

Science, Service, Stewardship



# Groundfish Assessment Review Meeting III

Assessment of 19 Northeast Groundfish  
Stocks through 2007

Northeast Fisheries Science Center

September 5, 2008

Presentation to  
New England Fishery Management Council  
September 3, 2008

**NOAA  
FISHERIES  
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<http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0815/>



## Objectives of Presentation

**Describe GARM Process**

**Summarize major changes**

- Data,
- Models,
- BRP

**Major Conclusions**

**Stock Status Summary**

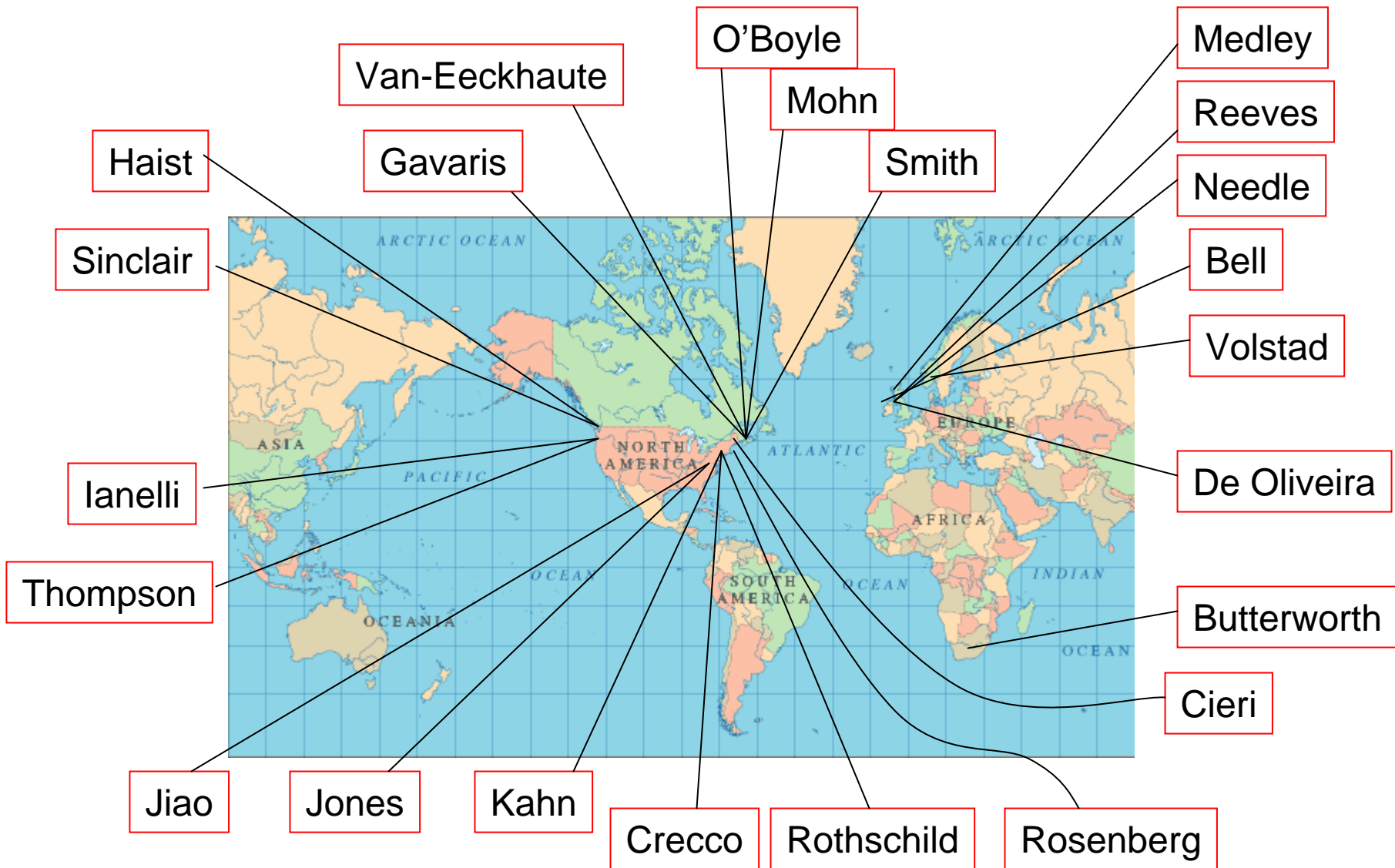
**Rebuild estimates**

**Retrospective Patterns**

**Ecosystem Conclusions**

# The GARM Process

Meeting	# Working Papers	# Authors	# Pages	# Participants	# Reviewers
Data Methods	34	94	1,022	52	3 SSC 4 External
Models	21	42	84	45	3 CIE 3 External
Biological Reference Points	42	76	1,534	45	3 CIE 2 External
Assess-ment	43	68	1,773	49	1 SSC 3 External
Total	140	280	5,177	191	22



<b>Data Source</b>	<b>Ave # Records per year (2002-2007)</b>
VTR	<b>148,187</b>
Dealer Transactions (Federal)	<b>170,197</b>
Observer Trips	<b>2,677</b>
Observer Days	<b>4,577</b>
Port Samples	<b>1,309</b>
Comm. Lengths	<b>88,201</b>
# Fish Aged	<b>21,173</b>
Tagging Databases	<b>2</b>
NEFSC Survey Stations	<b>811</b>

**+ State Surveys, Industry based surveys**

# What's Different between GARM II and GARM III?

- Complete re-examination of data, particularly
  - Landings allocation to stock areas
  - Discard estimation
  - Biological parameters—ave wt, maturity
  - Inclusion of historical landings data in assessment
- Major technical improvements in characterizing uncertainty in underlying data:
  - {Surveys, Landings at age, discards. }
- Improved model diagnostics.
- Review of Models for each stock
- Basis for biological reference points  $F_{40\%MSP}$  used for most age-based stocks.
- Estimation of  $F$  necessary to achieve rebuilding
- *Handling of Retrospective patterns*

# What's happened since June 4 presentation to Council?

- Inclusion of 2007 landings and discard data.
- Revision of biological reference points
- Computation of rebuild F
- Final stock assessment for all stocks
- Update of ecosystem data.
- Computation of the Overfishing/Overfished score card
- Agreement on procedures for retrospective pattern
- Estimate catches for 2009 given different scenarios

# Terms of Reference

- 1. Update landings, discard, surveys
- 2. Estimate  $F$ ,  $SSB$  and uncertainty
- 3. Update Biological Ref Pts.
- 4. Homework assignments...prev. mtgs.
- 5. Scientific basis for projections.
  - {Weights, Maturity, Selectivity, Recruits}
- 6. Compute Frebuild
- 7. Provisional estimates of 2009 Catch
- 8. Update ecosystem comparisons



## Major Conclusions (1)

Improved basis for estimation of stock status, uncertainty and forecasting

Reductions in average weights at age and changes in selectivity patterns.

6 stocks below  $F_{msy}$ ; 13 above  $F_{msy}$

Biomass  $> \frac{1}{2} B_{msy}$  for 6 stocks; 13 below  $B_{msy}$

Major improvements in GB and GOM haddock biomass, GOM cod, SNE yellowtail, CC/GOM yellowtail, southern windowpane.

Strong yearclasses in GB yellowtail flounder (2005), haddock (2003), GOM cod (2005)



## Major Conclusions (2)

Deterioration in status for pollock, witch, GB winter, GOM winter, Northern windowpane. (May need rebuilding programs extending to 2018-20)

SNE winter flounder at extremely low level; unlikely to rebuild by 2014.

Large reductions in  $F$  relative to  $F_{msy}$  but overfishing still occurring for 13 stocks

Retrospective patterns quantified and pragmatic measures for estimating current status developed.

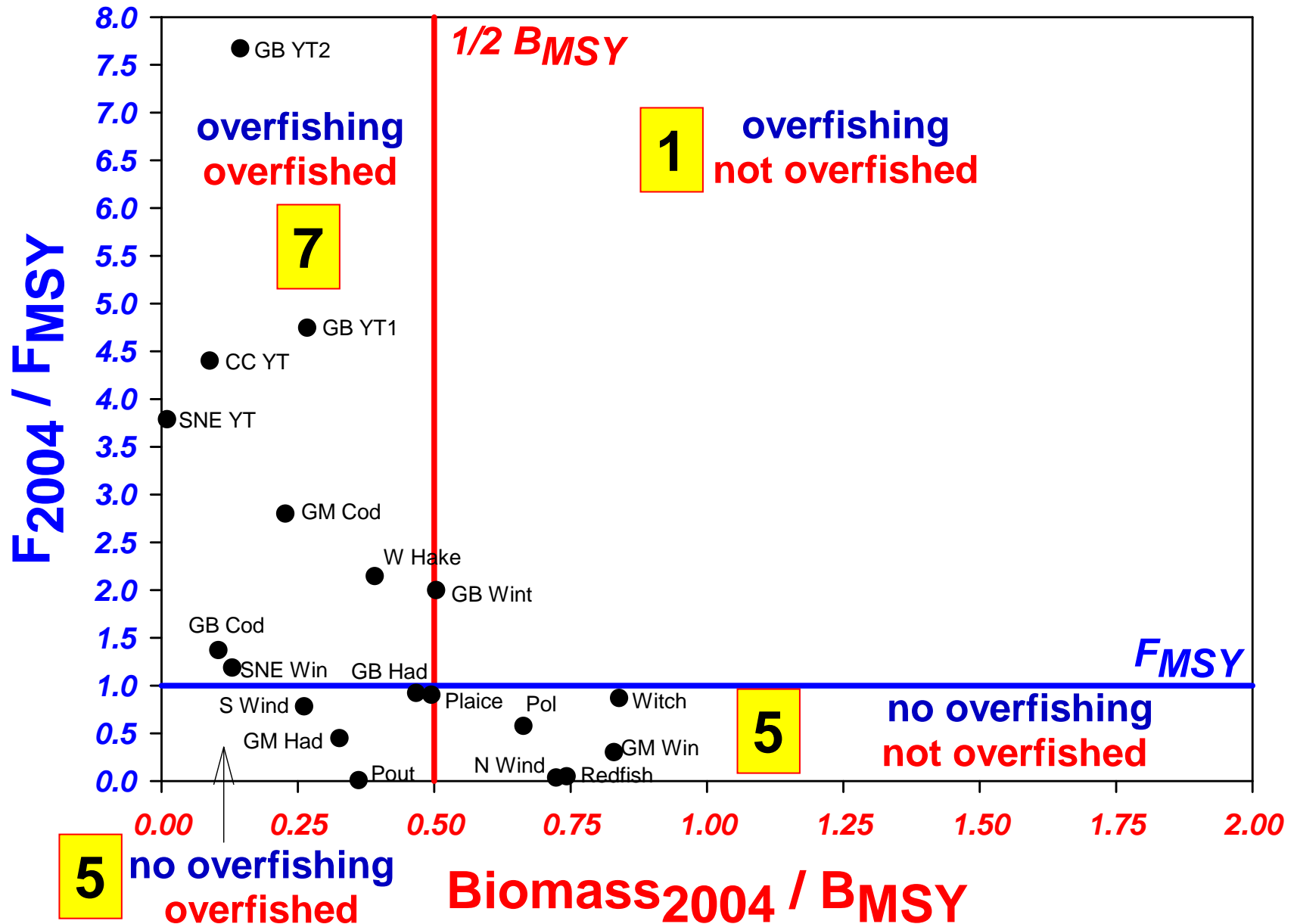
Close agreement between sum of individual stock assessments and ecosystem based approaches.  
Overall productivity lower than in GARM I.

