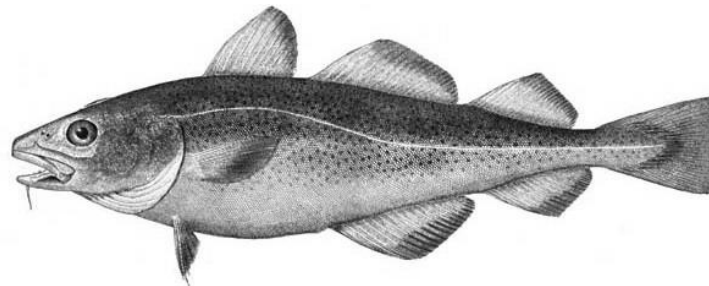




**NOAA**  
**FISHERIES**

# An overview of the 2014 update of the Gulf of Maine cod stock assessment

*Northeast Fisheries Science Center  
National Marine Fisheries Service  
166 Water St. Woods Hole, MA 02543*



Presentation to NEFMC  
*Hyannis, MA  
October 1, 2014*

# *Objectives*

- Overview of assessment findings
- Emphasize signals in primary data
- Compare model results with earlier assessments
- Compare Biological Reference Points
- Summarize stock status

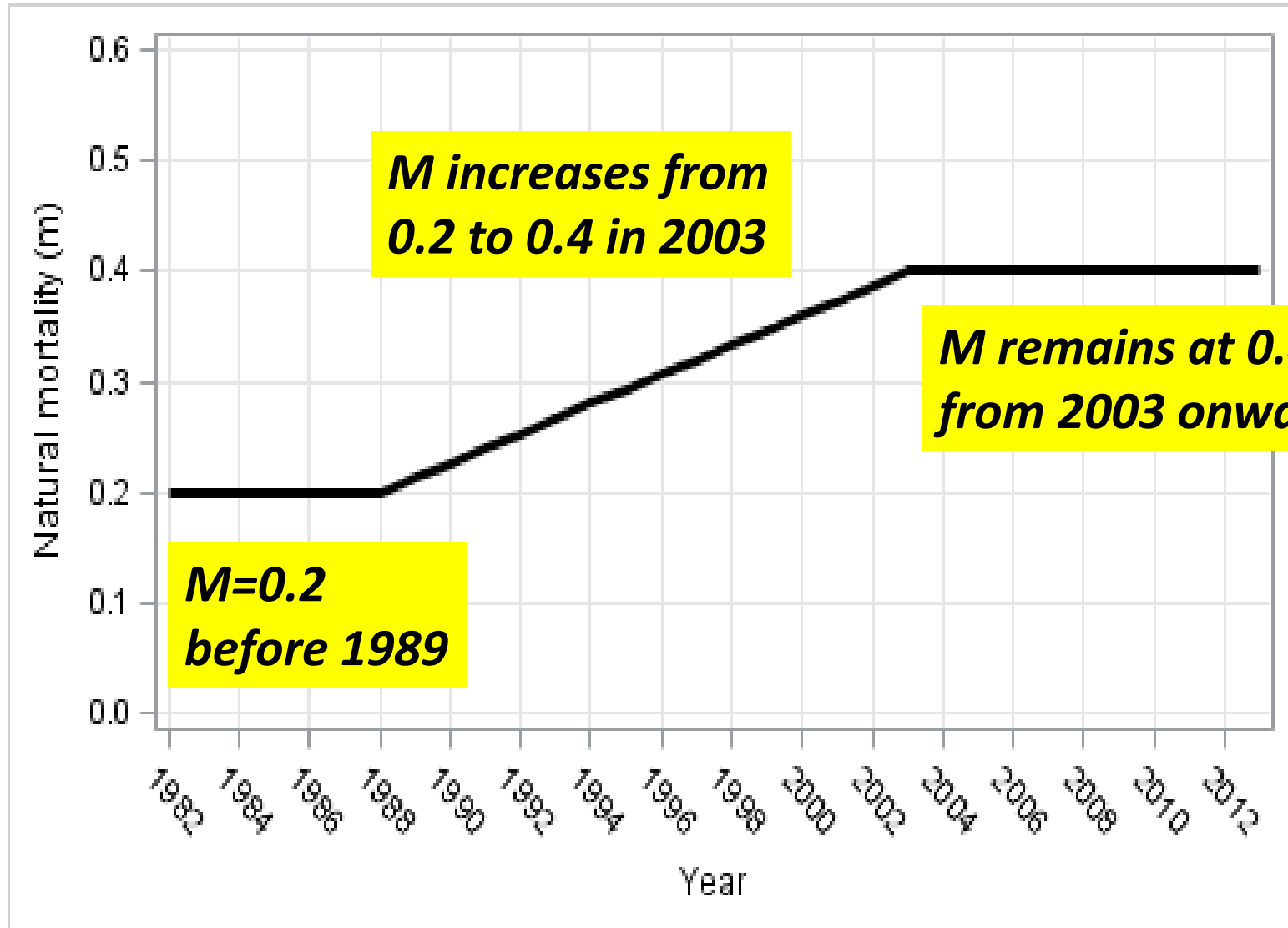
# *Major Findings of Assessment*

- Stock is overfished and overfishing is occurring
- 2013 SSB is estimated between 2,000-2,500 mt
  - (3-4% of  $SSB_{MSY}$ )
- Fishing mortality  $> 1.2$ 
  - (6-7 times greater than  $F_{MSY}$ )

# *What was done?*

- *Update of the SARC 55 assessment*
  - Retained 1982-2011 data inputs from SARC 55,
  - Updated model with 2012-2013 fishery catches and survey data
  - No changes to model configuration
- *Two assessment models were accepted at SARC 55*
  - M=0.2 and M-ramp models
  - No major changes in model diagnostics from SARC 55
    - Residual pattern in survey indices present at SARC 55 no longer exists in the updated model(s)
    - Retrospective error in both models

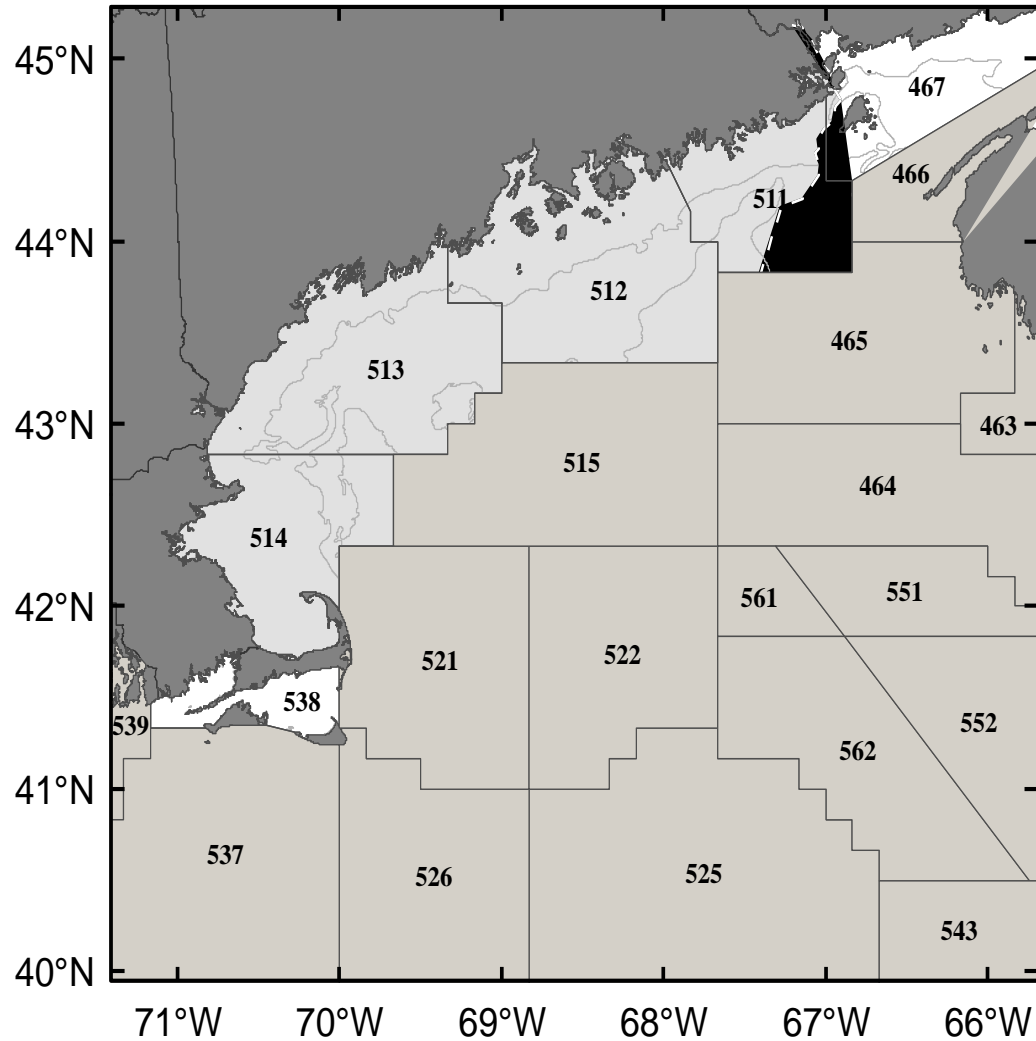
# *What is the M-ramp Model?*



# *Key Trends in Assessment Data Quality*

- In response to quota reductions commercial landings have continued to decline.
  - Higher proportion of commercial landings matched directly to VTR data. Assuming VTR area fished is reported correctly—higher confidence in stock landings
- **Commercial discards have declined.** CV on total discards  $< 0.3$ . Increase in CVs in 2013 (reduction in number of observed trips)
- **Recreational catches have declined**
  - CVs are low (0.07 – 0.25)
- **Survey indices have remained at same [low] levels or declined**
  - CVs  $< 0.3$

