An Optical Assessment of Sea Scallop Abundance, Distribution and Growth in the Nantucket Lightship and Southern Part of Georges Bank

Final Report

2018 Sea Scallop Research Set-Aside (RSA) Program
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Submitted by

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List of acronyms and terms

CFF	Coonamessett Farm Foundation, Inc.
FOV	field of view
m	meters
mm	millimeter
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NLS	Nantucket Lightship Scallop Access Area
NLS-N	Nantucket Lightship Scallop Access Area North
NLS-S	Nantucket Lightship Scallop Access Area South
NLS-Ext	Nantucket Lightship Scallop Extension Area
NLS-W	Nantucket Lightship Scallop Access Area West
NOAA	National Oceanic and Atmospheric Administration
nm	nautical mile
NMFS	National Marine Fisheries Service or NOAA Fisheries
PDT	NEFMC Plan Development Team(s)
RSA	NEMFC/NEFSC Research Set Aside Program
SAMS	Scallop Area Management Simulator (model) areas
SH	shell height
VIMS	Virginia Institute of Marine Science, College of William and Mary
VMS	Vessel Monitoring System
WHOI	Woods Hole Oceanographic Institution

EXECUTIVE SUMMARY

Coonamessett Farm Foundation's (CFF) 2018 Sea Scallop Research Set Aside (RSA) project entitled *"An Optical Assessment of Sea Scallop Abundance, Distribution and Growth in the Nantucket Lightship and Southern Part of Georges Bank"* was designed to provide critical survey-based information to help inform scallop fishery management efforts. The primary objectives of this project are to:

1. Provide biomass estimates and size distribution of scallops in Nantucket Lightship (NLS) Scallop Area Management Simulator (SAMS) area.
2. Derive length-frequency distributions of scallops within each NLS SAMS area.
3. Assess growth of scallops (as a measure of shell height) by comparing mean shell height and length frequency with previous surveys.

The RSA HabCam v3 survey took place July 15-21, 2018 and covered approximately 725 nm in the following areas: 1) the NLS; a portion of the southern flank immediately to the east of the NLS-Ext; and 3) a small area to the west of the NLS-W. The NLS-S SAMS Area was split along the 70m depth contour into two separate areas in 2019 (NLS-S-Shallow and NLS-S-Deep).

Biomass estimates

Estimated exploitable biomass was highest in the NLS-W (**Table ES-1**). Although NLS-S-Deep contained the most scallops by number, the average size of scallops in the NLS-S-Deep is substantially smaller than scallops found in other areas of the NLS as measured by shell height and calculated meat weight. This is worthy of noting because it is generally assumed that the majority of scallops in the NLS greater than 75mm are from the same 2012 year class.

Table ES-1. Total and exploitable biomass (metric tons) and average size (mm shell height) of measured scallops in images from the 2018 CFF RSA HabCam survey.

	Exploitable Biomass			Total Biomass						
SMAS Area	Number (millions)	Metric tons	SE	Number (millions)	Metric tons	SE	Mean weight (g)	Avg Size (mm)	Density (#/sq m)	images annotated
NLS-N	6.89	226.7	1.22	115	3794	20.4	32.91	120.6	0.11	1904
NLS-S-Shallow	110.9	1996	16.6	393	7075	58.86	17.99	94.9	1.36	507
NLS-S-Deep	588.2	5021	202.6	3742	31940	1289	8.54	78.4	5.12	1220
NLS-W	825.6	22308	1639	2237	60445	4442	27.02	99.3	1.53	2156
NLS-Ext	0.17	4.58	0.41	12.48	328	29.65	26.29	102.2	0.03	625

Size distribution and density

The SAMS areas with the highest density of scallops were NLS-S-Deep and NLS-W, as seen in RSA surveys in 2015 and 2017. Substantial numbers of recruit scallops (35-75mm shell height) were present in the deeper waters of NLS-S, though pre-recruit scallops (<35mm) were not seen in substantial densities in the NLS.

Despite the high density of scallops over 75mm in the NLS-S-Deep, scallops greater than 100mm are much more widely distributed than scallops 75-100mm in size in the NLS-S-Deep. The highest density of large (>100mm) scallops continues to be found in the NLS-W.

Additional observations

In 2018, a survey timing effect on biomass estimates generated from surveys was noted, particularly in the NLS-Ext. Surveys that took place nearer to the start of the fishing season (e.g., University of Massachusetts-Dartmouth School for Marine Science and Technology drop camera survey in the NLS-Ext, and to some degree in the NLS-W produced higher biomass estimates than surveys that took place later in the season. Continued discussions about how to account for and rectify such differences, as well as how best to combine survey results, are warranted. Notably, variations in biomass estimates with fishing season and survey method highlight the importance of employing multiple survey techniques in certain areas of interest.

FINAL REPORT

Background

The United States (US) Atlantic sea scallop fishery is one of the most valuable fisheries in the US, with revenues averaging $400-$600 million since 2006 (Smolowitz 2016). The scallop resource rebounded from a depleted state in the early 1990's due, in part, to management changes implemented to protect the resource in certain areas until scallops achieve marketable size. The primary management methods responsible for this turnaround included a reduction in Days-At-Sea (DAS), limits on crew size, gear modifications, and, perhaps most importantly, the institution of rotationally fished Scallop Access Areas. This last approach also included management provisions to temporarily close newly identified areas with high numbers of small scallops. These measures, coupled with the additional measures set forth in the open access areas aimed at ensuring continued growth and spawning of those populations, have aided in facilitating the current high and relatively stable output of the Atlantic sea scallop fishery (Hart 2003; NEFSC 2014).

Rotational management and the opening or closing of certain spatial management areas for harvest, as well as limiting effort in other management areas, is highly dependent on a sound estimation of the resource. Because the resource is spread over a large geographic area, reliance on industry-based surveys has become increasingly important in the face of limited federal resources. Traditional surveys (e.g., dredge-based), while providing critical biological information, have been shown to be potentially limited due to decreased catch efficiency in areas of dense scallop aggregation (NEFSC 2004; Gedamke et al. 2005).

Optical surveys are important components to an overall survey strategy and hold several key advantages over traditional dredge surveys. Optical surveys overcome the issue of decreased dredge efficiency which can lead to underestimation of biomass in dense aggregations. Additionally, optical surveys are able to characterize the spatial scale of areas containing seed and very small scallops, which may be missed or only qualitatively noted by dredge surveys due to size selectivity (Rudders 2015). Optical surveys can also cover large swept areas in a relatively short time frame, allowing for detection of fine-scale distribution changes. The images and metadata collected during optical surveys also holds ancillary information such as species interactions, distribution of additional flora and fauna, temperature, salinity, and substrate type.

The 2012 scallop year class that has settled in the deeper waters south of the Great South Channel has the potential to yield a substantial exploitable biomass. However, it has been noted that scallops in the NLS-S Scallop Area Management Simulator (SAMS) area are substantially smaller (2018 mean shell height: 79.8mm) than those in other areas in the NLS (e.g., 2018 mean shell height in NLS-W: 99.3mm). This seems to be particularly true in the deeper water of the NLS-S. Due to the disparity between the apparent growth rates of scallops in the shallow and deep portions of the NLS-S, the Atlantic Sea Scallop Plan Development Team (PDT) made the decision to split the NLS-S into two distinct SAMS areas for the purpose of biomass estimation (NLS-S-Shallow and NLS-S-Deep; **Figure 1**).

Data gaps exist pertaining to the precise cause or causes of the apparent smaller size-at-age, as well as to the factors that govern fine-scale scallop growth. Thus, continued fine-scale surveys of the NLS, and of the NLS-S in particular, may prove beneficial by providing information such as inter-annual growth and changes in distribution via a continuous time-series of scallop shell heights in these areas, as well as gathering other data, such as bottom temperature and salinity,

that may be critical to understanding any spatial or temporal differences in growth rates (Schick et al., 1988; Pilditch and Grant 1999).

