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Eric Reid, *Chairman* | Thomas A. Nies, *Executive Director*

MEMORANDUM

DATE: October 7, 2021

TO: Scientific and Statistical Committee (SSC)

FROM: Scallop Plan Development Team (PDT)

SUBJECT: **OFL and ABC for Framework 34 (FY2022 and FY2023 (default))**

This memorandum addresses the following 2021 SSC terms of reference for Atlantic sea scallops. The PDT also provides responses to the SSC recommendations from 2020.

2021 SSC Terms of Reference:

1. Review changes to meat weights and dredge efficiency used to develop 2021 survey estimates and growth and selectivity parameters used in the Scallop Area Management Simulator (SAMS) model to project biomass. Provide the Council with a recommendation as to whether these changes are appropriate.
2. Consider if the biomass estimates developed by the PDT for areas of the Gulf of Maine that have been surveyed but are outside of the Northern Gulf of Maine (NGOM) and the current Georges Bank scallop survey strata are appropriate to include in the biomass estimates for the resource as a whole in developing 2022 and 2023 Overfishing Limit (OFL) and Acceptable Biological Catch (ABC) estimates.
3. Using reference points updated by the 2020 management track assessment, and considering the Council's Risk Policy Statement, review the Scallop PDT's updated projections for the scallop resource, including the Gulf of Maine and NGOM management unit, and provide the Council with OFL and ABC recommendations using the Council's ABC control rule for fishing years 2022 and 2023 (default).

Follow-up on 2020 SSC Recommendations:

1. The SSC noted that the SAMS model seems to be having some difficulty capturing some of the recent stock changes. The SSC recommends a review of the SAMS model in the next management track assessment, and supports NEFSC's development of a geostatistical SAMS model for the 2024 research track assessment.
2. The SSC discussed the need to raise awareness about the decreasing biomass over the coming years. There has been a period of lower recruitment in the scallop stock, meaning biomass will decline back to B_{MSY} over the next few years in the absence of another large recruitment event. This loss of effective biomass is something that the NEFMC should take account of as they are looking forward over the next few years.

PDT Consensus Statement on Proposed Changes Outlined in this Memo:

Adjustments to the Nantucket Lightship South (NLS-S) 2021 survey data:

- The PDT recommends adjustments to the Nantucket Lightship South (NLS-S) 2021 survey data and projections to account for unique characteristics of scallops in this area. The SSC has approved adjustments to the survey data and projection model for several years, but the PDT feels that there is value in continuing to assess and evaluate them each year.
- Shell-Height and Meat Weight (SH-MW) Relationships: SH-MW parameters were updated through SARC 65 (2018). As with previous years, the PDT recommends using area-specific SH-MW parameter estimates from the recent dredge surveys conducted in the NLS-S area.
- Dredge Efficiency: 2021 surveys suggest that dredge efficiency in high density areas of the NLS-South continues to be an issue. The PDT recommends decreasing dredge efficiency for survey stations with high densities from 0.4 to 0.13. This recommendation is based on peer-reviewed findings from SARC 65 and accounts for changing resource conditions in the area (i.e., decreasing density).
- Selectivity: The PDT recommends applying the SARC 65 Georges Bank Open selectivity curve as estimated in the CASA model in the Nantucket South area. The Georges Bank Closed selectivity curve reflects targeting of very large scallops; however, considering that the year class in the Nantucket Lightship South area is smaller than normal, it is unlikely that the Georges Bank Closed selectivity would apply.

Adjustments to projections for FY 2021 (SAMS model):

- Growth: The 2020 management track assessment adjusted growth to assumptions to match slower growth in the Georges Bank and the Mid-Atlantic regions since the 2018 benchmark assessment. The PDT recommends that SAMS area growth assumptions ($L\infty$) be scaled to match the slower growth, consistent with the 2020 management track assessment. This change was recommended by the SSC in 2020 and appears to be appropriate based on comparisons of the 2021 survey length frequencies with projections (Appendix IV: Comparison of 2021 Surveys with Projections using 2020 Data).

FY 2022 & FY 2023 (default) OFL and ABC Calculation:

- The Council took action in Amendment 21 (2020) that adds scallops in the NGOM into the OFL and ABC for the entire fishery. Framework 34 is the specifications action that implements the Amendment 21 changes.
- Northern Gulf of Maine management area: The PDT has developed projections for this area using 2021 survey data and included the values in its recommendations for the overall OFL and ABC.
- Gulf of Maine: Survey frequency and intensity has increased in areas outside of the scallop survey strata north and east of Cape Cod, but south of the NGOM management unit. In light of environmental changes occurring throughout the range of the stock, the NGOM being added into the OFL and ABC, and the availability of the survey information from multiple sources (dredge and optical), the Scallop PDT evaluated the survey data from this region and developed projections for two sub-areas.
- There is no precedent from past scallop stock assessments or Council actions (ex: A21) to include the GOM data in the PDT's OFL and ABC recommendations. Therefore, the PDT recommends that the 2022 and 2023 (default) OFL and ABC be set using biomass from only GB/MA and the NGOM. These values are presented to the SSC (Table 1).

The updated OFL and ABC values are based on updated reference points from the 2020 management track assessment (OFL F=0.61; ABC F=0.45) and are relatively lower than values used in recent years following the 2018 benchmark assessment (SARC 65). The OFL and ABC estimates for Georges Bank and the Mid-Atlantic for 2022 are very similar to the 2022 (default) projection that was approved by the SSC in November 2020. Both the 2022 and 2023 biomass projections indicate a continued decline from the record high levels observed in recent years, even with the addition of biomass from the Northern Gulf of Maine. This decline is attributed to the continued harvest of the extraordinarily large 2012- and 2013-year classes, and the absence of strong recruitment in subsequent years. The exceptionally strong year 2013 year class in the Mid-Atlantic Access Area has been fished down and minimal exploitable biomass remains in this area. The majority of biomass for the stock is contained on Georges Bank (i.e., roughly 76% according to the 2021 surveys), specifically, in the Nantucket Lightship South and Closed Area II (CAII). The scallops in the NLS-S are part of the exceptional 2012 year class, though these animals have grown very slowly, and are small in size despite being 10 years old.

More than half of the population is considered exploitable (Table 2). The scallop fishery is expected to continue harvesting the 2012- year-classes in FY2022, resulting in an expected decline in biomass as these animals are removed from the population. The PDT cautions that if higher than expected natural, incidental, or discard mortality occurs, biomass estimates will be overestimated, especially for 2023. Looking ahead, there are several reasons for the decline in OFL and ABC estimates between 2022 and 2023: (1) removals of the strong 2012- year class (2) an extended period of low recruitment since 2013.

Table 1 – Scallop PDT recommendation for OFL and ABC for Framework 34, fishing years 2022 and 2023 (default). Values shown in metric tons (mt) and are based on biomass from Georges Bank, the Mid-Atlantic, and the Northern Gulf of Maine management area.

Fishing Year	Areas included	ABC	OFL
2022	GB, MA, NGOM	29,368	37,042
2023	GB, MA, NGOM	26,906	34,007

Table 2 - Estimated biomass (mt) and exploitable biomass (mt) for FY 2022.

Year	Biomass	Exploitable Biomass	Percent Exploitable
2022	119,906	71,058	59%

2022 & 2023 OFL and ABC Calculations

Amendment 21 to the Scallop FMP modifies how the scallops from the NGOM management unit are accounted for by including them as part of the OFL and ABC for the overall fishery. Scallop stock assessments include the resource found on Georges Bank and the Mid-Atlantic, but do not include the scallop resource in the Gulf of Maine, or Northern Gulf of Maine management unit (NGOM).

Northern Gulf of Maine

In the current absence of reference points and a stock assessment model for areas of the Gulf of Maine, the OFL and ABC estimates presented in this memo for both the Northern Gulf of Maine and Gulf of Maine were derived using the Georges Bank F_{MSY} estimates from the 2020 management track assessment ((F=0.46 for OFL, F=0.32 for ABC)). Optical (drop camera) and

dredge surveys were conducted in the Northern Gulf of Maine in 2021 (Figure 17, Figure 18). Biomass estimates for the Stellwagen Bank portion of the Northern Gulf of Maine were developed using the same survey area, and estimates for Platts Bank, Ipswich Bay, and Jeffreys Ledge were developed using the coverage of the drop camera survey (Table 6). Additional information about data treatments for this area are provided in Appendix I: 2021 Projections - Outputs and Assumptions.

Gulf of Maine

While the Gulf of Maine is generally considered to be data poor for scallops, the Council has prioritized data collection and surveys in this area for several years. In 2021, optical and dredge surveys were completed in areas that were outside of the NEFSC survey strata and NGOM management unit (i.e., Stellwagen South, Western Gulf of Maine Closed Area). Data collection in these GOM areas was ranked as a highest priority by the Council for the 2022 and 2023 Scallop RSA program.[1] The PDT felt that it was important to present information about the scallop resource in the GOM (WGOM, Stellwagen South) to the SSC as the NGOM becomes part of the OFL and ABC. Data changes are typically handled through other processes (ex: stock assessments, survey re-stratification, change to the FMP, Scallop Survey Working Group recommendations, etc.). There is no precedent from past scallop stock assessments or Council actions (ex: A21) to include the GOM data in the PDT's OFL and ABC recommendations. Therefore, the PDT recommends that the 2022 and 2023 (default) OFL and ABC be set using biomass from only GB/MA and the NGOM.

The PDT notes that there is not a biological justification for excluding scallops from the GOM considering that all other surveyed areas will be included in the OFL and ABC. Scallops are managed as a single unit throughout their range. Animals in the GOM and NGOM are part of the same cohorts and occupy similar habitats on Stellwagen Bank, and are only different in the scallop management areas they fall within. The Stellwagen South area is fished annually by Limited Access vessels using DAS and Limited Access General Category IFQ vessels using quota; however, scallops from this area have not been included in the overall fishery allocation because it has not been regularly surveyed and is not part of the SAMS model. Scallops that were surveyed in the Western Gulf of Maine closed area (WGOM) are off-limits to the fishery, much like the scallops in Closed Area II North HAPC. Scallops that are in habitat or groundfish closures and are not accessible to the scallop fishery are included in the OFL/ABC estimates, but are not included calculations when allocating DAS or rotational area allocations.

OFL and ABC calculations for the GOM have been prepared if the SSC considers it appropriate to include this biomass as part of the overall OFL and ABC for 2022 and 2023 (Table 3). The survey areas (Figure 17, Figure 18), survey results (Table 6), and data treatments (see Appendix I: 2021 Projections - Outputs and Assumptions) are available for review. Including the GOM biomass would increase the 2022 ABC by 919 mt or 3%.

[1] Council's 2022/2023 Scallop RSA Priorities: https://s3.amazonaws.com/nefmc.org/B1.-210625_NEFMC-to-NEFSC-re-Scallop-RSA.pdf

Table 3 - 2022 & 2023 Scallop OFL and ABC estimates with and without adding the GOM.

2022 Values	ABC	%increase	OFL	%increase
NGOM + GB & MA	29,386		37,042	
Adding GOM	30,305	3.0%	38,271	3.2%
2023 Values	**ABC**	**%increase**	**OFL**	**%increase**
NGOM + GB & MA	26,906		34,007	
Adding GOM	27,606	2.5%	34,941	2.7%

Adjustments to the SAMS Forecasting Model

The 2020 assessment update adjusted growth rates to account for slower than expected growth in the more recent time period. This was a change from the 2018 benchmark assessment, which estimated growth in 2012-2016 to be the fastest on record.

The PDT compared the survey estimates with projections since SARC 65 (i.e., 2019 -2021) by calculating the projection error. The projection error is calculated as 100*(predicted biomass – observed biomass)/predicted biomass (Figure 2). Positive error means the projection was an overestimate, and negative error means the projection was an underestimate. The PDT also compared the projected biomass for 2021 based on 2020 surveys with observations from the 2021 surveys and found that projections were overly optimistic (Figure 2). The most substantial overestimation was evident in SAMS areas that make up the Mid-Atlantic Access Area (i.e., ET-Open, ET-Flex, HCS). This divergence could have been driven by a combination of fishing and elevated natural mortality. Natural mortality can remove over 20% of scallops per year – given the signal of reduced biomass in the southern range of the Mid-Atlantic, it is possible that natural mortality was elevated between 2020 and 2021. Projections on Georges Bank did not diverge as drastically as in the Mid-Atlantic; however, 2021 projections for the areas that encompass the majority of biomass in this region (i.e., CAII and NLS-South) were overestimates. A comparison of projected vs. observed length-frequencies illustrates the overestimation of both biomass and growth for both the NLS-South and CAII SAMS areas (see Appendix IV). SAMS areas with the least divergence between 2021 projections and observations were those with lower biomass that were unlikely to have been targeted by the fishery.

The SAMS model considers area-specific (i.e., by SAMS area) growth parameters (i.e., L_∞, k) when making forward projections of biomass. The PDT discussed the variability in growth rates used in the model the past two years, and noted that growth assumptions that are faster than realized growth could contribute to projections being overly optimistic. Staying with the recommendation made in 2020 to address this issue, the PDT recommends that SAMS area-specific assumptions of L_∞ be scaled down proportionally from the most recent CASA period (i.e., 2012-2016) to the slowest growth period for the different regions included in CASA (i.e., 1993-1996 for Georges Bank, 1975-1977;1987-2003; 2006 for Mid-Atlantic) (Table 13).

Figure 1 - Comparison of 2021 L-F projections with 2021 survey data. See Appendix IV for all SAMS areas.