# *Statistical Areas for GOM Cod*



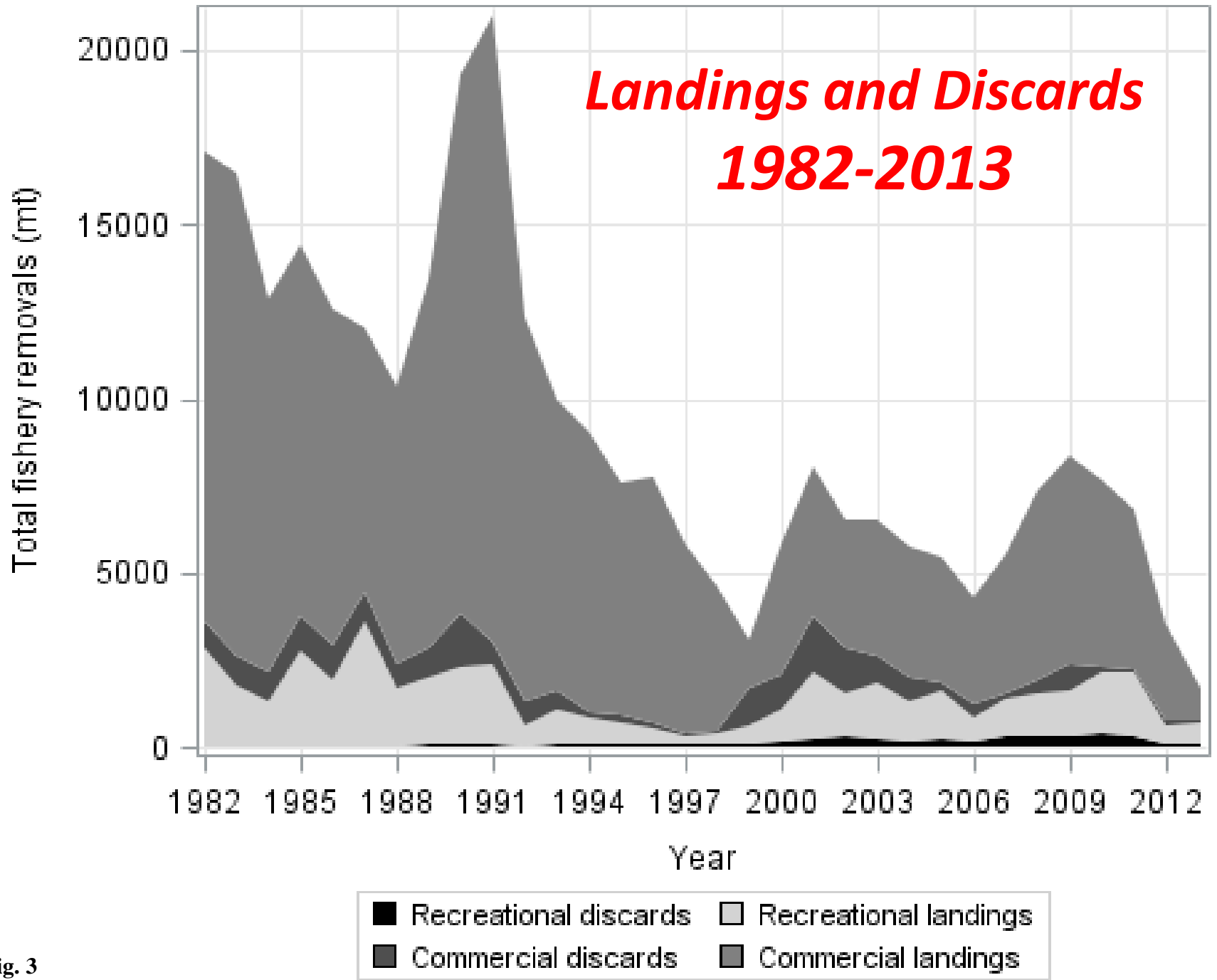


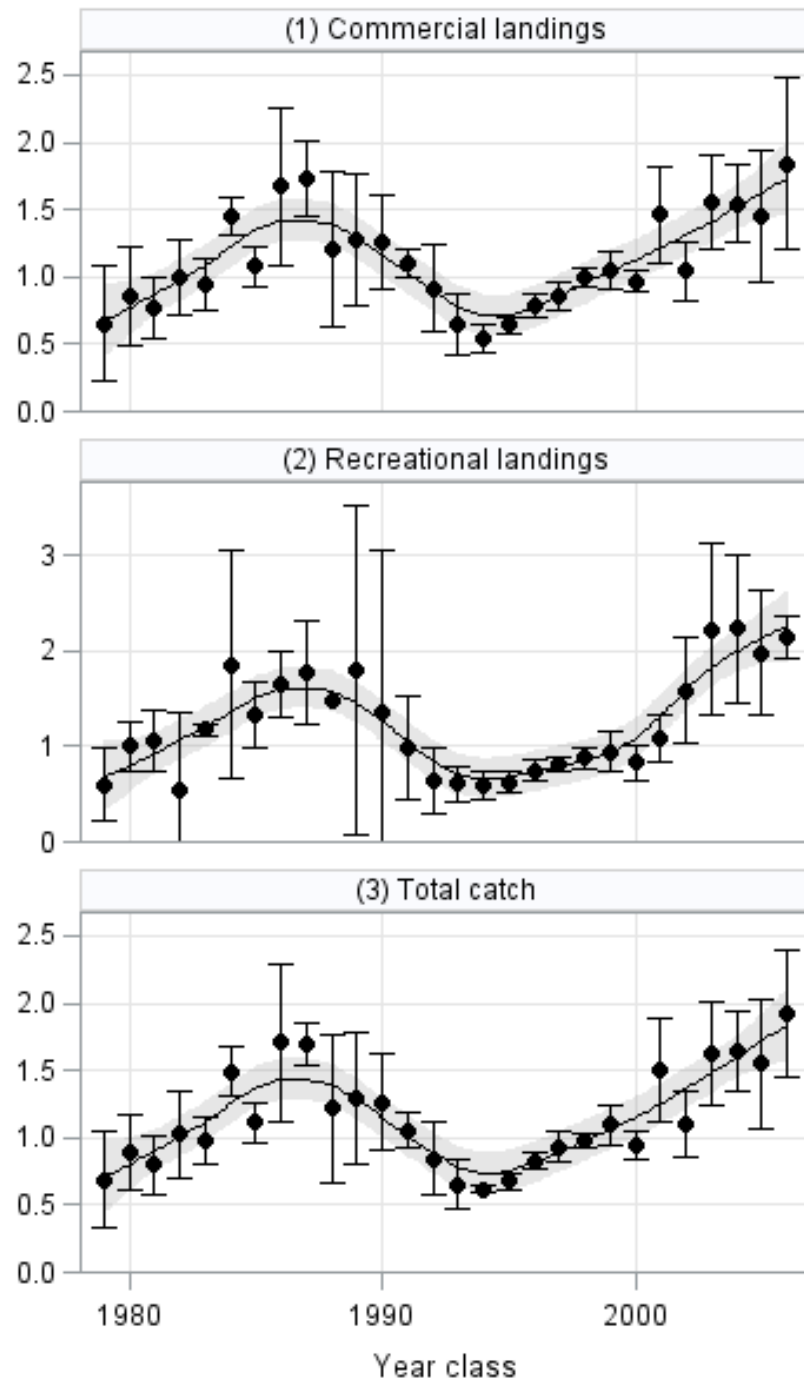
Fig. 3



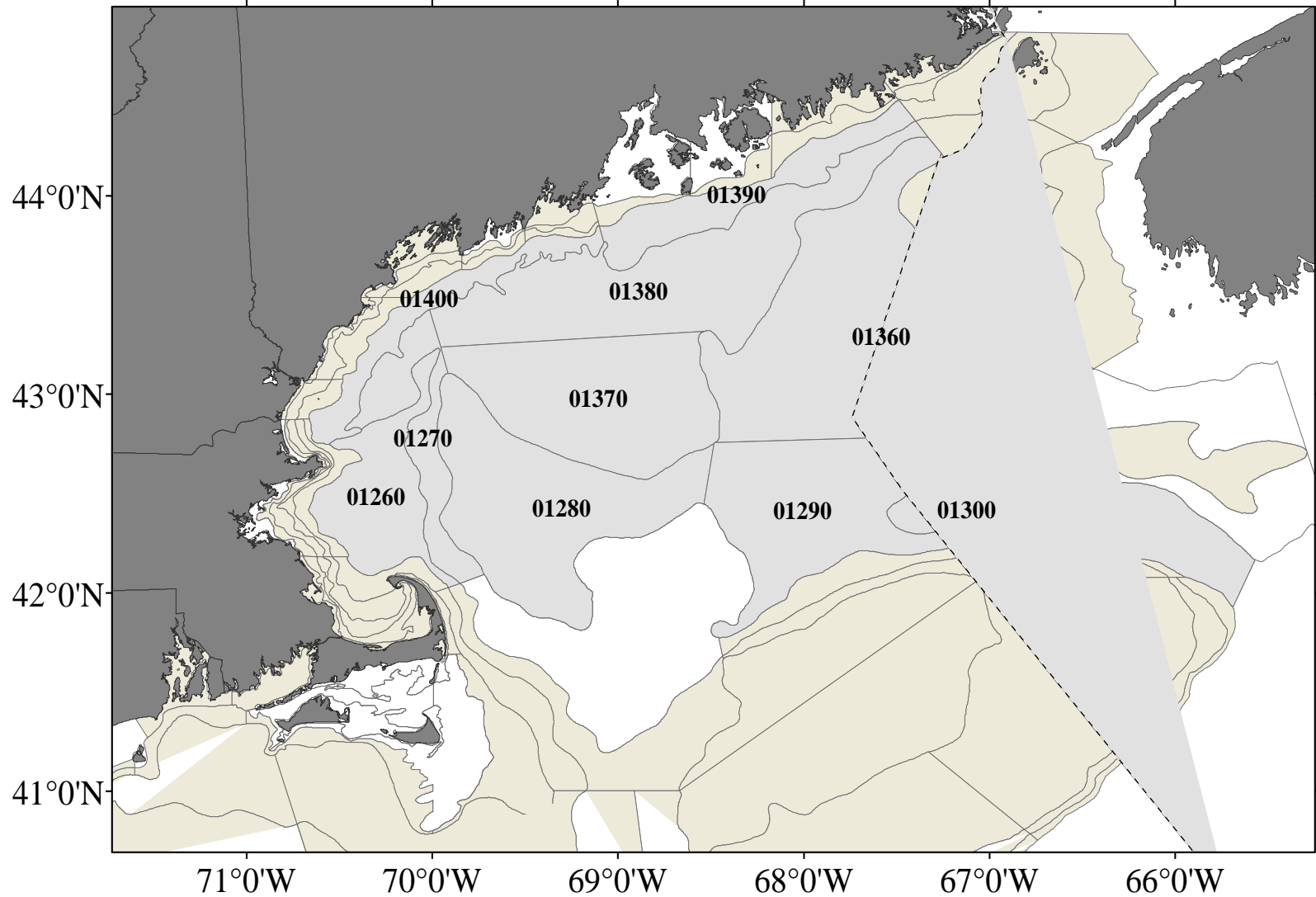
# Landings

- Total mortality ( $Z$ ) by year class derived from catch at age estimates for commercial, recreational, and total catch.
- Complementary trends in truncation of age distribution.

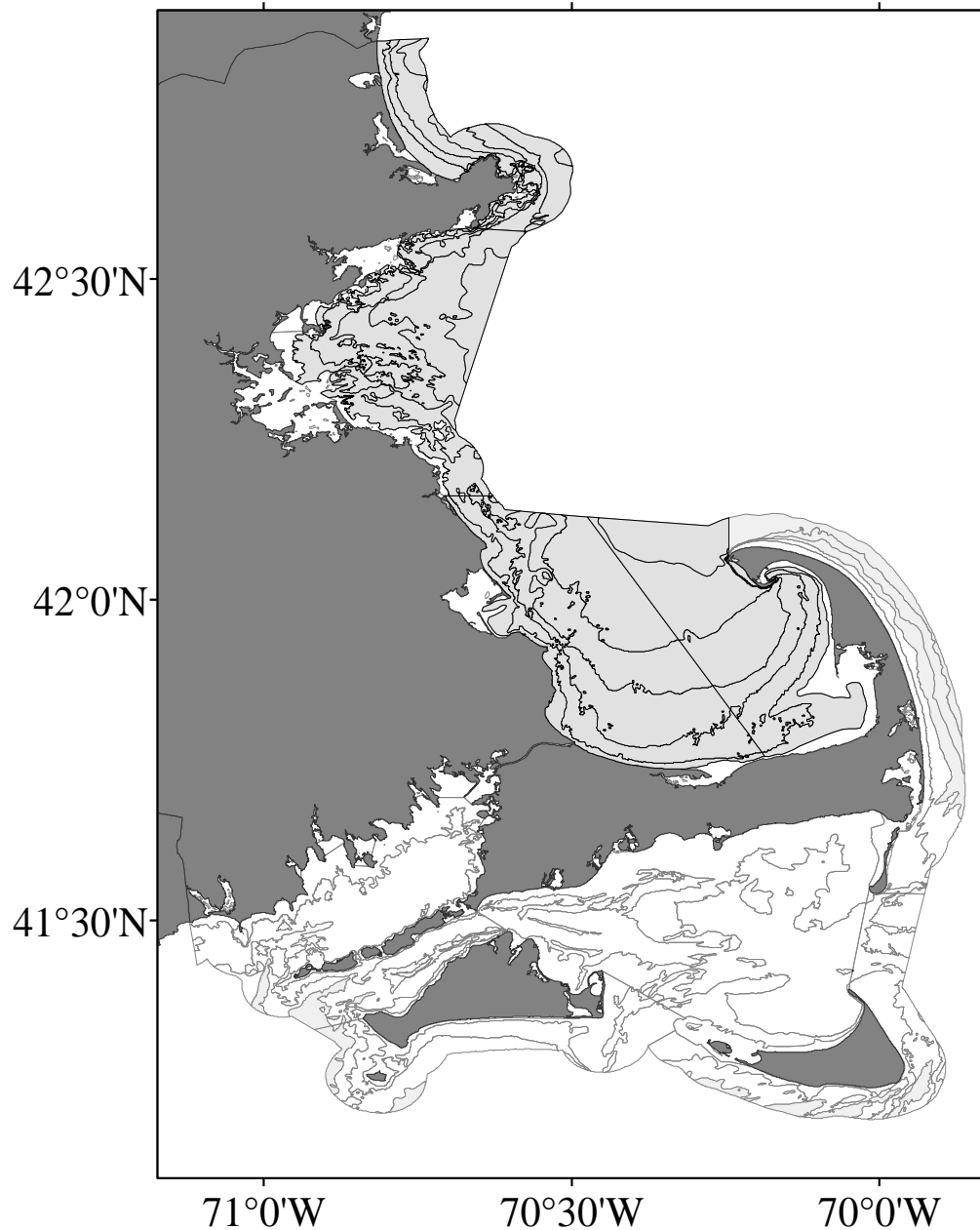
Fully Recruited Total Mortality ( $Z$ )



# *Survey Strata for GOM Cod*



***MADMF  
Bottom Trawl  
Survey Strata***



- **Survey indices (kg/tow) for NEFSC Spring, NEFSC Fall, and MADMF Spring bottom trawl surveys.**