# Some important caveats when comparing among GARMS

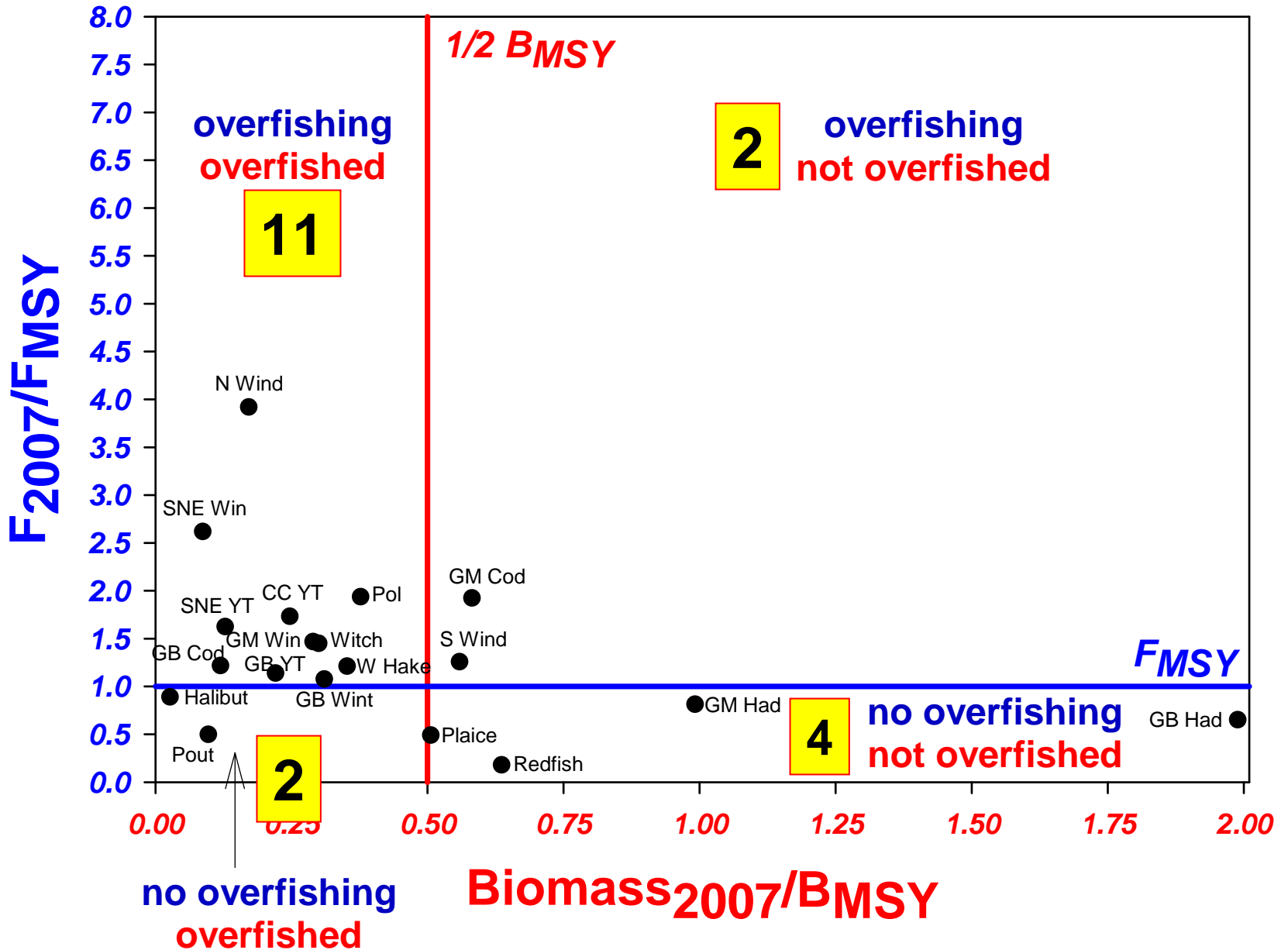
- Biomass targets have declined
- Fishing mortality rates are expressed as rate on fully vulnerable age groups BUT selectivity has changed for many stocks as a result of slower growth and gear changes.
- Changes in selectivity have important implications for fishing mortality reference points. Esp. GOM haddock.
- Previous GARMs did not include adjustments for retrospective patterns

Stock Status	2004 (GARM II)	2007 (GARM III)
<p><b><u>Overfished and Overfishing</u></b>  <b>Biomass &lt; 1/2 B<sub>MSY</sub></b>  <b>AND</b>  <b>F &gt; F<sub>MSY</sub></b></p>	<p>GB Cod            GB Yellowtail            SNE/MA Yellowtail            GOM/CC Yellowtail            SNE/MA Winter Flounder            White Hake            GOM Cod</p> <p style="text-align: right;"><b>7</b></p>	<p>GB Cod            GB Yellowtail            SNE/MA Yellowtail            GOM/CC Yellowtail            SNE/MA Winter Flounder            White Hake            Pollock            Witch            GB Winter Flounder            GOM Winter Flounder            No. Windowpane</p> <p style="text-align: right;"><b>11</b></p>
<p><b><u>Overfished but not Overfishing</u></b>  <b>Biomass &lt; 1/2 B<sub>MSY</sub></b>  <b>AND</b>  <b>F ≤ F<sub>MSY</sub></b></p>	<p>GB Haddock            GOM Haddock            So. Windowpane            Plaice            Ocean Pout</p> <p style="text-align: right;"><b>5</b></p>	<p>Ocean Pout            Halibut</p> <p style="text-align: right;"><b>2</b></p>
<p><b><u>Not Overfished but Overfishing</u></b>  <b>Biomass ≥ 1/2 B<sub>MSY</sub></b>  <b>AND</b>  <b>F &gt; F<sub>MSY</sub></b></p>	<p>GB Winter Flounder</p> <p style="text-align: right;"><b>1</b></p>	<p>GOM Cod            So. Windowpane</p> <p style="text-align: right;"><b>2</b></p>
<p><b><u>Not Overfished and not Overfishing</u></b>  <b>Biomass ≥ 1/2 B<sub>MSY</sub></b>  <b>AND</b>  <b>F ≤ F<sub>MSY</sub></b></p>	<p>Pollock            Redfish            No. Windowpane            GOM Winter Flounder            Witch</p> <p style="text-align: right;"><b>5</b></p>	<p>Redfish            Plaice            GB Haddock            GOM Haddock</p> <p style="text-align: right;"><b>4</b></p>

# 2004 Groundfish Stock Status



# 2007 Groundfish Stock Status



# Comparisons of Stock Status: 2004 vs 2007. See Table 1.

Table entries are number of stocks

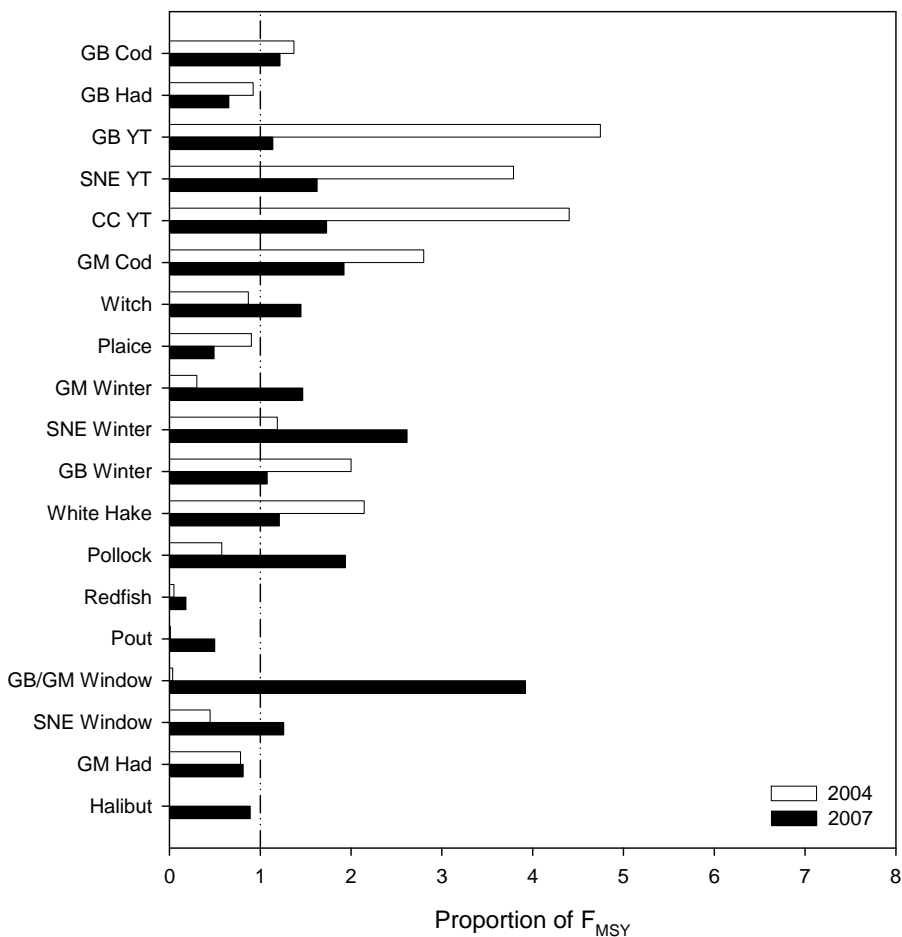
<b>Status 2004</b>	<b><math>B &lt; B_{MSY}</math> Over- fished</b>	<b><math>B &gt; B_{MSY}</math> NOT Over- fished</b>	<b>Total</b>
<b><math>F &gt; F_{MSY}</math> Over- fishing</b>	7	1	8
<b><math>F &lt; F_{MSY}</math> NOT Over- fishing</b>	5	5	10
<b>Total</b>	12	6	18

<b>Status 2007</b>	<b><math>B &lt; B_{MSY}</math> Over- fished</b>	<b><math>B &gt; B_{MSY}</math> NOT Over- fished</b>	<b>Total</b>
<b><math>F &gt; F_{MSY}</math> Over- fishing</b>	11	2	13
<b><math>F &lt; F_{MSY}</math> NOT Over- fishing</b>	2	4	6
<b>Total</b>	13	6	19

Atlantic halibut included in 2007

# Are the comparisons as bad as they seem?

- Remember that GARM III estimates are adjusted for retrospective pattern in 7 of 19 stocks. (Table 8). GARM II estimates were not adjusted.
- Of these 7 stocks,
  - 4 changed status from NOT overfishing to Overfishing (Table 4)
  - 2 changed status from NOT overfished to Overfished. (Table 4)
- Magnitude of relative overfish (compared to  $F_{msy}$ ) appears to be declining.



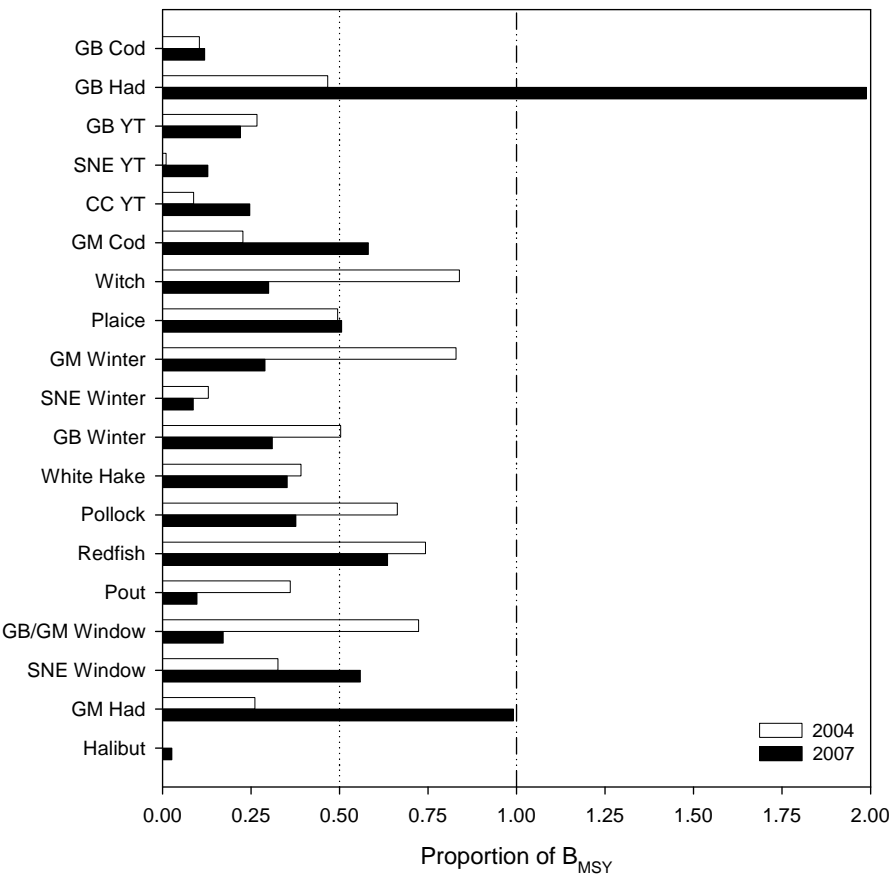
**Fig. 3.** Comparison between 2004 and 2007 fishing mortality with respect to  $F_{MSY}$  based on the GARM II and GARM III reviews.

## Fishing Mortality Decreases

- GB cod
- GB haddock
- GB Yellowtail
- SNE Yellowtail
- CC Yellowtail
- GOM Cod
- American Plaice
- GB Winter
- White Hake

## Fishing Mortality Increases

- Witch
- GOM Winter
- SNE Winter
- Pollock
- Redfish
- Ocean Pout
- Northern Windowpane
- Southern Windowpane
- GOM Haddock



**Fig. 4.** Comparisons between 2004 and 2007 stock biomass with respect to  $B_{MSY}$  based on the GARM II and GARM III reviews.

