An optical assessment of sea scallop abundance, distribution and growth in the Nantucket Lightship Scallop Management Area

Final Report

2019 Sea Scallop Research Set-Aside (RSA) Program
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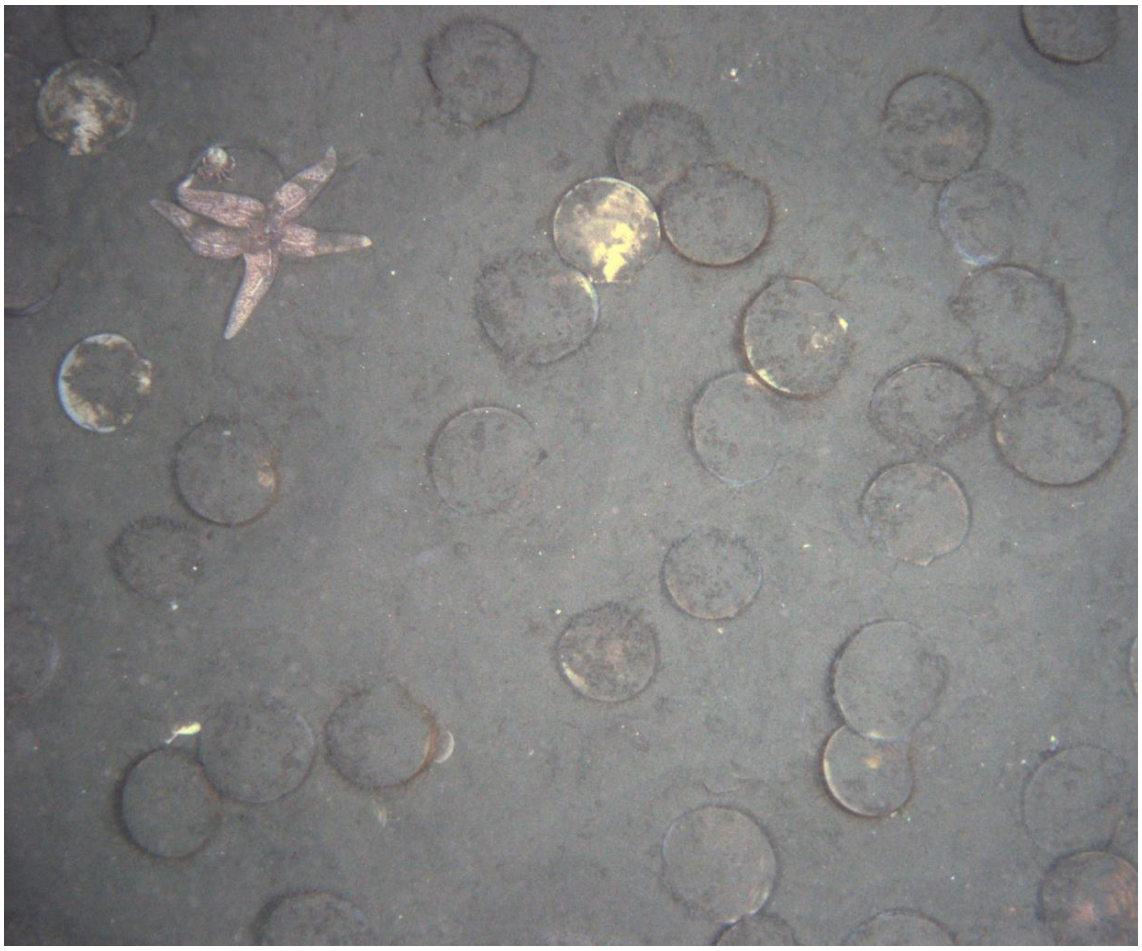

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List of acronyms and terms

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) 2019 Sea Scallop Research Set Aside (RSA) project entitled *"**An optical assessment of sea scallop abundance, distribution and growth in the Nantucket Lightship Scallop Management Area**"* 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 scallop count and shell-height measurement data needed to derive biomass estimates 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 second leg (Nantucket Lightship portion) of the RSA HabCam v3 survey took place July 9-15, 2019 and covered approximately 610 nm in the NLS-North, -West, and the -South (which is divided into Deep and Shallow sub portions along the 70-meter depth contour)

Biomass estimates

Estimated exploitable biomass was highest in the NLS-S-Deep, which was a change from 2018, when the highest exploitable biomass was found in the NLS-W. NLS-S-Deep also contained the most scallops by number; the average size of scallops in the NLS-S-Deep is smaller than scallops found in other areas of the NLS as measured by shell height and calculated meat weight, though a shell height growth in 2019 was double that of previous years. However, the mean size of the scallops in this area during the 2019 survey season showed that the growth rate had doubled from the previous two survey years (10 mm growth in 2019, versus 5 mm growth in 2017 and 2018).

Scallop size distributions and densities

The SAMS areas with the highest density of scallops, by a considerable amount, was the NLS-S-Deep. Substantial numbers of recruit scallops (35-75mm shell height) were present in the western portions of NLS-S-Deep, though pre-recruit scallops (<35mm) were not seen in substantial densities anywhere in the NLS. The greatest densities of scallops in the NLS-S-Deep were scallops 75-100mm and greater than 100mm.

Additional observations

One of the most noteworthy changes in the 2019 survey season was the significant decline in total and exploitable estimated biomass in the NLS-W. The estimated biomass was considerably lower than the 2019 projected biomass from the previous year. Proposed causes of this are increased mortality due to deck loading practices, increased predation events, or the accumulation of many mortality factors.

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 settled in the deeper waters south of the Great South Channel has yielded a substantial exploitable biomass. However, it has been noted that scallops in the NLS-S Scallop Area Management Simulator (SAMS) area are substantially smaller than those in other areas in the NLS. 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) previously 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**). Growth rates for the NLS-S-Deep scallops were found to be around 5mm/year based on mean shell height in the 2017 and 2018 HabCam v3 surveys. As these scallops reached exploitable sizes, the PDT made the decision to open the area to commercial fishing for 2020.

