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A Cooperative High Precision Dredge Survey to Assess the mid-Atlantic Sea Scallop Resource in 2018: Final Report

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Final Report

A Cooperative High Precision Dredge Survey to Assess the mid-Atlantic Sea Scallop Resource in 2018

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Project Summary

For the sea scallop, *Placopecten magellanicus*, the concepts of space and time have emerged as the basis of an effective management tool. The strategy of closing or limiting activities in certain areas for specific lengths of time has gained support as a method to conserve and enhance the scallop resource. In the last decade, rotational area management has provided a mechanism to protect juvenile scallops from fishing mortality by closing areas based upon scallop abundance and observed age distribution. Approximately half of the sea scallop industry's current annual landings are attributed to areas under this rotational harvest strategy. While this represents a management success, it also highlights the extent to which landings are dependent on the effective implementation of this strategy. The continued prosperity of scallop spatial management is dependent on both periodic and large incoming year classes, as well as a mechanism to delineate the scale of a recruitment event and subsequently monitor the growth and abundance of these scallops over time. Current and accurate information related to the abundance and distribution of adult and juvenile scallops is essential for managers to respond to changes in resource subunits.

Acknowledging the importance of accurate, timely and meaningful information necessary to meet the management challenges presented by this situation, the Virginia Institute of Marine Science (VIMS) conducted a synoptic high resolution (450 stations) survey of the mid-Atlantic (MAB) scallop resource from the VA/NC border to Block Island, RI encompassing the Delmarva (DMV), Elephant Trunk (ETCA) and Hudson Canyon (HCCA) Access Areas, collectively referred to as the Mid-Atlantic Access Area (MAAA), as well as the open areas of the MAB resource area during the spring of 2018. The primary objective of this survey was to assess the abundance and distribution of sea scallops, culminating with spatially explicit annual estimates of total and exploitable biomass. Secondary project objectives included: 1. Finfish bycatch species composition, and catch rates, 2. Scallop biological sampling (length:weight relationship, disease, product quality parameters, and shell samples for ageing) and 3. Selectivity and relative efficiency analysis of the Coonamessett Farm Turtle Deflector Dredge (CFTDD).

Survey results were presented to the Sea Scallop Plan Development Team (PDT) to inform management decisions for Framework (FW) 30 (i.e., access area access and catch allocation). Survey data were also provided to the Northeast Fisheries Science Center (NEFSC) for use in projections for Days-at-Sea (DAS) and access area catch allocation calculations. Results indicated that the exploitable biomass in the traditional access areas and open area off of Long Island remained high, although recruit was limited. Gear performance of the CFTDD indicated the dredge is more efficient than the New Bedford style dredge. Monitoring of nematode infected scallops indicated the spatial distribution of infected scallops was similar to that observed in 2016 and 2017 and that larger scallops (≥ 110 mm) were more likely to be infected compared to smaller scallops (< 110 mm).

Project Background

The sea scallop, *Placopecten magellanicus*, supports a fishery that landed over 50 million pounds of meats with an ex-vessel value in excess of US $ 500,000,000 in 2017 (NMFS, 2018). These landings resulted in the sea scallop fishery being one of the most valuable single species fisheries along the East Coast of the United States. While historically subject to extreme cycles of productivity, the fishery has benefited from management measures intended to bring stability and sustainability. These measures include: limiting the number of participants, total effort (days-at-sea) controls, gear, and crew restrictions, and a strategy to improve yield by protecting scallops through rotational area closures.

Amendment #10 to the Sea Scallop Fishery Management Plan (FMP) officially introduced the concept of area rotation to the fishery. This strategy seeks to increase the yield and reproductive potential of the sea scallop resource by identifying and protecting discrete areas of high densities of juvenile scallops from fishing mortality. By delaying capture, the rapid growth rate of scallops is exploited to realize substantial gains in yield over short time periods. In addition to the formal attempts established by Amendment #10 to manage discrete areas of scallops for improved yield, specific areas on Georges Bank (GB) are also subject to area closures. Since 1999, limited access to three closed areas on GB has been allowed for the harvest of scallops. Similar biological principals that guide MAB rotational scallop area management also apply to the GB areas. Spatial management on GB has also been adaptive (i.e., Nantucket Lightship Closed Area (NL) extension closure and the GB Closed Area II extension closure) to provide protection for observed recruitment events outside of the established access areas to meet management and fishery objectives.

In the context of the spatial management strategy for the MAB and GB, as well as open areas not currently included in the rotational area management program, timely and detailed abundance and distribution information becomes crucial. This information forms the basis for assessment of the species and specifications for the next fishing year, as well as the potential establishment of additional closed areas. Amendment #10 specifies that an area is a candidate to be closed when the annual growth potential in that area is greater than 30%. Additionally, when the annual growth rate is reduced to less than 15% the area is available for a controlled re-opening. Certain other criteria exist regarding the spatial requirements for a closed area, but growth rates, which are determined by the length distribution of the population within an area, is a key component of that determination. The collection of abundance and length distribution data from discrete areas is a major component of this strategy, and the use of commercial vessels provides a flexible and efficient platform to collect the required information.

Spatial management for scallops essentially provides a mechanism to delay age at first capture. This approach, while effective, is predicated on a level of recruitment sufficient to supply discrete areas with recruits. The MAB region emerged from a period of low abundance and experienced above average recruitment from 2012-2015. Scallop surveys of the MAB conducted in 2012 by VIMS and the National Marine Fisheries Service (NMFS) documented a stronger than average recruitment event. The VIMS 2012 survey found evidence of a broadly distributed, strong recruitment of juvenile scallops in the 35-55 mm size range, which at the time were two year old scallops. These animals were observed during the VIMS 2013, 2014, 2015, and 2016 surveys, and supported the commercial fishery. From the 2014 MAB VIMS survey, we observed yet another broadly distributed, strong recruiting class of two year old scallops in the MAB access areas, as well as additional observations documenting the presence of 5-15 mm scallops south of Long Island. During the VIMS 2015 survey, there was continued evidence of yet another, even larger, broad-scale recruitment in the MAB, with high concentrations of 25-75 mm scallops throughout the entire region. The locus of the distribution was in the rotational management access areas (specifically ETCA and HCCA). The 2016 survey continued to track the growth of this broad-scale recruitment in the MAB. High concentrations of 65-90 mm scallops were observed in the closed portion of the ETCA and in the HCCA, along with high levels of adult biomass throughout the access areas, although no strong signals of incoming recruitment were observed across the MAB area. The 2017 survey results were similar to those of 2016, high adult biomass was mainly concentrated in the MAAA and low levels of recruits were observed throughout the MAB.

Cooperative dredge surveys have been successfully completed with the involvement of industry, academic, and governmental partners since 2000 through funding from the Sea Scallop Research Set-Aside Program (RSA). The additional information provided by these surveys has been vital in the determination of annual specifications including appropriate Total Allowable Catches (TAC) in the subsequent re-openings of the closed access areas and determination of the number of open area DAS. This type of survey, using commercial fishing vessels, provides an excellent opportunity to gather required information and also involve stakeholders in the management of the resource.

In addition to collecting data to assess the abundance and distribution of sea scallops in the MAB, the operational characteristics of commercial scallop vessels allow for the simultaneous towing of two dredges. As in past surveys, we towed two dredges at each survey station. One dredge was a standard NMFS sea scallop survey dredge and the other was a CFTDD. This paired design, using one non-selective gear (NMFS) and one selective gear (CFTDD), allowed for the estimation of the size selective characteristics of the CFTDD. The CFTDD is mandated for use in the MAB during a portion of the fishing year. While the characteristics of the gear have been evaluated by the Scallop PDT, ongoing evaluations are beneficial to further refine the impact of the dredge on scallops, as well as finfish bycatch. In addition, selectivity analyses using the SELECT method provide insight to the relative efficiency of the two gears used in the study (Millar, 1992).

An advantage of a sea scallop dredge survey is that one can access and sample the target species. This has a number of advantages including accurate measurement of animal length and the ability to collect biological specimens. One attribute routinely measured is the shell height:meat weight relationship. While this relationship is used to determine swept area biomass for the area surveyed at that time, it can also be used to document seasonal shifts in the relationship due to environmental and biological factors. For this reason, data on the shell height:meat weight relationship are routinely gathered by both the NMFS and VIMS scallop surveys. While this relationship may not be a direct indicator of animal health in and of itself, long term data sets may be useful in evaluating changing environmental conditions, food availability, and density dependent interactions. While collecting data for shell height:meat weight determination, information is also collected on animal health and product quality (i.e., presence of disease and parasites). This information can be useful to the industry, as well as inform management measures. Since 2015, observations of nematode infected sea scallop adductor muscles in MAB have be documented by VIMS and presented to industry and the Scallop PDT.

For this study, we pursued multiple objectives. The primary objective was to collect information to characterize the abundance and distribution of sea scallops within the MAB resource area, ultimately culminating in estimates of scallop biomass to be used for subsequent management actions. Utilizing the same catch data with a different analytical approach, we estimated the size selectivity characteristics of the commercial sea scallop dredge. An additional component of the selectivity analysis allows for supplementary information regarding the efficiency of the commercial dredge relative to the NMFS survey dredge. As a third objective of this study, we collected biological samples to estimate time and area specific shell height:meat weight relationships. Additional biological samples were taken to assess product quality of the adult resource and to monitor scallop disease/parasite prevalence. Sea scallop shells were also collected to supplement the NEFSC shell collection for ageing.

Methods

Survey Area and Sampling Design

The MAB resource area was surveyed in May of 2018. Stations were selected using a stratified random sampling design with the strata consisting of the NMFS shellfish strata that have been used since the 1970s. Stations were allocated to strata using a hybrid approach consisting of both proportional and optimal allocation techniques based on the biomass (weight) and number of animals observed during the VIMS 2017 survey of the same area. A minimum of two stations were allocated to each stratum to allow for variance to be calculated. Station locations for the 2018 survey are shown in Figure 1. Two commercial vessels participated in the survey, with one commercial vessel completing a leg of the survey.

Sampling Protocols

While at sea, the vessels simultaneously towed two dredges. A NMFS sea scallop survey dredge, 8 ft. in width equipped with 2-inch rings, 3.5-inch diamond mesh twine top, and a 1.5-inch diamond mesh liner was towed on one side of the vessel. On the other side of the vessel, a 14 ft. CFTDD equipped with 4-inch rings, a 10-inch diamond mesh twine top, and no liner was utilized. In this paired design, it is assumed that the dredges cover a similar area of substrate proportional to their respective widths and sample from the same population of scallops.

For each survey tow, the dredges were fished for 15 minutes with a towing speed of approximately 3.8-4.0 kts. High-resolution navigational logging equipment was used to accurately determine and record vessel position. A Star-Oddi™ DST sensor was used on the dredge to measure and record dredge tilt angle, as well as depth and temperature (Figure 2). Data from the DST sensor was used to determine the actual start and end of each tow to provide a more accurate estimate of the area covered. Synchronous time stamps on both the navigational log and DST sensor were used to estimate the linear distance for each tow.

Sampling of the catch was conducted in the same manner described by DuPaul and Kirkley (1995), which has been utilized during all of our scallop surveys since 2005. For each station, the entire scallop catch from both the survey and commercial dredges was kept separate and placed in traditional scallop baskets to quantify total catch. Total scallop catch or a subsample, depending upon the volume of the catch, was measured to the nearest mm to determine size frequency. This protocol allows for the determination of the size frequency of the entire catch by expanding the catch at each shell height by the fraction of total number of baskets sampled. The result is an estimate of the number and size of the scallops caught for each dredge at each station. Catch data were also used to calculate biomass for both dredges and estimate the commercial gear selectivity.

Finfish and invertebrate bycatch were also quantified at each station for each gear, with commercially important finfish and barndoor skates being sorted by species and measured to the nearest mm (total length (TL)). All other skate species (consisting predominantly of little (*Leucoraja erinacea*) and winter skates (*Leucoraja ocellata*)) were grouped into an unclassified category and enumerated. At randomly selected stations, sea scallop predators were enumerated and weighed. *Cancer sp.* crabs and starfish were identified to the genus or species level.

Samples were taken to determine area specific shell height:meat weight relationships, as well as monitor animal health and product quality. At every station that contained scallops, 15 animals encompassing the size distribution observed at the station were selected for sampling. First, shell height was measured to the nearest mm. Then each scallop was carefully shucked and the adductor muscle individually weighed at sea to the nearest 0.5 gram with a Marel™ motion compensating scale. In addition to shell height and meat weight data collected, biological characteristics and product quality information were collected. Biological data included sex and reproductive stage. Product quality was also evaluated through visual inspection of each adductor muscle using a semi-qualitative ordinal coding scheme for each characteristic assessed. Characteristics evaluated included overall market condition, color, texture, and the presence of blister disease. The presence/absence and number of nematode lesions observed on each adductor muscle was also quantified through gross observation.

Five to ten scallop shells were collected at every fifth station from samples selected for shell height:meat weight assessment for ageing purposes. Shells were selected if there was no shell damage and the shell was relatively large. Shells were aged using the external ring method described in Hart and Chute (2009), as well as a novel method involving the resilium, which is being developed at VIMS by Dr. Roger Mann’s lab (Mann and Rudders, 2019). A subset of shells was added to the archived collection housed at VIMS.

Station level catch and location information were entered into FEED (Fisheries Environment for Electronic Data), a data acquisition program developed by Chris Bonzek at VIMS. Data from the bridge were entered into FEED using an integrated GPS input. Station level data included location, time, tow-time (break-set/haul-back), tow speed, water depth, weather, and comments relative to the quality of the tow. FEED was also used to record detailed catch information at the station level for scallops, finfish, and invertebrates. Catch by species was entered into FEED as either the number of baskets caught and measured (scallops) or number of animals (finfish, skates, etc.) caught. Length measurements were recorded using the Ichthystick measuring board connected to the FEED program that allows for automatic recording of length measurements. Shell height:meat weight and product quality data were also recorded using

FEED. The Marel scale was connected to FEED to allow for automatic recording of adductor muscle weight data.

Data Analysis

Catch and navigation data were used to estimate swept area biomass within the area surveyed by Scallop Area Management Simulator (SAMs area). The methodology to estimate biomass is similar to that used in previous survey work by VIMS. In essence, we estimate a stratified mean catch weight of either all scallops or the fraction available to the commercial gear (exploitable) from the point estimates and scale that value up to the entire area of the domain sampled following methods from Cochran (1977) for calculating a stratified random size of a population. These calculations are given as:

Stratified mean biomass per tow in stratum and subarea of interest:

$$\bar{C}_h = \frac{1}{n_h}\sum_{i=1}^{h} C_{i,h} \qquad (1)$$

Variance Equation 1

$$Var(\bar{C}_h) = \frac{1}{n_h(n_h-1)}\sum_{i=1}^{n_h}(C_{i,h}-\bar{C}_h)^2$$

Stratified mean biomass per tow in subarea of interest:

$$\bar{C}_s = \sum_{h=1}^{L} W_h \cdot \bar{C}_h \qquad (2)$$

Variance Equation 2

$$Var(\bar{C}_s) = \sum_{h=1}^{L} W_h^2 \cdot Var(\bar{C}_h)$$

Total biomass in subarea of interest:

$$\widehat{B_s} = \left(\frac{\left(\frac{\bar{C}_s}{\bar{a}_s}\right)}{E_s}\right) A_s \qquad (3)$$

Variance Equation 3

$$Var\left(\widehat{B_s}\right) = Var(\bar{C}_s) \cdot \left(\frac{A_s}{\bar{a}_s}\right)^2$$

where:

L = # of strata
n = # of stations in stratum h
h = stratum

$i =$ station i in stratum h
$s =$ subarea s in survey of interest
$A_s =$ area of survey of interest in subarea s
$E_s =$ gear efficiency estimate for subarea s
$\bar{a}_s =$ mean area swept per tow in subarea s
$\hat{B}_s =$ total biomass in subarea s
$\bar{C}_s =$ stratified mean biomass caught per tow for subarea s
$\bar{C}_{h,s} =$ mean biomass caught per tow in stratum h for subarea s
$W_h =$ proportion of survey/subarea area in stratum h

Stratified mean catch weight per tow of exploitable scallops was calculated from the raw catch data as an expanded size frequency distribution with a SAMS area appropriate shell height:meat weight relationship applied. Length-weight relationships used to convert the number of scallops to weight were determined by the Scallop PDT and came from SARC 65 (NEFSC, 2018). Exploitable biomass, defined as that fraction of the population vulnerable to capture by the currently regulated commercial gear, was calculated using two approaches. The observed catch at length data from the NMFS survey dredge (assumed to be non-size selective) was adjusted based upon the size selectivity characteristics of the commercial gear (Yochum and DuPaul, 2008). The observed catch at length data from the commercial dredge was not adjusted due to the fact that these data already represent that fraction of the population that is subject to exploitation by the currently regulated commercial gear.

Utilizing the information obtained from the high resolution GPS, an estimate of area swept per tow was calculated. Throughout the cruise, the location of the ship was logged every second. By determining the start and end of each tow based on the recorded times as delineated by the DST sensor data, a survey tow can be represented by a series of consecutive coordinates (latitude, longitude). The linear distance of the tow is calculated by:

$$TowDist = \sum_{i=1}^{n} \sqrt{(long_2 - long_1)^2 + (lat_2 - lat_1)^2}$$

The linear distance of the tow is multiplied by the width of the gear (either 14 or 8 ft.) for an estimate of the area swept during a given survey tow.

The final two components of the estimation of biomass are constants and not determined from experimental data obtained on these cruises. The efficiency estimates for the NMFS survey dredge (41%) and the NBD (65%) were also obtained from the SARC 65 document (NEFSC, 2018). To scale the estimated stratified mean scallop catch to the full domain, the total area of each resource subunit within the survey domain was calculated in ArcGIS v. 10.1. Biomass estimates were calculated for the MAB SAMS areas for the entire survey domain, including area outside of the SAMS areas that were surveyed (Figure 3).

Shell Height:Meat Weight

The relationship between shell height and meat weight was estimated using a generalized linear mixed effects model (gamma distribution, log link, and a random effect of station) using the glmer function in the lme4 package in R v. 3.2.1. The relationship was estimated with the following general model:

$$\mu = X'\beta + Z\gamma + \varepsilon$$

where μ is the predicted weight (grams), X' is a design matrix of covariates, β is a vector of coefficients, Z is a design matrix of random effects, γ is a vector of random effect parameters, and ε is the error term.

Models were developed with forward selection and variables were retained in the model if the Akaike Information Criterion (AIC) was reduced three or more units. Variables were added to the model based on individual model AIC values. SAMS area was included in all models to allow for the estimation of a SAMS area effect. The model with the lowest AIC was selected as the preferred model and used to predict shell height:meat weight relationships by SAMS area. If models were within three units of each other, a likelihood ratio test was used to test for a significant difference 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 of a tow), SAMS area (retained in all models), latitude (beginning latitude of a tow), and an interaction term of shell height and depth.

Size Selectivity

The estimation of size selectivity of the CFTDD was based on a comparative analysis of the catches from the two dredges used in the survey. For this analysis, the NMFS survey dredge is assumed to be non-selective (i.e., a scallop that enters the dredge is retained by the dredge). Catch at length from the selective gear (commercial dredge) were compared to the non-selective gear via the SELECT method (Millar, 1992). With this analytical approach, the selective properties (i.e., the length based probability of retention) of the commercial dredge were estimated. In addition to estimates of the length based probabilities of capture by the commercial dredge, the SELECT method characterizes a measure of relative fishing intensity. Assuming a known quantity of efficiency for one of the two gears (in this case the survey dredge at 41%), insight into the efficiency of the other gear (commercial dredge) can be attained.

Prior to analysis, all comparative tows were evaluated. Any tows that were deemed to have had problems during deployment or at any point during the tow (flipped, hangs, crossed towing wires, etc.) were removed from the analysis. In addition, tows where zero scallops or less than 20 scallops were captured by both dredges were also removed from the analysis. The remaining tow pairs were then used to analyze the size selective properties of the commercial dredge. The SELECT method was used to calculate selectivity and relative efficiency of the CFTDD.