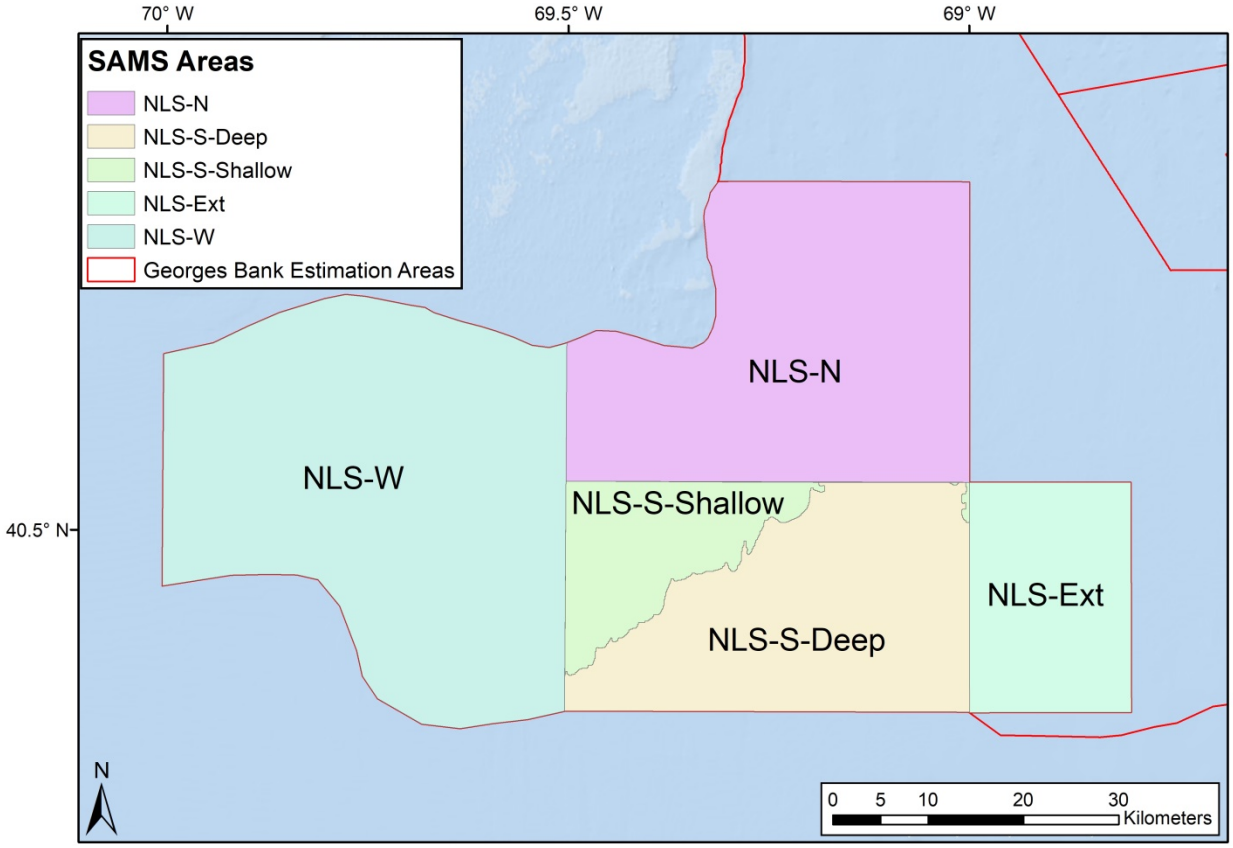

Figure 1. Scallop Area Management Simulator (SAMS) areas in the Nantucket Lightship Scallop Management Area (NLS-NA: non-access habitat closure; NLS-AC-N: Access area north; NLS-AC-S: Access area south; NLS-EXT: eastern extension).

Large scallop settlement event along the Southern New England shelf

In the summer of 2013, the Northeast Fisheries Science Center (NEFSC) and Virginia Institute of Marine Science (VIMS) RSA-sponsored scallop survey efforts located areas of high density age-1 scallop settlement south of the Great South Channel, extending both east and west along the 30-40 fathom edge of the Southern New England shelf (NEFSC 2013). In August 2013, the HabCam Group aboard the F/V Kathy Marie conducted a 3-day, 300-nm survey in the areas identified by the NEFSC and VIMS surveys, with expanded coverage in the western, southern, and eastern portions of the NLS. A large concentration of 15-25mm scallops were noted in the NLS-S SAMS area, as well extending just to the south of the NLS scallop management southern border. Scallop densities were also noted to be high in the NLS-W and within the current NLS-Ext SAMS area.

2014 RSA-sponsored HabCam v2 settlement survey - NA14NMF4540083

Over the course of four separate trips in June and July of 2014, HabCam Group surveyed the 2012 set of scallops on the southern New England shelf. Dense settlements of small scallops were seen in the southern NLS-S Area (**Figure 2**). HabCam imagery was also used to map the density of predators, particularly sea stars.

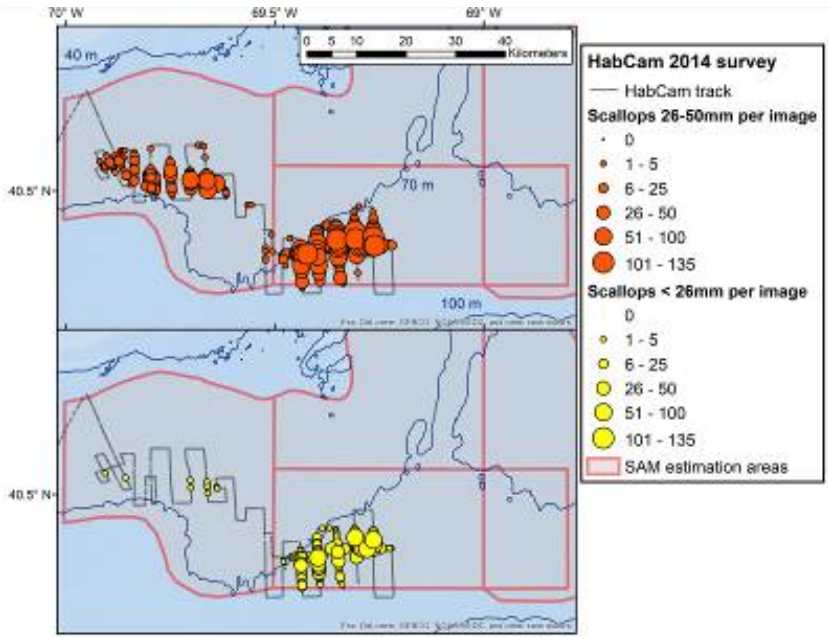

Figure 2. Distributions of 0-25mm and 26-50mm scallops from 2014 RSA HabCam survey in the NLS.

2015 RSA-sponsored survey of the NLS area - NA15NMF4540064

In June 2015, optical survey data was collected in southern New England waters and on Georges Bank. Dense scallop concentrations were again located in the eastern two thirds of the NLS, with much smaller numbers in the deeper waters southeast of Closed Area II. Overall, about 80% of the scallops in this region were located in the NLS. Most of the scallops were under 75 mm (**Figure 3**), presumably belonging to the 2012 year class.

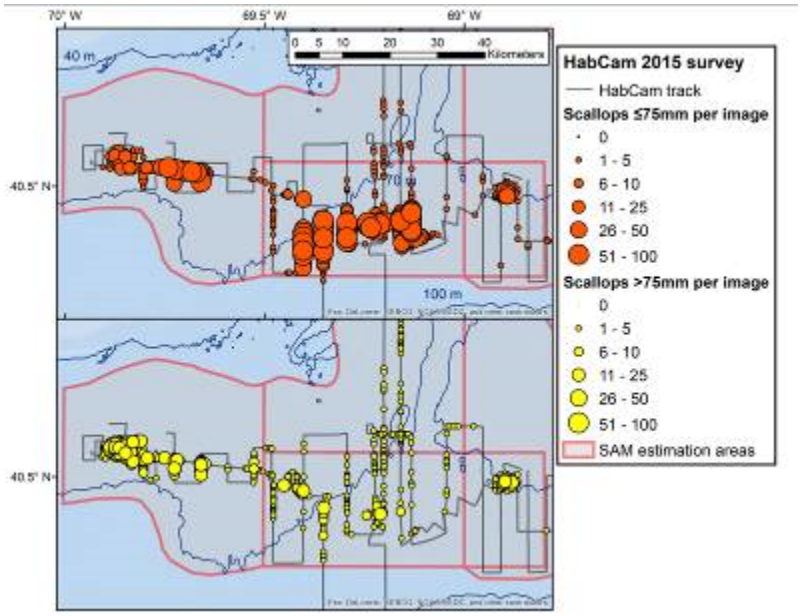

Figure 3. Distributions of 0-75mm and over 75mm scallops from 2015 RSA HabCam survey in the NLS.

