New England Fishery Management Council
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Eric Reid, *Chairman* | Thomas A. Nies, *Executive Director*

MEMORANDUM

DATE: October 7, 2022

TO: Scientific and Statistical Committee (SSC)

FROM: Scallop Plan Development Team (PDT)

SUBJECT: **OFL and ABC for Framework 36 (FY2023 and FY2024 (default))**

This memorandum addresses the following 2022 SSC terms of reference for Atlantic sea scallops. The PDT also provides responses to the SSC recommendations from 2021.

2022 SSC Terms of Reference:

1. Review information provided by the Scallop PDT on changes to scallop meat weights used to develop 2022 survey estimates. Review growth and selectivity parameters and assumptions of natural mortality used in the Scallop Area Management Simulation (SAMS) model to project biomass. Provide the Council with a recommendation as to whether these changes are appropriate.
2. Using reference points updated by the 2020 management track assessment, and considering the Council's Risk Policy Statement, review the Scallop PDTs updated projections for the scallop resource, including estimates from the Gulf of Maine and Northern Gulf of Maine management unit, and provide the Council with OFL and ABC recommendations using the Council's ABC control rule for fishing years 2023 and 2024 (default).

Follow-up on 2021 SSC Recommendations:

The SSC developed three research recommendations as part of their 2021 report responding to the scallop TORs:

1. The SSC recommends that in the future a more holistic consideration of stock changes and a more systematic approach to adjusting survey and model parameters be employed.
2. The SSC recommends consideration of the future of surveys in the GOM region be included in the ongoing Scallop Survey Working Group and NEFSC-supported scallop survey re-stratification efforts.
3. The SSC recommends that ongoing research on potential drivers of changes in sea scallop stock dynamics (e.g., changing ocean conditions, including ocean acidification and warming) be included in the upcoming review of the SAMS model and in the 2024 research track assessment for scallops.

PDT Consensus Statement on Proposed Changes Outlined in this Memo:

Adjustments to the 2022 survey data:

- Shell-Height to Meat Weight (SHMW) Relationships: SHMW parameters were updated through SARC 65 (2018). As with previous years, the PDT recommends using area-specific SHMW parameter estimates from the recent dredge surveys conducted in the NLS-South area to account for slow growth in this region. The PDT also recommends using an area specific SHMW relationship for the New York Bight (NYB) closure area.
- Selectivity: The PDT recommends applying the SARC 65 Georges Bank Open selectivity curve as estimated in the CASA model in the Nantucket Lightship 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 at age than normal, it is unlikely that the Georges Bank Closed selectivity would reflect expected fishing practices.

Adjustments to projections for FY 2023 (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 continues to recommend that SAMS area growth assumptions ($L\infty$) be scaled to match slower growth, consistent with the 2020 management track assessment. This change was recommended by the SSC in 2020 and 2021 and appears to be appropriate based on comparisons of the 2022 survey length frequencies with FW34 projections (Appendix IV: Comparison of 2022 Surveys with Projections using 2021 Data). The PDT recommends adjustments to the growth parameters used for the Gulf of Maine, and to continue adjusting growth in the NLS-South.
- Natural mortality: Projections in Virginia and to a lesser extent Delmarva have consistently overestimated biomass and abundance in recent years, despite the limited fishing in these areas. The PDT recommends increasing *M* in the SAMS model to account for possible environmental changes in these areas to attempt to improve forecast performance.

FY 2023 & FY 2024 (default) OFL and ABC Calculation:

- Gulf of Maine: Survey frequency and intensity has increased in areas outside of the scallop survey strata north and east of Cape Cod, including the NGOM management unit. In light of environmental changes occurring throughout the range of the stock, and the SSC's recommendation to include the Gulf of Maine as part of the OFL and ABC, the Scallop PDT evaluated the survey data from this region, which is included Georges Bank and the Mid-Atlantic in the calculation of the OFL and ABC.

2023 & 2024 OFL and ABC Calculations

The updated OFL and ABC values for the Georges Bank and Mid-Atlantic regions are based on updated reference points from the 2020 management track assessment (OFL F=0.61; ABC F=0.45). Based on adjustments to the Scallop FMP through Amendment 21 and methods approved by the SSC in October 2021, scallops in the Gulf of Maine region (including the Northern Gulf of Maine management area) are now included in the overall OFL and ABC estimates. In the absence of reference points and a stock assessment model for areas of the Gulf of Maine, the OFL and ABC estimates for the 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)). This approach was approved by the SSC in October 2021 and is explained in detail in the October 7, 2021 memo from the Scallop PDT to the SSC[1].

The OFL and ABC estimates for 2023 are lower than the 2023 (default) projections that were approved by the SSC in October 2021. The 2023 biomass projections indicate the continued decline from the record high levels observed in recent years. This decline is attributed to the extraordinarily large 2012- and 2013-year classes being fished down and the absence of strong recruitment in subsequent years. The biomass projection for 2024 is slightly higher than the estimate for 2023 due to the growth potential of incoming recruitment located in the New York Bight, Elephant Trunk, and the Closed Area I sliver. The majority of biomass for the stock is contained on Georges Bank (i.e., roughly 54% according to the 2022 surveys), specifically, in Closed Area II (CAII).

More than half of the population is considered exploitable (Table 2). The PDT cautions that if higher than expected natural, incidental, or discard mortality occurs, biomass estimates will be overestimated, especially for 2024.

Table 1 – Scallop PDT recommendation for OFL and ABC including discards for Framework 36, fishing years 2023 and 2024 (default). Values shown in metric tons (mt) and are based on biomass from Georges Bank, the Mid-Atlantic, and the Gulf of Maine management area.

Fishing Year	Areas included	ABC	OFL
2023	GB, MA, GOM	22,631	27,504
2024	GB, MA, GOM	23,289	29,151

Table 2 - Estimated biomass (mt) and exploitable biomass (mt) for FY 2023.

Year	Biomass	Exploitable Biomass	Percent Exploitable
2023	101,347	54,503	54%

Table 3 - 2023 Scallop ABC (excluding discards) estimates with and without adding the GOM.

2023 Values	ABC	%increase by adding GOM
GB	12,205	
MA	6,583	
GOM	1,040	
Total	19,828	~6%

Overly Optimistic Projections and Adjustments to the SAMS Forecasting Model

The PDT has been tracking the forecasting performance of the SAMS model for several years and has compared the survey estimates with projections since SARC 65 (i.e., 2019 -2022) 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 projected biomass for 2022 based on 2021 surveys with observations from the 2022 surveys and found that projections were overly optimistic (Figure 2). At the resource level, the projections have over-estimated scallop biomass for several years (Figure 3). At a finer scale, the most substantial

[1] https://s3.us-east-1.amazonaws.com/nefmc.org/1.3-211007-Memo-PDT-to-SSC-RE-ABC-OFL-2022-2023.pdf

overestimation was evident in SAMS areas that make up Closed Area II Access Area (i.e., CAII-SW, CAII-Ext) and the NLS-South. The divergence could have been driven by a combination of fishing and elevated natural/incidental mortality, particularly in the NLS-South where the remaining scallops from the 2012 year class dwindled to a point where trips to this area became economically unviable early in FY2022. 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 2022 projections and observations were those with lower biomass that were unlikely to have been targeted by the fishery, or areas where recruitment was observed.

The SAMS model considers area-specific (i.e., by SAMS area) growth parameters (i.e., L_∞, k) when making forward projections of biomass. 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 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 and 2021 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 10).

For areas in the Gulf of Maine, the PDT recommends using growth parameters from Georges Bank instead of the growth curves presented in Hodgdon et al. (2021). The growth curve applied in 2021 appears to be overestimating realized growth in this area (Figure 1), and a correction is warranted as fishing is expected in the NGOM next year.

Figure 1 - Comparison of 2022 L-F projections with 2022 survey data. 2021 projections are shown as the red dotted line. 2022 survey data is shown as the solid black line. See Appendix IV for all SAMS areas.

<table>
<tr>
<td>A. Example of projection overestimating recruitment and growth in the CAII-SW SAMS area relative to the 2022 surveys.</td>
<td>B. Example of projection overestimating abundance and growth in the CAII-Ext SAMS area relative to the 2022 surveys.</td>
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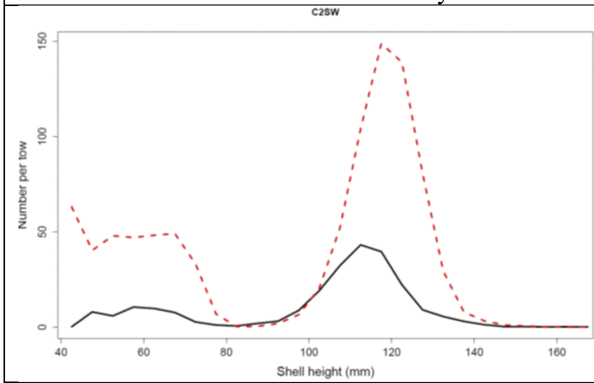

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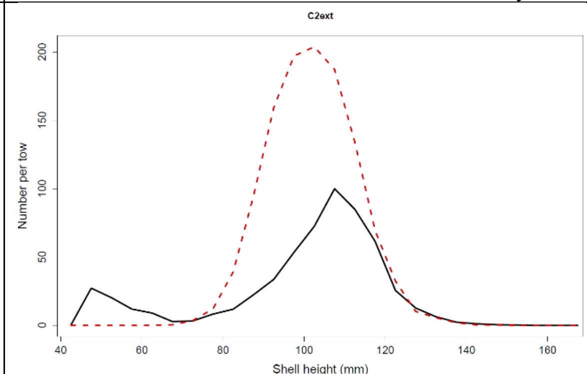

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<td>C. Examples of 2021 projection overestimating growth in the in Stellwagen area of the Northern Gulf of Maine relative to the 2022 surveys.</td>
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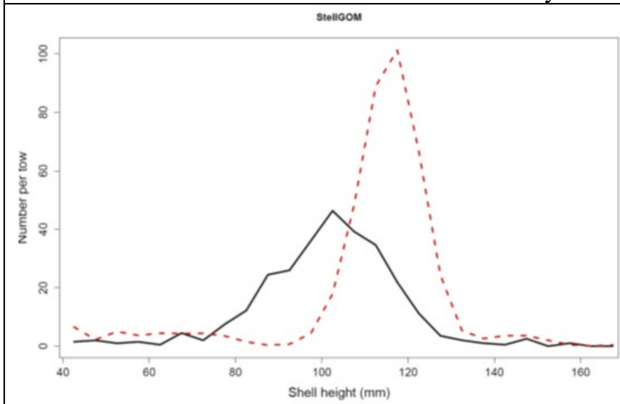

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Figure 2 - Comparison of projection error for 2019 - 2022 by region (top) and access and open areas (bottom). The percent error is calculated as 100*(predicted-observed)/predicted.

