

Assessment update for Atlantic sea scallops for 2020

*This assessment of the Atlantic sea scallop (*Placopecten magellanicus*) stock is a management track assessment updating the existing 2018 benchmark assessment (NEFSC 2018). Based on the previous assessment, the stock was not overfished and overfishing was not occurring. This assessment updates commercial fishery catch data, research survey indices of abundance, survey and commercial length compositions, and CASA and SYM model estimates (Appendices I and II) through 2019. In addition reference points using the SYM model were updated using the SARC-65 approach as well as a new method that couples selectivity to fishing mortality (Appendix III). No projections were made; these will be developed in the fall after the 2020 surveys have been completed.*

State of Stock: Based on this updated assessment, the Atlantic sea scallop (*Placopecten magellanicus*) stock is not overfished and overfishing is not occurring (Figures 1-2). Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2019 was estimated to be 147,073 t meats, which is 143% of the biomass target ($B_{MSY} = 102,657$ t meats; Figure 1). The 2019 fully selected fishing mortality was estimated to be 0.34, which is 56% of the overfishing threshold ($F_{MSY} = 0.61$; Figure 2).

Table 1. Catch and status table for Atlantic sea scallops by region: Mid-Atlantic (MA), Georges Bank (GB) and Gulf of Maine (GOM). Southern New England was included as part of Georges Bank. Nantucket Lightship deep water scallops (NLSDS) were not included in the models or in the totals. All weights are in units of (metric) tons meats.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<i>Data</i>										
Land MA	19532	17741	11583	6221	9442	10501	13470	15324	9857	10315
Land GB	6169	8644	13875	11935	5513	5315	4329	7158	15905	16681
Land GOM	185	256	428	502	388	391	640	976	681	651
Disc MA	730	536	278	157	70	562	2074	931	366	369
Disc GB	717	555	890	362	240	202	116	482	1102	835
Disc GOM	3	2	0	6	9	2	6	34	1	1
<i>Model</i>										
SSB Tot	131781	122560	113215	108533	132925	175263	188878	193441	173494	147073
SSB NLSDS						54898	65305	76967	39940	65561
SSB/ B_{MSY}	1.28	1.19	1.10	1.06	1.29	1.71	1.84	1.88	1.69	1.43
F Overall	0.34	0.34	0.40	0.35	0.25	0.26	0.23	0.23	0.23	0.34
F/F_{MSY}	0.56	0.56	0.65	0.57	0.41	0.42	0.38	0.37	0.37	0.56

Table 2. Comparison of reference points estimated from the 2018 benchmark, from the current assessment update using the same methods, and using the variable selectivity SYM model (see Appendix III).

	2018	2020	Variable selectivity
F_{MSY}	0.64	0.61	0.55
F_{ACL}	0.51	0.45	0.45
B_{MSY}	116,766	102,657	101,227
<i>Overfishing</i>	No	No	No
<i>Overfished</i>	No	No	No

Special Comments:

- What are the most important sources of uncertainty in this stock assessment? Explain, and describe qualitatively how they affect the assessment results such as estimates of biomass, F , and recruitment?

Natural mortality and growth, and their spatio-temporal variability. For reference points, recruitment, and in particular the weight put on large recruitment events by the SYM model, as well as the selectivity assumptions. In particular, portions of the very large 2012 year class in Georges Bank (mainly in Nantucket Lightship Closed Area) has been growing relatively slowly. The reference point calculations are based on growth in the most recent period. It is not clear whether the slower growth is only a particularity of this year class, or will persist. Previously, there had been a trend towards faster growth. Although not as striking, there are similar issues in the Mid-Atlantic with respect to its very strong 2013 year class.

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? A major retrospective pattern occurs when the adjusted SSB or F_{Full} lies outside of the approximate joint confidence region for SSB and F_{Full} .

Minor to moderate retrospective. In the three regional models, Mohn's ρ ranged from 0.23 to 0.33 for SSB and from -0.03 to 0.41 for F_{Full} . The largest ρ occurred for the Georges Bank open region. Part of the retrospective on Georges Bank is related to the elevated natural mortality rates for juveniles in the open area and adults in the closed area in certain years. No retrospective adjustments were made.

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.