The SELECT method is one of the preferred method to analyze size-selectivity studies encompassing a wide array of fishing gears and experimental designs (Millar and Fryer, 1999). This analytical approach conditions the catch of the selective gear at length *l* to the total catch (from both the selective gear variant and small mesh control).

$$\Phi_c(l) = \frac{p_c r_c(l)}{p_c r_c(l) + (1 - p_c)}$$

where *r(l)* is the probability of a fish at length *l* being retained by the gear given contact and *p* is the split parameter (measure of relative efficiency). Traditionally, selectivity curves have been described by the logistic function. This functional form has symmetric tails. In certain cases, other functional forms have been utilized to describe size selectivity of fishing gears. Examples of different functional forms include Richards, log-log, and complimentary log-log. Model selection was determined by an examination of model deviance (the likelihood ratio statistic for model goodness of fit), as well as AIC (Xu and Millar, 1993, Sala, *et. al.*, 2008). For towed gears; however, the logistic function is the most common functional form observed. Given the logistic function:

$$r(l) = \left(\frac{\exp(a+bl)}{1+\exp(a+bl)} \right)$$

by substitution:

$$\Phi(L) = \frac{pr(L)}{(1-p)+pr(L)} = \frac{p\dfrac{e^{a+bL}}{1+e^{a+bL}}}{(1-p)+p\dfrac{e^{a+bL}}{1+e^{a+bL}}} = \frac{pe^{a+bL}}{(1-p)+e^{ea+bL}}$$

where *a*, *b*, and *p* are parameters estimated via maximum likelihood. Based on the parameter estimates, L_{50} and the selection range (SR) were calculated as follows:

$$L_{50} = \frac{-a}{b} \qquad\qquad SR = \frac{2*\ln(3)}{b}$$

L_{50} defines the length at which an animal has a 50% probability of being retained, given contact with the gear and SR represents the difference between L_{75} and L_{25}, which is a measure of the slope of the ascending portion of the logistic curve.

In situations where catch at length data from multiple comparative tows is pooled to estimate an average selectivity curve for the experiment, tow by tow variation is often ignored. Millar *et al.* (2004) developed an analytical technique to address this between-haul variation and incorporate that error into the standard error of the parameter estimates. Due to the inherently variable environment that characterizes the operation of fishing gears, replicate tows typically show high levels of between-haul variation. This variation manifests itself with respect to estimated selectivity curves for a given gear configuration (Fryer 1991, Millar *et. al.*, 2004). If not accounted for, this between-haul variation may result in an underestimate of the uncertainty surrounding estimated parameters increasing the probability of spurious statistical significance (Millar *et. al.,* 2004).

Approaches developed by Fryer (1991) and Millar *et. al.,* (2004) address the issue of between-haul variability. One approach formally models the between-haul variability using a hierarchical mixed effects model (Fryer 1991). This approach quantifies the variability in the selectivity parameters for each haul estimated individually and may be more appropriate for complex experimental designs or experiments involving more than one gear. For more straightforward experimental designs, or studies that involve a single gear, a more intuitive combined-haul approach may be more appropriate.

This combined-hauls approach characterizes and then calculates an overdispersion correction for the selectivity curve estimated from the catch data summed over all tows, which is identical to a curve calculated simultaneously to all individual tows. Given this identity, a replication estimate of between-haul variation (REP) can be calculated and used to evaluate how well the expected catch using the selectivity curve calculated from the combined hauls fits the observed catches for each individual haul (Millar *et. al.* 2004).

REP is calculated as the Pearson chi-square statistic for model goodness of fit divided by the degrees of freedom.

$$REP = \frac{Q}{d}$$

where Q is equal to the Pearson chi-square statistic for model goodness of fit and *d* is equal to the degrees of freedom. The degrees of freedom are calculated as the number of terms in the summation, minus the number of estimated parameters. The calculated replicate estimate of between-haul variation was used to calculate observed levels of extra Poisson variation by multiplying the estimated standard errors by $\sqrt{REP}$. This correction is only performed when the data are not overdispersed (Millar, 1993).

A significant contribution of the SELECT model is the estimation of the split parameter which estimates the probability of an animal "choosing" one gear over another (Holst and Revill, 2009). This measure of relative efficiency, while not directly describing the size selectivity properties of the gear, is insightful relative to both the experimental design of the study, as well as the characteristics of the gears used. A measure of relative efficiency (on the observational scale) can be calculated in instances where the sampling intensity is unequal. In this case, the sampling intensity is unequal due to differences in dredge width. Relative efficiency can be computed for each individual trip by the following formula:

$$RE = \frac{p/(1-p)}{p_0/(1-p_0)}$$

where *p* is equal to the observed (estimated *p* value) and p_0 represents the expected value of the split parameter based upon the dredge widths in the study (Park *et. al.*, 2007). For this study, a 14 ft. commercial dredge was used with expected split parameter of 0.636. The computed relative efficiency values were then used to scale the estimate of the NMFS survey dredge efficiency obtained from the optical comparisons (41%). Computing efficiency for the estimated *p* value from Yochum and DuPaul (2008) yields a commercial dredge efficiency of 67.8% for a New Bedford style dredge.

Nematode Monitoring

Data on nematode distribution and prevalence from VIMS 2015, 2016, 2017, and 2018 surveys of the MAB resource area were mapped to understand the spatial extent of infections. Data were also compared across survey years to assess shifts in the spatial distribution of infected scallops. Analyses for the comparison between years included mapping the distribution and intensity of nematode infected scallops throughout the survey domain by year, as well as by size class (i.e., < 110 mm and ≥ 110 mm). The spatial distribution of nematode infections was estimated with an inverse distance weighted interpolation (IDW) method for both prevalence and intensity. IDW was used to estimate infections for areas unsampled by the VIMS surveys using point data from sampled stations by year (Fortin and Dale, 2006). IDW was conducted in R with the gstat package (R Core Team, 2006; Gräler et al., 2015).

Additional Analyses

An additional set of analyses were conducted at the request of the Scallop PDT to examine for variation in scallop shell height:meat weight relationships and length distributions at a finer scale in the ETCA. One analysis consisted of separating the ETCA Closed SAMS area, now referred to as the ET Flex area, into two distinct areas: a high density area and the remainder of the ETCA Flex SAMS area. The second analysis used the same high density area in the ET Flex SAMS area as one distinct area and combined the remainder of the ETCA Flex SAMS area with the ETCA Open SAMS area. Length frequency distributions and mean lengths were estimated for the two configurations. Shell height:meat weight relationships were estimated for each SAMS area, as described above, and included the ET Flex high density area as a separate SAMS area.

Results

Abundance and distribution

A total of 450 stations were completed over two survey legs. The *F/V Carolina Capes II* completed 227 survey stations from May 4-13, 2018 in the southern portion of the survey area (referred to as Cruise 201801). The *F/V Italian Princess* surveyed the northern area from May 19-29, 2018 and completed 223 stations (referred to as Cruise 201802). Boxplots depicting the estimated linear distances covered per tow over the entire survey by cruise are shown in Figure 4. Results from a pairwise Wilcoxon rank sum test analysis indicated there was a significant difference in the mean tow distance between the vessels (p-value < 0.001). The mean tow distance on Cruise 201801 was 1,759.64 m (s.d. 191.61), while the mean tow distance on Cruise 201802 was 1,549.57 m (s.d. 95.03).

Relative length frequency distributions for scallops, along with the expanded number of scallops, and mean length by gear captured during the survey by SAMS area are shown in Figure 5. Maps depicting the spatial distribution of the catches of pre-recruit (≤ 75 mm) and fully recruited (> 75mm) scallops from the survey dredge are shown in Figure 6. Total and exploitable biomass calculated using the SARC 65 area-specific shell height:meat weight coefficient, along with standard errors, coefficients of variation, and density by gear type and SAMS area are shown in Tables 1-2. Total biomass from the commercial dredge is not estimated due to the selective properties of the commercial gear. An estimate of the total number of animals by gear type and SAMS area are shown in Table 3. Shell height:meat weight relationships were estimated by SAMS area within the survey domain. The resulting parameters estimated are shown in Table 4. The predicted shell height:meat weight relationships for the SAMS areas are shown in Figure 7. Bycatch CPUE (number caught per unit of effort) and total number of animals observed are provided in Table 5. Length frequency distributions for the two finfish bycatch with sufficient sample sizes are shown in Figure 8 for each gear.

Size selectivity

The catch data were evaluated by the SELECT method with the logistic and Richards functional forms in an attempt to characterize the most appropriate model. Examination of residual patterns, model deviance, and AIC values indicated that the logistic curve provided the best fit to the data. The Richards model did also did not converge. An additional model run was conducted to determine whether the hypotheses of equal fishing intensity (i.e., the two gears fished equally) was supported. Visual examination of residuals, values of model deviance, and AIC indicated the model with an estimated split parameter provided the best fit to the data. Parameter estimates using the logistic function and with p being estimated are shown in Table 6. The fitted curve and deviance residuals are shown in Figure 9. The predicted selectivity curve is shown in Figure 10. Parameter estimates for L_{25}, L_{50} and L_{75} were estimated as 93.02, 104.65, and 116.29 mm, respectively (Table 10). The estimated p parameter of 0.84 is greater than reported in Yochum and DuPaul (2008) for the New Bedford Style dredge (0.77), indicating the CFTTD is more efficient than the New Bedford Style dredge. This higher relative efficiency is consistent with the efficiency value of 0.81 for the CFTTD for the time period of 2015-2017 reported in Roman and Rudders (2019).

Meat Quality and Shell Blisters

A total of 5,413 scallops were sampled at shell height:meat weight stations during the survey. Summary information on sex, market category, color, texture, and blister disease stage are provided in Table 7. Table 8 provides the classifications for market category, color, texture, and blister codes. The majority of scallops were classified as marketable with no texture or color deviations. Approximately 10 percent of scallops regardless of sex were observed to have some form of blister disease. Scallops with nematode infections were not downweighed in marketability classification.

Nematode Monitoring

All scallops assessed for meat quality and shell blisters were also monitored for nematode infections. Nineteen percent of scallops were observed to have at least one nematode lesion this year. The spatial distribution of infected scallops from 2015 through 2018 showed some shifts in the distribution of scallops infected for both prevalence and intensity (Figures 11-12). Prevalence is defined as the number of scallops observed to be infected out of all scallops sampled. Intensity is defined as the number of lesions observed in infected scallops. In 2015, the majority of infected scallops were located in the DMV. In 2016, there was a northward shift into the ETCA and the extent to which infected scallops were observed ranged from the most southern portion of the resource unit to the northern boundary of the HCCA (Figure 11). We observed a contraction in the range of infected scallops in 2017, with the locus of the observations in the northern portion of the DMV and ETCA. The overall spatial extent of infected scallop in 2018 was similar to that observed in 2016. The highest percentage of infected scallops was observed in the DMV and ETCA areas of the resource. The trend in the spatial distribution for intensity was similar to that for prevalence (Figure 12). When looking at the spatial distribution by size class for prevalence (e.g., <110 mm and ≥ 110 mm), it appears that small scallops were less infected over time compared to larger scallops, with the exception of 2018 (Figure 13). The distribution of infected scallops for both size classes was similar in 2018. The spatial extent of infections in larger scallops in 2018 remained consistent compared to 2016 and 2017 (Figure 13).

Scallop Shells

A total of 546 scallop shells were collected. All shell samples were aged and a subset archived at VIMS.

Additional Analyses

A presentation with additional length frequency and shell height:meat weight analyses are provided in Appendix D.

Outreach

As part of the outreach component of this project, a presentation detailing the annual results of the survey was compiled. This presentation was delivered to the Sea Scallop PDT at their meeting in Falmouth, MA during August 28-29, 2018. Results of this survey were used in the decision making process for FW 30 to the Sea Scallop FMP. The presentation is included as Appendix A. A presentation describing the continued investigation of the nematode parasite and observations from VIMS 2018 survey efforts was also given at the same meetings and included as Appendix B. An annual industry report was generated to summarize results from VIMS 2018 survey efforts and distributed to stakeholders. This report is included as Appendix C.

During the survey, we also collected samples for several organizations. Monkfish fin clips, length, and weight measurements were taken for a Cornell University Cooperative Extension Monkfish RSA project titled “Fine Scale Genetic Population Structure of Monkfish”. Associated station-level information was also collected. Clearnose skate and associated station-level data were collected for graduate student Lindsay Nelson of VIMS for her graduate work.

Presentations

Several other presentations were given at academic conferences that included information from this survey. Authors in bold represent presenters.

- 148th Annual American Fisheries Society Conference, Atlantic City, NJ. August 17-23,2018
    - Growth Rate Measurement in Scallops: Revisiting Merrill after 50 Years on the Library Shelf. M. Chase Long[1], Roger Mann[1], David Rudders[1], Sally Roman[1], Toni Chute[2], Sally Walker[3] and Kelly Cronin[3], (1)Virginia Institute of Marine Science, (2)Northeast Fisheries Science Center, (3)University of Georgia
    - Investigating the Impact of the Nematode *Sulcascaris Sulcata*: Spatial Distribution and Effect on the Sea Scallop Fishery. David Rudders[1], Sally Roman[1], Robert A. Fisher[2], David Bushek[3], Daphne Munroe[3], Eleanor Bochenek[3], Emily McGurk[3] and Benjamin Galuardi[4], (1)Virginia Institute of Marine Science, (2)Virginia Sea Grant Program, (3)Rutgers University, (4)NOAA NMFS Greater Atlantic Regional Fisheries Office

Discussion

Surveys of resource areas such as the MAB resource area are an important endeavor. These surveys provide information about a critical component of the resource that includes both rotational access areas and open area. Additionally, the timing of industry-based surveys can be tailored to give managers current information to guide important management decisions. This information can help determine access to closed areas, set TAC for re-opening of access areas, and determine the number of allowable DAS for open area fishing. Finally, this type of survey is important in that it involves the stakeholders of the fishery in the management of the resource.

Our results suggest that significant biomass continued to exist in the MAAA access areas of MAB resource area (i.e., ETCA and HCCA) in 2018. Biomass in the open areas off of Long Island was also high and would be able to support open DAS fishing in 2019. No large recruitment events have been observed in the resource unit since 2016. Nematode infected scallops were observed throughout ETCA south to the Delmarva and Virginia Beach open area, with patchy distributions of infected scallops in HCCA. Infected scallops were rarely observed in the open area off Long Island. The percentage of large scallops showing signs of infection in the southern extent of the resource was considerable in 2018 and similar to results in 2016 and 2017. The continued observance of infected scallops in the southern portion of the resource will likely reduce limit effort in this portion of the MAB. A shift in fishing effort as characterized by vessel monitoring data has been documented by NMFS and the NEFMC.

The use of commercial scallop vessels in a project of this magnitude presents some interesting challenges. One such challenge is the use of the commercial gear. This gear is not designed to be a survey gear; it is designed to be efficient in a commercial setting. The design of this current experiment however provides insight into the utility of using a commercial gear as a survey tool. One advantage of the use of this gear is that the catch from this dredge represents exploitable biomass and no further correction is needed. A disadvantage lies in the fact that there is very little ability of this gear to detect recruitment events.

The concurrent use of two different dredge configurations provides a means to not only test for agreement of results between the two gears, but also simultaneously conduct size selectivity experiments. In this instance, our experiment provided information regarding the CFTDD based on information collected during the survey. Selectivity of the New Bedford style dredge was estimated by Yochum and DuPaul (2008), but until recently no peer-reviewed analysis on selectivity for the CFTDD had been published (Roman and Rudders, 2019). Our results indicate the CFTDD is slightly more efficient than the New Bedford style dredge and the L_{50} is lower than that estimated for the New Bedford dredge (Yochum and DuPaul, 2008). This information is useful for managers and assessment scientists to understand the selectivity and relative efficiency of this dredge type.

Biomass estimates are sensitive to other assumptions made about the biological characteristics of the resource; specifically, the use of appropriate shell height:meat weight parameters. Parameters generated from data collected during the course of the study were appropriate for the area and time sampled. There is; however, a large variation in this relationship as a result of many factors. Seasonal and inter-annual variation can result in some of the largest differences in shell height:meat weight values. Traditionally, when the sea scallop undergoes its annual spawning cycle, metabolic energy is directed toward the production of gametes and the somatic tissue of the scallop is still recovering and is at some of their lowest levels relative to shell size (Serchuk and Smolowitz, 1989). While accurately representative for the month of the survey, biomass has the potential to be different relative to other times of the year. Area and time specific shell height:meat weight parameters are another topic that merits continued study.

The project budget and project compensation are included as Appendix E.

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Figure 1 Locations of sampling stations for the 2018 survey of the mid-Atlantic resource area.

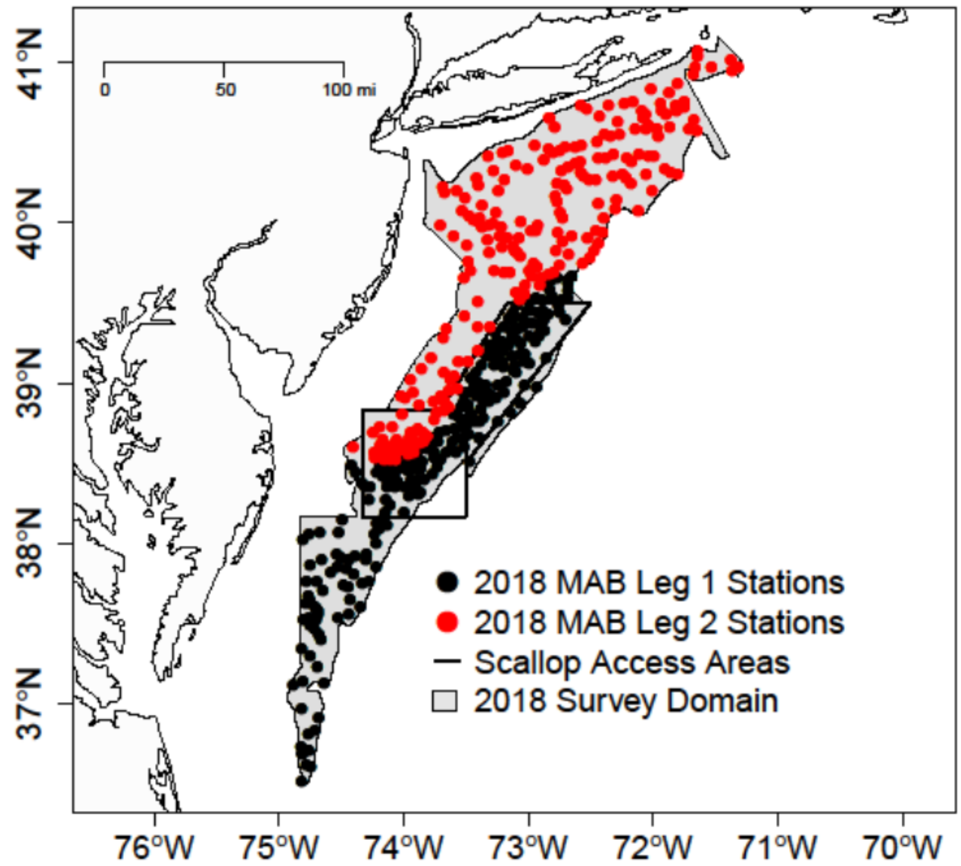


Figure 2 An example of the output from the Star-Oddi™ DST sensor. Arrows indicate the interpretation of the start and end of the dredge tow.

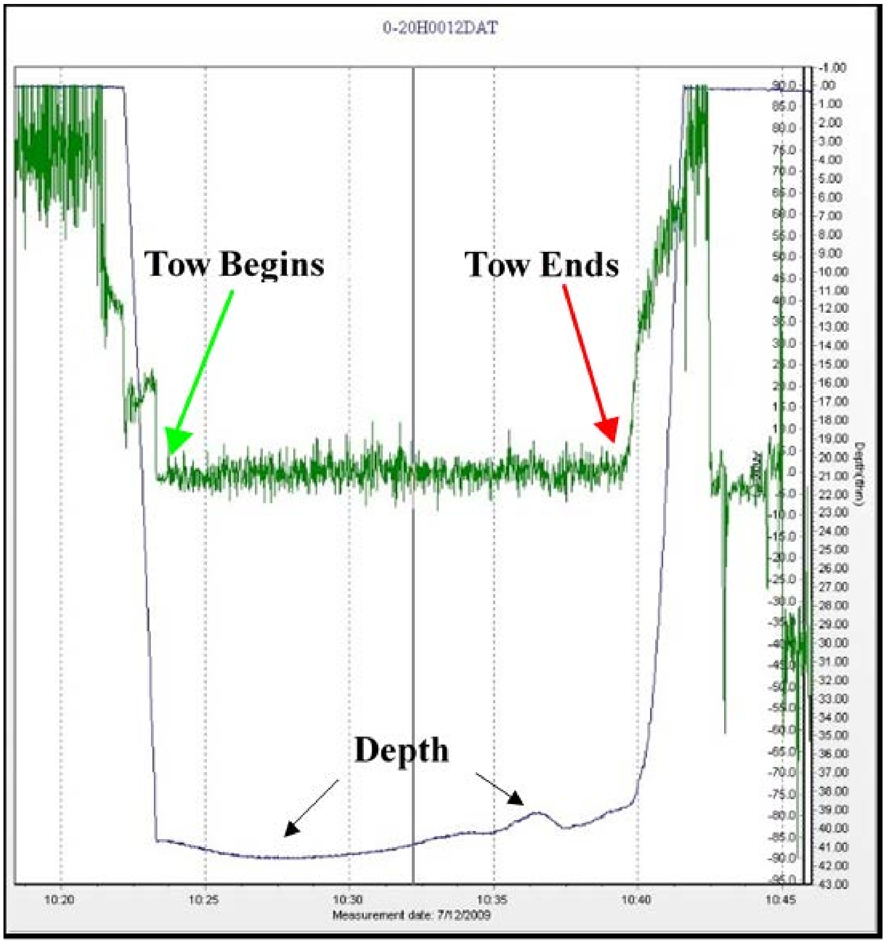


Figure 3 Map of the 2018 survey domain of the mid-Atlantic resource area with the SAMS area designations and NMFS and VIMS extents (gray and blue).

