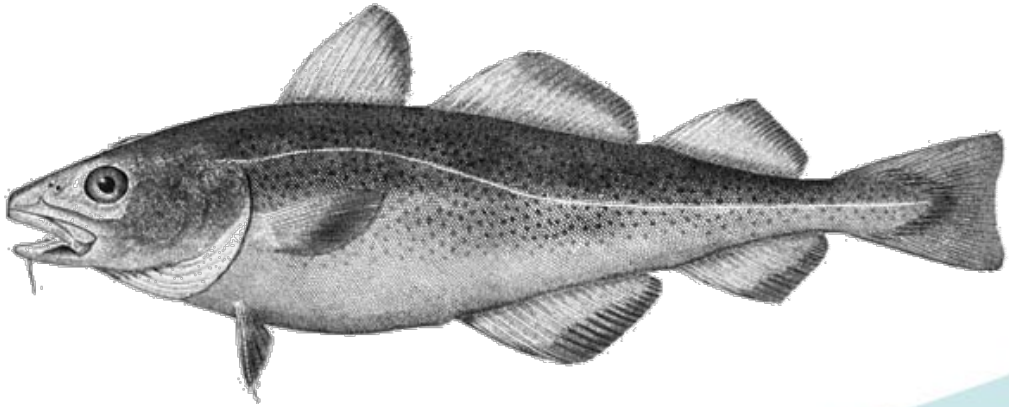
#9a

2021 Fall Management Track Assessments

NOAA FISHERIES
NEFSC

Gulf of Maine Cod
Georges Bank Cod

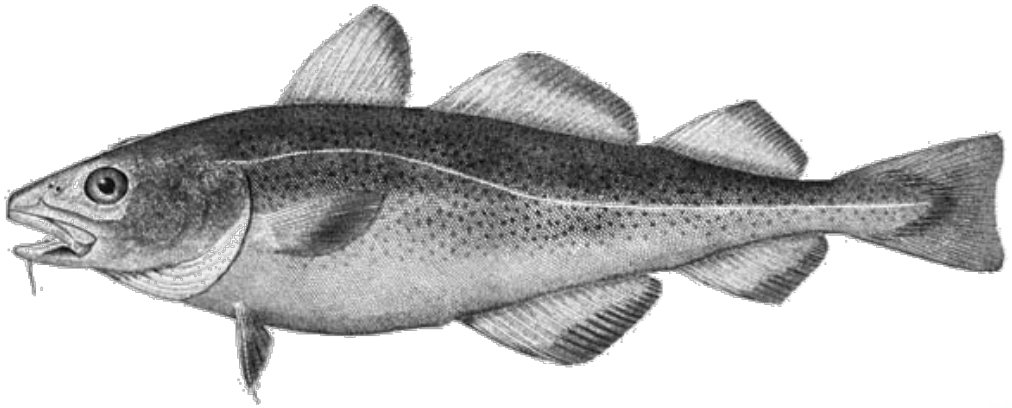


NOAA FISHERIES

NEFSC

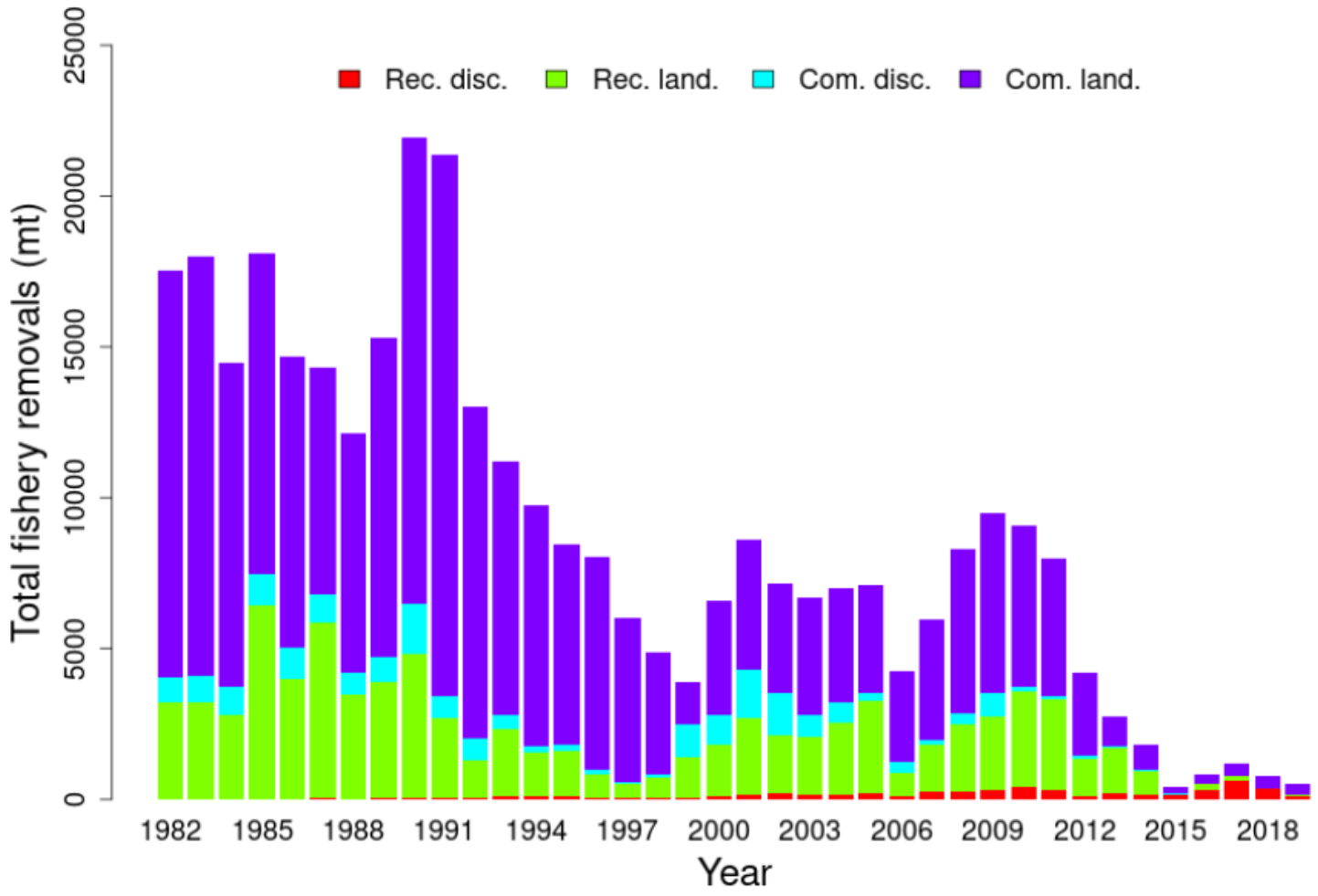
Gulf of Maine Atlantic cod

Assessment summary

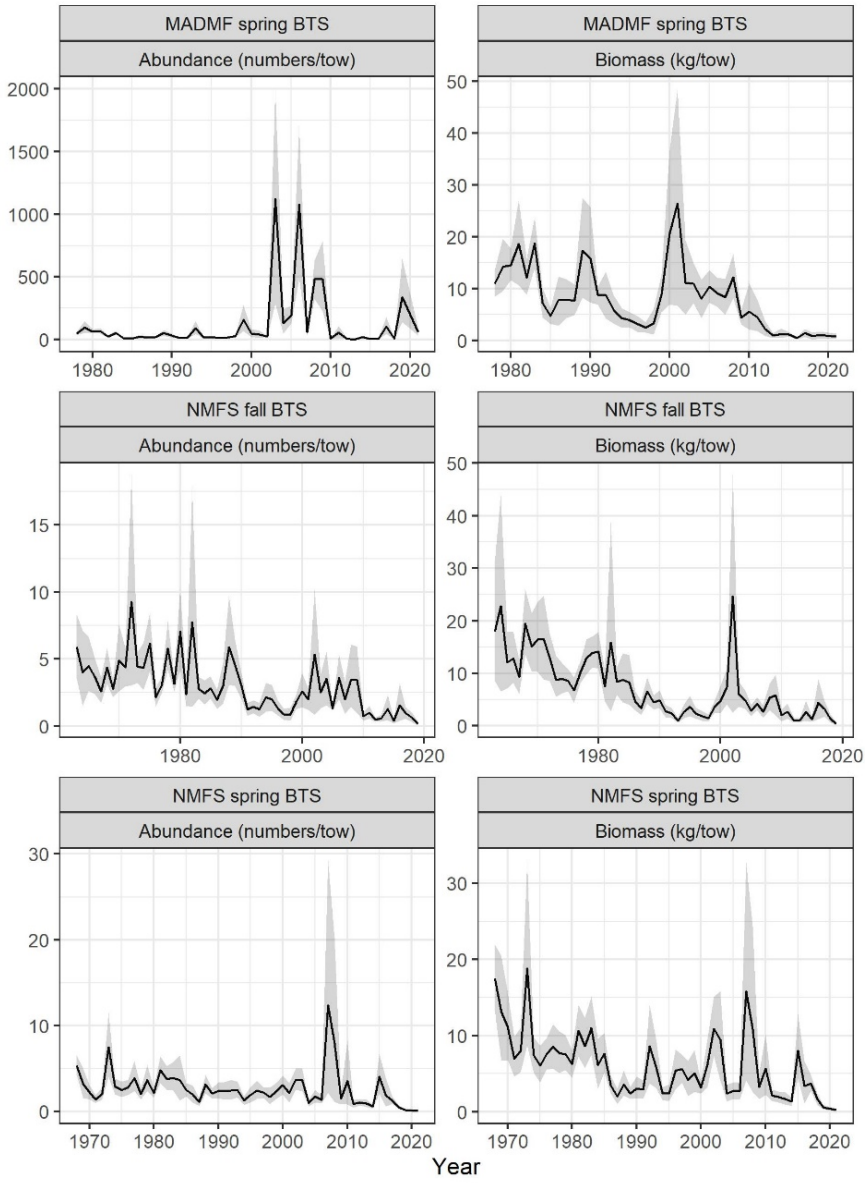


Overview of Fishery Data

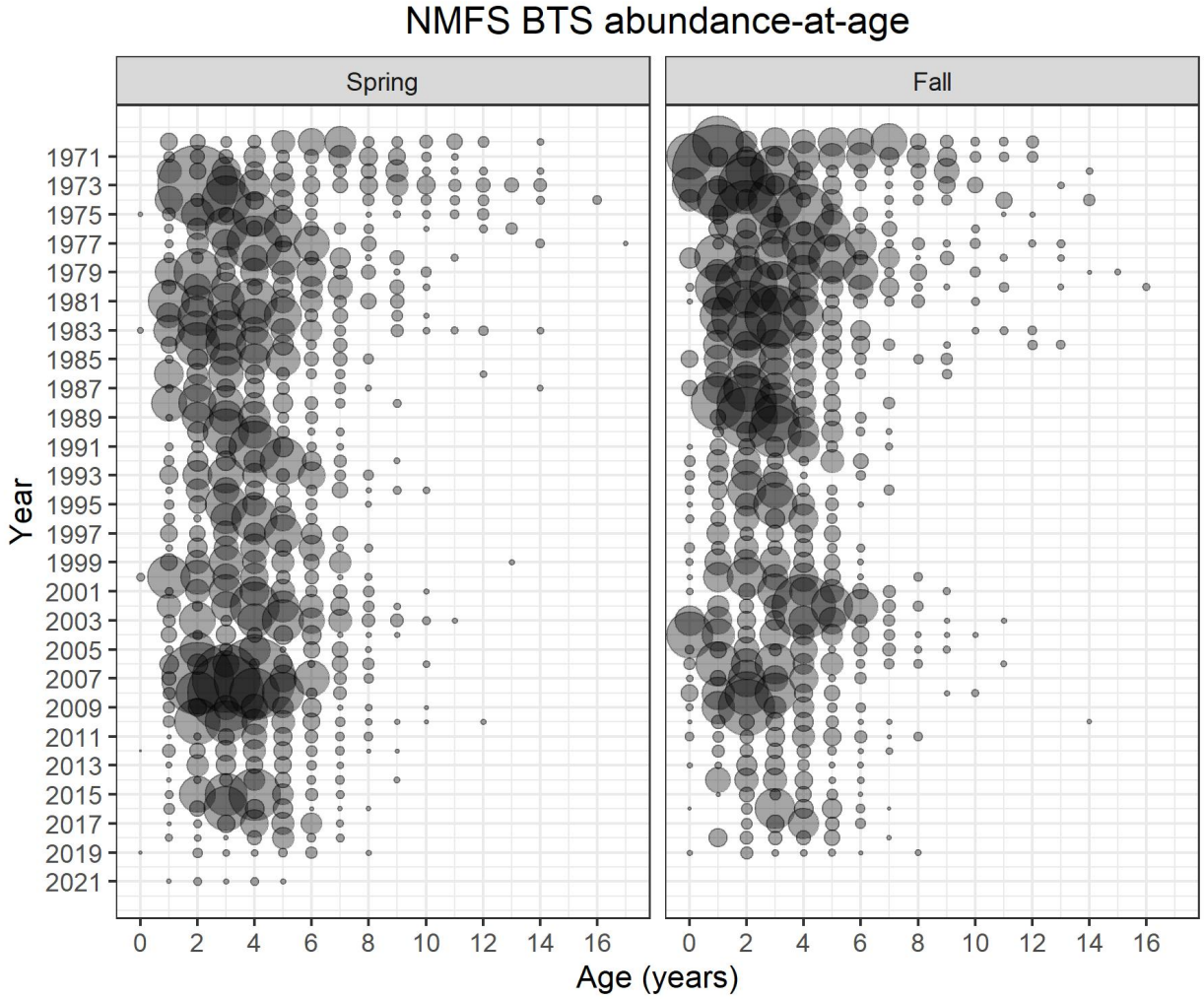
- Fishery: catch source



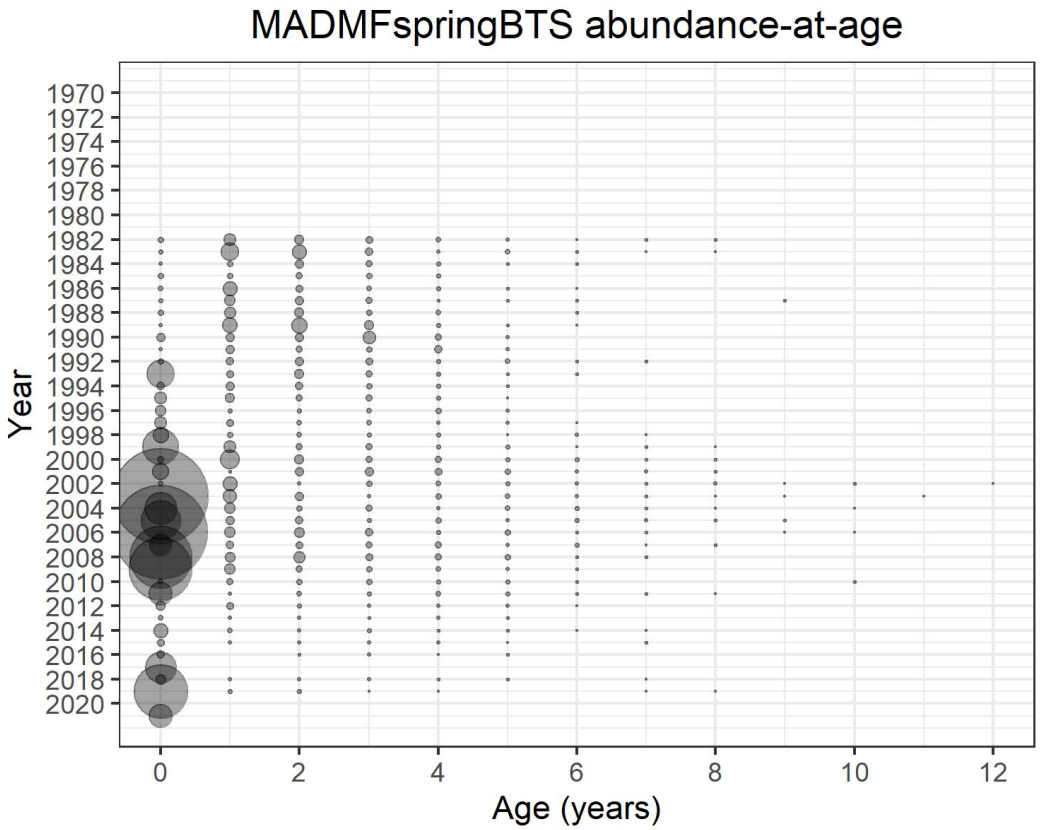
Overview of Survey Data



Overview of Survey Data

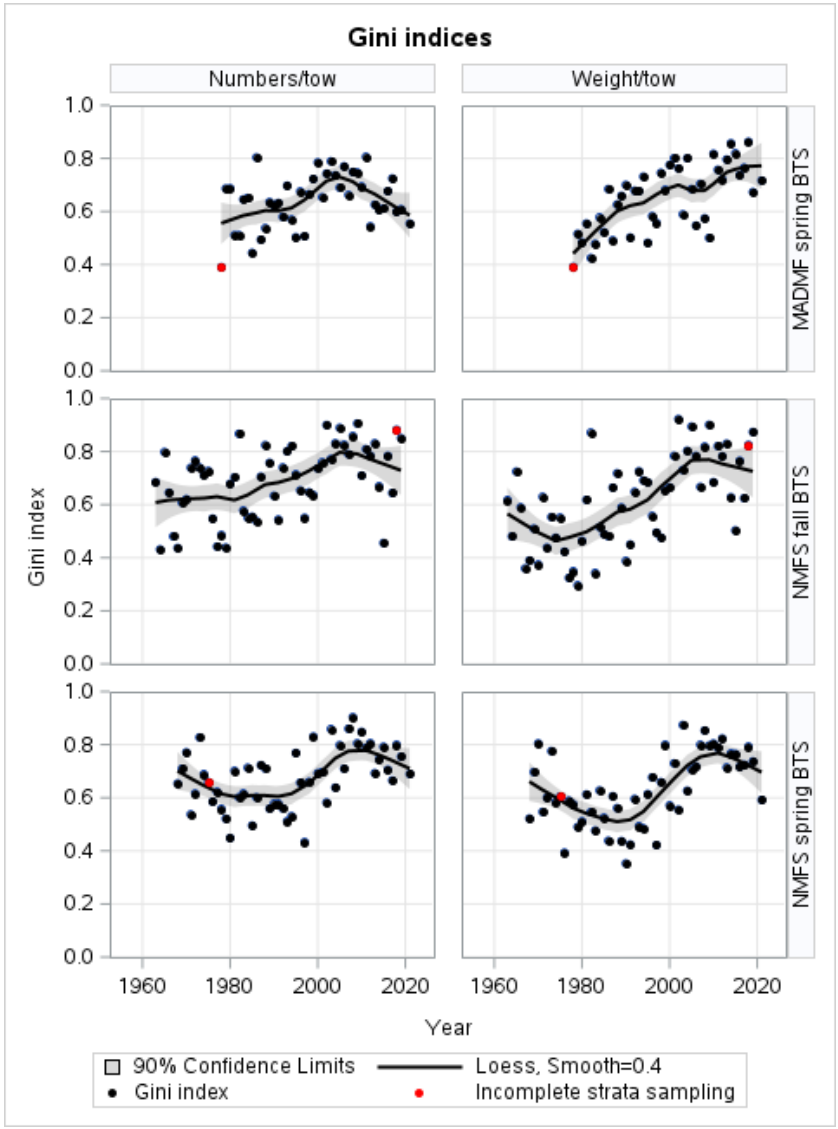


Overview of Fishery and Survey Data



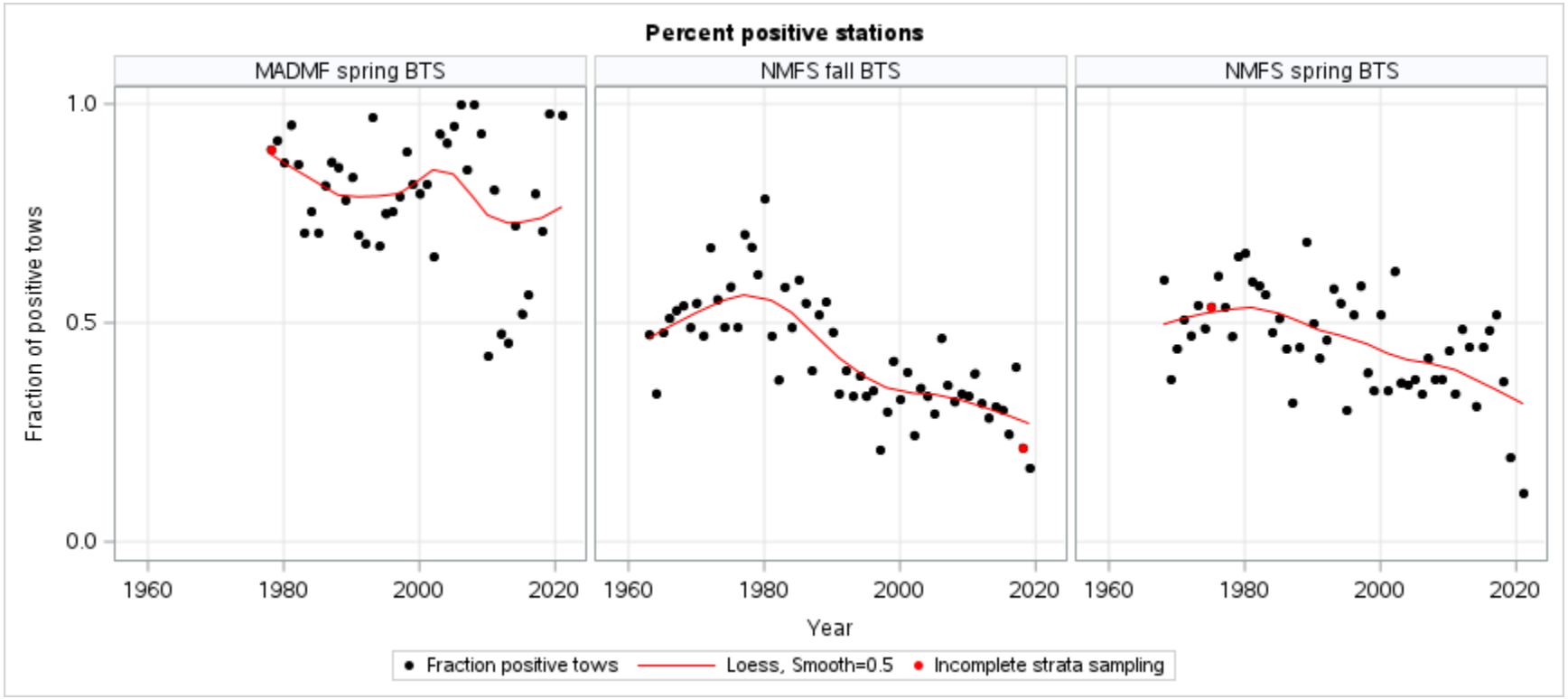
Overview of Fishery and Survey Data

- Survey: spatial distribution



Overview of Fishery and Survey Data

- Survey: spatial distribution



Assessment Model History

- SAW 7 (1988): VPA model developed (Serchuk and Wigley 1986)
- VPA in SAW 12 (1991), SAW 15 (1993), SAW 19 (1995), SAW 24 (1997), SAW 27 (1998)