2017 RSA-sponsored survey of NLS area - NA17NMF4540035

From July 14-22, 2017, CFF and the HabCam Group conducted an optical survey of the NLS on the F/V Kathy Marie. The total optical survey track in the NLS was 875 nm; 680 nm consisted of N-S transects with 1.5 nm spacing in between. A 130-nm E-W transect was conducted after completion of the N-S transects and targeted areas with high scallop density.

Recruit-size scallops (<75mm) were seen in substantial numbers in approximately 75-80 m of water in NLS-S and in moderate densities in the NLS-W area (**Figure 4**). The highest density and biomass was found within the NLS-AC-S area (**Figures 5**). Scallop distribution shifts markedly north with increasing size (**Figure 4**). After consultation with other survey groups and review of prior data, it appears that scallops in NLS-AC-S were not achieving the same size-at-age as scallops in other areas of the NLS.

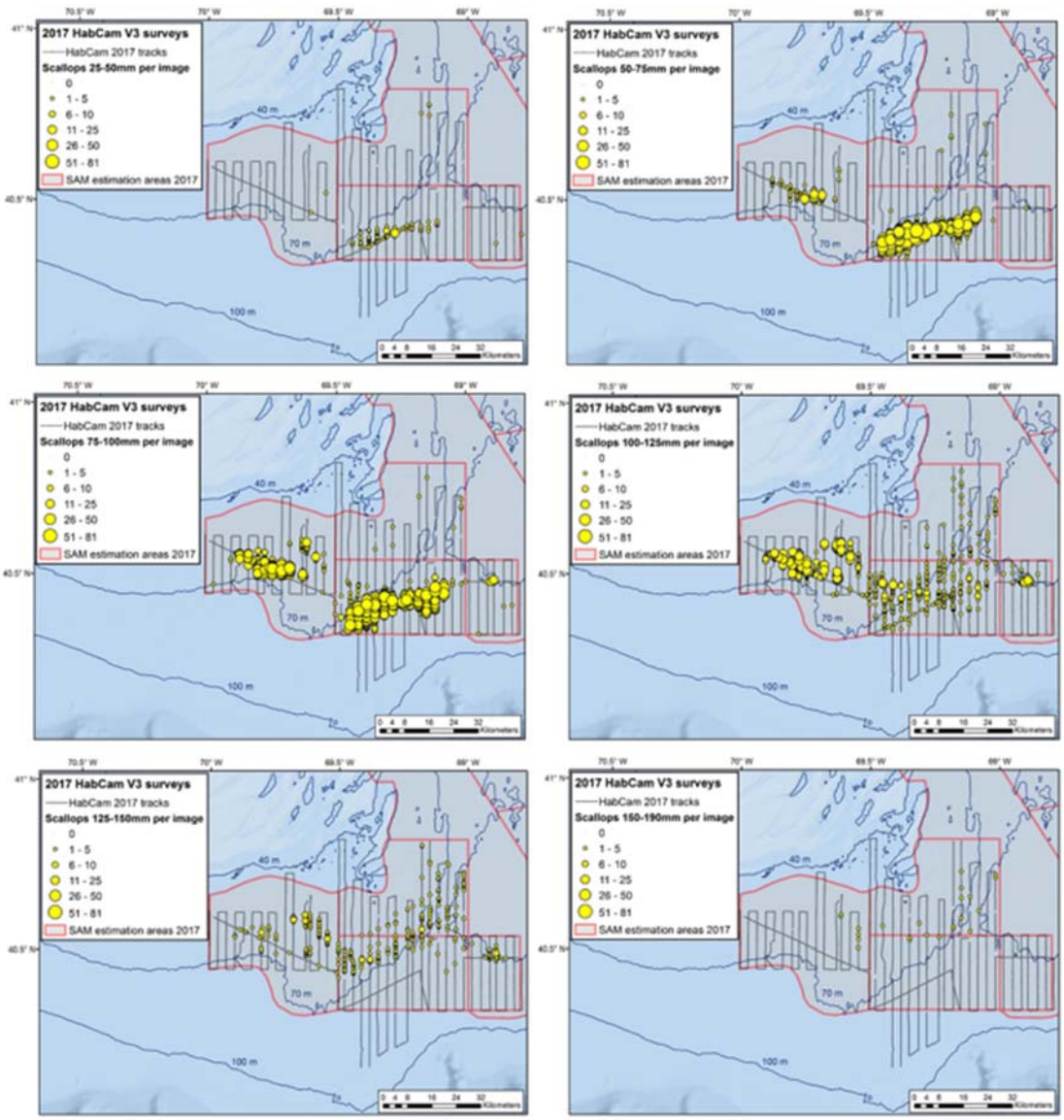

Figure 4. Distributions of scallops in size classes from 25-190 mm from 2017 RSA HabCam survey in the NLS.

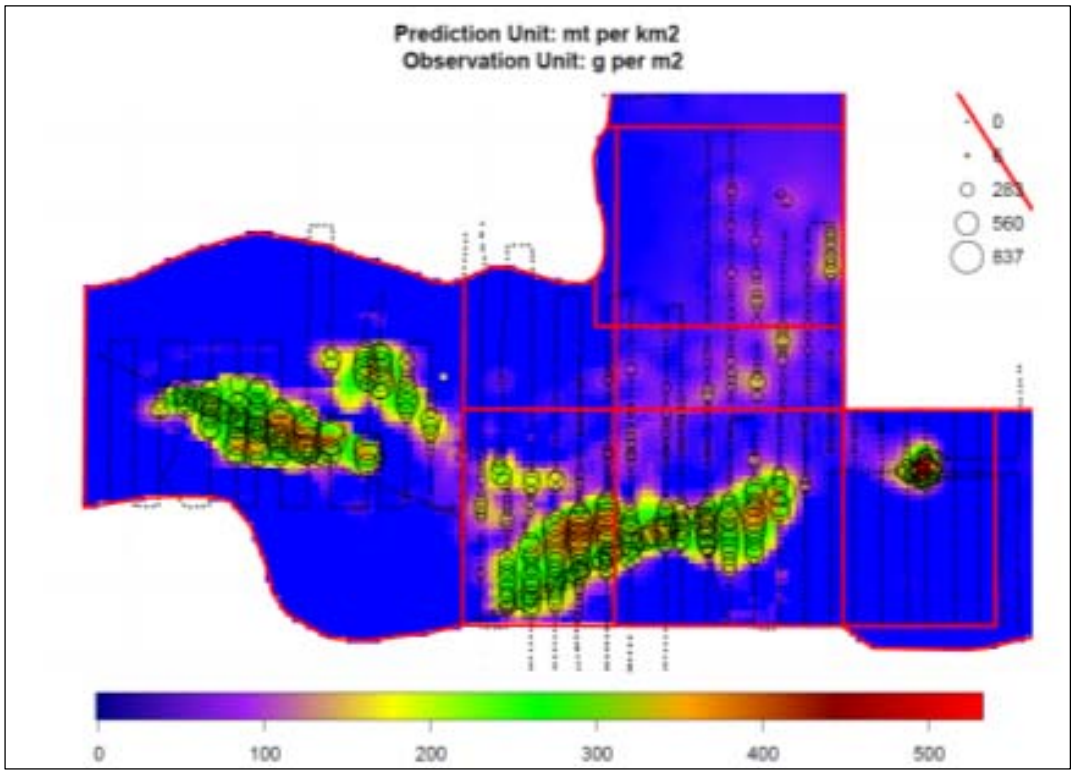

Figure 5. Observed and predicted biomass in the NLS from the 2017 RSA CFF HabCam survey.

Project Goals and Objectives

The overarching goal of this survey was to provide data for biomass estimates to the Atlantic Sea Scallop Plan Development Team (PDT) to inform management decisions. The primary objectives of the project were to:

1. Provide biomass estimates and size distribution of scallops in Nantucket Lightship (NLS) Scallop Area Management Simulator (SAMS) area.
2. Derive length-frequency distributions of scallops within each NLS SAMS area.
3. Assess growth of scallops (as a measure of shell height) by comparing mean shell height and length frequency with previous surveys.