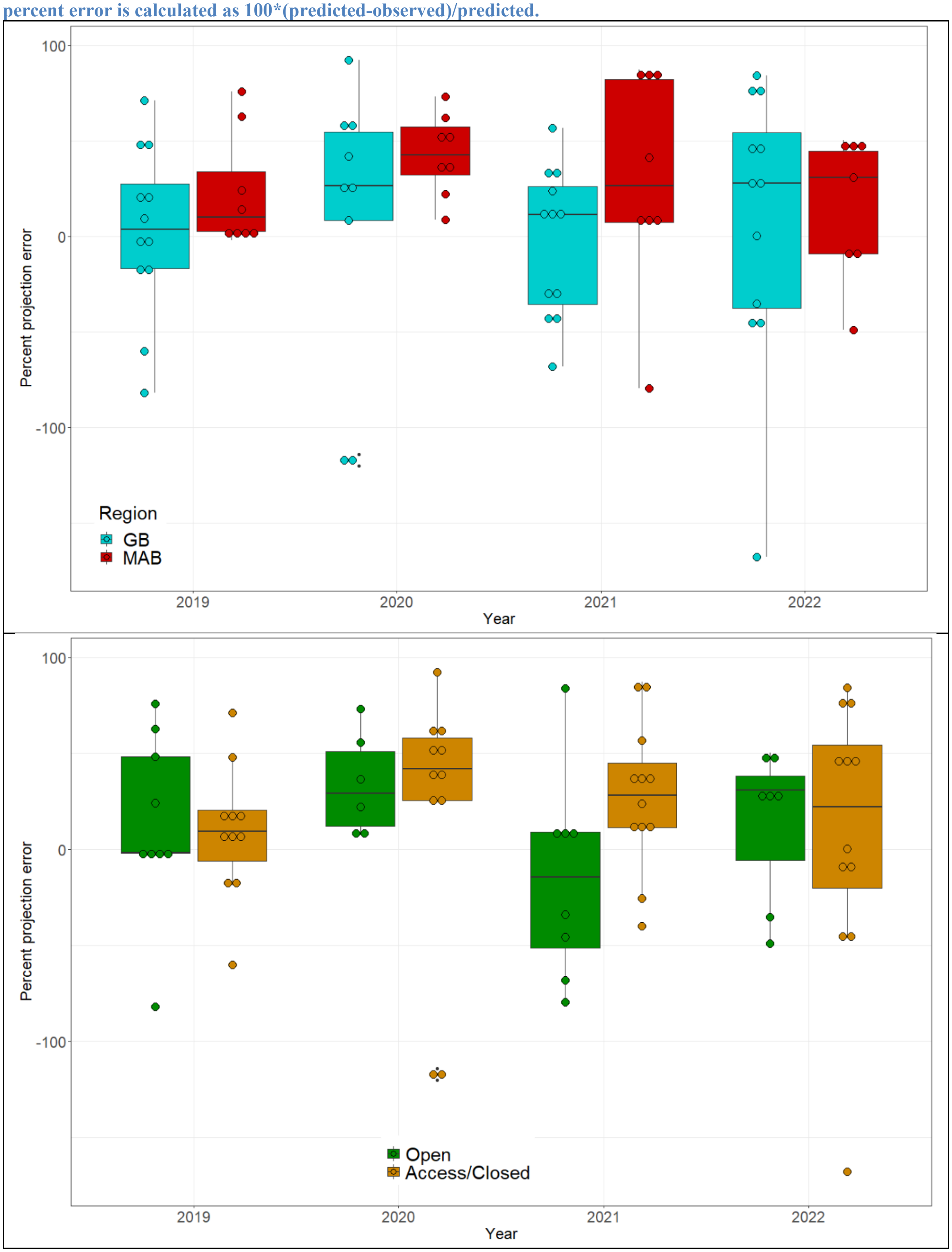
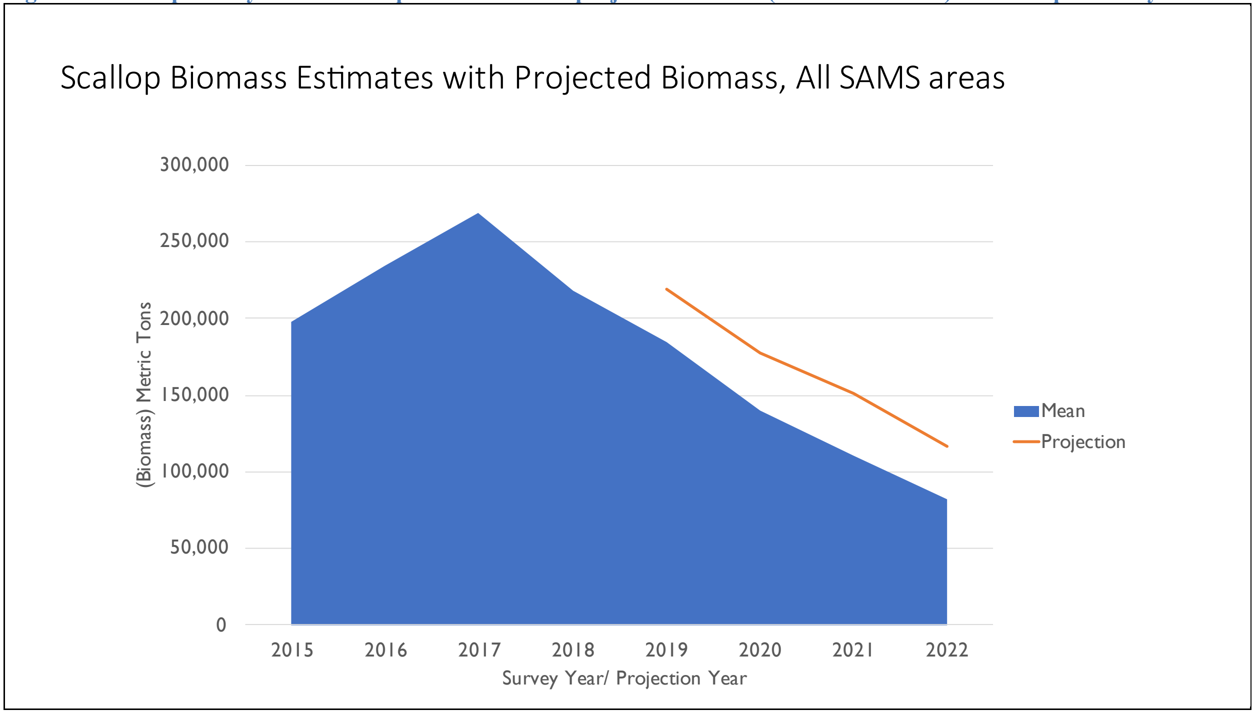


Figure 3 - Scallop survey biomass compared with mean projected biomass (1000 model runs) from the previous year.



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 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, moderate growth between 2020 and 2021, and what appears to be the fastest growth of this year class between 2021 and 2022 (Figure 5). Both biomass and density have decreased in this area since 2015 and there was an unexpected substantial decrease in biomass between the 2021 and 2022 surveys (Table 4). Estimated biomass from the 2022 surveys was roughly 85% less than what was projected for this area based on information from the 2021 surveys (Table 5). As discussed in the above section, the reduction in biomass could be a result of higher than expected natural mortality due to age, condition, predation, and(or) elevated mortality associated with fishing practices (e.g., higher than expected discarding). Figure 4 visualizes the contraction of biomass in the NLS-South between the 2021 and 2022 HabCam surveys of this area, with remaining biomass concentrated in the shallower northwest corner of the area adjacent to the NLS-Triangle closure.

To address the uncertainty around the scallops in the NLS-South area, the PDT recommends adjusting the shell height to meat weight relationship and selectivity curve for the SAMS area, which is consistent with the SSC approved approach used in the past several years. The rationale for these adjustments is explained in more detail in the following sections. The substantial declines in abundance and biomass of the 2012 year class may negate the need to adjust assumptions of SHMW and growth in future years for this region.

Figure 4 – The Nantucket Lightship region, with scallop rotational areas (black), SAMS areas (red), and predicted biomass estimates from the 2021 HabCam survey (left) and 2022 HabCam survey (right) of the Nantucket Lightship South area (kg per km²).

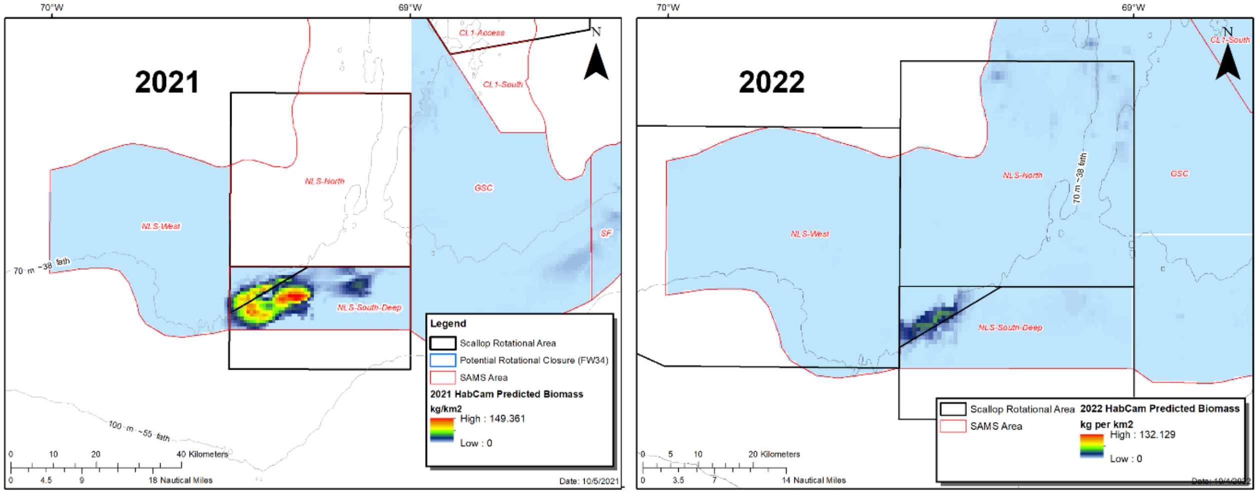


Figure 5 - Comparison of 2016 -2022 dredge survey observations in the NLS-South.

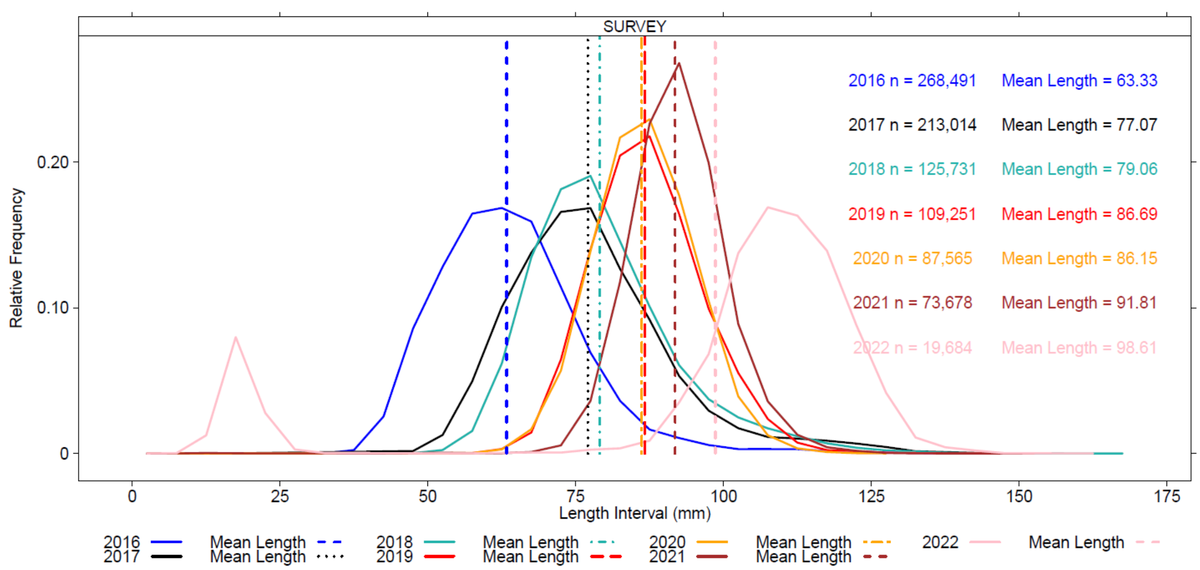


Table 4 – Scallop density per m² and average shell height from SMAST drop camera surveys of the NLS-South, 2017 to 2022. Density per m² continues to be the highest in this area compared to other parts of the resource.

Year	Density per m²	Avg. Size
2017	13.66	73mm
2018	6.85	76mm
2019	6.26	87mm
2020	3.69	93mm
2021	3.1	91mm
2022	0.33	97mm

Natural Mortality in Virginia and Delmarva

Projections in Virginia and to a lesser extent Delmarva have consistently overestimated biomass and abundance in recent years, despite the limited fishing in these areas. The PDT suspects that natural mortality has increased in these areas due to warming waters in the southern extend of the scallop resource, particularly in adult scallops, which is consistent with findings from Zang et al. 2022.

To estimate natural mortality in these areas, the Beverton-Holt length based estimator was applied:

$$Z = \frac{K(L_\infty - \bar{L})}{\bar{L} - L_c}$$

to the mean of the 2018-2021 40mm+ size frequencies observed in these two areas, using L_c = 42.5mm. The end result was an adjusted Z for Virginia of 4.2, which was assumed to be all attributed to natural mortality given that no fishing occurs in this area. For Delmarva, adjusted Z was equal to 0.66 i.e., 0.6 attributed to natural mortality, 0.06 attributed to fishing mortality given that some fishing has occurred here during the 2018-2021 time frame.