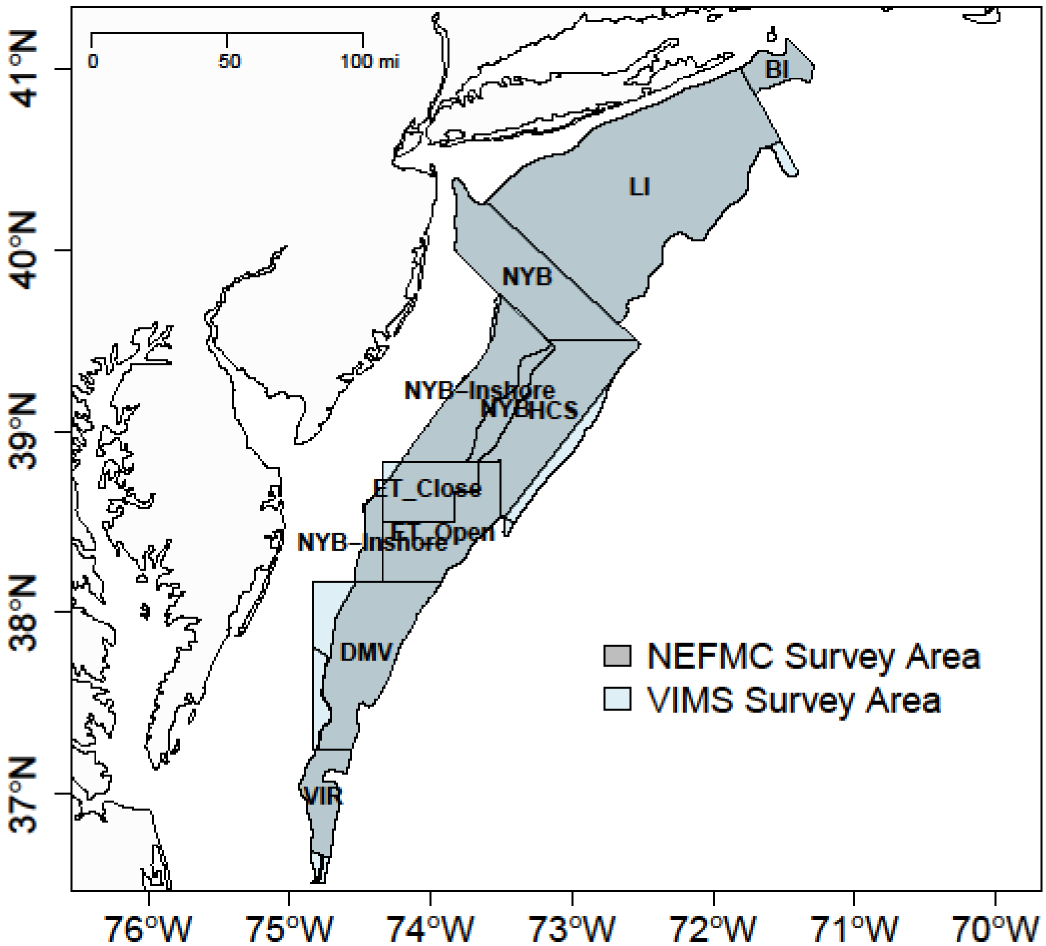


Figure 4 Boxplots of calculated tow lengths from the 2018 survey of the mid-Atlantic resource area by cruise. Overall mean tow length was 1,655.54 m with a standard deviation of 184.42 m.

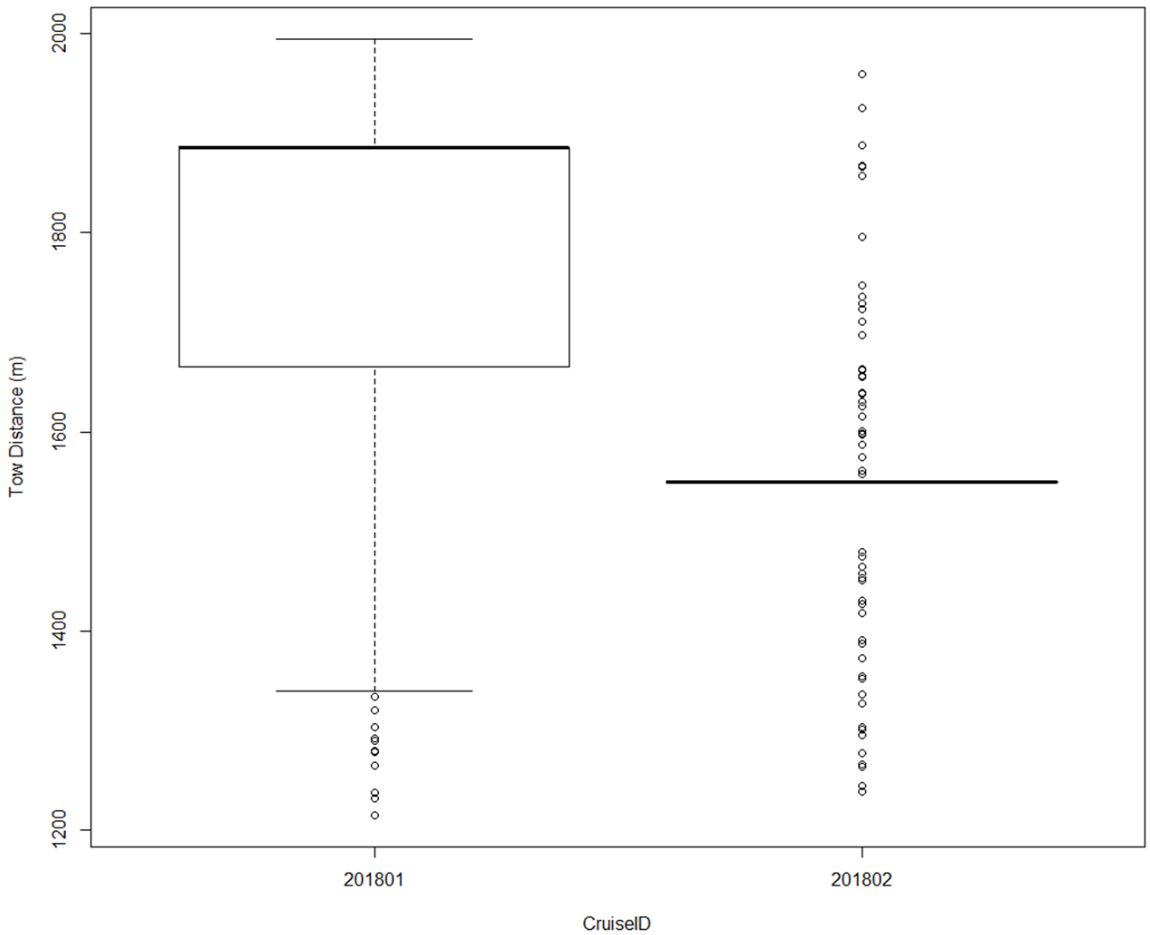
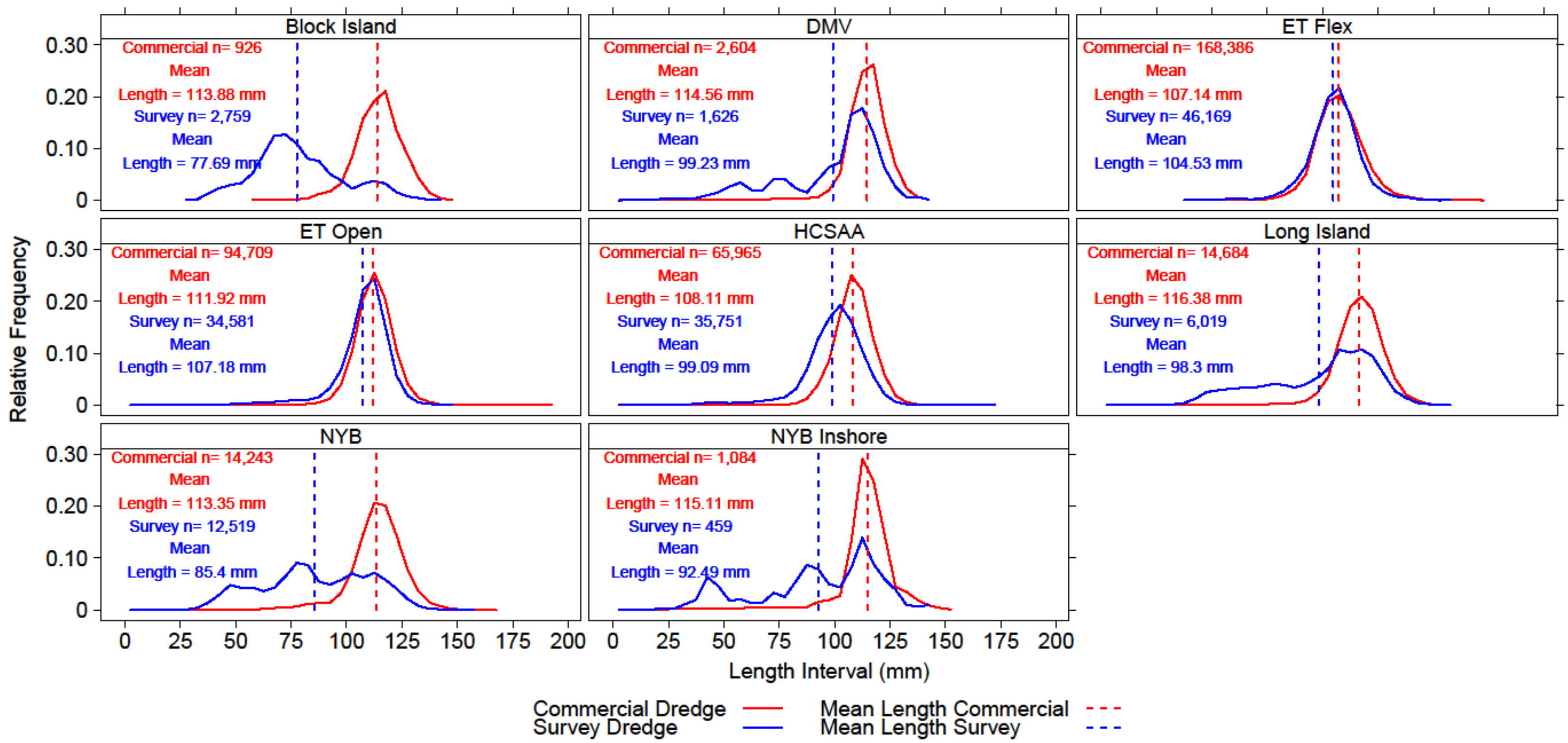
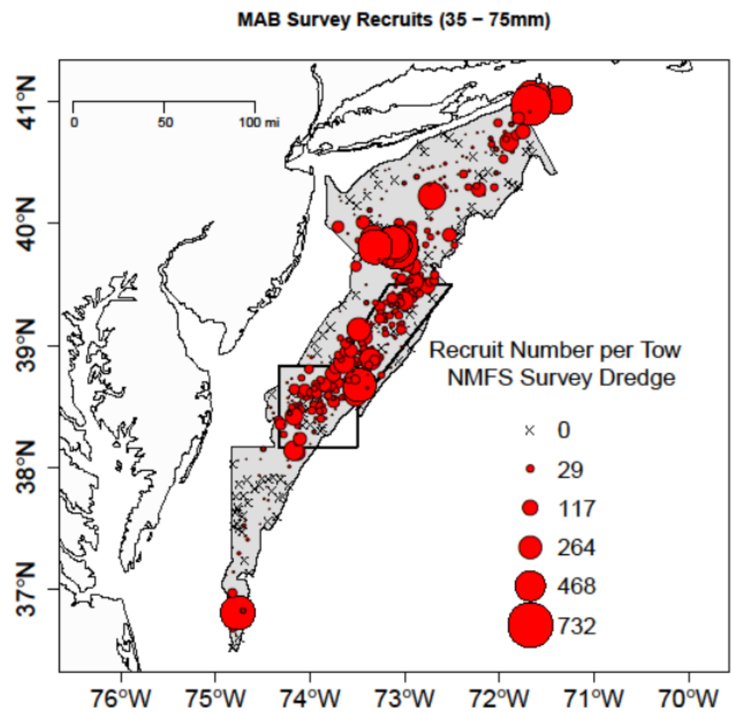


Figure 5 Shell height relative frequencies for the two dredge configurations used to survey the mid-Atlantic resource area in 2018 by SAMS area. The relative frequencies represent the expanded but unadjusted catches of the two gears for all sampled tows. The number of scallops sampled by gear and mean shell height are also provided.

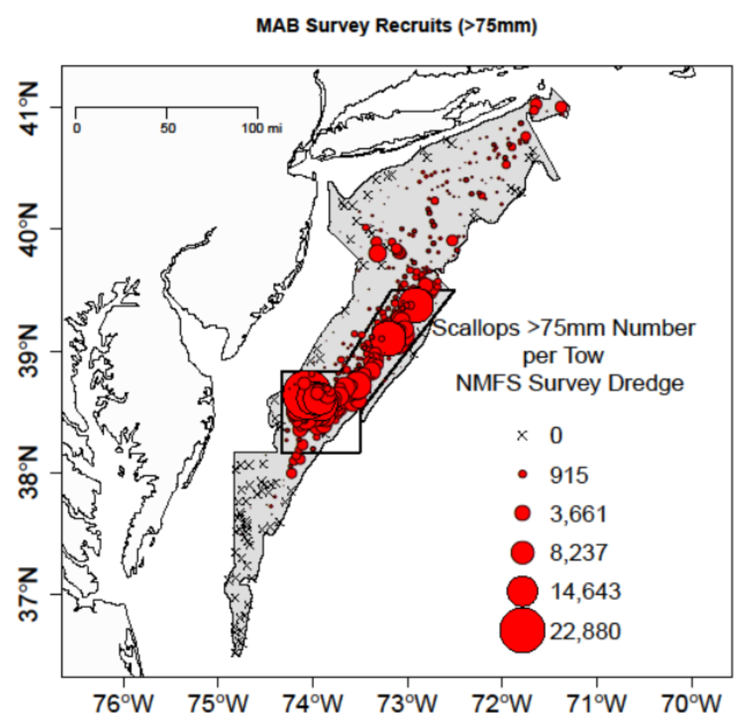


<u>Figure 6</u> Spatial distribution of the number of sea scallop caught per m^2 in the NMFS survey dredge during the 2018 survey of the mid-Atlantic resource area. This figure represents the catch of pre-recruit and recruited sea scallops. A- ≤ 75mm and B- >75mm.

A



B



<u>Figure 7</u> Predicted shell height:meat weight relationships by SAMS area estimated from scallops sampled during the mid-Atlantic resource area surveys in 2018.

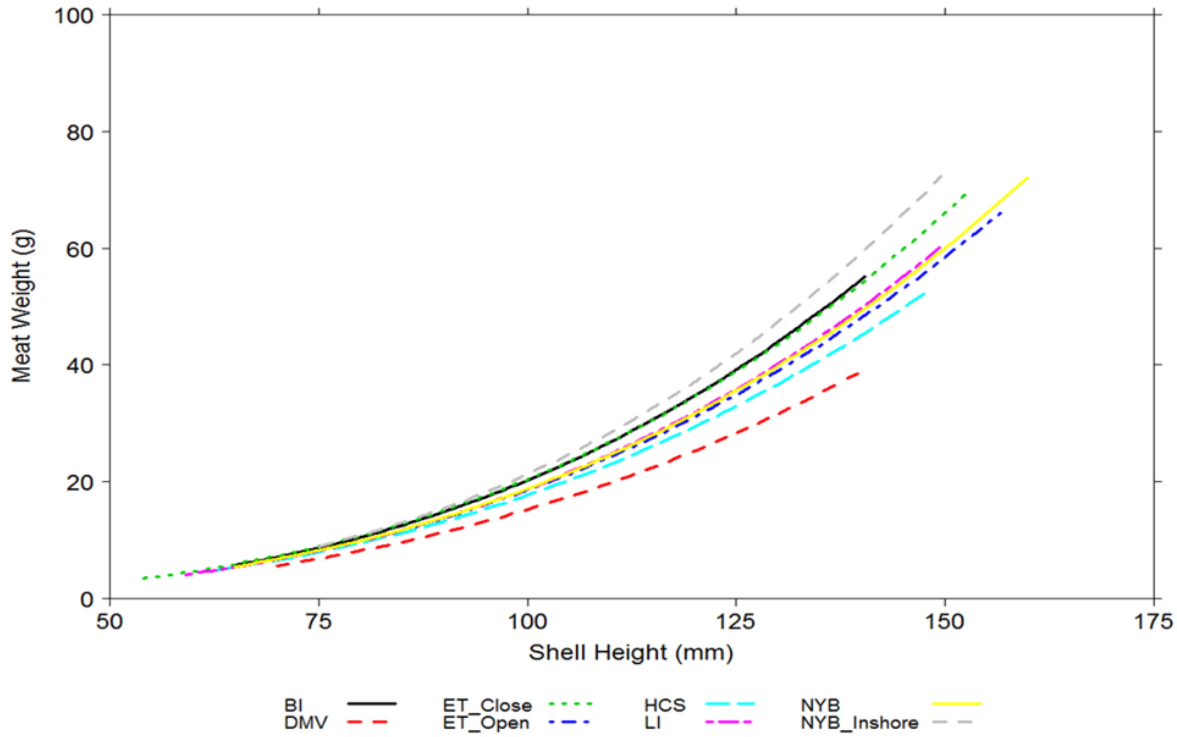
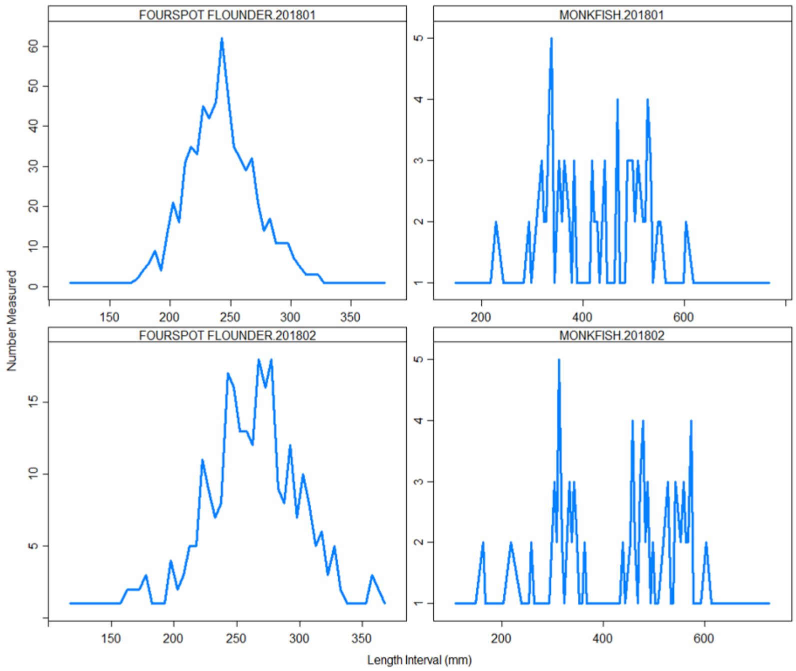


Figure 8 Length frequency distributions of bycatch by dredge with sufficient sample sizes for the mid-Atlantic resource area survey conducted during 2018 by gear. A - survey gear and B - Coonamessett Farm Turtle Deflector Dredge.