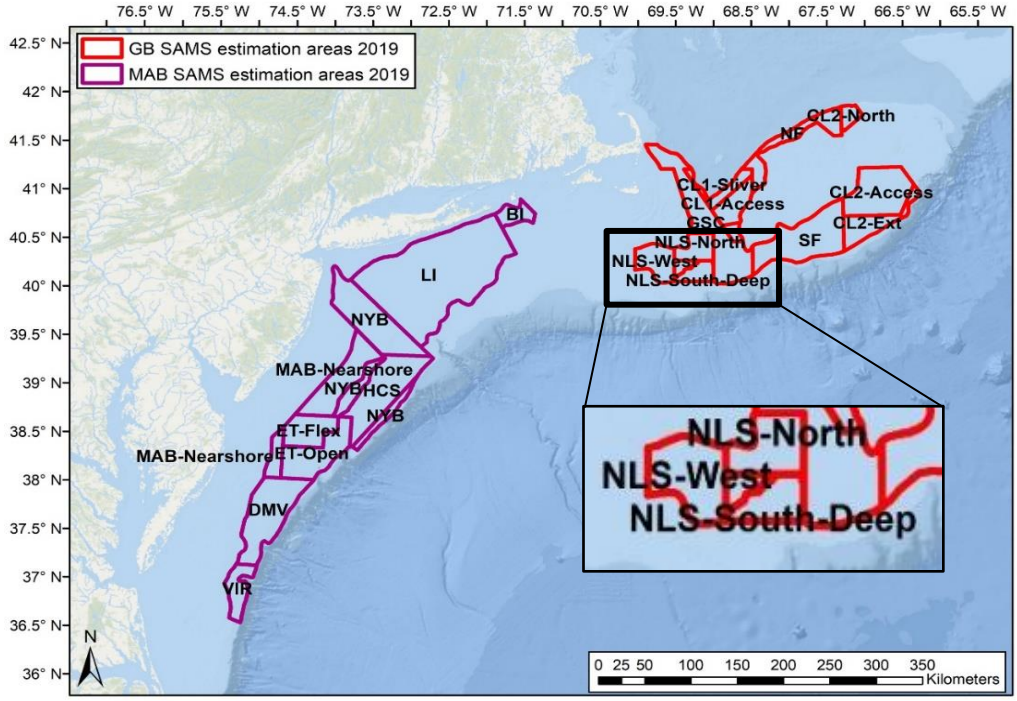

Figure 1. Scallop Area Management Simulator (SAMS) areas for assessing and projecting scallop biomass. The NLS SAMS areas are blown out.

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 (< 26 mm seed scallops and 26-50 mm pre-recruit and small recruit scallops) were seen in the southern NLS-S Area (**Figure 2, B&A, respectively**). HabCam imagery was also used to map the density of predators, particularly sea stars.

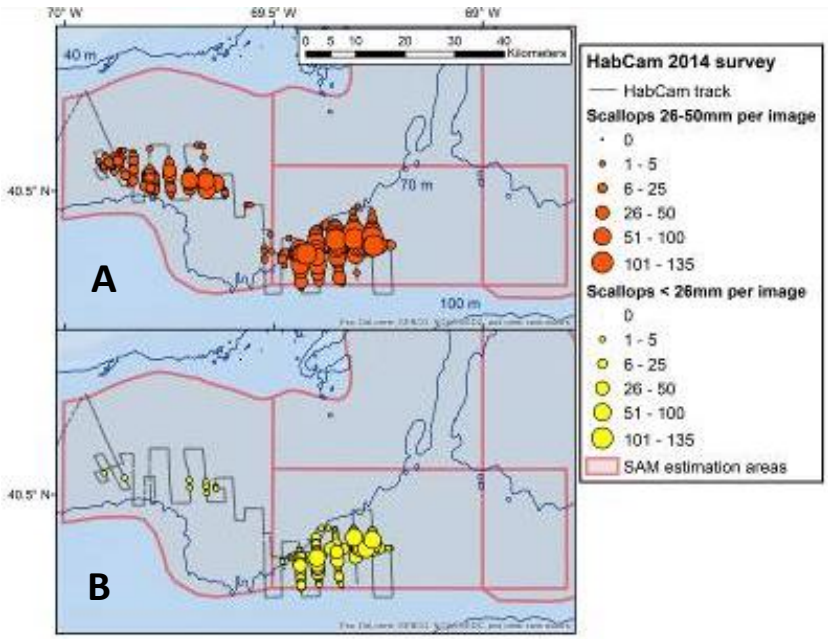

Figure 2. Distributions of (A) 26-50mm and (B) 0-25mm scallops from the 2014 RSA HabCam survey in the NLS.

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, A**), presumably belonging to the 2012 year-class.

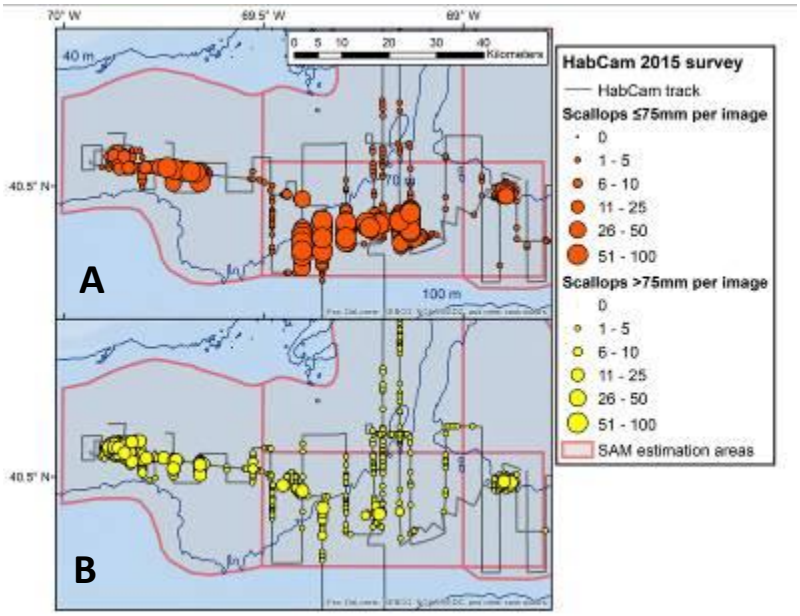

Figure 3. Distributions of (A) 0-75mm and (B) 75mm and greater scallops from the 2015 RSA HabCam survey in the NLS.