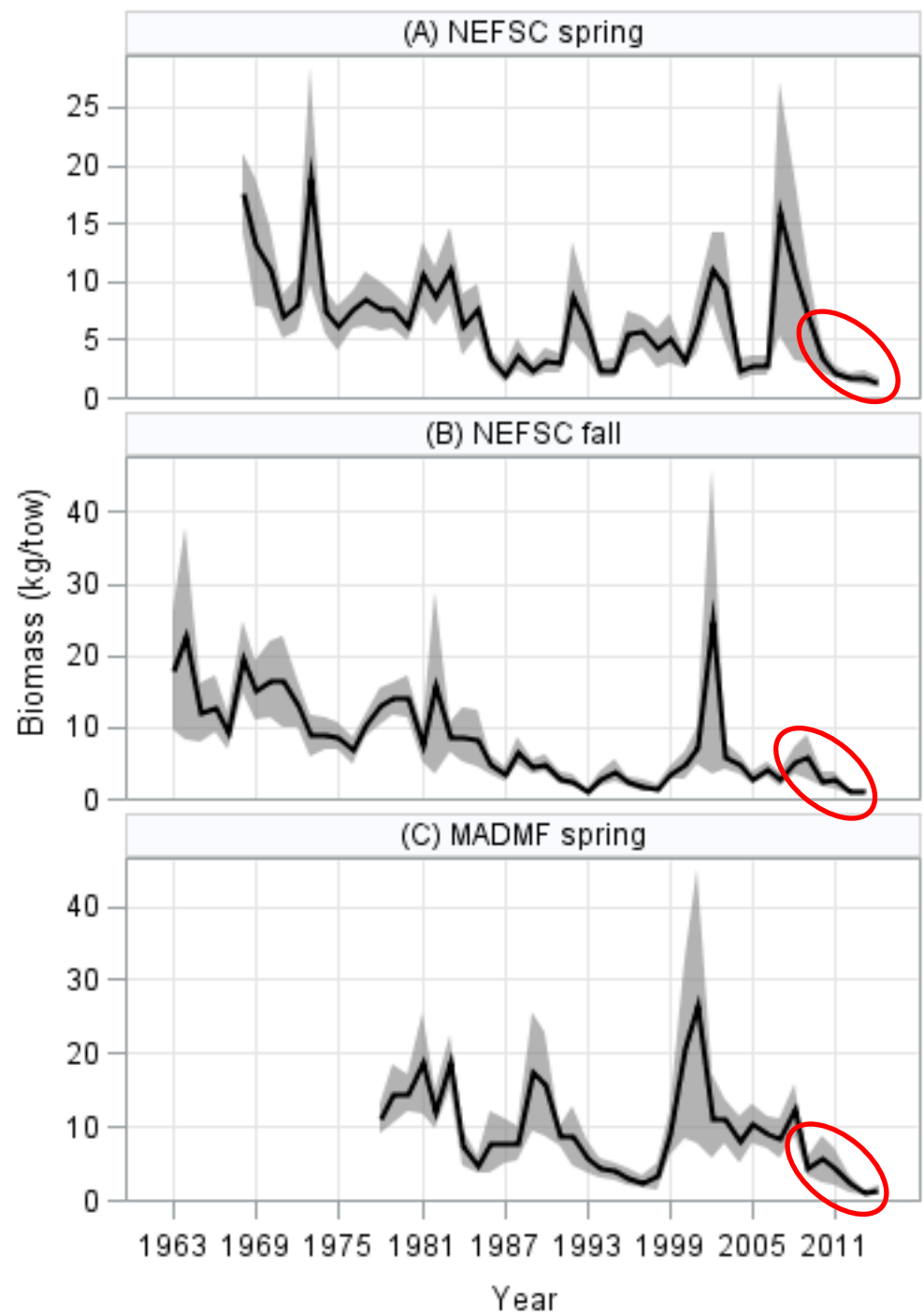


Fig. 1.17

# *Data Signals--Surveys*

- Fraction of Positive tows in NEFSC Spring, NEFSC Fall, and MADMF Spring surveys have declined.

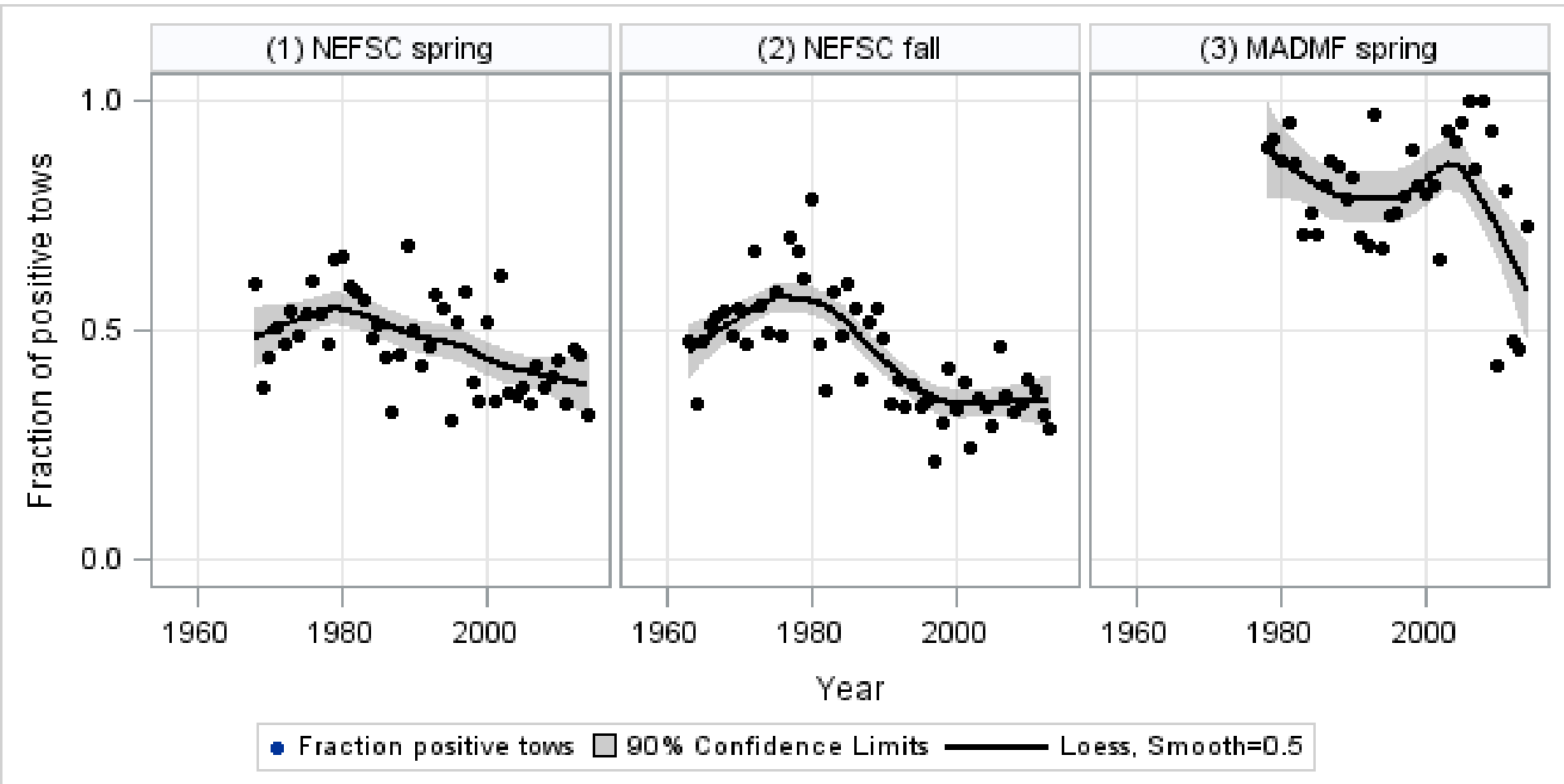


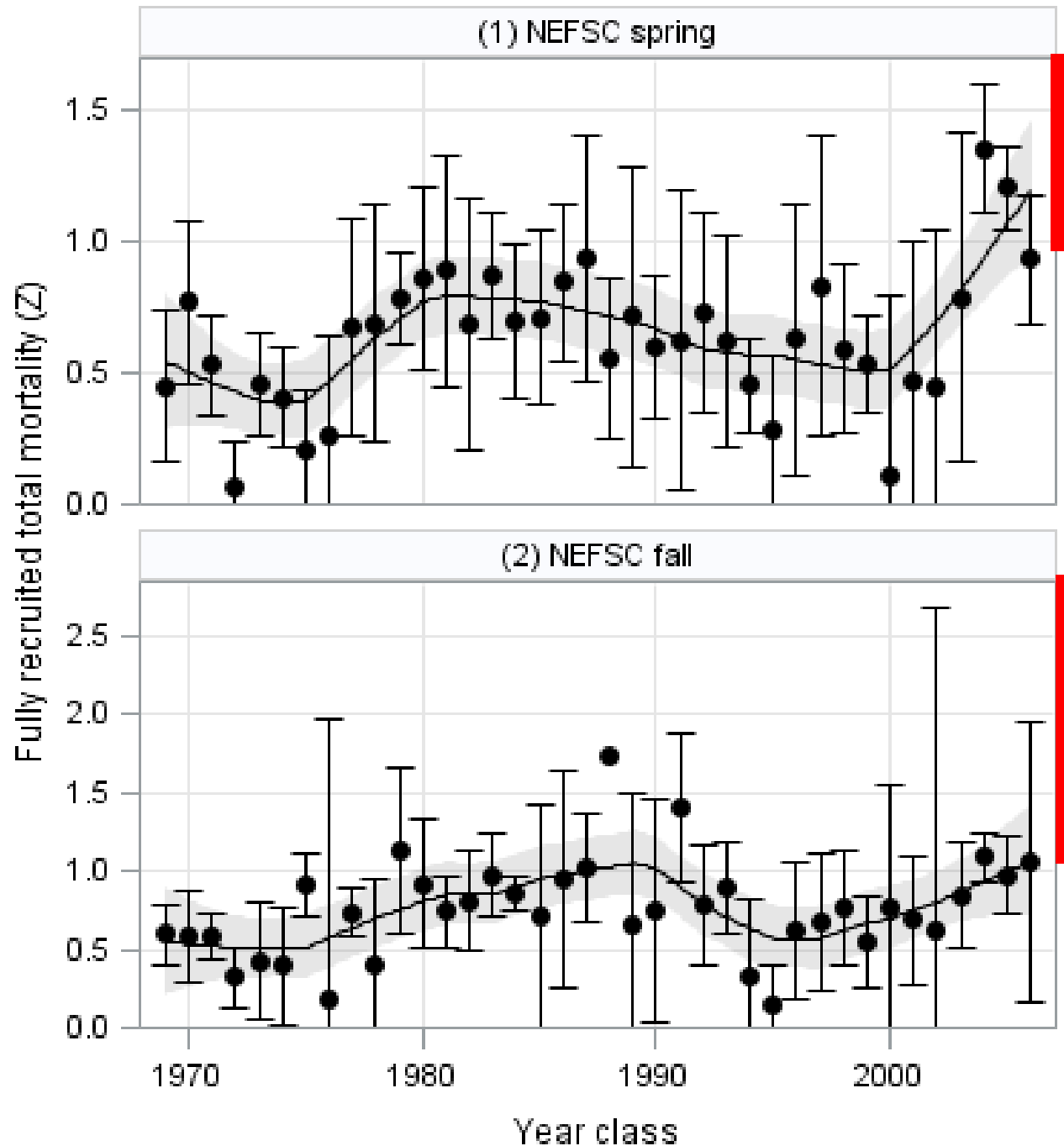
Figure adapted from Figs. 1.26 - 1.28

# Data

## Signals:

## Surveys

Total mortality ( $Z$ ) from NEFSC survey indices



## *Key Signals in the 2012-2013 Data*

- Despite reductions in catch, survey indices have either remained low or declined further
- Continued truncation in the age structure (catch and surveys) implies high total mortality
- No signal of incoming recruitment
- Resource is still highly concentrated in the western Gulf of Maine for both landings and surveys

# *Key Model Results*

- SARC 55 overestimated terminal (2011) SSB and underestimated F
- SSB has declined to 2,000-2,500 mt (time series lows)
- Fishing mortality  $>1.0$  since at least 2011
- Recruitment continues to be poor
  - 2009-2013 Geometric Mean
    - $M=0.2 \rightarrow 1.5$  million Age 1 recruits
    - $M\text{-ramp} \rightarrow 2.7$  million Age 1 recruits