- ADAPT VPA in SAW 33 (2001) - recreational landings included
- ADAPT VPA in GARM I (2002), GARMII (2005)
- Commercial discards included in GARMIII (2008)
- ASAP model in SARC 53 (2011) - recreational discards included
- ASAP model in SARC 55 (2013) (most recent benchmark)

Stock Status History

2001 – SAW 33 – Not overfished, overfishing is occurring
2002 – GARM I – Overfished, overfishing is occurring
2005 – GARM II – Overfished, overfishing is occurring
2008 – GARM III – Not overfished, overfishing is occurring
2011 – SARC 53 – Overfished, overfishing is occurring
2013 – SARC55 – Overfished, overfishing is occurring
2014 – Update – Overfished, overfishing is occurring
2015 – Update – Overfished, overfishing is occurring
2017 – Update – Overfished, overfishing is occurring
2019 – Update – Overfished, overfishing is occurring
2021 – Update – Overfished, overfishing is occurring*

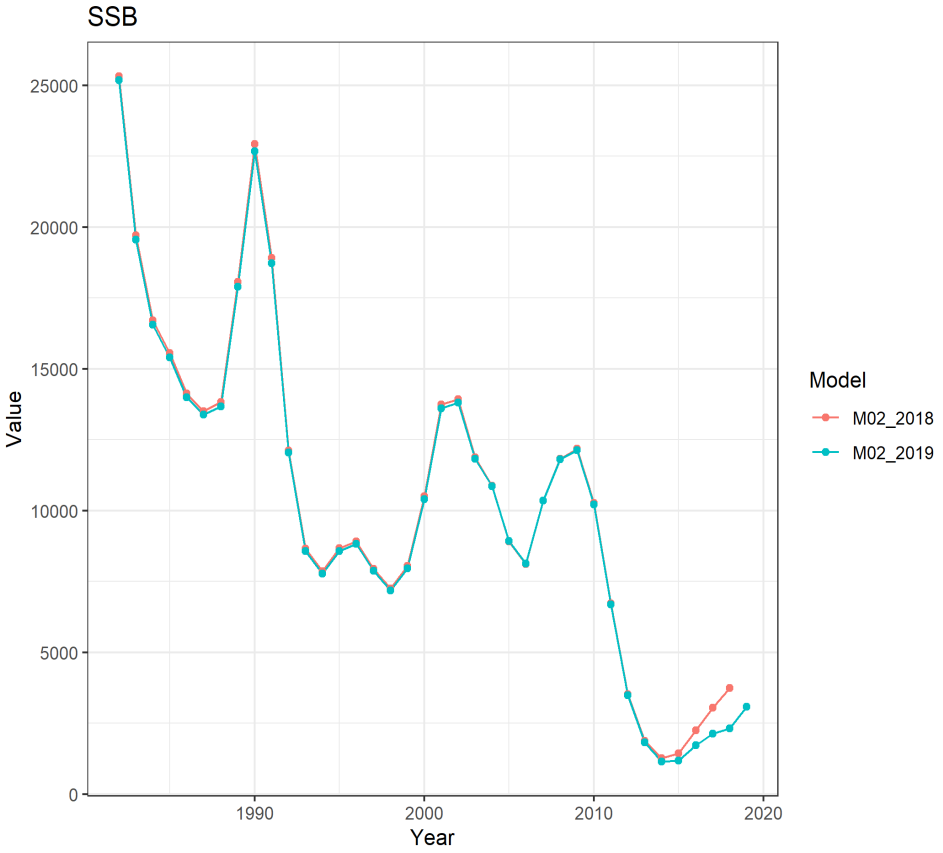
Model Inputs (2021 Management Track Update)