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, A&B**). The highest density and biomass were found within the NLS-AC-S area. Scallop distribution shifts markedly north with increasing size (**Figure 4, A-F**). 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.

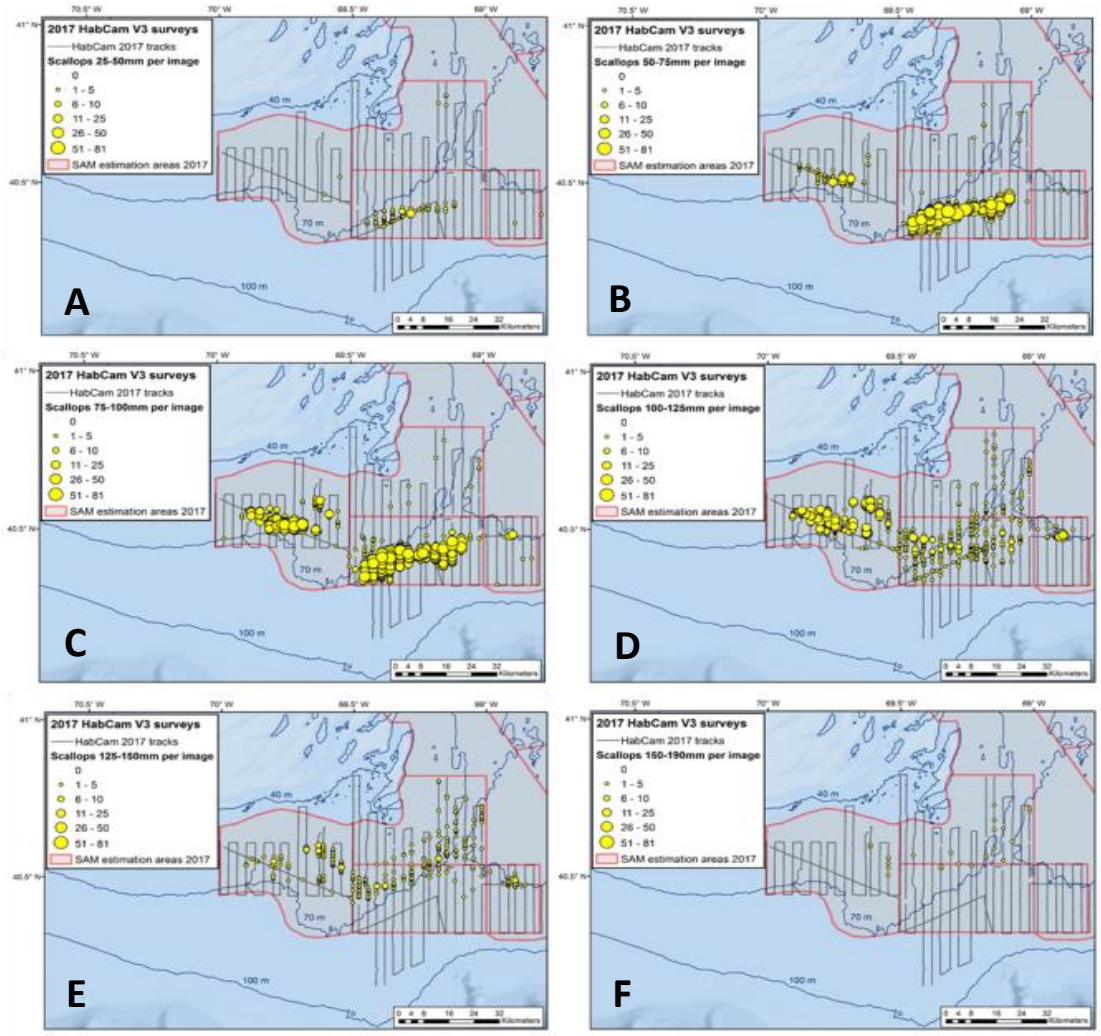

Figure 4. Distributions of scallops in size classes from 25-190 mm from 2017 RSA HabCam survey in the NLS. (A) scallops 25-50 mm, (B) scallops 50-75 mm, (C) scallops 75-100 mm, (D) scallops 100-125 mm, (E) scallops 125-150 mm, (F) scallops 150-190 mm.

2018 RSA-sponsored survey of NLS area -NA18NMF4540021

In 2018, CFF carried out an approximately 725 nm survey track through the NLS SAMS areas, including NLS-W, NLS-N, NLS-Ext, and NLS-S (Shallow and Deep). Approximately 2.9 million stereo image pairs were collected and 7,143 images were annotated.

The NLS-S-Deep was shown to have the greatest total number of scallops of any SAMS area, due to the settling of the 2012-year-class. However, these scallops, as in 2017, were shown to be much smaller on average and slower growing than those in other SAMS areas. The NLS-W was calculated to have the largest exploitable (22,308 mt) and total (60,445) biomass of any NLS area by a considerable amount (**Figure 5, C&D**).

