy editing.

Northeast Fisheries Science Center Reference Document -- This series is issued irregularly. The series typically includes: data reports on field and lab studies; progress reports on experiments, monitoring, and assessments; background papers for, collected abstracts of, and/or summary reports of scientific meetings; and simple bibliographies. Issues receive internal scientific review, but no technical or copy editing.

Resource Survey Report (formerly *Fishermen's Report*) -- This information report is a quick-turnaround report on the distribution and relative abundance of selected living marine resources as derived from each of the NEFSC's periodic research vessel surveys of the Northeast's continental shelf. There is no scientific review, nor any technical or copy editing, of this report.

OBTAINING A COPY: To obtain a copy of a *NOAA Technical Memorandum NMFS-NE* or a *Northeast Fisheries Science Center Reference Document*, or to subscribe to the *Resource Survey Report*, either contact the NEFSC Editorial Office (166 Water St., Woods Hole, MA 02543-1026; 508-495-2228) or consult the NEFSC webpage on "Reports and Publications" (*http://www.nefsc.noaa.gov/nefsc/publications/*).