## • Biomass Increases

- GB Cod (minor)
- GB Haddock (major)
- GM Cod (major)
- GM Haddock (major)
- American Plaice
- CC/GOM Yellowtail
- Southern Windowpane

## • Biomass Decreases

- GB Yellowtail
- Witch
- GOM Winter
- SNE winter
- GB Winter
- White Hake
- Pollock
- Redfish
- Pollock
- Pout
- Northern Windowpane

## Some Important Tables for Assessments and Reference Points

- Table 2—One-stop shopping for current (2007) F and SSB, and Biological Reference Points
- Table 3. Example calculations of Frebuild and projected catch in 2009.
- Table 5. Changes in assessment models
- Table 6. Changes in methods to estimate BRP
- Table 7. Comparison of BRP in 2002 and 2008

**TABLE 2. Current estimates of F and SSB compared to Biological reference points**

	2007 Estimates (GARM III)		Biological Reference Points (GARM III)		
	Fishing Mortality	Biomass (mt)	<i>Fmsy or proxy</i>	<i>Bmsy or proxy (mt)</i>	<i>MSY (mt)</i>
Stock					
GB	0.300	17,672	0.25	148,084	31,159
GOM	0.456	33,878	0.24	58,248	10,014
GB	0.230	315,975	0.35	158,873	32,746
GOM	0.350	5,850	0.43	5,900	1,360
GB	0.289	9,527	0.25	43,200	9,400
SNE/MA	0.413	3,508	0.25	27,400	6,100
CC/GOM	0.414	1,922	0.24	7,790	1,720
GB/GOM	0.090	11,106	0.19	21,940	4,011
	0.290	3,434	0.20	11,447	2,352
GB	0.280	4,964	0.26	16,000	3,500
GOM	0.417	1,100	0.28	3,792	917
SNE/MA	0.649	3,368	0.25	38,761	9,742
	0.007	172,342	0.04	271,000	10,139
GB/GOM	0.150	19,800	0.13	56,254	5,800
GB/GOM	10.975 c/i	0.754 kg/tow	5.66 c/i	2.00 kg/tow	11,320
GOM/GB	1.96 c/i	0.24 kg/tow	0.50 c/i	1.40 kg/tow	700
SNE/MA	1.85 c/i	0.19 kg/tow	1.47 c/i	0.34 kg/tow	500
	0.38 c/i	0.48 kg/tow	0.76 c/i	4.94 kg/tow	3,754
	0.065	1,300	0.07	49,000	3,500

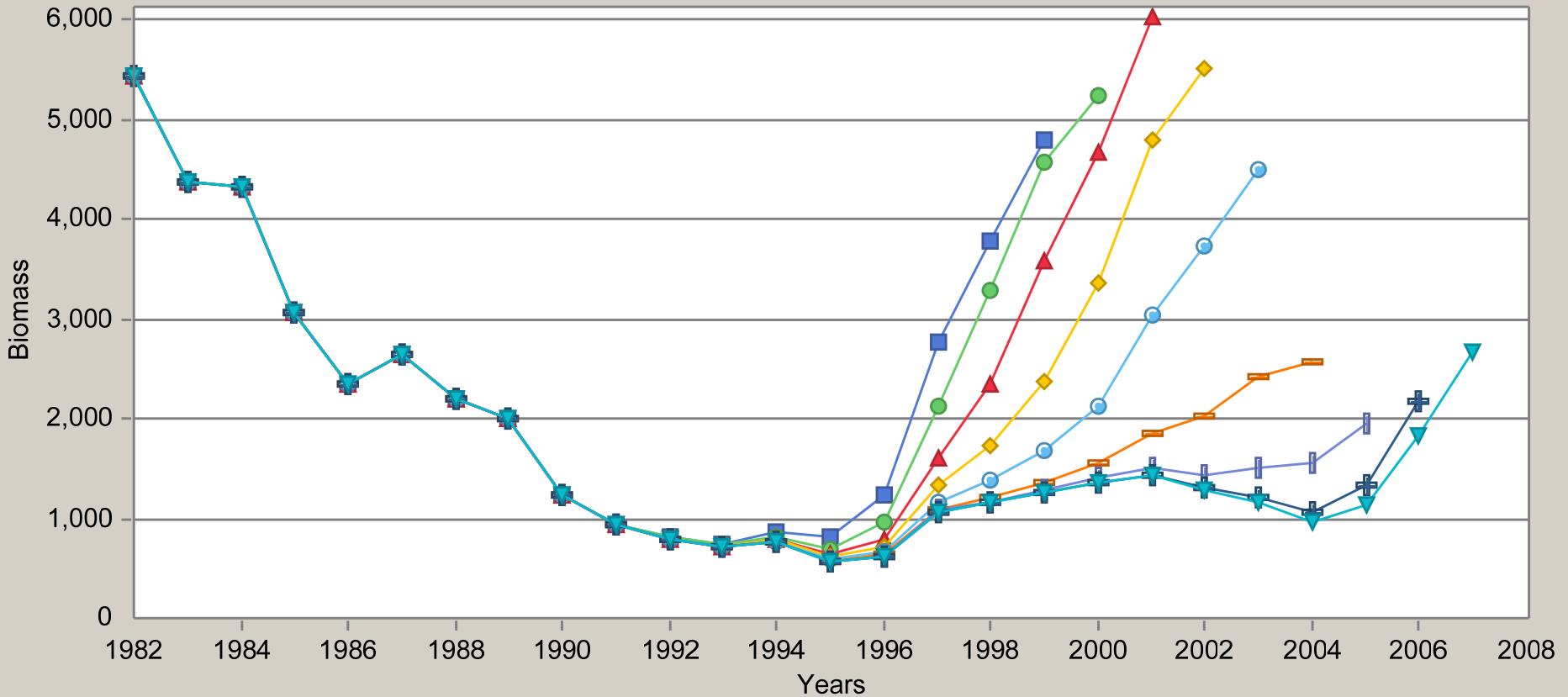
# What is a retrospective pattern?

- A consistent change in estimated quantities that occurs when additional years of information are added to a model.
  - Fishing mortality,
  - Spawning Stock Biomass, or
  - Recruitment
- Not a generic property of VPA; other models exhibit same properties
- Not evident for all stocks assessed by the GARM
- Provides insight into change in underlying process

# Example Retrospective Pattern: Biomass

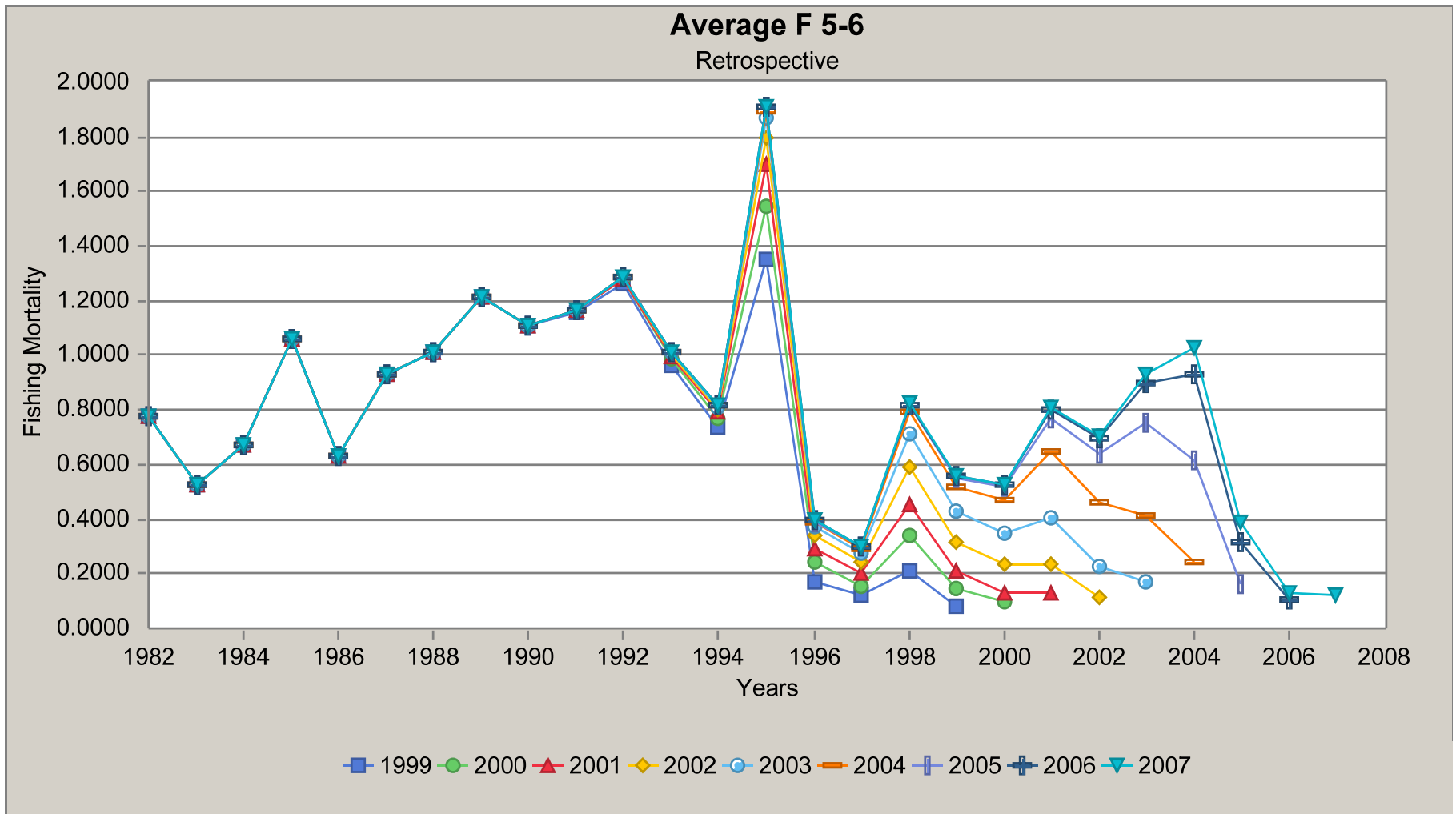
Spawning Stock Biomass

Retrospective



■ 1999 ● 2000 ▲ 2001 ◆ 2002 ○ 2003 □ 2004 + 2005 + 2006 ▼ 2007

# Example Retrospective Pattern: Fishing Mortality



# Handling the Retrospective Pattern

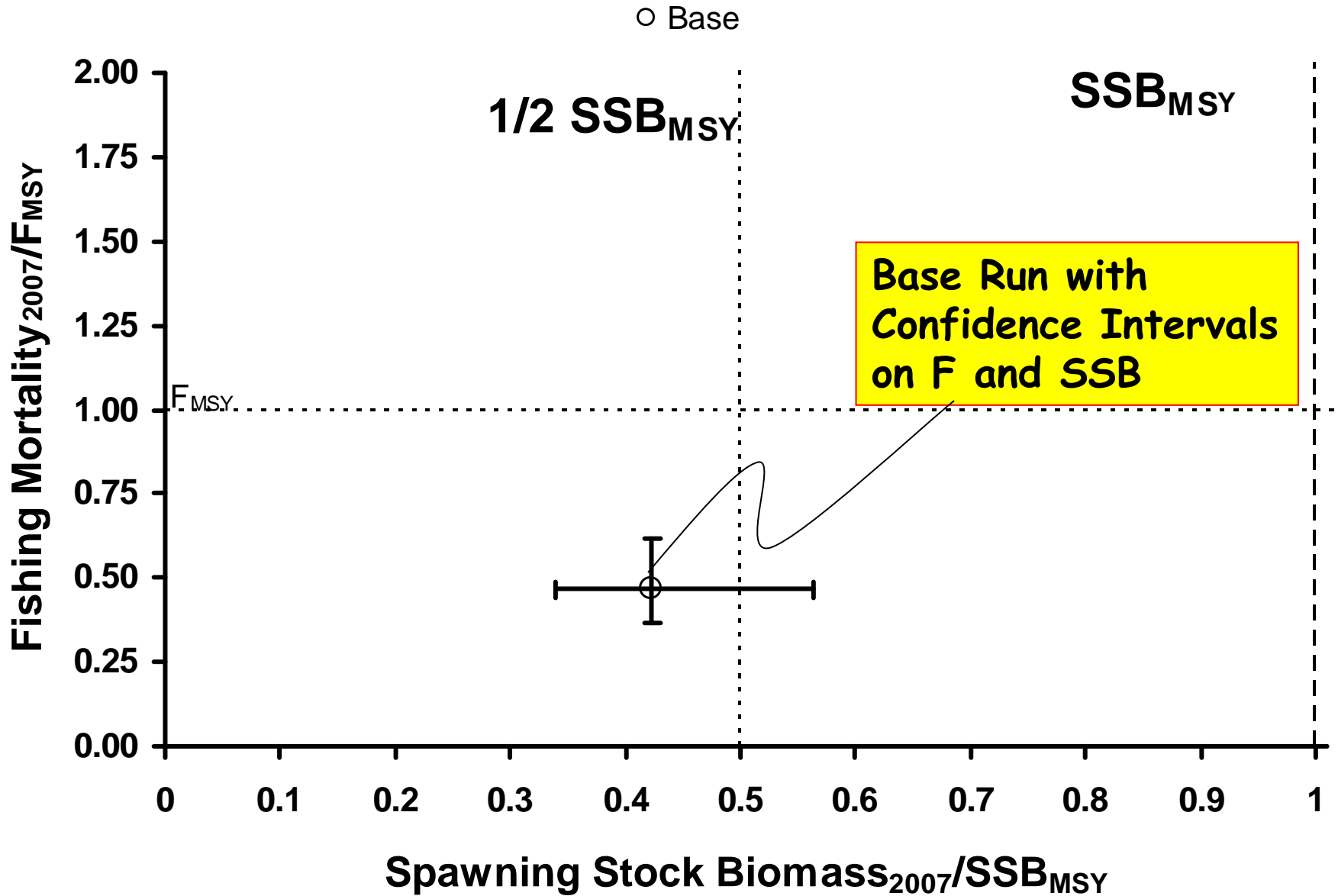
- Previously (GARM I & II) the pattern was reported qualitatively but not formally incorporated into stock status.
- In GARM III, retro pattern quantified (Mohn's rho)
- Objective methods of evaluating efficacy of break points were developed.
- Two Methods developed
  - Splitting the time series, pre and post 1994
  - Adjusting the current population estimates of F and SSB by the average Rho value
- Marked change from previous scientific advice.