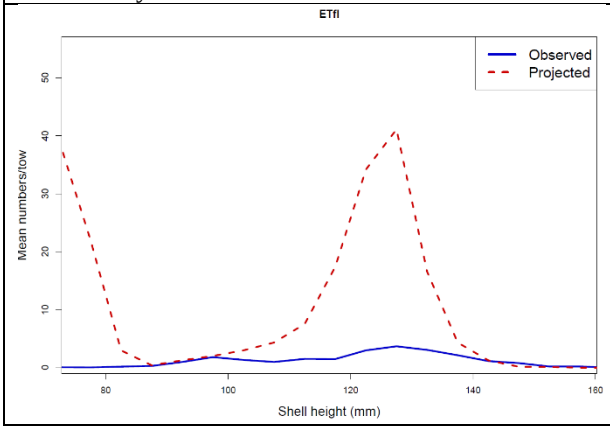
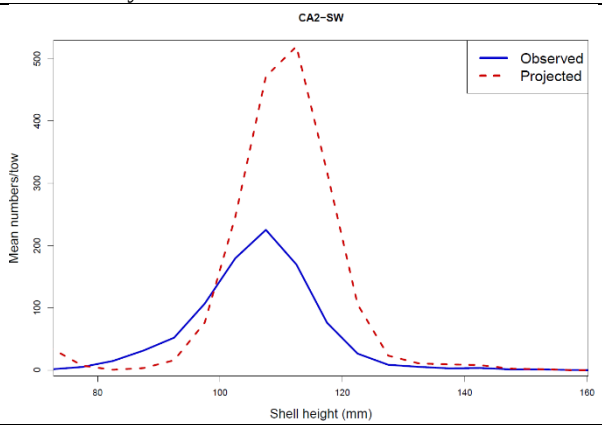
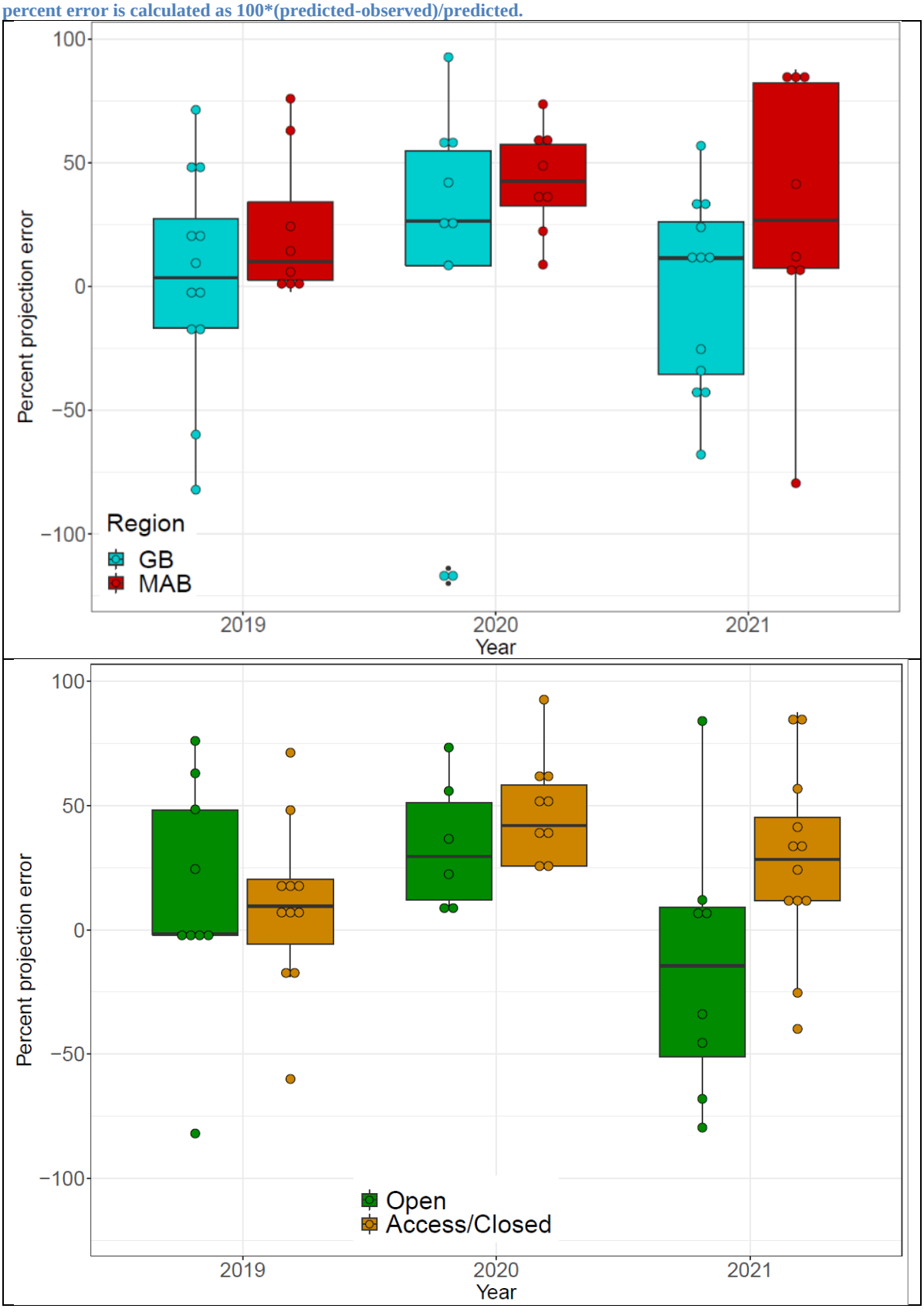
Example of projection overestimating recruitment and growth in the Elephant Trunk Flex Area relative to the 2021 surveys.	Example of projection overestimating abundance and growth in Closed Area II Southwest relative to the 2021 surveys.
	

Figure 2 - Comparison of projection error for 2019 - 2021 by region (top) and access and open areas (bottom). The percent error is calculated as 100*(predicted-observed)/predicted.



Tracking High Densities of Scallops in the Nantucket Lightship South

Annual surveys have tracked the size and growth of scallops in high-density aggregations within the Nantucket Lightship region for several years. There is uncertainty associated with biomass estimates in these high-density areas. Scallops in parts of the Nantucket Lightship, such as the deep-water portion to the south, exhibited almost no growth between 2017 and 2018, moderate growth between 2018 and 2019, limited growth between 2019 and 2020, and moderate growth between 2020 and 2021 (Figure 4), which could be explained by fishing activity and (or) slower growth. Estimated abundance in the area has decreased since 2015 and densities continue to decrease, as has been observed for several consecutive years by the SMAST drop camera surveys of the area (Table 4). To address this uncertainty, the PDT recommends adjusting the shell height to meat weight relationship, dredge efficiency, and selectivity curve for the NLS South SAMS area. The rationale for these adjustments is explained in more detail in the following sections. Figure 3 shows FY2021 rotational management areas, SAMS estimation areas, and biomass estimates from the 2021 HabCam survey of the NLS-South.

Figure 3 – The Nantucket Lightship region, with FY2021 scallop rotational areas (black), SAMS areas (red), and predicted biomass estimates from the 2021 HabCam survey of the Nantucket Lightship South area (mt per km^2).

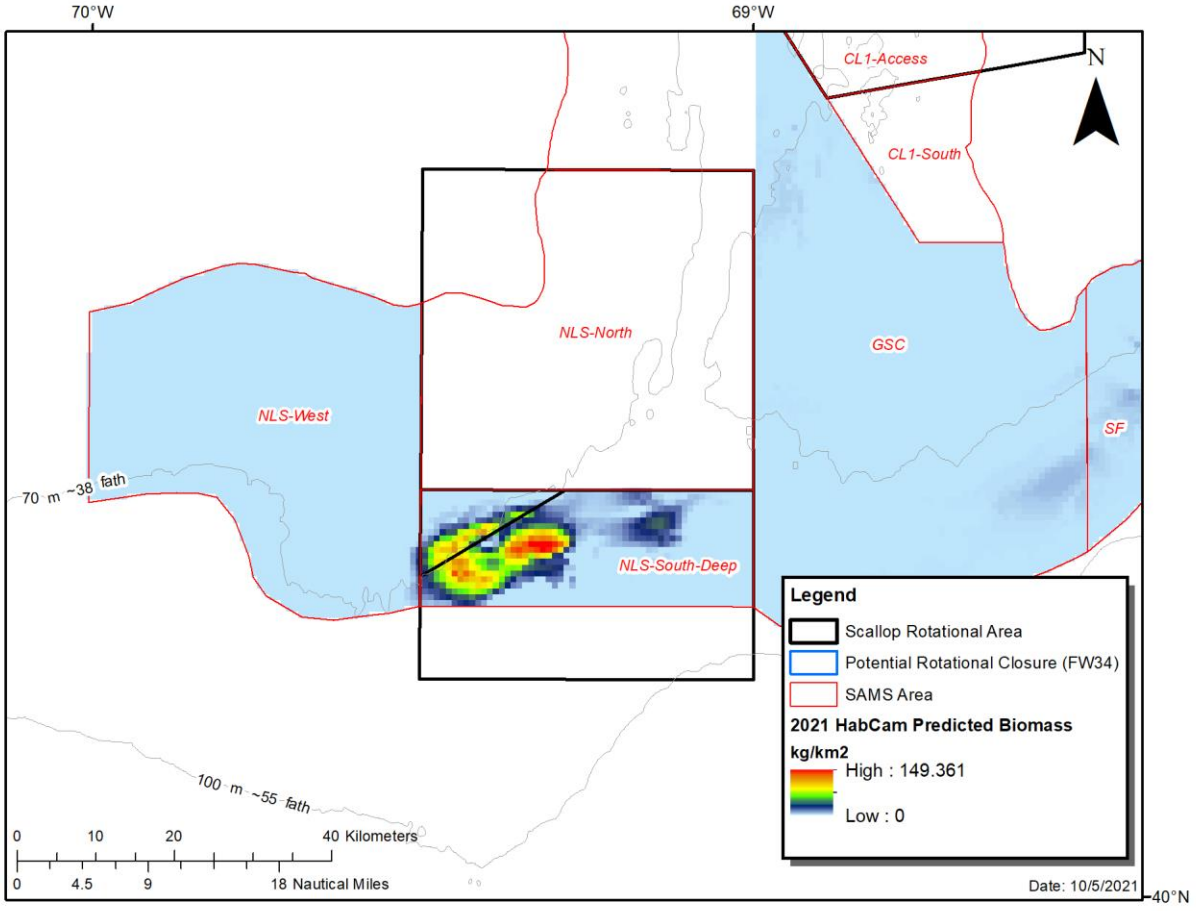


Figure 4 - Comparison of 2016 -2021 dredge survey observations in the NLS-South.

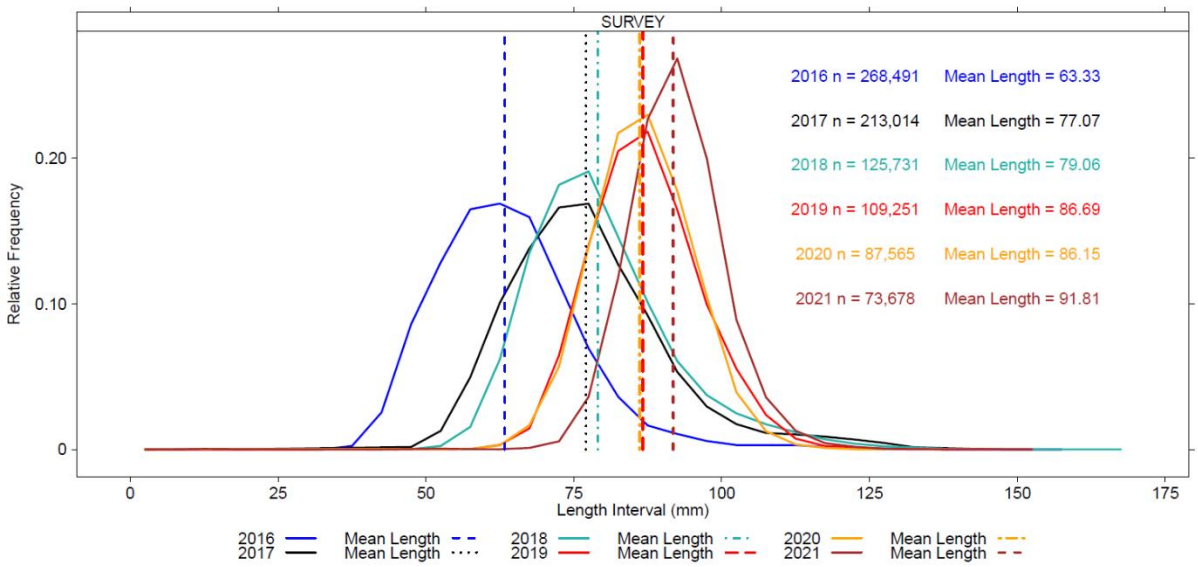


Table 4 – Scallop density per m^2 and average shell height from SMAST drop camera surveys of the NLS-South, 2017 to 2021. Density per m^2 continues to be the highest in this area compared to other parts of the resource.

Year	Density per m^2	Avg. Size
2017	13.66	73mm
2018	6.85	76mm
2019	6.26	87mm
2020	3.69	93mm
2021	3.1	91mm

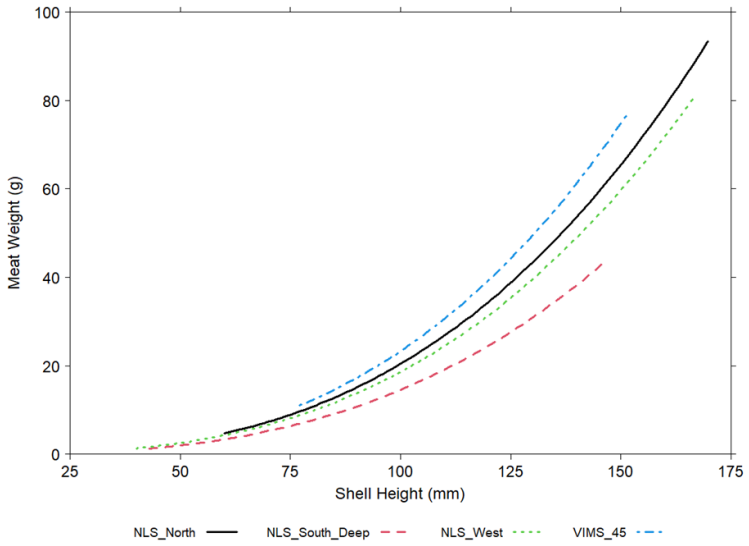
Shell Height Meat Weight Parameters:

The PDT has recommended in the past to deviate from the SARC 65 shell height to meat weight (SHMW) parameters in the Nantucket Lightship Region to account for unique growth in this area. Data from recent dredge surveys has been used to develop SHMW parameters for specific areas of the Nantucket Lightship region over time (see Appendix II). This year, the PDT recommends using SHMW parameters based on the last six years of dredge survey data for the SHMW relationship used in biomass calculations of the NLS-South. The scallops in the NLS-South will be 11 years old in FY 2022, but the majority of the animals have only reached 90mm in length. Given the unique growth characteristics of scallops in this area, the PDT recommends utilizing biological data from recent dredge surveys of the area to better inform SHMW relationships when projecting biomass. The PDT also notes that this area is likely to be fished in FY 2022, and that the difference in biomass estimates based on SARC 65 versus 2016-2021 dredge parameters for the NLS-South is small.

The methods used to develop the VIMS 2016 – 2021 parameter estimates are described in Appendix II. The model (m4) included shell height, depth, latitude, and SAMS area as predictors

(see Appendix II). Appendix III provides a comparison of drop camera, HabCam, and dredge survey biomass estimates using SARC 65 and VIMS 2016 - 2021 SHMW parameters.

Figure 5 - Predicted SH-MW relationships by SAMS area for the NLS using model m4 (Appendix II).



Dredge Efficiency in High Density Area of Nantucket Lightship

In addition to uncertainty around assumptions of natural mortality and anomalously slow growth, there is also uncertainty related to biomass estimates in the high-density area of the Nantucket Lightship. From 2017 - 2020, there were large differences between the individual survey estimates of biomass the Nantucket Lightship South area where high densities of animals had been observed. In 2018, 2019, and 2020, the optical (i.e. HabCam and drop camera) survey estimates of biomass in the NLS-South were very similar, but several times greater than the dredge survey estimates. Generally, some variation between survey biomass estimates can be expected due to differences in survey methods and coverage levels by area; however, the dredge surveys have consistently been well below the optical surveys in high density areas. The PDT noted that a reduction in dredge efficiency could be a causative factor in explaining the divergence of the dredge and optical estimates in high density areas in 2021. The PDT recommended reducing the dredge efficiency assumption from q=0.4 to q=0.13 in the NLS-S-deep for dredge stations in high density areas. Previously, dredge efficiency was adjusted for all dredge stations in the NLS-South; however, recognizing that density continues to drop as the area is fished over time, the PDT was concerned that reducing efficiency across the entire NLS-South would result in an overestimate. Therefore, the PDT used optical survey observations of the NLS-South to identify dredge stations that overlap areas with the higher density (i.e., > 2 scallops per m^2) and adjusted efficiency for only for those stations (Figure 6). The > 2 scallops per m^2 threshold was based on past experiments performed by VIMS (Rudders et al. 2019) and through the 2018 benchmark assessment (NEFSC 2018) that analyzed the relationship between scallop density and dredge efficiency. The resulting dredge estimate for the NLS-South was in agreement with the optical survey estimates for the area (Table 5). This approach is a minor adjustment to peer-reviewed data treatment methods developed in SARC 65, which accounts for the changing resource conditions (i.e., decrease in density) in the NLS-South and results in a different final combined estimate. The PDT recommends reducing dredge efficiency by two

thirds (.4*0.33) for high density stations, and averaging the overall estimate with other optical survey estimates. The PDT noted that dropping the dredge estimate in this high-density area and averaging only optical estimates yields a similar result to averaging all surveys with the reduced dredge efficiency applied (Table 5).