Changes were made in growth for the most recent years, adjusting to the observed slower growth, which is at least in part due to the large year classes. Fishery selectivity periods for 2018 and 2019 for Georges Bank Closed were added to account for the large landings of intermediate-sized scallops in the Nantucket Lightship West area. The assumed standard deviation of natural mortality in the SYM reference point model was reduced, which had very little effect on the reference points but helps stabilize the model.

- Provide qualitative statements describing the condition of the stock that relate to stock status.

Stock biomass has been declining since its time series peak in 2017 as the dominant 2012 and 2013 year classes are reduced due to both fishing and natural mortality. Poor recent recruitment and anomalously high mortality in the Nantucket Lightship West area are contributing to the decline. Nonetheless, the stock remains above B_{MSY} and fishing mortality is well below F_{MSY} .

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.

Better quantification of growth, especially in recent years. Work in this regard is underway, including an inter-reader comparison that will evaluate the precision of ageing among readers.

- Are there other important issues?

A novel approach to calculating reference points was explored. Standard methods assume that fishing mortality F and fishery selectivity are separable, that is, changes in fishing mortality do not affect selectivity. Evidence, however, indicates that in the sea scallop fishery (and likely many others), selectivity is shifted towards smaller scallops when F increases. Varying selectivity by F in the SYM reference point model resulted in lower predicted yields at very low and high F s, and hence a more distinct peak, but only affected the reference point estimates slightly.