**Table 4. Effects of Retrospective Adjustments on F and SSB. Shading indicates a change in status as a result of retro adjustment**

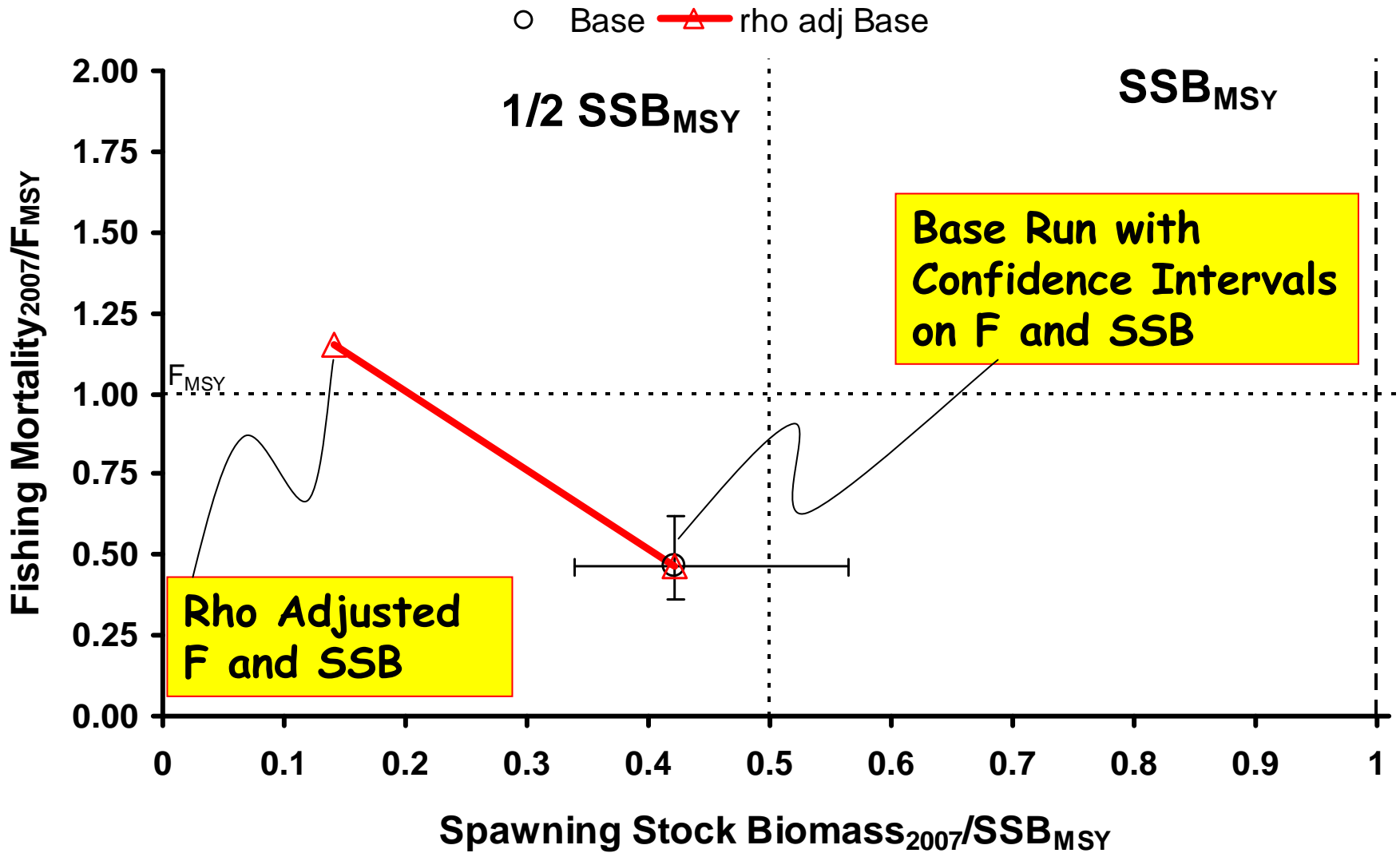
Species	Stock	2007 Fishing Mortality		
		Base	Final	Percent Change
Cod	GB	0.141	0.303	115.0
Yellowtail Flounder	GB	0.118	0.289	145.1
American Plaice	GB/GOM	0.065	0.094	44.9
Witch Flounder		0.143	0.292	103.9
Winter Flounder	GOM	0.115	0.283	146.6
Winter Flounder	SNE/MA	0.438	0.650	48.5
Redfish		0.005	0.007	36.8

Species	Stock	2007 Biomass		
		Base	Final	Percent Change
Cod	GB	25,377	17,672	-30.4
Yellowtail Flounder	GB	18,248	9,527	-47.8
American Plaice	GB/GOM	15,659	11,106	-29.1
Witch Flounder		7,354	3,434	-53.3
Winter Flounder	GOM	2,765	3,792	37.1
Winter Flounder	SNE/MA	4,565	3,368	-26.2
Redfish		234,609	172,380	-26.5