Figure 6 – 2021 VIMS survey stations in the NLS-South relative to predicted scallop density per m^2 from the 2021 HabCam survey. Dredge efficiency was adjusted for the dredge stations circled in red, which are stations assumed to have greater than 2 scallops per m^2.

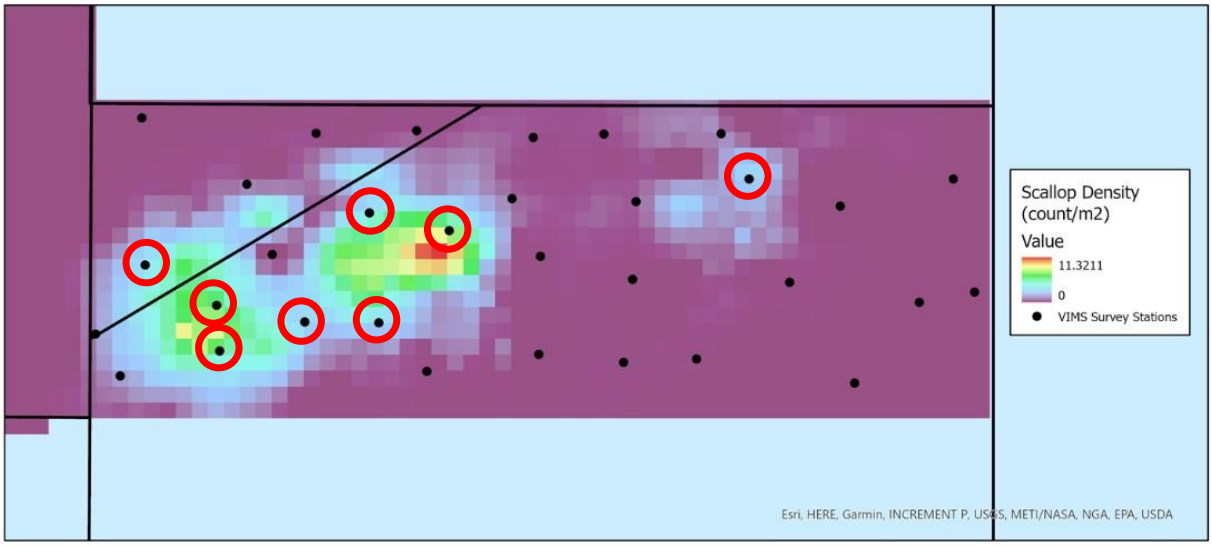


Table 5 - Comparison of 2021 survey biomass estimates in the NLS-South using VIMS 2016-2021 SH-MW parameters and varying dredge efficiency estimates (q=0.4 at all stations, 0.13 at all stations, and 0.13 at select stations).

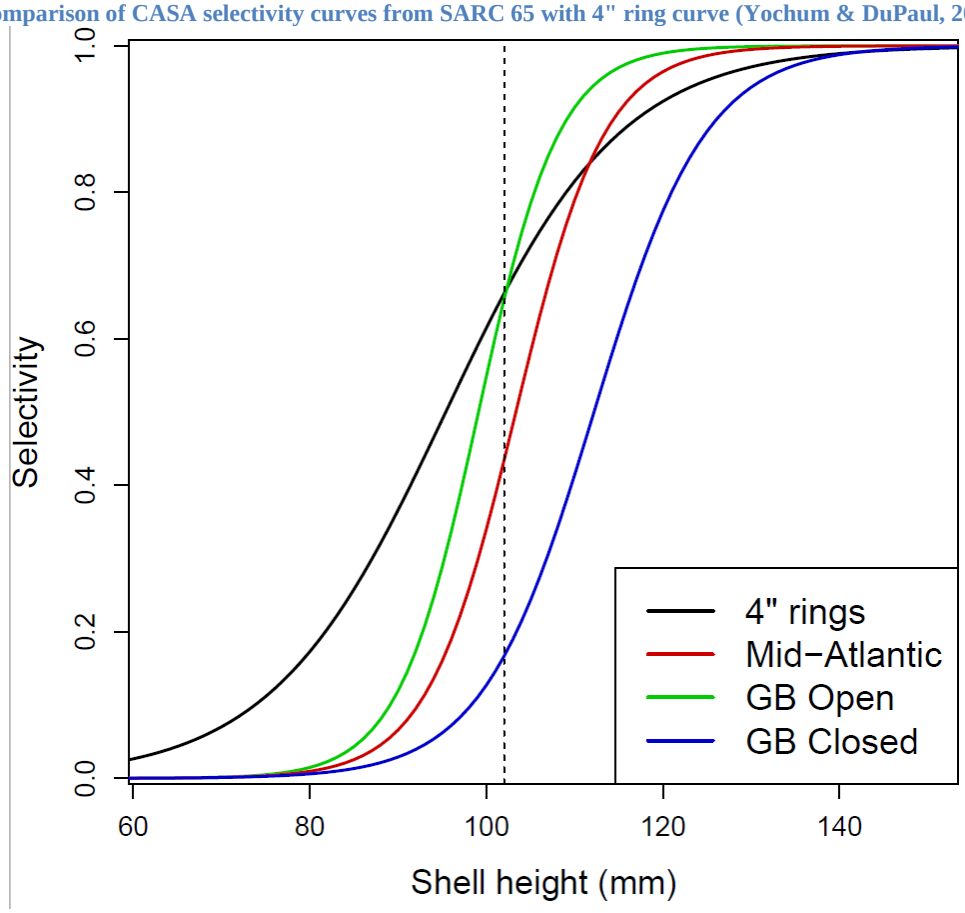
q Scenario	Total Biomass (mt)	SE Biomass (mt)	Density (scal/m^2)	Avg MW (g)	Total Number
0.4 all stations	9,375	2,126	1.28	11.6	802
0.13 all stations	28,846	6,543	1.28	11.6	2468
0.13 select stations	22,546	6,276	3.13	11.6	1953
SMAST	27,361	10,188		13.6	2012
HabCam	19,995	1,207		15.6	1285

Selectivity in the Nantucket Lightship South SAMS Area

Selectivity curves for each CASA region (Georges Bank Open, Georges Bank Closed, and Mid-Atlantic) were updated through SARC 65 and in the 2020 management track assessment. All three fishery selectivity curves are shifted to the right of the 4” ring selectivity curve (Yochum & DuPaul 2008), meaning that the fishery selects larger scallops relative to what the gear will retain (Figure 7). The Georges Bank selectivity curves are applied to finer-scale areas within the SAMS model. The Georges Bank Closed curve is normally used to calculate exploitable biomass in the Georges Bank access areas, and is expected to select around 50% of scallops at 110 mm, reflecting targeting and discarding practices that are typical in these areas. The Georges Bank

Closed curve selects larger scallops to reflect the larger scallops typically found in access areas as well as observed fishing behavior (i.e., targeting larger scallops). The Georges Bank Open curve more closely follows the 4" ring curve (i.e. selects smaller scallops than the Georges Bank Closed curve) because of the size and fishing behavior in open areas under DAS management. Applying the Georges Bank Open curve allows selectivity for a larger proportion of scallops currently in the size distribution in the NLS-South and more accurately captures the fishing dynamics in this area as a result of the dominant year class of small scallops. Similar to 2018, 2019, and 2020, the PDT recommends applying the Georges Bank Open selectivity curve in the Nantucket Lightship South area to select a larger proportion of the 10-year-olds in this area that have already recruited to the fishery but are not growing normally. As shown in Figure 4, the mean shell height in the NLS-South area in the 2021 surveys was approximately 92mm.

Figure 7 - Comparison of CASA selectivity curves from SARC 65 with 4" ring curve (Yochum & DuPaul, 2008).



Recruitment and Outlook

One of the reasons for the decline in OFL and ABC estimates between 2021 and 2022 is low recruitment in recent years (Figure 8). Results from the 2020 management track assessment suggest that recruitment tailed off following two exceptional year classes (Figure 9) in 2012 and 2013. As the OFL and ABC values presented in Figure 8 approach 2015 values after reaching record biomass, an important difference between 2015 and 2022 is that there are no exceptional year classes in the pipeline. Annual optical and dredge surveys of the scallop resource have not detected recruitment at this magnitude for the past five years (not shown in Figure 9), though there are now several year classes on eastern Georges Bank. Some recruitment was observed

during the 2021 surveys of the New York Bight/Long Island region and signals of a one year old cohort were observed in the NLS-West. The Council is considering rotational closures of both these areas in FY2022 with the goal of optimizing yield of the juvenile scallops (see Figure 10 and Figure 11). Recent research on source/sink dynamics in the Mid-Atlantic indicates that another benefit of a closure in the New York Bight area could be increased odds of downstream recruitment in the Hudson Canyon and/or Elephant Trunk areas (Hart, 2020). Based on recent survey data, the scallop resource is not projected to return to the record high biomass observed in 2018 in the short-term. Opportunities for access area fishing will be constrained to Georges Bank for the foreseeable future. The pre-recruits observed in the NLS-West are susceptible to natural mortality at this life stage. If this cohort persists, it is still several years from reaching harvestable size.

Shell blister disease has become increasingly prevalent in the Mid-Atlantic over the last two years and impacts meat quality and yield. Based on concerns from the PDT that the effect of shell blister disease could significantly impact SHMW relationships in the Mid-Atlantic, a sensitivity analysis was performed comparing SHMW estimates for diseased animals based on their condition factor (i.e., condition factor 1 – 4) relative to the SARC 65 SHMW estimate used in the SAMS model (Figure 12). This analysis suggested that the shell blister SHMW curves reduced as the condition factor worsened relative to the SARC 65 curves. This was especially the case in southern and offshore SAMS areas compared to those farther north and inshore. Reduced meat yield as a result of shell blister disease could be part of the reason why Mid-Atlantic projections have been overestimates in the past several years; however, interannual variability in SHMW relationships are expected and that differences between the SHMW curves were not substantial. Since data on shell blister disease are only available for the past two years, the PDT suggests continuing to use the SARC 65 SHMW estimates in the projection model, which are based on 15 years of data. It will be important to continue monitoring shell blister disease in the future as well as considering the impact it may have on fishing behavior.

Figure 8 - Scallop Fishery OFL and ABC values for Georges Bank and the Mid-Atlantic (2011-2021), with 2022 estimates.

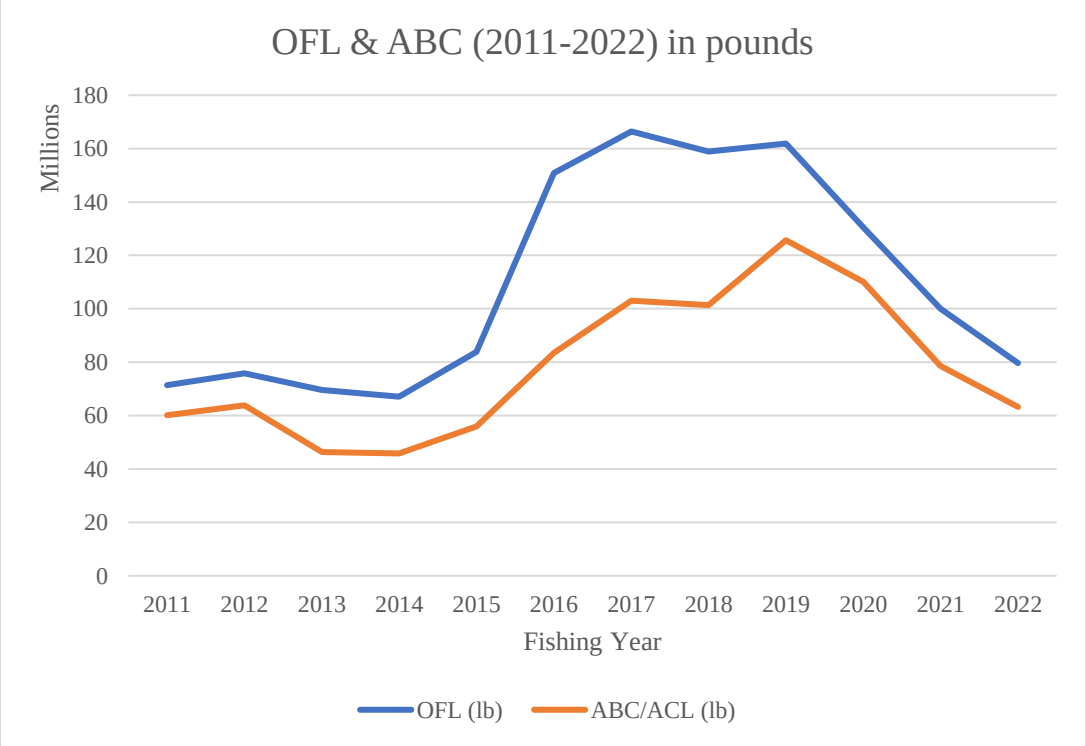


Figure 9 - Sea scallop recruitment (age 1) by region, 1975-2016. Regions are: Mid-Atlantic (MA, red) and Georges Bank (GB, blue). (Source: 2020 assessment update).

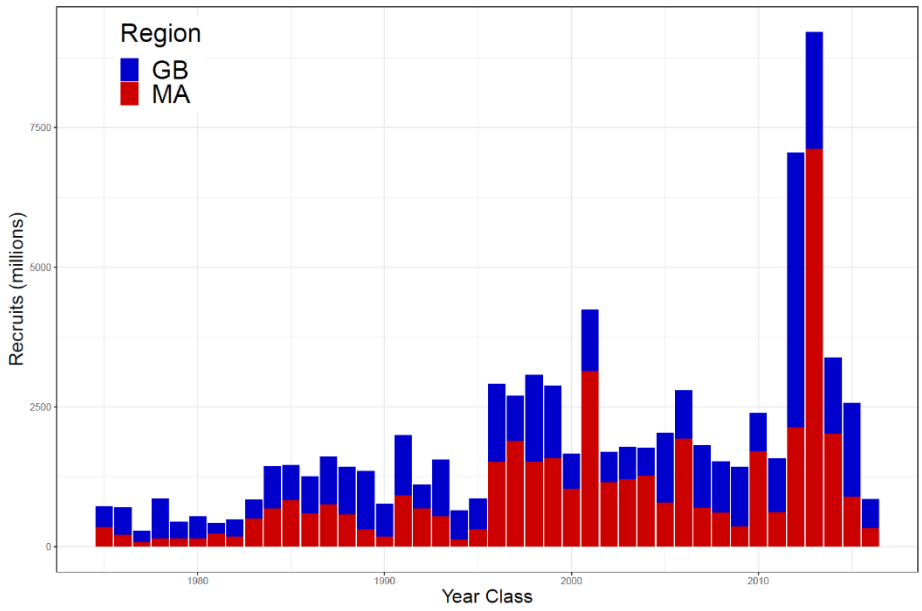


Figure 10 – The New York Bight closure area under development through FW34 relative to 2021 VIMS scallop abundance per station for scallops <65mm SH, SAMS areas, and proposed wind lease areas.