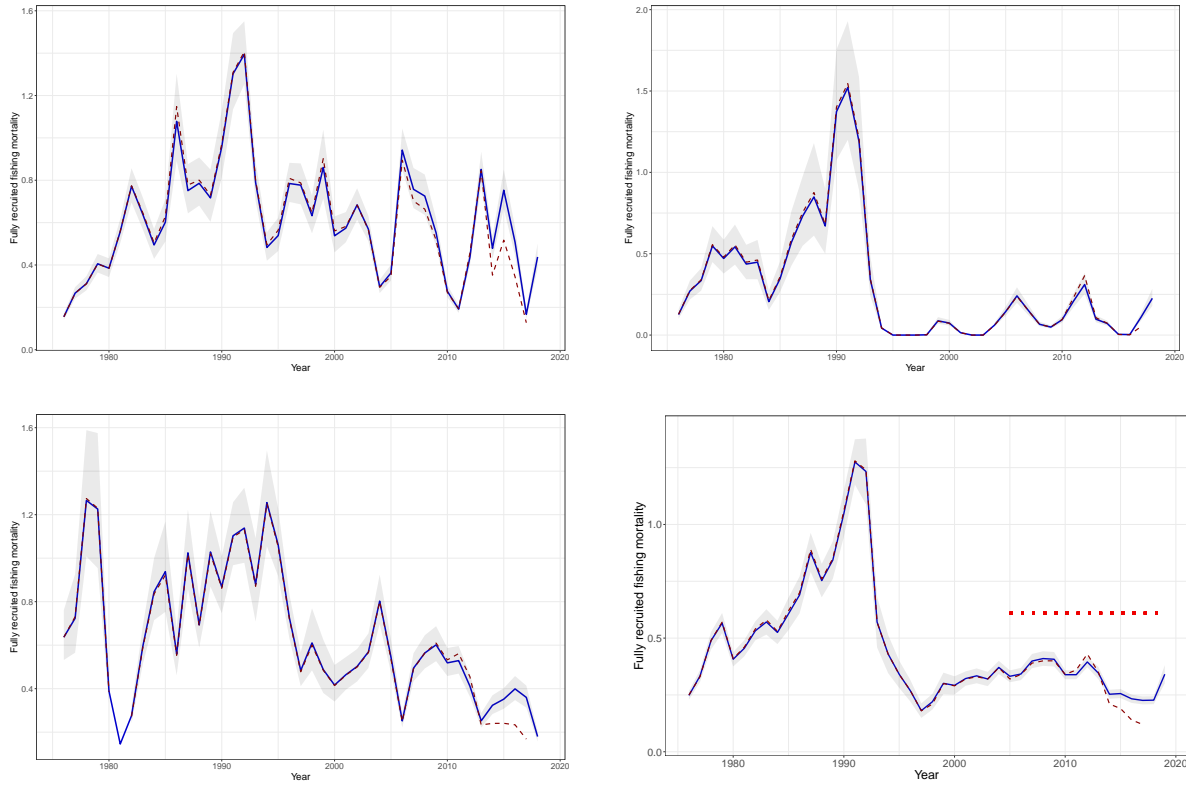


Figure 1. Estimates of fully recruited fishing mortality from CASA for Georges Bank open (top left), Georges Bank closed (top right), Mid-Atlantic (bottom left), and combined (bottom right). The blue solid lines are the point estimates for the current update, the shading is their 95% confidence interval, and the dark red dashed lines are the estimates from the 2018 benchmark assessment. The F_{MSY} reference point is shown on the combined plot (red dotted line); it is shown only from 2005 to 2019 since the fishery was less selective prior to this time, which implies that F_{MSY} during that period was less than that from the current period.

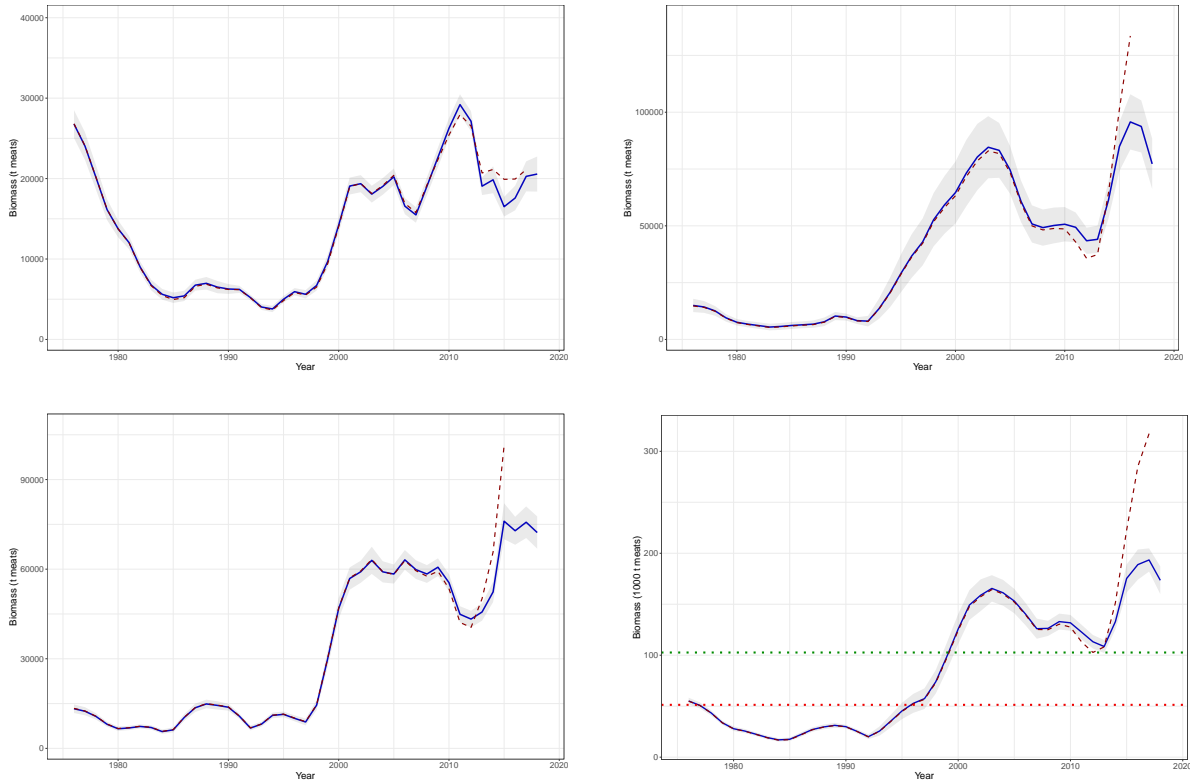


Figure 2. Estimates of biomass (t meats) from CASA for Georges Bank open (top left), Georges Bank closed (top right), Mid-Atlantic (bottom left), and combined (bottom right). The blue solid lines are the point estimates for the current update, the shading is their 95% confidence interval, and the dark red dashed lines are the estimates from the 2018 benchmark assessment. The biomass target (B_{MSY} , green dotted line), and biomass threshold ($B_{MSY}/2$, red dotted line) are also shown in the combined plot.