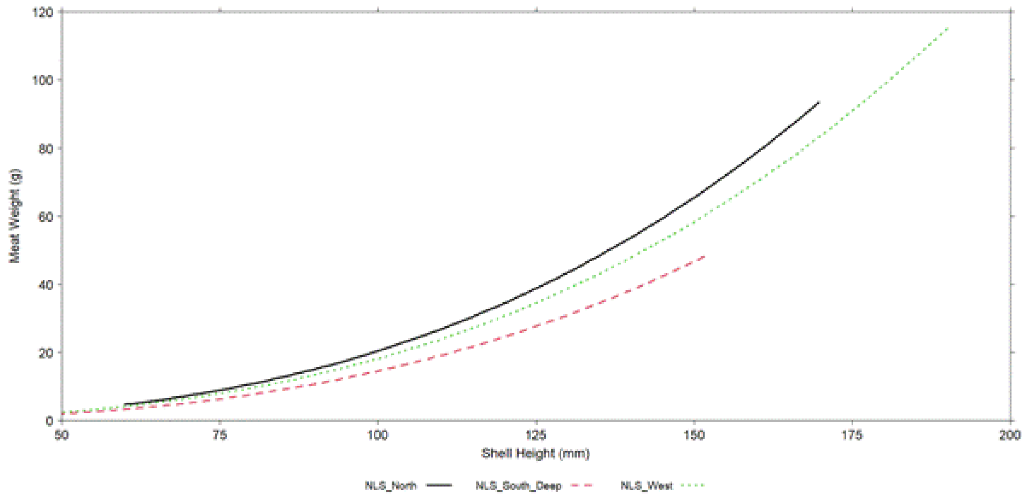
Shell Height Meat Weight Parameters

The PDT has recommended deviations from the SARC 65 shell height to meat weight (SHMW) parameters in recent years in an effort to accurately characterize scallop condition in specific regions. The PDT has focused most on the Nantucket Lightship Region to account for unique growth of the 2012 year class in this area. This year, the PDT recommends using SHMW parameters based on the last seven years of dredge survey data for the SHMW relationship used in biomass calculations of the NLS-South (Appendix IIA). The scallops in the NLS-South will be 12 years old in FY 2023 and the majority of the animals have reached around 110mm 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 the difference in biomass estimates based on SARC 65 versus 2016-2022 dredge parameters for the NLS-South is small. Given the continued decline of the dominant 2012 year class in this area, the use of region specific SHMW relationships may not be necessary for the NLS-South going forward.

The New York Bight closure that was created in 2021 through Framework 34 includes large portions of the Long Island SAMS area and New York Bight SAMS area. To investigate if there were differences in the shell-height to meat-weigh relationship in the NYB-closure area, the PDT conducted sensitivity analyses using an area specific SHMW equation (Appendix IIB). Estimates based on VIMS 2022 data were greater than both SARC 65 and VIMS 2015-2022 data. The PDT recommends using the VIMS 2015-2022 SHMW parameters, recognizing that they were area specific and representative of the dynamics in this area over the past several years. The SARC 65 SHMW equation includes a covariate for the status of the area with regard to it being a rotational area or part of the open bottom. Considering that the NYB closure is a new closure (i.e., not a traditional rotational area, such as the ET and HC), the PDT does not feel it is appropriate to assign the SARC 65 covariate as “closed” because SHMW relationships for this area may be more a function of geography than the area being part of the open bottom or a rotational closure.

The methods used to develop the VIMS 2016 – 2022 parameter estimates are described in Appendix IIA (for the NLS) and Appendix IIB (NYB). Appendix III provides a comparison of drop camera, HabCam, and dredge survey biomass estimates using SARC 65 and VIMS 2016 - 2022 SHMW parameters.

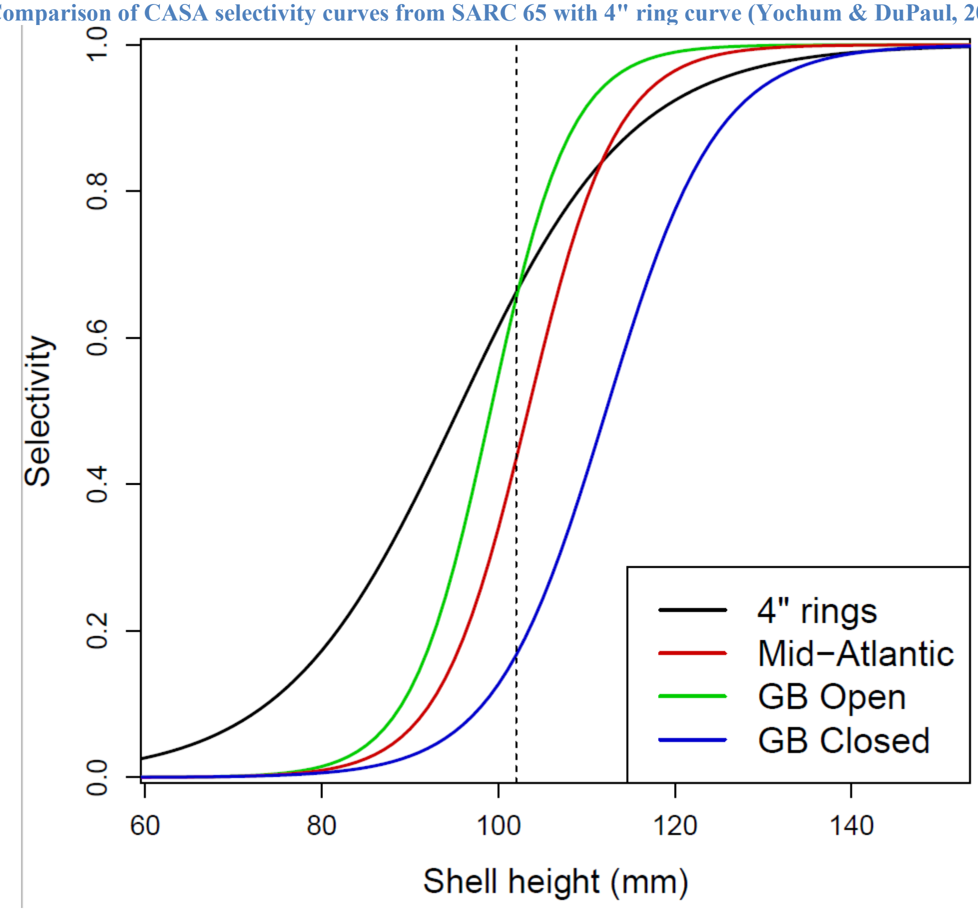
Figure 6 - Predicted SH-MW relationships by SAMS area for the NLS using model m4 (Appendix IIA).



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 likely fishing dynamics in this area. Similar to 2018, 2019, 2020, and 2021, the PDT recommends applying the Georges Bank Open selectivity curve in the Nantucket Lightship South area to select a larger proportion of the scallops in this area that have already recruited to the fishery. As shown in Figure 4, the mean shell height of the 2012 year class in the NLS-South area in the 2022 surveys was approximately 110 mm.

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 2022 and 2023 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. Scallop biomass in 2022 was the lowest observed since 1999 and less than one quarter of peak biomass estimated in 2017. As the OFL and ABC values presented in Figure 8 reach 2014 values, an important difference between 2014 and 2023 is that there are no exceptional year classes in the pipeline. Recruitment in Closed Area I is considered to be strong, but not at the magnitude of the 2012 or 2013 year classes. Some recruitment was observed during the 2022 surveys in the Elephant Trunk (Figure 10) and signals of a one-year-old cohort were observed in the NLS-West for the second year in a row. The Council is considering rotational closures of Closed Area I, the Elephant Trunk, and the NLS-West in FY2023 with the goal of optimizing yield of the juvenile scallops (Figure 10). Recent research on source/sink dynamics in the Mid-Atlantic indicates that another benefit of the 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 2017 in the short-term. Opportunities for access area fishing will be constrained to Georges Bank for the 2023 fishing year. Pre-recruits observed in the NLS-

West are susceptible to natural mortality at this life stage, as illustrated by the absence of a two-year-old cohort 2022 being observed in the 2023 surveys.

Figure 8 - Scallop Fishery OFL and ABC values for Georges Bank and the Mid-Atlantic (2011-2022), with 2023 estimates.[2]

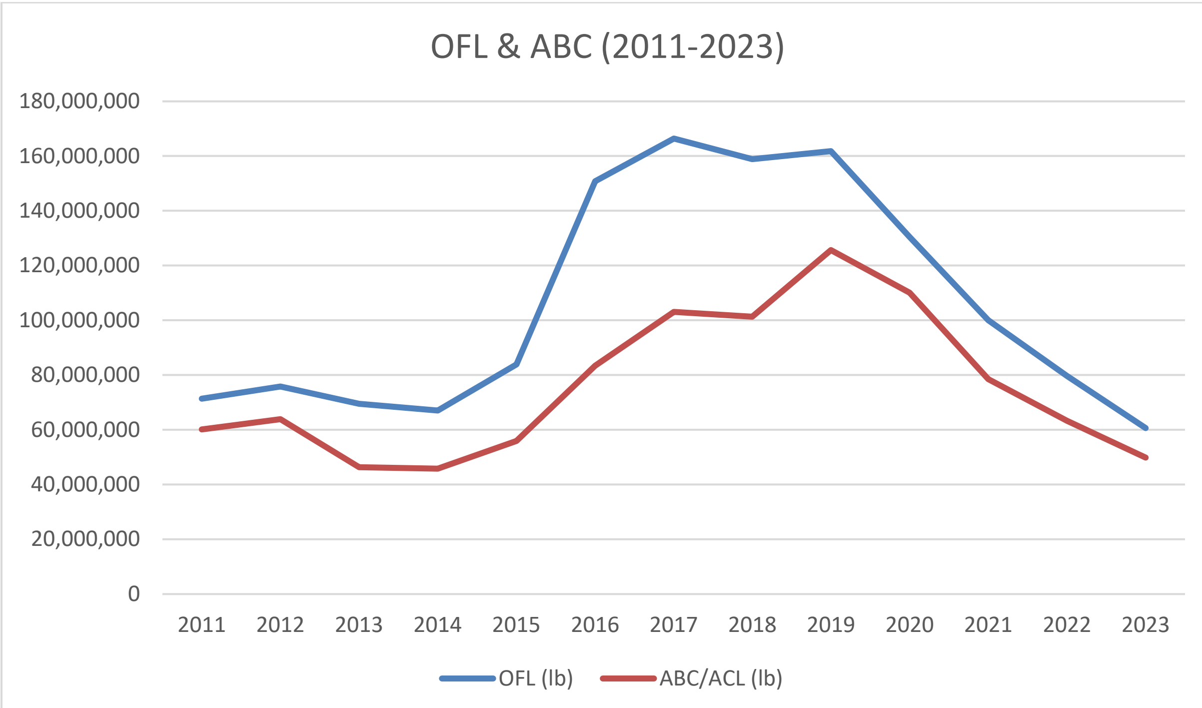
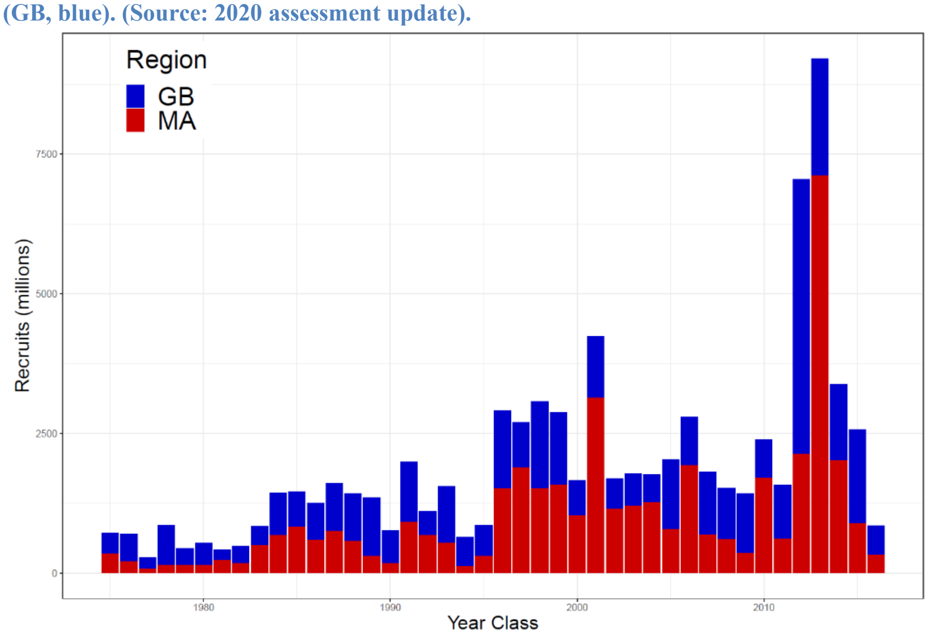
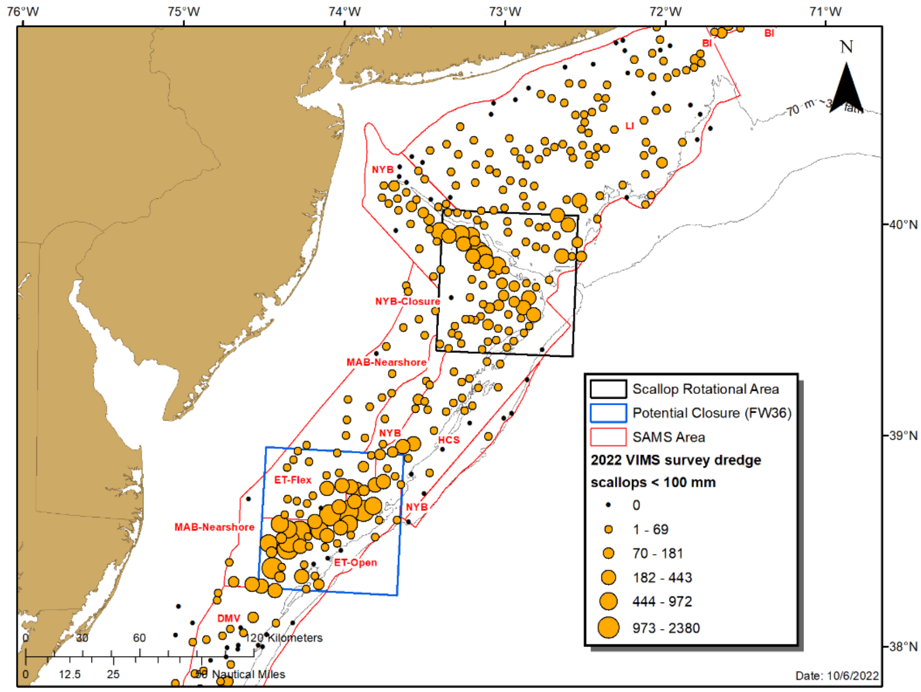


Figure 9 - Sea scallop recruitment (age 1) by region, 1975-2016. Regions are: Mid-Atlantic (MA, red) and Georges Bank (GB, blue). (Source: 2020 assessment update).