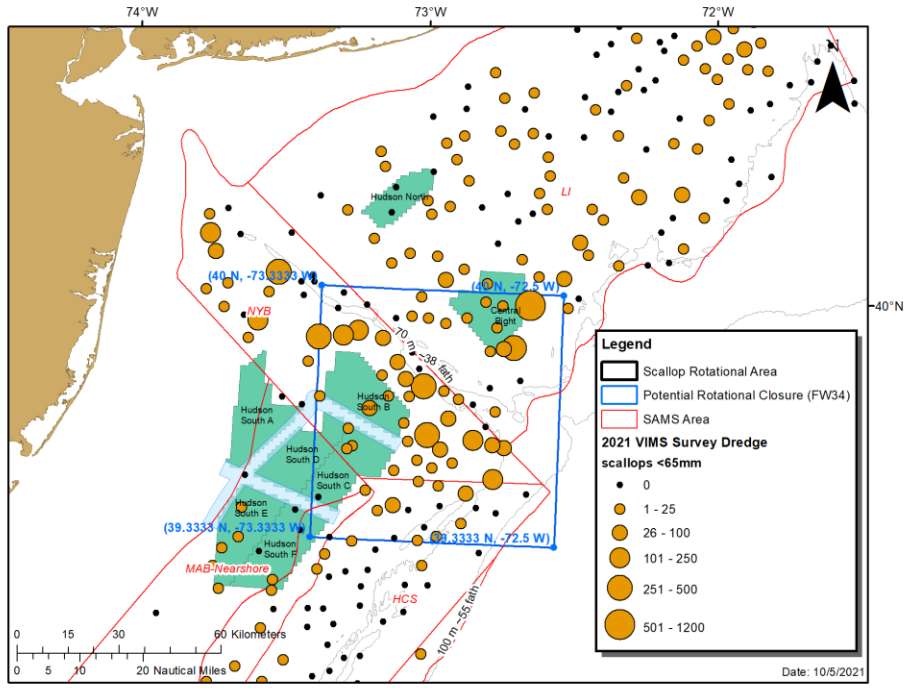


Figure 11 – The Nantucket Lightship West closure area under development through FW34 relative to 2021 SMAST drop camera survey density per m^2 for scallops 35mm, SAMS areas, and wind energy areas.

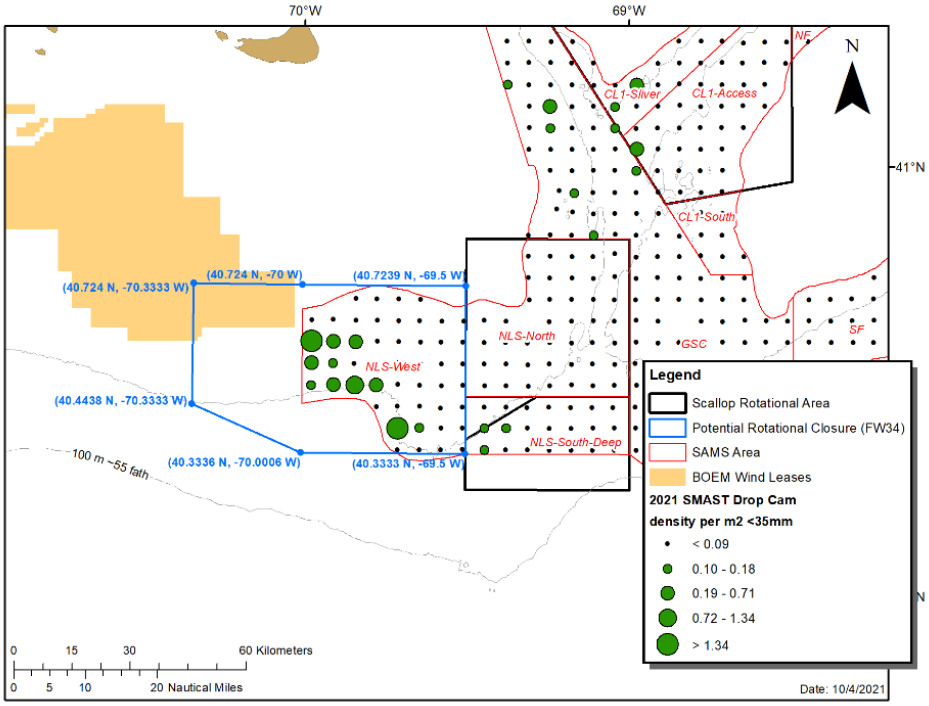
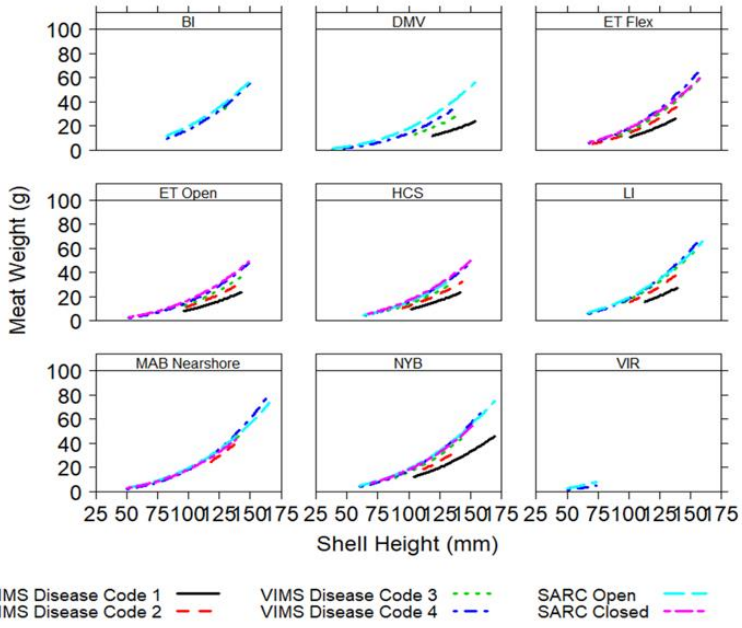


Figure 12 - SHMW comparisons between SARC65 and shell disease condition factors by SAMS area.



Scallop Rotational Management

While the OFL and ABC establish bounds for resource removals, in recent years, scallop rotational management has resulted in realized harvests (and corresponding fishing mortality

rates) far below these legal limits. For example, in fishing year 2021, the ABC was 30,517 mt (not including discards), whereas fishery allocations were 17,269 mt. Based on initial discussions around rotational management measures to be considered in FW34, is it reasonable to expect that fishery removals in FY2022 will continue to be below the OFL and ABC estimates recommended in this memo. The PDT expects that fishery allocations will approach legal limits in the coming years since there is limited biomass in areas closed to the scallop fishery, and the majority of the scallop resource is considered to be exploitable. The Council considers a range of additional issues and uncertainties as part of the annual rotational management process, such as the proportion of available biomass that the fishery is likely to target ('effective biomass'). The Council recently started a project to evaluate the rotational management program. The final report is expected to provide insights into the performance of this program, and will be available in February 2022.

Updates on 2020 SSC Recommendations:

Last year the SSC recommended further investigation into:

1. *The SAMS model seems to be having some difficulty capturing some of the recent stock changes. The SSC recommends a review of the SAMS model in the next management track assessment, and supports NEFSC's development of a geostatistical SAMS model for the 2024 research track assessment.*

A review of the SAMS model has been scheduled for the Spring of 2023. The Northeast Fisheries Science Center has hired a contractor to develop a geostatistical projection model for the scallop fishery. Updates on this work are expected later in 2022.

2. *The SSC discussed the need to raise awareness about the decreasing biomass over the coming years. There has been a period of lower recruitment in the scallop stock, meaning biomass will decline back to BMSY over the next few years in the absence of another large recruitment event. This loss of effective biomass is something that the NEFMC should take account of as they are looking forward over the next few years*.

Council staff and members of the PDT have presented to the Council on the decreasing biomass and lack of strong recruitment in recent years. The PDT has taken the opportunity in the Recruitment and Outlook section of the memo to further elaborate on the SSC's 2020 recommendation to raise awareness about these concerns. Staff will continue to present information about the health of the scallop resource to the Council, Scallop Committee, and Advisory Panel.

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Yochum, N. and DuPaul, W.D. 2008. Size-selectivity of the northwest Atlantic sea scallop (*Placopecten magellanicus*) dredge. Journal of Shellfish Research, Vol. 27, No.2, 265-271.

Table 6 – Final combined survey estimates for 2021 by SAMS areas, including values from the GOM and Northern Gulf of Maine Management Area.

		Dredge				DropCam				Habcam				Mean				F33 Projections		
Region	Subarea	Num	Bmsmt	SE	MeanWt	Num	Bmsmt	SE	MeanWt	Num	Bmsmt	SE	MeanWt	Num	Bmsmt	SE	MeanWt	Num	Bmsmt	%Change
GB	CL1ACC					65	1254	634	19.2					65	1254	634	19.2	78	896	40.0%
GB	CL1-Sliver	37.8	792	55	20.0	131	1125	382	8.6	113.0	1387	224	12.3	93.9	1101	149	11.7	76	878	25.4%
GB	CL-2(N)	177.7	4958	1418	27.9	246	1,886	727	14.1	282.0	7371	103	26.1	235.2	4738	532	20.1	335	5375	-11.8%
GB	CL-2SE	353.7	5942	409	16.7	753	9464	2634	12.6	283	3947	429	13.9	463.2	6451	900	13.9	892	7251	-11.0%
GB	CL-2SW	452.4	11852	1684	26.3	608	14724	2578	24.2	397	9970	682	25.1	485.8	12182	1051	25.1	1296	28145	-56.7%
GB	CL2Ext	767.8	13602	1581	18.0	1093	18983	2720	17.4	890	14724	829	16.6	916.9	15770	1084	17.2	1279	17984	-12.3%
GB	SF	741.3	13125	1574	17.7	734	11516	2829	15.7	707	11398	729	16.1	727.4	12013	1106	16.5	876	7149	68.0%
GB	NLSAccN	27.9	886	85	30.8	83	1,830	926	22.0					55.5	1358	465	24.5	128	2019	-32.7%
GB	NLSAccS-Deep	1953	22546	6276	11.5	2012	23009	9662	13.1	1285	17,333	728	13.5	1750.0	20963	3848	12.0	2551	31835	-34.2%
GB	NLS-W	8.1	228	50	28.0	10	202	1,658	20.4	17	400	171	23.9	11.7	277	556	23.6	38	364	-24.0%
GB	NF	117.8	1710	639	14.3	94.0	1,886	727	14.1	296.0	4295	361	14.5	169.3	2630	344	15.5	203	1806	45.6%
GB	GSC-N	222.0	3936	924	17.7	246	5716	1269	23.2	141.0	3024	394	21.5	203.0	4225	539	20.8	460	3154	34.0%
GB	GSC-M	54.2	1091	167	20.1	190	4872	1200	25.7					122.1	2981	606	24.4	277	2225	34.0%
GB	GSC-S	16.0	353	156	22.1	103	1775	553	17.2	66.0	1396	21	21.1	61.7	1175	192	19.0	140	877	34.0%
GB	TOTAL	4929.7	81021	7121	16.4	6368	98242	11441	15.4	4477	75245	1665	16.8	5361	87118	4601	16.3	8628	109958	-20.8%
MAB	BI	93.0	1564	274	17.1					32	815	66	25.5	62.5	1190	141	19.0	141	1294	-8.1%
MAB	LI	436.5	8302	367	19.3					613	13463	269	22.0	524.8	10883	228	20.7	1362	11454	-5.0%
MAB	NYB	414.8	6043	446	14.4					332	4919	851	14.8	373.4	5481	480	14.7	488	6234	-12.1%
MAB	MA inshore	34.0	513	44	15.2					52	1479	130	28.5	43.0	996	69	23.2	60	555	79.6%
MAB	HCSAA	89.4	2019	94	22.8					206	4453	239	21.6	147.7	3236	128	21.9	475	5507	-41.2%
MAB	ET Open	81.0	1814	71	22.7					97	1664	272	17.2	89.0	1739	141	19.5	510	9526	-81.7%
MAB	ET Flex	33.1	812	58	27.1					32	677	190	21.1	32.6	745	99	22.9	400	5884	-87.3%
MAB	DMV	17.5	115	15	7.2					13	163	80	12.3	17.5	115	41	6.6	322	719	-84.0%
MAB	VIR	3.6	16	2	4.6									3.6	16	2	4.4	61	146	-89.0%
MAB	TOTAL	1203	21198	654	17.6					1377	27633	996	20	1294	24400	596	18.9	3819	41319	-40.9%
GOM	WGOM Closure					106	2160	326	21.7					106	2160	326	21.7			
GOM	Stellwagen South	18	355	92	20.4	31	512	29	17.5					24.4	434	48	17.8			
GOM	TOTAL	18	355	92	20	137	2672	327	19.5					130	2594	330	19.9			
NGOM	Stellwagen AOI	86	1427	668	21	112	1539	511	13.4					99.0	1483	421	15.0			
NGOM	Jeffreys					15	268	48	17.7					15	268	48	17.7			
NGOM	Platts					7	108	24	14.7					7	108	24	14.7			
NGOM	Ipswich					10	143	28	14.7					10	143	28	14.7			
NGOM	TOTAL	86	1427	668	21	144.0	2058	515	14.3					131.0	2002	425	15.3			
TOTAL	TOTAL	6236	104001	7183	16.7	6649	102972	11458	15.5	5854	102878	1940	17.6	6786	113520	4659	16.7	12447	151277	-25.0%

Figure 13 - 2020 Georges Bank SAMS Areas.

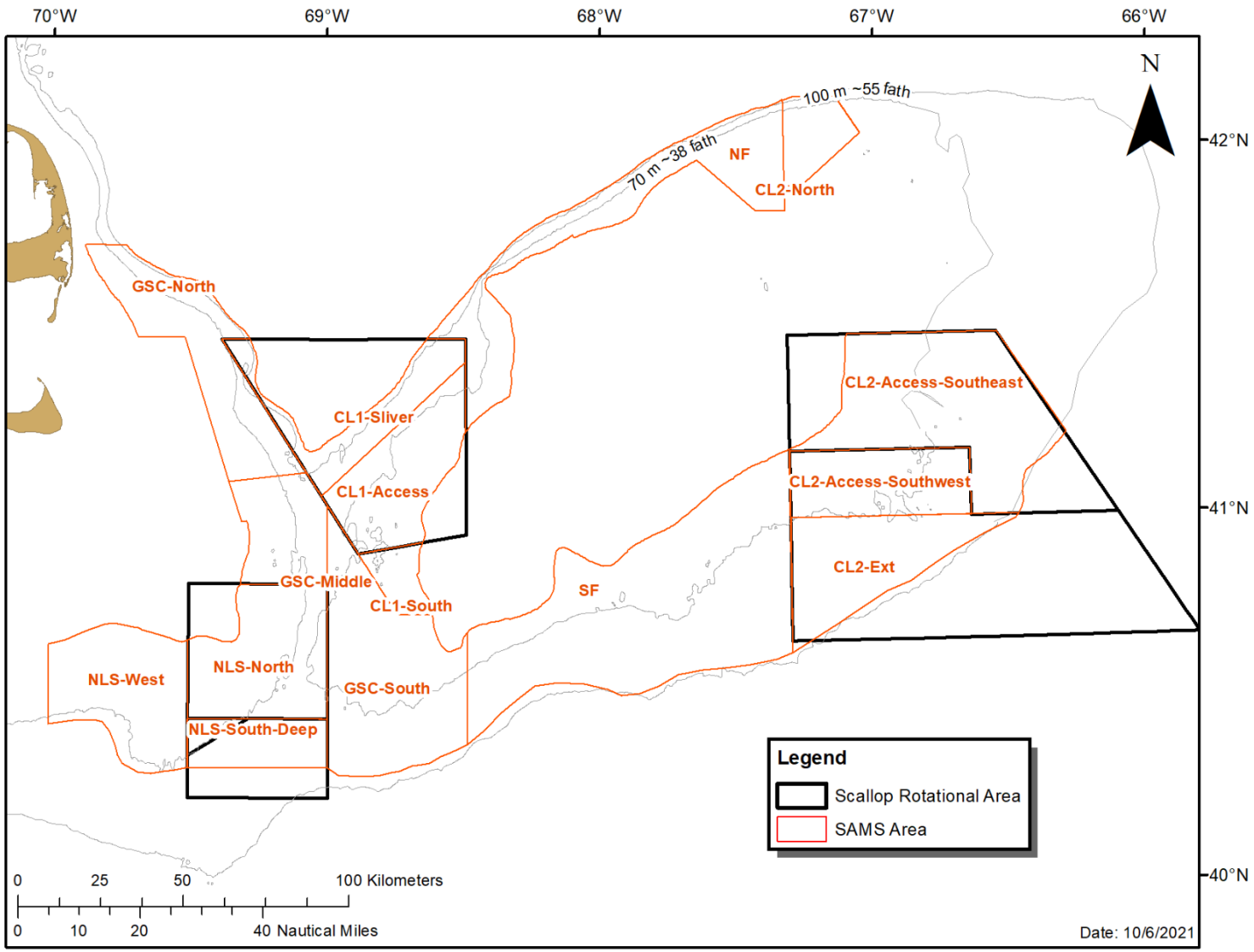


Figure 14 – 2020 Mid-Atlantic Bight SAMS Areas.