# Georges Bank Yellowtail Flounder

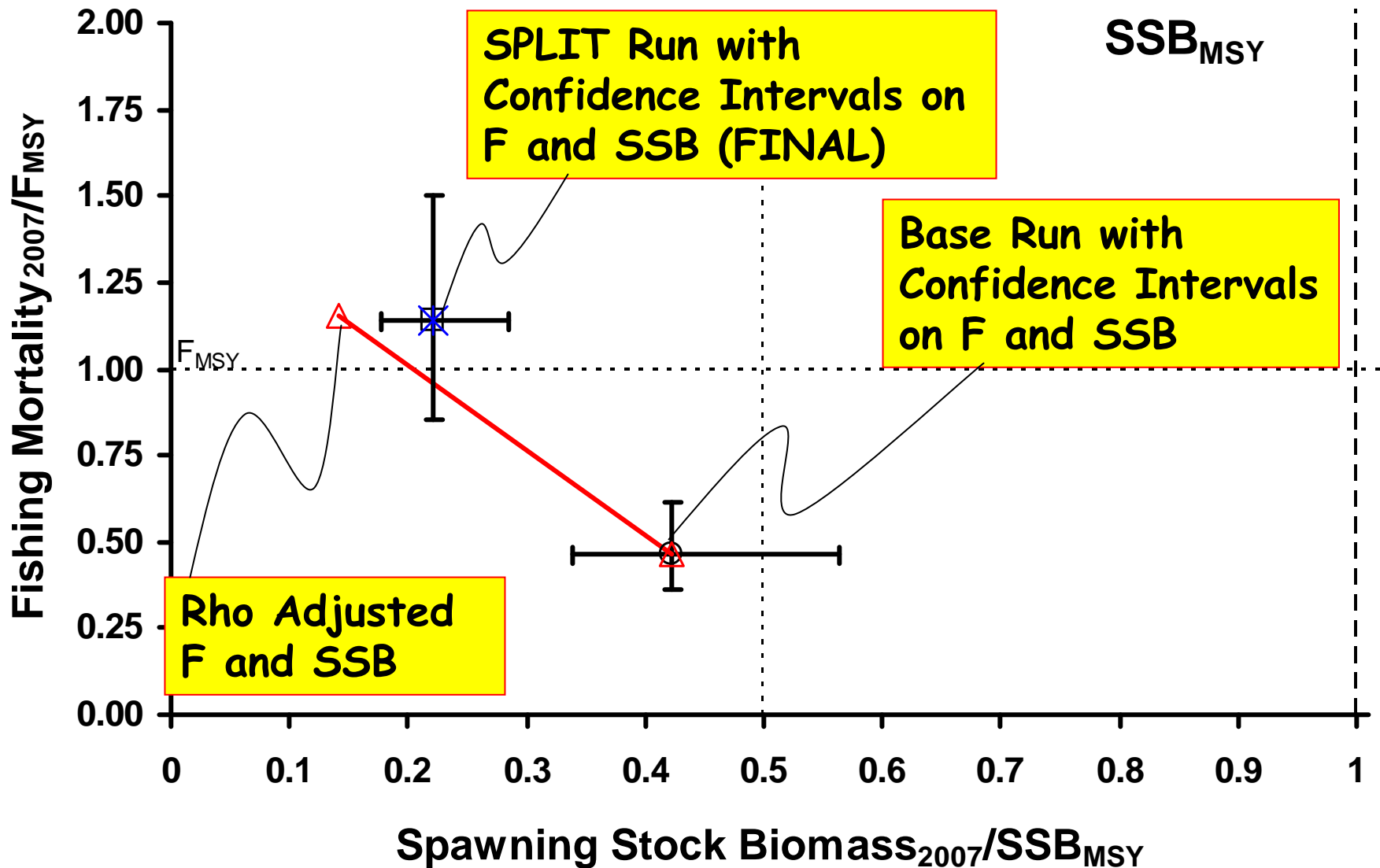


# Georges Bank Yellowtail Flounder



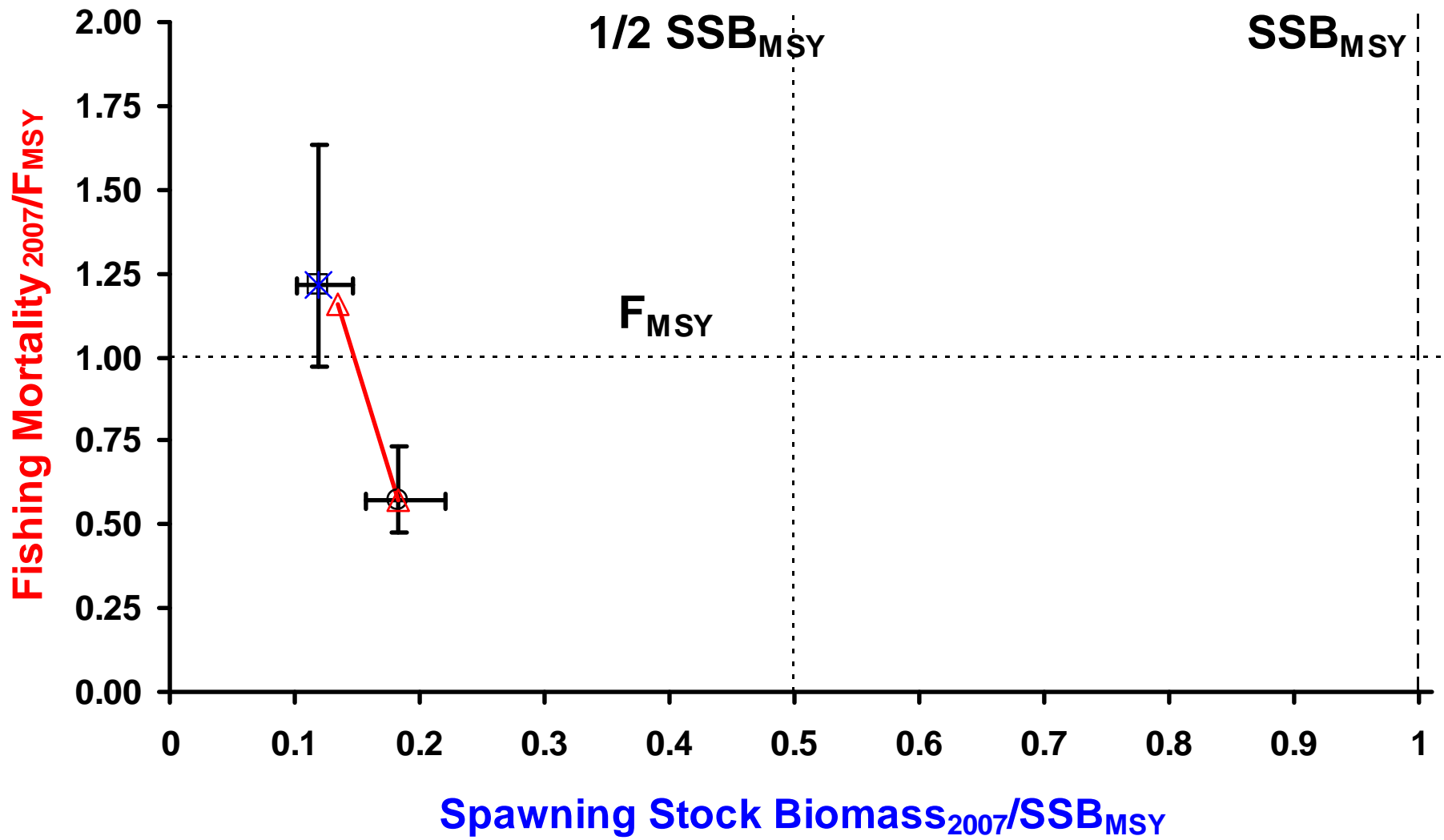
# Georges Bank Yellowtail Flounder

○ Base    —△ rho adj Base    □ Split    × Final

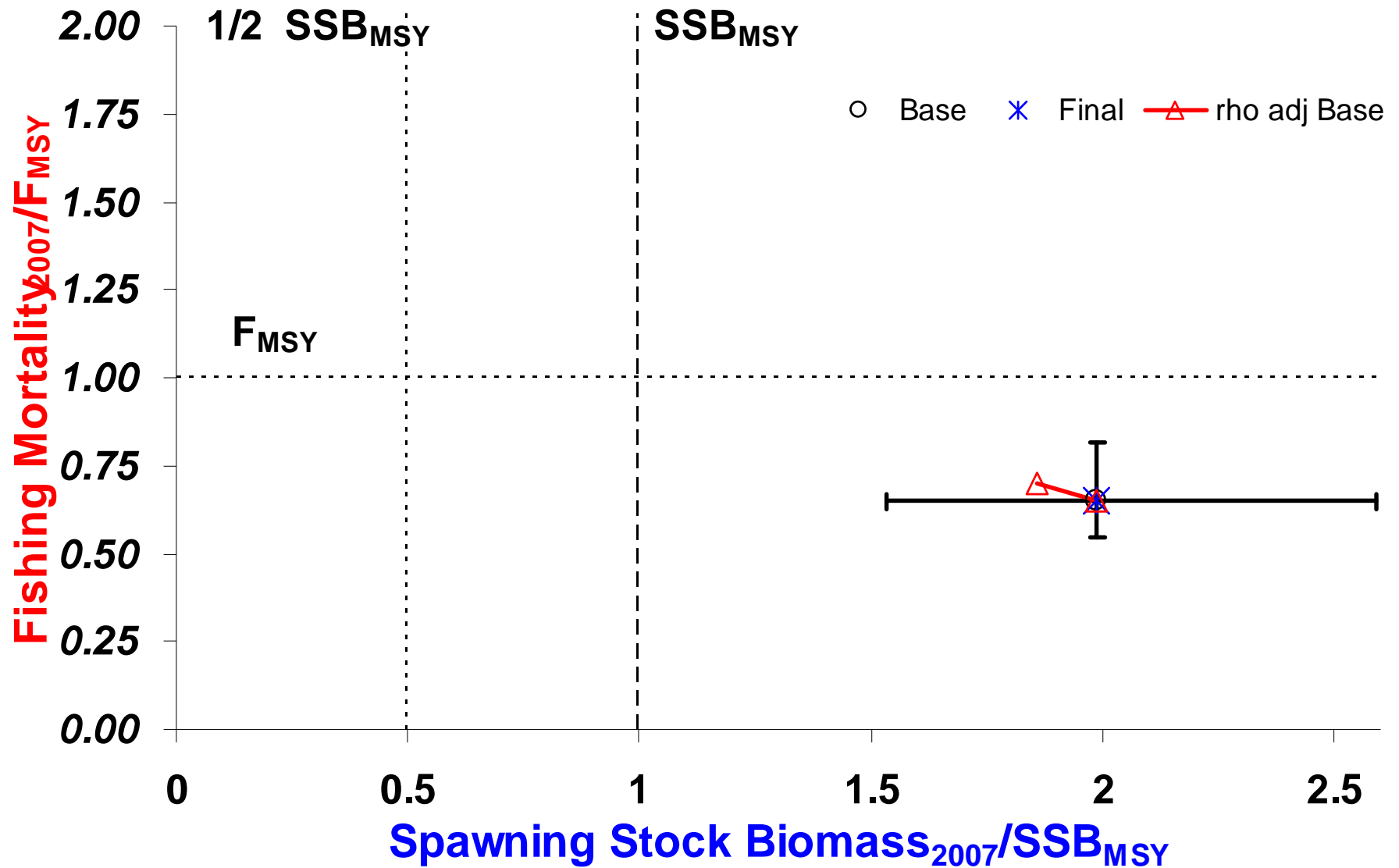


# Georges Bank Atlantic Cod

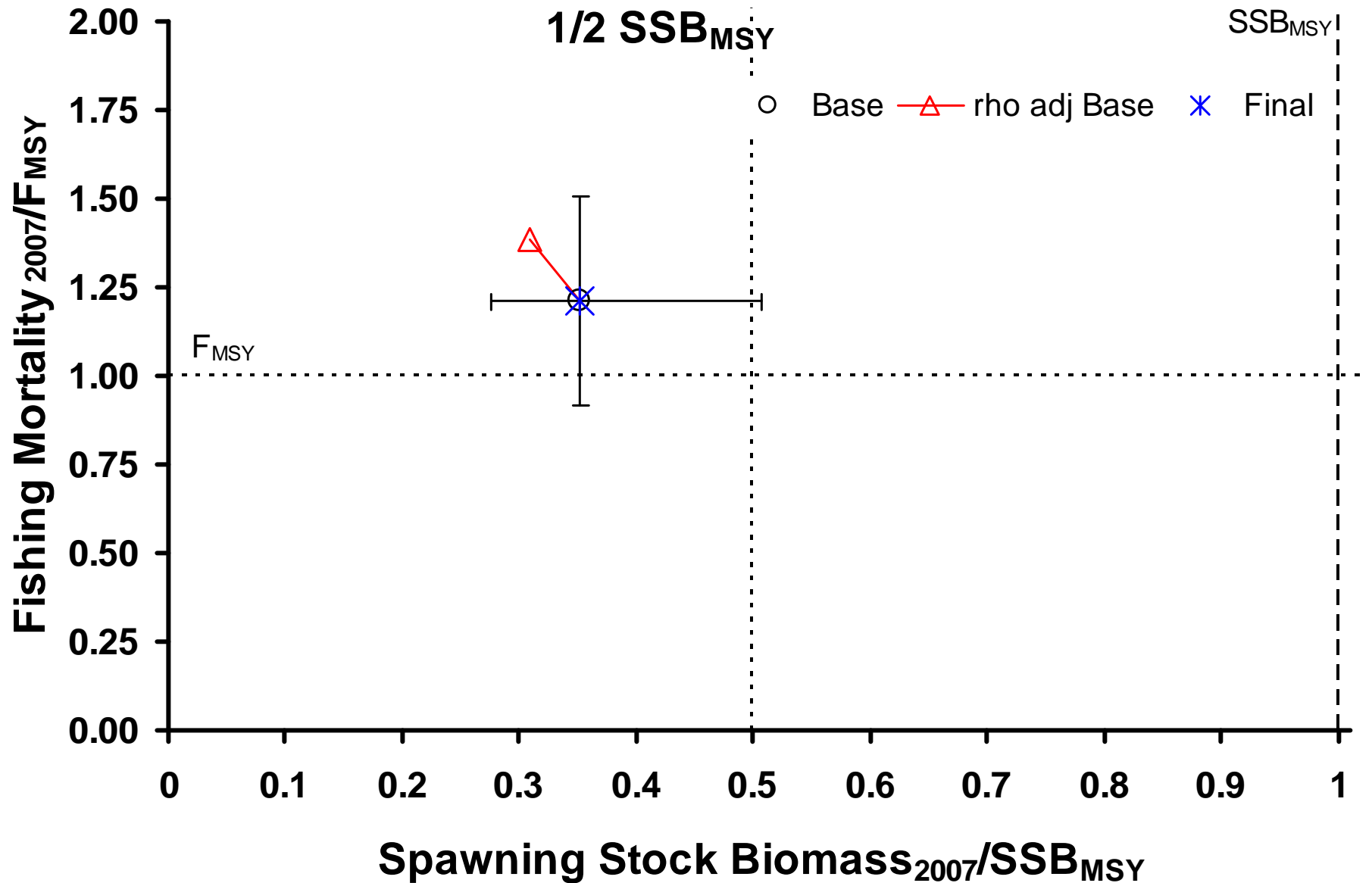
○ Base    —△ rho adj Base    □ Split    \* Final



# Georges Bank Haddock



# White hake



The GARM III 'Assessment Models' review identified four potential causes of retrospective patterns:

- (1) unrecorded change in catches;
- (2) change in natural mortality;
- (3) change in the abundance index catchability;
- (4) change in fishery selectivity.

It is important to emphasize that retrospective patterns adjustments **do not resolve the underlying problem**. Rather, further work on the nature and causes of the retrospective pattern is required to facilitate more explicit treatments of these patterns in future assessments.

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

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

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

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

## Relationship between biomass reference point, rebuild F, and rebuild strategies

- SSB ref pts based on split series of recruitment. i.e., Select  $R > SSB_{crit}$
- Rebuild F depends on current biomass, target biomass and number of years to rebuild
- When recruitment series is dependent on split series, then use two stage model for rebuilding.

# Individual Stock Assessments

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

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

# Panel Comments on Assessments (1)

- Question

- Was the assessment consistent with previously agreed standards and recommendations?

- Answer

- Panel considered that all 19 assessments were consistent with the previously agreed standards and recommendations made at the first three GARM III meetings.
- Where the previous reviews had recommended explorations of different assessment model assumptions, these were undertaken and provided to the Panel for its consideration.
- Comment on these is provided, as appropriate.

# Panel Comments on Assessments (2)

- Question

- Has the assessment incorporated new information appropriately?

- Answer

- The Panel also considered that the 19 assessments had incorporated the most recent information appropriately.
- Considerable attention was paid at the meeting to the examination of model fit to these data to ensure that the models recommended at the previous GARM III meetings remained valid.

Stock  
Area  
Map



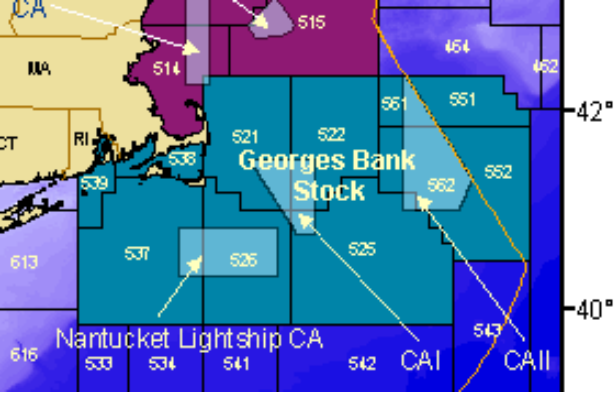
$\Delta F$	-
$\Delta B$	+

Overfished?	
Overfishing?	
$F_{REBUILD}$ (2026)	
C('09 Frebuild)	
Retro Adjust?	
SSB Cut Pt for R	
Model Type	

## X. Generic Stock

	GARM I	GARM III
$B_{msy}$ (mt)	Value from GARM I	GARM III <i>{~Biomass in 2007}</i>
$F_{MSY}$	Value from GARM I	GARM III <i>{~F in 2007}</i>
$MSY$ (mt)	Previous	Current

1. Special Comments on assessments



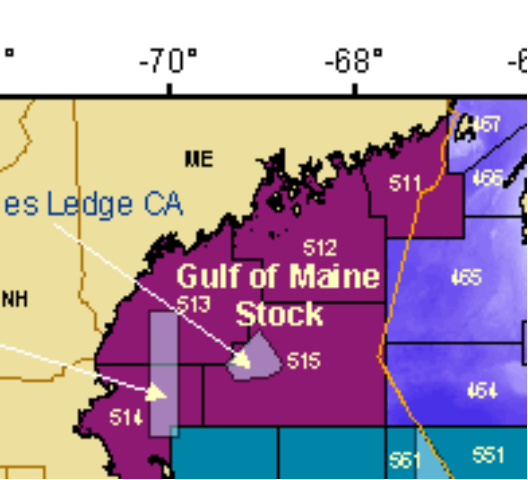
# A. Georges Bank Cod

$\Delta F$	-
$\Delta B$	+

	GARM I	GARM III
$B_{msy}$ (mt)	216,800	148,084 <b>{17,672}</b>
$F_{msy}$	0.18	0.25 <b>{0.30}</b>
$MSY$ (mt)	35,200	31,159

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (2026)	0.186
C('09 Frebuild)	3,722
Retro Adjust?	split
SSB Cut Pt for R	50,000
Model Type	VPA

1. Decline in average size of ages 5-8 in 7 of last 10 years
2. Last above ave. R in 1990.
3. Fully recruited F shifts from age 4, as seen in previous assessments, to fully recruited F at age 5



## F. Gulf of Maine Cod

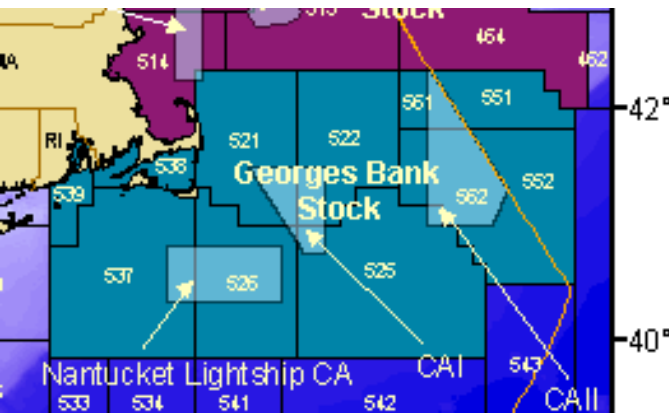
$\Delta F$	--
$\Delta B$	+++

	GARM I	GARM III
$B_{msy}$ (mt)	82,830	51,248 <span style="color: red;">{33,878}</span>
$F_{msy}$	0.23	0.24 <span style="color: red;">{0.456}</span>
MSY (mt)	16,660	10,014

Overfished?	NO
Overfishing?	YES
$F_{REBUILD}$ (2014)	0.281
C('09 Frebuild)	12,714
Retro Adjust?	NO
SSB Cut Pt for R	na
Model Type	VPA

1. Modest "dome-shaped" partial recruitment evident in VPA
2. Used tagging studies from GMRI, SMAST, NEC
3. Use 11+ age group
4. Comparisons with ASPM valuable