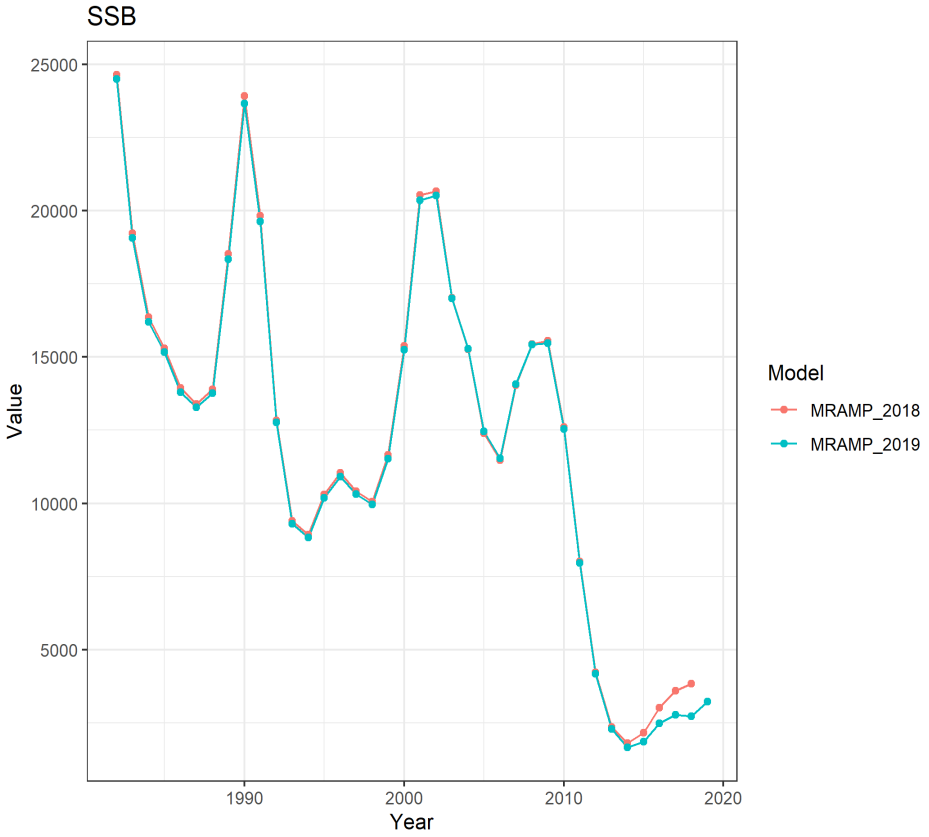
- Biology
  - Maturity-at-age (1982-2019 time series average)
  - Natural mortality differs across models (M=0.2 or M-ramp from 0.2→0.4)
  - Stock weights-at-age using the Rivard approach

- Fishery removals
  - Commercial landings and discards (ages 1-9^{+})
    - Discard mortality rate varies by gear
  - Recreational landings and discards (ages 1-9^{+})
    - Discard mortality rate = 15%
  - Catch weights-at-age

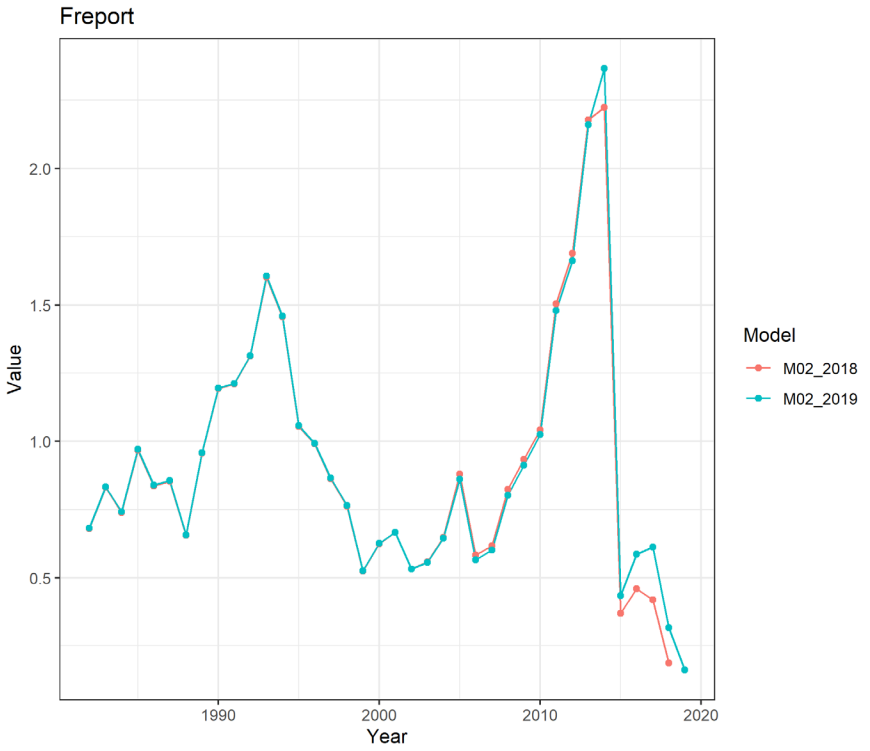
- Surveys
  - NEFSC spring and fall (ages 1-9^{+})
  - MADMF spring (ages 1-6)

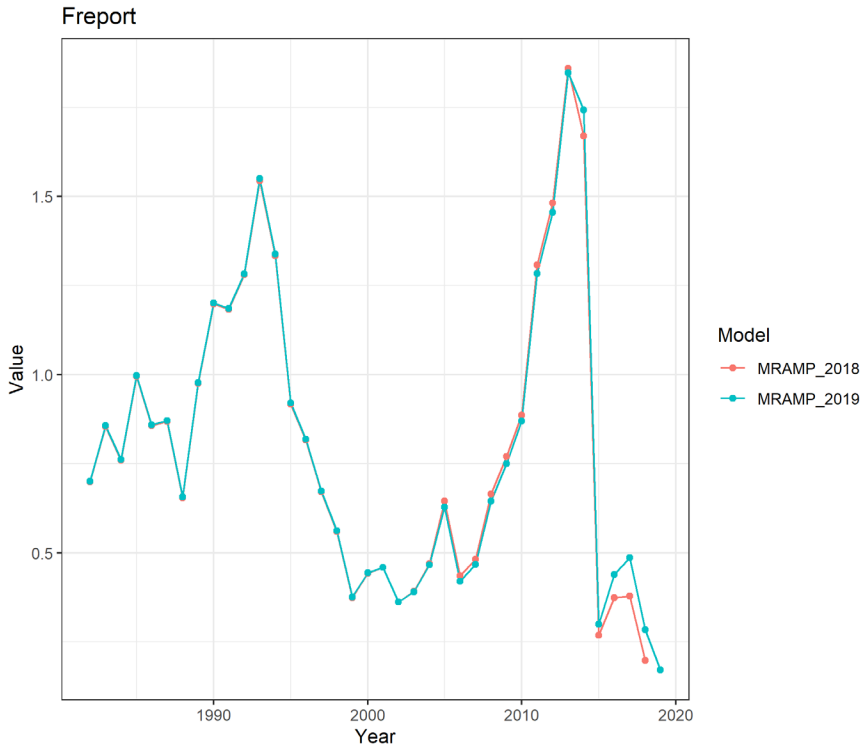
Model Results: comparison to last update





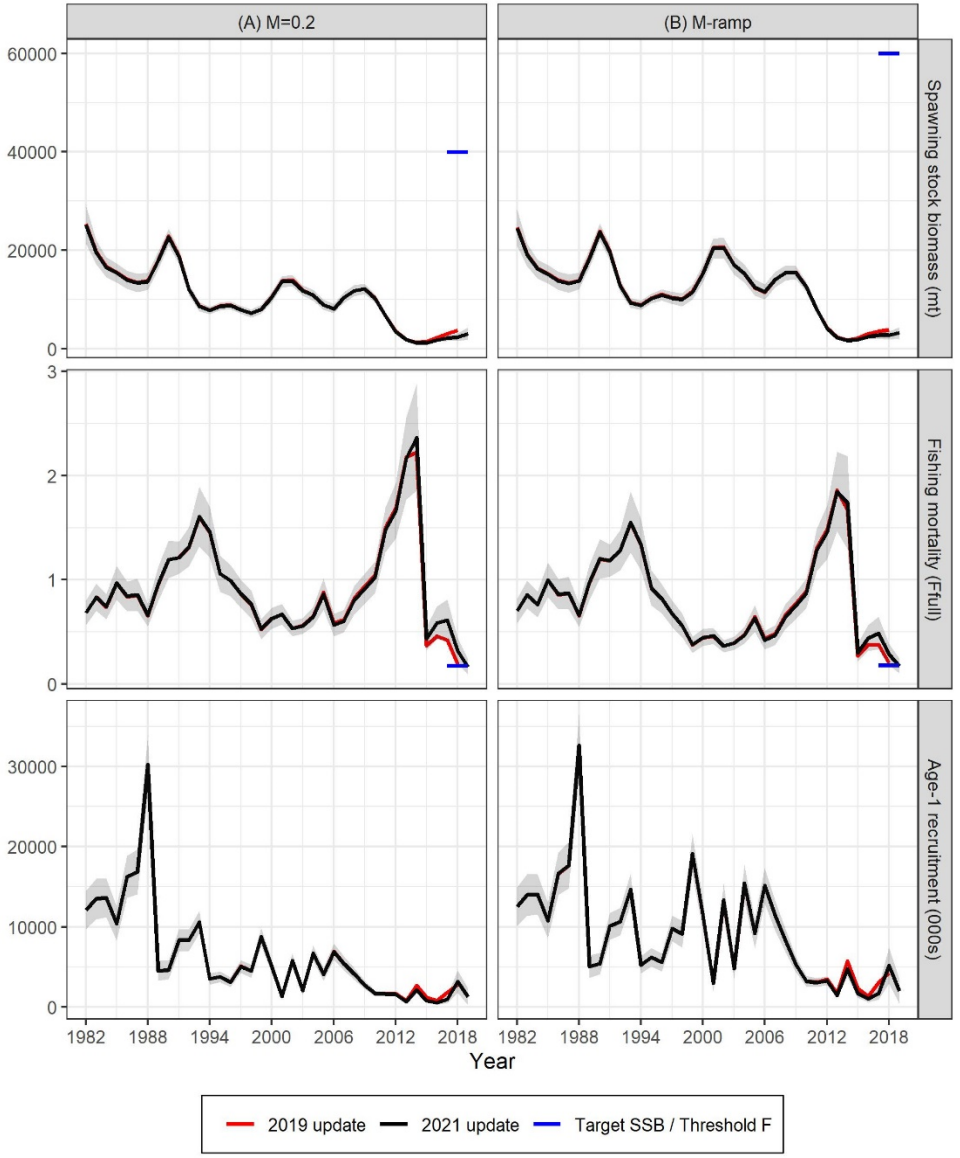
Model Results: comparison to last update





Model Results

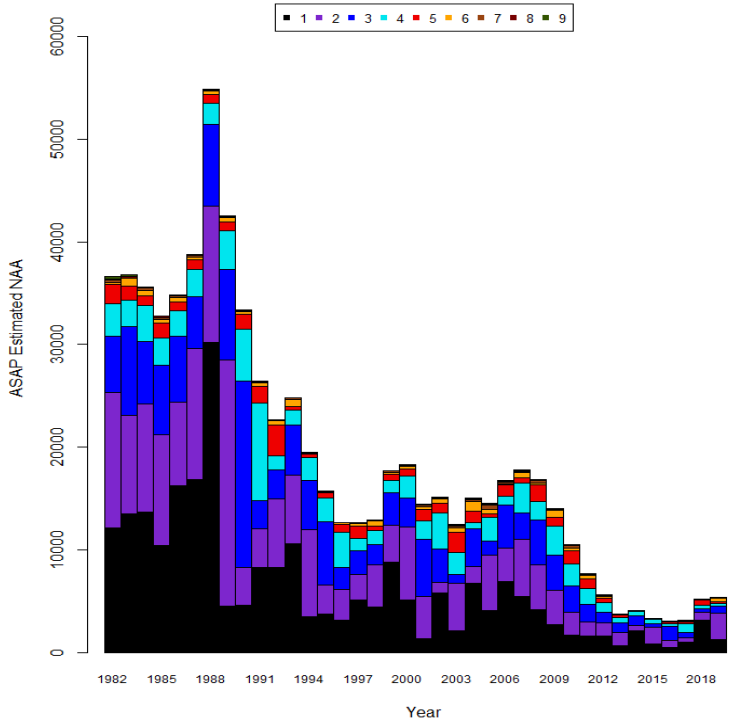
- Model results
  - 2021 update results are consistent with the 2019 update, but terminal year SSB has decreased compared to the 2019 update.
  - $SSB_{2019\ (terminal\ year)}$
    - M=0.2: 3,083 mt
    - M-ramp: 3,223 mt
  - $F_{2019\ (terminal\ year)}$
    - M=0.2: 0.162
    - M-ramp: 0.172
  - Recruitment
    - Continues to be low under both models