# Spawning Stock Biomass Estimates

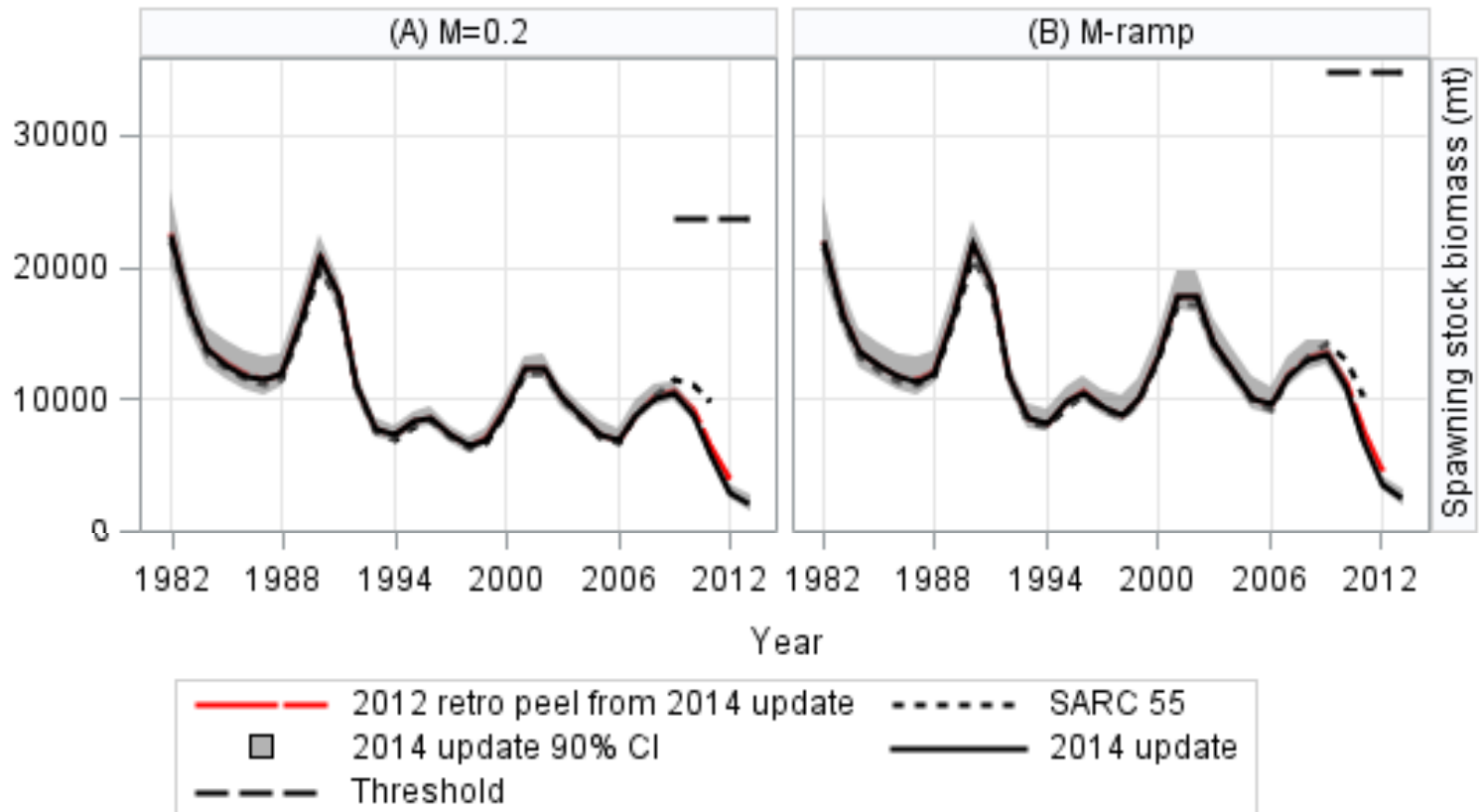


Fig. 2

# *Fishing Mortality Estimates*

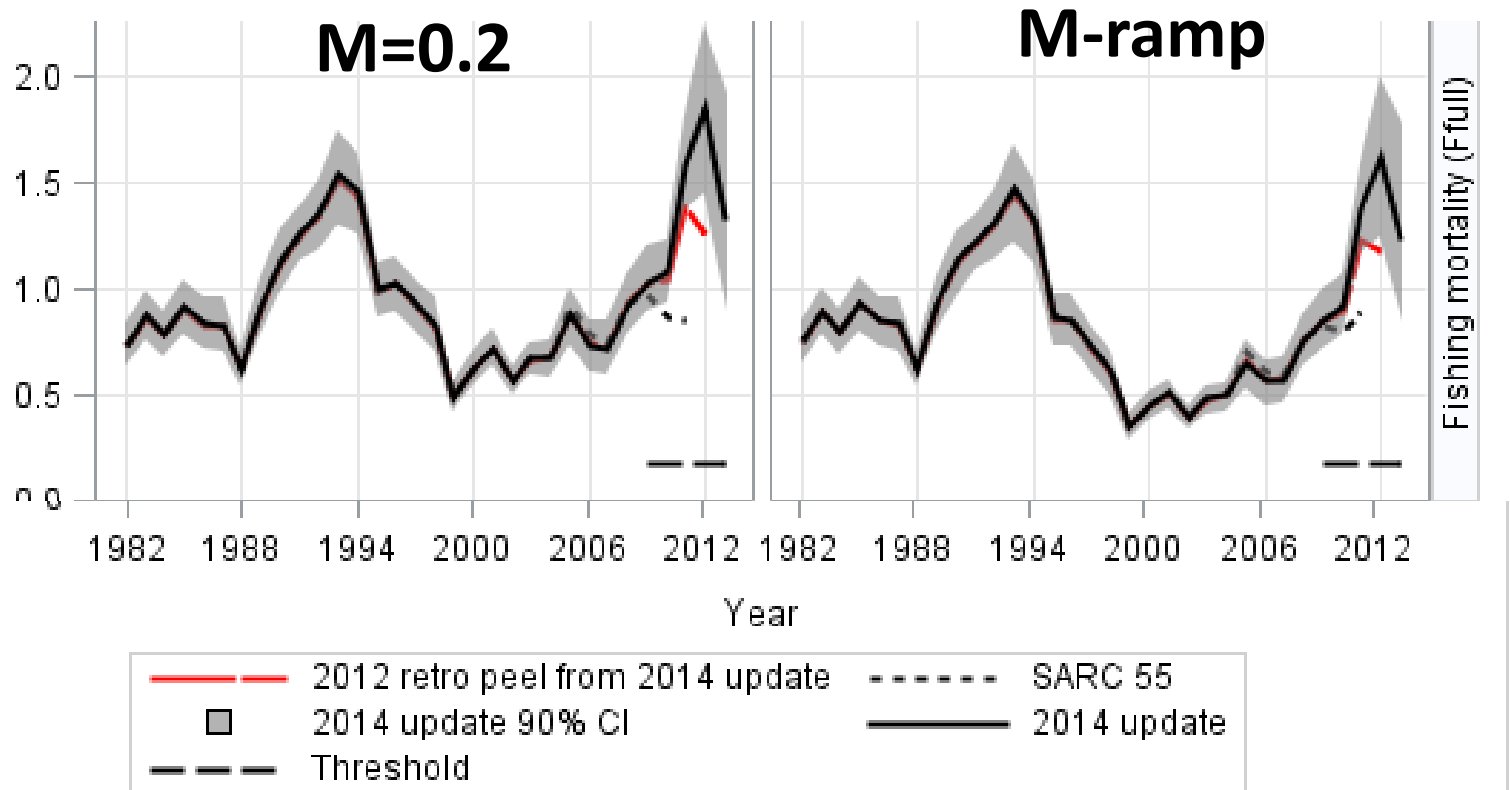


Fig. 2

# Recruitment (Age 1) Estimates

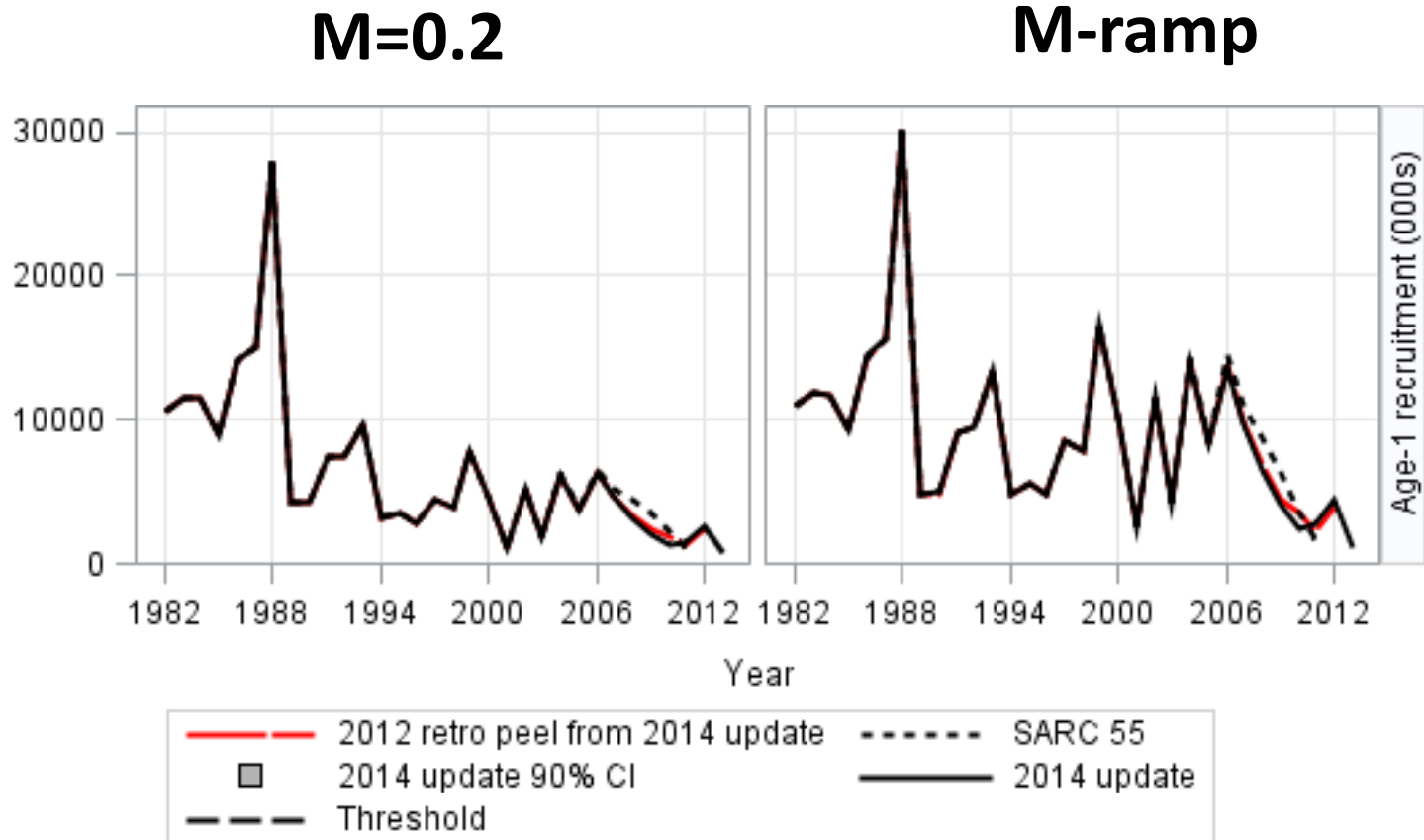


Fig. 2

# *Model Diagnostics*

- No major changes in model diagnostics for either the  $M=0.2$  or  $M$ -ramp models relative to SARC 55.
- Residual patterns in survey indices present at SARC 55 no longer exists in the updated model(s)
- $M=0.2$  model has moderate retrospective error, but similar in magnitude to the SARC 55  $M=0.2$  model (for which no adjustment was made).