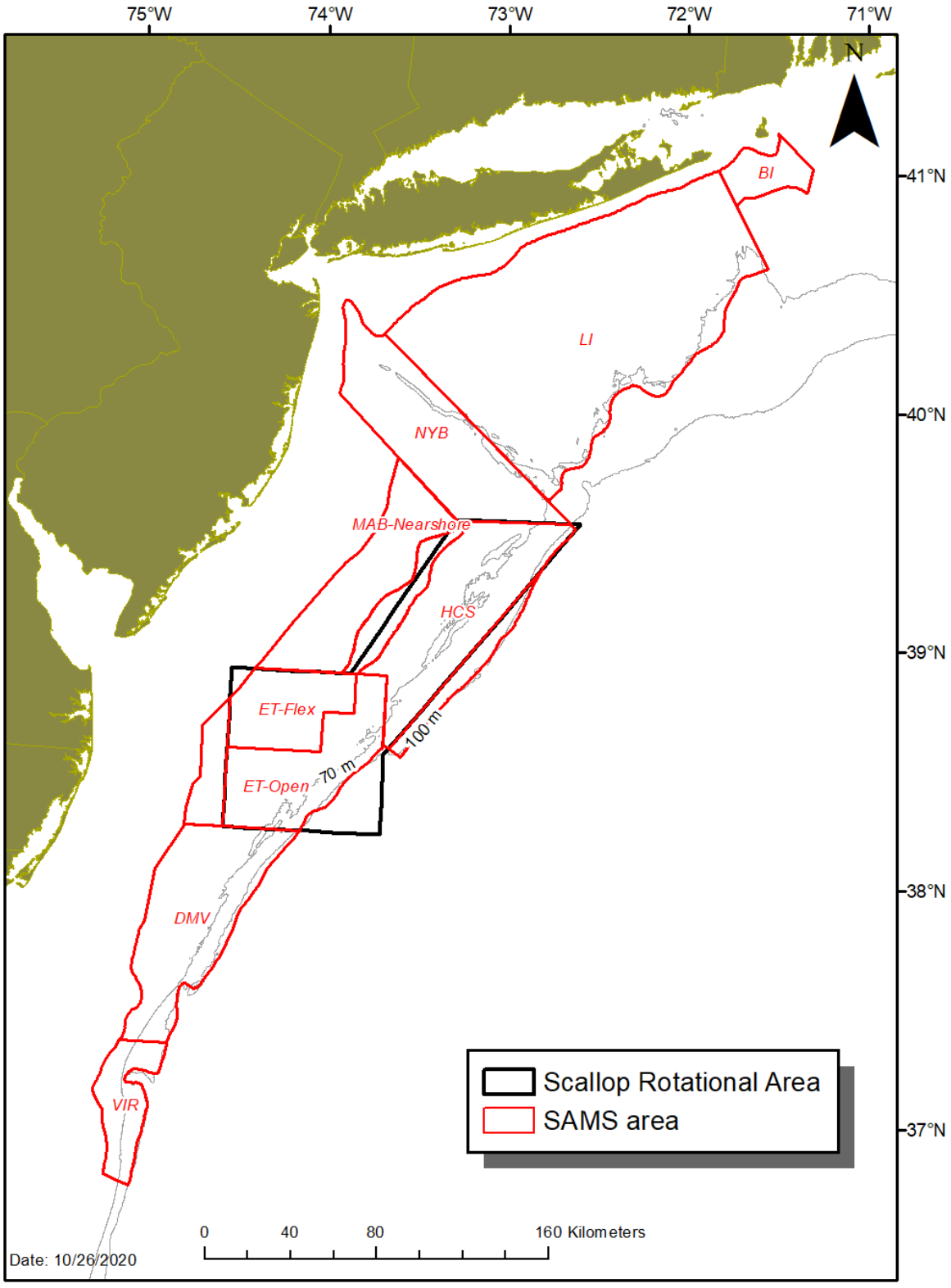


Figure 15 - 2021 Scallop RSA Survey Coverage for Georges Bank and the Mid-Atlantic.

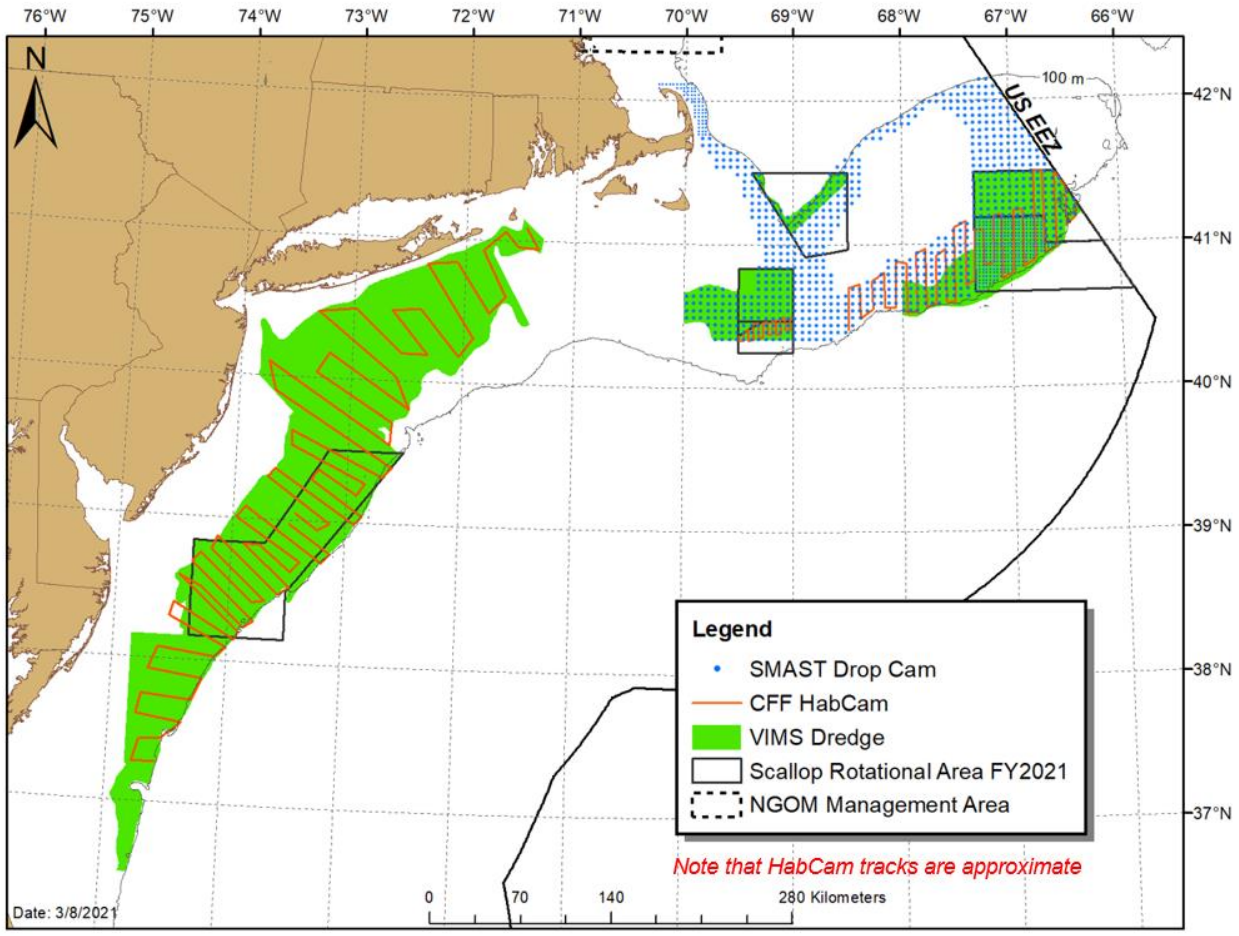


Figure 16 – 2021 Scallop RSA survey coverage for the Gulf of Maine relative to the Northern Gulf of Maine Management Area and Western Gulf of Maine Closure area.

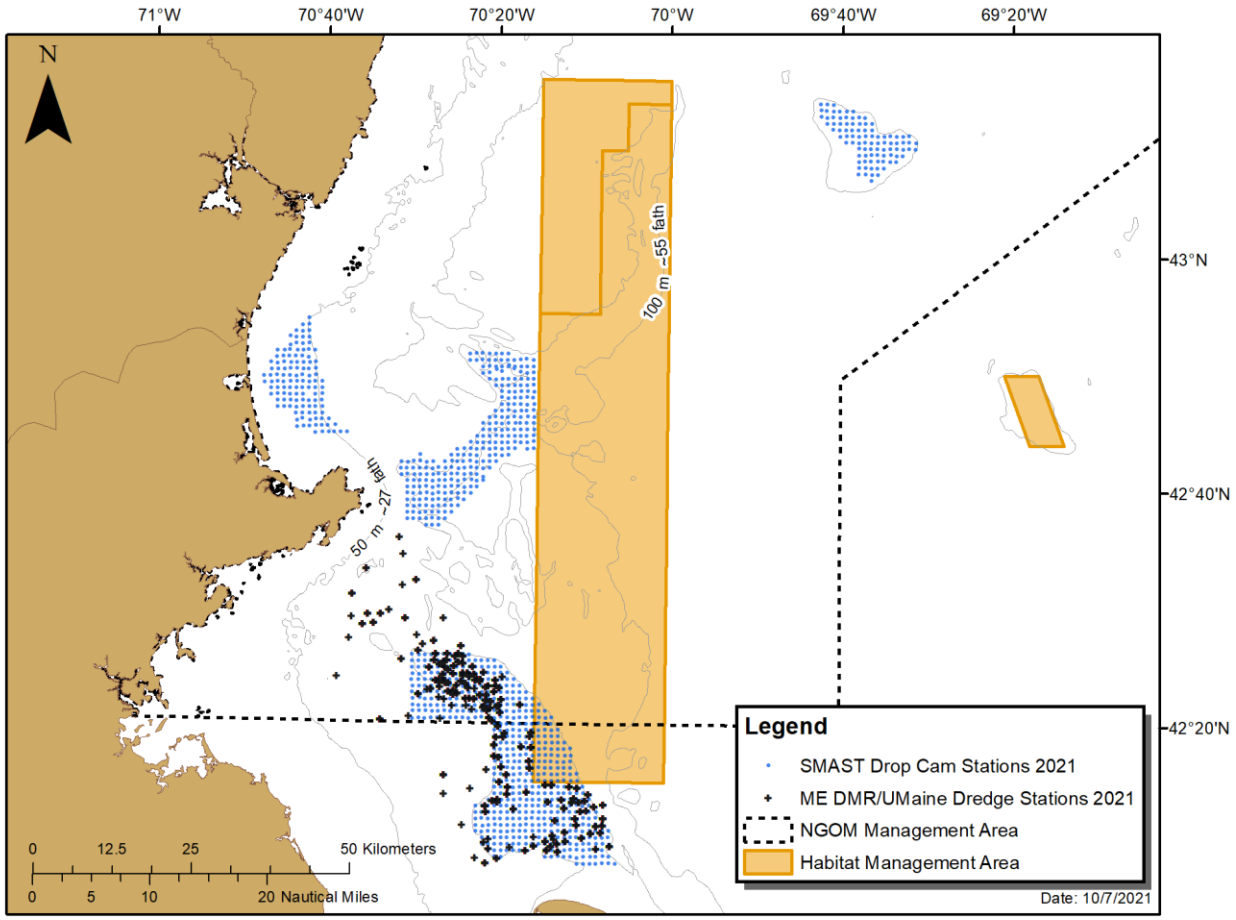


Figure 17 - 2021 UMaine/DMR GOM survey area (dredge – black dots), by stratum, with SMAST drop camera stations in the NGOM (Stellwagen), WGOM area, and Southern Stellwagen.

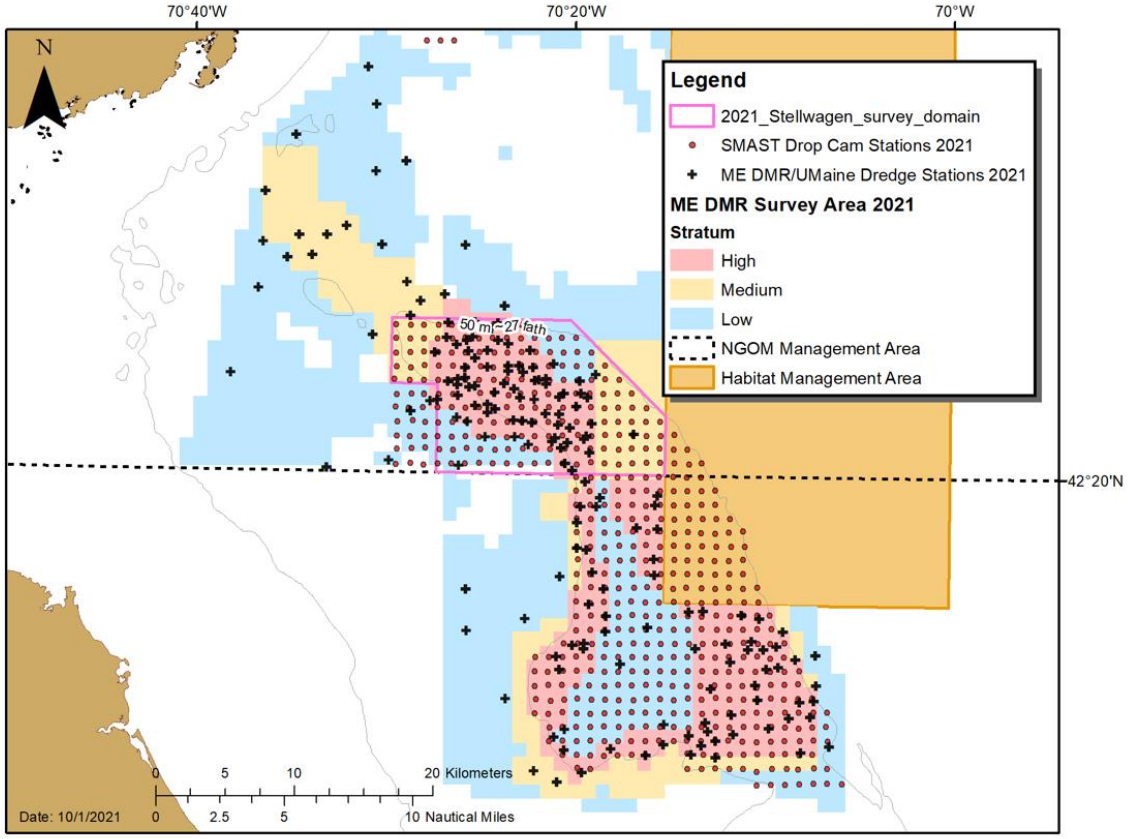
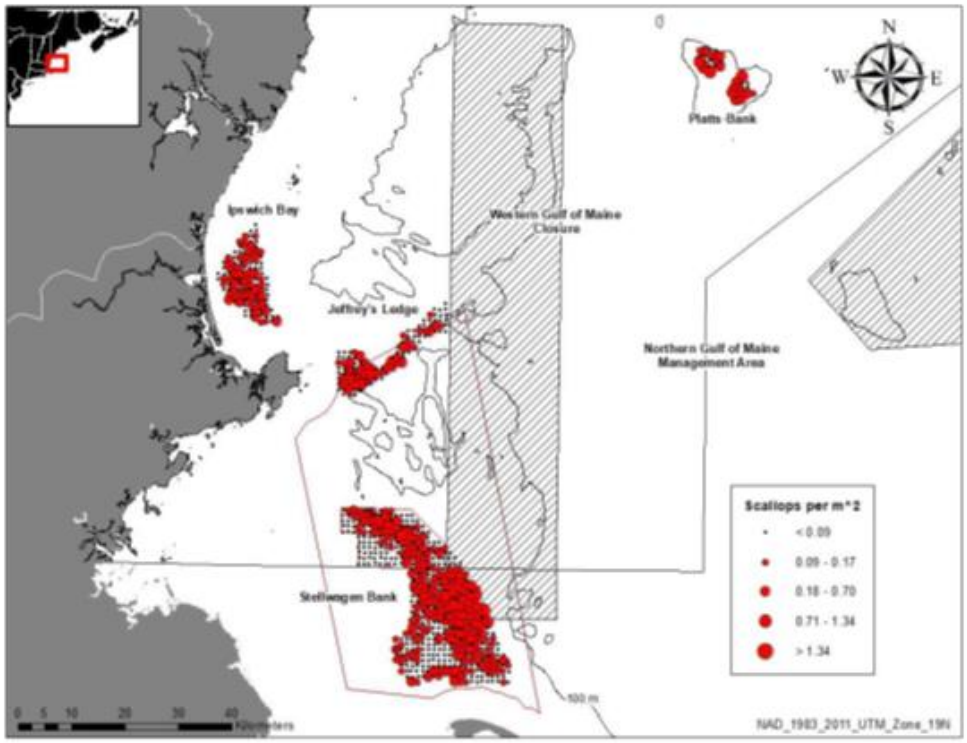