[2] The 2022 and 2023 estimates include biomass from the Gulf of Maine.

Figure 10 – The New York Bight closure area (FW34) and Elephant Trunk closure area under development through FW36 relative to 2022 VIMS scallop abundance per station for scallops <100mm SH and SAMS areas.



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) below these legal limits. Even as biomass declines, fishery allocations are based on an average F that is below the reference points for this fishery. For example, in fishing year 2022, the ABC was 25,724 mt (not including discards), whereas fishery allocations were 14,251 mt. Based on initial discussions around rotational management measures to be considered in FW36, is it reasonable to expect that fishery removals in FY2023 will continue to be below the OFL and ABC estimates recommended in this memo. The PDT expects that fishery allocations will remain relatively close to legal limits in the coming years since there is limited portion of overall biomass in areas closed to the scallop fishery (i.e., 14% of ABC biomass is within habitat closures). 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').

Updates on 2021 SSC Recommendations:

Last year the SSC recommended further investigation into:

1. *The SSC recommends that in the future a more holistic consideration of stock changes and a more systematic approach to adjusting survey and model parameters be employed.*

In developing the 2023 and 2024 OFL and ABC estimates, the PDT evaluated adjustments to the survey and model parameters in the context of recommendations in past memos, the performance the forward projection model, and overall resource trends. The PDT has recommended adjustments to address unique issues in the Nantucket Lightship region for the last five years and feels that it is important to carry through adjustments for this specific cohort. Additional adjustments were recommended to address the concerns about overly optimistic projections, such as reducing growth in the Gulf of Maine and increasing M in areas at the southern end of the range of the resource. The 2024 research track assessment will provide a new formulation that the PDT plans to rely on for estimating future OFL and ABC values.

2. *The SSC recommends consideration of the future of surveys in the GOM region be included in the ongoing Scallop Survey Working Group (SSWG) and NEFSC-supported scallop survey re-stratification efforts*.

The SSWG final report[3] was presented to the Council in September 2022. The SSWG included the Gulf of Maine (including the NGOM management area) in the discussion around a coordinated strategy for scallop resource assessment surveys. The PDT notes that Appendix II of the final report contains a set of guiding principles that are intended to assist in survey-related decision making and ensure adequate coverage. Including the Gulf of Maine region in regular survey coverage was part of the SSWG's Guiding Principles.

The NEFSC-led scallop survey re-stratification effort is on-going, and the current focus is on applying a generalized random tessellation stratified (GRTS) approach.[4] While the Gulf of Maine was not a specific focus of this effort, the method could be applied to developing survey strata in the future.

3. *The SSC recommends that ongoing research on potential drivers of changes in sea scallop stock dynamics (e.g., changing ocean conditions, including ocean acidification and warming) be included in the upcoming review of the SAMS model and in the 2024 research track assessment for scallops.*

The TORs for the 2024 research track assessment are currently under development and have not been finalized. These recommendations, and any new recommendations from the SSC, will be communicated through the Council.

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[3] https://s3.us-east-1.amazonaws.com/nefmc.org/4b.-SSWG-Report-September-2022.pdf

[4] See https://s3.us-east-1.amazonaws.com/nefmc.org/Scallop-Restrat-Presentation-12-1-21_distribute.pdf for more information.

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Table 5 – Final combined survey estimates for 2022 by SAMS areas, including values from the GOM and Northern Gulf of Maine Management Area.

version 3 - Sept.14, 2022

This version updates the NLS-S using VIMS SHMW from 2016-2022, NYB Closure using VIMS SHMW from 2015-2022, MAB nearshore transcription error, and GOM/NGOM estimates using DMR 2021 SHMW with covariates.

		Dredge				DropCam				Habcam				Mean				F34 Projections		
Region	Subarea	Num	Bmsmt	SE	MeanWt	Num	Bmsmt	SE	MeanWt	Num	Bmsmt	SE	MeanWt	Num	Bmsmt	SE	MeanWt	Num	Bmsmt	%Change
GB	CL1ACC	4	95	90	23.3	37	524	235	14.2	10	215	13	22.1	17	278	84	16.4	109	1296	-78.5%
GB	CL1-Sliver+S	3302	3955	1422	1.2	932	4876	2526	5.2	373	1578	33	4.2	1536	3470	966	2.3	101	1420	144.3%
GB	CL-2(N)	525	11092	4001	21.1	429	9209	2040	21.5	350	6916	175	19.7	435	9072	1498	20.9	360	6203	46.3%
GB	CL-2SE	645	11619	813	17.9	466	8131	1047	17.4	842	7631	248	9.1	651	9127	450	14.0	824	9163	-0.4%
GB	CL-2SW	143	3783	384	26.8	99	2892	483	29.2	150	3105	158	20.7	131	3260	212	24.9	560	11600	-71.9%
GB	CL2Ext	408	9371	951	23.1	575	9223	1405	16.0	501	7227	242	14.4	495	8607	571	17.4	1074	16767	-48.7%
GB	SF	764	11714	1207	15.4	537	6377	1479	11.9	627	7328	114	11.7	643	8473	637	13.2	815	11125	-23.8%
GB	NLSAccN	44	857	63	21.8	71	923	606	13.0	65	990	41	15.3	60	923	204	15.4	117	1641	-43.7%
GB	NLSAccS-Deep	162	2842	365	17.5	226	2973	1123	13.2	115	2043	42	17.7	168	2619	394	15.6	1276	16873	-84.5%
GB	NLS-W	7	293	31	39.1	36	784	356	21.8	8	202	16	24.1	17	426	119	25.1	33	294	45.0%
GB	NF	216	3707	1664	17.1	92	2264	1081	24.6	315	4414	307	14.0	208	3462	669	16.7	213	2563	35.1%
GB	GSC	957	4745	557	5.0	597	9081	1256	15.2	411	5368	44	13.1	655	6398	458	9.8	980	9406	-32.0%
GB	**TOTAL**	**7177**	**64073**	**4942**	**8.9**	**4097**	**57257**	**4537**	**14.0**	**3767**	**47017**	**538**	**12.5**	**5014**	**56116**	**2244**	**11.2**	6462	88351	-36.5%
MAB	BI	29	680	48	23.5					12	316	10	26.2	21	498	25	24.3	74	609	-18.2%
MAB	LI	225	5403	280	24.9					250	5764	51	23.1	238	5584	142	23.5	962	8090	-31.0%
MAB	NYB	91	1183	93	13.2					50	1028	48	20.4	71	1106	52	15.7	202	2230	-50.4%
MAB	NYB_Closure	423	8626	496	20.4					328	7041	106	21.5	376	7834	254	20.9	537	7002	11.9%
MAB	MAB_Nearshore	52	500	98	10.1					24	390	40	16.5	38	445	53	11.7	134	1102	-59.6%
MAB	HCS	71	1142	97	16.2					49	1009	69	20.6	60	1076	60	17.9	232	1945	-44.7%
MAB	ET	676	4733	259	6.9					691	4232	45	6.1	684	4483	131	6.6	541	4215	6.3%
MAB	DMV	141	756	100	5.6					89	615	8	6.9	115	686	50	6.0	268	460	49.0%
MAB	VIR	69	327	47	4.7									69	327	47	4.7	40	73	347.9%
MAB	**TOTAL**	**1777**	**23350**	**659**	**13.1**					**1493**	**20395**	**157**	**14**	**1670**	**22036**	**341**	**13.2**	2990	25726	-14.3%
GOM	WGOM Closure					62	2111	420	34.0					62	2111	420	34.0			
GOM	Stellwagen South					29	373	43	12.9					29	373	43	12.9	21	579	-35.6%
GOM	**TOTAL**					**91**	**2484**	**422**	**27.3**					**91**	**2484**	**422**	**27.3**			
NGOM	Stellwagen AOI					66	1337	420	20.3					66	1337	420	20.3	77	2169	-38.4%
NGOM	Jeffreys					9	186	31	21.2					9	186	31	21.2			
NGOM	Platts					6	125	35	20.5					6	125	35	20.5			
NGOM	Ipswich					10	160	33	16.6					10	160	33	16.6			
NGOM	*Total-no Stellwagen*					*25*	*471*	*99*	*58.3*					*25*	*471*	*99*	*58.3*	28	692	-31.9%
NGOM	**TOTAL**					**91**	**1808**	**519**	**19.9**					**91**	**1808**	**519**	**19.9**			
TOTAL	**TOTAL**	**8954**	**87423**	**4986**	**9.8**	**4279**	**61549**	**4587**	**14.4**	**5260**	**67412**	**561**	**12.8**	**6774**	**79960**	**2328**	**11.8**	9452	114077	-29.9%

Figure 11 - 2022 Georges Bank SAMS Areas.

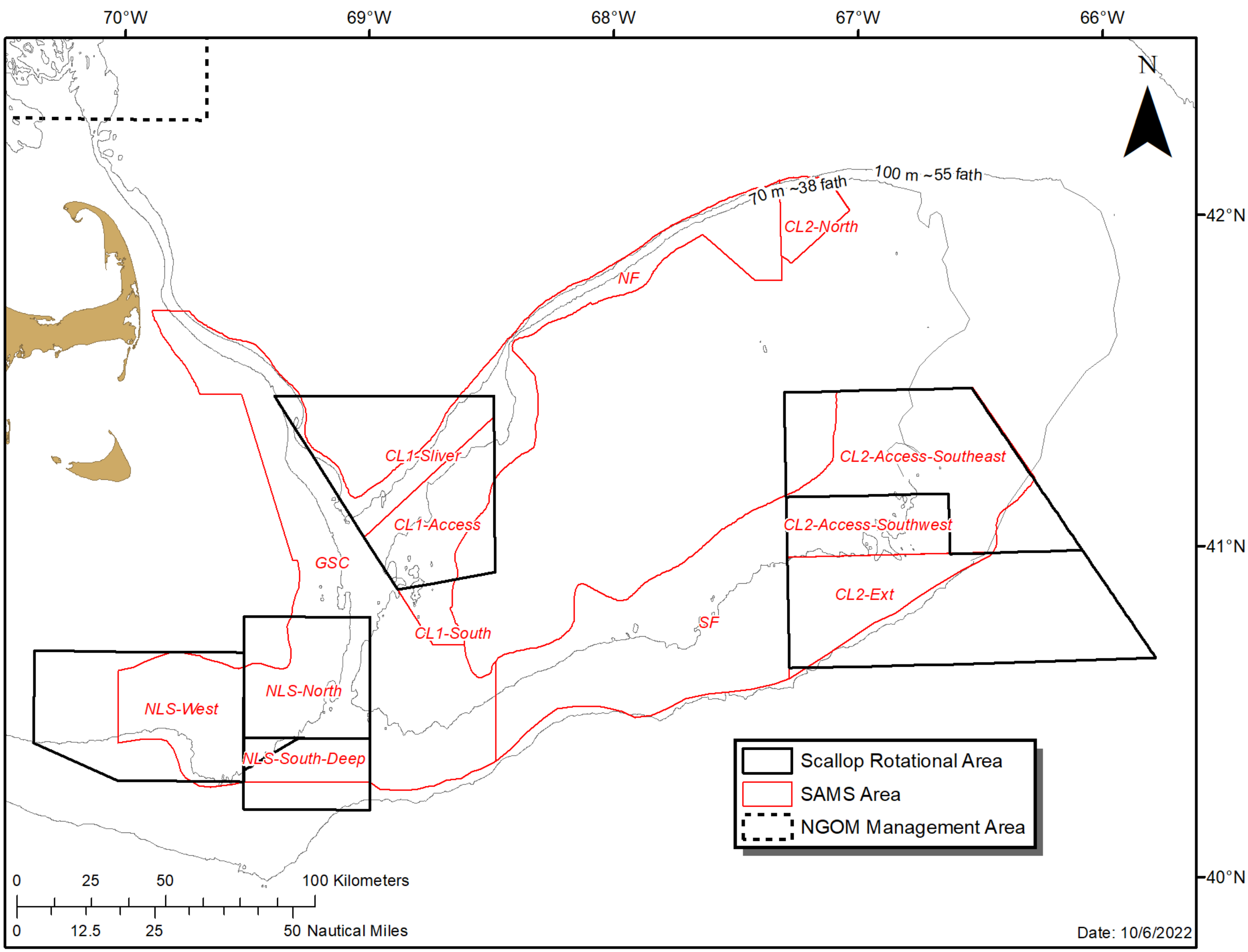


Figure 12 – 2022 Mid-Atlantic Bight SAMS Areas.