A



B

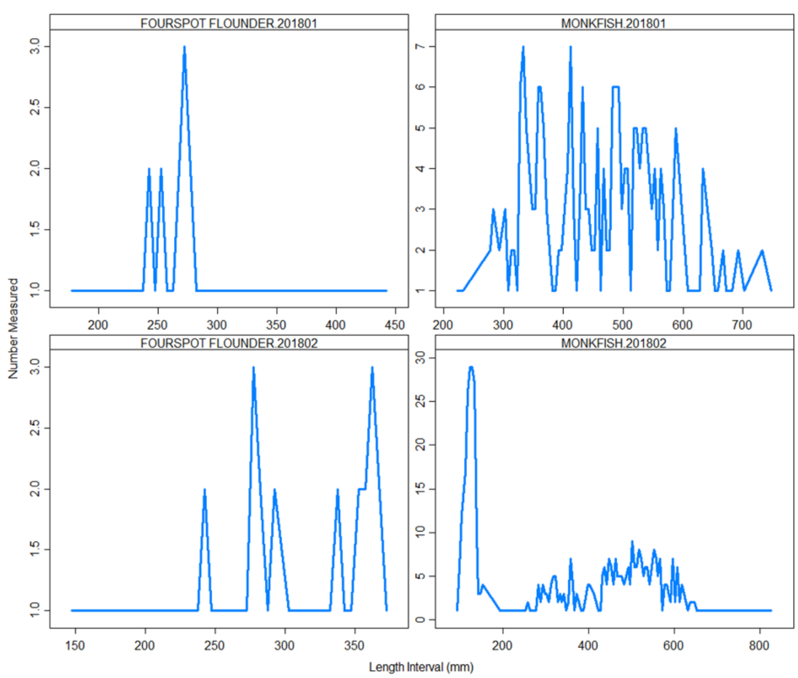
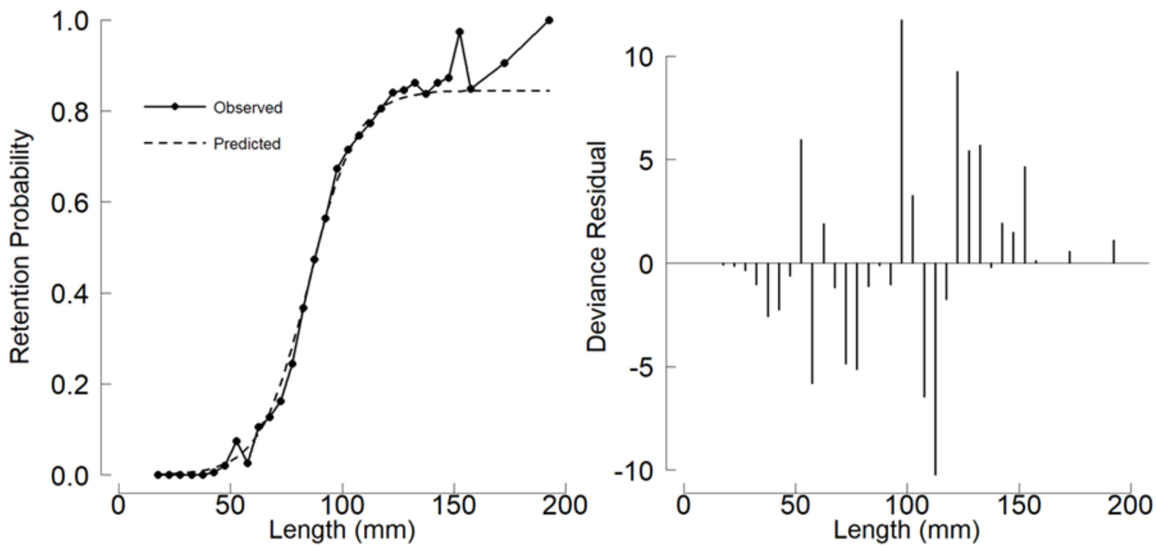


Figure 9 Left: Logistic SELECT curve fit to the proportion of the total catch in the Coonamessett Farm Turtle Deflector Dredge relative to the total catch (survey and commercial) for the 2018 mid-Atlantic resource area survey. Left – The predicted and observed retention probability for the commercial dredge. Right – Deviance residuals for the model fit.



<u>Figure 10</u> Estimated selectivity curves for the Coonamessett Farm Turtle Deflector Dredge based on data from the 2018 mid-Atlantic resource area survey. The middle dashed line represents the length at 50% retention probability. The lower and upper dashed lines represent the lengths at the 25% and 75% retention probabilities.

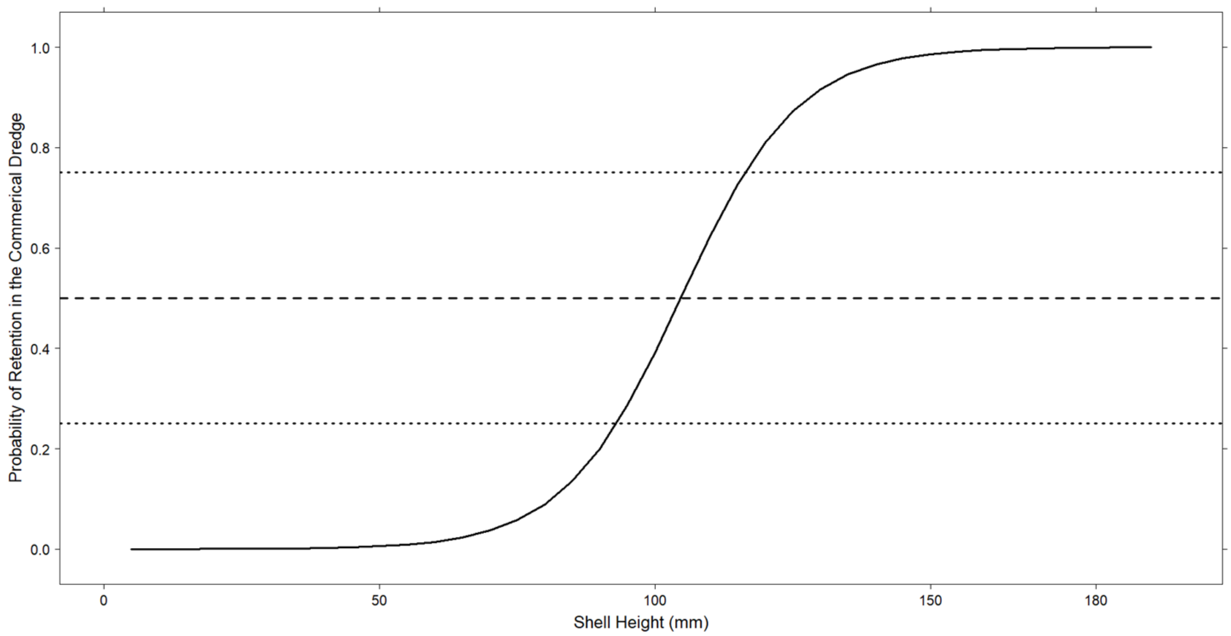


Figure 11 Spatial distribution of the proportion of nematode infected scallops (prevalence) by year for the mid-Atlantic resource area survey. Data are from the 2015, 2016, 2017, and 2018 mid-Atlantic resource area surveys. The open circles are station locations.

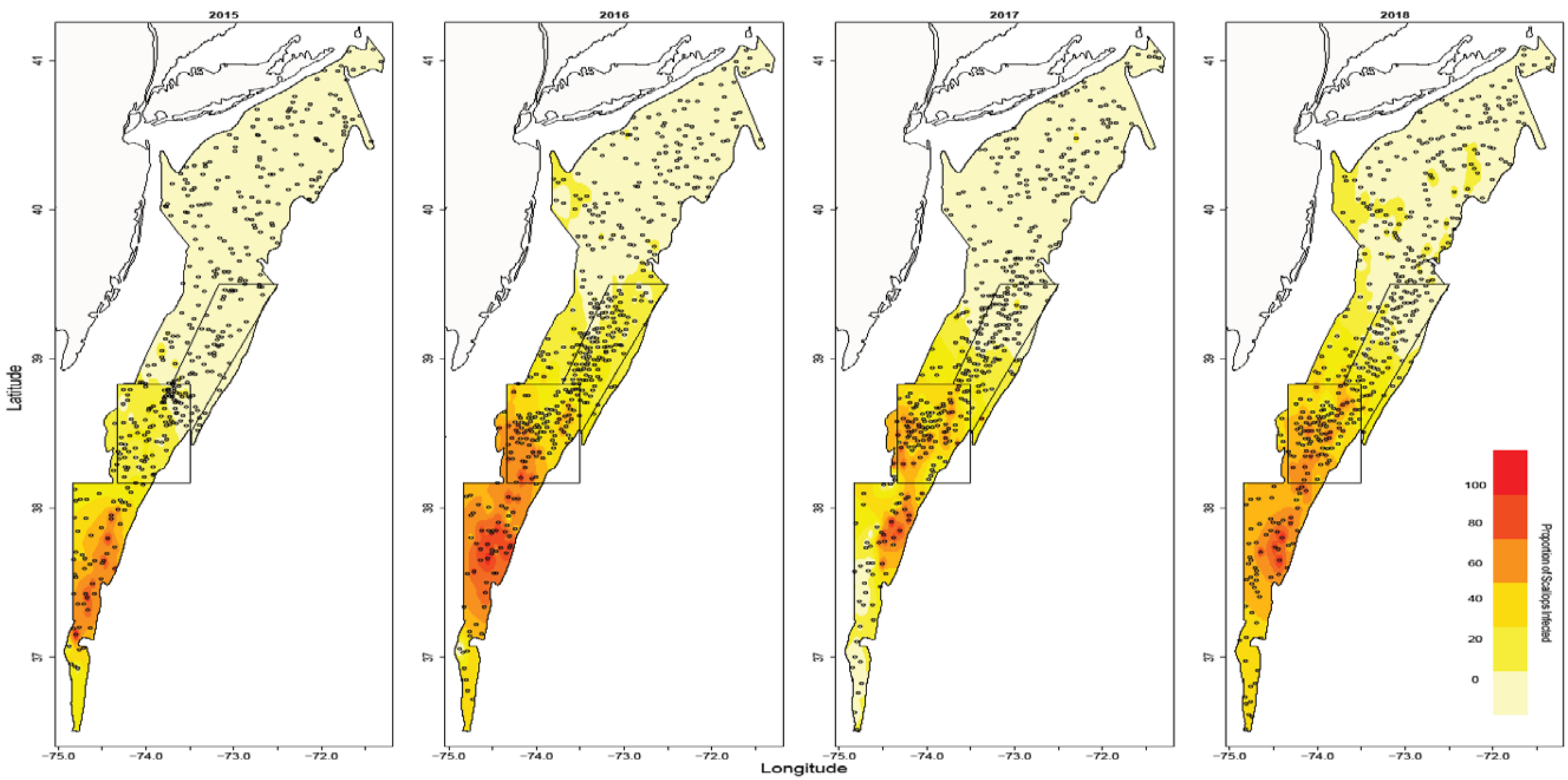


Figure 12 Spatial distribution of the mean number of nematode per infected scallops (intensity) by year for the mid-Atlantic resource area survey. Data are from the 2015, 2016, 2017, and 2018 mid-Atlantic resource area surveys. The open circles are station locations.

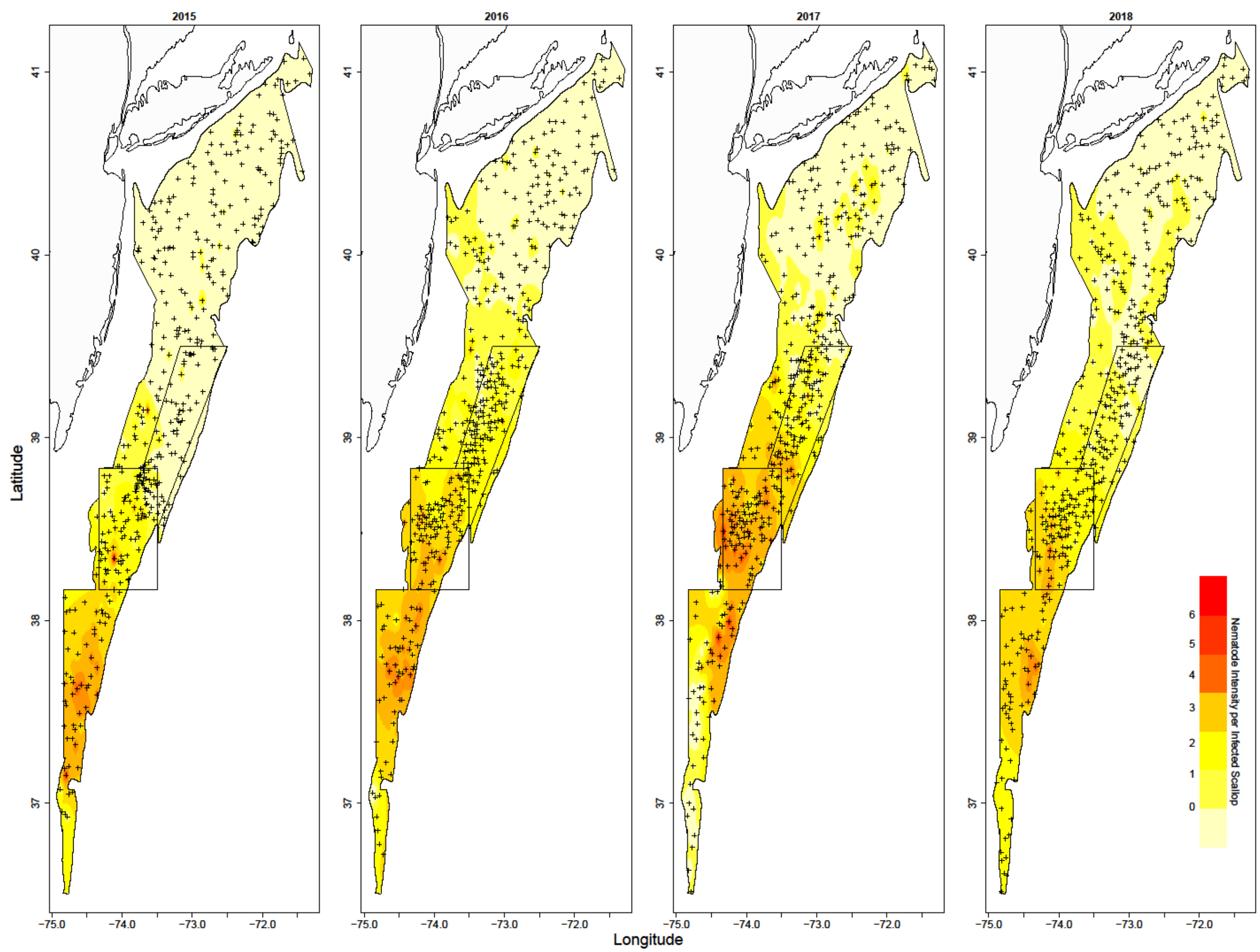


Figure 13 Spatial distribution of the mean number of the proportion of nematode infected scallops (prevalence) by year and size class for the mid-Atlantic resource area survey. Data are from the 2015, 2016, 2017, and 2018 mid-Atlantic resource area surveys. Top panel plots show the distribution of scallops <100 mm. Bottom panel plots show the distribution of scallops ≥ 100 mm.

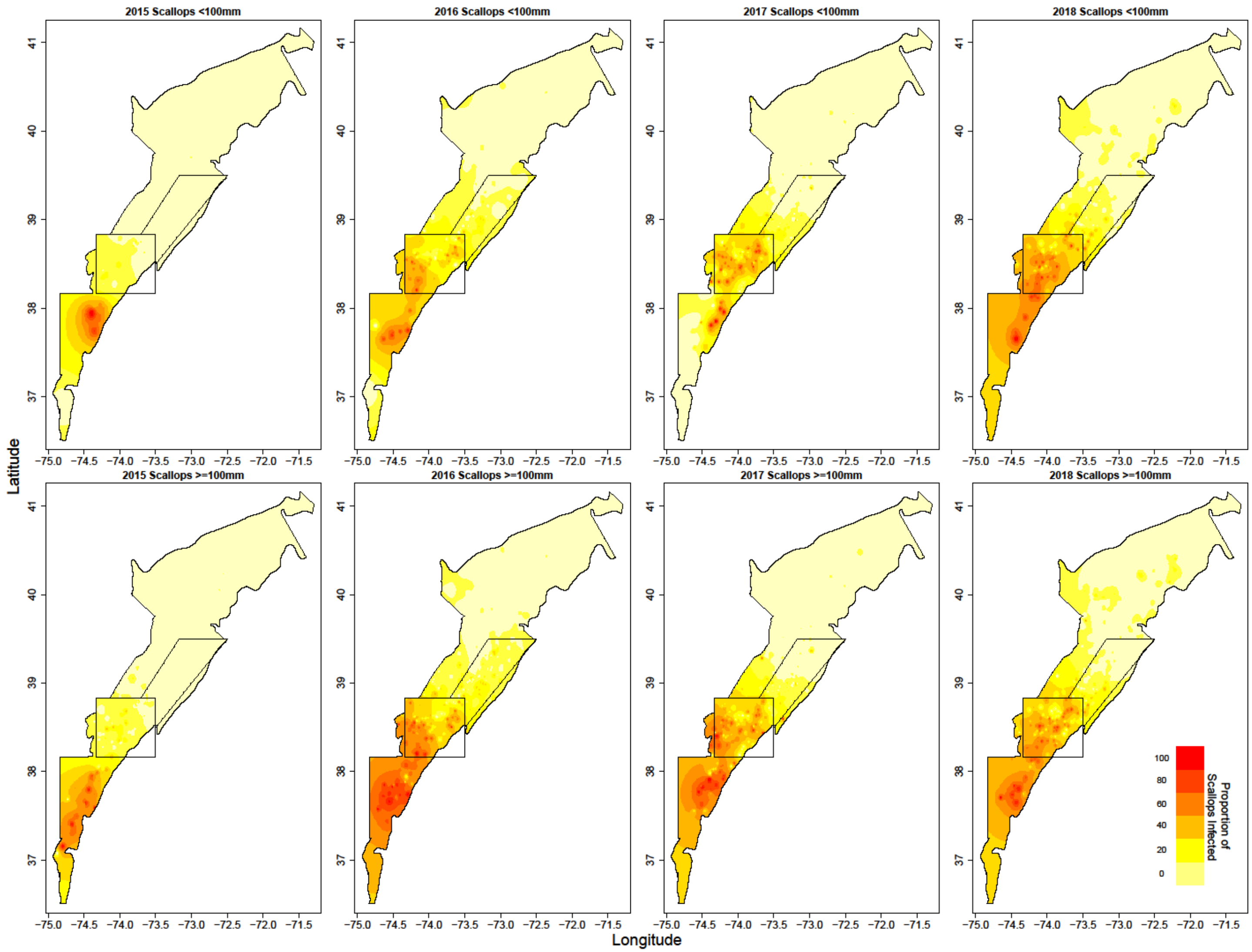


Table 1 Estimated total and exploitable biomass (mt) for the NMFS survey dredge for the mid-Atlantic resource area surveyed during 2018 by SAMS area. Standard errors, coefficient of variation (CV), and density of scallops is also provided.

	SAMS Area	Total Biomass (mt)	SE (mt)	CV	Density (scal/m^2)
Total Biomass	BI	2,572.29	243.90	23.70	0.25
	DMV	1,149.53	160.81	34.97	0.02
	ET_Close	18,017.59	1,196.50	16.60	0.76
	ET_Open	15126.01	709.69	11.73	0.36
	HCS	13,528.53	853.14	15.77	0.27
	LI	8,813.44	470.95	13.36	0.03
	NYB	6666.68	770.54	28.9	0.12
	NYB_Inshore	931.19	170.47	45.77	0.02
	VIR	85.79	19.11	55.69	0.03
Exploitable Biomass	BI	927.50	90.83	24.48	0.05
	DMV	771.67	107.47	34.82	0.01
	ET_Close	11,546.29	742.63	16.08	0.45
	ET_Open	10543.8	505.23	11.98	0.23
	HCS	7595.7	414.65	13.65	0.13
	LI	6,121.56	334.58	13.66	0.02
	NYB	3197.17	242.14	18.93	0.04
	NYB_Inshore	595.58	118.95	49.93	0.01
	VIR	0.40	0.08	47.56	0.000

Table 2 Estimated exploitable biomass for the Coonamessett Farm Turtle Deflector Dredge commercial dredge for the mid-Atlantic resource area surveyed during 2018 by SAMS area. Standard errors, coefficient of variation (CV), and density of scallops is also provided.