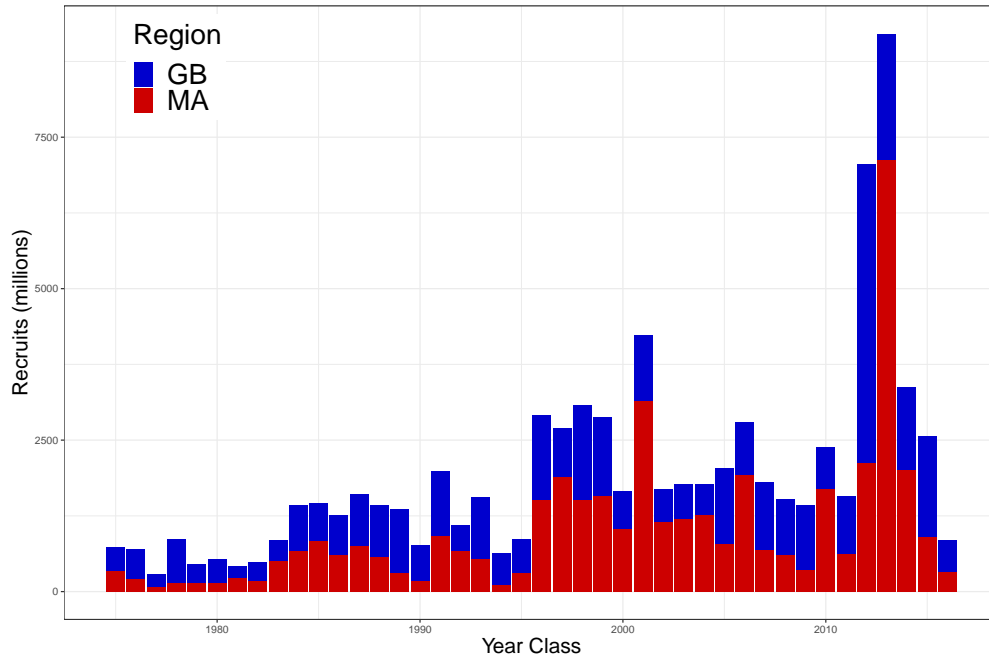


Figure 3. Recruitment (as three year olds) in Georges Bank (blue) and the Mid-Atlantic (red).

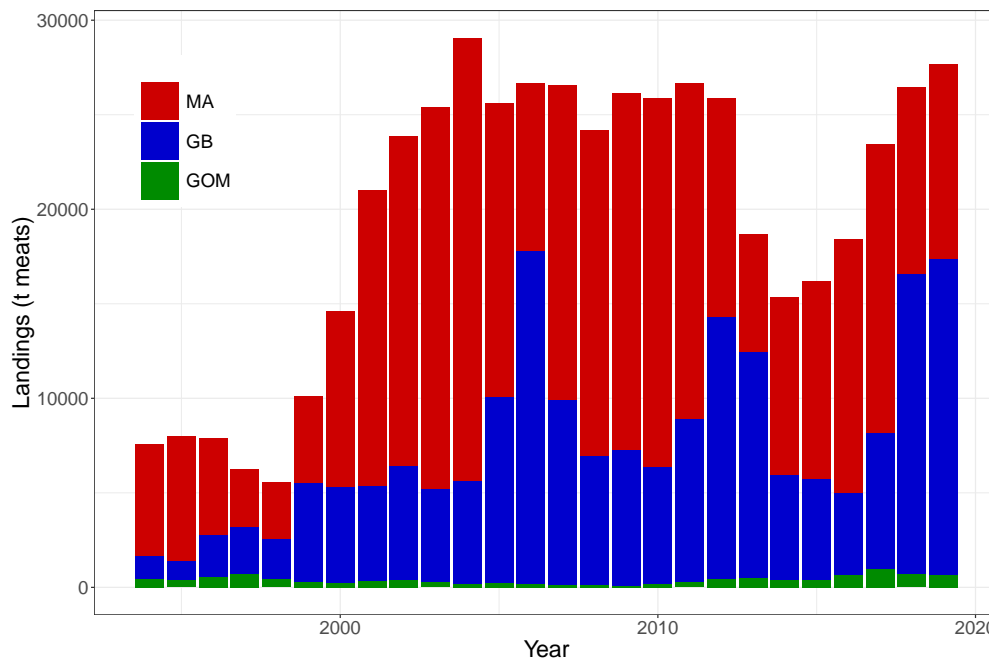


Figure 4. Landings from Mid-Atlantic, Georges Bank, and the Gulf of Maine 1994-2019.

