# Georges Bank Cod

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With lots of help from Chris Legault and Charles Peretti

NEFMC SSC Meeting

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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
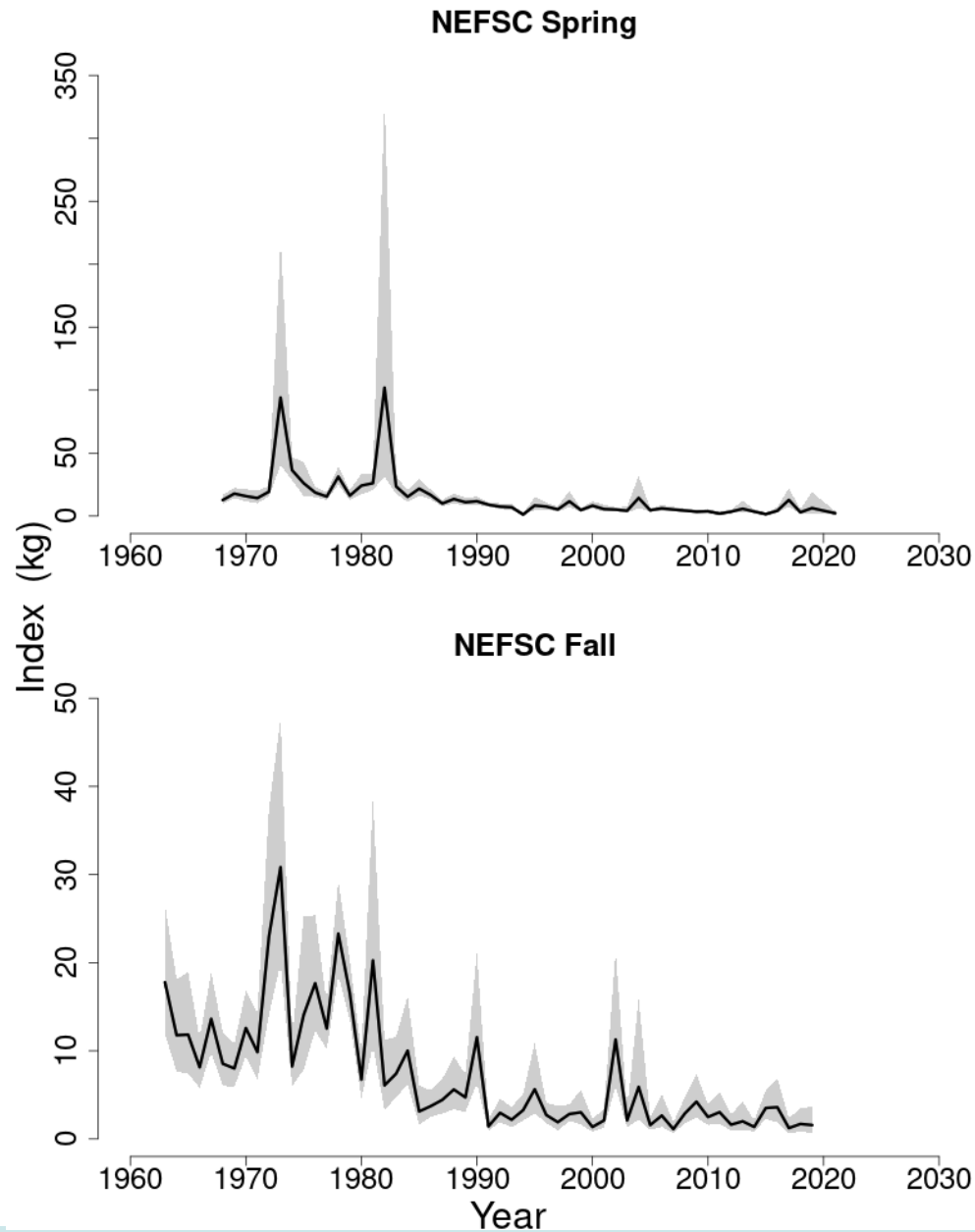 - 2019 Overfished, overfishing unknown
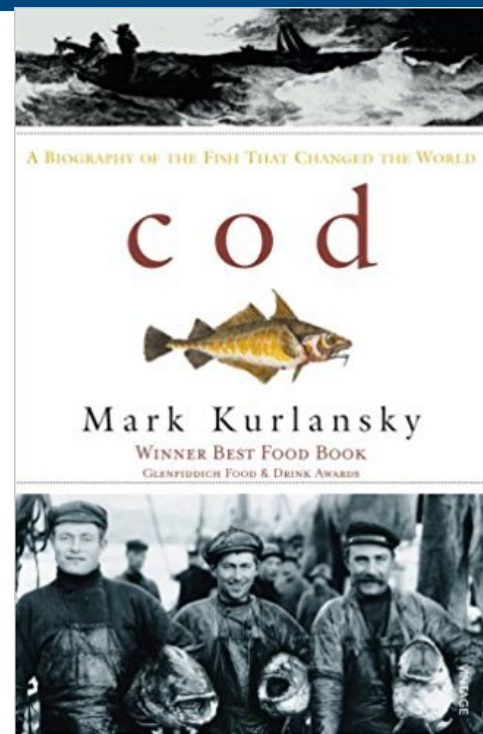