	SAMS Area	Total Biomass (mt)	SE (mt)	CV	Density (scal/m^2)
Exploitable Biomass	BI	474.72	71.48	23.17	0.02
	DMV	679.36	170.21	38.54	0.01
	ET_Close	18,692.46	2003.44	16.49	0.62
	ET_Open	12193.59	907	11.44	0.25
	HCS	7,350.24	809.07	16.93	0.11
	LI	8,888.05	659.92	11.42	0.02
	NYB	3541.49	293.94	12.77	0.04
	NYB_Inshore	949.22	361.08	58.52	0.01
	VIR	0.00	0.00	0.00	0.00

Table 3 Estimated total number of scallops for the NMFS survey dredge for the mid-Atlantic resource area surveyed during 2018 by SAMS area.

	SAMS Area	Survey Dredge	Commercial Dredge
		Number	Number
Total	BI	217,817,496	-
	DMV	63,000,193	-
	ET_Close	887,649,787	-
	ET_Open	714,719,928	-
	HCS	786,604,209	-
	LI	428,240,799	-
	NYB	512,746,047	-
	NYB_Inshore	50,430,227	-
	VIR	65,685,644	-
Exploitable	BI	43,097,735	15,980,143
	DMV	33,219,891	26,648,044
	ET_Close	501,910,317	750,740,058
	ET_Open	457,378,768	492,507,928
	HCS	388,201,042	329,856,061
	LI	220,817,010	292,590,857
	NYB	144,958,012	122,851,362
	NYB_Inshore	22,464,157	32,228,479
	VIR	218,525	0

Table 4 Shell height:meat weight parameters estimated from scallops sampled during the mid-Atlantic resource area survey in 2018. Ln shell height:ln depth indicates an interaction term.

Parameter	Parameter Estimate
Intercept	-19.72
ln shell height	5.06
ln depth	2.38
DMV	-0.24
ET_Close	0.03
ET_Open	-0.05
HCS	-0.09
LI	-0.06
NYB	-0.05
NYB_Inshore	0.03
ln shell height:ln depth	-0.55

Table 5 Total catch (number of animals) and catch per unit effort for bycatch for the 2018 survey of the mid-Atlantic resource area for the NMFS survey dredge and the Coonamessett Farm Turtle Deflector Dredge by cruise.

CruiseID	Common Name	Commercial Gear Catch (Number)	Commercial Gear CPUE	Survey Gear Catch (Number)	Survey Gear CPUE
201801	CHAIN DOGFISH	3	0.013	26	0.114
201801	FOURSPOT FLOUNDER	30	0.131	663	2.895
201801	SCUP	1	0.004	105	0.459
201801	BARNDOOR SKATE	10	0.044	1	0.004
201801	GREY SOLE	9	0.039	28	0.122
201801	BLACK SEA BASS	24	0.105	298	1.301
201801	NORTHERN SEAROBIN	255	1.114	2,341	10.223
201801	HORSESHOE CRAB	249	1.087	106	0.463
201801	UNCLASSIFIED SKATES	1,746	7.624	392	1.712
201801	SPOTTED HAKE	11	0.048	1,097	4.79
201801	RED HAKE	2	0.009	35	0.153
201801	SILVER HAKE	2	0.009	92	0.402
201801	MONKFISH	231	1.009	115	0.502
201801	SMOOTH DOGFISH	2	0.009	3	0.013
201801	SUMMER FLOUNDER	21	0.092	47	0.205
201801	WINDOWPANE FLOUNDER	5	0.022	10	0.044
201801	LOLIGO SQUID	0	0	4	0.017
201801	GULFSTREAM FLOUNDER	0	0	92	0.402
201801	ATLANTIC MACKEREL	0	0	1	0.004
201801	STRIPED SEAROBIN	0	0	20	0.087
201802	BARNDOOR SKATE	11	0.048	4	0.018
201802	BLACK SEA BASS	10	0.044	67	0.295
201802	NORTHERN SEAROBIN	104	0.458	401	1.767
201802	FOURSPOT FLOUNDER	36	0.159	281	1.238
201802	SPINY DOGFISH	1	0.004	2	0.009
201802	GREY SOLE	13	0.057	13	0.057
201802	SPOTTED HAKE	2	0.009	133	0.586
201802	SUMMER FLOUNDER	50	0.22	14	0.062
201802	CHAIN DOGFISH	1	0.004	0	0
201802	SILVER HAKE	3	0.013	230	1.013
201802	UNCLASSIFIED SKATES	4,159	18.322	1,220	5.374
201802	RED HAKE	5	0.022	443	1.952
201802	HORSESHOE CRAB	6	0.026	1	0.004
201802	SMOOTH DOGFISH	1	0.004	0	0
201802	WINDOWPANE FLOUNDER	84	0.37	28	0.123
201802	MONKFISH	300	1.322	120	0.529
201802	YELLOWTAIL FLOUNDER	1	0.004	1	0.004
201802	BLACKBACK FLOUNDER	4	0.018	11	0.048
201802	AMERICAN LOBSTER	0	0	1	0.004
201802	OCEAN POUT	0	0	19	0.084
201802	LOLIGO SQUID	0	0	1	0.004
201802	LONGHORN SCULPIN	0	0	3	0.013
201802	SCUP	0	0	27	0.119
201802	GULFSTREAM FLOUNDER	0	0	42	0.185

Table 6 Selectivity analysis parameter values estimated with a logistic curve and estimated split parameter (*p*) for the 2018 survey of the mid-Atlantic resource area for the Coonamessett Farm Turtle Deflector Dredge.

Parameter	Parameter Estimate	S.E.
a	-9.88	-
b	0.09	-
p	0.84	0.87
L25	93.02	1.21
L50	104.65	1.6
L75	116.29	0.4
SR	23.27	0.91
REP Factor	16.07	

Table 7 Summary for scallops assessed for marketability, color, texture, and blister disease at shell height:meat weight stations by sex during the 2018 survey of the mid-Atlantic resource area.

Sex	Market Classification			
	1	2	3	4
Female	151	101	324	2,092
Male	131	81	287	2,187
Unknown	4	5	4	46
	Color Classification			
	1	2	3	4
Female	19	31	99	2,519
Male	12	14	44	2,616
Unknown	0	0	0	59
	Texture Classification			
	1	2	3	4
Female	45	80	231	2,312
Male	40	57	216	2,373
Unknown	2	3	2	52
	Disease Classification			
	1	2	3	4
Female	49	78	123	2,418
Male	48	72	116	2,450
Unknown	0	2	0	57

Table 7 Description of marketability, color, texture, and blister codes for Table 6.

Classification	Color	Texture	Marketability	Blister
1	Extreme color deviation	Extreme stringiness, tearing, flaccid	Unmarketable	Blister in advanced stage
2	Noticeable color deviation	Noticeable stringiness, tearing, flaccid	Marginally marketable	Moderate blister severity
3	Slight color deviation	Slight stringiness, tearing, flaccid	Slightly inferior marketability	Blister in early stage
4	No color deviation	No texture concern	Marketable	No blister present

Appendix A

An Assessment of Sea Scallop Abundance and Distribution in the Mid-Atlantic Bight, Nantucket Lightship Closed Area, Closed Area I and Closed Area II

David B. Rudders

Sally Roman

Sara Thomas

Virginia Institute of Marine Science

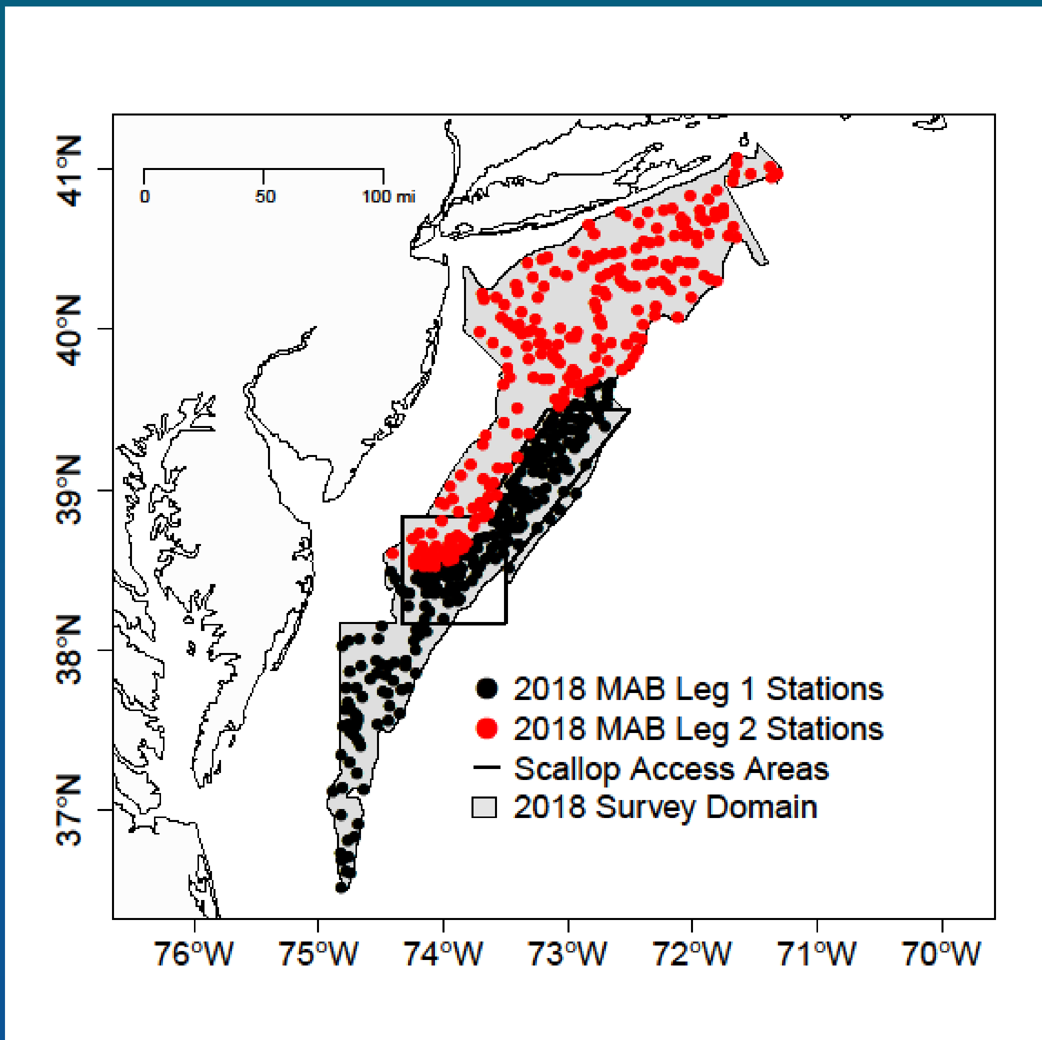
Sea Scallop Plan Development Team

Falmouth, MA

August 28-29, 2018

Preliminary – PDT use only.

2018 VIMS-Industry Cooperative Surveys
Mid-Atlantic Bight



First Leg

- F/V Carolina Capes II
- 5/4/18 - 5/13/18
- 227 Stations

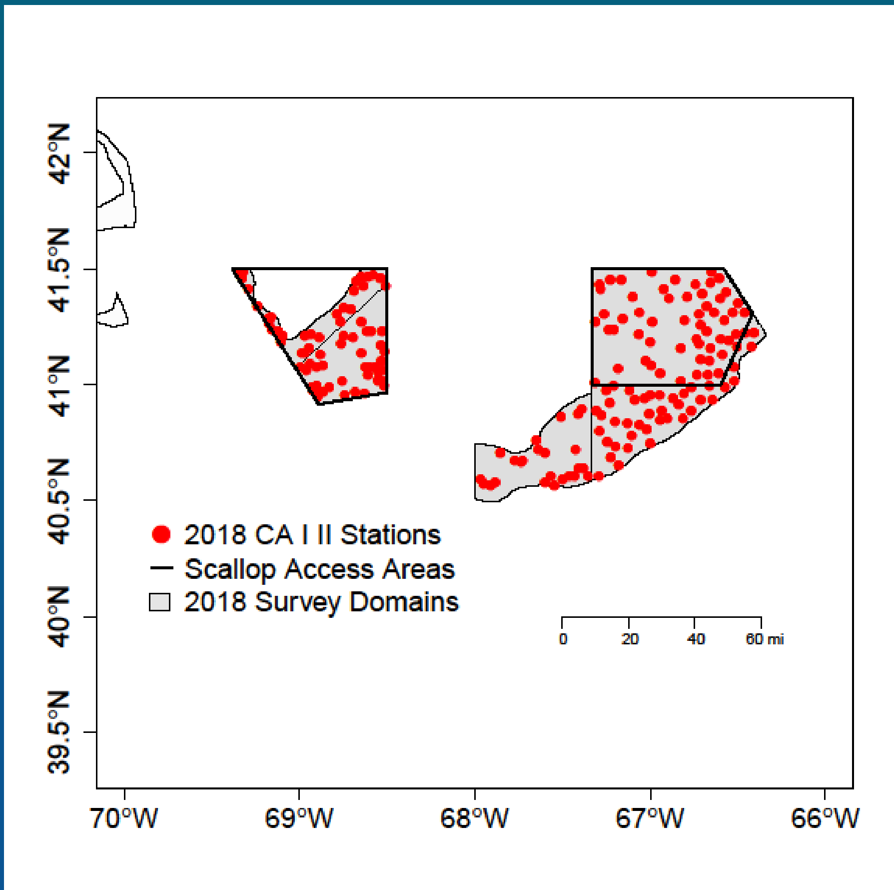
Second Leg

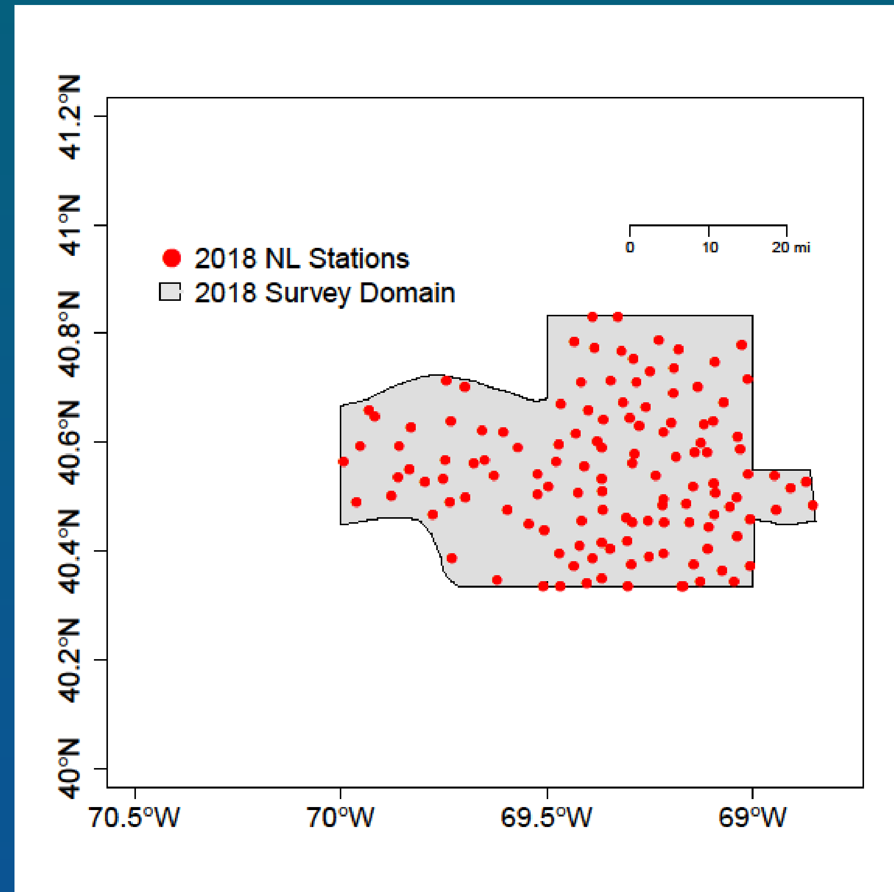
- F/V Italian Princess
- 5/19/18 - 5/29/18
- 223 Stations

Total

- 450 Stations

2018 VIMS-Industry Cooperative Surveys
CA I II and NLCA





- F/V Arcturus
- 6/8/18 - 6/16/18
- 189 Stations

- F/V Celtic
- 7/12/18 - 7/18/18
- 130 Stations

2018 VIMS-Industry Cooperative Surveys
Analytical Framework

- **Swept area method is used to calculate biomass estimates (Cochran, 1997)**
- **Area swept per tow (a_s)**
  - **Navigational info**
  - **Tilt sensor**
- **Catch weight per tow (C_h)**
  - **Expanded length frequencies**
  - **Length-weight relationship (SARC values or determined by PDT- SARC 65)**
  - **Selectivity (Yochum and DuPaul, 2008)**
- **Efficiency (E_s)**
  - **Values from SARC 2014**
    - **65%Commercial Dredge**
    - **40% NMFS Survey Dredge**

Stratified mean biomass per tow in stratum and subarea of interest

$$\bar{C}_{h,s} = \frac{1}{n_h}\sum_{i=1}^{h} C_{i,h,s}$$

Stratified mean biomass per tow in subarea of interest

$$\bar{C}_s = \sum_{h=1}^{L} W_h \cdot \bar{C}_{h,s}$$

Total biomass in subarea of interest

$$\widehat{B_s} = \left(\frac{\left(\frac{\bar{C}_s}{\bar{a}_s}\right)}{E_s}\right) A_s$$

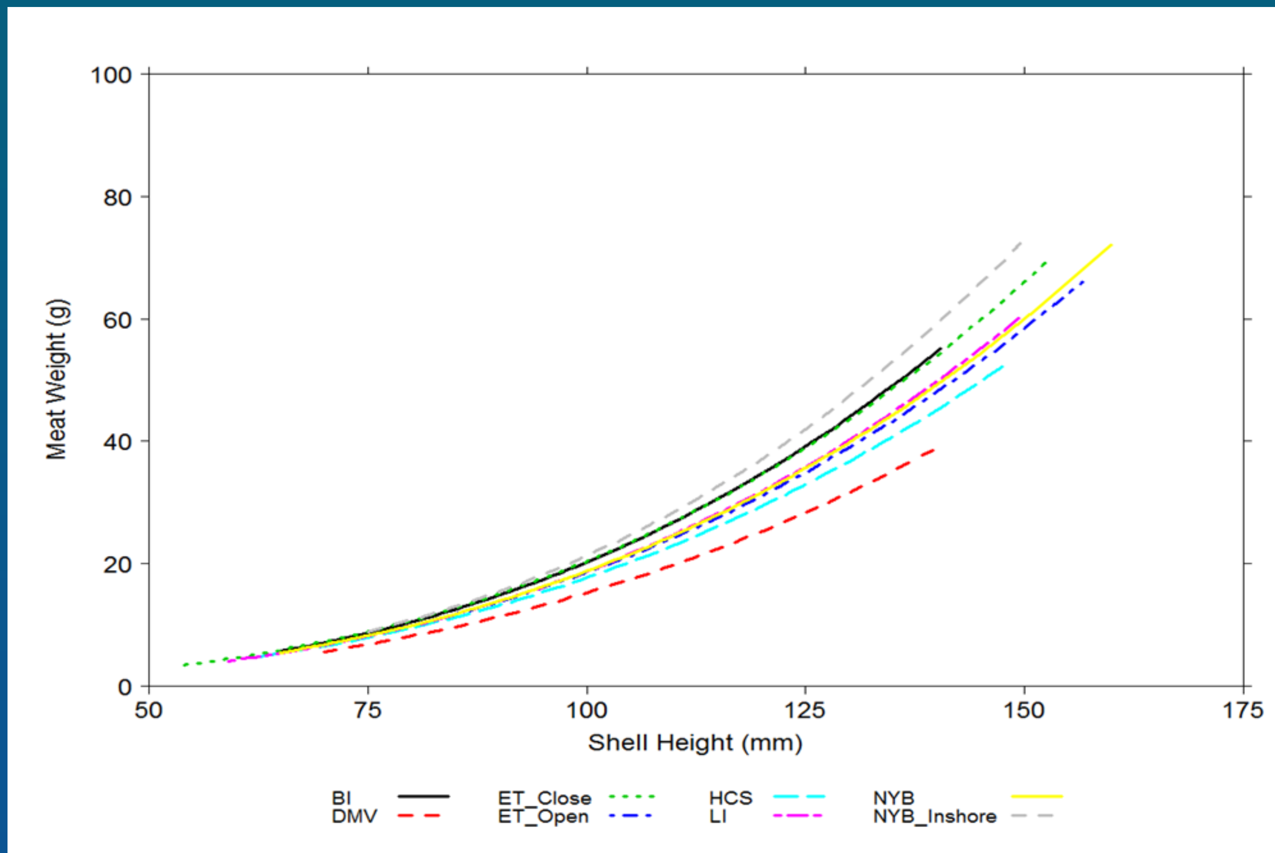
L = # of strata
n = # of stations in stratum h
h = stratum
i = station i in stratum h
s = subarea s in survey of interest
A_s = area of survey of interest in subarea s
E_s = gear efficiency estimate for subarea s

$\bar{a}_s$ = mean area swept per tow in subarea s
$\hat{B}_s$ = total biomass in subarea s
$\bar{C}_{h,s}$ = mean biomass caught per tow in stratum h for subarea s
$\bar{C}_s$ = stratified mean biomass caught per tow for subarea s
W_h = proportion of survey/subarea area in stratum h

2018 VIMS-Industry Cooperative Surveys
SH:MW Relationship

- SH:MW samples were taken from all stations that had scallops (15/station):
  - MAB Survey: 5,413 (380 stations)
  - CA I II Survey: 1,971 (157 stations)
  - NL Survey: 1,831 (113 stations)
- The objective is to construct a model to predict meat weight based on a suite of potential covariates (i.e. shell height, depth, SAMS area, sex, disease…).
- Average depth was calculated for each tow from tilt sensor
- A GLMM was used to fit model (Gamma distribution, log link, random effect at the station level) with R v 3.3.1 Package lme4.