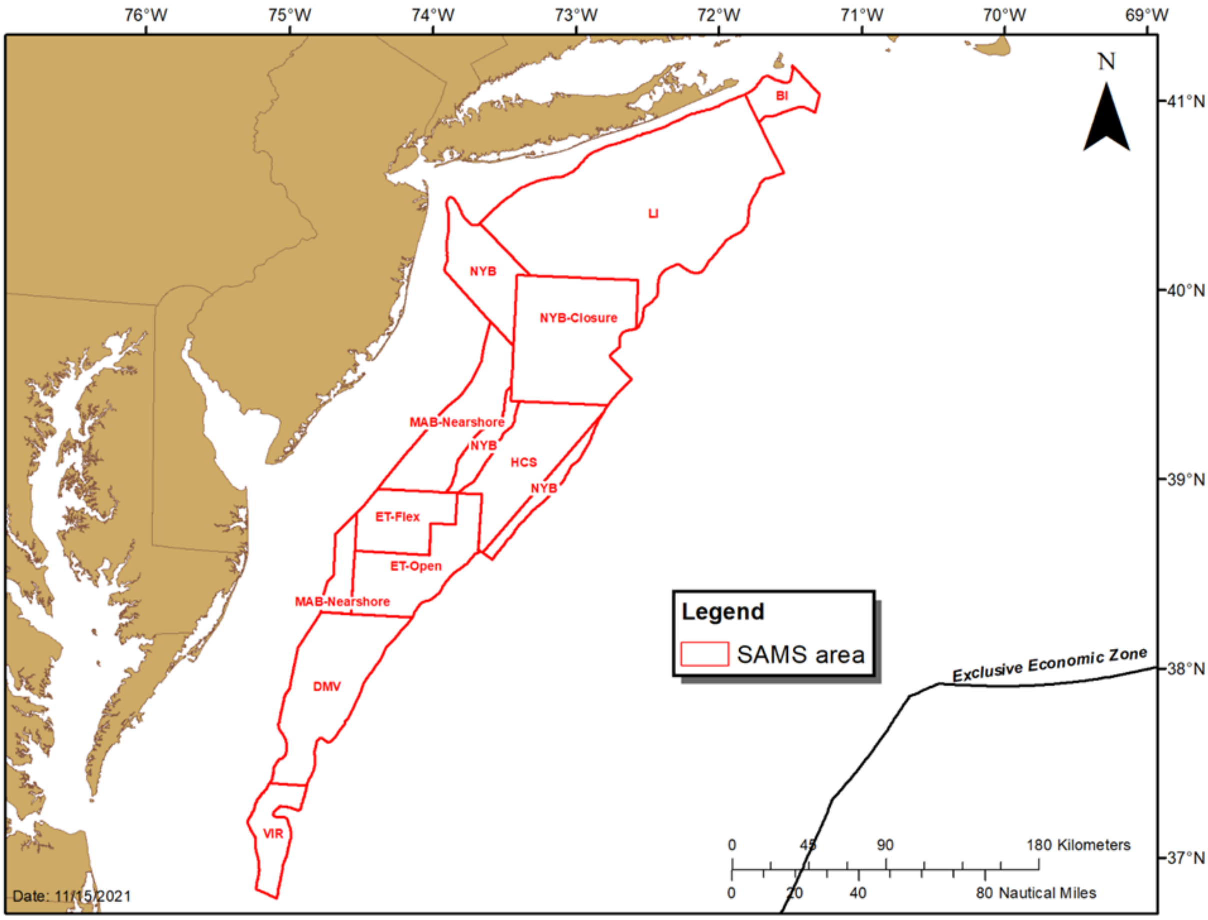


Figure 13 - 2022 Scallop RSA Survey Coverage for Georges Bank and the Mid-Atlantic.

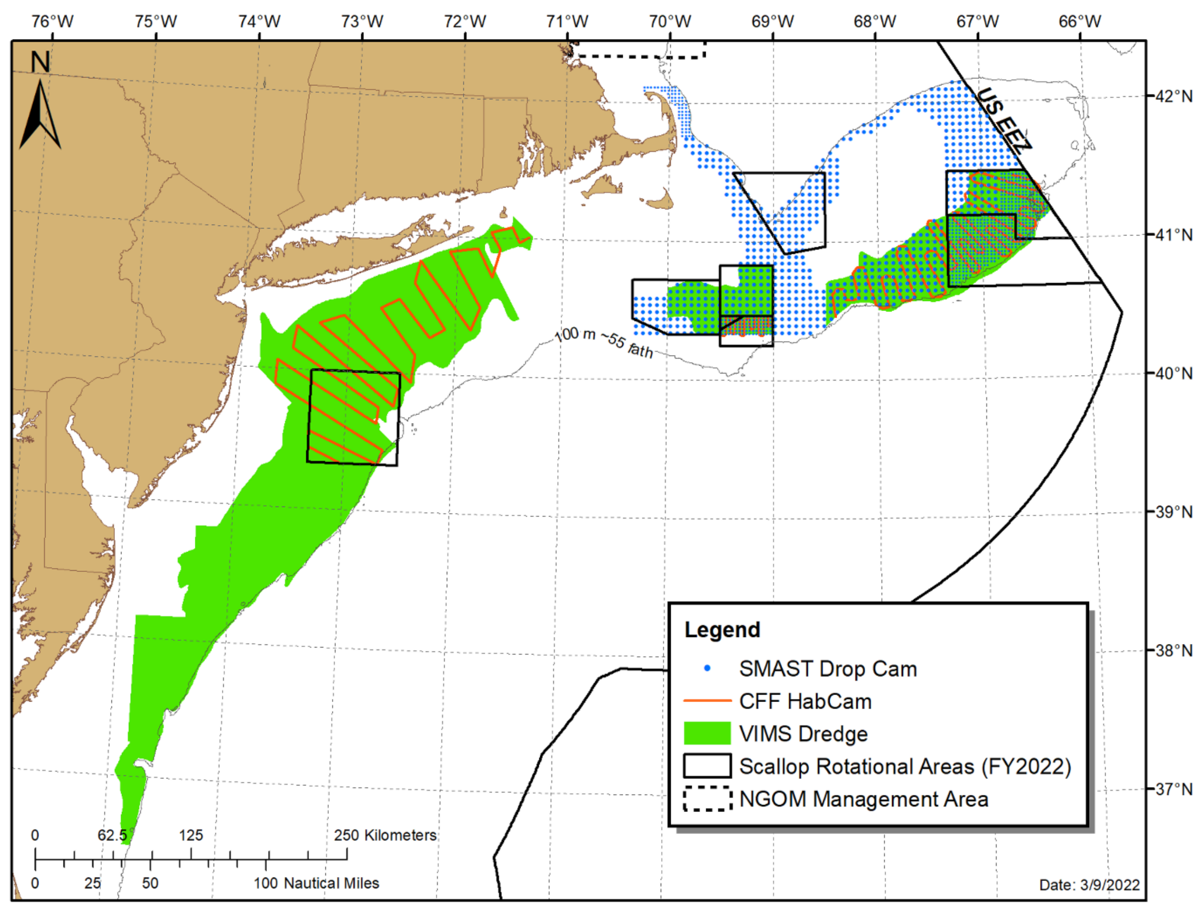
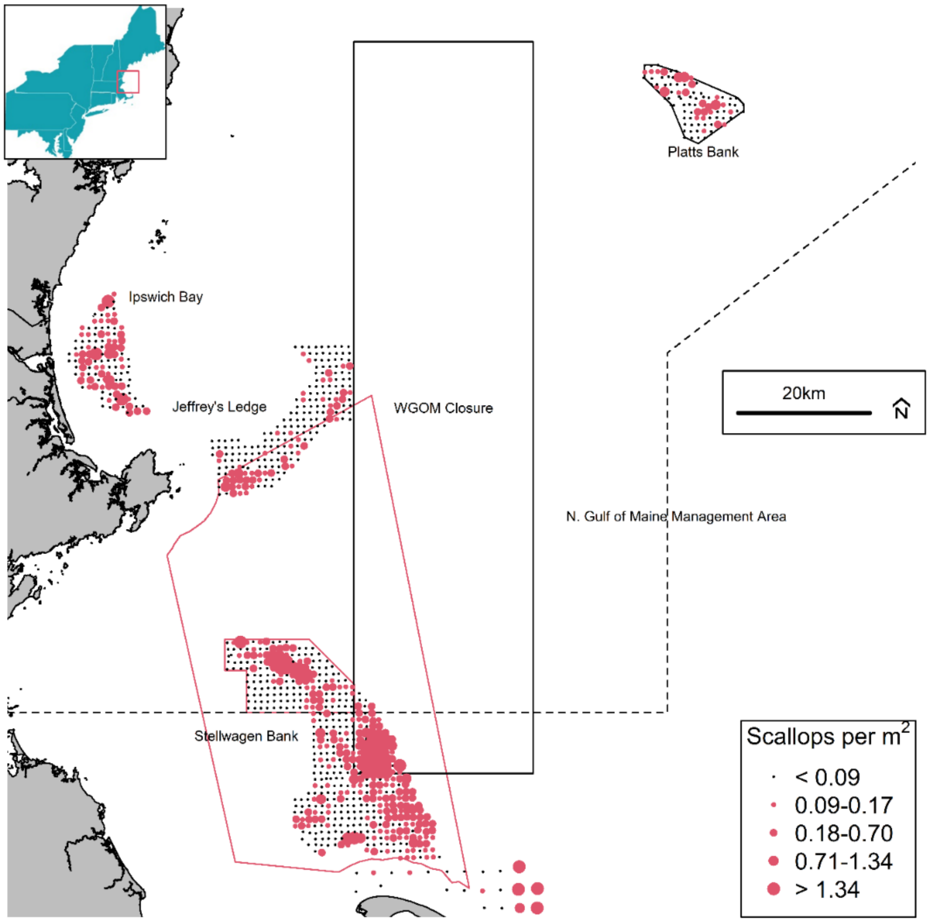


Figure 14 – 2022 Scallop RSA survey coverage for the Gulf of Maine by the SMAST drop camera relative to the Northern Gulf of Maine Management Area (dotted black line), Western Gulf of Maine Closure area (solid black line), and Stellwagen Bank National Marine Sanctuary (red line).



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Appendix I: 2022 Projections - Outputs and Assumptions

2023 Projections for Georges Bank and the Mid-Atlantic:

1. Model configured the same as in Framework 34, with 8 areas in MA, 12 in GB, and 4 in the Gulf of Maine.
2. Initialized using the average (mean) of available 2022 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. In the GOM, growth was set to match GB estimates from the most recent period.

Table 6 - Projected biomass and exploitable biomass for 2023 for Georges Bank and Mid-Atlantic SAMS area and the Gulf of Maine.

Region/SAMS	Bms (mt)	Ebms (mt)	ACL Land (F=0.45, mt)
GB			
C1Mid	927	209	66
C1N	6,624	804	446
C2E	11,338	5,115	1,868
C2Ext	8,598	6,964	2,131
C2N	11,853	7,017	2,252
C2W	2,771	1,771	616
GSC	8,667	4,043	1,526
NF	3,411	2,298	785
NLSN	1,344	638	207
NLSS	1,771	1,635	450
NLSW	1,054	340	103
SF	7,909	5,031	1,754
GB Total	**66,267**	**35,865**	**12,205**
MAB			
Dmv	2,270	205	161
ET	9,232	2,081	1,837
HCS	1,948	534	220
Inshore	1,431	606	299
LI	4,739	3,683	1,226
NYB	1,453	610	302
NYBcl	9,440	7,249	2,538
Vir	65	6	1
MAB Total	**30,577**	**14,974**	**6,583**
GOM			
Ips/Jeff	335	296	67
StellwN	1,453	1,092	411
StellwS	520	266	89
WGOM	2,196	2,009	473
GOM Total	**4,503**	**3,664**	**1,040**

Table 7 - 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.
2022	SARC 65, with changes to SH-MW parameters in the NLS-South using VIMS 2016 – 2022 data. Changes to NYB-closure using 2015-2022 data. Stellwagen Region using ME DMR/UMAINE 2021 SH-MW (w/ covariates). Other areas using Hart 2020 SHMW curves.	SARC 65, scaled to the growth expectations from the 2020 management track assessment for all areas except NLS-South and CAII-SW. GB growth applied to areas of the GOM.