Catch
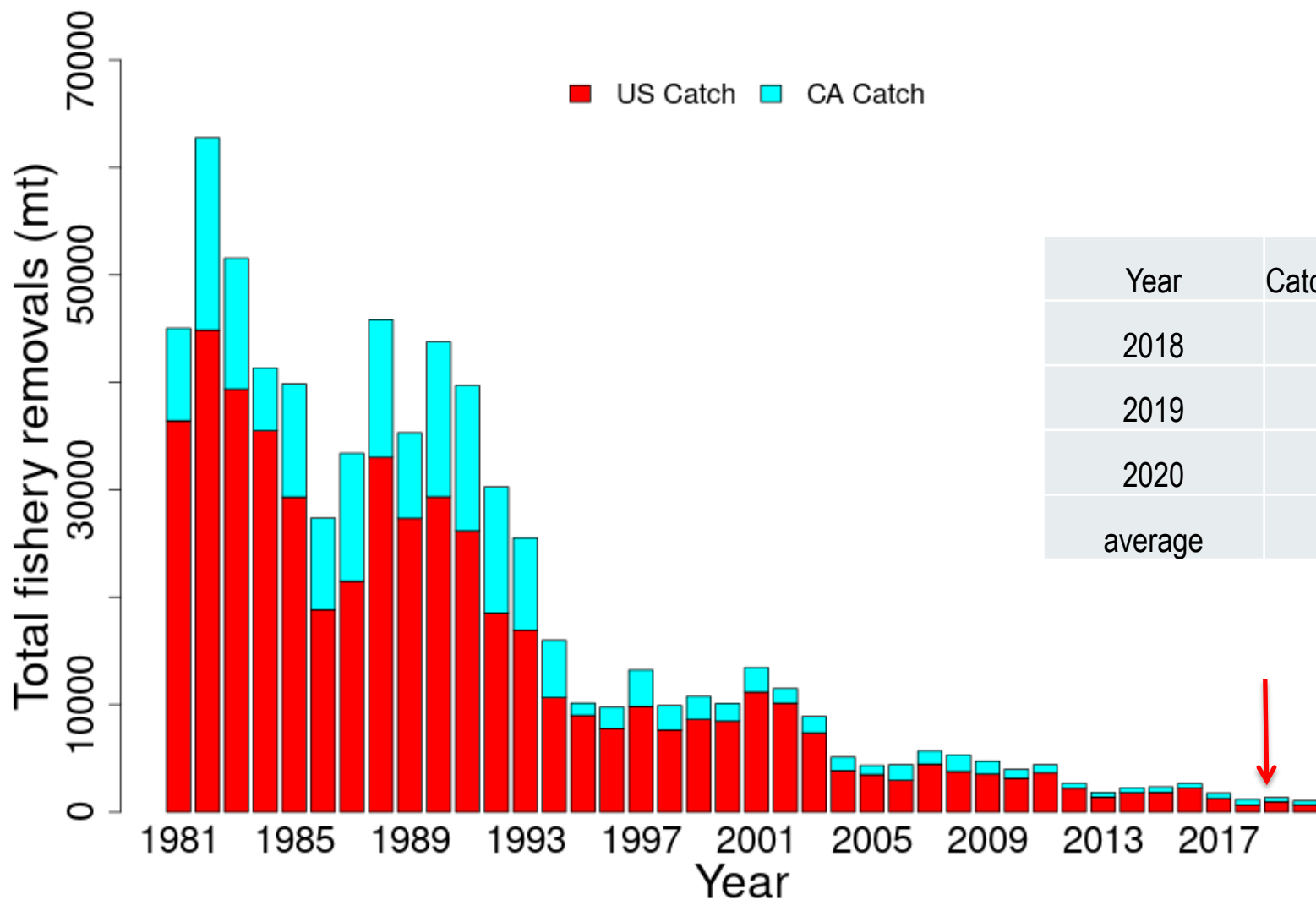
Year	Catch (mt)
2018	1,183
2019	1,344
2020	1,053
average	1,193
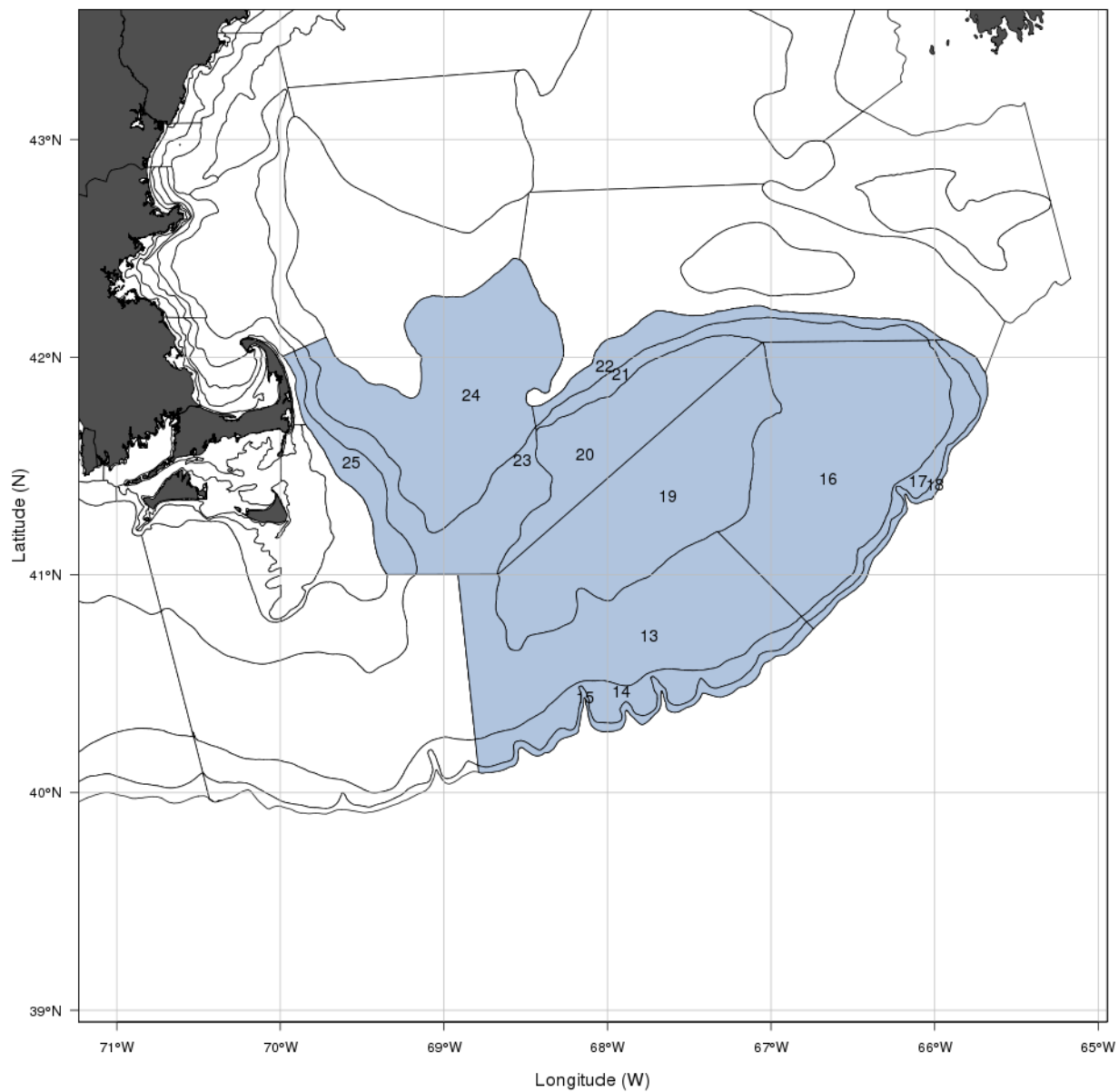
Surveys