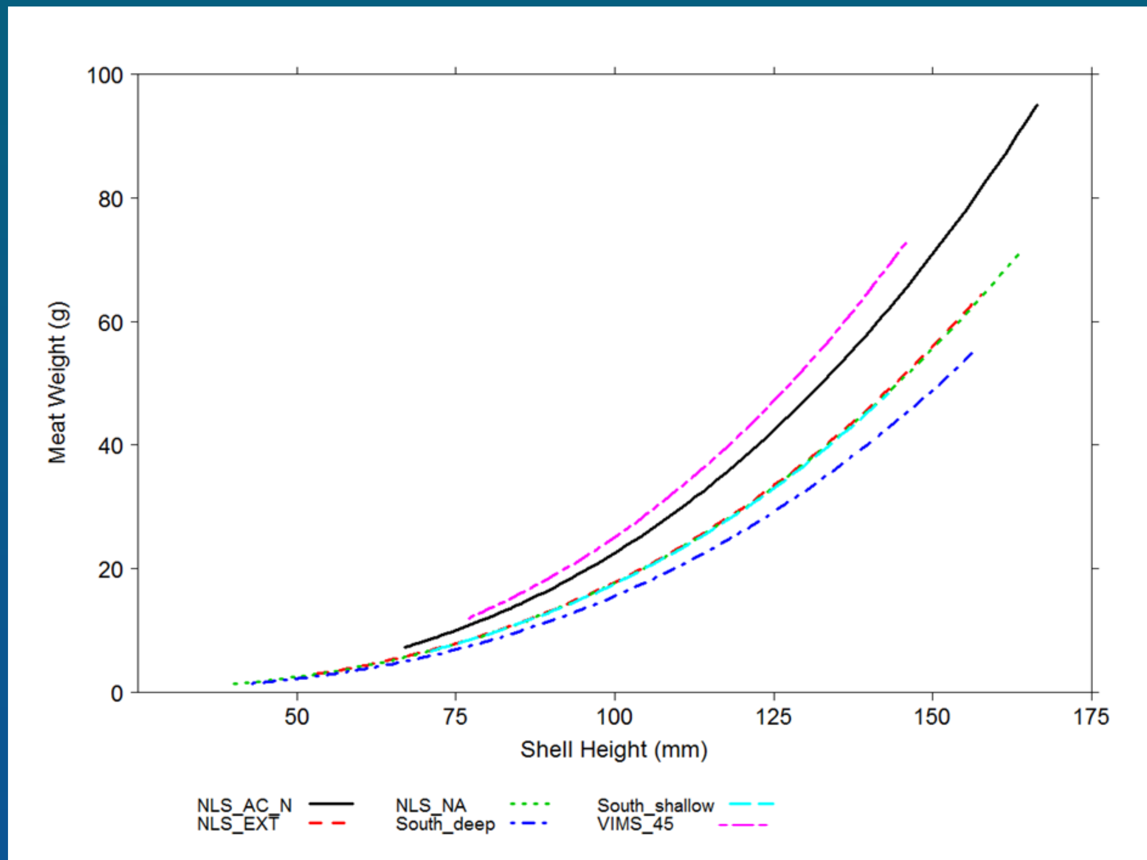
2018 VIMS-Industry Cooperative MAB Survey
SHMW Results



- Trend of increasing meat weight at length with latitude (SAMS Area) this year and results are similar 2017 SHMW relationships for the MAB

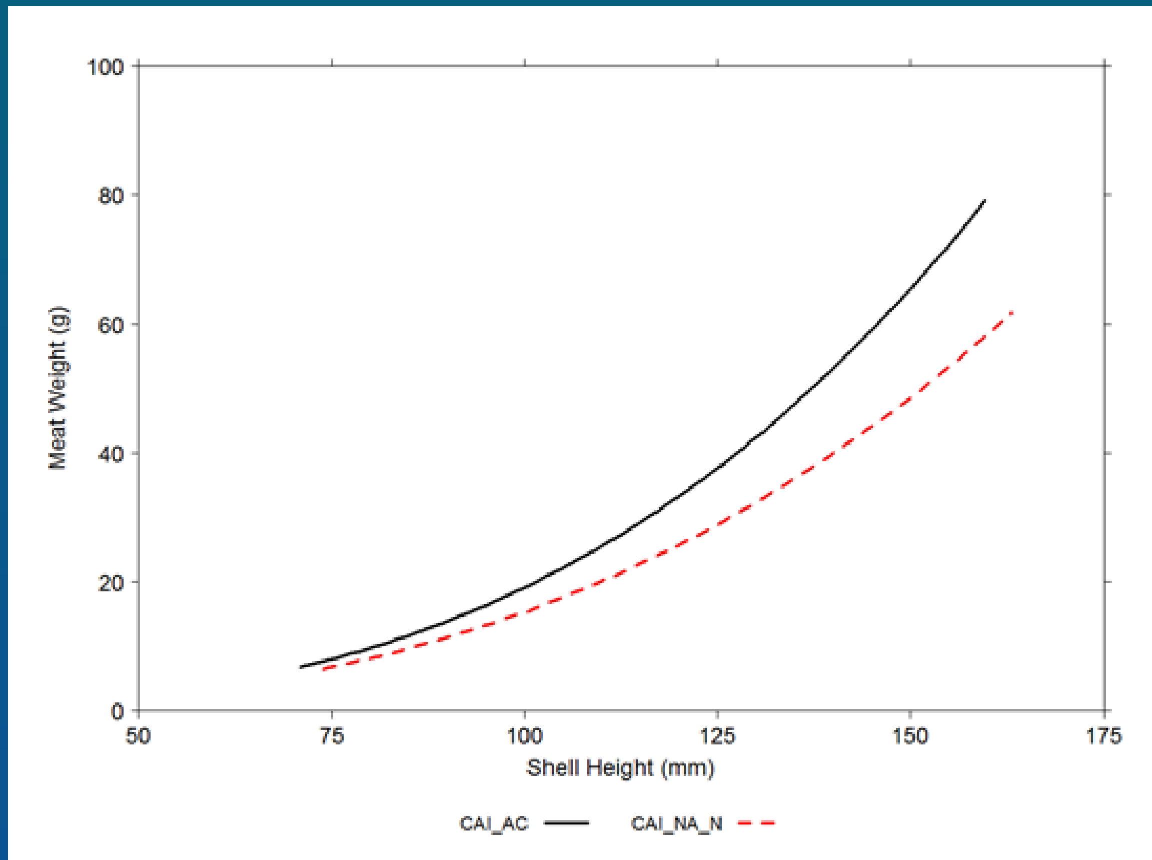
2016-2018 VIMS-Industry Cooperative NLCA Survey

SHMW Results



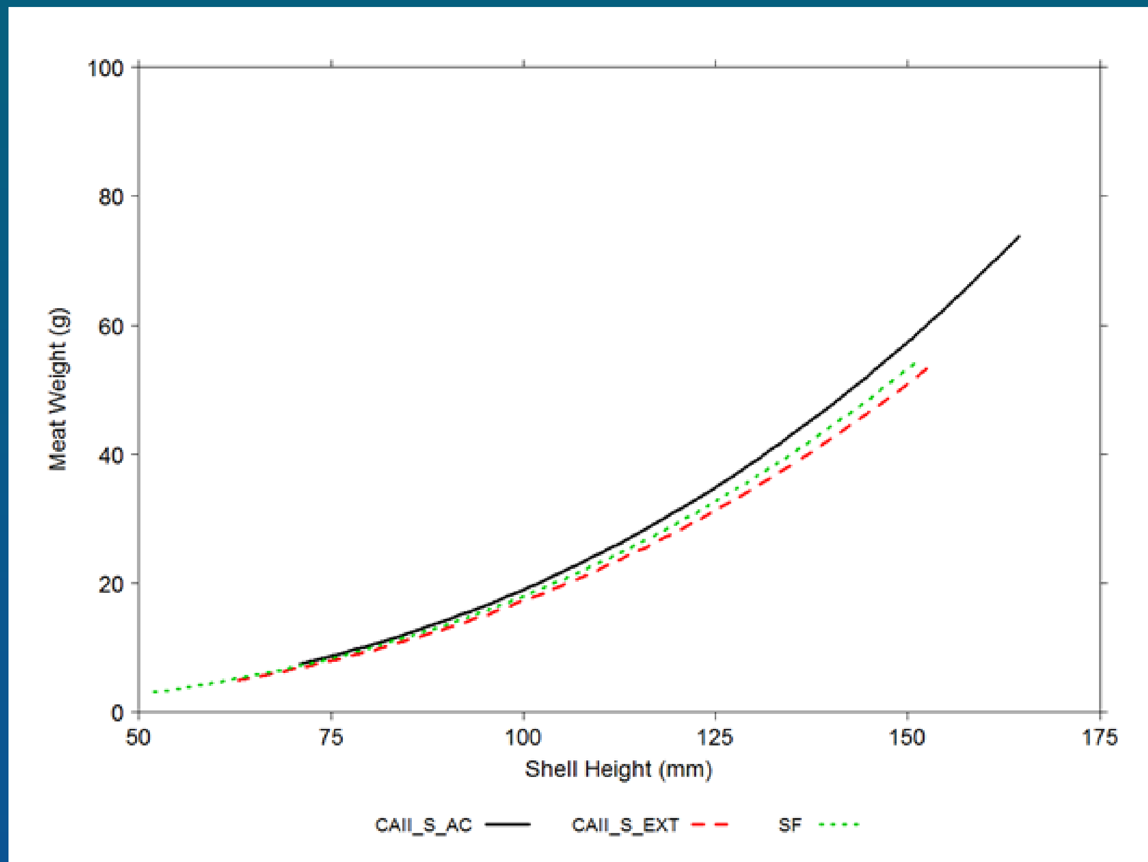
- Significantly different relationships for all SAMS Area except VIMS 45 compared to the Northern SAMS Area.

2018 VIMS-Industry Cooperative CA I Survey
SHMW Results



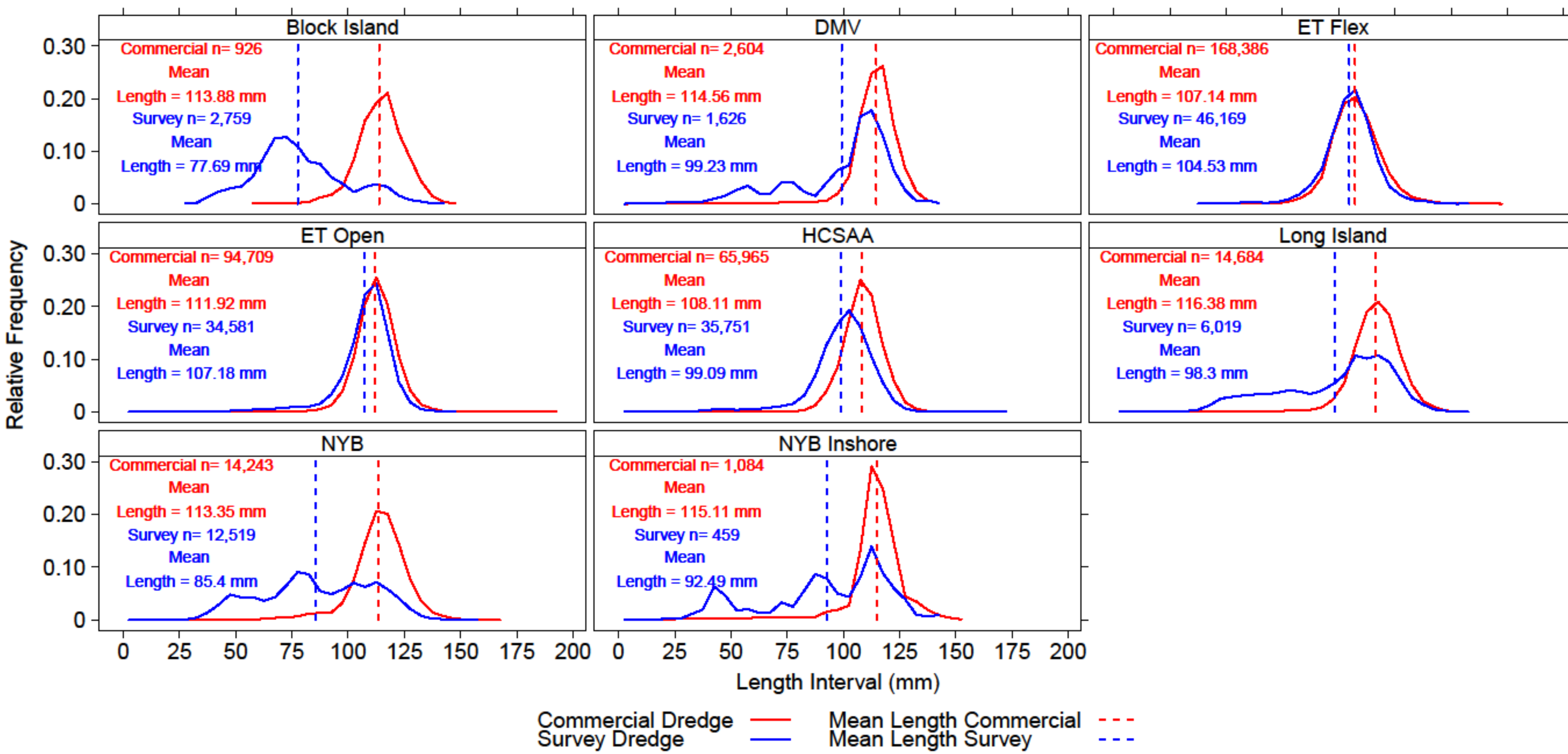
- Southern SAMS SHMW curve is greater than the Northern Area
- Likely a function of average depths for each of subarea, as well as the temporal spread of the sampling

2018 VIMS-Industry Cooperative CA II Survey
SHMW Results

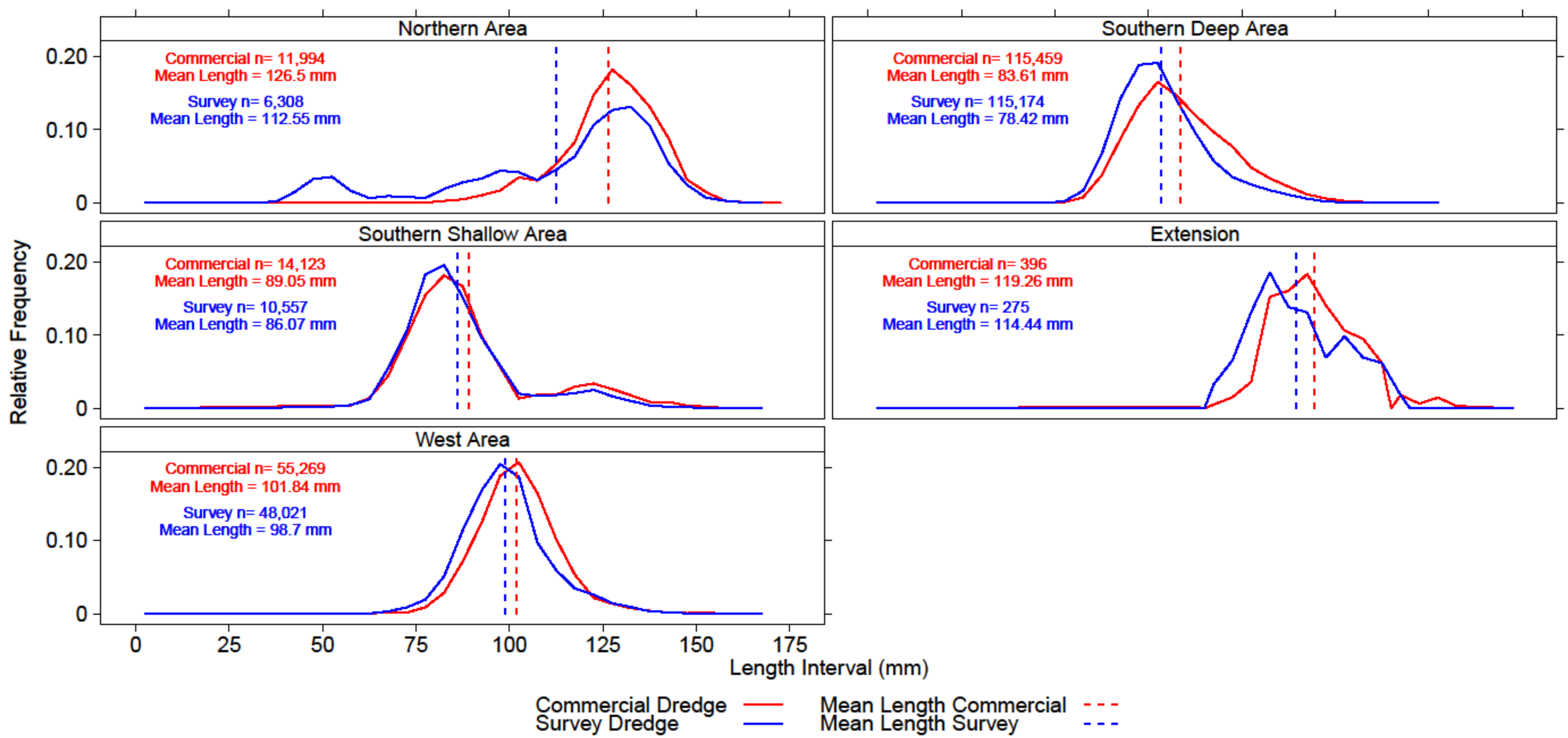


- Extension and Open Area SF SHMW curves are lower than the Northern Access Area

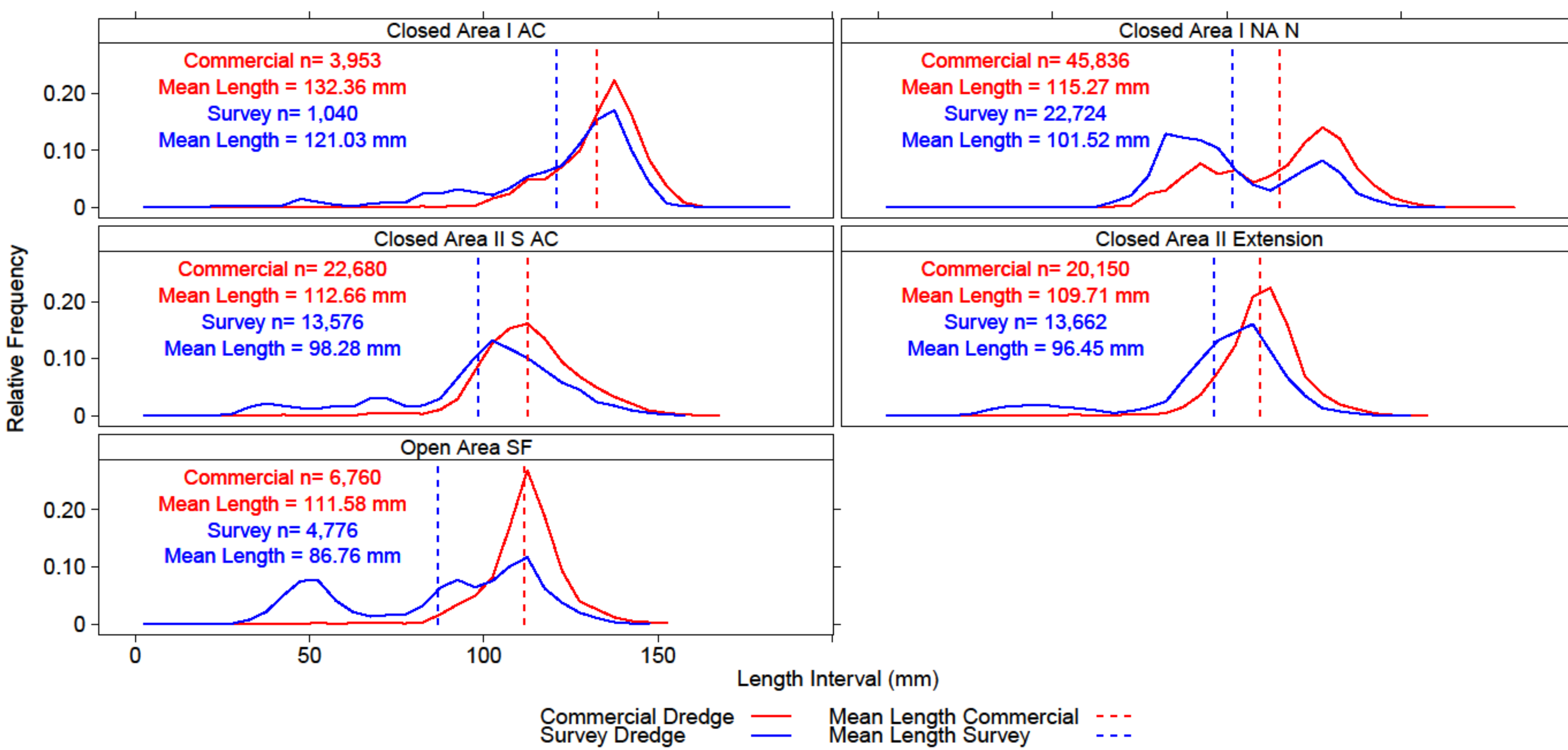
2018 VIMS-Industry Cooperative MAB Survey
Length Frequency- SAMS Areas