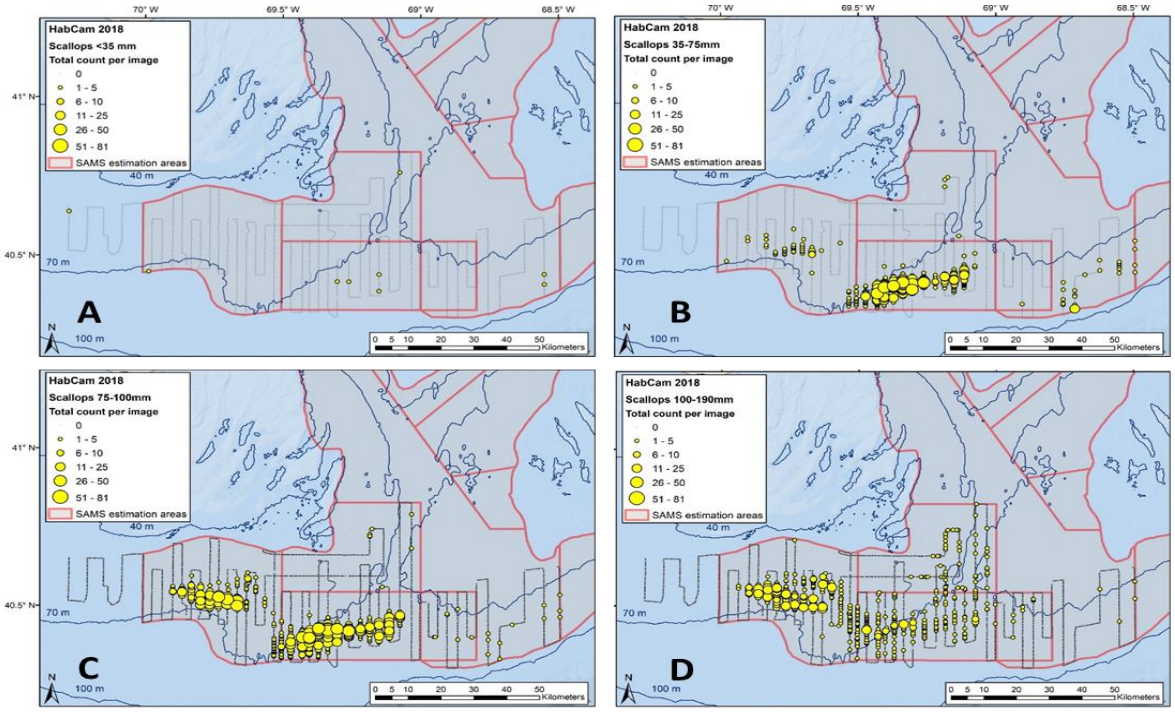

Figure 5. Distributions of measured scallops in size classes from (A) 0-35mm, (B) 35-75mm, (C) 75-100mm, and (D) 100-190mm from the 2018 RSA HabCam survey in the NLS.

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 scallop count and shell-height measurement data needed to derive biomass estimates 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 second leg (NLS portion) of the 2019 RSA HabCam v3 survey took place July 9-15, 2019 and covered approximately 610 nm in the NLS-North, -West, and the -South (which is divided into Deep and Shallow sub portions along the 70-meter depth contour) (**Figure 6**).

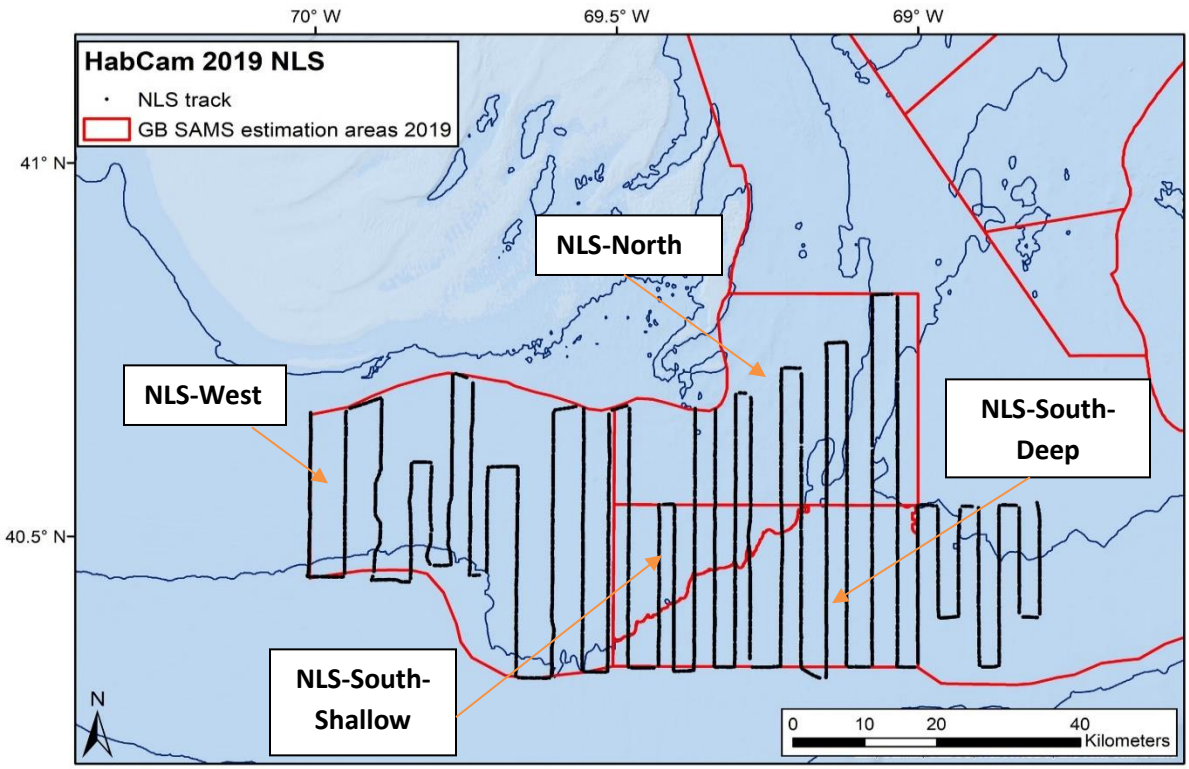

Figure 6. CFF 2019 RSA HabCam v3 survey track. The newly formed NLS-S-Shallow and NLS-S-Deep SAMS areas are demarcated by the 70m isobar, which can be seen running SW-NE in the NLS-S in the above distribution plots.

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 image stereo pairs 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 lefthand raw TIF files were processed into 8-bit JPG image files, which were used for annotation. Of the 2.6 million stereo image pairs collected, 6,505 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 were merged with the image metadata files that include HabCam v3 sensor measurements.