Surveys at Age
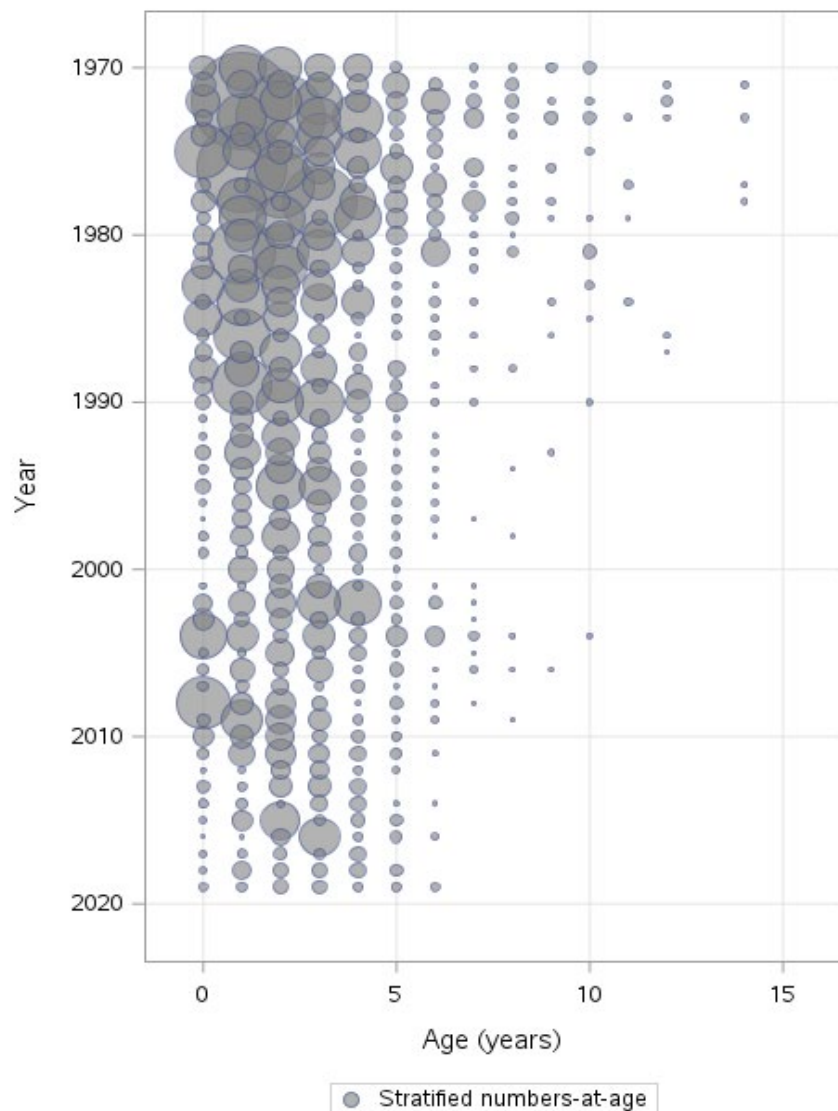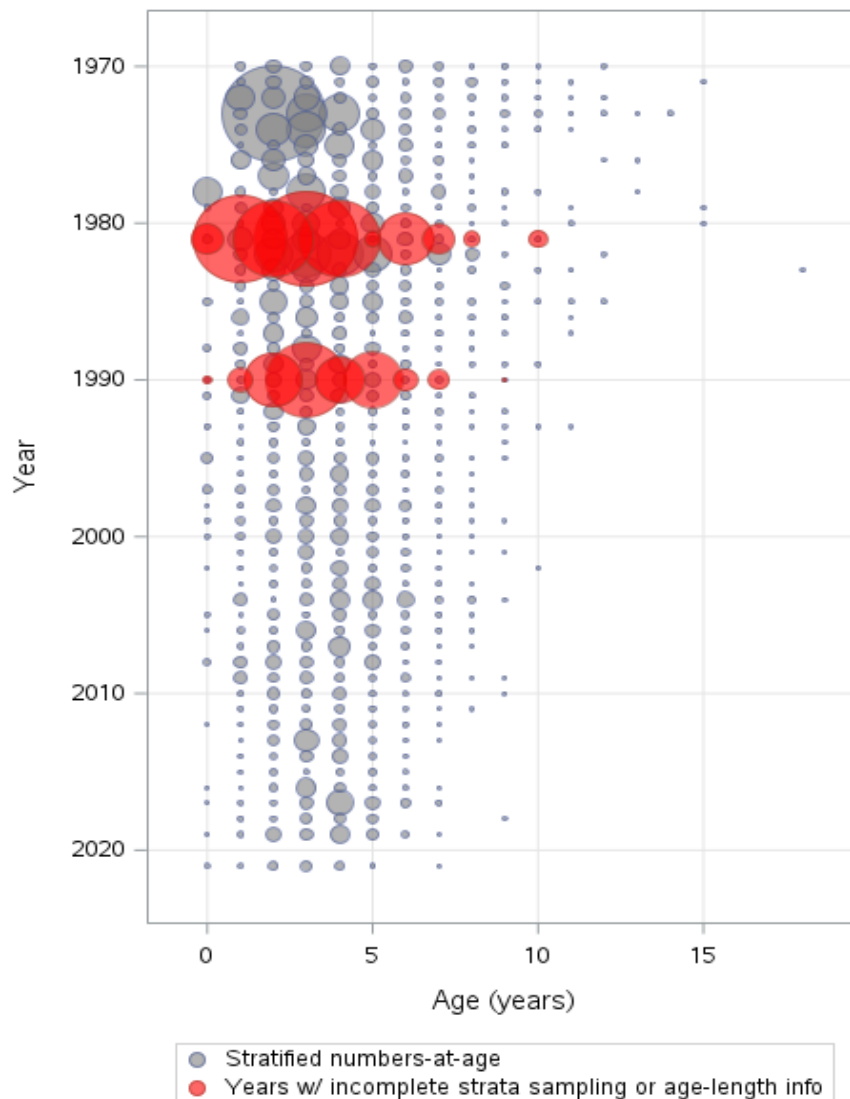
PlanBsmooth