Figure 18 - 2021 SMAST Drop Camera survey coverage in the Gulf of Maine, with estimates of scallops per meter squared.



Appendix I: 2021 Projections - Outputs and Assumptions

2022 Projections for Georges Bank and the Mid-Atlantic:

1. Model configured the same as in Framework 33, with 8 areas in MA and 12 in GB. In 2019, the Closed Area II access area was partitioned into CAII-SW and CAII-SE.
2. Initialized using the average (mean) of available 2021 survey data.
3. L_∞ in NLS-S-deep was set to 110 mm to match observed growth (SARC 65).
4. L_∞ was reduced in all SAMS areas except CAII-SW and NLS-South to match observed growth.

Table 7 - Projected exploitable biomass for 2022 by Georges Bank and Mid-Atlantic SAMS area.

SAMS	Bms22 (mt)	EBms22 (mt)	EBMs22_LBS	Land@F=0.45 (mt)	Land@F=0.45 _LBS
CAI	1294	666	1,468,279	215	473,994
CAI-	1455	580	1,278,681	221	487,222
CAII-N	6185	3378	7,447,215	1105	2,436,108
CAII-SE	8975	3776	8,324,655	1344	2,963,013
CAII-SW	10378	7094	15,639,593	2605	5,743,042
CAII-Ext	17231	11945	26,334,217	4446	9,801,752
NLS-W	336	224	493,835	66	145,505
NLS-N	1564	977	2,153,916	313	690,047
NLS-S	17536	8187	18,049,245	3139	6,920,310
GSC	9386	5572	12,284,157	1831	4,036,664
NF	2884	1885	4,155,714	654	1,441,823
SF	10979	7529	16,598,604	2611	5,756,270
Total-GB	**88203**	**51813**	**114,228,112**	**18550**	**40,895,750**
HCS	2829	1378	3,037,970	449	989,876
ETop	2243	747	1,646,853	291	641,545
ETflex	1400	331	729,730	129	284,396
VIR	73	4	8,818	8	17,637
DMV	437	69	152,119	44	97,003
NYB	6024	3852	8,492,206	1573	3,467,871
LI	10879	7233	15,946,035	2876	6,340,495
Inshore	1650	872	1,922,431	387	853,189
Total-MA	**25535**	**14486**	**31,936,163**	**5757**	**12,692,012**
TOTAL	**113738**	**66299**	**146,164,275**	**24307**	**53,587,762**

2022 Projections for the Northern Gulf of Maine and Gulf of Maine

1. Projections for 2 areas in NGOM and 2 areas in the GOM. The OFL and ABC values were calculated using Fmsy values for Georges Bank from the 2020 management track assessment, consistent with the approach for the NGOM outlined in Amendment 21 to the Scallop FMP.
2. Until recently, the Gulf of Maine region has been relatively data poor. These four areas are outside of the CASA models, and this is the first time they have as part of the SAMS model, and considered for inclusion in OFL/ABC estimates for the scallop fishery.
3. Initialized using the average (mean) of available 2021 survey data (Table 6).
4. Shell-height meat weights were derived using recent survey information from the 2019 ME DMR survey (Hart 2020), and the 2021 ME DMR/UMaine dredge survey (Table 11)
5. L_∞ was set using the Hodgdon et al. (2020).

Table 8 - 2022 and 2023 projections for the Northern Gulf of Maine and Gulf of Maine.

Northern Gulf of Maine Estimates (Stellwagen Bank & NGOM other). NGOM other combines Platts, Jeffreys, and Ipswich Bay.							
	Year	NGOM-Stellwagen	Disc	NGOM-Stellwagen TOTAL	NGOM-Oth	Disc	NGOM-Other Total
ACL	2022	494	66	560	108	16	124
ACL	2023	434	56	490	104	14	118
OFL	2022	647	94	741	145	21	166
OFL	2023	573	80	653	138	19	157
Bms	2022	2167			504		
Bms	2023	1941			469		
ExpBms	2022	1514			342		
ExpBms	2023	1721			392		
Gulf of Maine Estimates (Stellwagen South & Western Gulf of Maine Closed Area)							
	Year	Stellwagen-S	Disc	Stellwagen-S Total	WGOM	Disc	WGOM Total
ACL	2022	158	22	180	660	79	739
ACL	2023	139	20	159	485	56	541
OFL	2022	209	30	239	876	114	990
OFL	2023	184	28	212	641	81	722
Bms	2022	711			2819		
Bms	2023	659			2119		
ExpBms	2022	552			2349		
ExpBms	2023	530			2024		

Table 9 - Comparison of the meat weight and growth parameters used in recent SAMS configurations for GB and MA.

	Meat weight	Growth
2015	SARC 59	SARC 59
2016	SARC 59, with changes to SH-MW parameters using VIMS 2016 data (NLS-S, NLS-NA, NLS-ext)	SARC 59, with reductions to growth in NLS
2017	SARC 50, with changes to SH-MW parameters in NLS using VIMS 2016 & 2017 data (NLS-S, NLS-NA).	SARC 59, with reductions to growth in NLS-S deep (>70m) based on observed growth between 2016 and 2017. Change ET-Flex L infinity to 110 mm based on observed growth in 2016 and 2017.
2018	SARC 65, with changes to SH-MW parameters in the NLS using VIMS 2016 – 2018 data	SARC 65, with reduction in L_∞ in NLS-W to 119mm. SARC 65 set the L_∞ of scallops in the NLS-S-deep at 110 mm.
2019	SARC 65, with changes to SH-MW parameters in the NLS using VIMS 2016 – 2019 data	SARC 65, with reduction in L_∞ in NLS-W to 119mm. SARC 65 set the L_∞ of scallops in the NLS-S-deep at 110 mm.
2020	SARC 65, with changes to SH-MW parameters in the NLS using VIMS 2016 – 2020 data (NLS-S, NLS-N, NLS-W)	SARC 65, scaled to the growth expectations from the 2020 management track assessment for all areas except NLS-South and CAII-SW.
2021	SARC 65, with changes to SH-MW parameters in the NLS-South using VIMS 2016 – 2021 data NGOM-Stellwagen-AOI using ME DMR/UMAINE 2021 SH-MW (w/ covariates)	SARC 65, scaled to the growth expectations from the 2020 management track assessment for all areas except NLS-South and CAII-SW.

Table 10 - 2022 and 2023 Georges Bank and Mid-Atlantic OFL and ABC estimates, with estimated discards (mt).

	Bms	Land	Discards	TotCatch
ACL22	113738	24304	4398	28702
ACL23	109774	22038	4260	26298
OFL22	113738	30384	5751	36135
OFL23	109774	27610	5587	33197

Table 11 - 2021 Survey Data Treatments by SAMS areas for GB, MA, NGOM, and GOM.

GB	***SHMW equation, Dredge Efficiency***	***Treatment, notes***
CL1-Access (M)	SARC 65	SMAST Drop Camera Data only
CL1-Sliver (N)	SARC 65	Survey mean
CL1-South	SARC 65	SMAST Drop Camera Data only
CL2-North	SARC 65	Survey mean
CL2-SE	SARC 65	Survey mean
CL2-SW	SARC 65	Survey mean
CL2-Ext	SARC 65	Survey mean
NLS-North	SARC 65	Survey mean
NLS-South-	VIMS 16-21, q=0.13 select stations	Survey mean
NLS-West	SARC 65	Survey mean
NF	SARC 65	Survey mean
GSC	SARC 65	Survey mean, split into 3 areas because of missing HabCam data in the middle part of the GSC.
SF	SARC 65	Survey mean
MidAtlantic		
BI	SARC 65	Survey mean
LI	SARC 65	Survey mean
NYB	SARC 65	Survey mean
MAB-Nearshore	SARC 65	Survey mean
HCS	SARC 65	Survey mean
ET Open	SARC 65	Survey mean, HabCam estimate using stratified mean
ET Flex	SARC 65	Survey mean, HabCam estimate using stratified mean
DMV	SARC 65	Survey mean, HabCam estimate using stratified mean
VIR	SARC 65	VIMS Dredge Data (no other survey data)
Gulf of Maine and Northern Gulf of Maine		
NGOM - Stellwagen	ME DMR/UMaine 2021 SH MW	Survey mean, GB Open Selectivity
NGOM Other	Hart 2020	SMAST Drop Camera only
WGOM Closure	ME DMR/UMaine 2021 SH MW	SMAST Drop Camera only, inside WGOM closed area
Stellwagen South	ME DMR/UMaine 2021 SH MW	Survey mean (dredge and drop camera surveys covered slightly different areas).

Table 12 - Description of the SH-MW changes in Nantucket Lightship SAMS areas from 2016 to 2021.

SAMS area	SH-MW applied in 2016, FW28	SH-MW applied in 2017, FW29	SH-MW applied in 2018, FW30	SH-MW applied in 2019, FW32	SH-MW applied in 2020, FW33	SH-MW applied in 2021, FW34
NLS-N	SARC 59	SARC 50	VIMS 2016-2018 Combined	VIMS 2016-2019 Combined	VIMS 2016-2020 Combined	SARC 65
NLS-S 'Shallow' (>70m)	SARC 59	SARC 50	VIMS 2016-2018 Combined (South Shallow only	VIMS 2016-2019 Combined	VIMS 2016-2020 Combined (Merged into one SAMS area in 2020)	VIMS 2016-2021 Combined (Merged into one SAMS area in 2020)
NLS-S 'Deep' (<70m)	VIMS 2016	VIMS 2016/2017 Combined (NLS S)	VIMS 2016-2018 Combined (Deep only)	VIMS 2016-2019 Combined		
NLS-Ext	VIMS 2016	SARC 50	SARC 65	N/A (part of GSC)	N/A (part of GSC)	N/A (part of GSC)
NLS-W	VIMS 2016	VIMS 2016/2017 Combined (NLS W)	VIMS 2016-2018 Combined (West only)	VIMS 2016-2019 Combined	VIMS 2016-2020 Combined	SARC 65
Estimate of relative meat weight were derived using the following assumptions: Length = 100 mm, mean depth by SAMS area used. Mean depth for NLS-S SAMS area calculated by depth bin. Mean latitude by SAMS area used for SARC 50.						

Table 13 - Comparison of SARC 65 and FW34 growth parameters

		SARC-65		FW-34	
Subarea	**Years**	**L_∞**	**K**	**L_∞**	**K**
Sch	**12-16**	**150.3**	**0.397**	**135.7**	**0.397**
NF	**12-16**	**148.8**	**0.397**	**134.3**	**0.397**
SF	**12-16**	**137.3**	**0.464**	**123.9**	**0.464**
CA-I	**12-16**	**149.4**	**0.397**	**134.5**	**0.397**
CA-II	**12-16**	**146.9**	**0.397**	**132.3**	**0.397**
CAII-SW	**12-16**	**146.9**	**0.397**	**146.9**	**0.397**
NLS	**12-16**	**151.2**	**0.397**	**136.1**	**0.397**
NLS-S	**15-16**	**110.3**	**0.423**	**110.3**	**0.423**
DMV	**08-12**	**136.4**	**0.547**	**130.5**	**0.547**
ET	**08-12**	**137.9**	**0.547**	**131.9**	**0.547**
HCS	**08-12**	**129.5**	**0.547**	**123.9**	**0.547**
NYB	**08-12**	**140.8**	**0.547**	**134.6**	**0.547**
LI	**08-12**	**139.6**	**0.547**	**133.5**	**0.547**
Inshore	**08-12**	**147.3**	**0.547**	**140.8**	**0.547**

Appendix II: VIMS Nantucket Lightship Shell-Height Meat-Weight Analysis

Ms. Sally Roman

August 3, 2021

Methods

Shell height meat weight relationships (SHMW) were estimated for the Nantucket Lightship (NL) survey by SAMS Area with VIMS survey data. SHMW relationships were developed using a combined dataset from 2016 - 2021. Surveys from 2016 - 2019 and 2021 occurred in June or July of a given year. The 2020 survey was delayed due to COVID-19 travel restrictions and was completed in late September of 2020.

Station-level data from the 2016 - 2019 surveys were reassigned to 2020/2021 SAMS Areas for analysis. VIMS' protocols dictate that at every station with scallop catch, up to 15 scallop that encompass the length distribution of scallops at a given station are sampled to collect data on meat weight, gonad weight, meat quality, sex, maturity stage, and disease prevalence. The shell height is taken for each scallop assessed, and then the adductor muscle and gonad are carefully removed. The adductor muscle and gonad are weighed with a Marel M200 motion compensating scale. Maturity stage is assessed by visual examination of the gonad. VIMS classifies maturity into six stages: rebuilding, mature, spent, spawning, resting, and unknown. SHMW mixed effect models were developed with forward selection and variables were retained in the model if the AIC was reduced three or more units. SAMS Area was included in all models to estimate the SAMS Area effect. The model with the lowest AIC was selected as the preferred model and used to predict SHMW relationships by SAMS Area. If models were within three units of each other, a likelihood ratio test was used to test for significant differences between model. If there was no significant difference between the models, the more parsimonious model was selected as the preferred model. Variables considered were: ln shell height, ln depth (average depth for a station), SAMS Area (retained in all models), latitude (beginning latitude of a station), an interaction term of shell height and depth, year, and maturity stage. Maturity stage was included to account for the delay of the 2020 survey. Models with and without maturity stage were compared to assess the need to include this variable. Post-hoc multiple pairwise comparisons for the levels of maturity stage and SAMS Area were also completed. The interaction term was not considered in model development if the term was not significant in the individual model. Year was included to test for a year effect. Year was found to have a significant effect on SHMW relationships this year. Models with Year as a fixed and random effect were also developed. Models with Year, either as a fixed or random effect, had lower AIC values than models presented in this report, but are not included. These models can be presented if requested by the PDT. Tables provided below include the SHMW models with parameters and AIC by SAMS Area. Parameter estimates for the preferred model and predicted SHMW relationships are also provided.