## B. Georges Bank Haddock

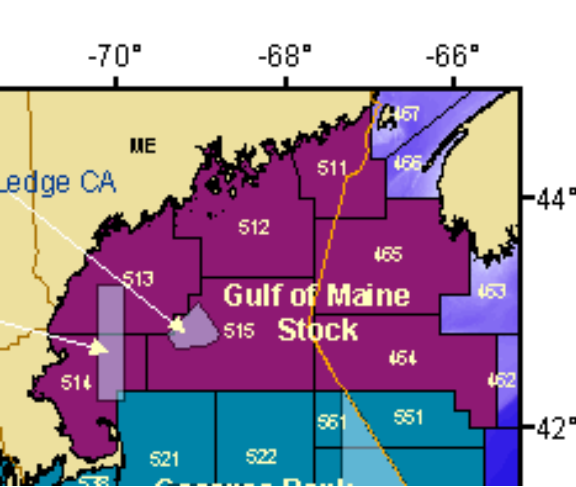


$\Delta F$	--
$\Delta B$	+++

	GARM I	GARM III
$B_{msy}$ (mt)	250,300	158,873 <b>{315,975}</b>
$F_{msy}$	0.26	0.35 <b>{0.23}</b>
$MSY$ (mt)	52,900	32,746

Overfished?	NO
Overfishing?	NO
$F_{REBUILD}$ (yr)	na
C('09 Frebuild)	na
Retro Adjust?	NO
SSB Cut Pt for R	75,000
Model Type	VPA

1. 1931 - 2007—Age structured data
2. Characterized by very strong year classes
3. Marked changes in average weight at size
4. High rates of discarding



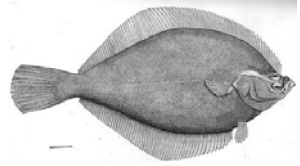
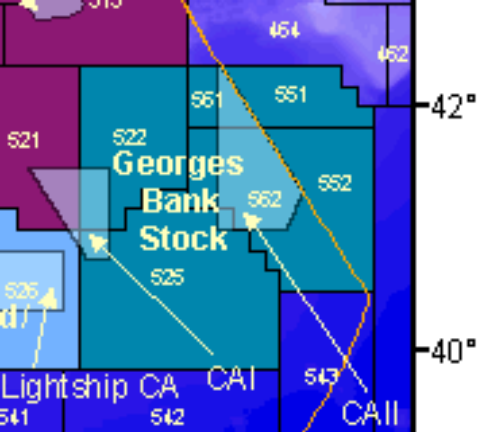
$\Delta F$	+
$\Delta B$	+++

## R. Gulf of Maine Haddock

	GARM I	GARM III
$B_{msy}$ (mt)	22.17 kg/tow	5,900 <b>{5,850}</b>
$F_{msy}$	0.23 c/i	0.43 <b>{0.35}</b>
<b>MSY</b> (mt)	5,100	1,360

Overfished?	NO
Overfishing?	NO
$F_{REBUILD}$ (yr)	na
C('09 Frebuild)	na
Retro Adjust?	NO
SSB Cut Pt for R	3,000
Model Type	VPA

1. Formerly Index based, Now VPA
2. High  $F_{msy}$  is based on low partial recruitment by age.
3. Slower growth rate and increases in mesh are likely causes
4. Increases in recreational landings.



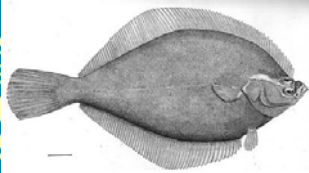
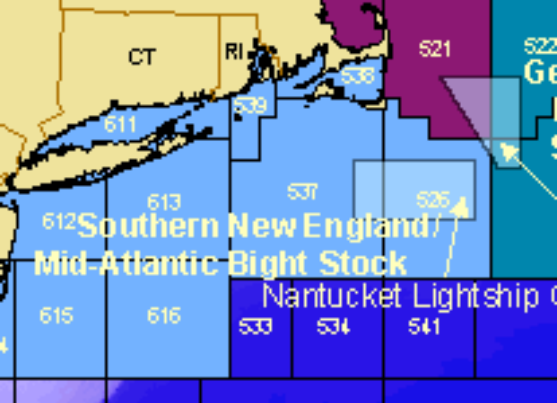
$\Delta F$	---
$\Delta B$	-

## C. Georges Bank Yellowtail flounder

	GARM I	GARM III
$B_{msy}$ (mt)	58,800	43,200 <span style="color: red;">{9,527}</span>
$F_{msy}$	0.25	0.25 <span style="color: red;">{0.289}</span>
$MSY$ (mt)	12,900	9,400

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (2014)	0.107
C('09 Frebuild)	2,114
Retro Adjust?	split
SSB Cut Pt for R	5,000
Model Type	VPA

1. "Major Change" Model
2. 1963-72 hindcast Recruits
3. Strong 2005 year class
4. Excluded 2008 DFO survey due to large tow.



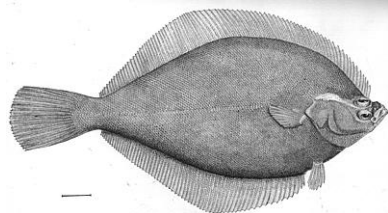
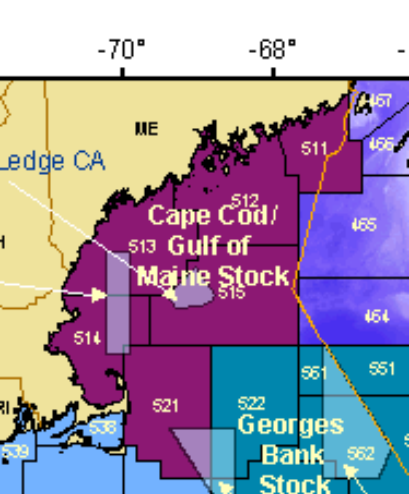
## D. SNE & Mid Atlantic Yellowtail flounder

$\Delta F$	--
$\Delta B$	+++

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (2014)	0.08
C('09 Frebuild)	425
Retro Adjust?	NO
SSB Cut Pt for R	5,000
Model Type	VPA

	GARM I	GARM III
$B_{msy}$ (mt)	69,500	27,400 <span style="color: red;">{3,508}</span>
$F_{msy}$	0.26	0.25 <span style="color: red;">{0.413}</span>
$MSY$ (mt)	14,200	6,100

1. Has been at low abundance level for extended number of years but 2005 yearclass moderately strong
  2. Use of Industry Based Survey
  3. Movement among stock areas



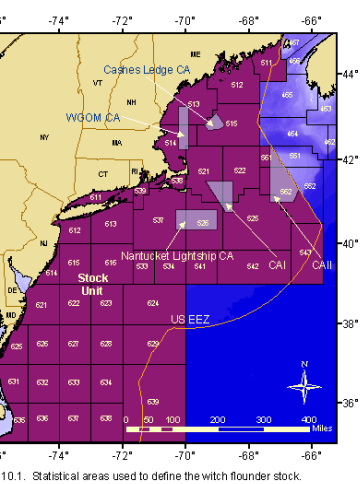
$\Delta F$	--
$\Delta B$	+++

## E. Cape Cod/Gulf of Maine Yellowtail flounder

	GARM I	GARM III
$B_{msy}$ (mt)	12,600	7,790 <b>{1,922}</b>
$F_{msy}$	0.17	0.24 <b>{0.414}</b>
$MSY$ (mt)	2,300	1,720

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (2023)	0.238
C('09 Frebuild)	904
Retro Adjust?	NO
SSB Cut Pt for R	na
Model Type	VPA

1. Hindcast estimates of Recr '77-84
2. 2005 Yearclass moderately strong
3. Movements among areas complicate assessment



10.1. Statistical areas used to define the witch flounder stock.



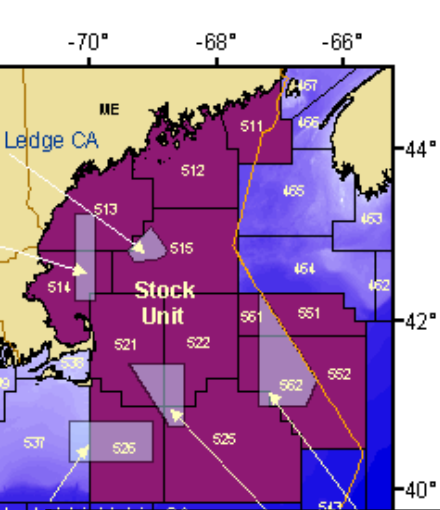
$\Delta F$	++
$\Delta B$	--

## G. Witch flounder

	GARM I	GARM III
$B_{msy}$ (mt)	25,248	11,447 {3,434}
$F_{msy}$	0.23	0.20 {0.29}
MSY (mt)	4,375	2,352

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (2018*)	0.194
C('09 Frebuild)	896
Retro Adjust?	split
SSB Cut Pt for R	na
Model Type	VPA

1. Major declines in size at age
2. Discards small component
3. 2003-05 recruitments above average
4. No support for inverse S-R relation



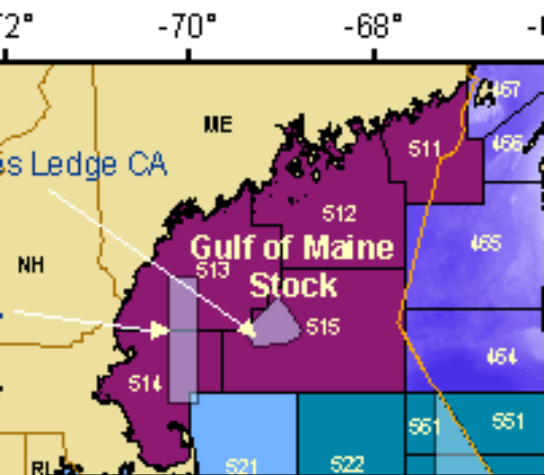
$\Delta F$	--
$\Delta B$	+

## H. American plaice

	GARM I	GARM III
$B_{msy}$ (mt)	28,600	21,940 <b>{11,106}</b>
$F_{msy}$	0.17	0.19 <b>{0.09}</b>
$MSY$ (mt)	4,900	4,011

Overfished?	NO
Overfishing?	NO
$F_{REBUILD}$ (2014)	0.208
C('09 Frebuild)	3,499
Retro Adjust?	Rho Adj
SSB Cut Pt for R	na
Model Type	VPA

1. GB vs GOM sub stocks?
2. F in 2007 lowest in time series.
3. Biomass increasing since 2002.
4. 2004 and '05 yearclasses near or above average



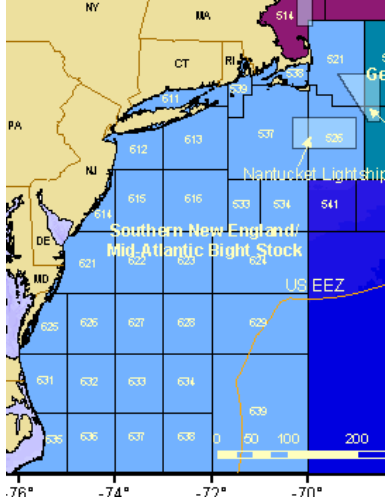
$\Delta F$	+++
$\Delta B$	--

# I. Gulf of Maine Winter Flounder

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (2018*)	0.275
C('09 Frebuild)	376
Retro Adjust?	split
SSB Cut Pt for R	na
Model Type	VPA

	GARM I	GARM III
$B_{msy}$ (mt)	4,100	3,792 {1,100}
$F_{msy}$	0.43	0.28 {0.417}
MSY (mt)	1,500	917

1. Comparative models: VPA vs SCALE
2. Difficulties with model fit—tracking year classes, conflicting trends in surveys
3. Current trend in population was "very troubling"



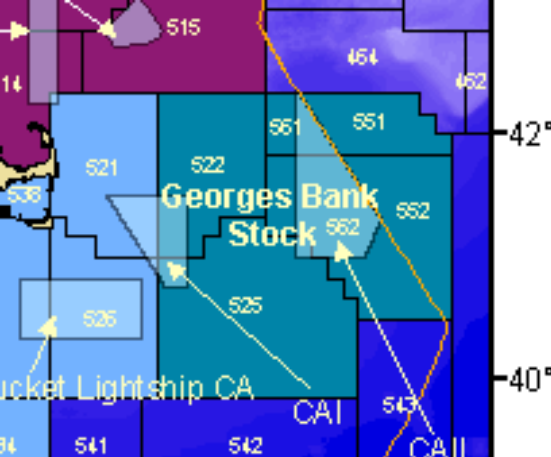
## J. SNE and Mid Atlantic Winter Flounder

$\Delta F$	+++
$\Delta B$	--

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (2014)	0
C('09 Frebuild)	0
Retro Adjust?	split
SSB Cut Pt for R	5,700
Model Type	VPA

	GARM I	GARM III
$B_{msy}$ (mt)	30,100	38,761 <b>{3,368}</b>
$F_{msy}$	0.32	0.25 <b>{0.649}</b>
$MSY$ (mt)	10,600	9,742

1. Large retrospective pattern
2. Very low recent recruitment.
3. Population biomass unlikely to increase without recruitment pulse



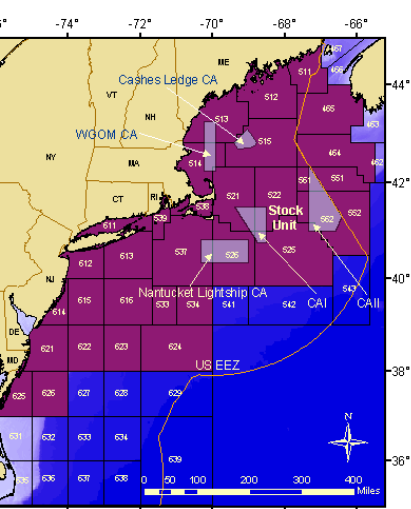
$\Delta F$	--
$\Delta B$	--

## K. Georges Bank Winter Flounder

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (2018*)	0.254
C('09 Frebuild)	980
Retro Adjust?	NO
SSB Cut Pt for R	na
Model Type	VPA