- 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
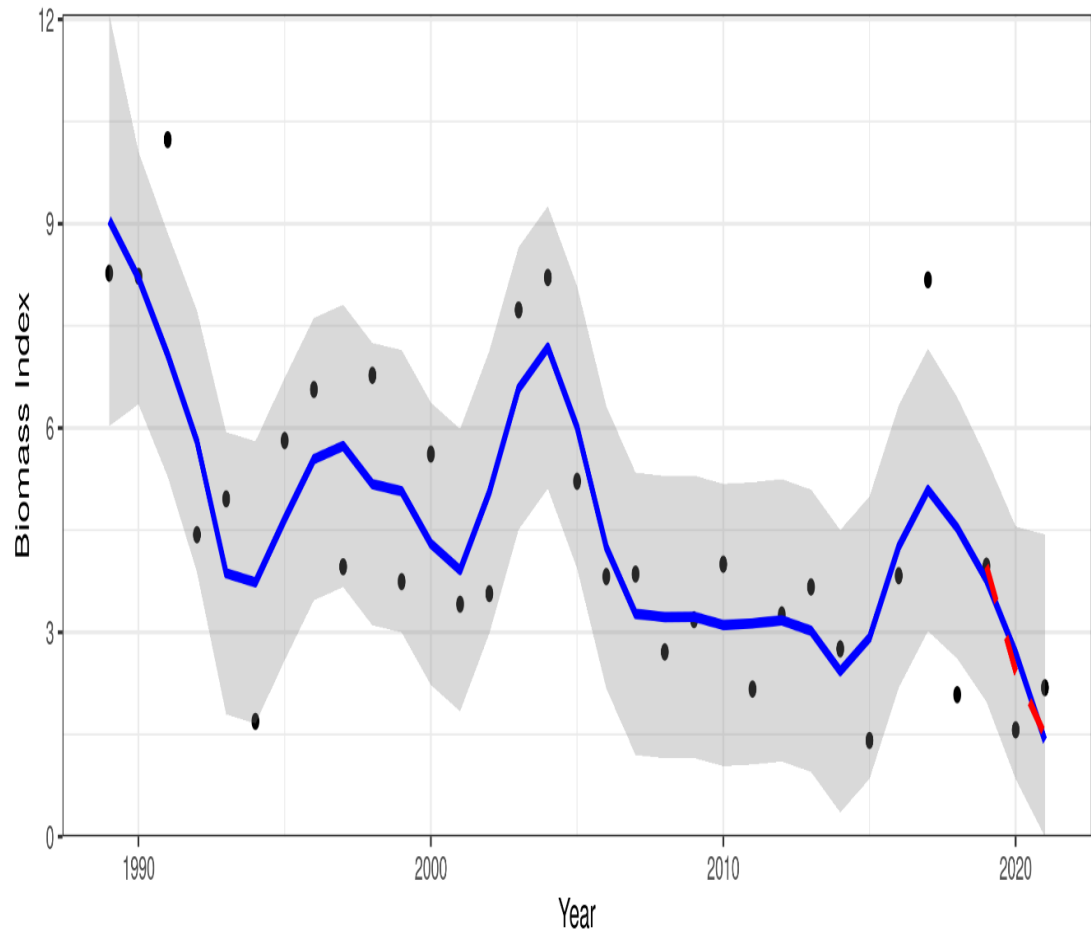
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GB Cod PlanBsmooth Applied