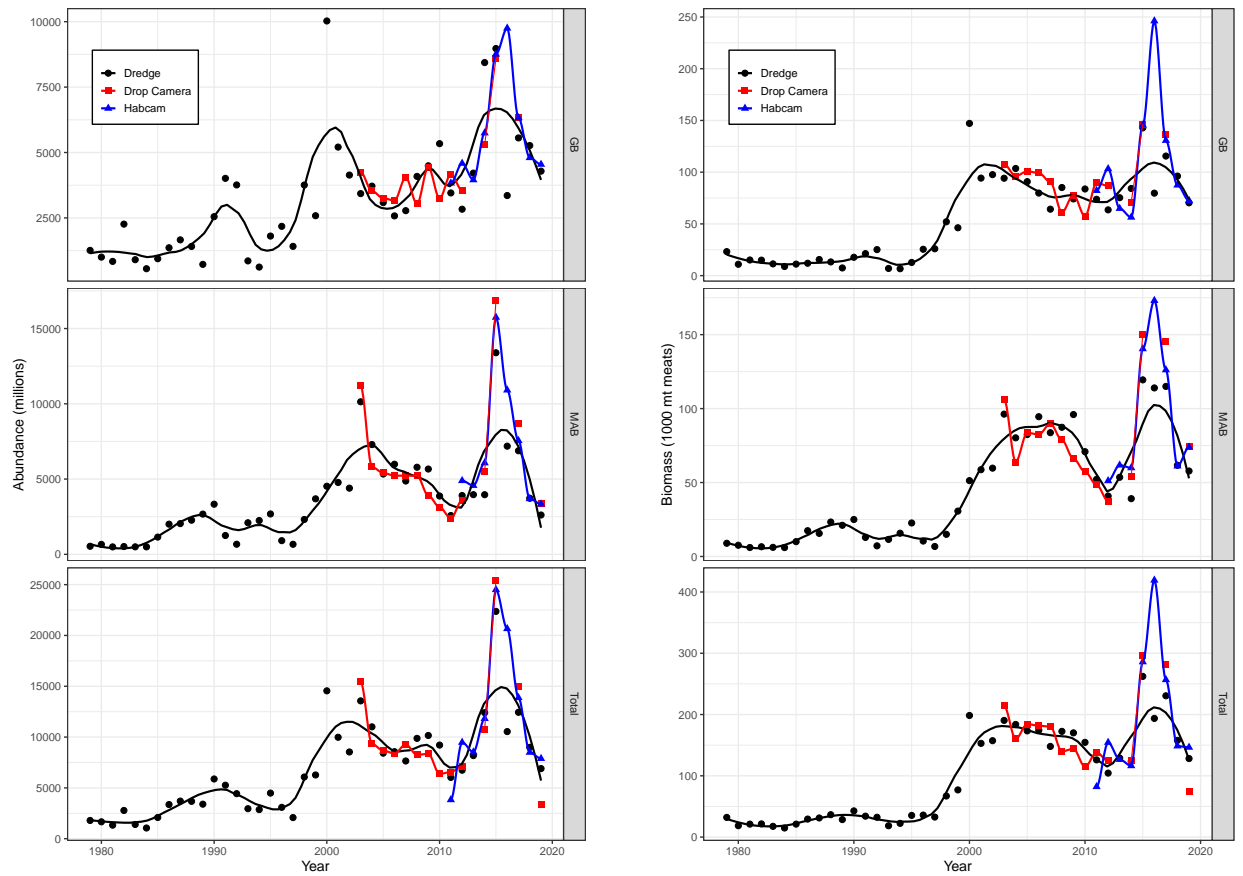


Figure 5. Indices of sea scallop abundance (left) and biomass (right) for the lined dredge, drop camera, and Habcam surveys on Georges Bank (top row), the Mid-Atlantic (middle row) and combined (bottom row). The lines represent lowess smoothers.