All annotated images were reviewed for quality control prior to final data being sent to the NEFSC for biomass 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), although most surveys achieved 50-100% QA/QC rate for annotations.

Data files containing raw annotation data and image metadata 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).

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-S-Deep (**Table 1, Figure 7**), which was a change from 2018, when the highest exploitable biomass was found in the NLS-W. NLS-S-Deep also contained the most scallops by number; however the average size of scallops in the NLS-S-Deep is smaller than scallops found in other areas of the NLS, based on average shell height in mm (**Table 1**).

Table 1: Total and Exploitable biomass (metric tons) and average size (mm shell height) of measured scallops in images. Data derived from the 2019 RSA CFF v3 and 2019 NEFSC v4 HabCam surveys.

	Exploitable Biomass				Total Biomass						
SAMS Area	**Number (millions)**	**Metric Tons**	**SE**	**Mean Weight (g)**	**Number (millions)**	**Metric Tons**	**SE**	**Mean Weight (g)**	**Average Size (mm)**	**Density (#/m^2)**	**Images Annotated**
NLS-N	58.4	2886.4	356.9	49.4	71	3066	379	42.9	124.6	0.07	1939
NLS-S-Shallow	104.9	1924.5	5.2	18.4	219	3420	9	15.6	96.9	0.76	531
NLS-S-Deep	1410.7	21002	396.8	14.9	3829	46060	871	12	91.2	5.24	1309
NLS-W	331.3	7734.1	2226	23.4	623	12575	3618	20.2	99.5	0.43	1946

Table 2: HabCam total biomass (NEFSC v4 and CFF v3 derived) estimates for NLS SAMS areas in 2018 and 2019. Note the significant changes in estimates between the years in NLS-S-Deep and NLS-W (highlighted).

	HabCam Total Biomass (mt)	
SAMS Area	**2018**	**2019**
NLS-N	3585	3066
NLS-S-Shallow	4964	3420
NLS-S-Deep	31790	46060
NLS-W	41155	12575

A distinct shift in the NLS-W occurred between 2018 and 2019 (**Table 2**); in 2018, one of the largest proportions of total and exploitable biomass was found in NLS-W, and biomass predictions for 2019 were significantly higher than actual total and exploitable biomass estimates for the area found in the 2019 surveys. Based on conversations at the August 2019 PDT survey meeting, possible causes of this discrepancy were thought to be increased mortality due to fishing practices, increased predation events, or the accumulation of many mortality factors. See the **Additional Observations** section for more information.

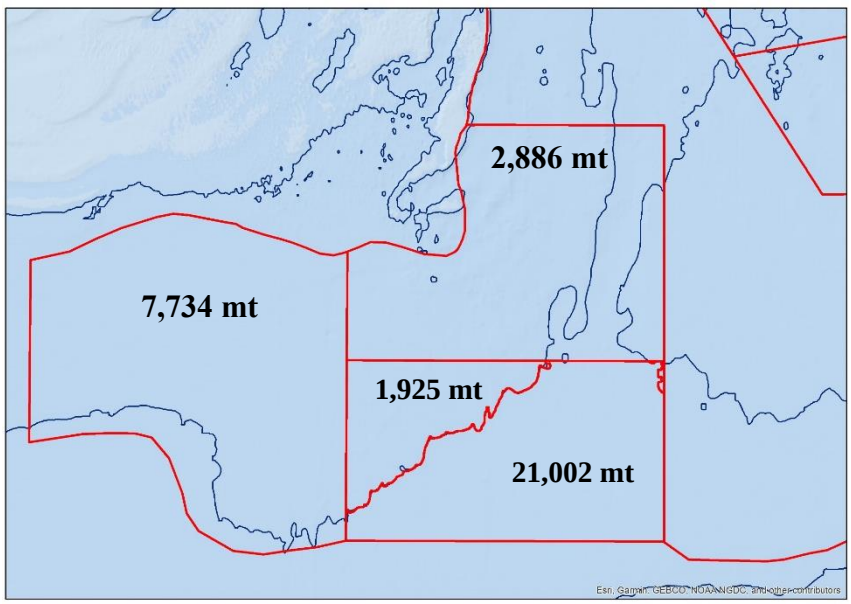

Figure 7. Total exploitable biomass by NLS SAMS area derived from 2019 CFF RSA v3 and NEFSC v4 HabCam data.

Scallop size distributions and densities

The SAMS areas with the highest density of scallops, by a considerable amount, was the NLS-S-Deep (**Table 1**). Substantial numbers of recruit scallops (35-75mm shell height) were present in the western portions of NLS-S-Deep (**Figure 8, B**), though pre-recruit scallops (<35mm) were not seen in substantial densities in the NLS (**Figure 8, A**). The size classes with the greatest densities of scallops in the NLS-S-Deep were exploitable scallops 75-100mm and greater than 100mm (**Figure 8, C&D**).