Methods

The RSA HabCam v3 survey took place from July 15-21, 2018 and covered approximately 725 nm in the NLS as well as a portion of the southern flank immediately to the east of the NLS-Ext and a small area to the west of the NLS-W (**Figure 6**). Actual cruise tracks were modified from proposed cruise tracks in the NLS due primarily to the decoupling of the winch slip ring that was repaired at-sea. The northern portion of the north-south transects in the NLS-N were initially truncated to concentrate efforts where high scallop density was known to occur in past surveys. Attempts were made to recover some of the lost survey track once confidence built in the at-sea repair of the winch slip ring coupling.

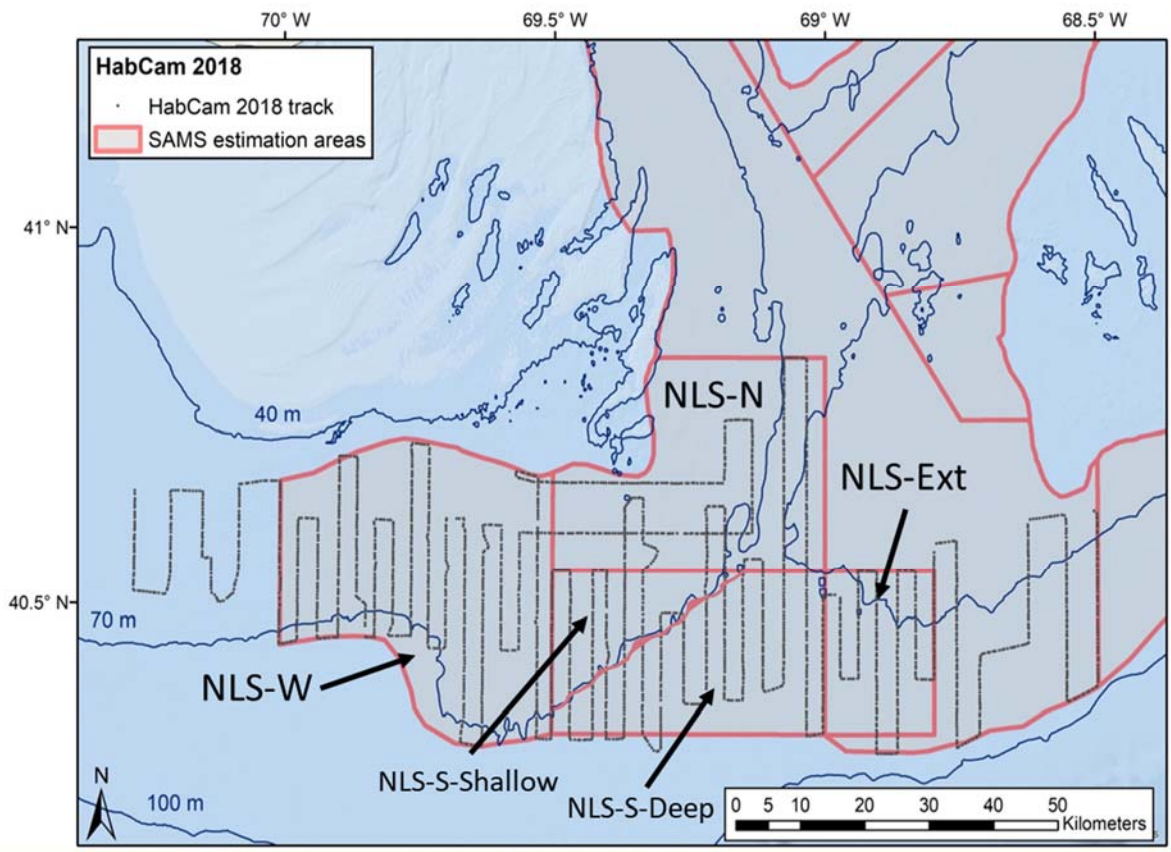

Figure 6. CFF RSA HabCam v3 survey track. The newly formed NLS-S-Shallow and NLS-S-Deep SAMS areas are demarcated by the 70m isobar, which can be seen running SW-NE in the NLS-S in the above distribution plots.

The HabCam v3 optical imaging system was "flown" 1.5 to 2.5 meters off the seafloor while being towed at 4-5 knots. Raw images were captured and saved as 12-bit high dynamic range TIF files to a Synology Network Attached Storage system. The TIF files also contained the metadata associated with a particular image (e.g., date, time, latitude, longitude, temperature, conductivity, speed, vessel sounder depth, and heading). After collection, copies of the raw TIF files were processed into 8-bit JPG image files, which were used for annotation. Of the 2.9 million stereo image pairs collected, 7,143 were annotated, yielding an annotation rate of approximately 1:400.

Images were annotated using the MATLAB® Manual Identification Program (MIP). Scallops were counted and measured, while fish, sea stars, and other organisms of interest were counted. Scallop shell heights were measured when the hinge was visible – if this was not possible, scallop shell width was used in lieu of height. Annotation data was recorded into data files that also include HabCam v3 sensor measurements.

All annotated images were reviewed for quality control prior to final data being sent to the NEFSC for biomass estimate modeling. Quality control (QC) was performed on a minimum of 25% of the annotated images (QC rate was increased in areas of high scallop density).

Data files containing raw annotation data were supplied to NEFSC Population Dynamic Branch staff for biomass modeling. The resulting image-based annotation data was also plotted for scallop size distributions (numbers of scallops per image) and scallop length-frequency distributions by SAMS area.

Biomass estimates

Scallop lengths were initially recorded in pixels and were subsequently converted into shell heights based on the image field of view (FOV). Each shell height (SH) measured from the HabCam images was converted to a meat weight (MW) in grams using published location-specific SH-MW equations that include depth as a covariate (e.g., Hennen and Hart 2012). Biomass per m^2 was then calculated by summing all MWs in an image and dividing by the FOV of that image.

To estimate biomass, the NEFSC used a combination of a hurdle generalized additive model (GAM) and ordinary kriging (Chang et al. 2017). The hurdle GAM (quasi-binomial distribution for the presence/absence model and quasi-Poisson distribution for the positive model) was used to estimate the large-scale trends in biomass with respect to latitude, longitude, and depth. Kriging on the model residuals was used to improve estimates over smaller scales.

Results and Discussion

Biomass estimates

Estimated exploitable biomass was highest in the NLS-W (**Table 1, Figure 7**). Although the deep portion of the NLS-S (>70m; NLS-S-Deep) contained the most scallops by number, the average size of scallops in the NLS-S-Deep is substantially smaller than other areas of the NLS as measured by shell height and calculated meat weight (**Table 1**; **Figure 7**). This is worthy of noting because it is generally assumed that the majority of scallops in the NLS greater than 75mm are from the same 2012 year class.

Table 1. Total and exploitable biomass (metric tons) and average size (mm shell height) of measured scallops in images from the 2018 CFF RSA HabCam survey.