- 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

Georges Bank Cod

Multiplier = 0.611

GB Cod PlanBsmooth Estimates

- 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.
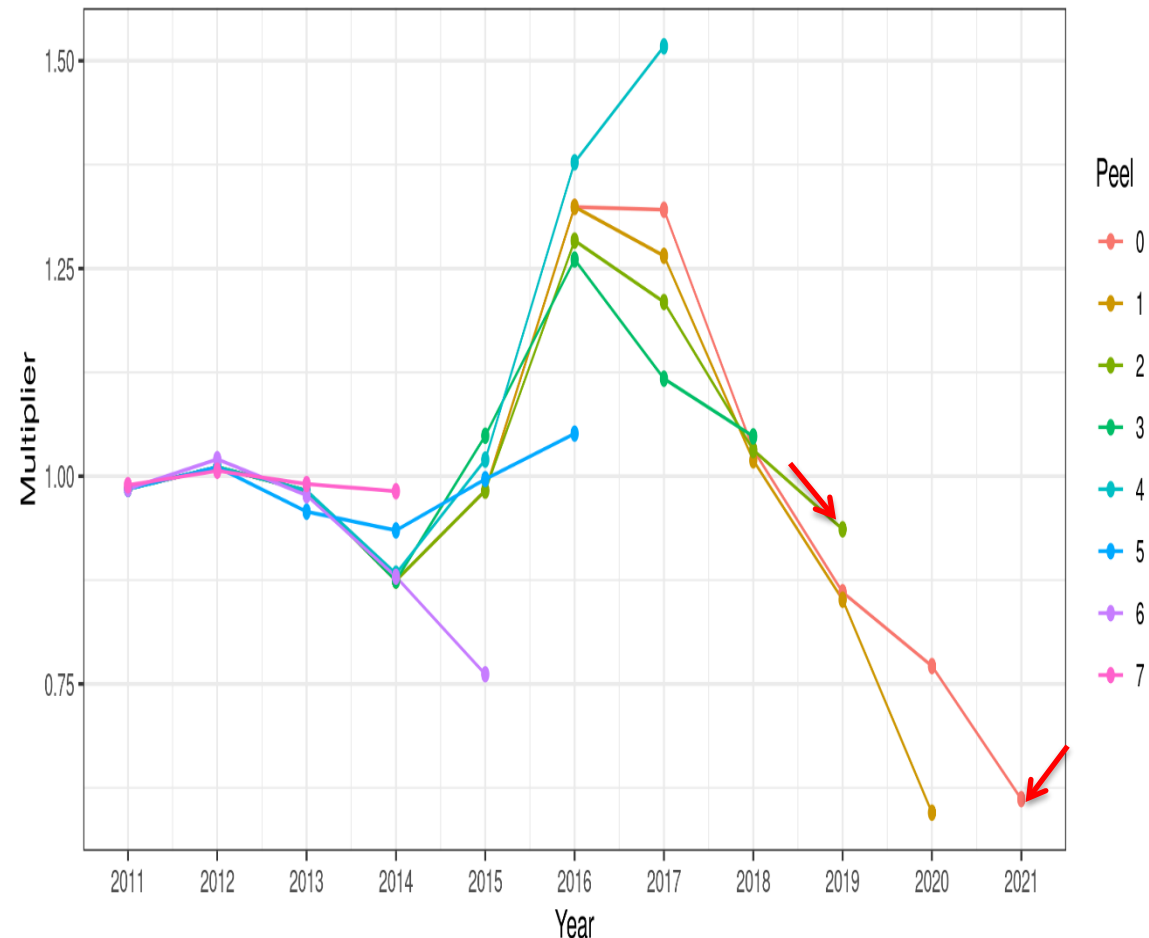
GB Cod PlanBsmooth Loess Retrospective