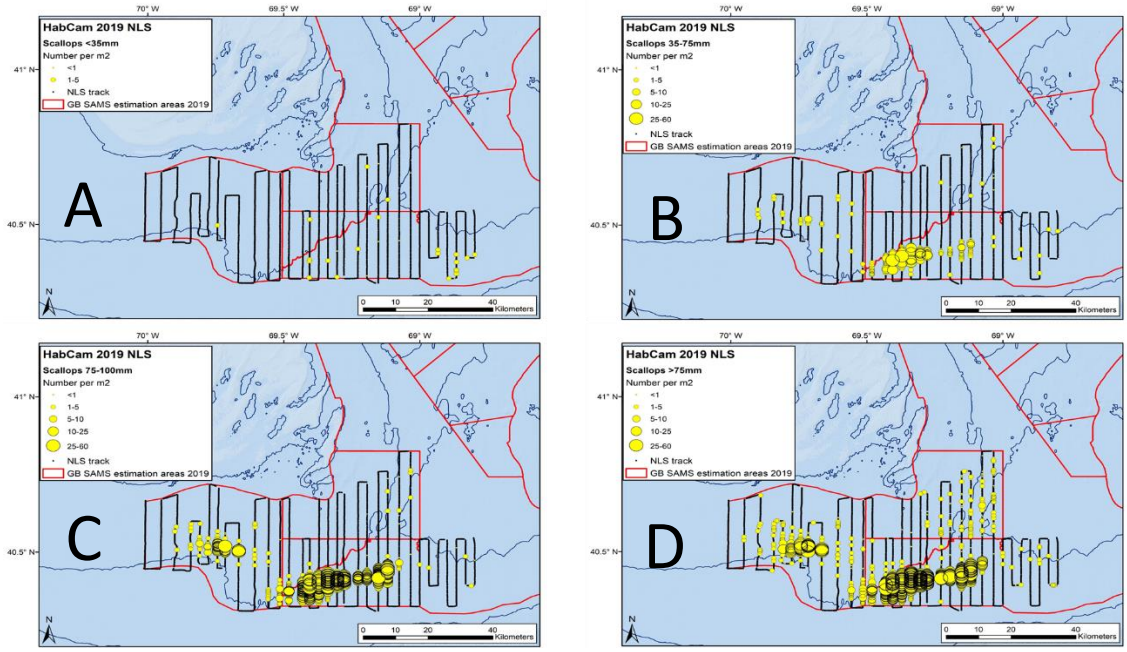

Figure 8. Distributions of measured scallops in size classes from (A) < 35mm, (B) 35-75mm, (C) 75-100mm, and (D) all scallops over 75 mm from the 2019 RSA CFF v3 HabCam survey in the NLS.

Length-frequency distributions

Average shell heights were highest in the NLS-N (123.7 mm; **Figure 9, A**), which was similar to the 2018 CFF RSA HabCam survey, where NLS-N again had the highest mean shell heights of any of surveyed NLS SAMS areas (121.6 mm). The NLS-S-Deep had the smallest average shell height in the SAMS areas (89.6 mm; **Figure 9, D**), though this value did show a substantial increase from 2018 (**Figure 10**). Average shell heights in the NLS-S-Shallow and the NLS-W were similar at 99.2 mm and 97.5 mm, respectively (**Figure 9, B&C**).

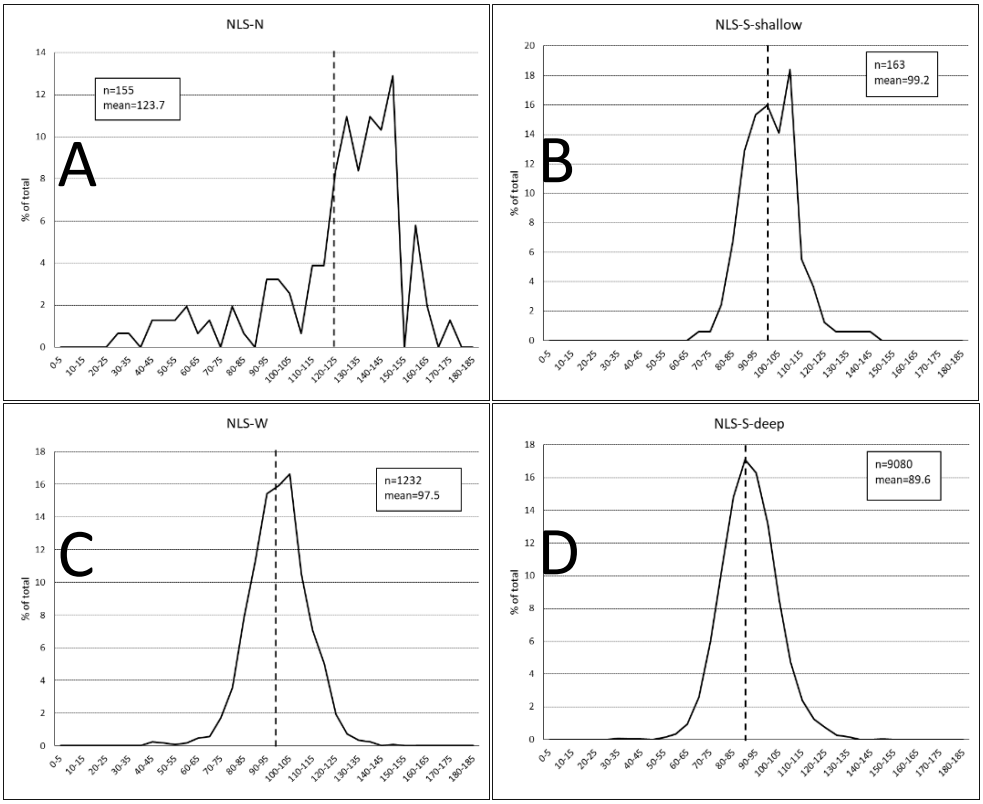

Figure 9. Length-frequency plots of measured scallops in the 2019 CFF v3 HabCam images from the NLS SAMS areas – (A) NLS-N, (B) NLS-S-Shallow, (C) NLS-W, and (D) NLS-S-Deep in 2019. Dashed line represents the mean scallop size (height mm) in each survey year; n=total number of scallops counted.

Scallop growth & survival

Scallop sizes, as indicated by average measured shell heights, did not show appreciable growth from 2017-2018 in any NLS SAMS area, or in 2019, with the exception of the NLS-S-Deep (**Table 3, Figure 10**). Because the NLS-W was subject to intense fishery activity in 2019, the slight decrease in average shell heights for measured scallops in the NLS-W (**Table 3**) may be due in part to fishery removals of larger scallops and/or high mortality of larger scallops in the area.

Table 3: Changes in mean shell height in mm from 2017-2019 RSA CFF v3 data in all surveyed NLS SAMS areas. Information for NLS-S data was not broken into NLS-S-S (shallow) and NLS-S-D (deep) specific subareas in the 2017 survey.