# Retrospective Pattern: 2014

	Mohn's Rho	
Output	M=0.2	M-ramp
F	-0.33	-0.05
SSB	0.53	0.17

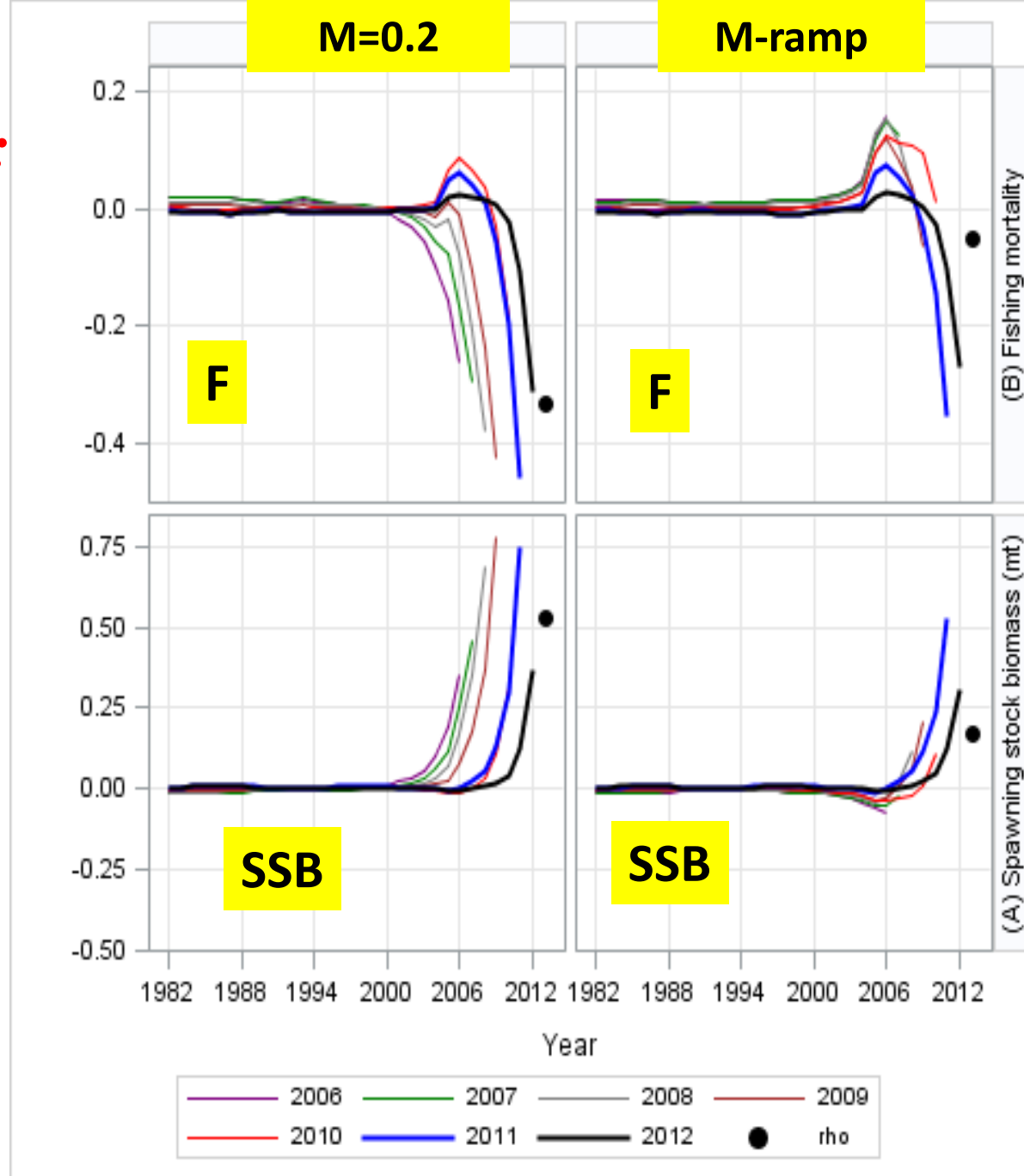


Fig. 2.2

**Recruitment estimates well below long term and previous 10 year averages irrespective of model used.**

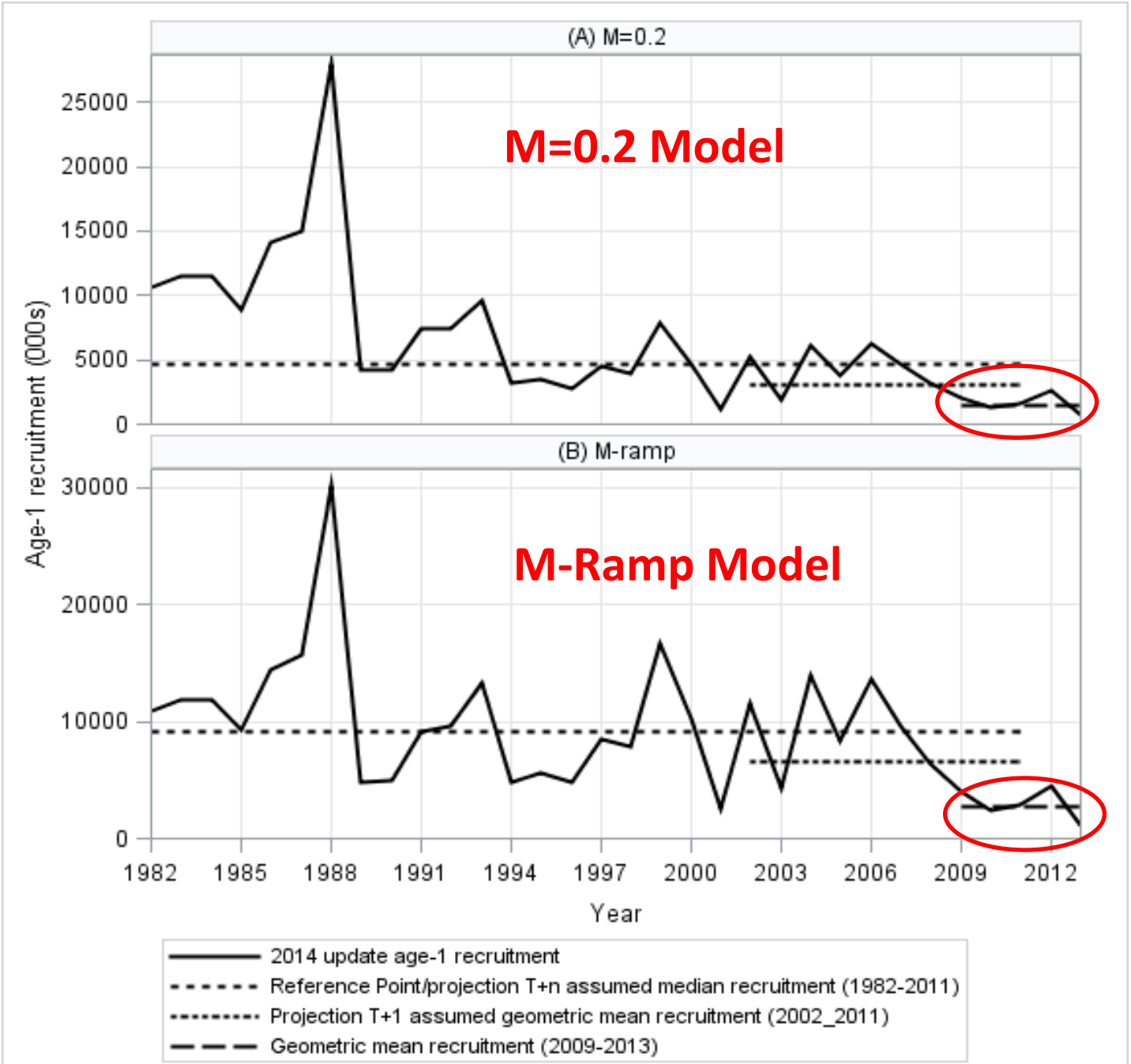


Fig. 1.44 (left), Fig. 6 (right)

# *Updated Biological Reference Points*

- Reference points have been calculated assuming  $M=0.2$  over the long-term consistent with SARC 55 recommendations
- Minor changes to the data inputs (maturity, weights, selectivity)
- Retained  $F_{40\%}$  as the  $F_{MSY}$ -proxy
- Revisions to the recruitment inputs (median 1982-2009  $\rightarrow$  1982-2011)

# Reference Points

Minor changes to the biological data inputs to reference points (i.e., maturity, average weights, selectivity at age).

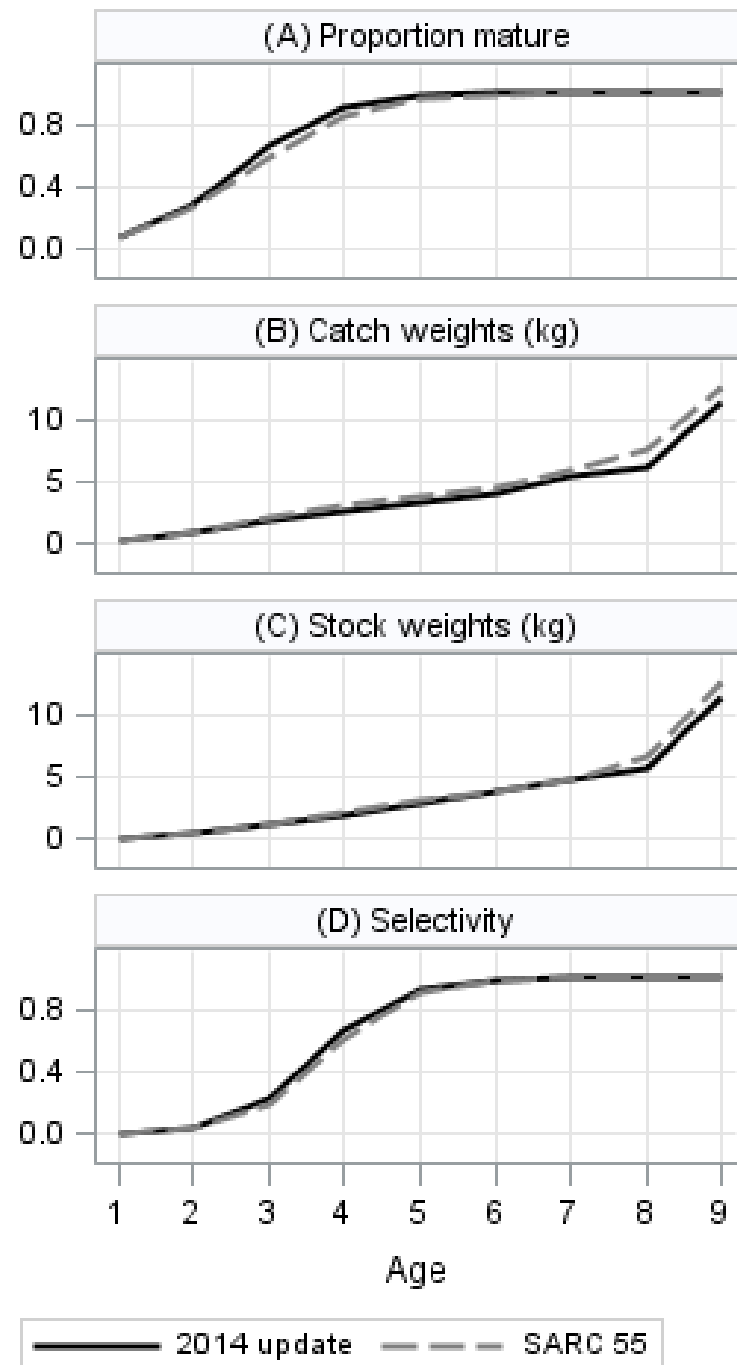


Fig. 1.44 (left), Fig. 6 (right)



# *Resource Status and Productivity:*

## *$H_o: M=0.2$*

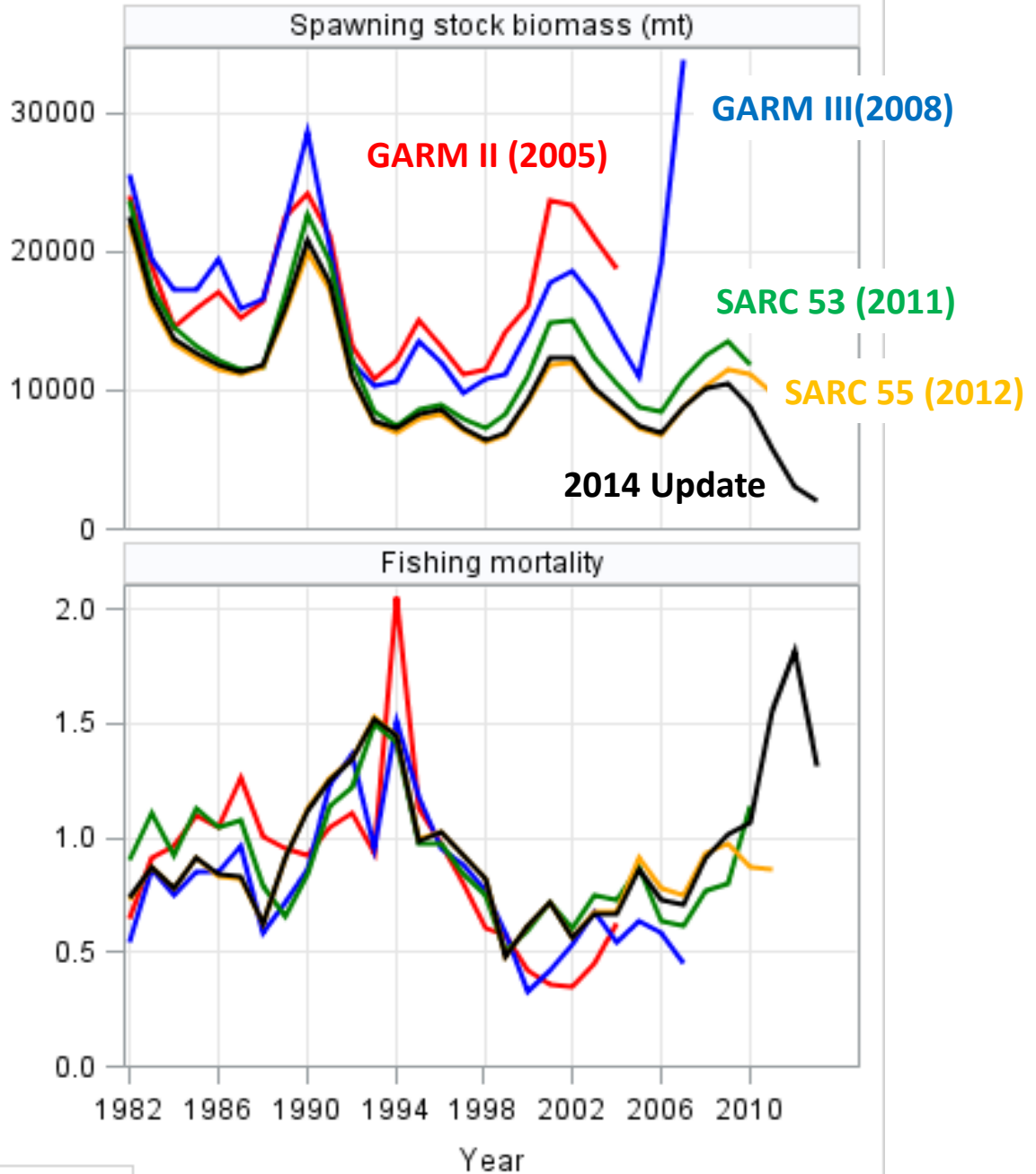
Parameter	SARC 55	2014 Update	Percentage Change
$F_{msy}$	0.18	0.18	0%
$B_{msy}$ (mt)	54,743	47,184	-14%
$F_{current}/F_{msy}$	4.78	7.39	+55%
$B_{current}/B_{msy}$	0.18	0.04	-78%
Median Recruitment (000's)	5,254	4,665	-11%
Max Sustainable Yield (mt)	9,399	7,753	-18%
Overfishing	Yes	Yes	-
Overfished	Yes	Yes	-