- Small Mohn's rho - 0.072

- Peels all within CI

- No directional pattern
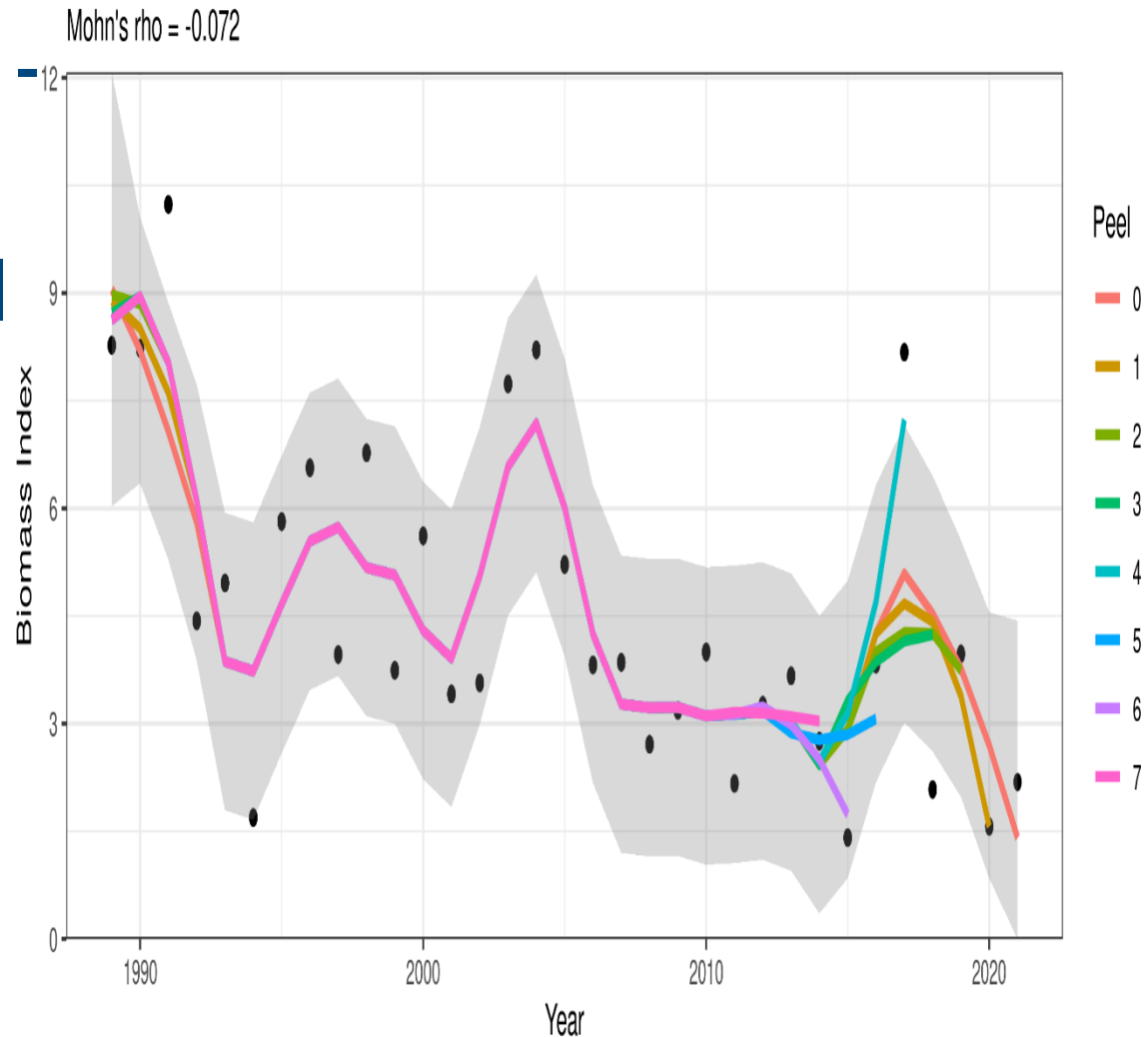
GB Cod PlanBsmooth Multiplier Retrospective