2018 VIMS-Industry Cooperative NLCA Survey
Length Frequency- SAMS Areas

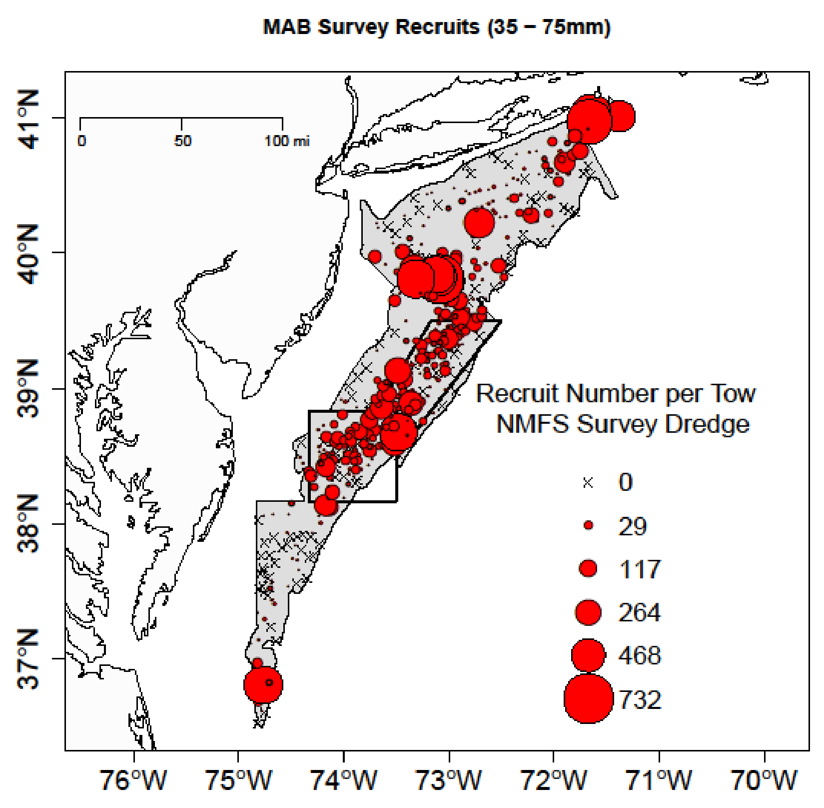


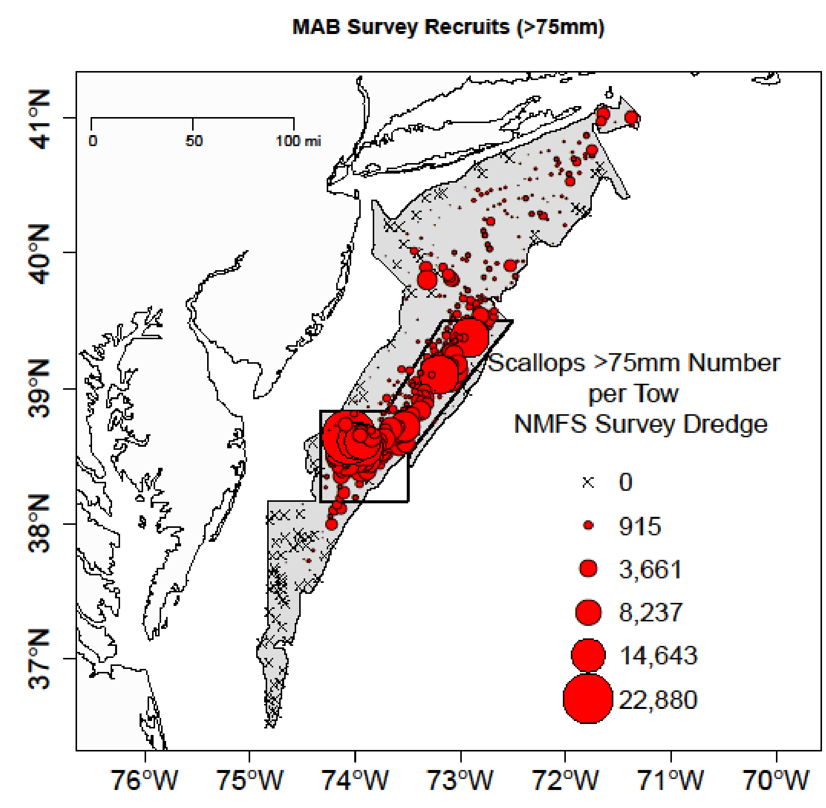
2018 VIMS-Industry Cooperative CA I II Survey
Length Frequency- SAMS Areas



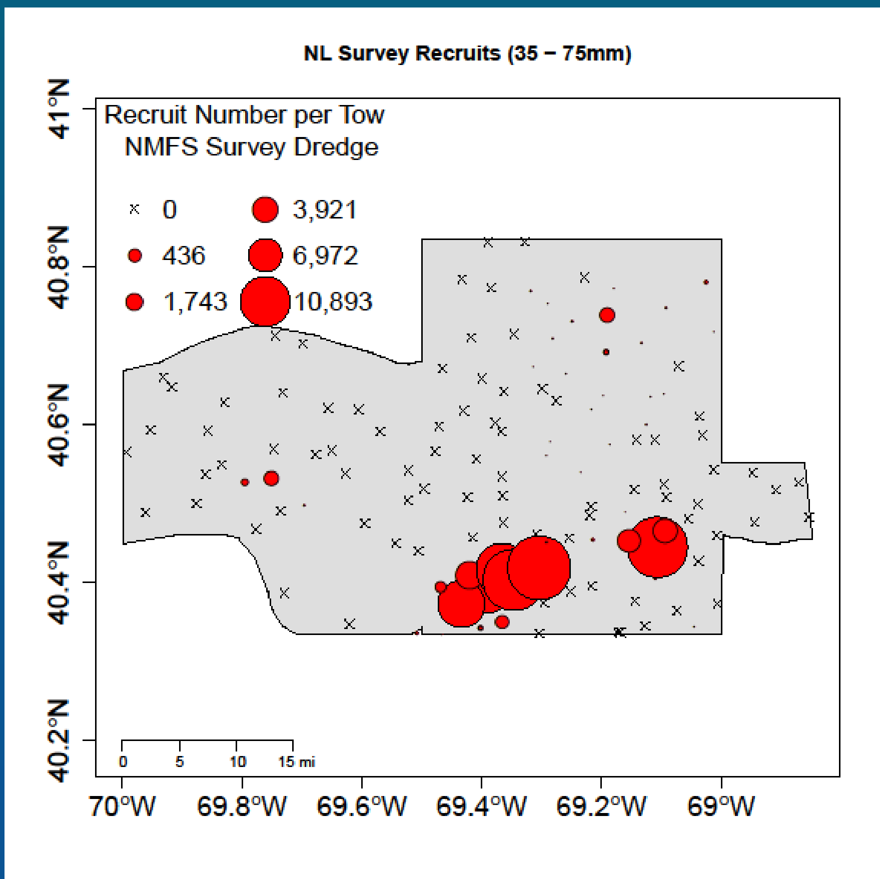
2018 VIMS-Industry Cooperative MAB Survey

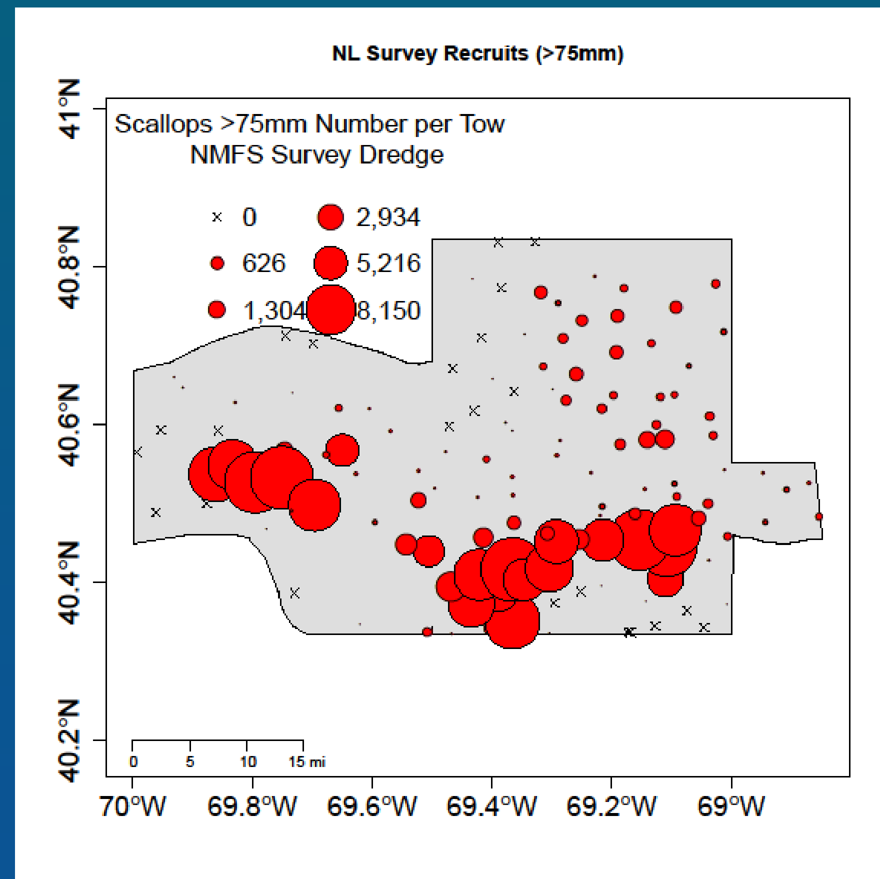
Scallop Distribution



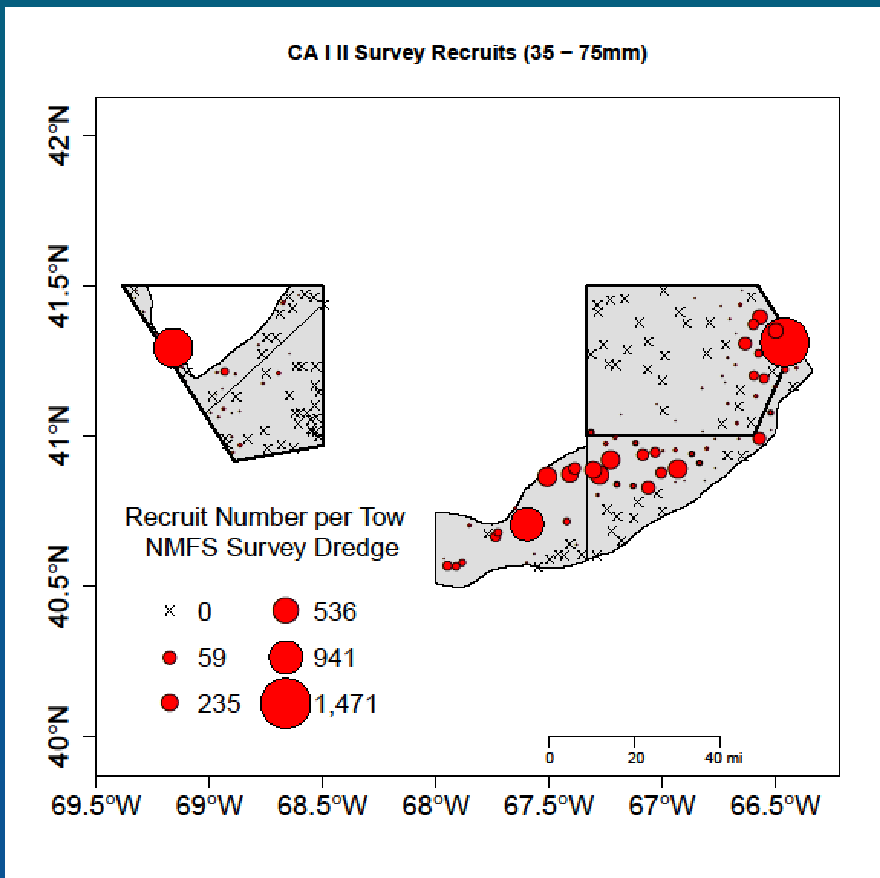


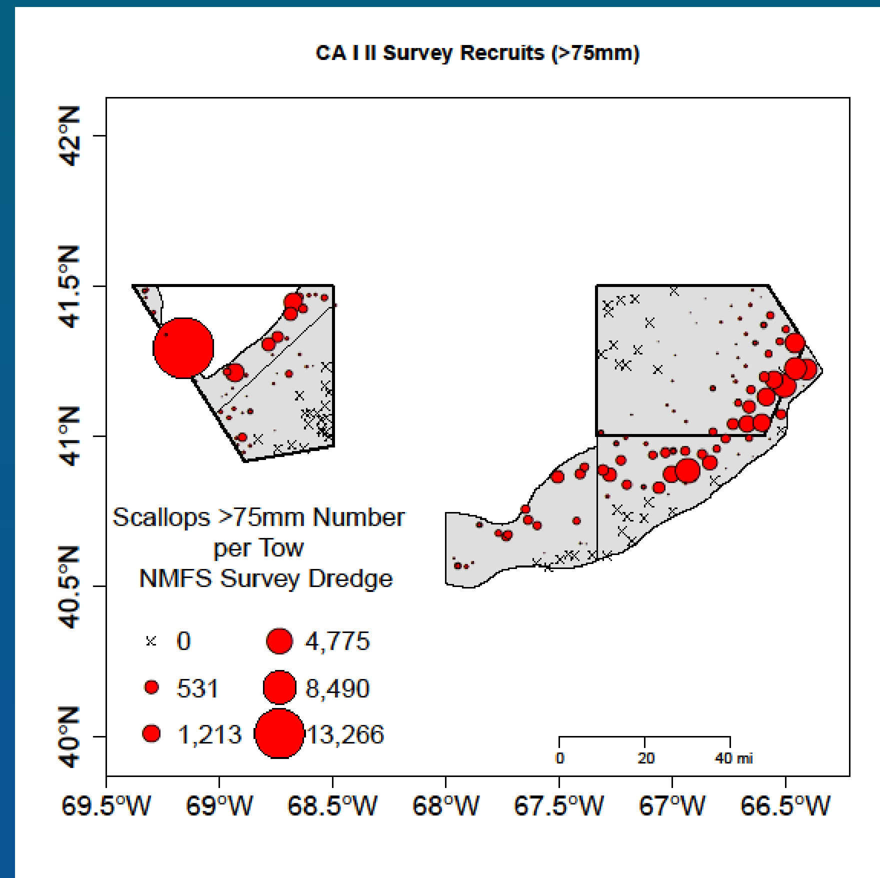
2018 VIMS-Industry Cooperative NLCA
Surveys Scallop Distribution





2018 VIMS-Industry Cooperative CA I II
Surveys Scallop Distribution





2018 VIMS-Industry Cooperative Surveys

Total Biomass – SAMS Areas

SAMS Area	Total Biomass (mt)	SE Biomass (mt)	CV Biomass (mt)	Density (scal/m^2)	Avg MW (g)	Total Number
BI	2,572.29	243.9	23.7	0.25	12.01	217,817,496
LI	8,790.28	470.51	13.38	0.03	20.51	428,240,799
NYB	6,662.31	770.64	28.92	0.12	13.37	512,746,047
MA Inshore	931.16	170.47	45.77	0.02	18.58	50,430,227
HCSAA	13,514.22	853.36	15.79	0.27	17.26	786,604,209
ET Flex	18,017.59	1,196.50	16.6	0.76	20.57	887,649,787
ET Open	15,126.01	709.69	11.73	0.36	21.51	714,719,928
DMV	1,149.53	160.81	34.97	0.02	18.53	63,000,193
VIR	79.42	19.04	59.95	0.03	1.31	60,972,878
NLS_AC_N	3,903.67	207.81	13.31	0.09	38.3	107,655,195.70
NLS_AC_S_DEEP	9,799.14	874.19	22.3	1.84	7.8	1,247,918,295.50
NLS_AC_S_SHALLOW	3,545.32	722.02	50.91	0.78	18.06	196,340,172.60
NLS_EXT	136.84	12.88	23.53	0.03	32.27	4,240,617.60
NLS_West	21,642.34	2,627.27	30.35	0.68	26.21	798,406,571.10
VIMS_45	7.78	2.01	64.57	0	47.13	164,990.60
CAI_AC	1,137.34	138.31	30	0.03	43.23	26,382,669
CAI_NA_N	8,888.71	1,432.35	40	0.46	26.2	324,965,631
CAII_S_AC	8,875.33	687.95	19	0.17	24.8	344,346,037
CAII_S_EXT	7,230.23	688.04	24	0.21	19.33	375,172,617
SF	3,447.58	309.37	22	0.11	16.71	206,330,069

2018 VIMS-Industry Cooperative Surveys

Exploitable Biomass Survey – SAMS Areas

SAMS Area	Exp Biomass (mt)	SE Biomass (mt)	CV Biomass (mt)	Density (scal/m^2)	Avg MW (g)	Exp Number
BI	927.5	90.83	24.48	0.05	21.94	43,097,734.90
LI	6,103.02	334.09	13.69	0.018	27.57	220,817,010.10
NYB	3,193.47	242.1	18.95	0.04	22.03	144,958,011.50
MA Inshore	595.58	118.95	49.93	0.007	26.52	22,464,156.80
HCSAA	7,586.50	414.8	13.67	0.133	19.6	388,201,041.80
ET Flex	11,546.29	742.63	16.08	0.447	22.33	501,910,317.10
ET Open	10,543.80	505.23	11.98	0.231	23.11	457,378,767.50
DMV	771.67	107.47	34.82	0.01	23.18	33,219,891.20
VIR	0.38	0.08	49.24	0	1.88	212,200.70
NLS_AC_N	3,260.78	172.65	13.24	0.07	46.75	70,686,624.20
NLS_AC_S_DEEP	2,460.12	231.42	23.52	0.29	12.03	201,416,118.40
NLS_AC_S_SHALLOW	1,376.84	202.91	36.84	0.19	27.43	50,191,068.90
NLS_EXT	108.28	11.28	26.03	0.02	34.54	3,134,925.40
NLS_West	12,591.91	1,501.94	29.82	0.33	29.95	406,111,567.80
VIMS_45	6.62	1.71	64.74	0	51.07	129,542.80
CAI_AC	1,003.69	119.17	30	0.02	48.64	20,570,022
CAI_NA_N	5,949.09	659.32	28	0.23	33.13	175,033,057
CAII_S_AC	6,164.89	421.25	17	0.09	32.13	184,198,349
CAII_S_EXT	4,433.65	437.81	25	0.1	24.01	183,009,790
SF	2,112.21	191.53	23	0.04	26.57	79,484,292