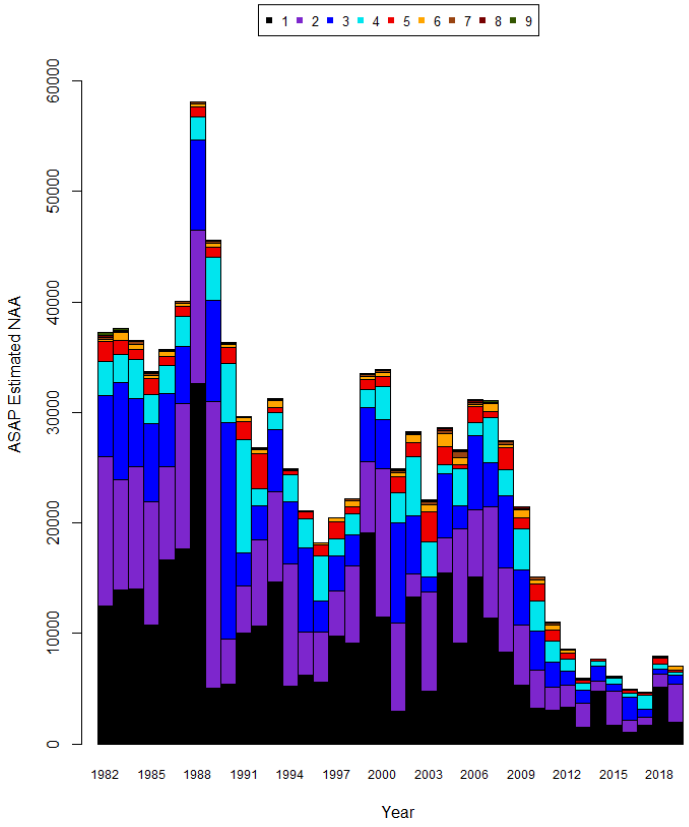
Model Results

- Numbers-at-age

M=0.2



M-ramp



Model Results

- Retrospective error (7-year peel)

M=0.2

Terminal year	Assessment	SSB	F
2012	SARC 55	0.47	-0.32
2013	2014 update	0.53	-0.33
2014	2015 update	0.54	-0.31
2016	2017 update	0.53	-0.31
2018	2019 MT	0.52	-0.29
2019	2021 MT	0.73	-0.35

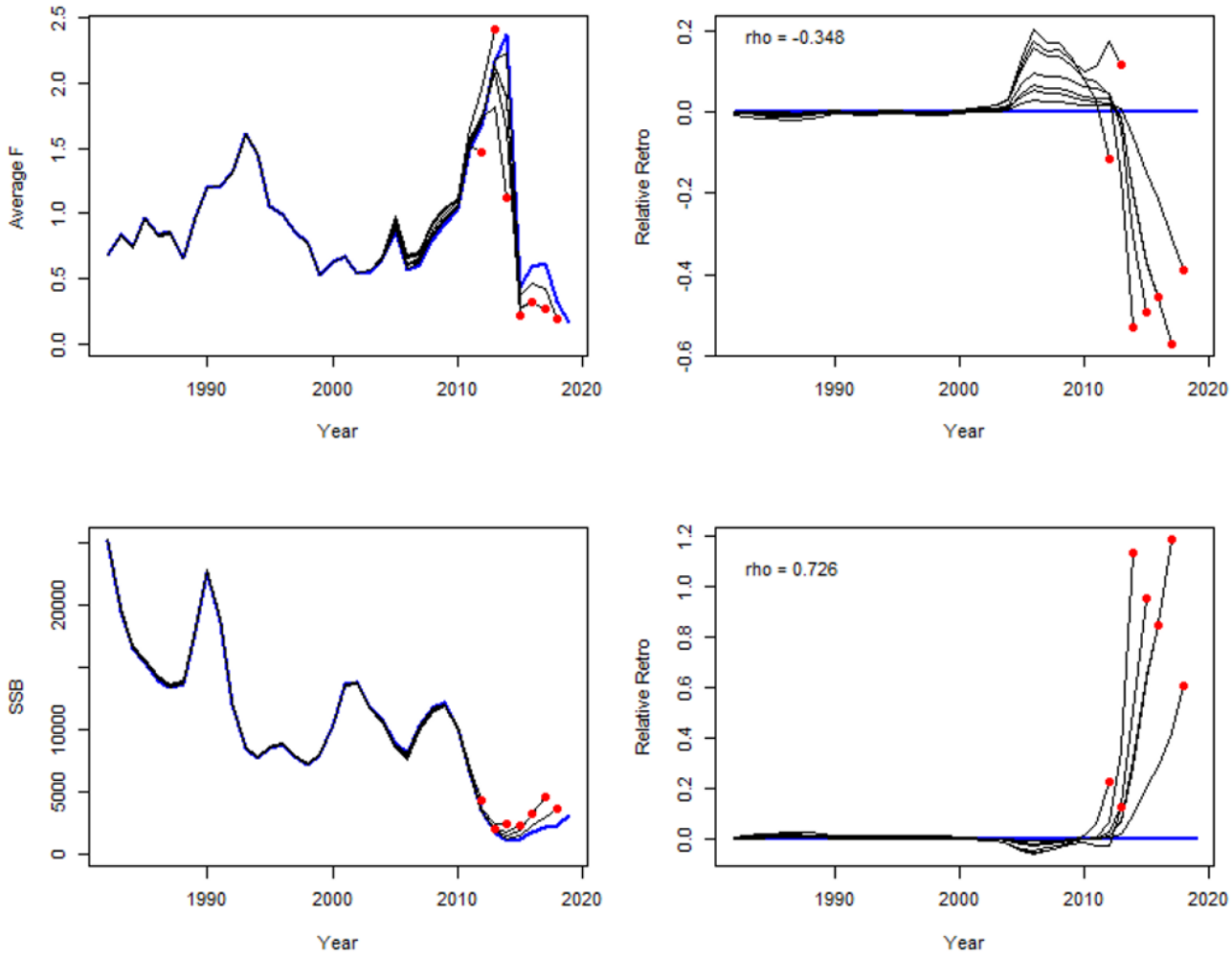
M-ramp

Terminal year	Assessment	SSB	F
2012	SARC 55	-0.01	0.04
2013	2014 update	0.17	-0.05
2014	2015 update	0.20	-0.08
2016	2017 update	0.30	-0.17
2018	2019 MT	0.29	-0.16
2019	2021 MT	0.42	-0.21