# *Resource Status and Productivity:*

## *H<sub>o</sub>:M-ramp*

Parameter	SARC 55	2014 Update	Percentage Change
F <sub>msy</sub>	0.18	0.18	0%
B <sub>msy</sub> (mt)	80,200	69,621	-13%
F <sub>current</sub> /F <sub>msy</sub>	5.00	6.89	+38%
B <sub>current</sub> /B <sub>msy</sub>	0.13	0.03	-77%
Median Recruitment (000's)	9,446	9,173	-3%
Max Sustainable Yield (mt)	13,786	11,388	-17%
Overfishing	Yes	Yes	-
Overfished	Yes	Yes	-

# Comparison of Historical Model Results: 2005-2014



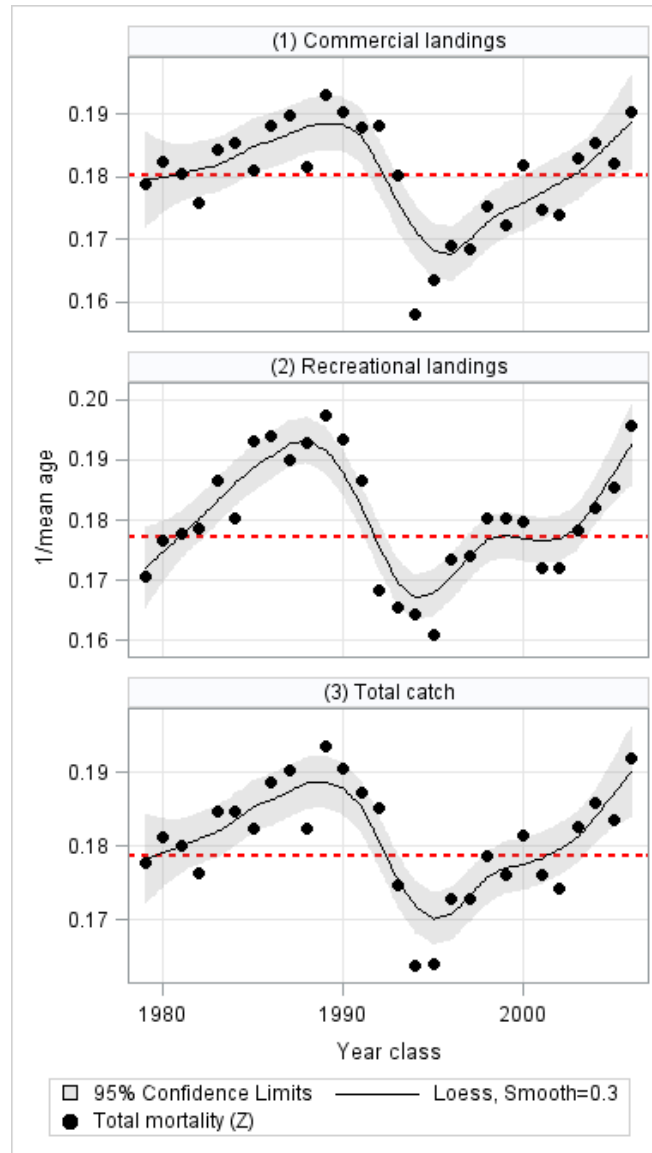
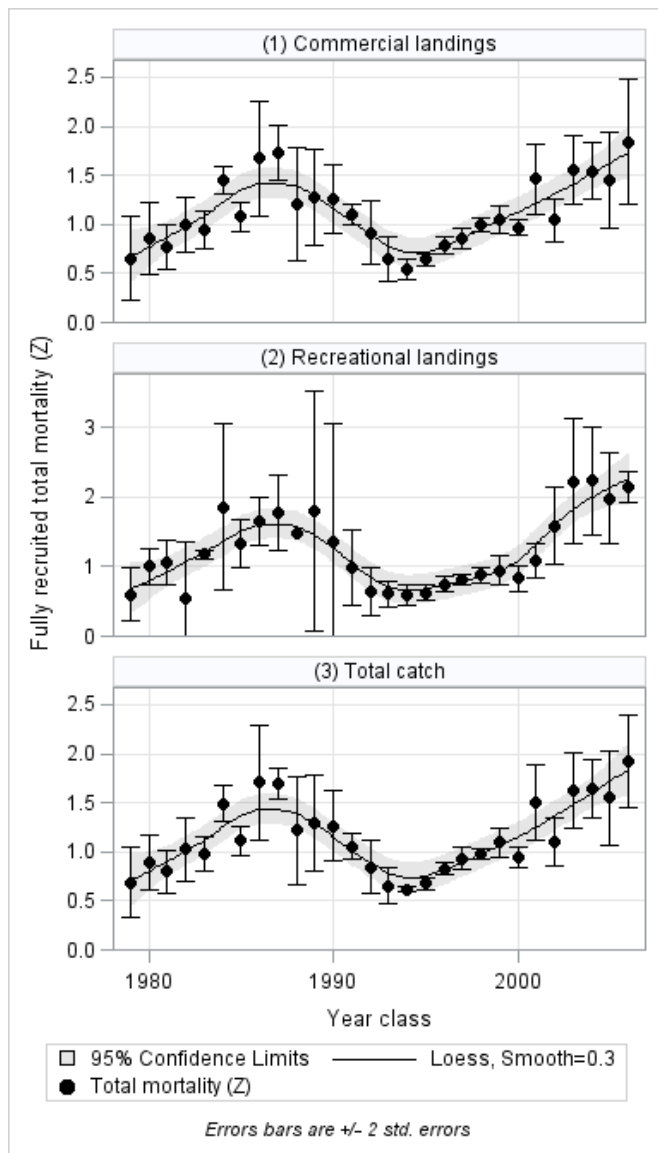
# *Summary*

- Catch and survey data suggest high rates of total mortality
- Survey data suggest low rates of overall abundance
- Alternative model results lead to similar conclusions on stock status
- Low levels of recruitment
- Biomass as lowest level in time series
- Stock condition continues to worsen

**Questions?**

# Catch

- Total mortality ( $Z$ ) and mean age from commercial and recreational catch



Figures not in report (adapted from Tables 1.5 and 1.17)