	2017	**2018**	**2019**		
SAMS Area	**Mean height (mm)**	**Mean height (mm)**	**Mean height (mm)**	**Change 2017-18**	**Change 2018-19**
NLS-N	124	120.6	123.7	-2.7%	2.6%
NLS-W	98.8	99.3	97.5	0.5%	-1.8%
NLS-S-S		94.9	99.2		4.5%
NLS-S-D	75	79.8	89.6	6.4%	12.3%

The 2012 year-class in NLS-S-Deep has been slower growing overall compared to scallops from other NLS SAMS areas each year. CFF surveyed this area in 2017, 2018, and 2019 (with

plans to continue surveys of NLS-S-Deep through 2022). In 2019, the mean shell height was ~10 mm greater than in 2018, which is double the average growth between previous surveys of the area (10 mm growth in 2019, versus 5 mm growth in 2017 and 2018, **Table 3** & **Figure 10**). Likewise, SMAST observed a similar notable growth in the shell height in the NLS-S-Deep in their 2019 drop camera survey compared to previous years Bethoney & Stokesbury, 2019.

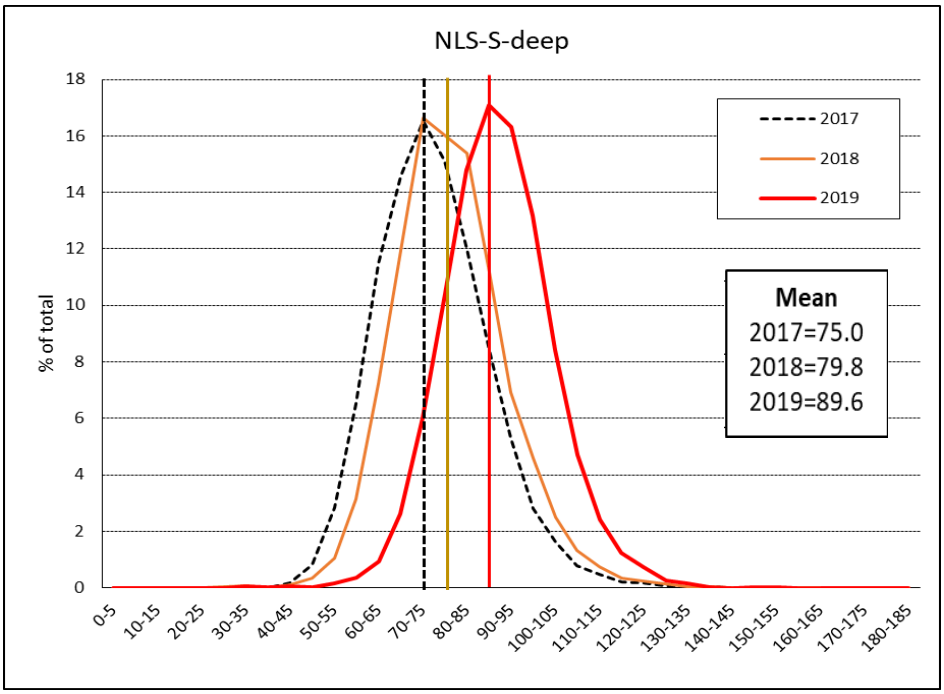

Figure 10. Length-frequency plots of measured scallops in HabCam images from the NLS-S-Deep from 2017-2019 (using CFF v3 data). From 2017-2018, there was a 5 mm increase in mean shell height, but a 10 mm increase in mean shell height between 2018 and 2019. Note the colored or dashed lines to indicate the mean scallop size in each survey year.

Between the 2017 and 2018 HabCam surveys, the estimated number and total biomass of scallops decreased substantially in all NLS SAMS areas with the exception of biomass in the NLS-W (**Table 4**). From 2018-2019, the estimated number and biomass of scallops decreased in all areas again, with the exception of the NLS-S-Deep area. From 2018-19, the decrease of total biomass in the NLS-W was the most notable, though there was a significant decrease in the NLS-S-Shallow and NLS-N. The Shallow and Deep subareas of the NLS-S were not divided during the 2017 surveys, so the 2017-2018 biomass change in **Table 4** includes combined Shallow and Deep data.

Table 4: Change in total estimated biomass (number and metric tons) by NLS SAMS area from 2017-2019 from HabCam (CFF v3 and NEFSC v4) surveys. In 2019, the only increase in total biomass in all NLS SAMS areas was observed in the NLS-S-Deep. During the 2017 surveys, the data from the NLS-S was not broken into NLS-S-Shallow or NLS-S-Deep subregions.

	2017		2018		2019		Change 2017-2018		Change 2018-2019	
	Number (million)	Metric Tons	Number (million)	Metric Tons	Number (million)	Metric Tons	Number (million)	Metric Tons	Number (million)	Metric Tons
NLS-N	222	10083	112	3585	71	3066	-49.5%	-64.4%	-36.6%	-14.5%
NLS-S*	9315	77827	4060	36754	4048	49480	-56.4%	-52.8%	-0.3%	34.6%
Shallow			374	4964	219	3420			-41.4%	-31.1%
Deep			3686	31790	3829	46060			3.9%	44.9%
NLS-W	2906	56066	2262	41155	623	12575	-22.2%	-26.6%	-72.5%	-69.4%

Accomplishments by objective

Objective 1: Provide scallop count and shell-height measurement data needed to derive biomass estimates of scallops in Nantucket Lightship (NLS) Scallop Area Management Simulator (SAMS) area.

We were able to provide timely estimates of scallop counts and size distributions throughout the NLS. Biomass estimates, derived by NEFSC, and size distributions (length-frequency and spatial distribution) for the NLS were presented to the Atlantic Sea Scallop PDT in August 2019. Of particular interest was the continued large biomass of slower-growing scallops in the deeper waters of NLS-S-Deep SAMS area.

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

We were able to derive SAMS-area-specific length-frequency distributions within the NLS. Similar to observations over the past two survey seasons, scallops in the NLS-S-Deep are smaller than those in surrounding SAMS areas. 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 by comparing mean shell height and length frequencies in specific SAMS areas with previous surveys.