Model Results

- Retrospective error

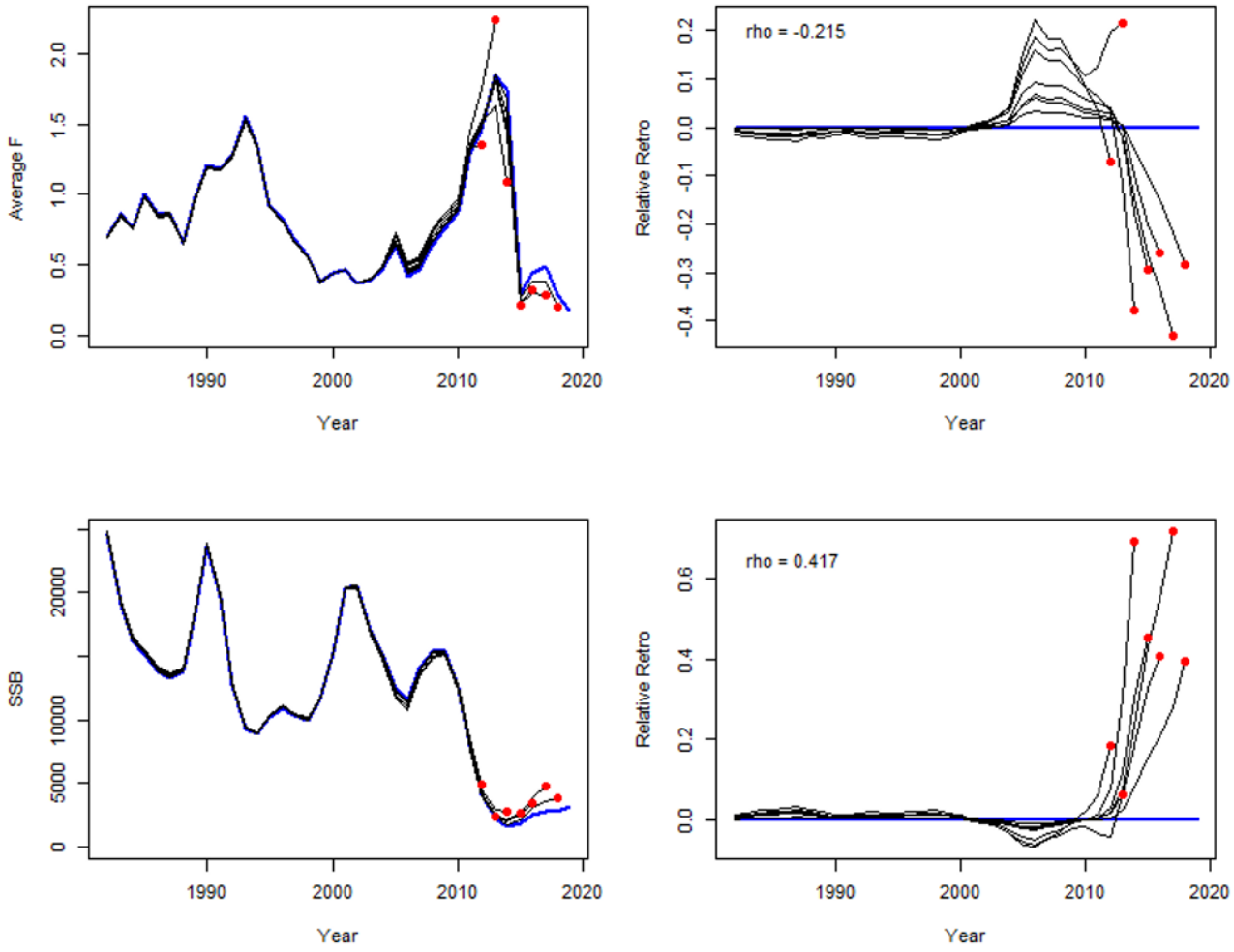
M=0.2



Model Results

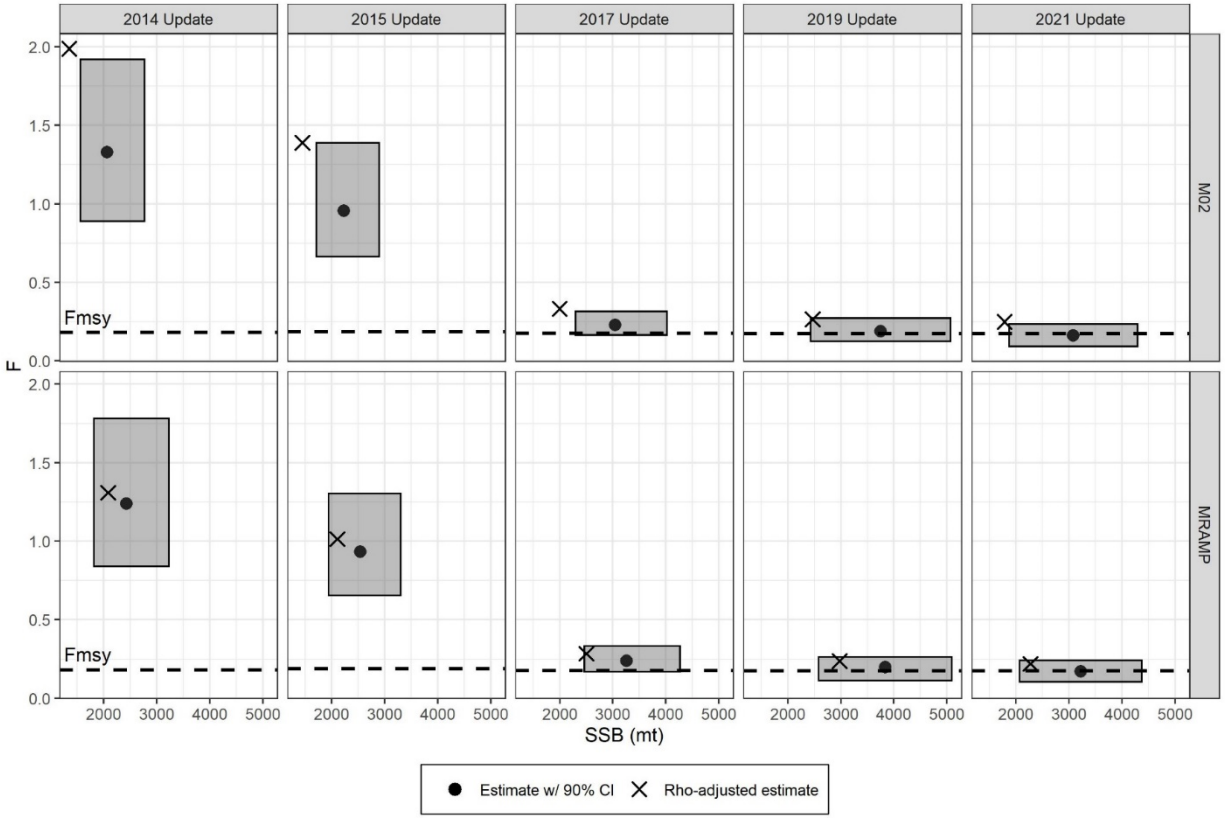
- Retrospective error

M-ramp



Model Results

- Retrospective error: M=0.2 – Major, M-Ramp – Minor

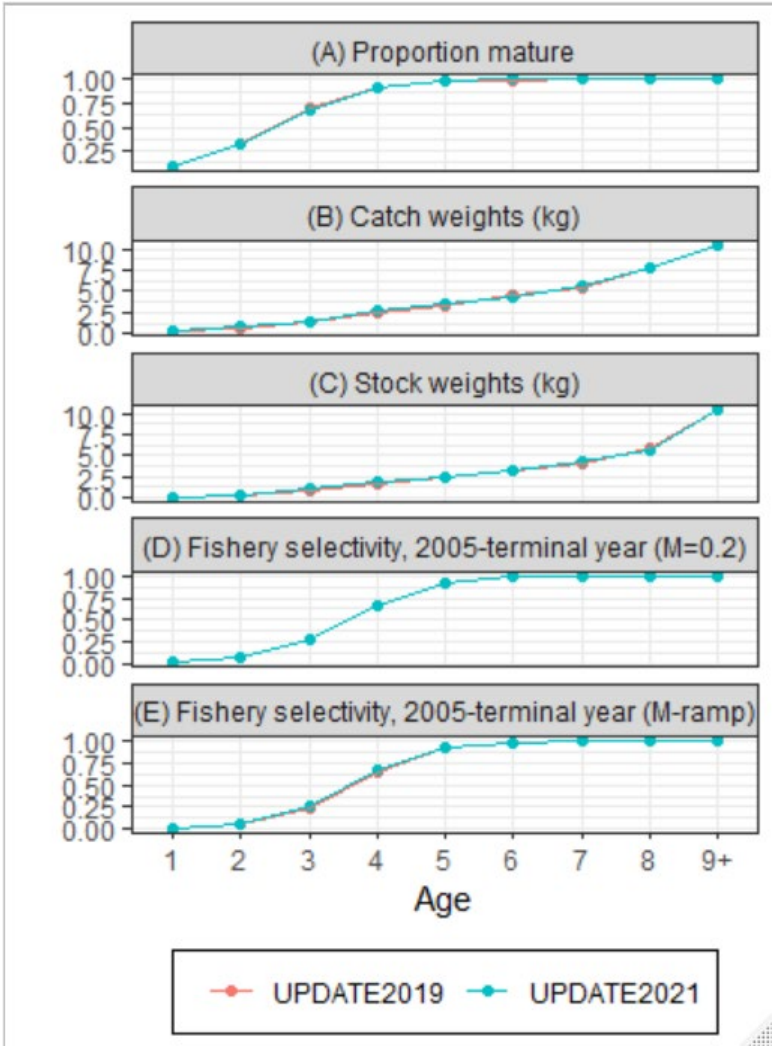


Model	Terminal year	Assessment	ssb.rho	f.rho	recr.rho	SSB	SSB_95_lo	SSB_95_hi	SSB_adjust	F	F_95_lo	F_95_hi	F_adjust
M=0.2	2019	2021 Update	0.726	-0.348	0.298	3083	1873	4293	1786	0.162	0.091	0.233	0.249
M-Ramp	2019	2021 Update	0.417	-0.215	0.025	3223	2073	4373	2275	0.172	0.103	0.241	0.219

Biological Reference Points (F_{MSY})

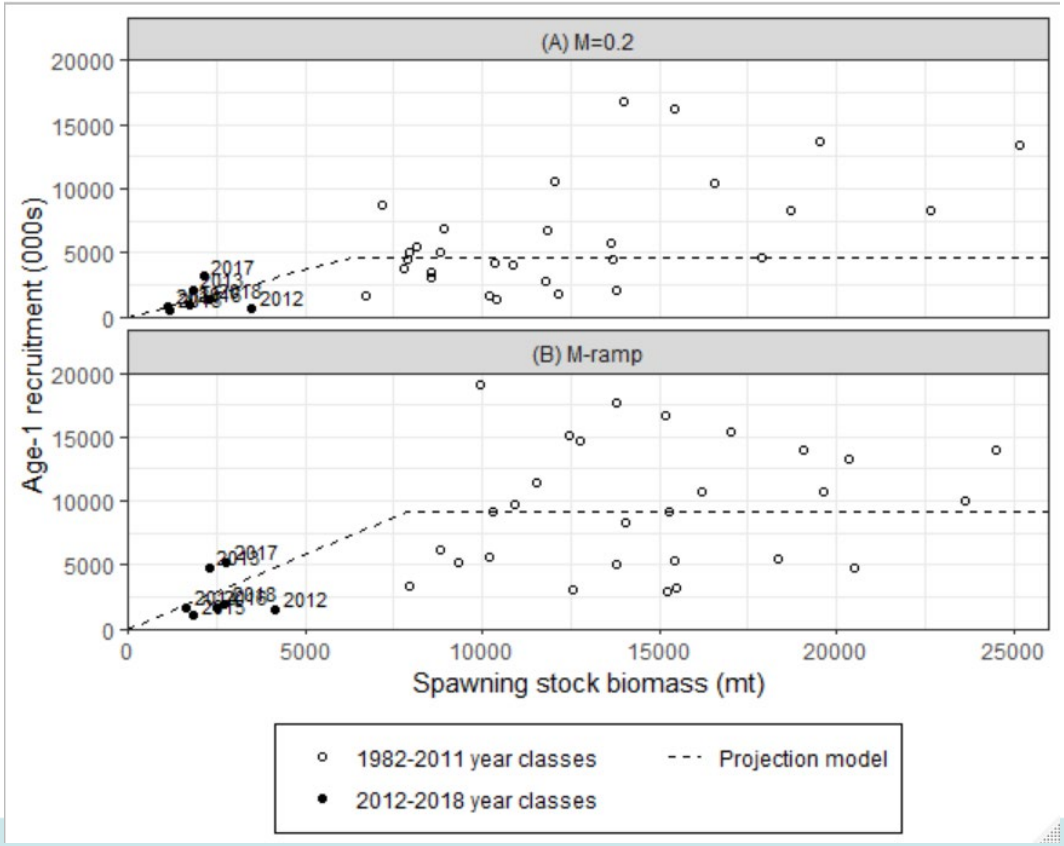
- Update $F_{40\%}$ F_{MSY} proxies
  - Natural mortality assumed equal to 0.2
  - Time series average maturity ogive
  - 3-year average of weights (2017-2019)
  - Last selectivity block (2004-2019)

Age	Natural mortality	Fraction mature	Jan1/SSB weights (kg)	Catch weights (kg)	Fishery selectivity (M = 0.2)	Fishery selectivity (M-ramp)
1	0.200	0.090	0.054	0.315	0.015	0.011
2	0.200	0.320	0.405	0.749	0.073	0.057
3	0.200	0.690	1.003	1.544	0.286	0.256
4	0.200	0.910	1.777	2.655	0.672	0.663
5	0.200	0.980	2.471	3.434	0.913	0.918
6	0.200	1.000	3.174	4.438	0.982	0.985
7	0.200	1.000	4.191	5.777	0.997	0.997
8	0.200	1.000	5.678	7.658	0.999	1.000
9^{+}	0.200	1.000	10.372	10.477	1.000	1.000



Biological Reference Points (SSB_{MSY})

- Update SSB_{MSY} proxies
  - Based on 100 year projections run at the F_{MSY} proxy
  - Projection model samples from CDF of recruitment from 1982-2017
    - When SSB is below a hinge point recruitment declines linearly to zero
      - M=0.2: 6,300 mt, M-ramp: 7,900 mt



Stock Status

- According to M=0.2 model, overfishing is occurring.
- According to M-ramp model, overfishing is not occurring, but it very close to the threshold.
- Both models indicate the stock is overfished.

Proxy reference points	M=0.2 (retro-adjusted)	M-ramp
$F_{full,\ 2019}$	0.249	0.172
F_{MSY}	0.173	0.175
$F_{full,\ 2019}/F_{MSY}$	1.44	0.98
Overfishing	**Yes**	**No**
SSB_{2019} (mt)	1,786	3,223
SSB_{MSY} (mt)	39,912	60,010
SSB_{2019}/SSB_{MSY}	0.04	0.05
Overfished	**Yes**	**Yes**
MSY (mt)	7,171	10,873
Median age1 recruitment (000s)	4,494	8,790

Short-term Projections

- Short-term projections chosen by the 2021 MT Review Panel:
  - M=0.2: retro-adjusted projection
  - M-ramp: M=0.4 short-term natural mortality

  - All projections run at F_{MSY}
  - Assumed 2020 & 2021 catch of 409 mt & 523 mt (*NEFMC PDT*)
  - 2021 catch is set to the total ACL

Year	Input	M=0.2 model			M-ramp model		
		Retrospective adjustment			M=0.4		
		Catch (mt)	Spawning stock biomass (mt)	F_{full}	Catch (mt)	Spawning stock biomass (mt)	F_{full}
2019	Model result	497	1,969	0.266	497	3,223	0.172
2020	Assumed catch	409	2,635	0.162	409	3,925	0.119
2021	Assumed catch	523	3,599	0.137	523	4,759	0.113
2022	Projection	821	4,508	0.173	892	5,254	0.175
2023	Projection	959	5,488	0.173	919	5,707	0.175
2024	Projection	1,244	7,279	0.173	1,071	6,802	0.175

Summary

- Consistent signals across data sources, models and approaches
- Fishery and survey data continue to show few old fish and few incoming recruits
- Survey indices and percent occurrence remain low
- Stock remains overfished
- Not clear whether overfishing status has changed