	Exploitable Biomass			Total Biomass						
SMAS Area	**Number (millions)**	**Metric tons**	**SE**	**Number (millions)**	**Metric tons**	**SE**	**Mean weight (g)**	**Avg Size (mm)**	**Density (#/sq m)**	**images annotated**
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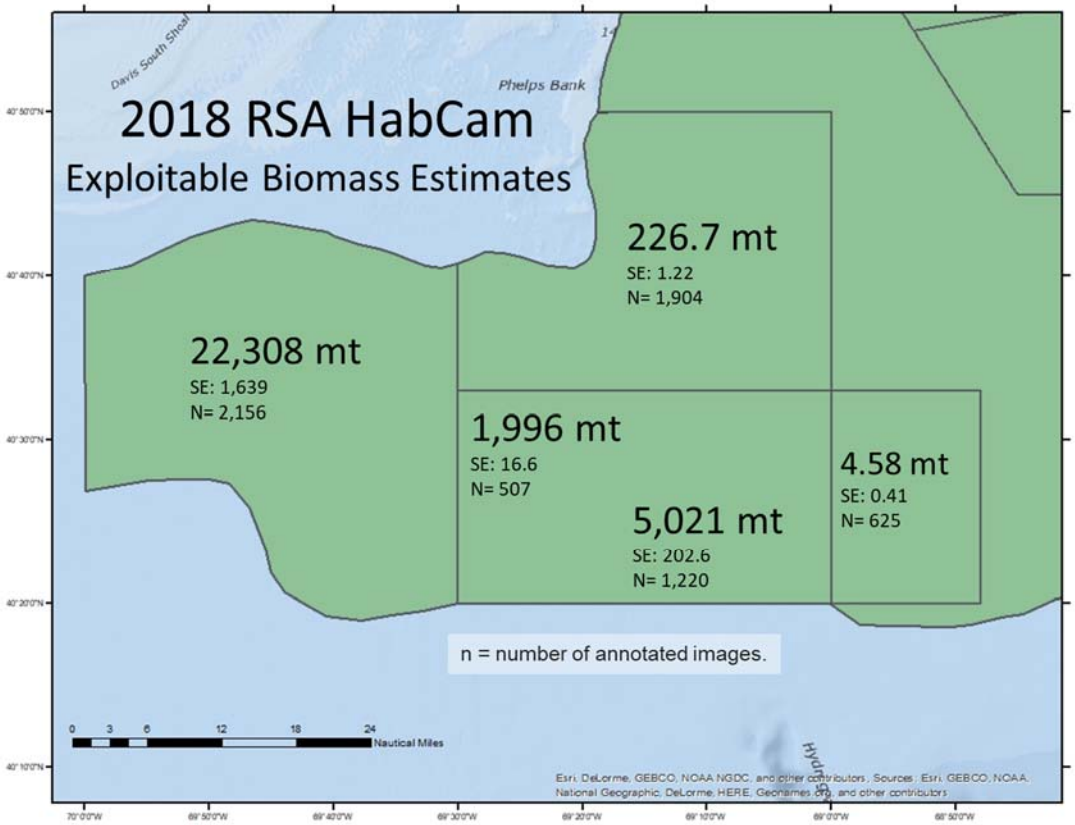

Figure 7. Exploitable biomass by NLS SAMS area derived from 2018 RSA HabCam data (note: additional NEFSC HabCam data also used in the NLS-N and NLS-Ext SAMS areas).

Size distribution and density

The SAMS areas with the highest density of scallops were NLS-S-Deep and NLS-W (**Figure 8**) as seen in RSA surveys in 2015 and 2017. Substantial numbers of recruit scallops (35-75mm shell height) were present in the deeper waters of NLS-S, though pre-recruit scallops (<35mm) were not seen in substantial densities in the NLS.

Despite the high density of scallops over 75mm in the NLS-S-Deep, scallops greater than 100mm are much more widely distributed than scallops 75-100mm in size in the NLS-S-Deep. The highest density of large (>100mm) scallops continues to be found in the NLS-W.

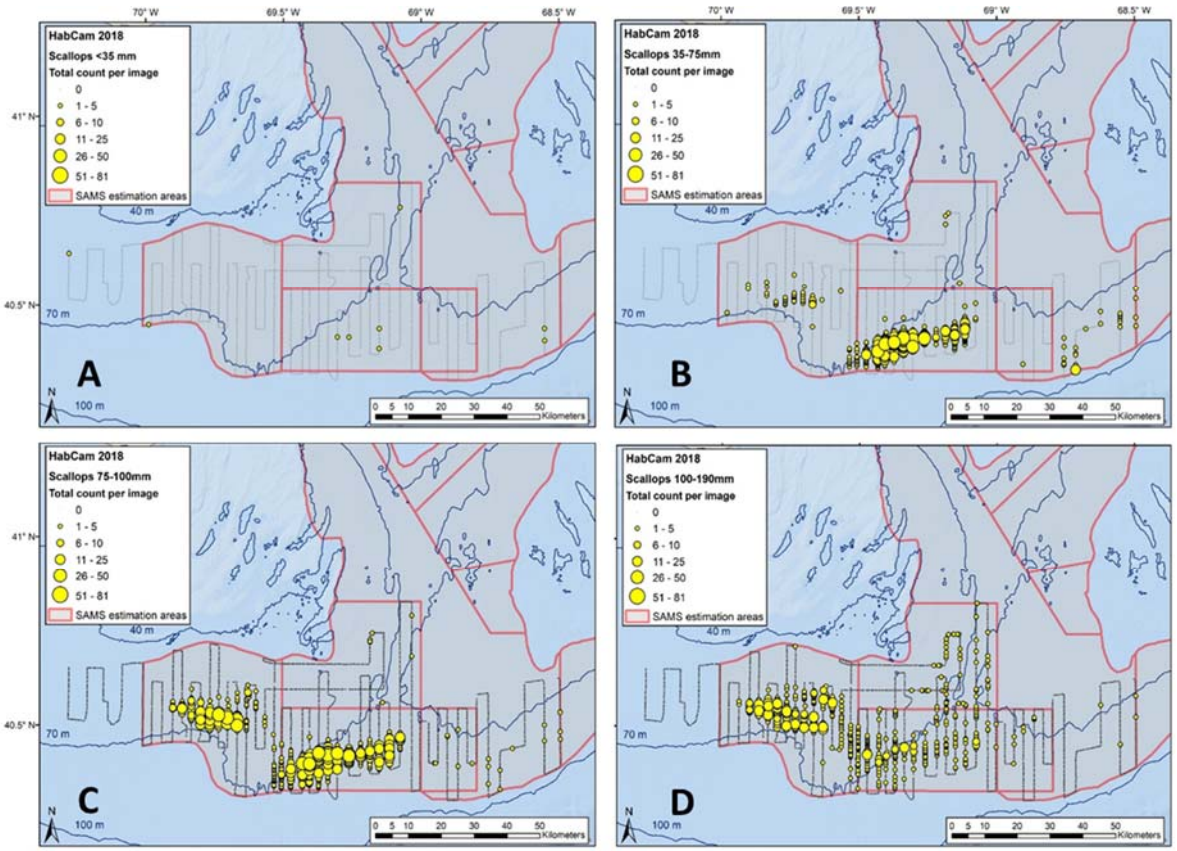

Figure 8. Distributions of measured scallops in size classes from (A) 0-35mm, (B) 35-75mm, (C) 75-100mm, and (D) 100-190mm from the 2018 RSA HabCam survey in the NLS.

Length-frequency distributions

Average shell heights were largest in the NLS-N and NLS-Ext, although densities and numbers of scallops counted in these two SAMS areas were much smaller than in the NLS-W and NLS-S (**Figure 8**). Average size of measured scallops in the NLS-S was substantially smaller than those in NLS-W (NLS-S: 79.8mm; NLS-W: 99.3mm; **Figure 9**, **Table 2**).