Results

Maturity stage was not considered in final model development based on a comparison of predicted SHMW curves with and without maturity stage, as well as a lack of significance between maturity factor levels in the preferred model, and post-hoc pairwise comparisons between maturity stage levels. The preferred model included shell height, SAMS Area, latitude, and depth as fixed effects (Table 1). This result is consistent with results from 2020. All

predictor variables were significant (Table 2). The NL_South_Deep and NLS_West SAMS Areas were significantly different from the reference SAMS Area, the NLS_North SAMS Area. Predicted SHMW curves indicate the NLS_South_Deep continues to have lower meat weights across all lengths compared to the other three SAMS Areas (Figure 1). Post-hoc pairwise comparisons for SAMS Area indicated the NL_South_Deep SAMS Area was significantly different from all other SAMS Areas. All parameter estimates and the predicted SHMW curves for the preferred model in Figure 1 and Table 2 include all data from all stations within the VIMS NL survey domain for 2016 - 2021.

Table 1. SHMW models for the 2016 - 2021 VIMS NL survey data. Bold variables indicate significance. Model in red was selected as the preferred model. The number of parameters (K), AIC, ΔAIC, AIC weight (AICWt), and Deviance explained are also included.

Models	Parameters	K	AIC	ΔAIC	AICWt	Deviance
m4	**~1 + Shell Height + SAMS Area + Depth + Latitude**	9	53,011.38	0	0.81	76.18
m1	~1 + **Shell Height*Depth + SAMS Area + Latitude**	10	53,014.57	3.19	0.17	76.17
m3	~1 + **Shell Height + SAMS Area + Depth**	8	53,020.53	9.15	0.01	76.17
m5	~1 + **Shell Height + SAMS Area + Latitude**	8	53,020.65	9.26	0.01	76.19
m2	~1 + **Shell Height*Depth + SAMS Area**	9	53,021.96	10.58	0	76.17
null	~1	3	66,565.99	13,554.61	0	

Table 2. Parameter estimates for model m4 from Table 1.

Parameter	Parameter Estimate
Intercept	-22.64
log Shell Height	2.87
NLS_South_Deep	-0.24
NLS_West	-0.08
VIMS_45	-0.02
log Depth	-0.23
Latitude	0.33

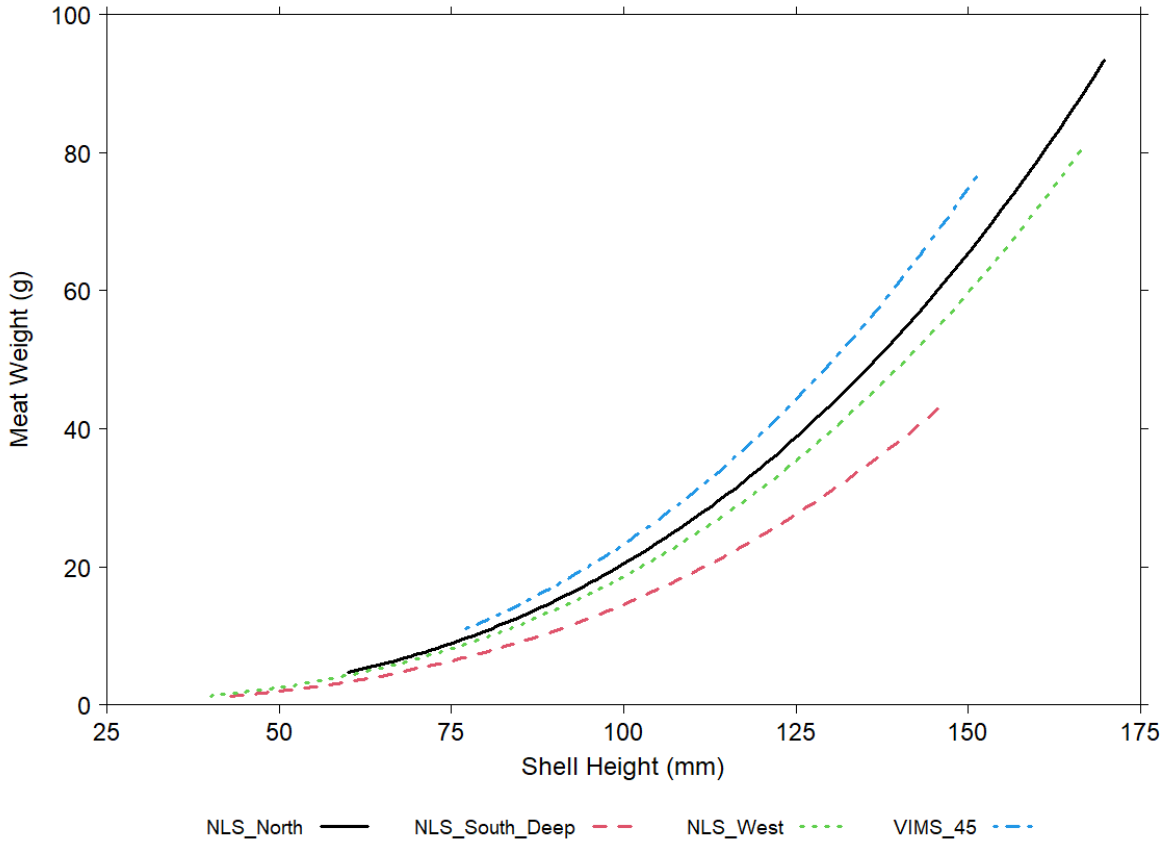


Figure 1. Predicted SHMW relationships by SAMS Area for the NL using model m4 from Table2.

Discussion

SHMW relationships in the NL continue to show a similar trend across years. Results from the 2020 and 2021 SHMW analyses are similar with respect to the preferred model, parameter estimates, and predicted SHMW curves by SAMS Area. The South_Deep SAMS Area continues to have a lower meat weight at shell height compared to the other SAMS Areas. This SAMS Area is significantly different from the reference case, NLS_North SAMS Area and the NL_West SAMS Area. Biomass estimates for the VIMS NL Survey domain have not been calculated yet, but the assumption of reduced dredge efficiency in the high density area in the South_Deep SAMS Area may persist.

Parameter estimates from 2016 – 2020 for shell height meat weight relationships for the Nantucket Lightship region derived from VIMS dredge survey data can be found under Appendix II in the Scallop PDT's November 17, 2020 memo to the SSC re: 2021 and 2022 OFL and ABC recommendations.[2]

[2] November 17, 2020 memo can be accessed at this link: https://s3.amazonaws.com/nefmc.org/1.3-201118-Memo-PDT-to-SSC-RE-ABC-OFL-2021-2022_final.pdf

Appendix III:

SH-MW Parameters for Biomass Estimation
Comparison of Biomass Estimates Using SARC 65 vs. VIMS 2016-2021
Nantucket Lightship South SAMS Area

Note: Biomass values in mt.

Total VIMS dredge biomass estimates (mt) for the NLS-South using SARC 65 parameter estimates and VIMS 2016-21 parameter estimates the current SAMS areas. Dredge efficiency issues persist in high density areas in the NLS-South SAMS Area.

	SARC 65 SH/MW	VIMS SH/MW 2016-2021
NLS-South	9,863.43	9,375.19

Total biomass estimates from the 2021 SMAST drop camera survey in the Nantucket Lightship area using the 65th SARC or the 2016-2021 Virginia Institute of Marine Science (VIMS) shell-height to meat-weight formulas.

	SARC 65 SH/MW BmsMT (SE)	VIMS SH/MW 2016-2021 BmsMT (SE)
NLS-South	24,263 (10,188)	23,009 (9,662)

Comparison of 2021 HabCam biomass estimates (40+ mm) using VIMS 2016-2021, SARC 65 SH-MW equations for Nantucket Lightship South Area. Percent difference was calculated using biomass estimates (VIMS - SARC 65)/(VIMS).

SAMS Area	BmsMT (SARC 65)	BmsMT (VIMS)	%Diff
NLS-South	19995	17333	13.32

Appendix IV: Comparison of 2021 Surveys with Projections using 2020 Data

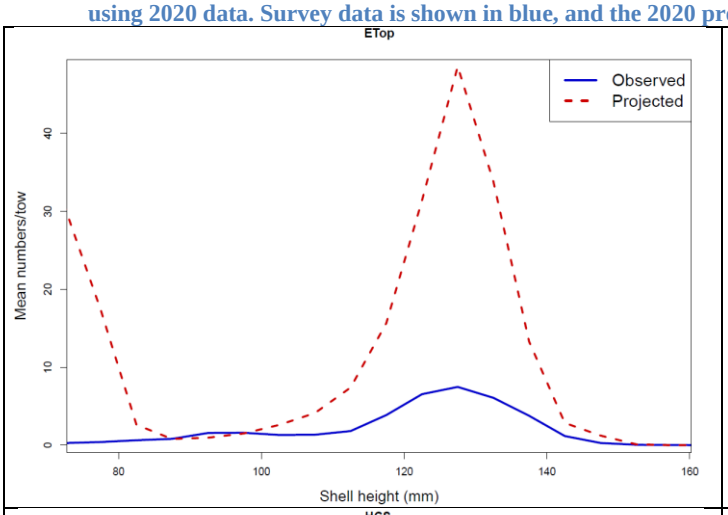
The Scallop PDT prepared an analysis comparing the length frequencies (L-Fs) from 2021 survey data with projections from the SAMS model for 2021. The "2020 run" of the SAMS model was initialized using survey data from 2020, and model results account for various factors including fishing mortality, natural mortality, discard mortality, and recruitment. The 2021 projections use slower growth stanzas for most areas. Observed length frequencies from the 2021 surveys were used to compare to the 2021 projections for all SAMS areas.

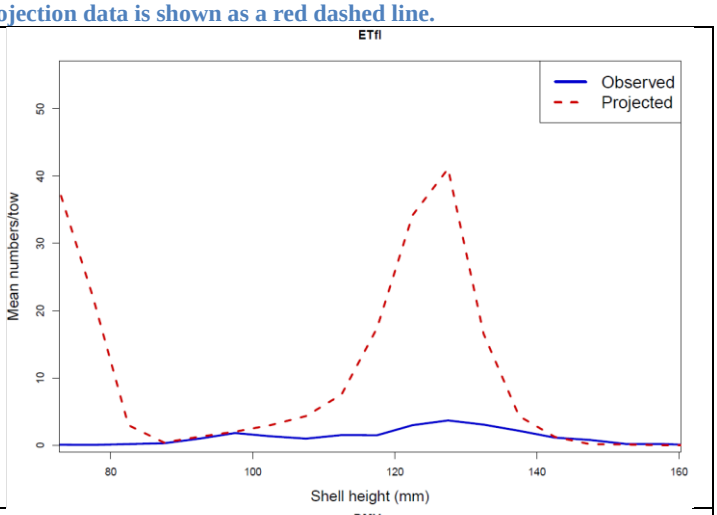
The plots in Table 14 display L-Fs by SAMS areas from across Georges Bank and the Mid-Atlantic. The length-frequencies are shown by mean number per tow.

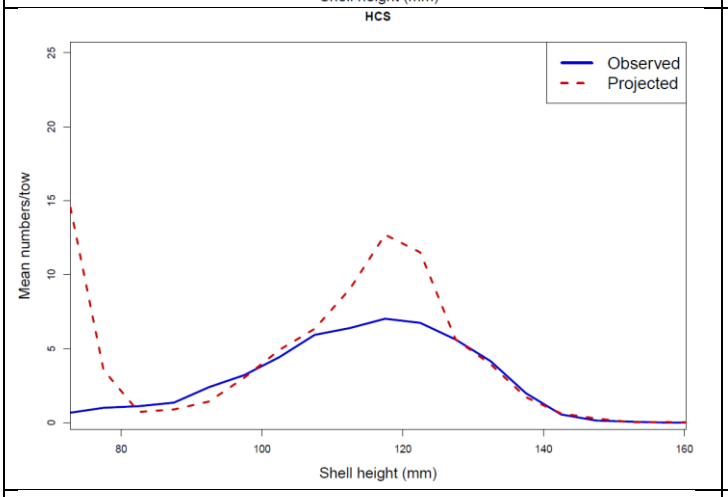
Discussion:

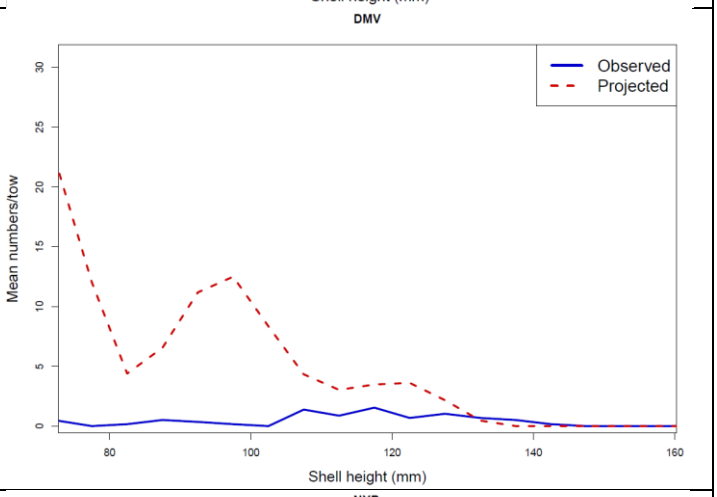
- Observed number per tow from the 2021 survey data are both higher and lower than the 2020 projections, depending on the SAMS area. This suggests that some combination of realized F, M, and growth was different than what was assumed in the 2020 SAMS model run.
- Changes to growth assumptions in the 2021 projections (slower growth) likely improved the agreement between surveys and projections. The decision to reduce growth in 2020 was based on the results of the 2020 management track assessment, and a comparison of 2020 survey data and 2020 projections from 2019 data.
- Error in surveys could explain some of the difference in observed versus projected L-Fs - for example, if both the 2020 and 2021 surveys in an area have 20% CVs, projections and surveys could differ by up to 50% due to survey error alone.
- The comparison shows that the 2021 projections for SAMS areas in the Mid-Atlantic Access Area estimated substantially more scallops than were observed in the 2021 surveys. While the survey data and projections generally tracked the shell-heights of the dominant 2013 year class in the Mid-Atlantic Access Area (i.e., ET-Open, ET-Flex, and HCS SAMS areas), the 2021 projections substantially overestimated biomass and abundance in these three areas. In the Mid-Atlantic, where the largest declines were observed, it is worth noting that normal natural mortality removes over 20% of the scallops per year; when considering the divergence between projections and observations in this part of the resource, note that there is a strong possibility that *M* was elevated in the southern MA last year.