Georges Bank Cod

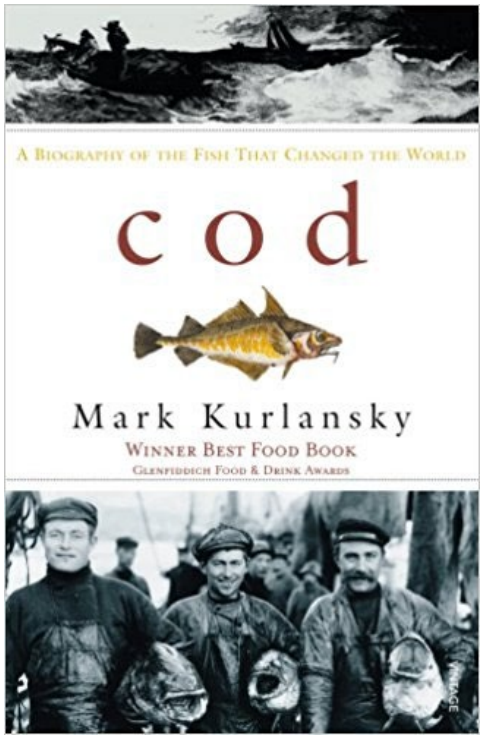
NOAA FISHERIES

- NEFSC

- Katherine Sosebee
- With lots of help from Chris Legault and Charles Peretti

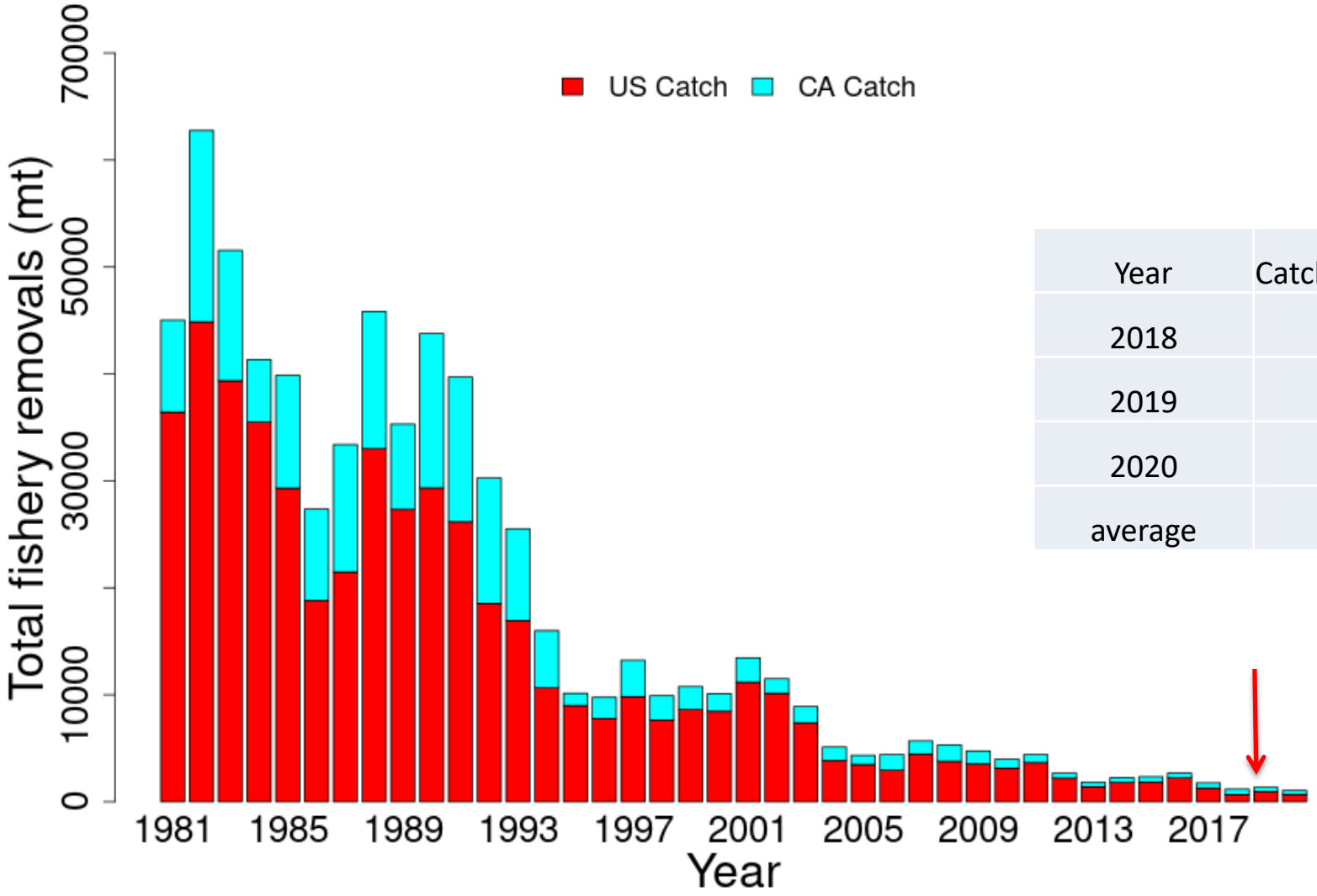
- NEFMC SSC Meeting
- 25 October 2021

Background

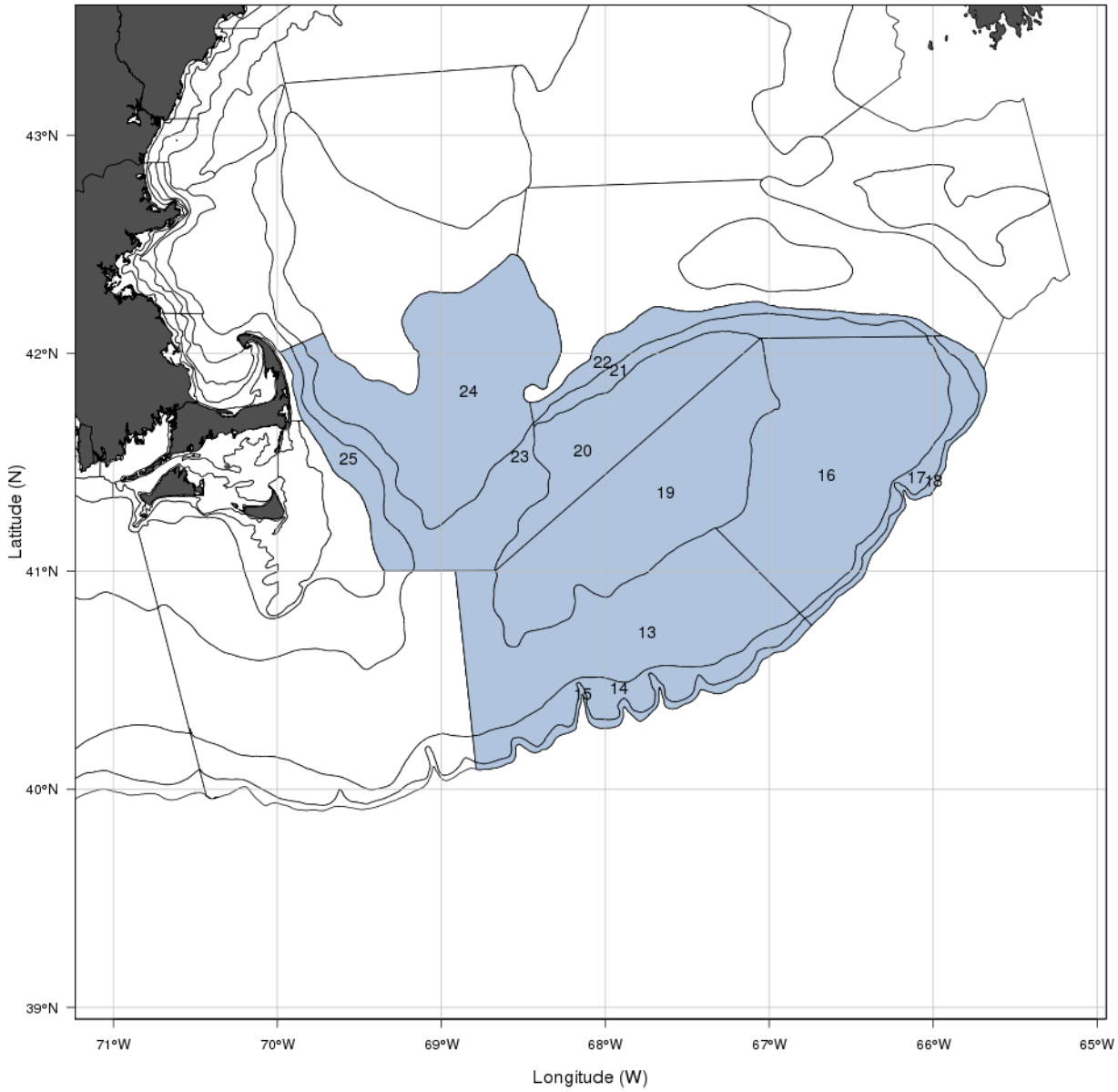


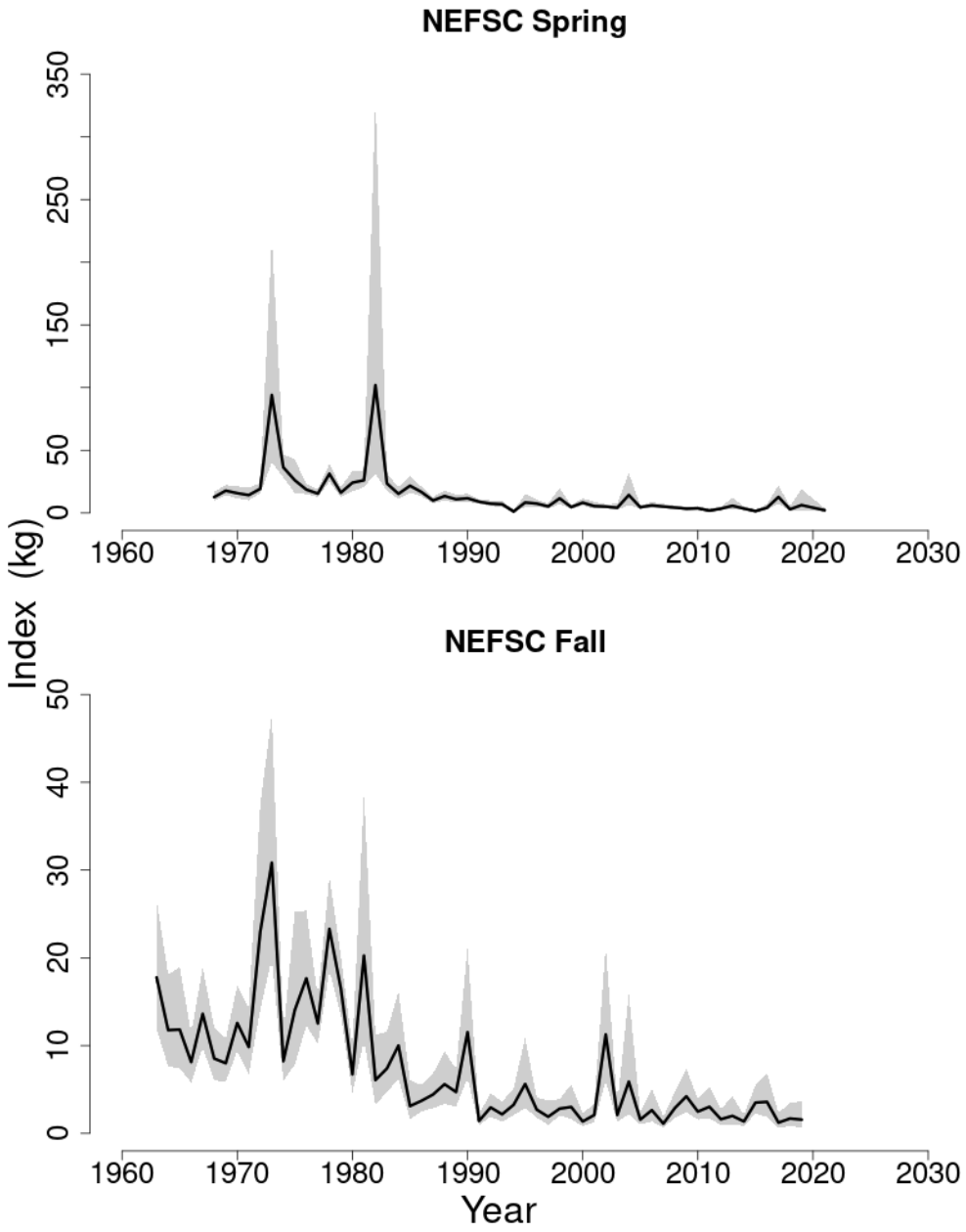
- Fishery for GB cod since 1700s
- 2012 SARC 55 benchmark
  - ASAP with retrospective adjustment
- 2015 groundfish update
  - ASAP not accepted
  - Smoothing approach developed during meeting
    - Change in survey applied to recent catch
- 2017 and 2019 groundfish updates
  - Used same smoothing approach
  - 2019 Overfished, overfishing unknown