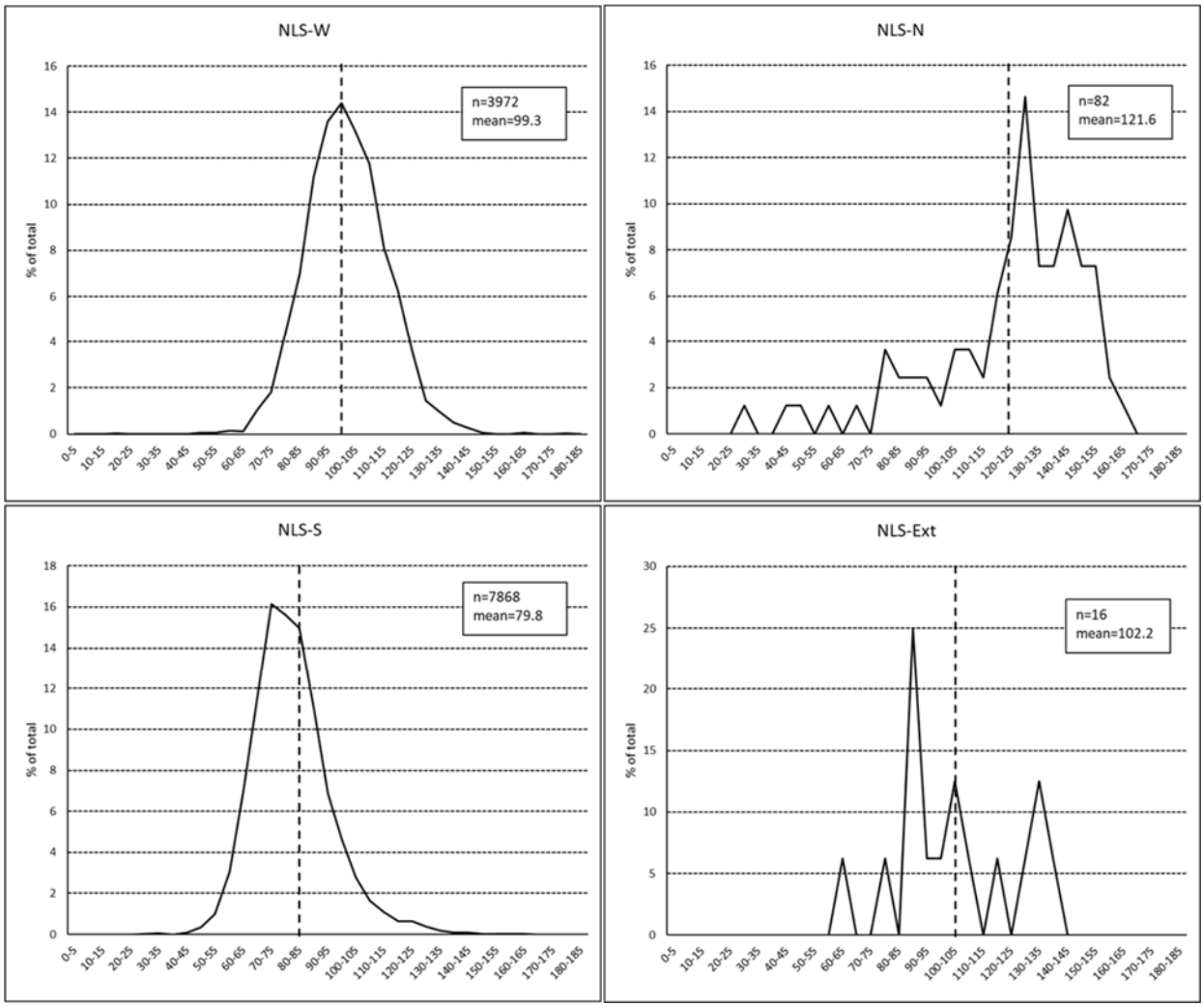

Figure 9. Length-frequency plots of measured scallops in HabCam images from the NLS SAMS areas – (A) NLS-W, (B) NLS-N, (C) NLS-S, and (D) NLS-Ext in 2018. Dashed line represents the mean scallop size in each survey year; n=total number of scallops counted.

There was a substantial difference in the average shell heights of measured scallops in the deep portion (>70m) of the NLS-S than those measured in the shallow (<70m) portion (**Figure 10**). This size difference between scallops found inhabiting the shallow and deeper waters of the NLS-S has been observed over the past 2 years. It is generally assumed that the portion of the scallop cohort inhabiting deeper waters of the NLS-S are growing more slowly than those found elsewhere in the NLS.

Table 2. Frequency of scallops in 5mm size bins observed in 2018 (by NLS SAMS area).

	Frequency			
Range	**NLS-W**	**NLS-S**	**NLS-N**	**NLS-Ext**
0-5	0	0	0	0
5-10	0	0	0	0
10-15	0	0	0	0
15-20	1	0	0	0
20-25	0	0	0	0
25-30	0	1	1	0
30-35	0	5	0	0
35-40	0	0	0	0
40-45	0	8	1	0
45-50	2	27	1	0
50-55	2	79	0	0
55-60	6	238	1	0
60-65	5	552	0	1
65-70	41	914	1	0
70-75	73	1269	0	0
75-80	172	1229	3	1
80-85	277	1179	2	0
85-90	445	865	2	4
90-95	540	540	2	1
95-100	572	365	1	1
100-105	522	219	3	2
105-110	467	130	3	1
110-115	322	85	2	0
115-120	248	50	5	1
120-125	145	49	7	0
125-130	58	31	12	1
130-135	38	14	6	2
135-140	20	7	6	1
140-145	11	6	8	0
145-150	2	2	6	0
150-155	0	2	6	0
155-160	0	1	2	0
160-165	2	1	1	0
165-170	0	0	0	0
170-175	0	0	0	0
175-180	1	0	0	0
180-185	0	0	0	0
Total:	**3972**	**7868**	**82**	**16**

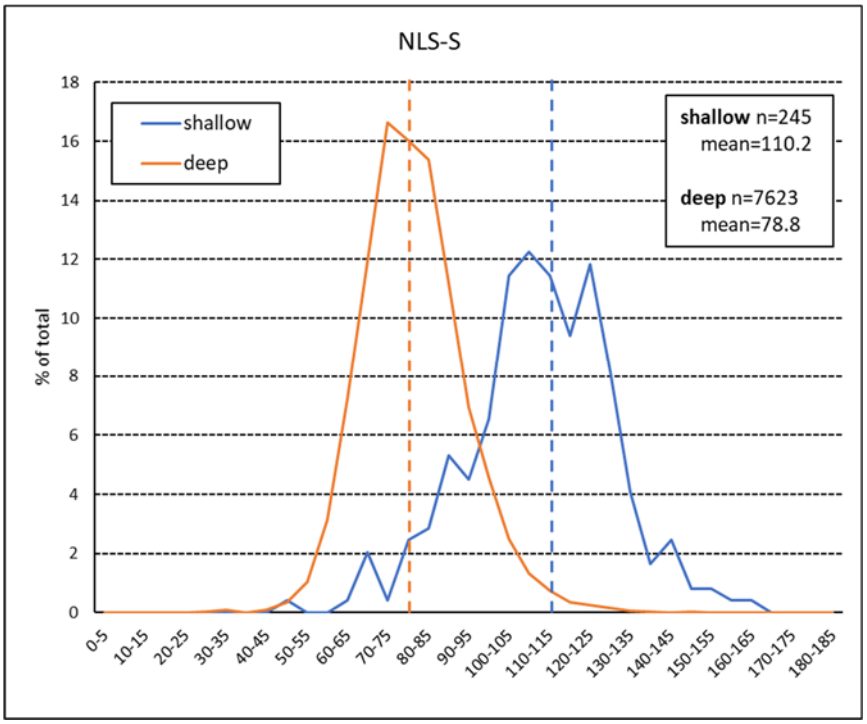

Figure 10. Length-frequency plot of sea scallops observed in the shallow (<70m) and deep (>70m) portions of the NLS-S SAMS area in 2018. n=total number of scallops counted. Dashed line represents 5mm bin where mean shell height is contained.

Scallop growth & survival

Scallop growth, as indicated by average measured shell heights, showed substantial increases in all NLS SAMS areas from 2015-2017 (**Figures 11** and **12**). However, average shell heights did not increase appreciably from 2017-2018 in any NLS SAMS area (**Figures 11** and **12**). It is worthy to note that sample sizes in the NLS-Ext were substantially smaller than in years past, likely due to fishery removals.

In the NLS-S-Shallow there was a slight decrease in average shell height of measured scallops, though the difference is not significant (**Figure 13**). This may be indicative of a slowing or cessation of scallop growth. Because the NLS-W was subject to intense fishery activity April-July 2018, the lack of increase in average shell heights for measured scallops in the NLS-W may be due in part to fishery removals of larger scallops (**Figure 14**).

Estimated number and biomass of scallops decreased substantially from 2017-2018 in all NLS SAMS areas with the exception of biomass in the NLS-W (**Table 3**). Although the relatively high standard error in modeled biomass and number estimates is well-recognized, the marked decrease in both biomass and number may be indicative of scallop mortality (natural, fishing, or a combination of the two). This is most evident in the NLS-Ext, which was subjected to intense fishing pressure in 2018; thus the extreme drop in biomass and numbers is likely reflective of direct fishing mortality.