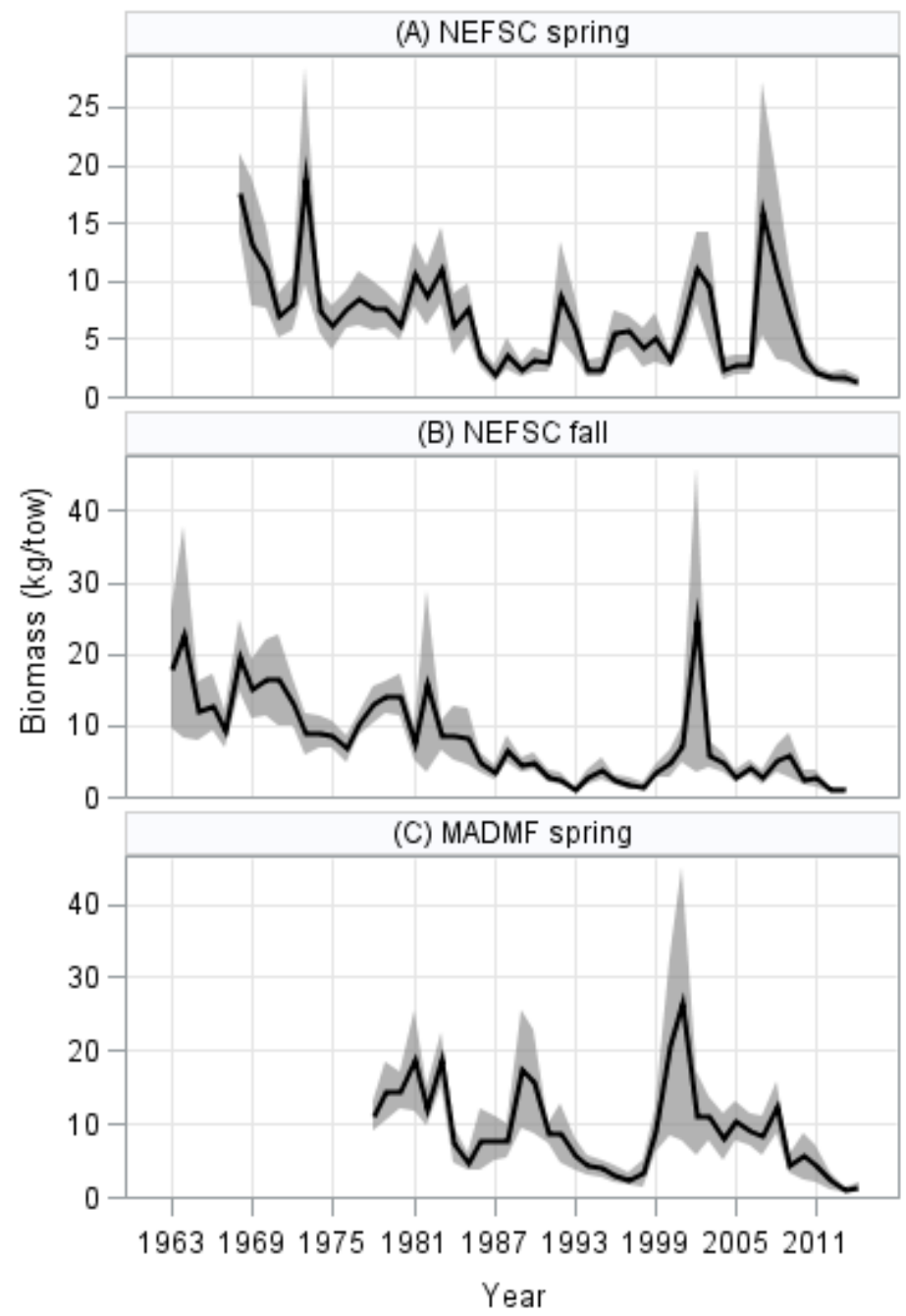
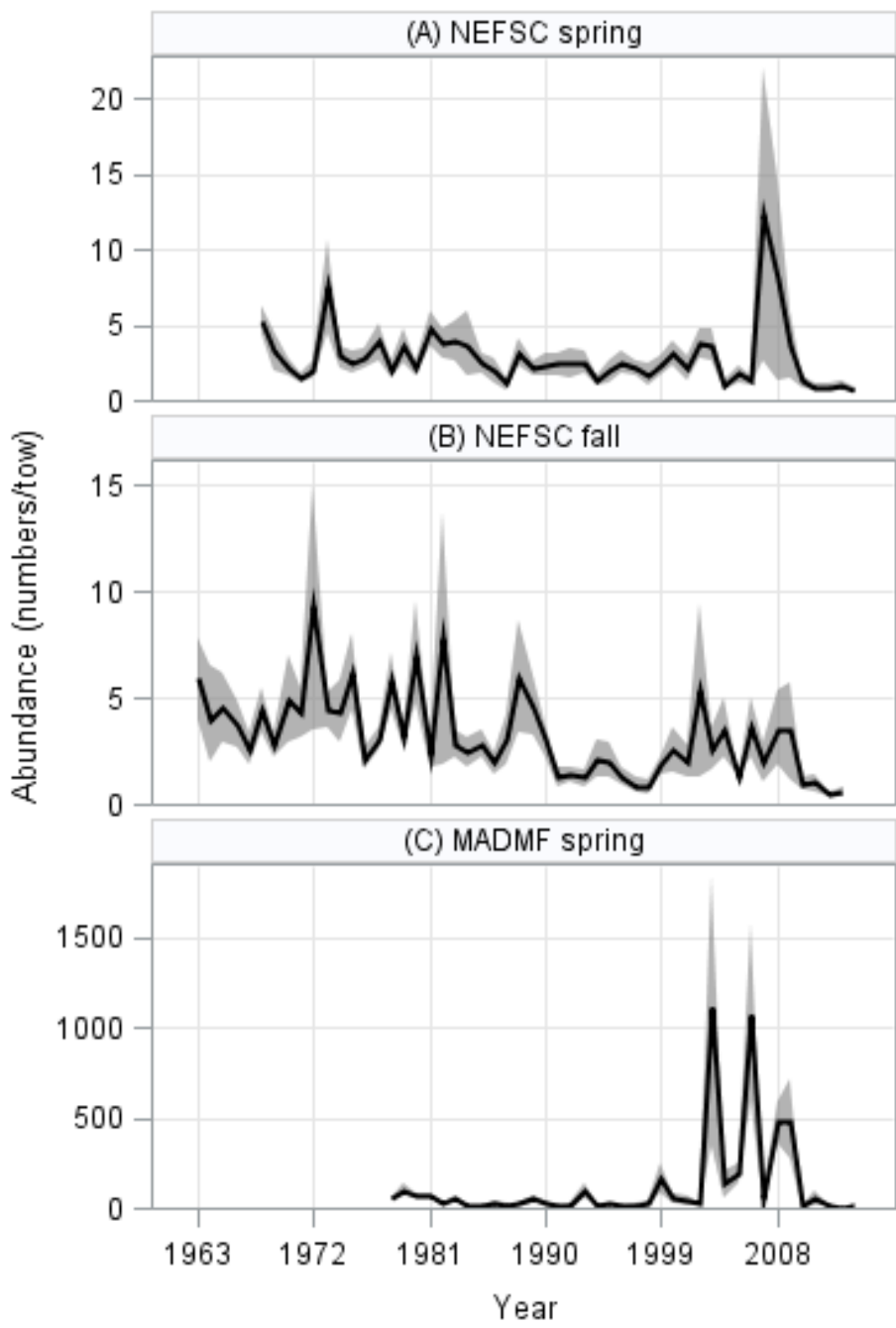
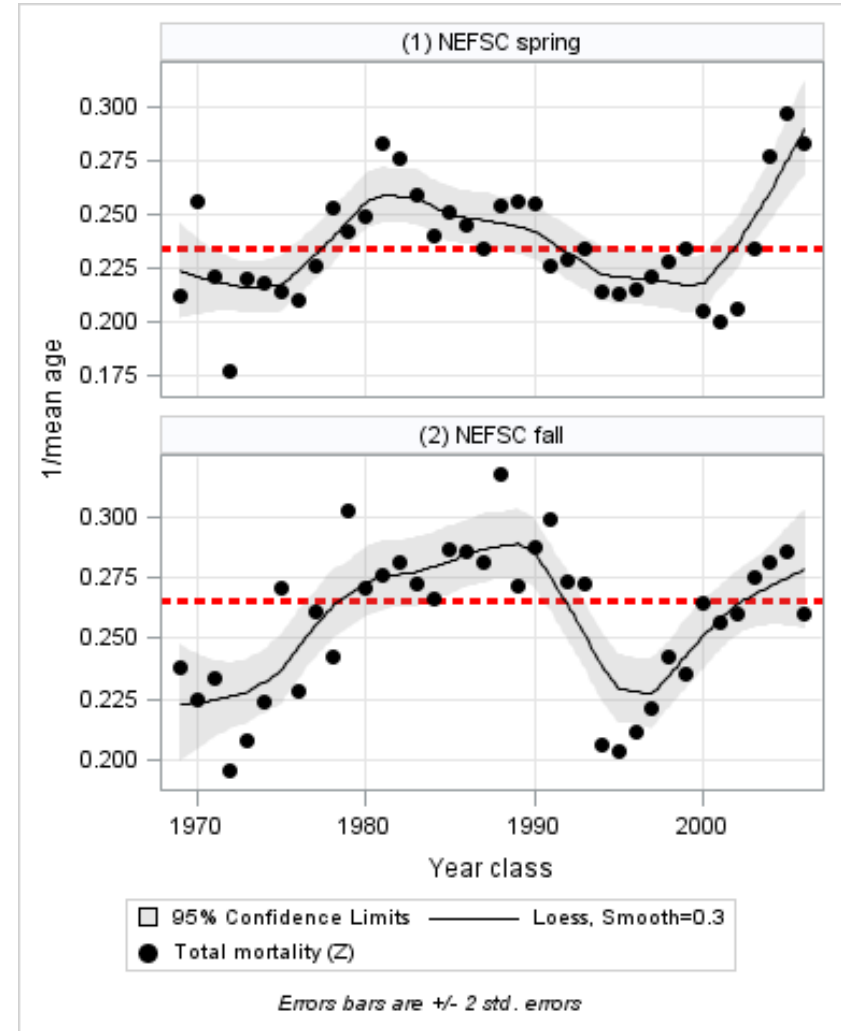
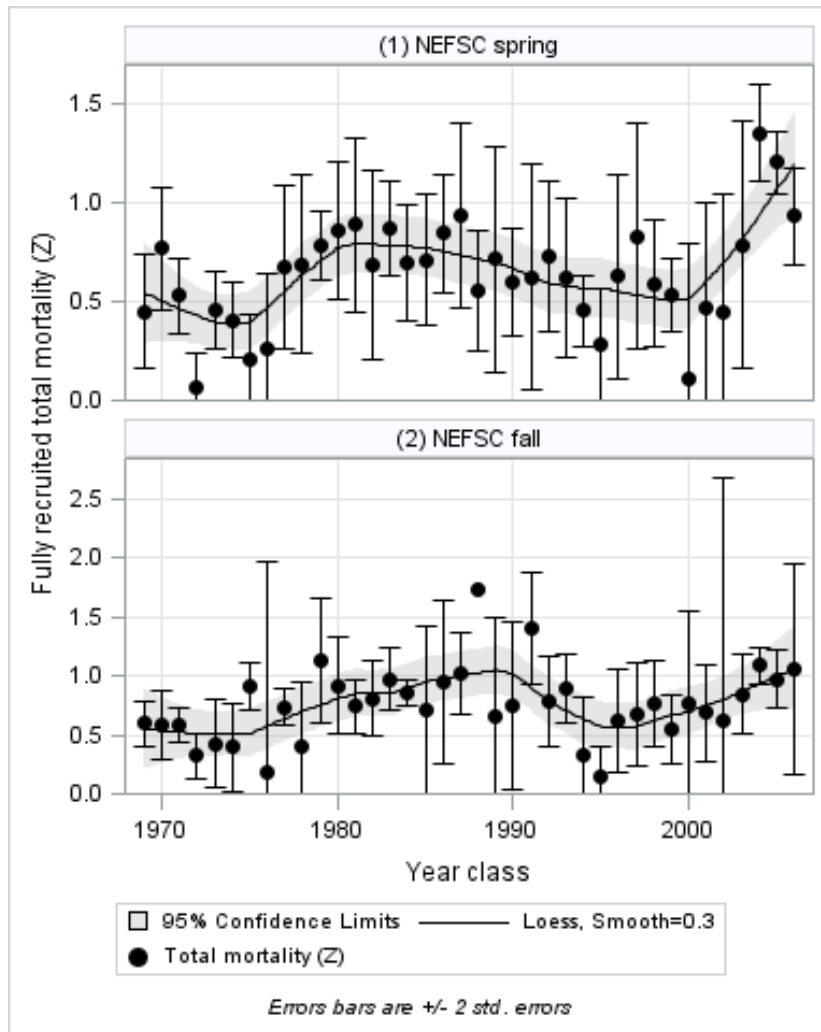


Fig. 1.17

## Surveys

- Total mortality ( $Z$ ) and mean age from NEFSC survey indices





## Data summary

- Fishery catches
  - Catches have declined since 2011 (in response to quota reductions)
  - Truncation in the size/age structure is evident in both the commercial and recreational fleets
    - Commercial and recreational mean age has declined
  - Fishery catches-at-age indicate that recent total mortality has approached or exceeded 1.5 (78% annual mortality)
  - Catches remain highly concentrated in the western Gulf of Maine
- Survey indices
  - Despite reductions in catch, survey indices have declined to the lowest levels of the time series
    - Includes not only NEFSC surveys, but also the MADMF survey
    - Truncation in the size/age structure is evident in all surveys
    - NEFSC survey mean age has declined
  - Survey indices-at-age indicate that recent total mortality is in excess of 1.0 (63% annual mortality)
  - Cod resource remains highly concentrated in the western Gulf of Maine
    - Percent occurrence of cod has declined

## Model diagnostics: Retrospective Pattern

- “While the retrospective pattern is larger than that observed in the SAW53 model, the directionality in the terminal year has shifted such that spawning stock biomass tended to be underestimated and fishing mortality overestimate[d]. It appeared that the retrospective pattern was transient with a one year peel showing no bias. Both the SAW 55 WG and SARC 55 Panel agreed that no adjustment be made for retrospective pattern given that the retrospective pattern is small, it may be transient in nature and that SAW 53 made no retrospective adjustment.”  
(SARC 55 Assessment Report)

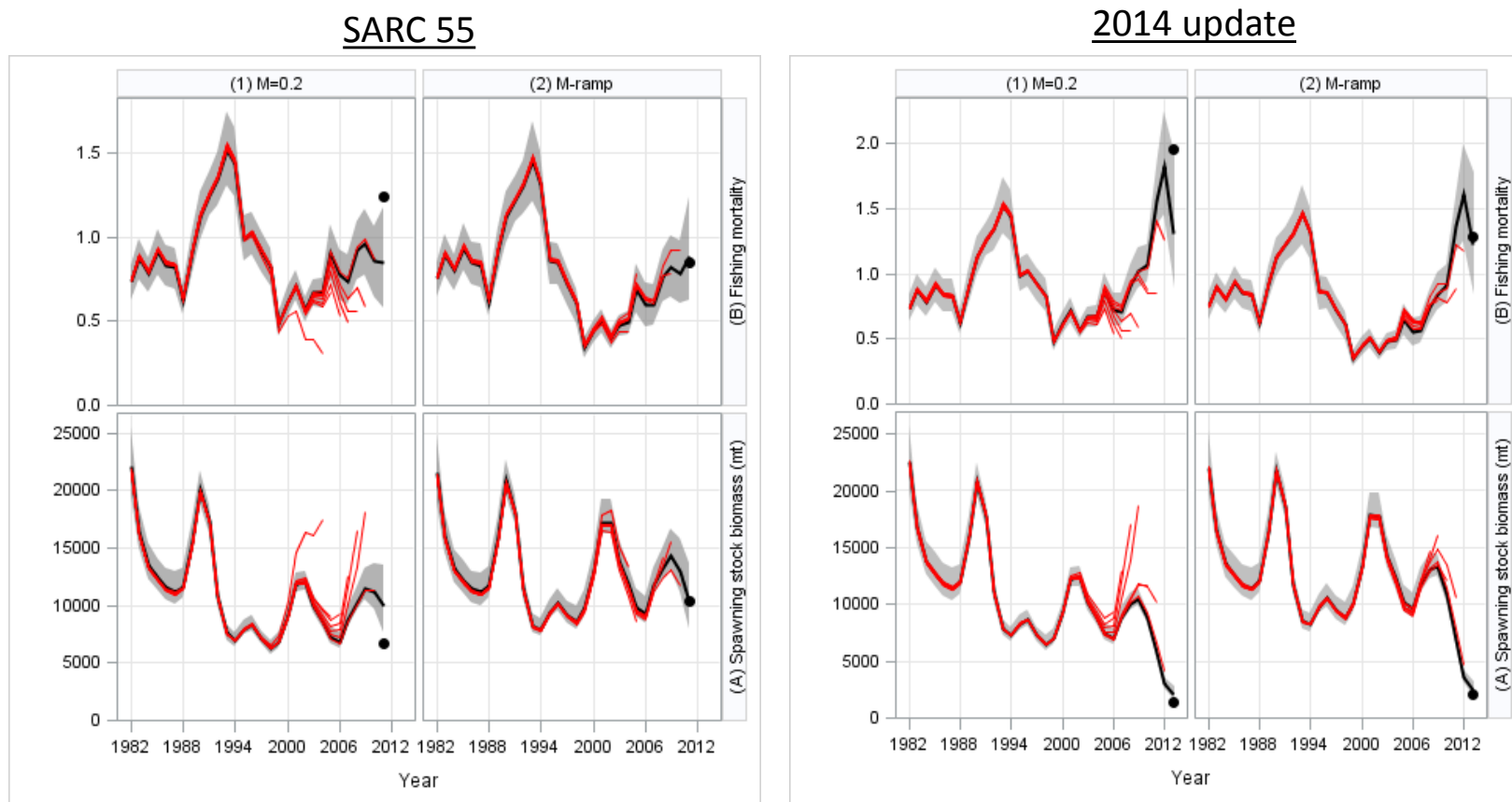


Figure not in report (left), Fig. 1.41 (right)