Table 8 - 2022 Survey Data Treatments by SAMS areas for GB, MA, NGOM, and GOM.

GB	*SHMW equation, Dredge Efficiency*	*Treatment, notes*
CL1-Access (M)	SARC 65	Survey mean
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 16-22	Survey mean
NLS-West	SARC 65	Survey mean
NF	SARC 65	Survey mean
GSC	SARC 65	Survey mean
SF	SARC 65	Survey mean
MidAtlantic		
BI	SARC 65	Survey mean
LI	SARC 65	Survey mean
NYB	SARC 65	Survey mean
NYB-Closure	VIMS 15-22	Survey mean
MAB-Nearshore	SARC 65	Survey mean
HCS	SARC 65	Survey mean
ET Open	SARC 65	Survey mean
ET Flex	SARC 65	Survey mean
DMV	SARC 65	Survey 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	SMAST Drop Camera only, 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	SMAST Drop Camera only

Table 9 - Description of the SH-MW changes in Nantucket Lightship SAMS areas from 2016 to 2022.

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	SH-MW applied in 2022, FW36
NLS-N	SARC 59	SARC 50	VIMS 2016-2018 Combined	VIMS 2016-2019 Combined	VIMS 2016-2020 Combined	SARC 65	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)	VIMS 2016-2022 Combined
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)	N/A
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	SARC 65
NYB-Closure	N/A						VIMS 2015-2022

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 10 - Comparison of SARC 65 and FW36 growth parameters

		SARC-65		FW-36	
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 IIA: VIMS Nantucket Lightship Shell-Height Meat-Weight Analysis

Ms. Sally Roman

July 28, 2022

Methods

Shell height meat weight relationships (SHMW) were estimated for the Nantucket Lightship (NL) survey for the NLS_West, NLS_North, and NLS_South_Deep SAMS Areas with VIMS dredge survey data. SHMW relationships were developed using a combined dataset from 2016 - 2022. Surveys from 2016 - 2019, 2021, and 2022 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 2022 SAMS Areas for analysis. These SAMS Areas have been consistent for 2020 – 2022. 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 M2200 motion compensating scale. Maturity stage, classified into six stages, is assessed by visual examination of the gonad.
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 models. 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), and an interaction term of shell height and depth. The impact on a delayed 2020 survey on SHMW relationships was investigated in 2021 by including maturity stage as a predictor variable. There were no differences between SHMW curves with and without maturity and as such this variable was not considered in 2022. A Tukey's honestly significant difference post-hoc test was run to test for differences between SAMS Area means for all three SAMS Areas. 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

The preferred model included shell height, SAMS Area, latitude, and depth as fixed effects (Table 1). This is consistent with results from 2020 and 2021. 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 the length range compared to the other three SAMS Areas (Figure 1). Post-hoc pairwise comparisons for SAMS Area indicated significant differences between all pairs of SAMS Areas (all p-values < 0.001).

Table 1. SHMW models for the 2016 - 2022 VIMS NL survey data. Model in bold was selected as the preferred model. The number of parameters (K), AIC, ΔAIC, AIC weight, and Deviance explained are also included.

Models	Parameters	K	AIC	ΔAIC	AIC Weight	Deviance
m4	**~1 + Shell Height + SAMS Area + Depth + Latitude**	**8**	**59,797.90**	**-**	**0.77**	**75.19**
m2	~1 + Shell Height*Depth + SAMS Area + Latitude	9	59,800.29	2.40	0.23	75.19
m5	~1 + Shell Height + SAMS Area + Latitude	7	59,813.25	15.36	0	75.20
m3	~1 + Shell Height + SAMS Area + Depth	7	59,819.42	21.53	0	75.18
m1	~1 + Shell Height*Depth + SAMS Area	8	59,821.10	23.20	0	75.18
null	~1	3	74,657.66	14,859.76	0	

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

Parameter	Parameter Estimate
Intercept	-30.73
Shell Height	2.87
NLS_South_Deep	-0.19
NLS_West	-0.08
Depth	-0.26
Latitude	0.53

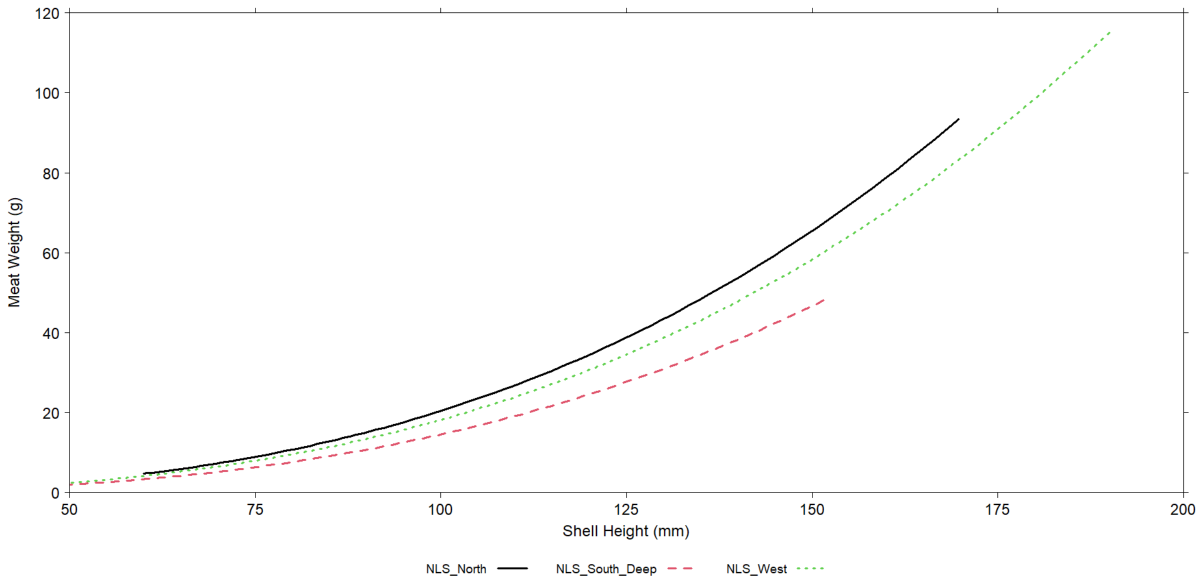


Figure 1. Predicted SHMW relationships by SAMS Area using the preferred model m4 from Table 2.

Discussion

SHMW relationships in the NL continue to show a similar trend across years. Results from the 2020 and 2021 SHMW analyses are similar to this year's analysis 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. A comparison of biomass estimates for the three SAMS Areas is provided below. Table 3 compares total biomass (mt) using the SARC 65 SHMW parameters and the VIMS SAMS Area specific SHMW parameters for all three SAMS Areas. As with 2021, applying VIMS SHMW parameters lowers biomass estimates.

Table 3. Total biomass (mt) estimates for the three NL SAMS Areas using the SARC 65 and VIMS 2016-2022 SHMW equations along with the relative difference.

SAMS Area	Total Biomass (mt)		Relative Difference
	SARC 65	VIMS 2016-2022	
NLS_North	857.20	668.05	-22%
NLS_South_Deep	3,381.79	2,842.72	-16%
NLS_West	292.95	175.32	-40%

Appendix IIB: VIMS Mid-Atlantic Bight Shell-Height Meat-Weight Analysis

Ms. Sally Roman

August 2, 2022

Methods

Shell height meat weight relationships (SHMW) were estimated for the Mid-Atlantic (MAB) survey to compare biomass estimates for the new NYB-Closure SAMS Area/access area. SHMW relationships were developed using a combined dataset from 2015 - 2022. Station-level data from the 2015 - 2021 surveys were reassigned to 2022 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 M2200 motion compensating scale.

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 models. 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), and an interaction term of shell height and depth. A Tukey's honestly significant difference post-hoc test was run to test for differences between SAMS Area means for all combinations of SAMS Areas. Tables provided below include the SHMW models with parameters and AIC values. Parameter estimates for the preferred model and predicted SHMW relationships are also provided. Predicted SHMW curves estimated from the VIMS preferred model were compared to those using the SARC 65 parameters. Biomass estimates for the new NYB-Closure SAMS Area/access area were also estimated with the VIMS and SARC 65 equations.

Results

Table 1 provides the number of scallops assessed and number of stations included in the analysis. The preferred model included an interaction of shell height and depth and SAMS Area as fixed effects (Table 2). Parameter estimates are provided in Table 3. Several SAMS Areas, including the new NYB-Closure area were significantly different from the reference level (BI SAMS Areas). Post-hoc comparisons indicated the NYB-Closure Area was significantly different from all other SAMS Areas except the LI SAMS Area = (p-value = 0.11) and the MAB Nearshore SAMS Area (p-value = 0.63). Predicted SHMW curves are provided in Figure 1 and a comparison of SHMW curves with the SARC 65 and VIMS equations is in Figure 2. The NYB-Closure SHMW curve is in the middle of all the predicted SHMW curves (Figure 1). The VIMS SHMW curve and the SARC 65 Access Area curve are similar for scallops ranging in size from 50 mm to approximately 125 mm (Figure 2). The two curves diverge at approximately 125 mm, with the VIMS curve predicting a high meat weight at length relative to the SARC 65 curves for scallops larger than 125 mm. Total biomass estimates are in Table 4. Biomass increased by 597 mt, for a relative difference of 7%, using the VIMS equation compared to the SARC 65 equation.

Table 1. Number of scallops assessed and number of stations included in the SHMW analysis by year.

Year	Number of Scallops	Number of Stations
2015	4,935	436
2016	5,534	408
2017	5,750	417
2018	5,398	380
2019	5,489	375
2020	4,762	377
2021	4,843	376
2022	4,813	380
Total	41,524	3,149

Table 2. SHMW models for the 2015 - 2022 VIMS MAB survey data. Model in bold was selected as the preferred model. The number of parameters (K), AIC, ΔAIC, AIC weight, and Deviance explained are also included.

Model	Parameters	K	AIC	ΔAIC	AIC Weight	Deviance Explained
mab2	Shell Height*Depth, SAMS Area, Latitude	15	247,983	-	0.66	78
mab1	**Shell Height*Depth, SAMS Area**	**14**	**247,985**	**1.36**	**0.34**	**78**
mab3	Shell Height, Depth, SAMS Area	15	248,207	223.65	0	77.88
mab4	Shell Height, Depth, SAMS Area, Latitude	14	248,224	240.65	0	77.88
mab5	Shell Height, SAMS Area, Latitude	13	248,299	315.99	0	77.89
mab6	Shell Height, SAMS Area	12	248,316	332.59	0	77.89
mabnull	Intercept	3	314,401	66,417.63	0	

Table 3. Parameter estimates for model mab1 from Table 2.

Parameter	Estimate	P-value
Intercept	-18.36	<0.001
Shell Height	4.76	<0.001
Depth	2.08	<0.001
DMV	-0.12	<0.001
ET	0.015	0.57
HCS	0.04	0.16
LI	0.07	0.01
MAB_Nearshore	0.07	0.03
NYB	0.04	0.13
NYB Closure	0.10	0.02
VIR	-0.25	<0.001
Shell Height*Depth	-0.49	<0.001

Table 4. Total biomass (mt) estimates for the NYB-Closure area estimated with the SARC 65 and VIMS SHMW equations.