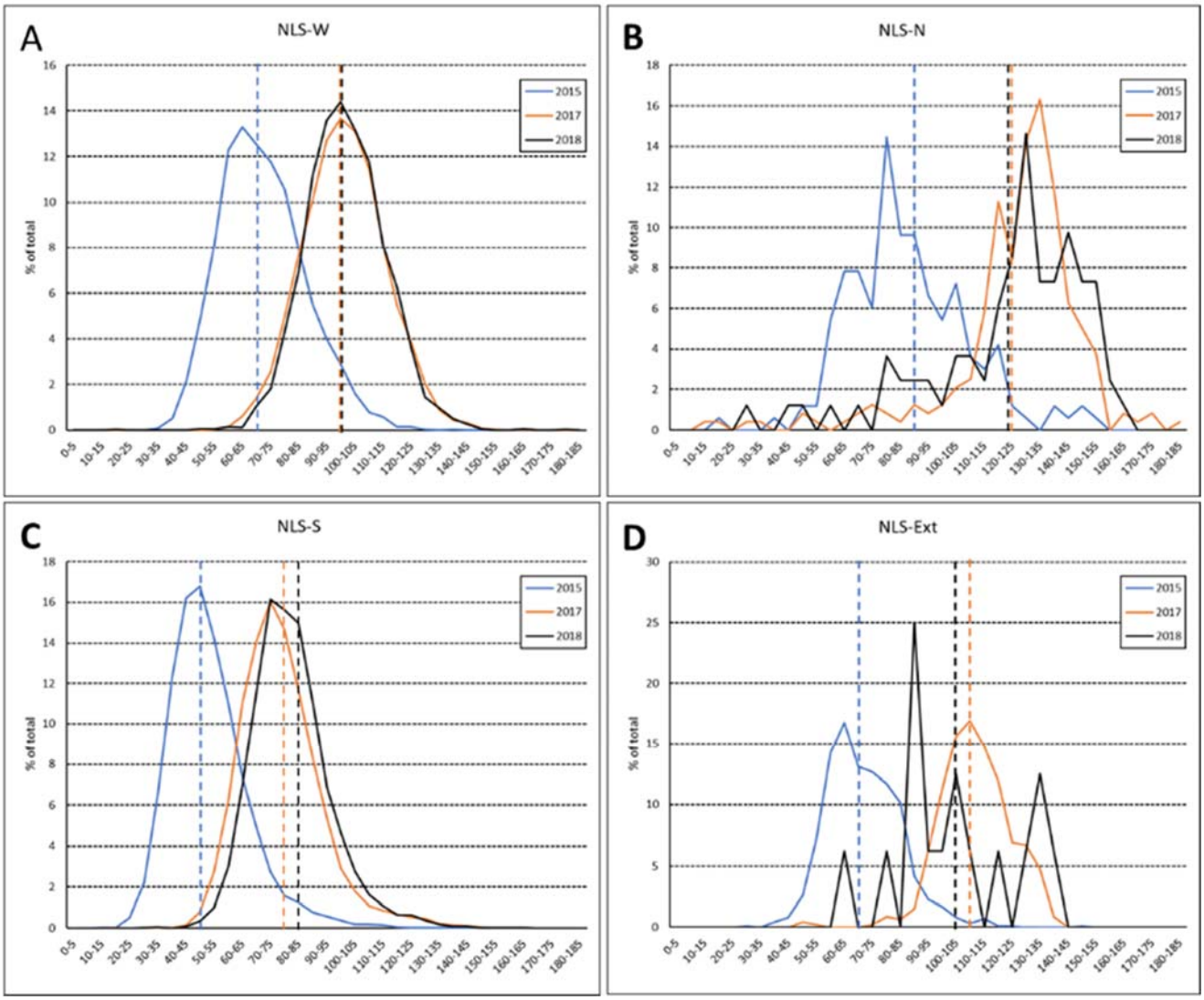

Figure 11. Length-frequency plots of measured scallops in HabCam images from the NLS SAMS areas – (A) NLS-W, (B) NLS-N, (C) NLS-S, and (D) NLS-Ext in 2015, 2017 and 2018. Dashed line represents the mean scallop size in each survey year.

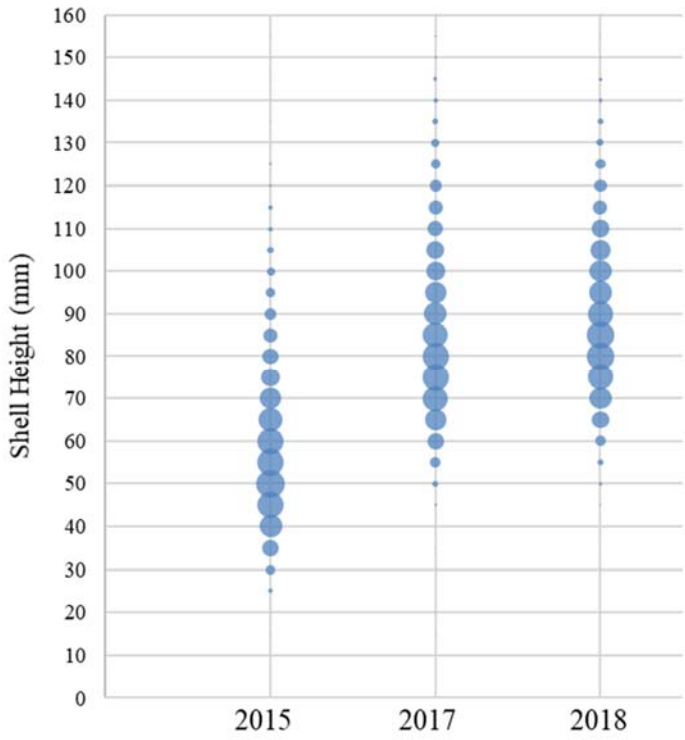

Figure 12. Estimated abundance by shell height as derived from the RSA HabCam survey by year in the NLS (symbols are proportional to abundance).

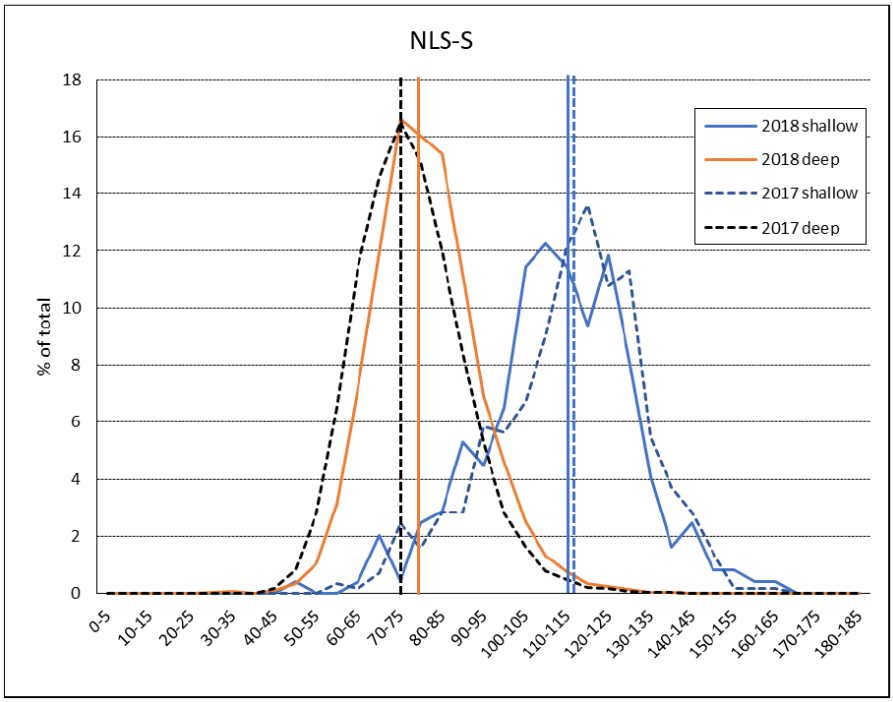

Figure 13. Length-frequency plots of measured scallops in HabCam images from the NLS-S-Shallow and NLS-S-Deep SAMS in 2017 and 2018. Vertical line represents the mean scallop size in each survey year.