	GARM I	GARM III
$B_{msy}$ (mt)	9,400	16,000 <b>{4,964}</b>
$F_{msy}$	0.32	0.26 <b>{0.28}</b>
MSY (mt)	3,000	3,500

1. Change from Surplus Production model to VPA
2. Lack of tracking of year classes in surveys and catch
3. Consider stock complex



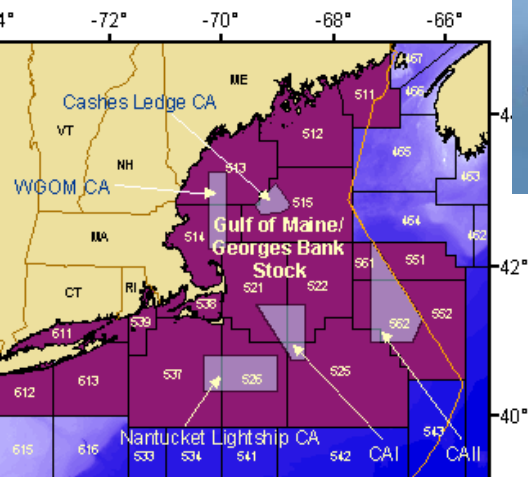
## *L. White hake*

$\Delta F$	--
$\Delta B$	-

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (yr)	0.078
C('09 Frebuild)	2,200
Retro Adjust?	NO
SSB Cut Pt for R	na
Model Type	SCAA

	GARM I	GARM III
$B_{msy}$ (mt)	14,700	56,254 <b>{19,800}</b>
$F_{msy}$	0.29	0.13 <b>{0.15}</b>
$MSY$ (mt)	4,234	5,800

1. Assessment Change: Index model to forward projecting model ASPM
2. GARM III is age-based assessment. GARM I was index with sizes >60 cm
3. Extensive comparisons btw alternative models



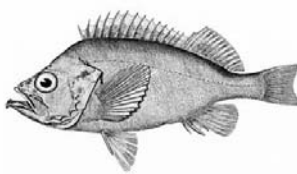
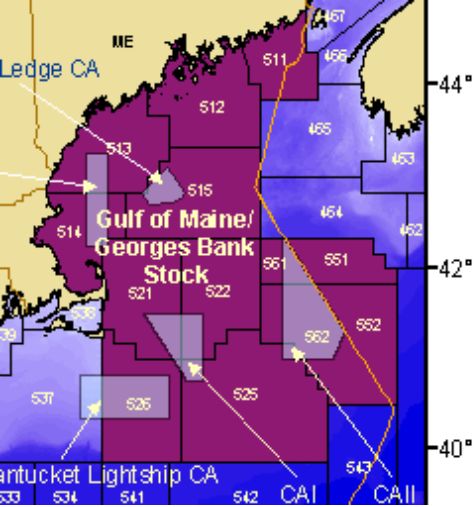
# M. Pollock

$\Delta F$	+++
$\Delta B$	--

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (yr)	5.31 c/i
C('09 Frebuild)	8003
Retro Adjust?	NO
SSB Cut Pt for R	na
Model Type	AIM

	GARM I	GARM III
$B_{msy}$ (mt)	3.0 kg/tow	2.0 kg/tow {0.754 kg/tow}
$F_{msy}$	5.88 c/i	5.66 c/I {10.975}
MSY (mt)	17,640	11,320

Still an index-based assessment  
 Shared resource with Canada.  
 Scheduled for TRAC



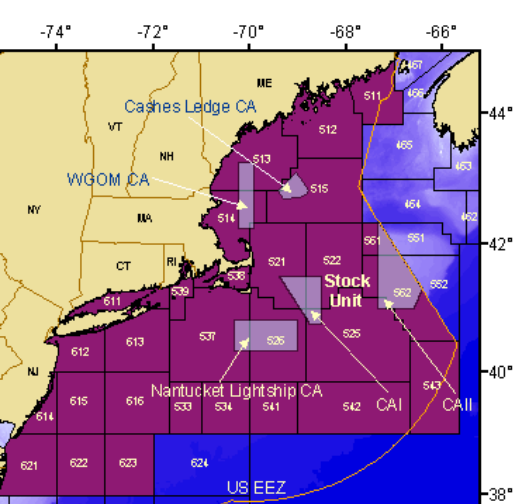
## N. Acadian redfish

$\Delta F$	+++
$\Delta B$	-

	GARM I	GARM III
$B_{msy}$ (mt)	236,700	271,000 <b>{172,342}</b>
$F_{msy}$	0.04	0.04 <b>{0.007}</b>
$MSY$ (mt)	8,200	10,139

Overfished?	NO
Overfishing?	NO
$F_{REBUILD}$ (2051)	0.038
C('09 Frebuild)	8,631
Retro Adjust?	Rho Adj
SSB Cut Pt for R	na
Model Type	ASAP

1. Very low  $F$
2. Imprecise estimation of Biomass
3. Sensitivity analysis to  $M$ .  
 $M=0.05$  selected
4. Strong year classes in '90's



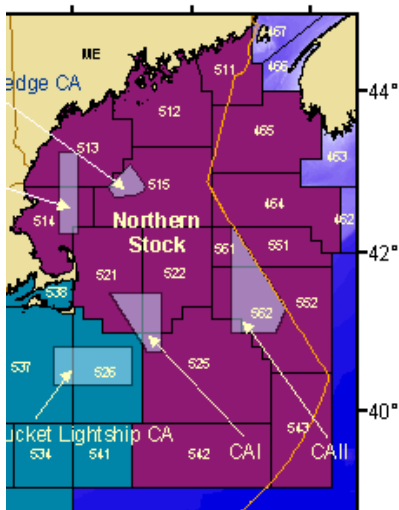
# O. Ocean pout

$\Delta F$	+++
$\Delta B$	--

	Current	Revised
$B_{msy}$ (mt)	4.9 kg/tow	4.94 kg/tow <b>{0.48}</b>
$F_{msy}$	0.31 c/I	0.76 c/I <b>{0.38}</b>
$MSY$ (mt)	1,500	3,754

Overfished?	YES
Overfishing?	NO
$F_{REBUILD}$ (2014)	na
C('09 Frebuild)	na
Retro Adjust?	na
SSB Cut Pt for R	na
Model Type	Index

1. Weak relation between survey trends and catches
2. No rebound from longterm low levels.
3. Possible depensatory state may preclude rebuilding.



## *P. Northern Windowpane Flounder*

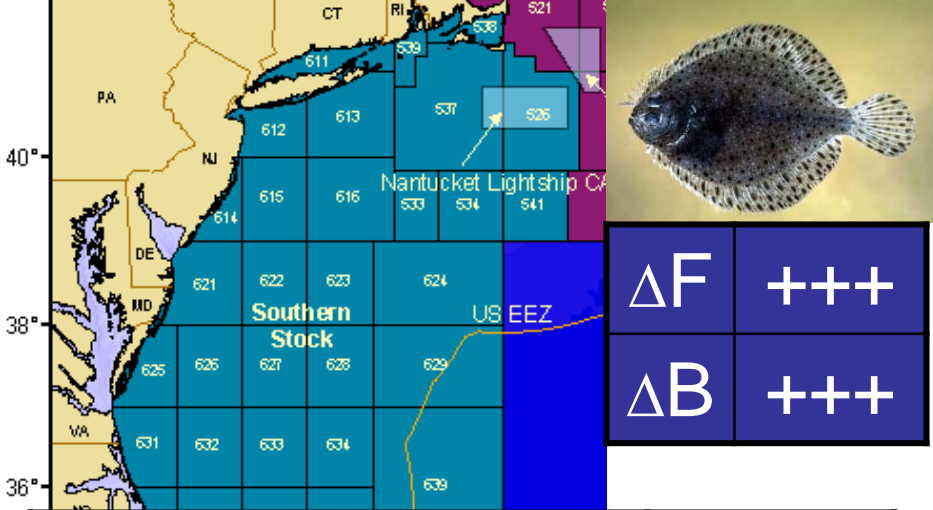
$\Delta F$	+++
$\Delta B$	---

	GARM I	GARM III
$B_{msy}$ (mt)	0.94 kg/tow	1.40 kg/tow <b>{0.24}</b>
$F_{msy}$	1.11 c/i	0.50 c/I <b>{1.96}</b>
$MSY$ (mt)	1,000	700

Overfished?	YES
Overfishing?	YES
$F_{REBUILD}$ (yr)	na
C('09 Frebuild)	na
Retro Adjust?	na
SSB Cut Pt for R	na
Model Type	AIM

1. Primarily a discard fishery
2. High uncertainty of index assessment—rapid drop in abundance in survey estimates.
3. Recommend NOT computing Frebuild

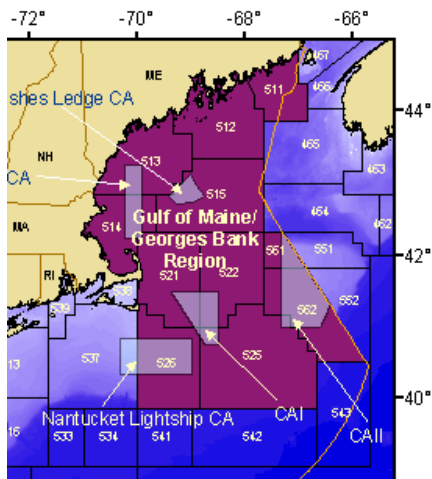
## Q. Southern Windowpane Flounder



Overfished?	NO
Overfishing?	YES
$F_{REBUILD}$ (yr)	na
C('09 Frebuild)	na
Retro Adjust?	na
SSB Cut Pt for R	na
Model Type	AIM

	GARM I	GARM III
$B_{msy}$ (mt)	0.92 kg/tow	0.34 kg/tow <b>{0.19}</b>
$F_{msy}$	0.98 c/i	1.47 c/I <b>{1.85}</b>
$MSY$ (mt)	900	500

1. Primarily a discard fishery
2. High uncertainty of index assessment—rapid drop in abundance in survey estimates.
3. Recommend NOT computing Frebuild



$\Delta F$	na
$\Delta B$	na

## S. Atlantic Halibut

	GARM I	GARM III
$B_{msy}$ (mt)	5,400	49,000 <b>{1,300}</b>
$F_{msy}$	0.06	0.07 <b>{0.065}</b>
MSY (mt)	300	3,500

Overfished?	YES
Overfishing?	NO
$F_{REBUILD}$ (2056)	0.044
C('09 Frebuild)	68
Retro Adjust?	na
SSB Cut Pt for R	Na
Model Type	Repl Yld

1. Based on Replacement yield model of Butterworth.
2. Estimate of  $F_{0.1}$  was used as  $F_{msy}$  proxy.
3. Limited survey data.
4. Evidence of migration into Canadian waters

# Ecosystem Terms of Reference

- Use the most recent data and BRP estimates to update the ecosystem results with respect to:
  - production potential of the fishery based on food chain processes and aggregate yield from the ecosystem and
  - comment on aggregate single stock yield projections in relation to overall ecosystem production

# Ecosystem Conclusions

- Sum of MSY for GARM species is 149 kt (145 kt in text)
- Ratio of current total GARM stock biomass to  $B_{msy}$  is 0.65 ( esp. GB haddock)
- Total biomass ( $t/km^2$ ) in US NE shelf=14.62
- Ave of 9 temporal and boreal systems =15.2  $t/km^2$ .
- Comparison of MSY as sum of single stock assessments (tot=148 kt) with aggregate surplus production model (tot=139 kt) are favorable.

# Panel Conclusions: Ecosystems

- “It was noted that the sum of the GARM single species targets is close to the multispecies estimate of system productivity considering only those stocks”
- “The ecosystem work was recognized as being innovative, but too early in its development for implementation.”
- “Notwithstanding this, efforts are encouraged that explore how broader ecosystem considerations could be used to complement and enhance single stock management in the Northeast Region.”



## Major Conclusions (1)

Improved basis for estimation of stock status,  
uncertainty and forecasting

Reductions in average weights at age and changes in  
selectivity patterns.

6 stocks below  $F_{msy}$ ; 13 above  $F_{msy}$

Biomass  $> \frac{1}{2} B_{msy}$  for 6 stocks; 13 below  $B_{msy}$

Major improvements in GB and GOM haddock  
biomass, GOM cod, SNE yellowtail, CC/GOM  
yellowtail, southern windowpane.

Strong yearclasses in GB yellowtail flounder (2005),  
haddock (2003), GOM cod (2005)



## Major Conclusions (2)

Deterioration in status for pollock, witch, GB winter, GOM winter, Northern windowpane. (May need rebuilding programs extending to 2018-20)

SNE winter flounder at extremely low level; unlikely to rebuild by 2014.

Large reductions in  $F$  relative to  $F_{msy}$  but overfishing still occurring for 13 stocks

Retrospective patterns quantified and pragmatic measures for estimating current status developed.

Close agreement between sum of individual stock assessments and ecosystem based approaches.  
Overall productivity lower than in GARM I.