SAMS Area	Total Biomass (mt)	
	SARC 65	VIMS 2015 - 2022
NYB-Closure	8,029	8,626

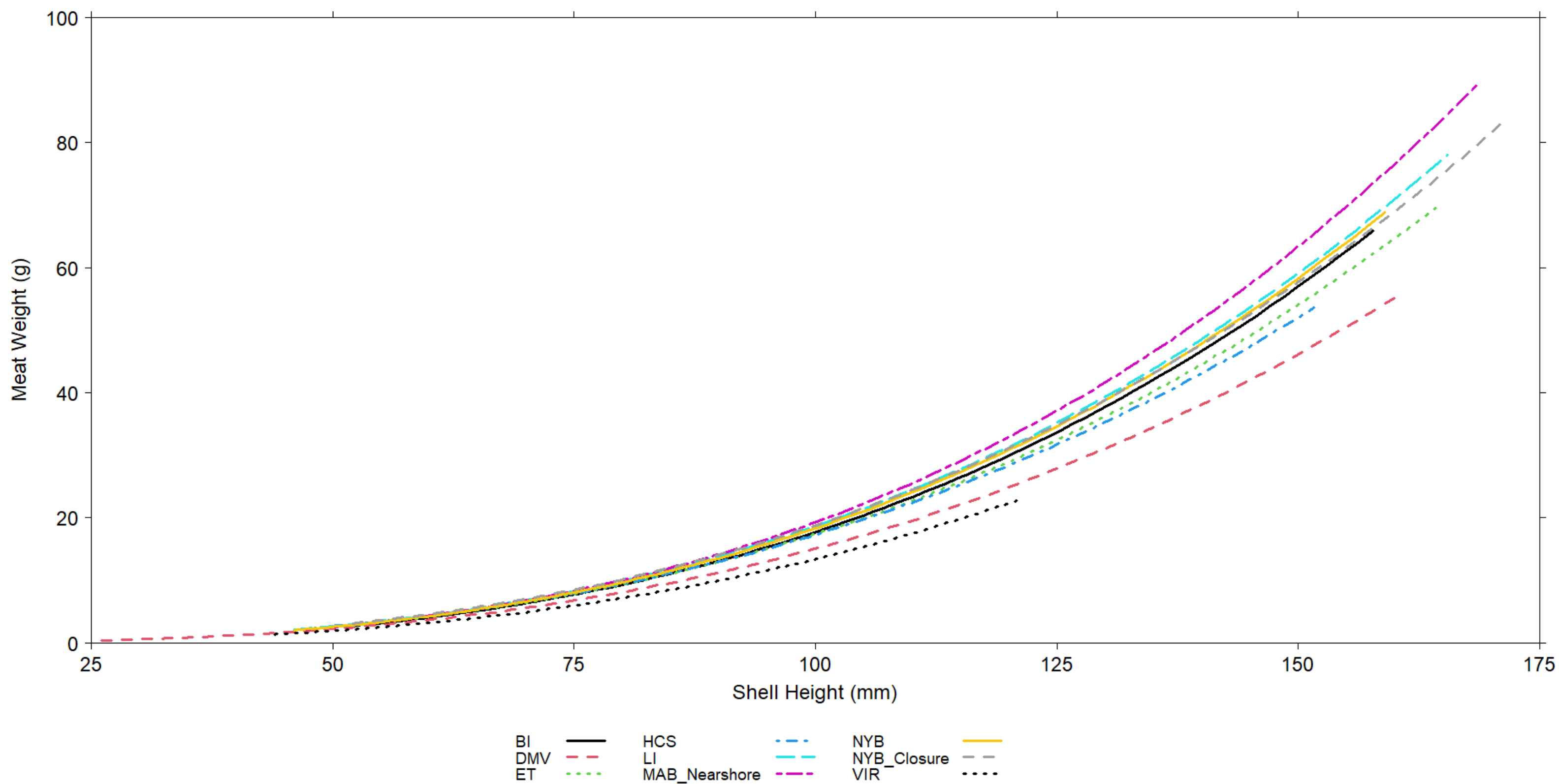


Figure 1. Predicted SHMW relationships by SAMS Area using model mab1 from Table2.

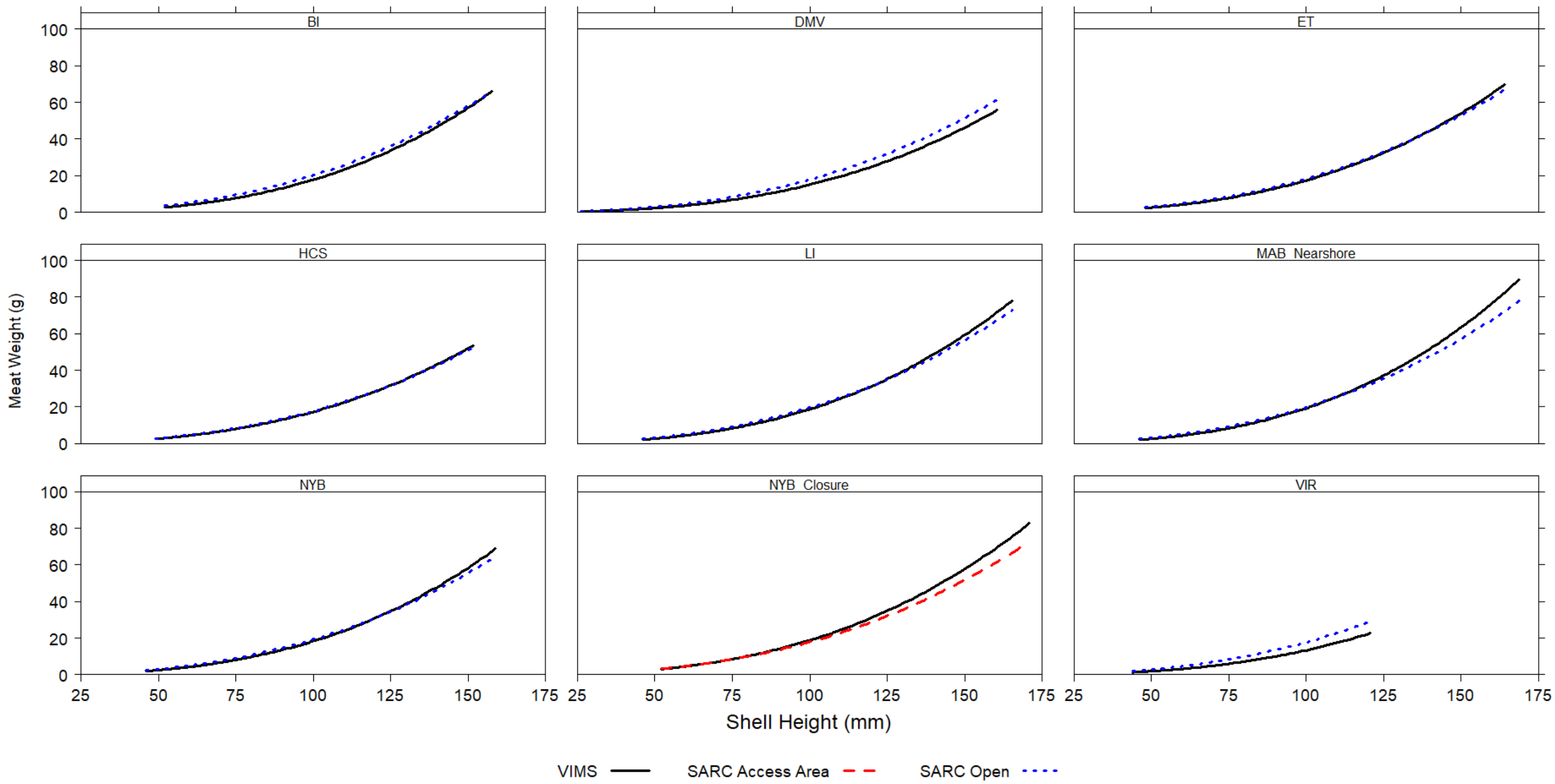


Figure 2. Predicted SHMW relationships by SAMS Area using the SARC 65 and VIMS equations.

Appendix III:

SH-MW Parameters for Biomass Estimation
Comparison of Biomass Estimates Using SARC 65 vs. VIMS 2016-2022
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 2016-22 parameter estimates the current SAMS areas.

	SARC 65 SH/MW	**VIMS SH/MW 2016-2022**
NLS-South	3,381	2,842

Total biomass estimates from the 2022 SMAST drop camera survey in the Nantucket Lightship area using the 65th SARC or the 2016-2022 Virginia Institute of Marine Science (VIMS) shell-height to meat-weight formulas.

NLS-South	SARC 65 SH/MW	VIMS SH/MW 2016-2022
Biomass (mt)	3,451	2,973

Comparison of 2022 HabCam biomass estimates (40+ mm) using VIMS 2016-2022, 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 (VIMS16-22)	%Diff
NLS-South	2517	2043	18.84

Appendix IV: Comparison of 2022 Surveys with Projections using 2021 Data

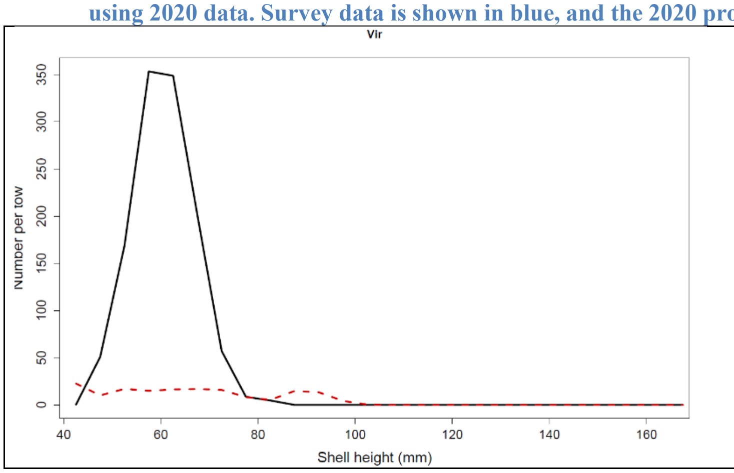
The Scallop PDT prepared an analysis comparing the length frequencies (L-Fs) from 2022 survey data with projections from the SAMS model for 2022. The base run of the SAMS model was initialized using survey data from 2021, and model results account for various factors including fishing mortality, natural mortality, discard mortality, and recruitment. The 2022 projections use slower growth stanzas for most areas. Observed length frequencies from the 2022 surveys were used to compare to the 2022 projections for all SAMS areas.

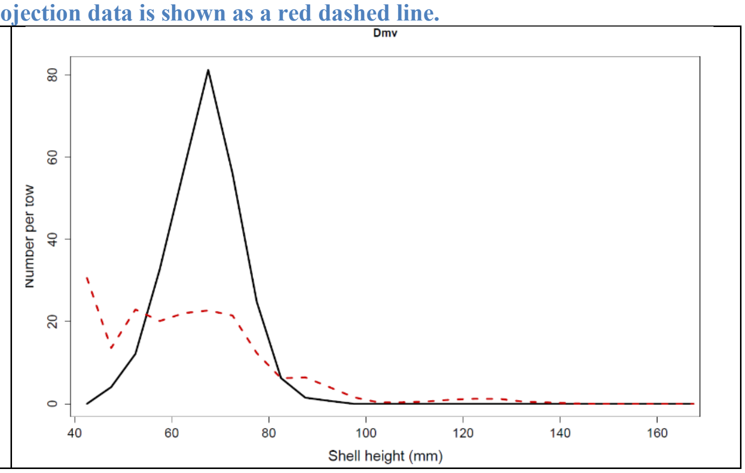
The plots in Table 11 display L-Fs by SAMS areas from across Georges Bank and the Mid-Atlantic, and for parts of the NGOM/GOM. The length-frequencies are shown by mean number per tow.