Catch

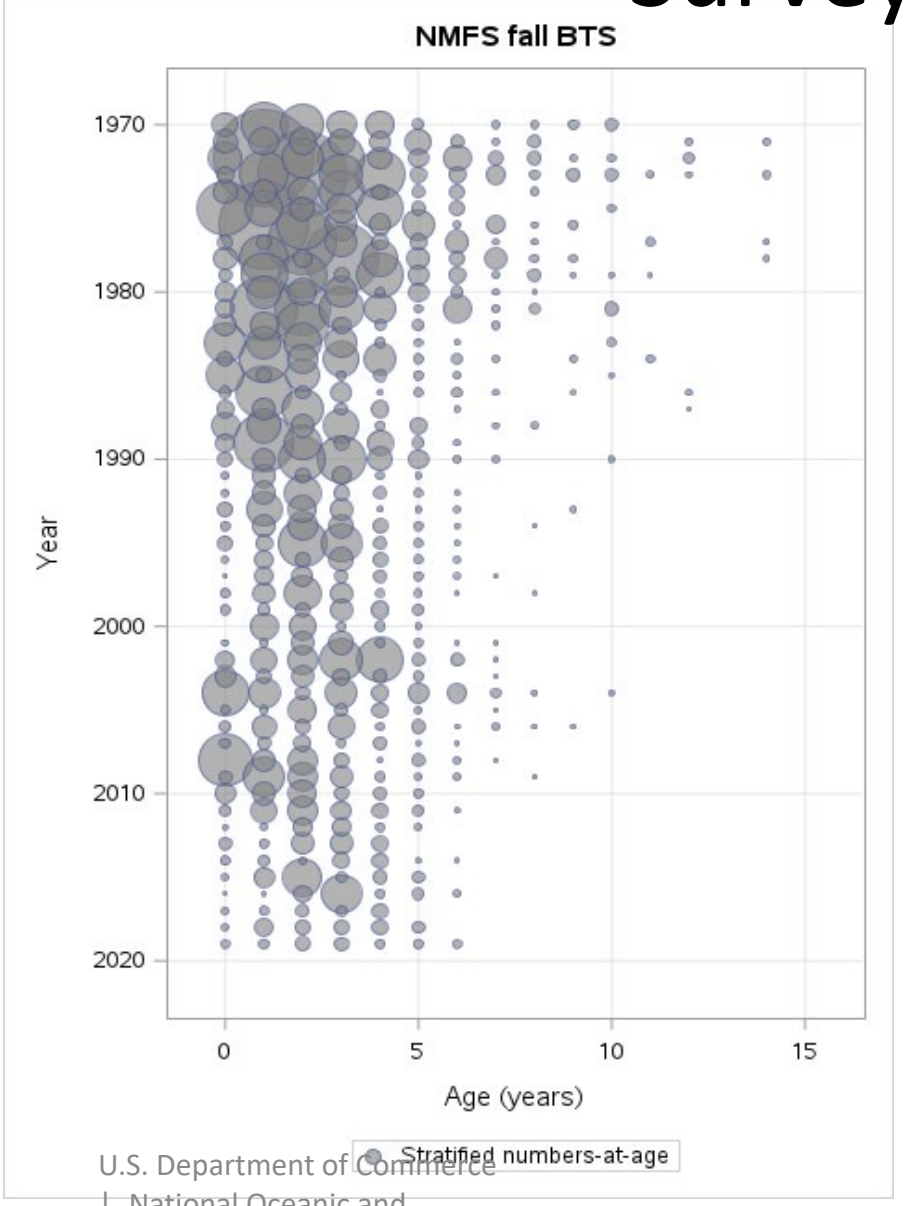


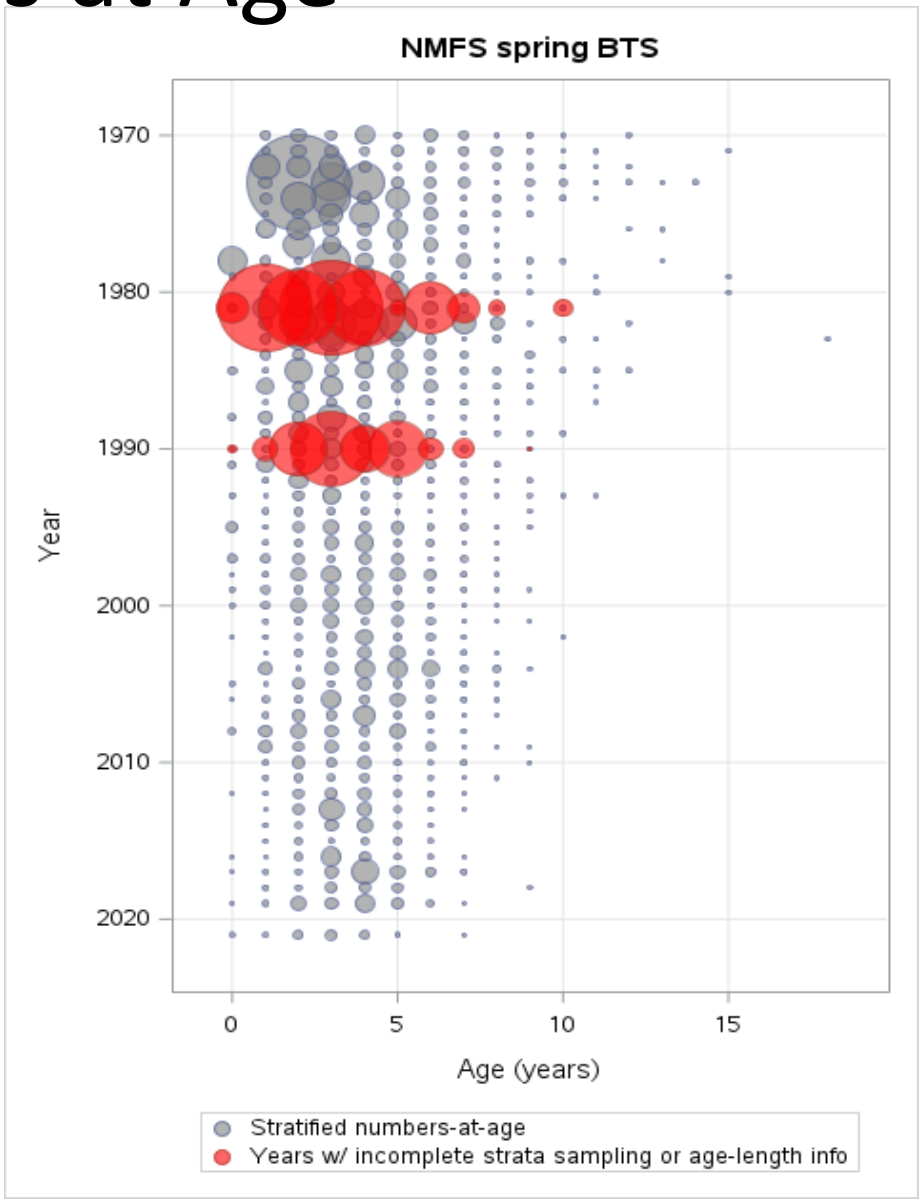
Year	Catch (mt)
2018	1,183
2019	1,344
2020	1,053
average	1,193


43°N
42°N
41°N
40°N
39°N
Latitude (N)
71°W
70°W
69°W
68°W
67°W
66°W
65°W
Longitude (W)
24
22
21
25
23
20
19
16
17
18
13
15
14


NEFSC Spring
NEFSC Fall
Index (kg)
0
50
150
250
350
0
10
20
30
40
50
1960
1970
1980
1990
2000
2010
2020
2030
Year

Surveys at Age





PlanBsmooth

- R package to apply agreed smoothing
  - https://github.com/cmlegault/PlanBsmooth
- Average surveys (bring fall forward one year)
- Loess smooth
  - 33 years
  - 0.3 span
- Log-linear regression of recent 3 smoothed points
  - Rate of change recently
- Retransform and apply as multiplier to average of 3 years catch

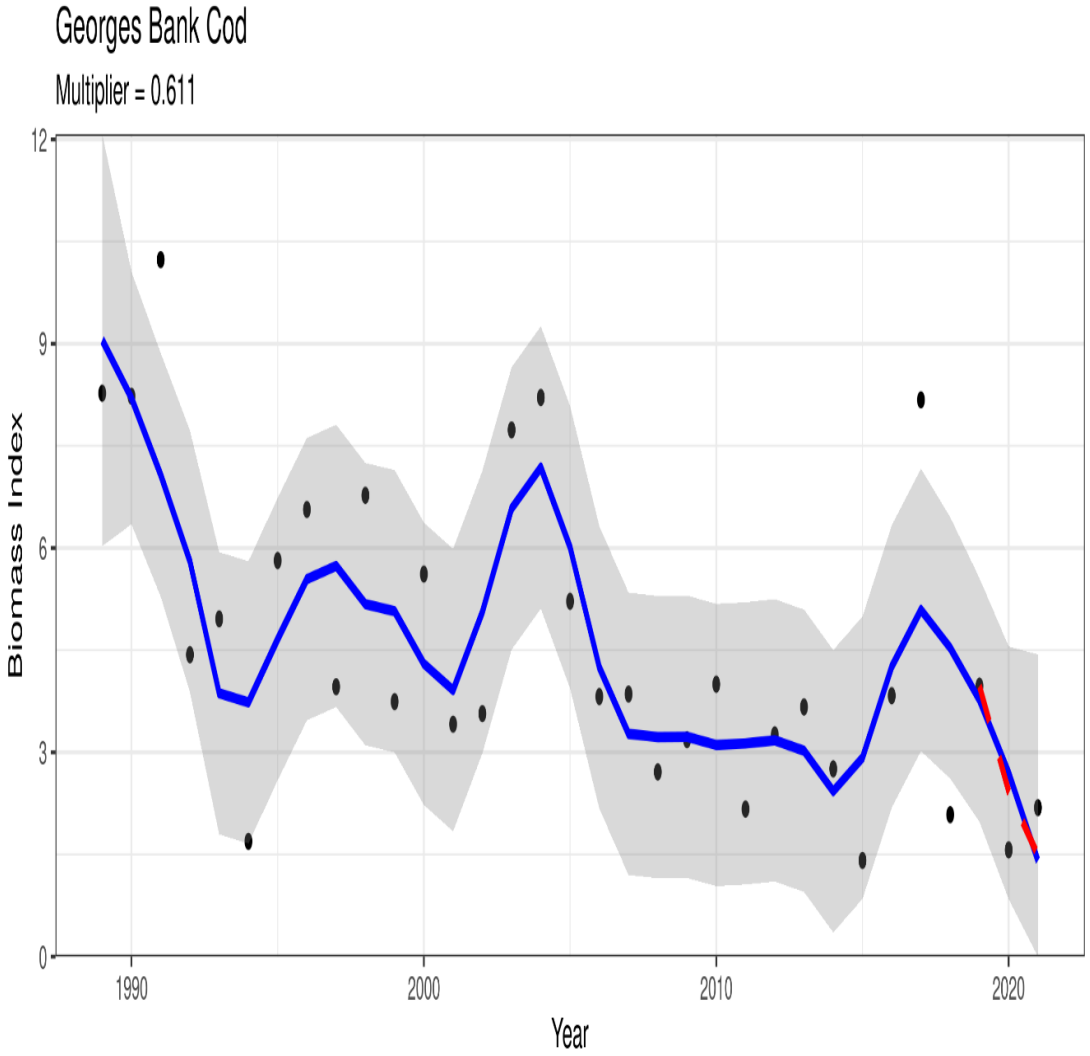
- PlanBsmooth can handle missing information
  - Last two survey values based on one survey only
  - 2020 catch provided by Groundfish PDT

Year	Spring	Fall	Average	Catch
2018	U	V		D
2019	W	X	V,W	E
2020	NA	NA	X,NA	F
2021	A	NA	NA,A	

Simulations were run to examine the impact of missing survey data on PlanBsmooth. There were not large impacts found. This analysis and code is available on GitHub https://github.com/cmlegault/PlanBsmooth_missing_data

GB Cod PlanBsmooth Applied

- Black dots = average survey biomass
- Blue line = loess smooth
- Grey area = 95% confidence interval for loess smooth
- Red dashed line = retransformed log-linear fit to recent 3 years of smoothed data



GB Cod PlanBsmooth Esti

- avg = average survey biomass
- pred = loess smooth
- loci, hici = 95% confidence interval for loess smooth

Year	avg	pred	loci	hici
1989	8.272	9.052	6.029	12.076
1990	8.227	8.202	6.348	10.056
1991	10.234	7.074	5.286	8.863
1992	4.432	5.804	3.885	7.723
1993	4.959	3.866	1.794	5.938
1994	1.692	3.732	1.660	5.804
1995	5.815	4.661	2.589	6.733
1996	6.565	5.542	3.470	7.615
1997	3.962	5.736	3.664	7.809
1998	6.773	5.175	3.103	7.247
1999	3.744	5.071	2.999	7.143
2000	5.616	4.299	2.227	6.371
2001	3.412	3.912	1.840	5.984
2002	3.567	5.058	2.986	7.130
2003	7.733	6.580	4.507	8.652
2004	8.209	7.182	5.110	9.255
2005	5.216	6.012	3.939	8.084
2006	3.818	4.247	2.175	6.319
2007	3.855	3.270	1.198	5.342
2008	2.711	3.223	1.151	5.295
2009	3.185	3.227	1.155	5.299
2010	3.998	3.107	1.035	5.179
2011	2.166	3.130	1.057	5.202
2012	3.255	3.175	1.103	5.248
2013	3.665	3.022	0.950	5.094
2014	2.756	2.428	0.356	4.501
2015	1.412	2.919	0.846	4.991
2016	3.830	4.257	2.185	6.329
2017	8.175	5.090	3.018	7.162
2018	2.084	4.532	2.613	6.451
2019	3.971	3.768	1.979	5.556
2020	1.566	2.698	0.844	4.552
2021	2.186	1.409	-1.617	4.435