## SARC 55

### Retrospective Pattern

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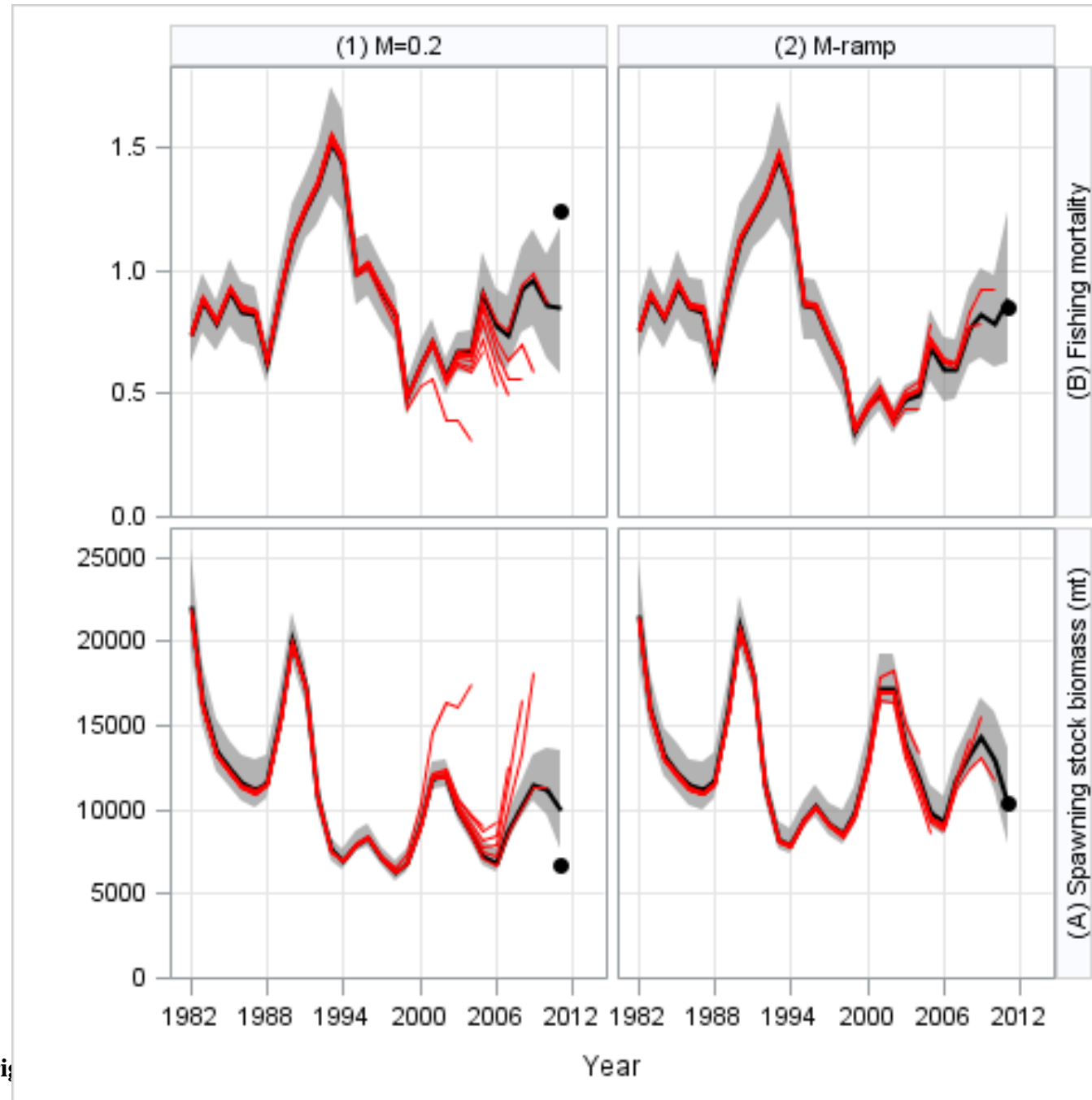


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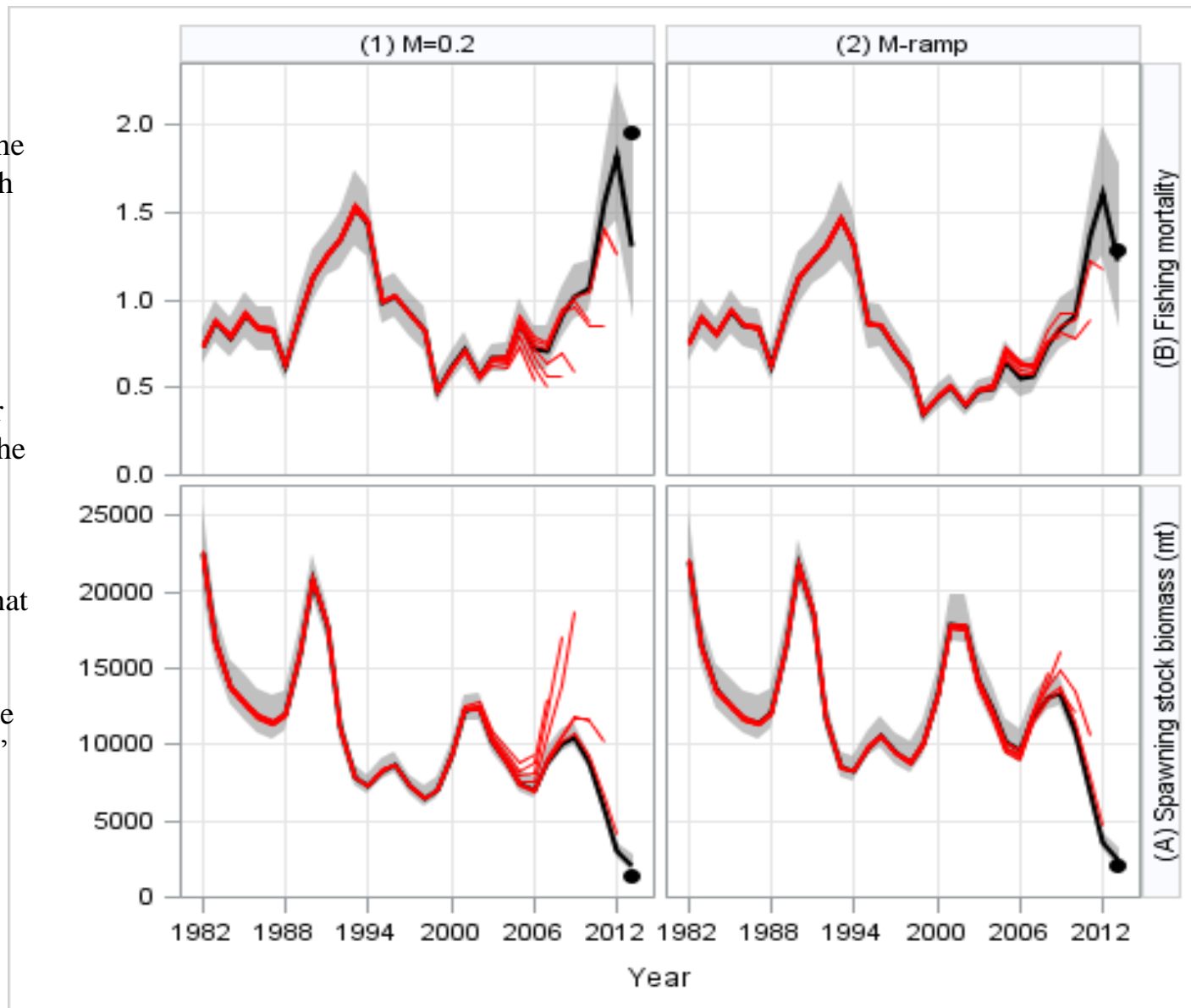


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## Assessment retrospective

- Why were the SARC 53 and SARC 55 assessments optimistic?

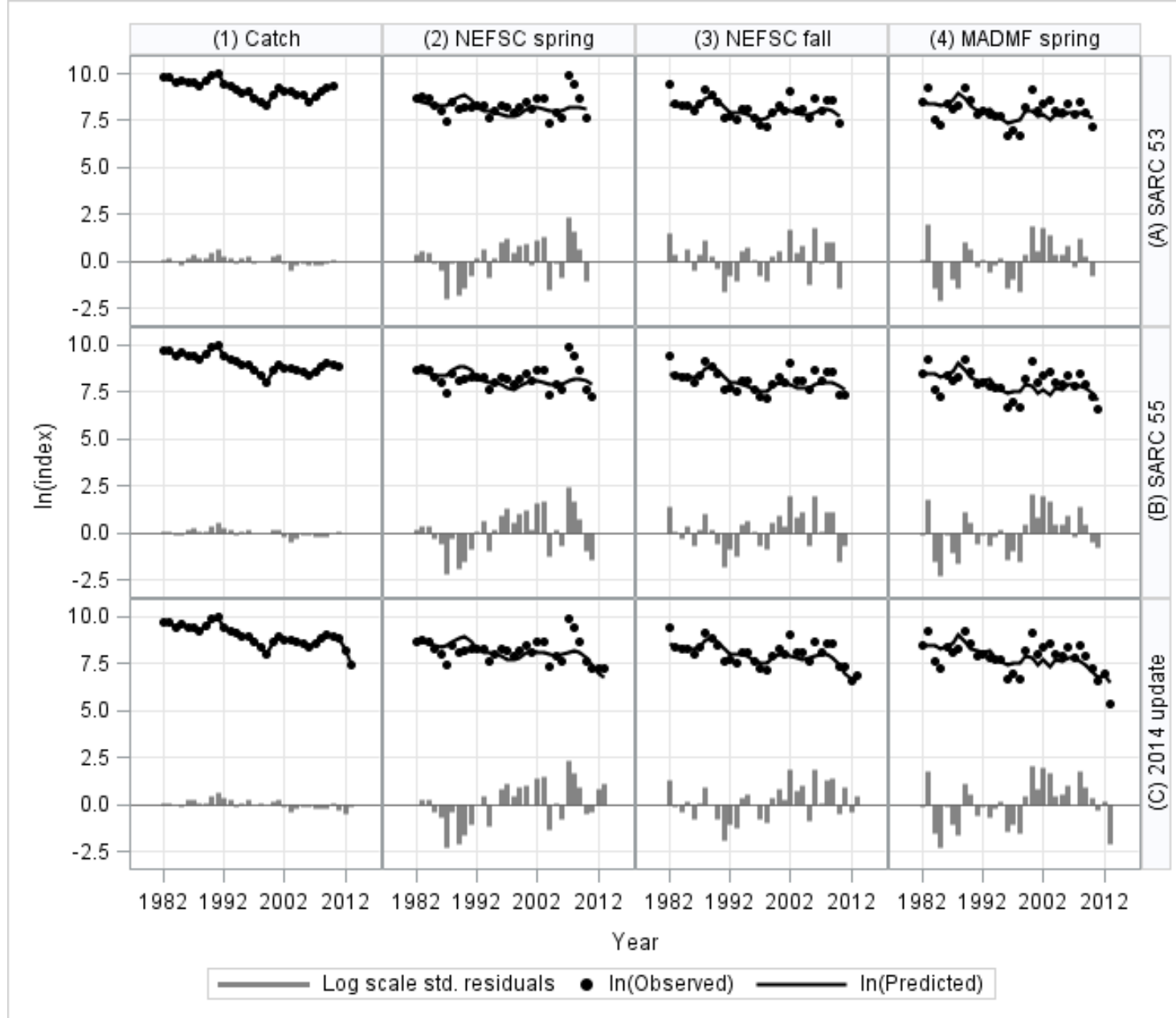


Fig. 8

## Reference points

- Stock status unchanged from previous assessment (overfished and overfishing)

Assessment	Proxy reference points	M=0.2	M-ramp
SARC 55	$F_{full, 2011}$	0.86 (0.58 - 1.17)	0.90 (0.62 - 1.23)
	$F_{MSY}$	0.18	0.18
	$F_{full, 2011}/F_{MSY}$	4.78	5.00
	Overfishing	Yes	Yes
	$SSB_{2011}$ (mt)	9,903 (7,644 - 13,503)	10,221 (7,943 - 13,676)
	$SSB_{MSY}$ (mt)	54,743 (40,207 - 73,354)	80,200 (64,081 - 99,972)
	$SSB_{2011}/SSB_{MSY}$	0.18	0.13
	Overfished	Yes	Yes
	MSY (mt)	9,399 (6,806 - 13,153)	13,786 (10,900 - 17,329)
Median age1 recruitment (000s)	5,254 (2,206 - 14,727)	9,446 (4,480 - 16,321)	
2014 update	$F_{full, 2013}$	1.33 (0.89 - 1.92)	1.24 (0.84 - 1.78)
	$F_{MSY}$	0.18	0.18
	$F_{full, 2013}/F_{MSY}$	7.39	6.89
	Overfishing	Yes	Yes
	$SSB_{2013}$ (mt)	2,063 (1,561 - 2,774)	2,432 (1,819 - 3,230)
	$SSB_{MSY}$ (mt)	47,184 (32,903 - 67,045)	69,621 (53,349 - 89,302)
	$SSB_{2013}/SSB_{MSY}$	0.04	0.03
	Overfished	Yes	Yes
	MSY (mt)	7,753 (5,355 - 11,162)	11,388 (8,624 - 14,750)
Median age1 recruitment (000s)	4,665 (1,414 - 14,649)	9,173 (2,682 - 16,262)	

**Table 2**

## Projections

- Retained the 'hinge' values from SARC 55 and assumes recruitment success is compromised under current SARC 55
  - M=0.2 (6.5%)
  - Age-1 recruitment success is 50% of current recruitment