Shell height and length frequency data were compared from 2017-2019 in the NLS SAMS areas. Of particular note, the mean shell height of the NLS-S-Deep scallops increased by ~10 mm, nearly double the mean growth between the 2017 and 2018 surveys. Additionally, changes in total biomass were assessed to examine survival of scallops by SAMS area.

Additional observations

One of the most noteworthy changes in the 2019 survey season was the significant decline in total and exploitable estimated biomass in the NLS-W. Total estimated biomass decreased by 72% in millions of animals counted; total biomass in mt decreased by 79% (**Table 4**). Additionally, the estimated biomass was considerably lower than the 2019 projected biomass based on surveys from the previous year. For example, the SMAST drop cam survey projected the area would have around 40,000 mt of total biomass in 2019, but they estimated a total biomass of only 13,438 mt in the NLS-W in 2019 (Bethoney & Stokesbury 2019, NEFMC

2020). Projected exploitable biomass in NLS-W, based on data from all of the 2018 surveys combined and using the SAMS, was 31,926 mt (NEFMC 2019), while total biomass from all of the 2019 surveys combined was only 12,031 mt (NEFMC 2020). Increased predation, coupled with fishing pressure, was considered as an explanation for this discrepancy. Predator maps were supplied to the PDT and presented by CFF in September 2019 (**Figure 11**); however, though there was a strong number of predators in the area, there did not appear to be a substantial enough increase compared with the previous year to account for massive biomass losses in the NLS-W (2018 predators- **Figure 11, A, C, E** and 2019 predators- **Figure 11, B, D, F**). Sea stars, moon snails, and cancer crabs were annotated in both years, and whelks were annotated in 2019. Further discussions concluded that such drastic declines in biomass would likely not be caused by fishing pressure or predators alone, but could conceivably be due to a compounding of fishing pressure, destructive fishing practices (such as deck loading leading to higher than normal discard mortality), predation, and other environmental and fishing factors. Additionally, the 2017 RSA HabCam survey of the NLS noted a high abundance of predators, particularly in the NLS-W, so it does not seem probable that increased predation alone could be the main cause of the loss of total biomass in this area in 2019.

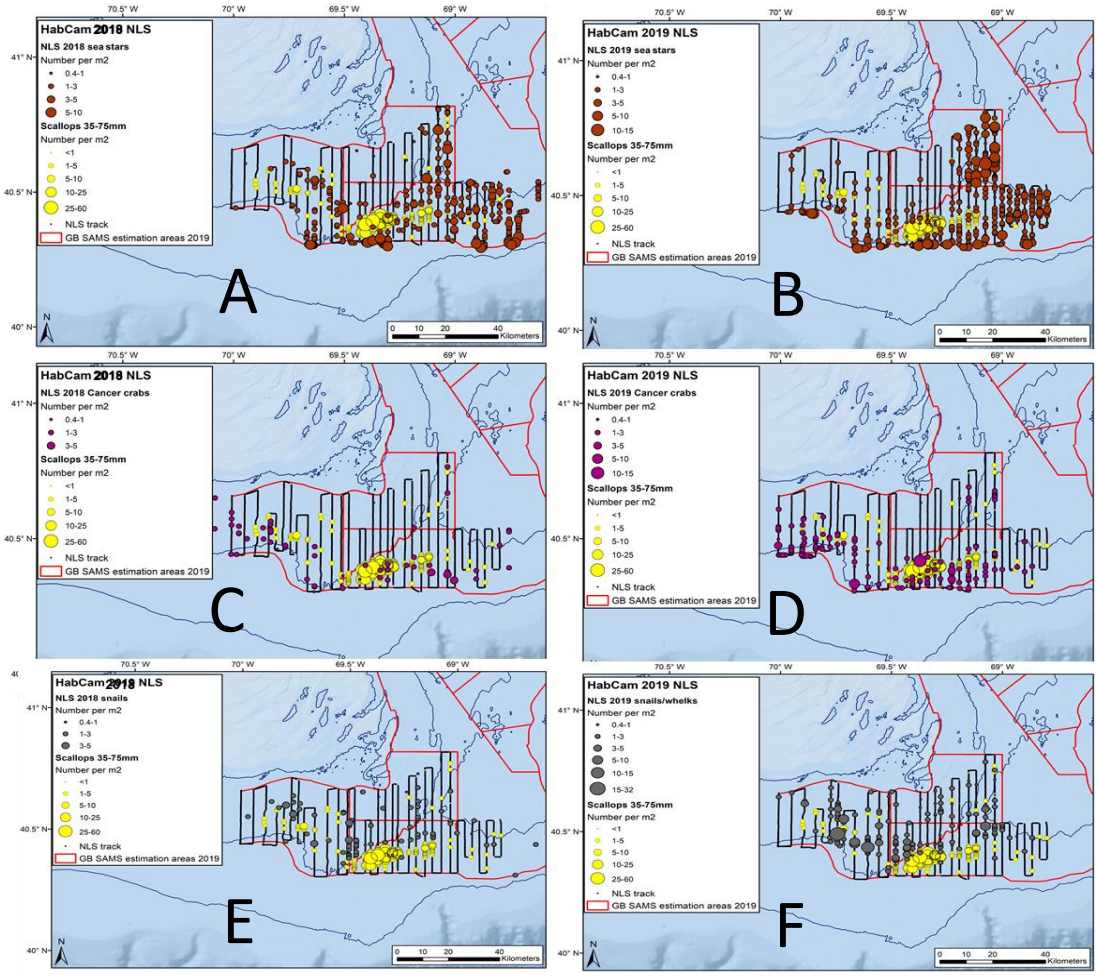

Figure 11. Above are predator abundance maps from the 2019 CFF v3 HabCam survey in the NLS SAMS Areas- (A) Seastar abundance 2018 (B) Seastar abundance 2019 (C) Cancer Crabs abundance 2018 (D) Cancer Crab abundance 2019 (E) Moon snail abundance 2018 (F) Moon snail and Whelk abundance 2019

Future research recommendations

The RSA program has supported overlapping optical surveys in the NLS for several years (with additional overlapping surveys planned for 2020 and 2021). 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.

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