GB Cod PlanBsmooth Applied

- Average recent catches
- Apply multiplier
- Catch advice for 2022

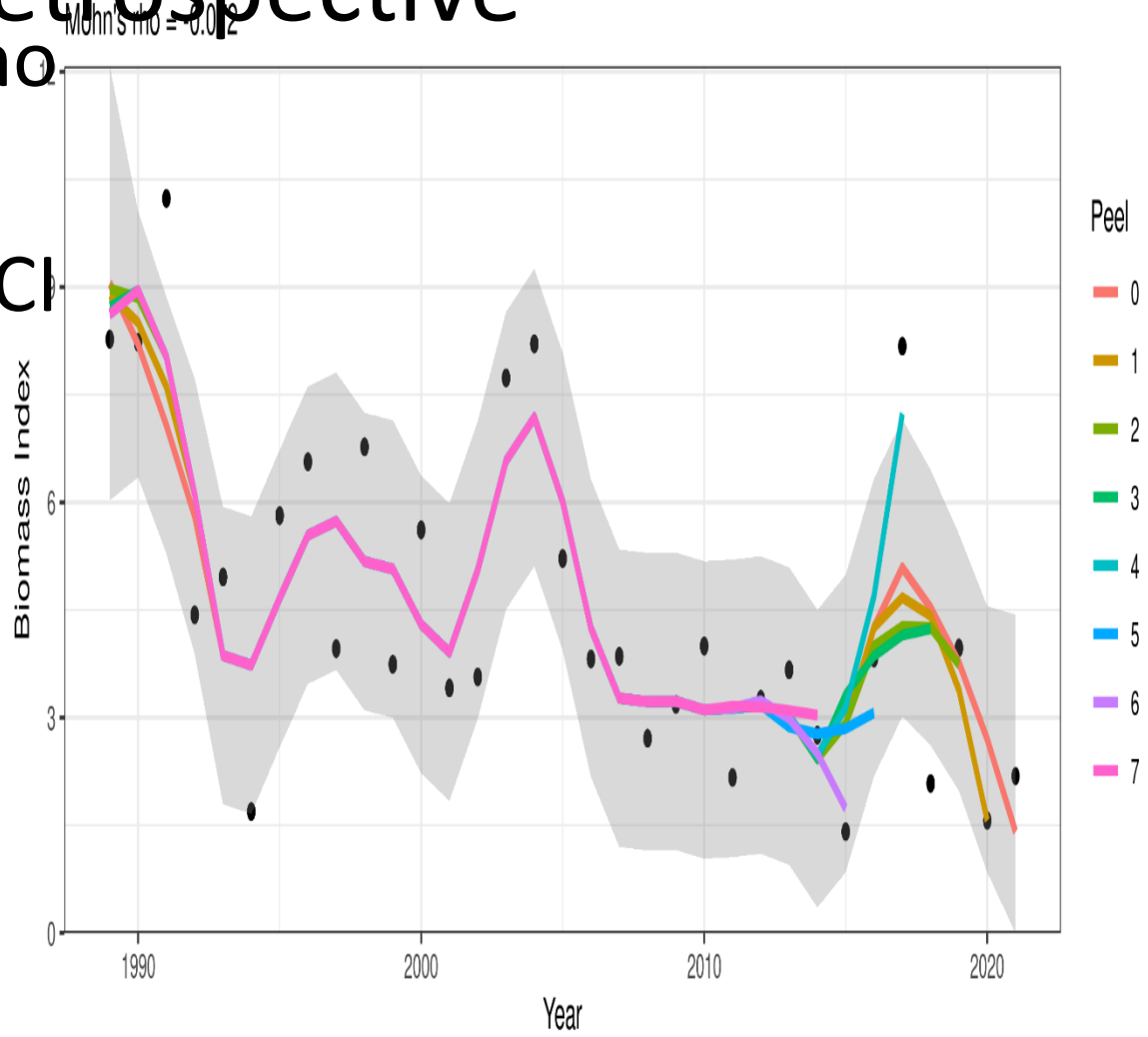
Year	Catch (mt)
2018	1,183
2019	1,344
2020	1,053
average	1,193
multiplier	0.611
catch advice	729

PlanBsmooth caveats

- Not a dynamic model
  - No reference points or projections
  - Cannot predict future responses
- Survey noise may not be sufficiently handled by averaging surveys and using loess smooth
  - Smoothers most uncertain at ends of time series
- Large changes (multipliers) possible
- If catch not close to quota, then could have large change in quota even with multiplier close to one
- Missing data from 2020 means autumn survey only 2020 index (lagged from 2019) and spring 2021 only 2021 index.

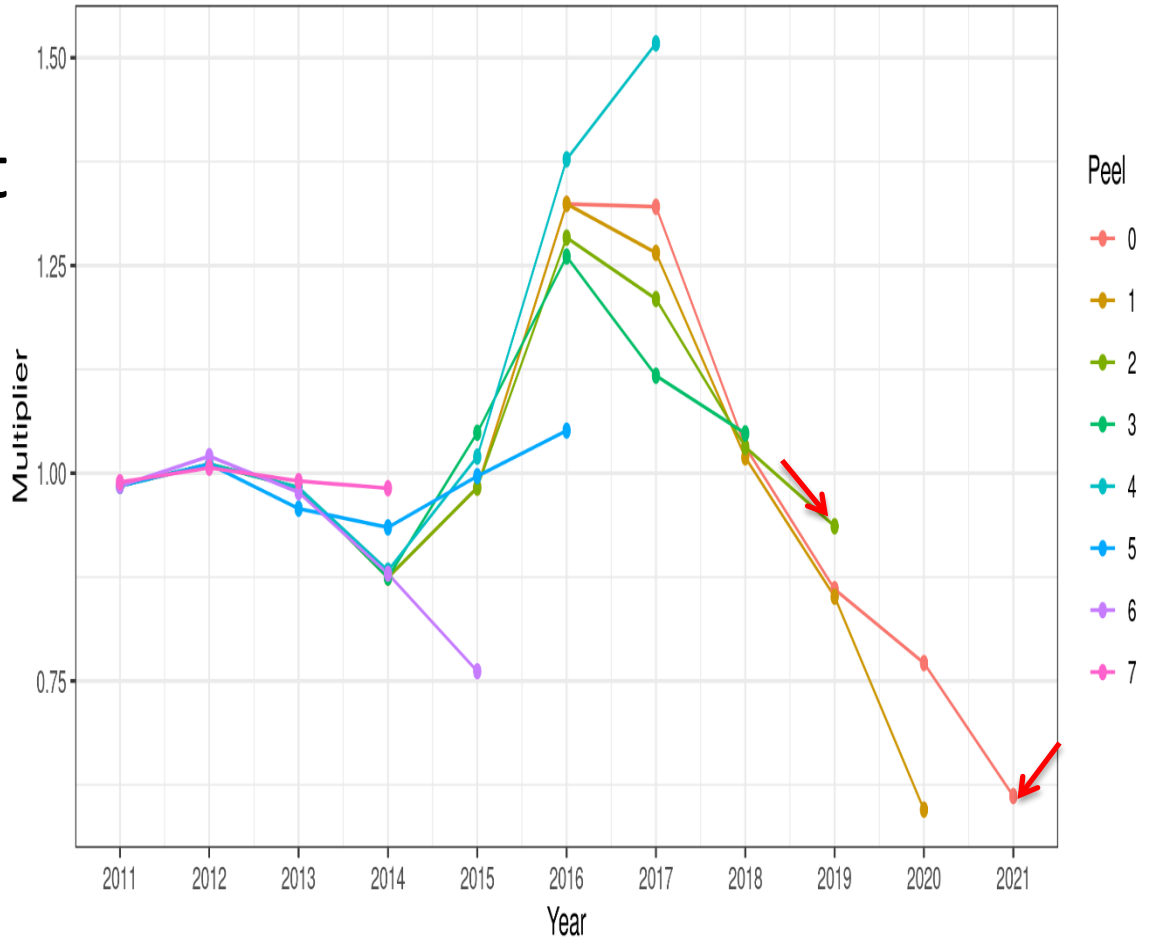
GB Cod PlanBsmooth Loess Retrospective

- Small Mohn's rho -0.072
- Peels all within CI
- No directional pattern



GB Cod PlanBsmooth Multiplier Retrospective

- No systematic pattern
- Change from last update: 2019 multiplier was 0.936



Sensitivity Run

Without imputing

Year	Spring	Fall	Average	Catch
2018	U	V		D
2019	W	X	V,W	E
2020	NA	NA	X,NA	F
2021	A	NA	NA,A	

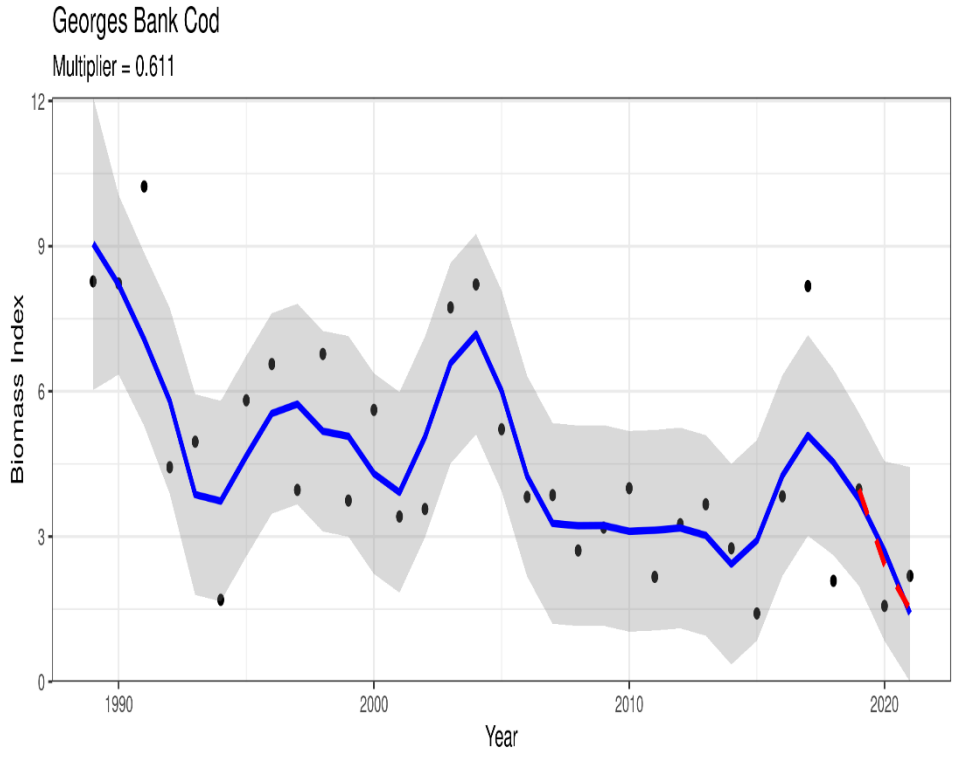
Year	Spring	Fall	Average	Catch
2018	2.94	1.69		D
2019	6.25	1.57	3.97	E
2020	NA	NA	1.57	F
2021	2.19	NA	2.19	

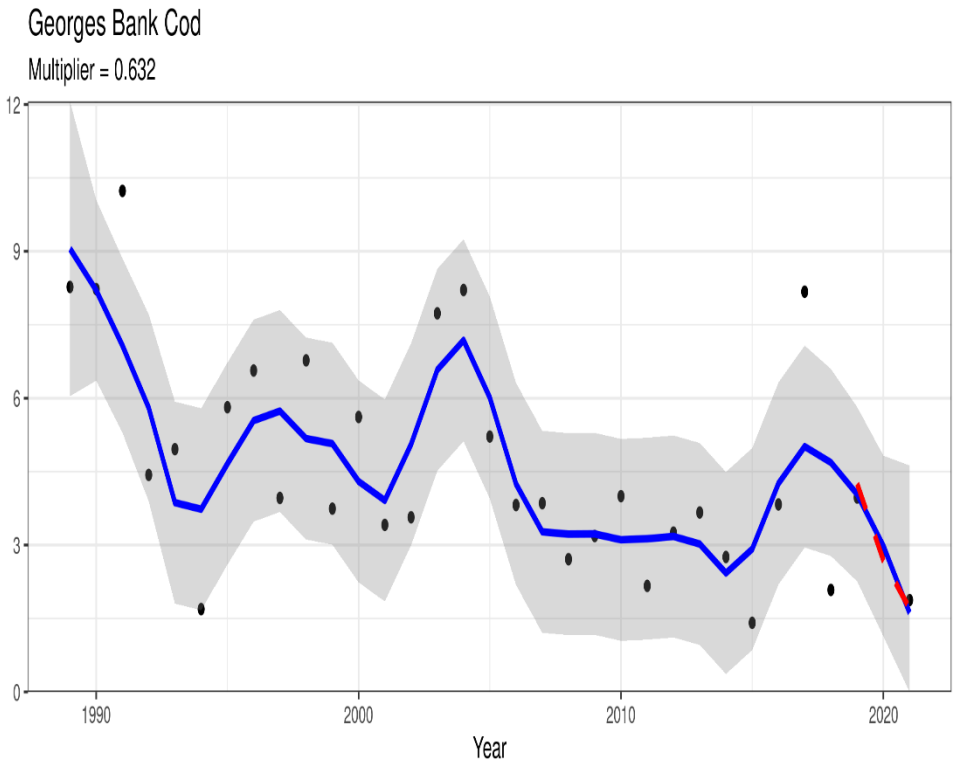
With imputing
2020 fall = 2019 fall
2020 spring = avg(2019 and 2021)

Year	Spring	Fall	Average	Catch
2018	U	V		D
2019	W	X	V,W	E
2020	Avg(W,A)	X	X,avg(W,A)	F
2021	A	NA	X,A	

Year	Spring	Fall	Average	Catch
2018	2.94	1.69		D
2019	6.25	1.57	3.97	E
2020	4.22	1.57	2.89	F
2021	2.19	NA	1.88	

Sensitivity Run





Year	Catch (mt)		Catch (mt)
2018	1,183		1,183
2019	1,344		1,344
2020	1,053		1,053
average	1,193		1,193
multiplier	0.611		0.632
catch advice	729		754

Questions?