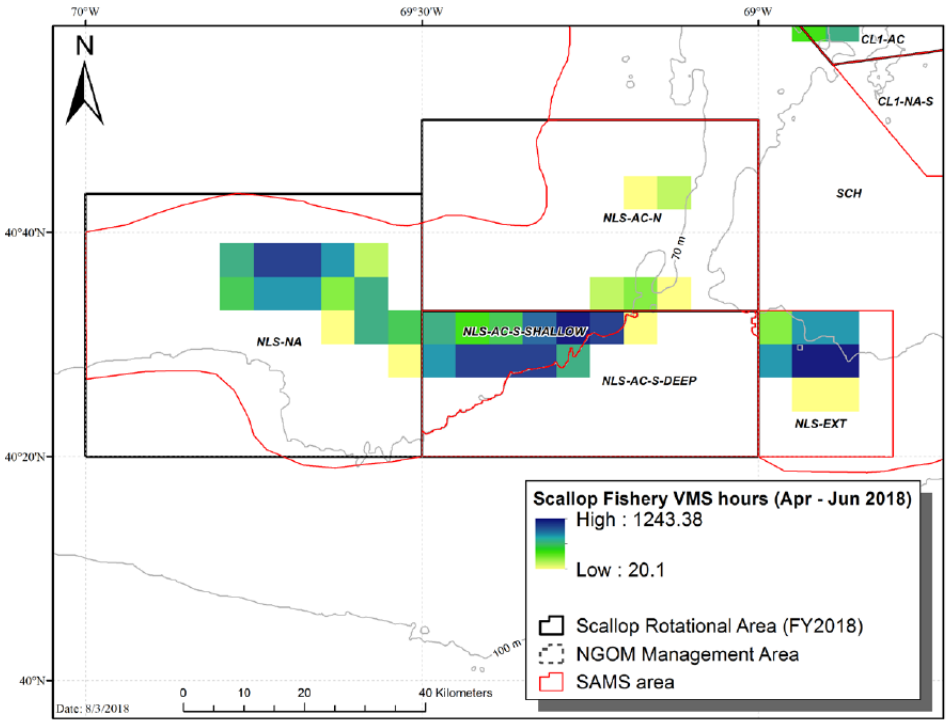

Figure 14. Scallop fishery effort as indicated by VMS hours at speeds between 2-5 knots. Data and imagery from NEFMC 2018.

Table 3. Total estimated number (millions), biomass (metric tons) and percent change of scallops in the NLS as estimated by RSA HabCam surveys in 2017 and 2018.

	2017			2018			Percent change	
Area	**Number (millions)**	**Biomass (mt)**	**SE**	**Number (millions)**	**Biomass (mt)**	**SE**	**Number (millions)**	**Biomass (mt)**
NLS-NA / W	2906	56066	1831	2237	60445	4442	-23.0%	7.8%
NLS-S*	9315	77827	3174	4135	39016	1289**	-55.6%	-49.9%
NLS-N	222	10083	300	115	3794	20.4	-48.1%	-62.4%
NLS-Ext	171	5682	1831	13	328	29.65	-92.4%	-94.2%
Total	**12614**	**149658**		**6500**	**103583**			

*: NLS-S-Shallow and NLS-S-Deep combined **: SE of NLS-S-Deep used for 2018

Accomplishments by objective

Objective 1: Provide biomass estimates and size distribution of scallops in Nantucket Lightship (NLS) Scallop Area Management Simulator (SAMS) area.

We were able to provide timely estimates of biomass and scallop size distribution throughout the NLS. Biomass estimates and size distributions (length-frequency and spatial distribution) for the NLS were presented to the Atlantic Sea Scallop PDT in August, 2018. Of particular interest was the continued large biomass of presumably slower-growing scallops in the deeper waters of NLS-S SAMS area.

Objective 2: Derive length-frequency distributions of scallops within each NLS SAMS area.

We were able to derive SAMS-specific length-frequency distributions within the NLS. Similar to observations over the past two survey seasons, there was a marked difference in the average shell heights of measured scallops in the deep portion (>70m) of the NLS-S than those measured in the shallow (<70m) portion.

Objective 3: Assess growth of scallops (as a measure of shell height) by comparing mean shell height and length frequency with previous surveys.

Length-frequency distributions by SAMS in 2015, 2017 and 2018 were compared. Scallop growth, as indicated by average measured shell heights, showed substantial increases in all NLS SAMS areas from 2015-2017, but no growth was apparent from 2017-2018 in any NLS SAMS area. In the NLS-S-Shallow there was a slight decrease in average shell height of measured scallops that may be indicative of a slowing or cessation of scallop growth.

Additional observations

In 2018, a survey timing effect on biomass estimates generated from surveys was noted, particularly in the NLS-Ext. Concentrated biomass that was present in 2017 in the north-central portion of the NLS-Ext was not encountered during the 2018 CFF HabCam survey, even though the survey track was similar (**Figure 15**). Heavy fishing pressure was noted in the NLS-Ext from April to July 2018 (NEFMC 2018; **Figure 14**). Thus, surveys that took place in this area near the start of the fishing season (e.g., University of Massachusetts-Dartmouth School for Marine Science and Technology drop camera survey) produced higher biomass estimates than biomass estimates derived from surveys that took place later in the season (**Table 4**). A timing effect may also be evident in NLS-W, where there were also differences in biomass estimates between the two optical surveys. Continued discussions about how to account for and rectify such differences, as well as how best to combine survey results, are warranted. Notably, variations in biomass estimates with fishing season and survey method highlight the importance of employing multiple survey techniques in certain areas of interest.

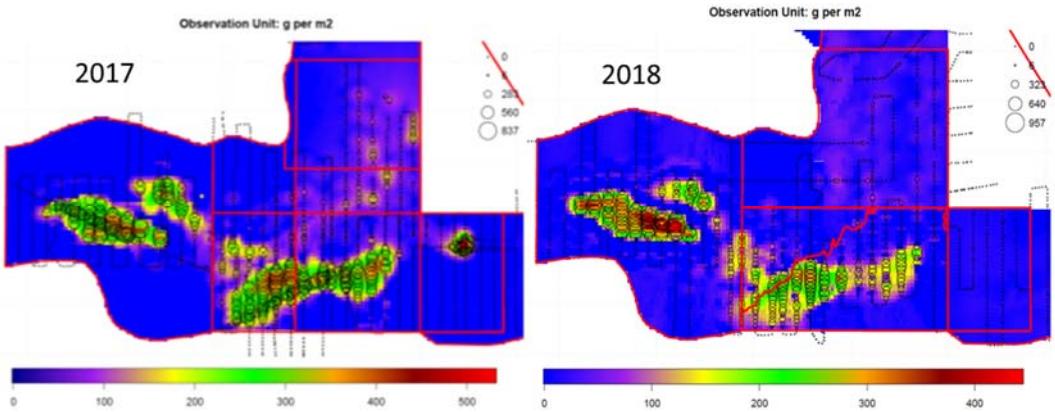

Figure 15. Predicted biomass estimates in the NLS from the 2017 (left panel) and 2018 (right panel) RSA CFF HabCam surveys.

Table 4. Total and exploitable biomass (metric tons) and average size (mm shell height) of measured scallops in images from the CFF HabCam and Umass-Dartmouth SMAST drop camera surveys.

	HabCam			SMAST		
SAMS Area	**Total Biomass (MT)**	**Average Size**	**Exp Biomass (MT)**	**Total Biomass (MT)**	**Average Size**	**Exp Biomass (MT)**
NLS-N	3794	120.62	227	4250	102.14	3450
NLS-S-Shallow	7075	94.87	1996	6950	88.8	3500
NLS-S-Deep	31940	78.36	5021	37950	75.4	7700
NLS-W	60445	99.3	22308	86000	96.55	43300
NLS-Ext	328	102.2	5	2200	100.25	1385

Future research recommendations

The RSA program has supported overlapping optical surveys in the NLS for the past two years (with additional overlapping surveys planned for 2019). This presents a unique opportunity to compare results using alternative biomass modeling methods between the two groups (i.e., SMAST and CFF). While much effort has gone towards comparisons of dredge surveys to optical survey methods, much less emphasis has been placed on comparing the RSA-funded optical surveys to each other, particularly in regards to the different biomass modeling methods used. Financial support for such an exercise is recommended.

Encouraging and supporting multi-year funding for surveys would be of great benefit to the survey teams. The extended lead-times associated with preparing for survey activities, sourcing necessary parts, and planning capital expenditures/scheduling for maintenance and upkeep of critical system components is becoming increasingly difficult. Due to the nature of intensive surveys, preparing for and overcoming mechanical failures resulting from aged equipment is becoming increasingly difficult on the short timeframes between proposal acceptance and survey start dates. Spreading the cost and capacity of such activities over the course of two or more years would greatly benefit the survey programs.

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