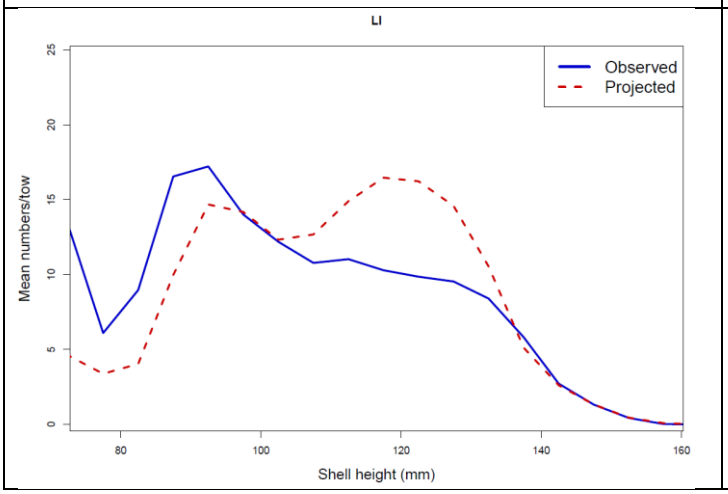
Table 14 – Length frequency plots comparing mean number of scallops per tow using 2021 survey data to projection using 2020 data. Survey data is shown in blue, and the 2020 projection data is shown as a red dashed line.

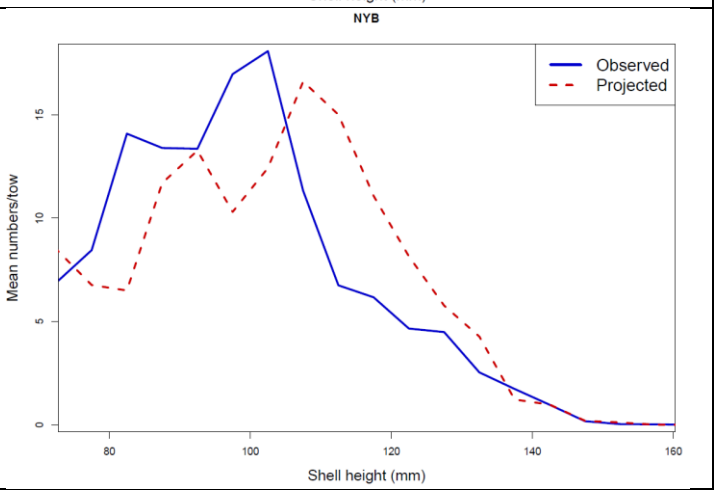


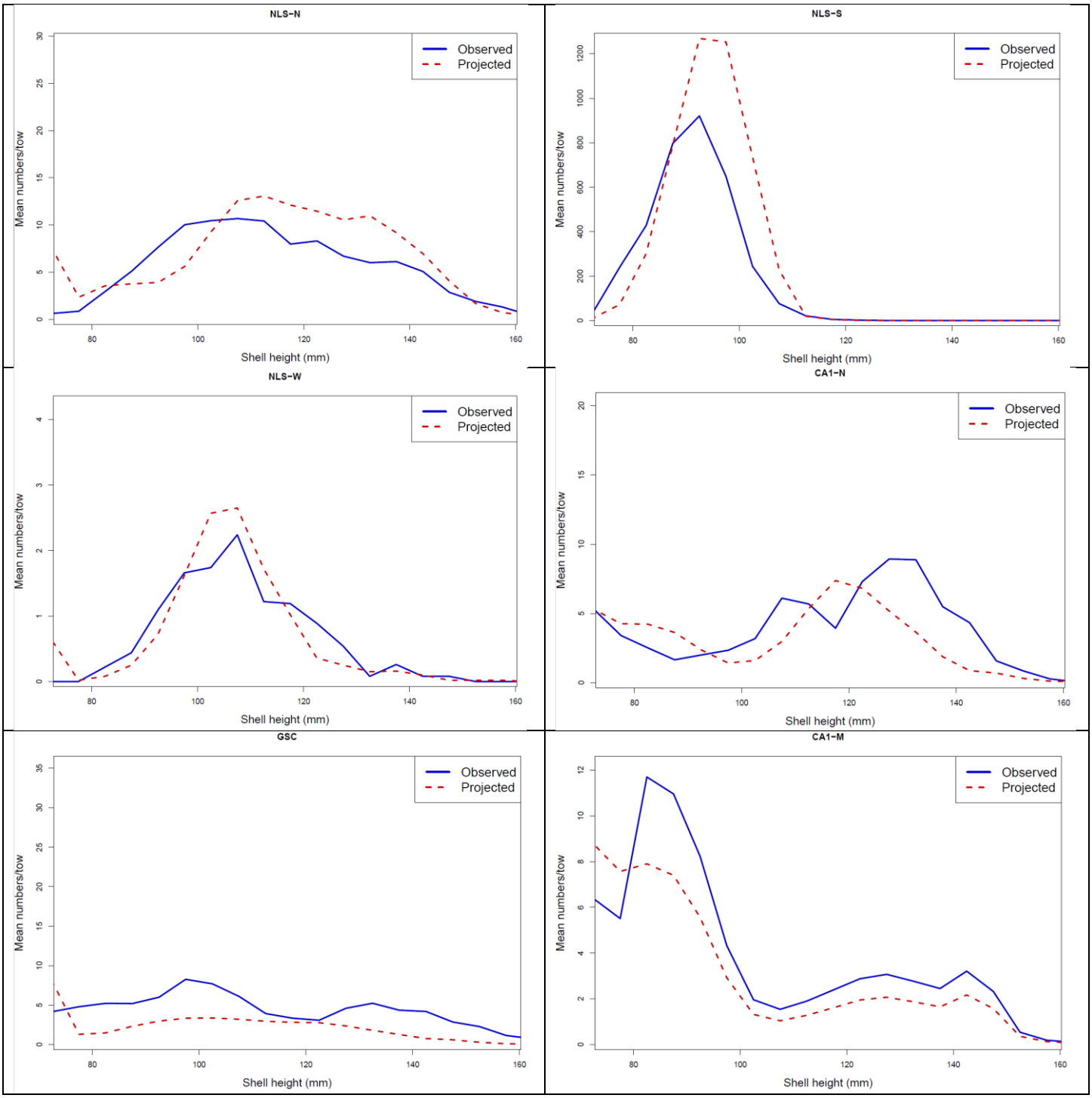


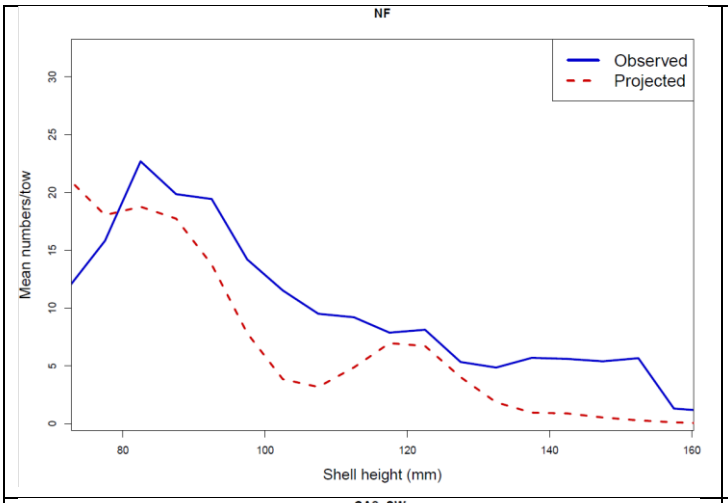


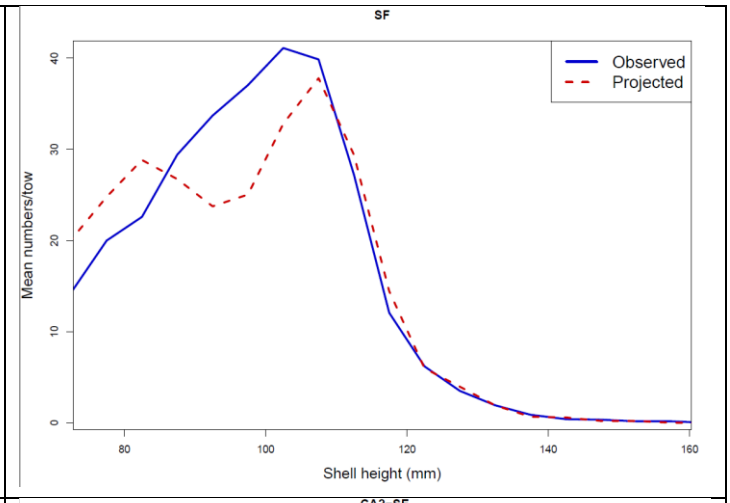


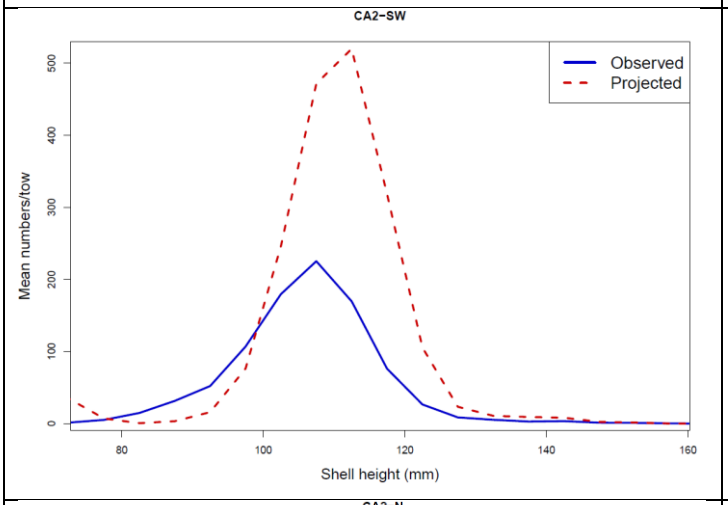


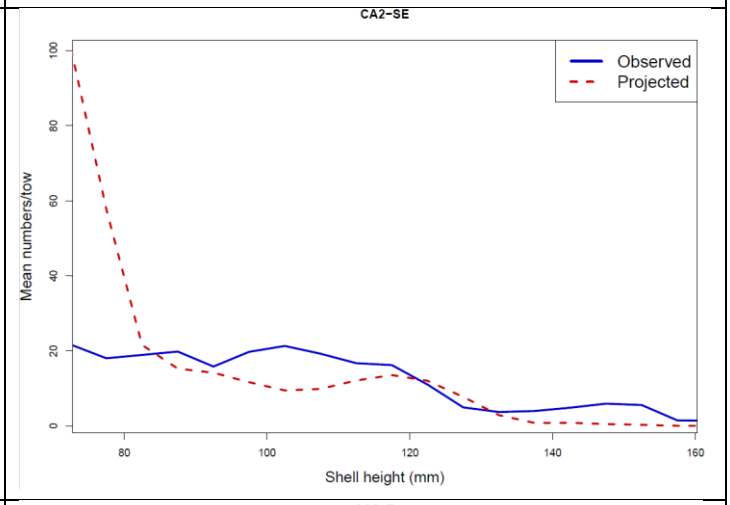


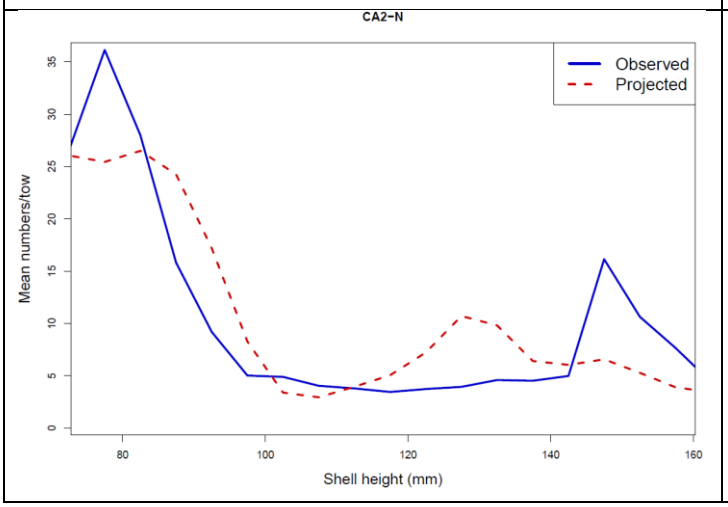

NLS-N
Observed
Projected
Mean numbers/tow
Shell height (mm)
NLS-S
Observed
Projected
Mean numbers/tow
Shell height (mm)
NLS-W
Observed
Projected
Mean numbers/tow
Shell height (mm)
CA1-N
Observed
Projected
Mean numbers/tow
Shell height (mm)
GSC
Observed
Projected
Mean numbers/tow
Shell height (mm)
CA1-M
Observed
Projected
Mean numbers/tow
Shell height (mm)

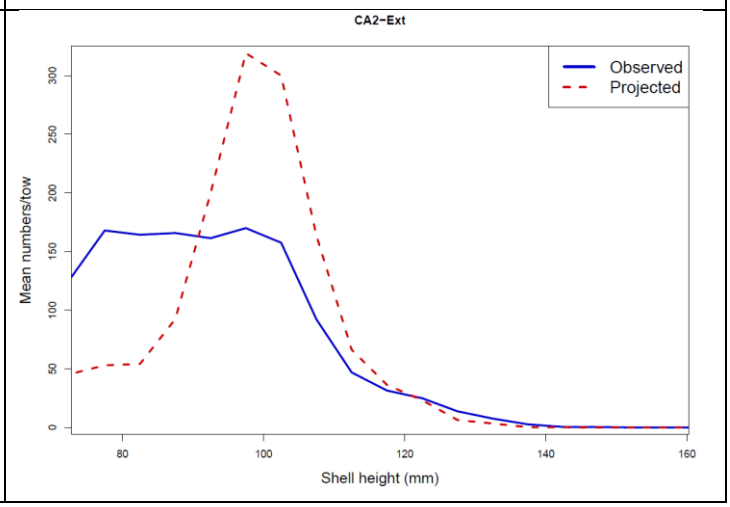

NF
Observed
Projected
Mean numbers/tow
Shell height (mm)


SF
Observed
Projected
Mean numbers/tow
Shell height (mm)


CA2−SW
Observed
Projected
Mean numbers/tow
Shell height (mm)


CA2−SE
Observed
Projected
Mean numbers/tow
Shell height (mm)


CA2−N
Observed
Projected
Mean numbers/tow
Shell height (mm)


CA2−Ext
Observed
Projected
Mean numbers/tow
Shell height (mm)

Appendix V: Geostatistical Estimation for Elephant Trunk and Delmarva SAMS

A geostatistical model could not be completed for the HabCam survey of the Elephant Trunk (ET) Open, ET-Flex, or Delmarva (DMV) SAMS areas because of the low number of scallops observed in the data.[3] While a 1:400 annotation rate proved adequate for several years when scallop abundance was higher in the region, the 1:400 annotation rate coupled with the declining population resulted in a small number of measured scallops. In lieu of a geostatistical model, estimates for these SAMS areas were calculated using a stratified mean approach for HabCam data. This approach was presented at the 2015 Scallop Survey Review and the methods are described in detail in Chang et al. 2017. The PDT acknowledged that using the stratified mean approach is not preferable to the geostatistical approach, but that the stratified mean approach is sufficient when stratification of the survey area is done correctly. The strata used for the ET-Open, ET-Flex, and DMV SAMS areas were delineated based on areas of high density and low density. The PDT recommended using the stratified mean approach for HabCam estimates because geostatistics could not be performed with the available data and the method has been peer-reviewed. The PDT noted that this approach resulted in similar estimates compared to the dredge survey, meaning that either not using the HabCam data or combining the stratified mean with the dredge survey would yield similar results for management. The PDT recommends that HabCam survey groups increase their annotation rates in areas of low abundance in the future to enable the use of geostatistical estimation methods. The PDT notes that the Scallop Survey Working Group – a joint effort between the Council and Northeast Fishery Science Center – could be an appropriate venue to develop specific annotation rates.

[3] HabCam annotation rates by SAMS area can be found in the NEFSC HabCam Survey Report (4.3, p. 29): https://s3.amazonaws.com/nefmc.org/2ei.-NEFSC-HabCam-PDT_ShortReport_2021_V2.pdf