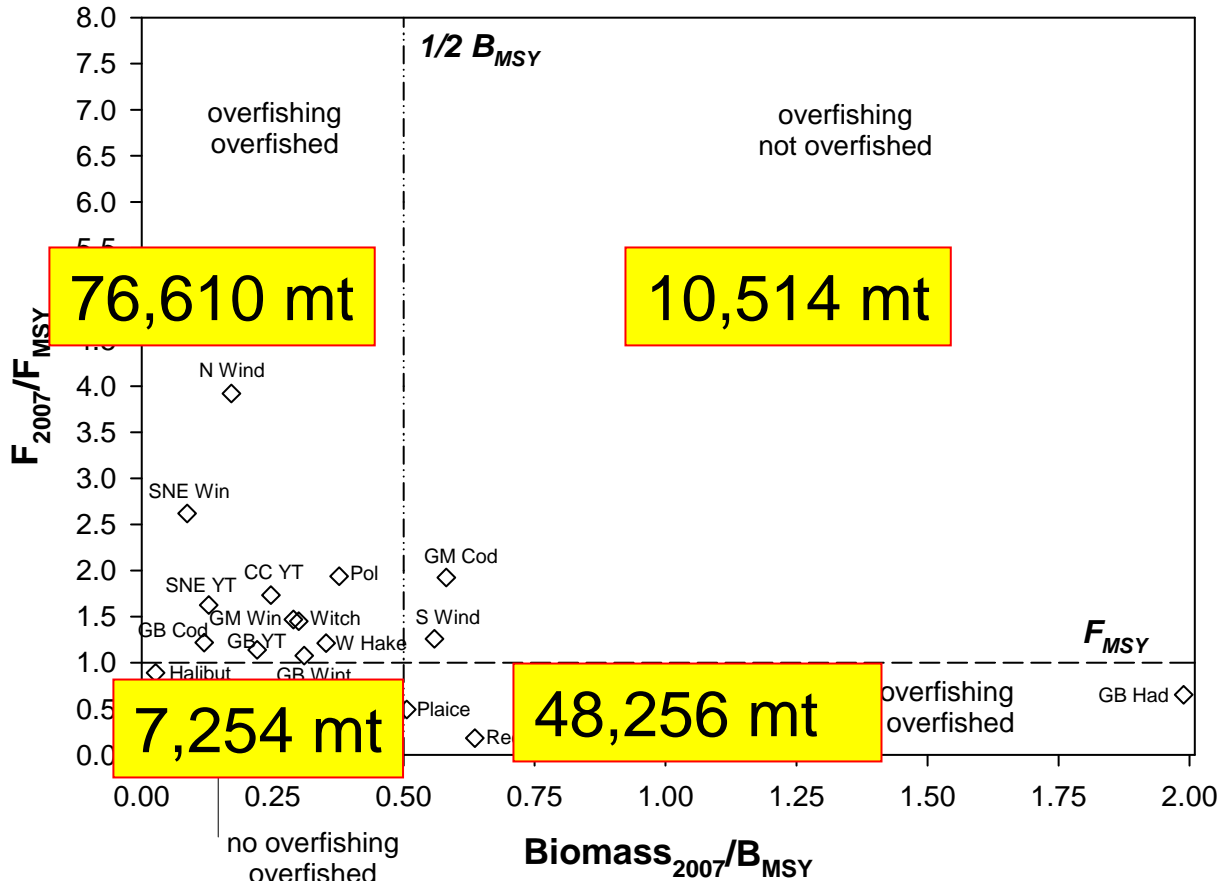
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FISHERIES  
SERVICE**



END

# Cumulative MSY (mt) of stocks in each quadrant. (2007, GARM III)

## 2007 Groundfish Stock Status



1. Stocks that constitute 58,770 mt of MSY are now above  $1/2 B_{MSY}$
2. Low fishing rates on plaice, GB and GOM haddock have resulted in improved biomass.
3. Average magnitude of overfishing has declined.
4. Important to remember that 2007 estimates are corrected for retrospective pattern; the 2004 estimates were not adjusted.

Major improvements to modeling approaches for GOM Haddock, GB Winter Flounder, GOM Winter flounder, white hake, redfish, and halibut. (See Table 5)

<b>Species</b>	<b>Stock</b>	<b>GARM II</b>	<b>GARM III</b>
Cod	GB	VPA	VPA
Cod	GOM	VPA	VPA
Haddock	GB	VPA	VPA
Haddock	GOM	AIM	VPA
Yellowtail Flounder	GB	VPA	VPA
Yellowtail Flounder	SNE/MA	VPA	VPA
Yellowtail Flounder	CC/GOM	VPA	VPA
American Plaice	GB/GOM	VPA	VPA
Witch Flounder		VPA	VPA
Winter Flounder	GB	ASPIC	VPA
Winter Flounder	GOM	VPA	VPA & SCALE
Winter Flounder	SNE/MA	VPA	VPA
Redfish		RED	SCAA
White Hake	GB/GOM	ASPIC & AIM	SCAA
Pollock	GB/GOM	AIM	AIM
Windowpane Flounder	GOM/GB	AIM	AIM
Windowpane Flounder	SNE/MA	AIM	AIM
Ocean Pout		Index Method	Index Method
Altantic Halibut		None	Replacement Yield

		<b>GARM II</b>		
Species	Stock	S_R Model	Bmsy or proxy	Fmsy or proxy
Cod	GB	Parametric	BH SSBmsy	BH Fmsy
Cod	GOM	Parametric	BH SSBmsy	BH Fmsy
Haddock	GB	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
Haddock	GOM	Equilibrium point	Fall RV msy (5100t) Frep (0.23)	Rel F at Rep
Yellowtail Flounder	GB	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
Yellowtail Flounder	SNE/MA	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
Yellowtail Flounder	CC/GOM	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
American Plaice	GB/GOM	Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
Witch Flounder		Non-parametric	SSB/R (F40%MSP) avg R	F 40% MSP
Winter Flounder	GB	NA	SP Bmsy	SP Fmsy
Winter Flounder	GOM	Parametric	BH SSBmsy	BH Fmsy
Winter Flounder	SNE/MA	Parametric	BH SSBmsy	BH Fmsy
Redfish		Non-parametric	SSB/R (F50%MSP) avg R	F 50% MSP
White Hake	GB/GOM	Equilibrium point	SP Bmsy	Rel F at Rep
Pollock	GB/GOM	Equilibrium point	Fall RV	Rel F at Rep
Windowpane Flounder	GOM/GB	Equilibrium point	Fall RV	Rel F
Windowpane Flounder	SNE/MA	Equilibrium point	Fall RV	Rel F at Rep
Ocean Pout		Equilibrium point	Spring RV	Rel F at Rep
Altantic Halibut		NA	External: MSY/F0.1	Proxy F 0.1 MSY (300t)

		<b>GARM III</b>		
Species	Stock	S_R Model	Bmsy or proxy	Fmsy or proxy
Cod	GB	Non-parametric	SSB/R (40%MSP)	F40%MSP
Cod	GOM	Non-parametric	SSB/R (40%MSP)	F40%MSP
Haddock	GB	Non-parametric	SSB/R (40%MSP)	F40%MSP
Haddock	GOM	Non-parametric	SSB/R (40%MSP)	F40%MSP
Yellowtail Flounder	GB	Non-parametric	SSB/R (40%MSP)	F40%MSP
Yellowtail Flounder	SNE/MA	Non-parametric	SSB/R (40%MSP)	F40%MSP
Yellowtail Flounder	CC/GOM	Non-parametric	SSB/R (40%MSP)	F40%MSP
American Plaice	GB/GOM	Non-parametric	SSB/R (40%MSP)	F40%MSP
Witch Flounder		Non-parametric	SSB/R (40%MSP)	F40%MSP
Winter Flounder	GB	Non-parametric	SSB/R(40%MSP)	F40%MSP
Winter Flounder	GOM	Non-parametric	SSB/R (40%MSP)	F40%MSP
Winter Flounder	SNE/MA	Non-parametric	SSB/R (40%MSP)	F40%MSP
Redfish		Non-parametric	SSB/R (50%MSP)	F50%MSP
White Hake	GB/GOM	Non-parametric	SSB/R (40%MSP)	F40%MSP
Pollock	GB/GOM	Visual interpretation	External	Rel F at replacement
Windowpane Flounder	GOM/GB	Visual interpretation	External	Rel F at replacement
Windowpane Flounder	SNE/MA	Visual interpretation	External	Rel F at replacement
Ocean Pout		Visual interpretation	External	Rel F at replacement
Altantic Halibut		Implied	Internal	F0.1

		<b>GARM II</b>			
<i>Species</i>	<i>Stock</i>	<i>Model</i>	<i>Bmsy or proxy (mt)</i>	<i>Fmsy or proxy</i>	<i>MSY (mt)</i>
Cod	GB	VPA	216,800	0.18	35,200
Cod	GOM	VPA	82,800	0.23	16,600
Haddock	GB	VPA	250,300	0.26	52,900
Haddock	GOM	Landings & Survey	22.17 kg/tow	0.23c/i	5,100
Yellowtail Flounder	GB	VPA	58,800	0.25	12,900
Yellowtail Flounder	SNE/MA	VPA	69,500	0.26	14,200
Yellowtail Flounder	CC/GOM	VPA	12,600	0.17	2,300
American Plaice	GB/GOM	VPA	28,600	0.17	4,900
Witch Flounder		VPA	25,250	0.23	4,375
Winter Flounder	GB	ASPIC	9,400	0.32	3,000
Winter Flounder	GOM	VPA	4,100	0.43	1,500
Winter Flounder	SNE/MA	VPA	30,100	0.32	10,600
Redfish		RED	236,700	0.04	8,200
White Hake	GB/GOM	AIM	14,700	0.29	4,200
Pollock	GB/GOM	AIM	3.00 kg/tow	5.88 c/i	17,600
Windowpane Flounder	GOM/GB	AIM	0.94 kg/tow	1.11 c/i	1,000
Windowpane Flounder	SNE/MA	AIM	0.92 kg/tow	0.98 c/i	900
Ocean Pout		Index Method	4.9 kg/tow	0.31 c/i	1,500
Altantic Halibut		None	5,400	0.06	300
		<b>GARM III</b>			
<i>Species</i>	<i>Stock</i>	<i>Model</i>	<i>Bmsy or proxy (mt)</i>	<i>Fmsy or proxy</i>	<i>MSY (mt)</i>
Cod	GB	VPA	148,084	0.25	31,159
Cod	GOM	VPA	58,248	0.24	10,014
Haddock	GB	VPA	158,873	0.35	32,746
Haddock	GOM	VPA	5,900	0.43	1,360
Yellowtail Flounder	GB	VPA	43,200	0.25	9,400
Yellowtail Flounder	SNE/MA	VPA	27,400	0.25	6,100
Yellowtail Flounder	CC/GOM	VPA	7,790	0.24	1,720
American Plaice	GB/GOM	VPA	21,940	0.19	4,011
Witch Flounder		VPA	11,447	0.20	2,352
Winter Flounder	GB	VPA	16,000	0.26	3,500
Winter Flounder	GOM	VPA	3,792	0.28	917
Winter Flounder	SNE/MA	VPA	38,761	0.25	9,742
Redfish		ASAP	271,000	0.04	10,139
White Hake	GB/GOM	SCAA	56,254	0.13	5,800
Pollock	GB/GOM	AIM	2.00 kg/tow	5.66 c/i	11,320
Windowpane Flounder	GOM/GB	AIM	1.40 kg/tow	0.50 c/i	700
Windowpane Flounder	SNE/MA	AIM	0.34 kg/tow	1.47 c/i	500
Ocean Pout		Index Method	4.94 kg/tow	0.76 c/i	3,754
Altantic Halibut		Replacement Yield	49,000	0.07	3,500

The retrospective pattern adjustments changed the status of four of the seven stocks (Table 4). For both GB cod and GB yellowtail, the adjustment resulted in the stocks being classified as experiencing overfishing (both stocks had already classified as being overfished, which did not change with the adjustments). However, the retrospective pattern adjustments for witch and GOM winter flounder resulted in these stocks being classified as both experiencing overfishing and being overfished. The status of the other three stocks (plaice, SNE/MA winter flounder, and redfish) did not change due to the adjustments.

Retrospective pattern adjustments were approached in two ways.

The first involved an analysis to determine whether a split in the survey time series would either reduce or eliminate the retrospective pattern. This split survey approach had previously been recommended by the GARM III 'Assessment Models' review as a way to adjust for the retrospective pattern in the Georges Bank yellowtail flounder assessment, and thus the same approach was attempted on the other stocks.

The second approach was an adjustment to the population numbers at age in the terminal year in the VPA based upon a measure of the age-specific retrospective pattern during the past seven years.

The split survey approach was used to adjust for retrospective patterns in five of the seven assessments where it was deemed necessary. Only for plaice and redfish was the second approach used, although both approaches produced similar levels of adjustment.

Of the 14 groundfish stocks assessed in GARM III using an analytical assessment model, seven stocks exhibited retrospective patterns that were considered severe enough that an adjustment to the population numbers and fishing mortality in 2007 was deemed necessary before determining current stock status and subsequently conducting projections. The largest retrospective patterns were observed in GB yellowtail, GOM winter flounder, and SNE/MA winter flounder. Moderate retrospective patterns occurred in GB cod, plaice, witch, and redfish.