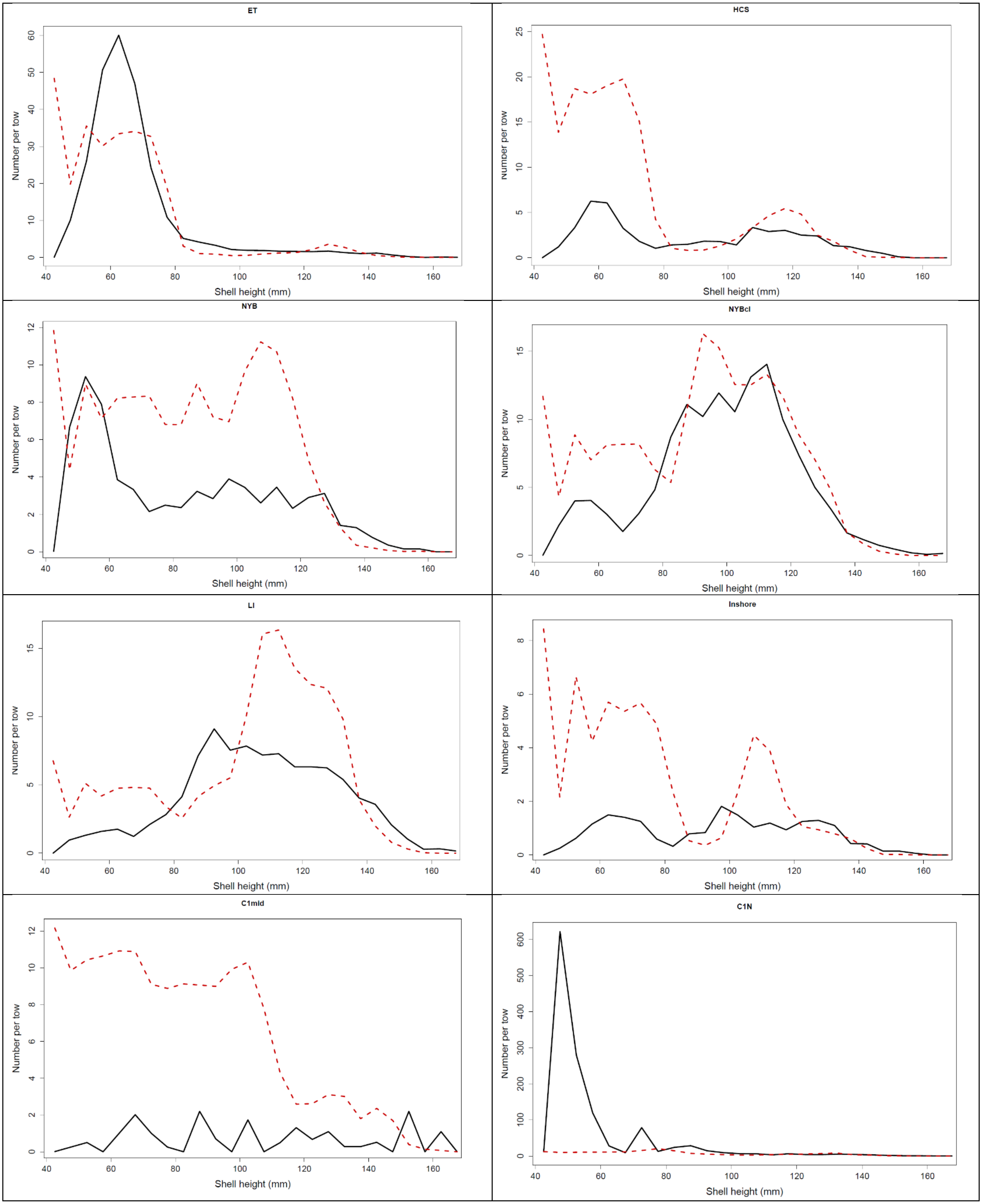
Discussion:

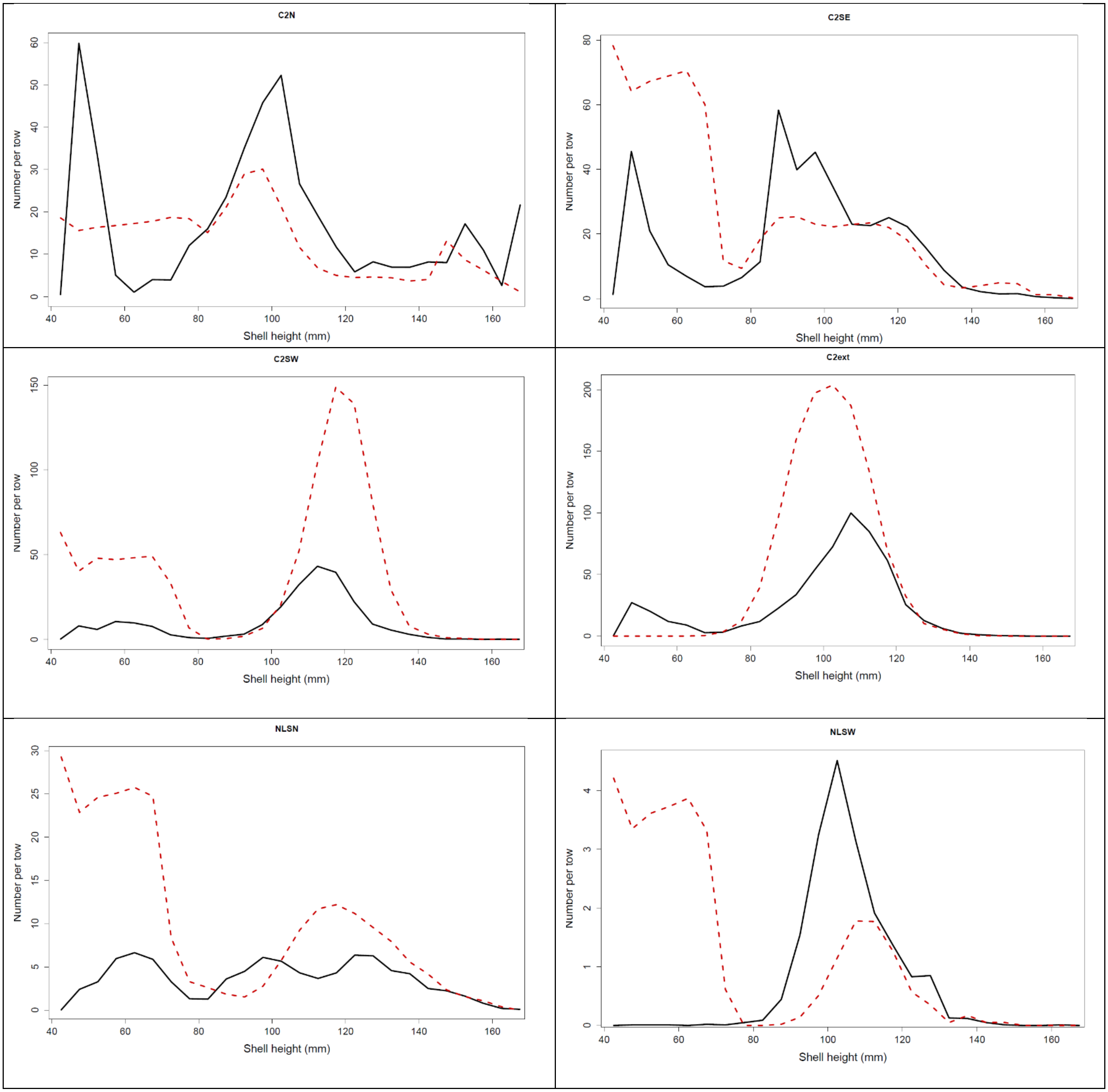
- Observed number per tow from the 2022 survey data are both higher and lower than the 2022 projections, depending on the SAMS area. This suggests that some combination of realized F, M, and growth was different than what was assumed in the 2021 SAMS model run.
- Changes to growth assumptions in the 2022 projections (slower growth) likely improved the agreement between surveys and projections. The decision to reduce growth 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 the 2021 surveys in an area have 20% CVs, 2022 projections could differ by up to 40% compared to the 2021 surveys due to survey error alone.
- The comparison shows that the 2022 projections for SAMS areas that make up Closed Area II estimated substantially more scallops than were observed in the 2022 surveys. While the survey data and projections generally tracked the shell-heights of the dominant classes in CAII-SW and CAII-Ext, the 2022 projections substantially overestimated biomass and abundance in these areas and appeared to have overestimated growth.
- While growth tracked similarly between the 2022 projection and observation for the NLS-South, abundance was substantially overestimated for this area in the projection.

Table 11 – 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.

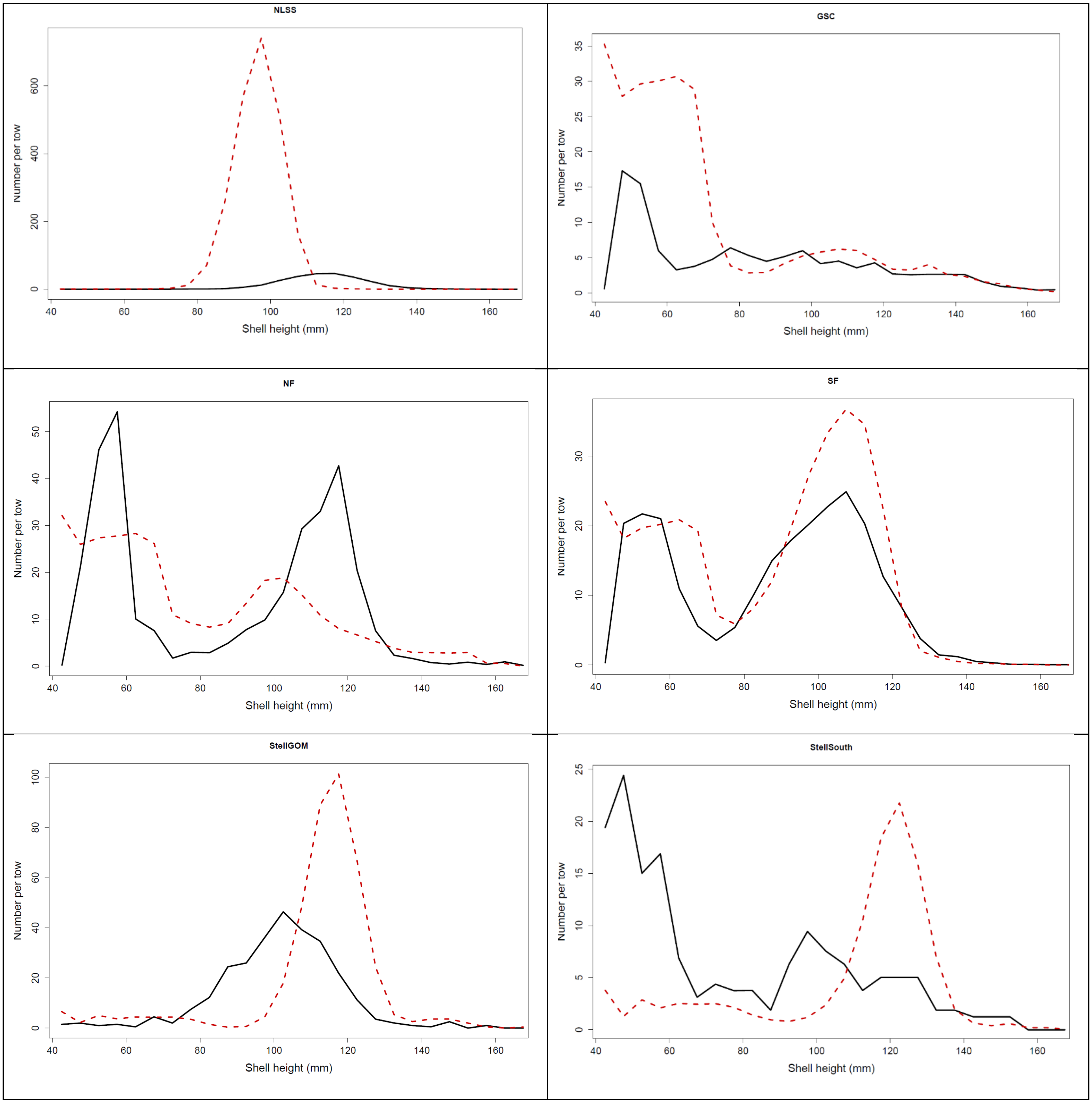


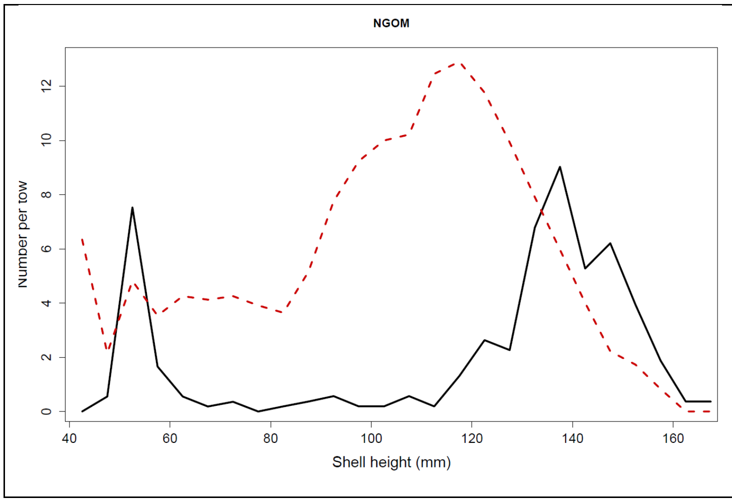



ET
HCS
NYB
NYBcl
LI
Inshore
C1mid
C1N
Number per tow
Shell height (mm)



C2N
C2SE
C2SW
C2ext
NLSN
NLSW
Number per tow
Shell height (mm)


NLSS
Number per tow
0
200
400
600
40
60
80
100
120
140
160
Shell height (mm)
GSC
Number per tow
0
5
10
15
20
25
30
35
40
60
80
100
120
140
160
Shell height (mm)
NF
Number per tow
0
10
20
30
40
50
40
60
80
100
120
140
160
Shell height (mm)
SF
Number per tow
0
10
20
30
40
60
80
100
120
140
160
Shell height (mm)
StellGOM
Number per tow
0
20
40
60
80
100
40
60
80
100
120
140
160
Shell height (mm)
StellSouth
Number per tow
0
5
10
15
20
25
40
60
80
100
120
140
160
Shell height (mm)


NGOM
Number per tow
0
2
4
6
8
10
12
40
60
80
100
120
140
160
Shell height (mm)