- 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

Georges Bank Cod

Multiplier = 0.611
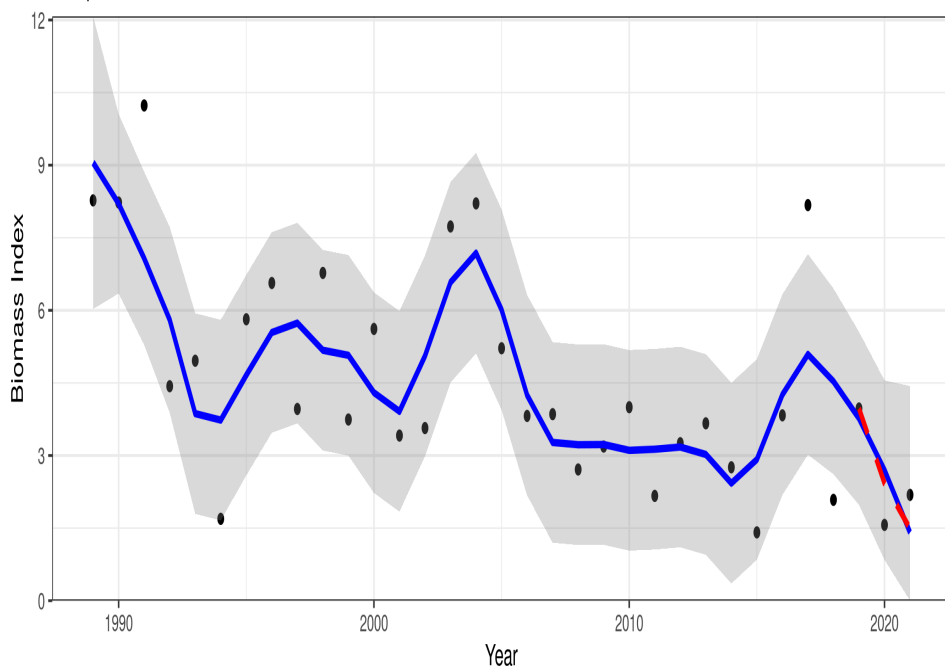
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Multiplier = 0.632

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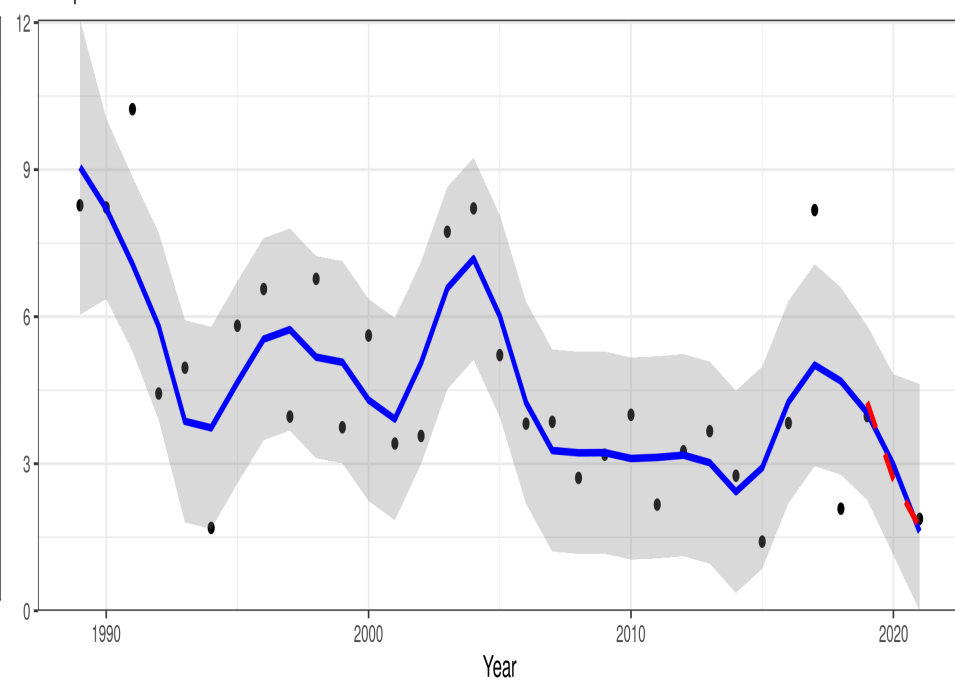
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catch advice	729		754

Questions?