2018 VIMS-Industry Cooperative Surveys
Exploitable Biomass - Commercial by SAMS Areas

SAMS Area	Exp Biomass (mt)	SE Biomass (mt)	CV Biomass (mt)	Density (scal/m^2)	Avg MW (g)	Exp Number
BI	474.72	71.48	23.17	0.02	30.18	15,980,143
LI	8,863.35	658.72	11.43	0.02	30.14	292,590,857
NYB	3,534.80	293.34	12.77	0.04	27.56	122,851,362
MA Inshore	949.18	361.08	58.52	0.01	29.46	32,228,479
HCSAA	18,692.46	2,003.44	16.49	0.62	23.36	750,740,058
ET Flex	12,193.59	907	11.44	0.25	24.7	492,507,928
ET Open	7,341.13	809.31	16.96	0.11	22.25	329,856,061
DMV	679.36	170.21	38.54	0.01	25.49	26,648,044
VIR	0	0	0	0	0	0
NLS_AC_N	2,715.98	241.56	13.68	0.05	48.86	55,575,435.40
NLS_AC_S_DEEP	1,442.60	222.5	23.73	0.15	14.22	101,140,484.70
NLS_AC_S_SHALLOW	872.12	197.17	34.78	0.11	31.52	27,671,940.60
NLS_EXT	65.77	8.66	20.26	0.01	37.66	1,746,595.50
NLS_West	5,735.35	1,087.27	29.17	0.15	31.1	181,551,040.10
VIMS_45	6.75	1.98	45.18	0	53.39	126,370.20
CAI_AC	1,551.35	248.77	25	0.03	52.9	28,985,404.48
CAI_NA_N	6,986.45	859.31	19	0.22	37.75	183,166,619.29
CAII_S_AC	5,202.97	487.26	14	0.07	35.33	140,890,700.35
CAII_S_EXT	3,649.74	542.41	23	0.07	27.76	130,468,711.79
SF	2,011.38	360.54	28	0.04	30.25	66,483,411.57

SARC 65 Total Biomass Estimates Compared to VIMS 2016-18 Estimates NL

SAMS Area	SARC 65		VIMS 2016-18	
	Total Biomass (mt)	Avg MW (g)	Total Biomass (mt)	Avg MW (g)
NLS_AC_N	3,903.67	38.3	3,607.85	35.59
NLS_AC_S_DEEP	9,799.14	7.8	10,320.88	8.22
NLS_AC_S_SHALLOW	3,545.32	18.06	2,111.41	10.75
NLS_EXT	136.84	32.27	111.98	26.41
NLS_WEST	21,642.34	26.21	14,929.89	18.07
VIMS_45	7.78	47.13	6.79	41.16

VIMS

Acknowledgements

- The owners, captains and crews;
  - F/V *Carolina Capes II*
  - *F/V Italian Princess*
  - F/V *Arcturus*
  - F/V *Celtic*

- Lee Rollins, Kelly Lewis, Victoria Thomas, Matthew Cunningham, Chase Long, Theresa Redmond and Patricia Perez

- Support from NMFS NEFSC: Dvora Hart and Pete Chase.

- Funding through Sea Scallop RSA program.

Appendix B

2018 update on the nematode, *Sulcascaris sulcata*: Spatial distribution and effect on the sea scallop fishery

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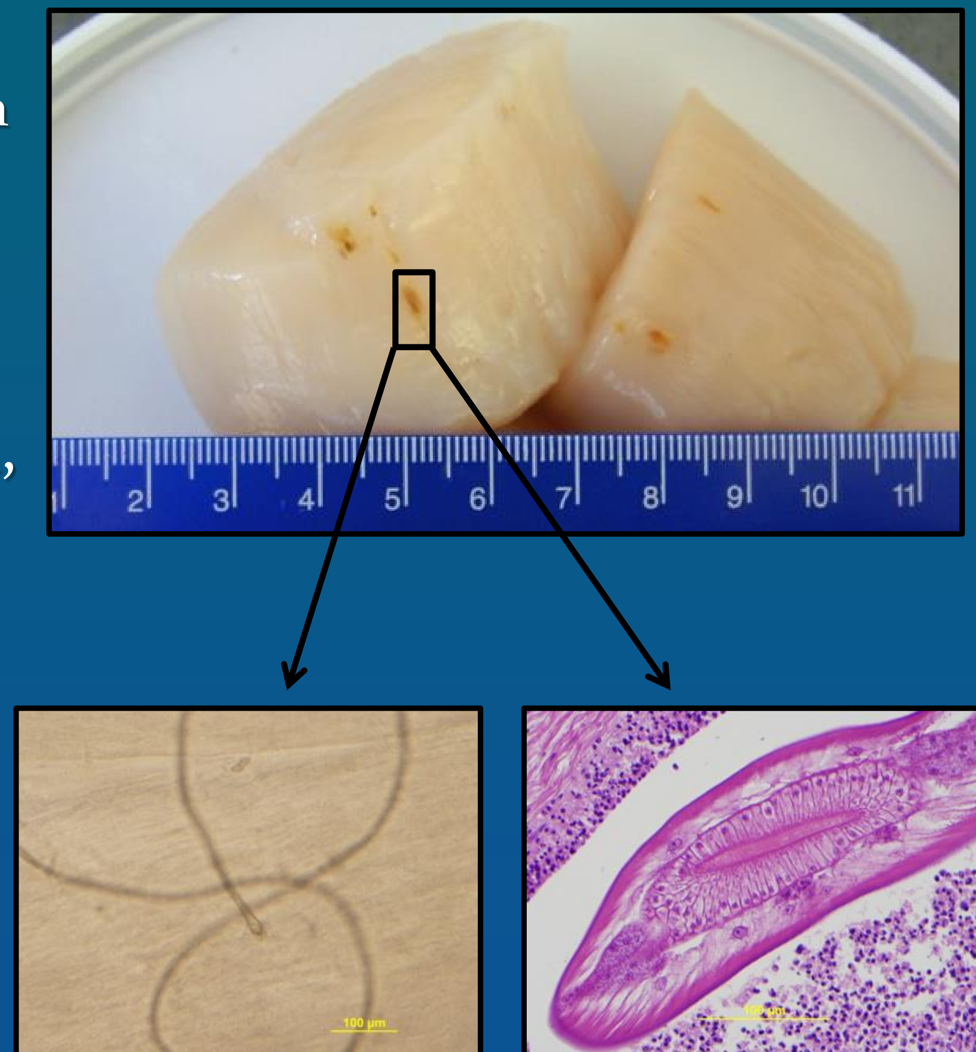
Sea Scallop Plan Development Team
Falmouth, MA
August 28-29, 2018

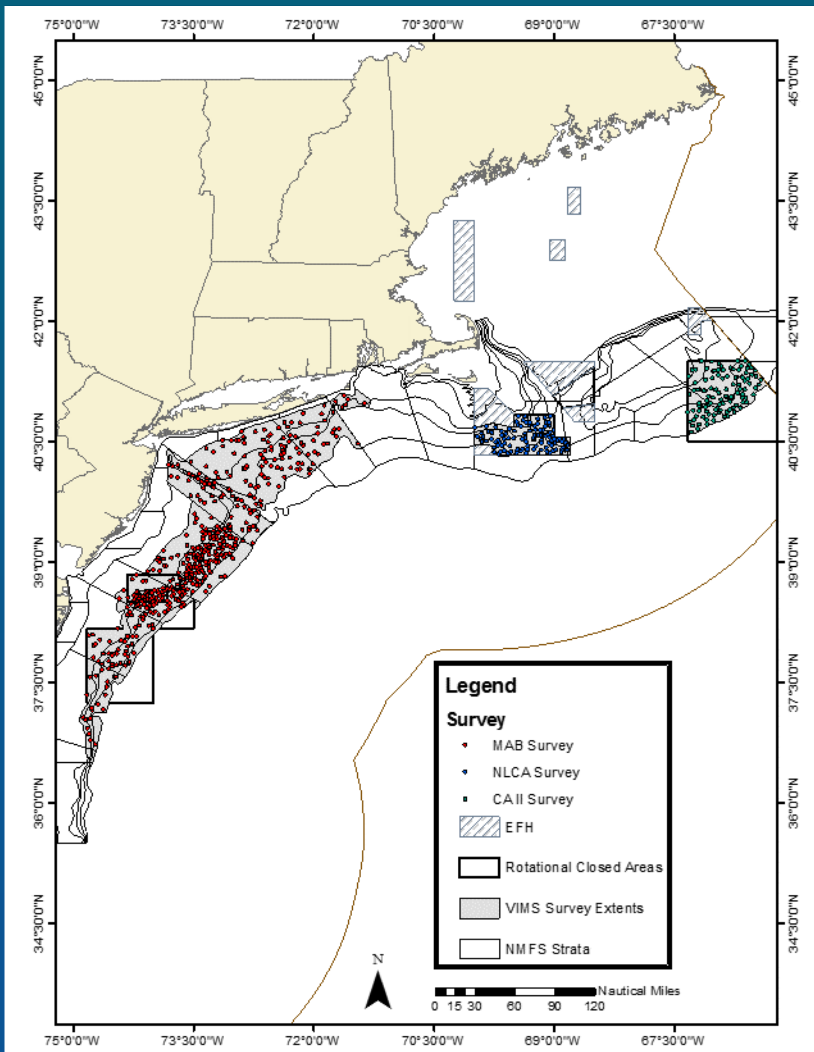
VIMS | William & Mary
Virginia Institute of Marine Science

A re-emerging epizootic

- Nematodes were first observed in 2015 in the newly re-opened MAAA.
- Initial research efforts have focused on species identification, biology, life history and spatial distribution.
- 4 years of survey information related to spatial extent of affected scallops.

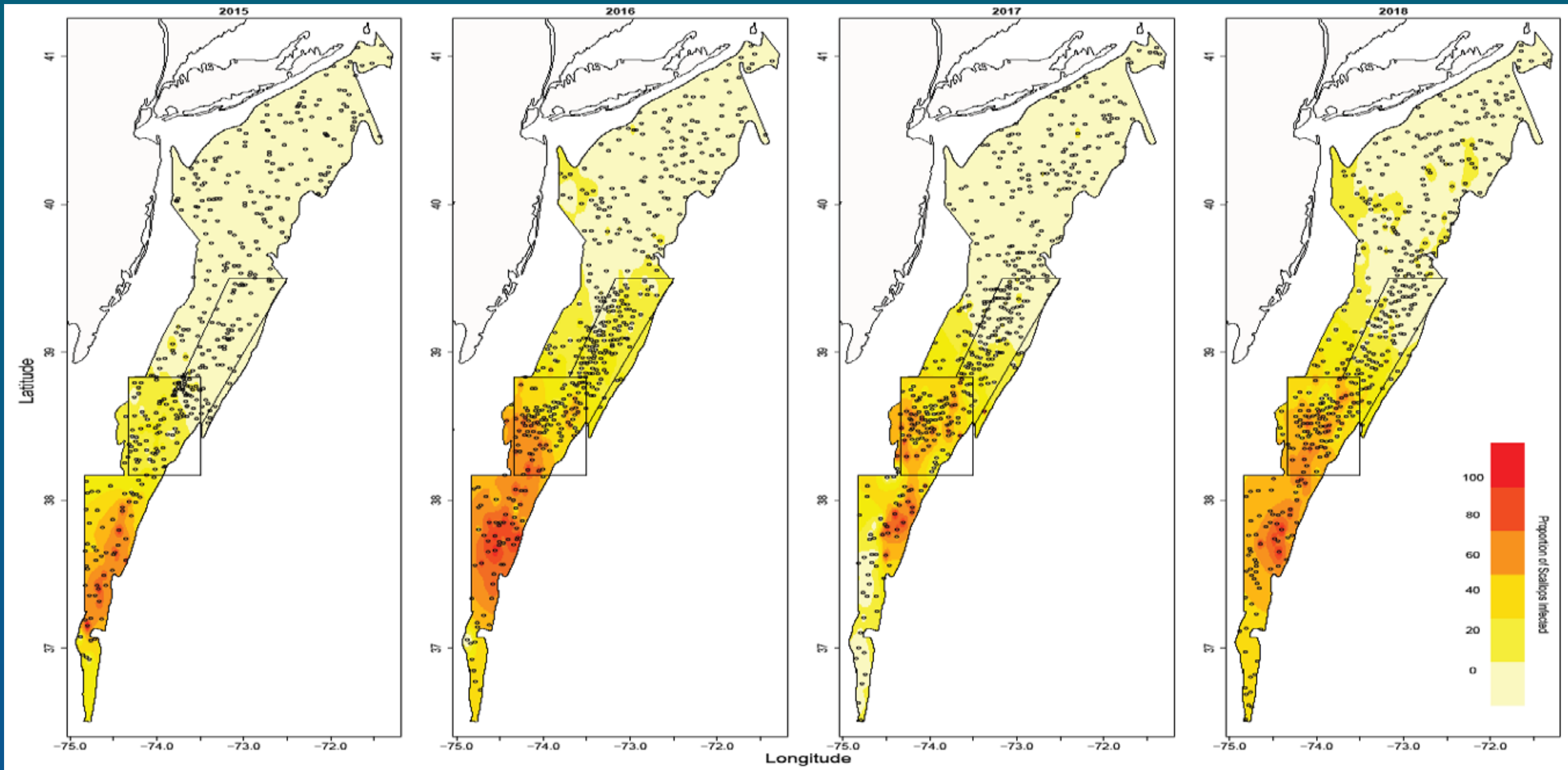


Parasite surveillance



- For the 2015-18 surveys, VIMS expanded the biological sampling protocol to capture the spatial extent of the parasite as well as the prevalence and intensity of infected scallops.
- Sampled 15 animals at every station that had scallops .
  - Histological and genetic samples.
  - Gross observation of the number of infected scallops/sample (prevalence).
  - Gross observation of the number of nematodes/scallop (intensity).

Nematode Prevalence 2015-18



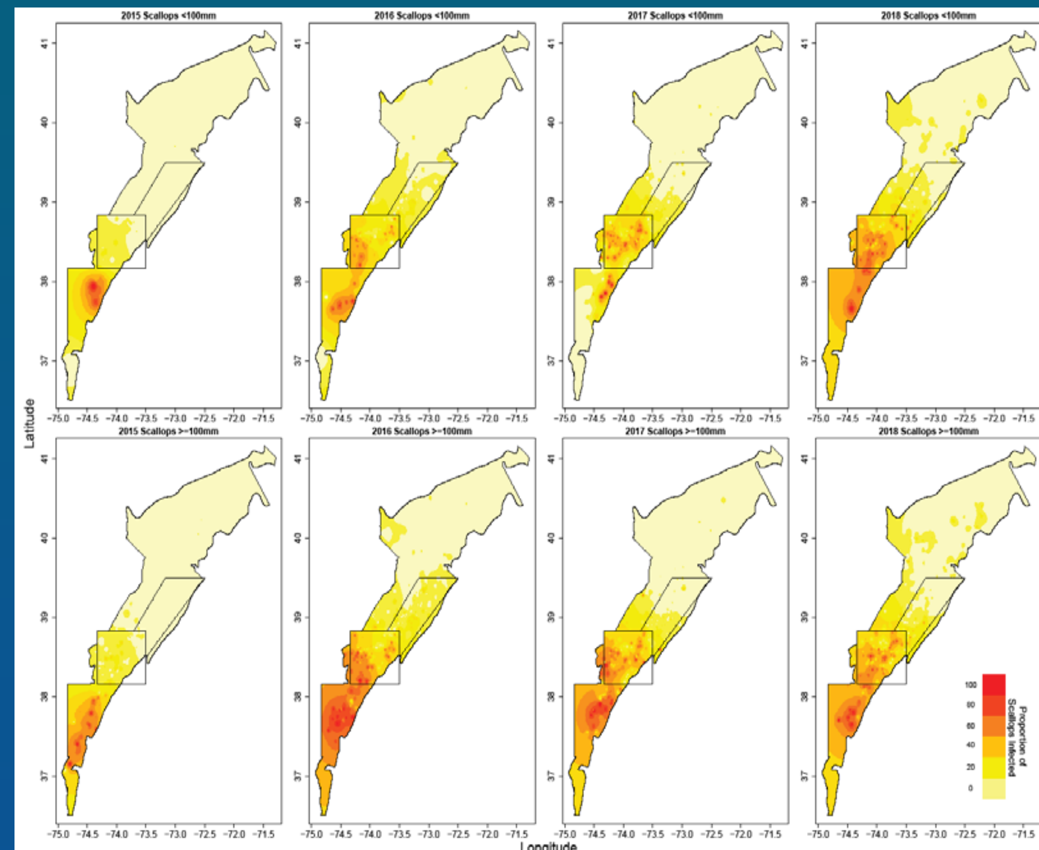
- % of scallops in a sample that contain at least one lesion.
- Northward expansion 2015-16.
- Apparent stabilization of the spatial extent 2016-17.
- Possible slight northward expansion from 2017-18.

Size-based nematode prevalence 2015-18

- Spatial distribution of the prevalence of the parasite in sampled scallops by year and size class

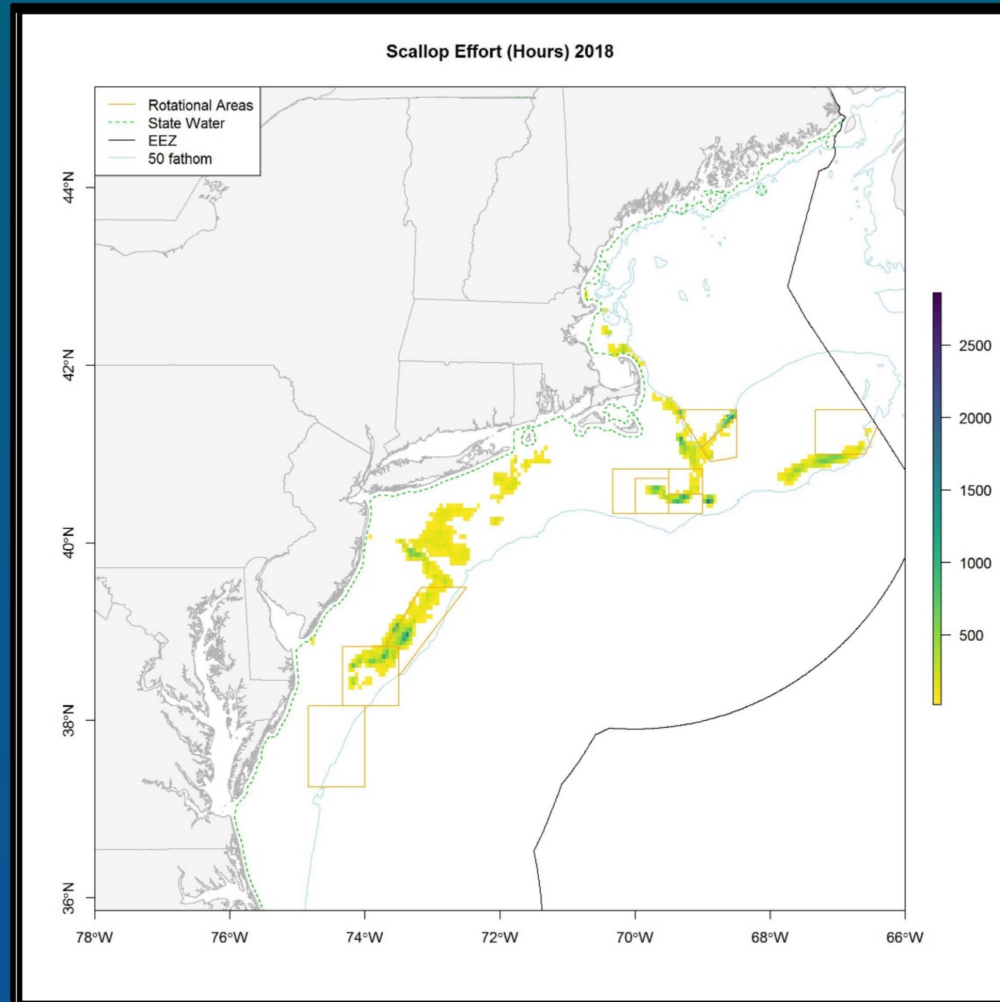
- Smaller sizes appear to be less infected over time 2015-17, convergence in 2018 as a dominant year class grows.

- The spatial extent of infections in larger scallops has contracted in 2017 compared to 2016, but the extent still covers the majority of the southern range.

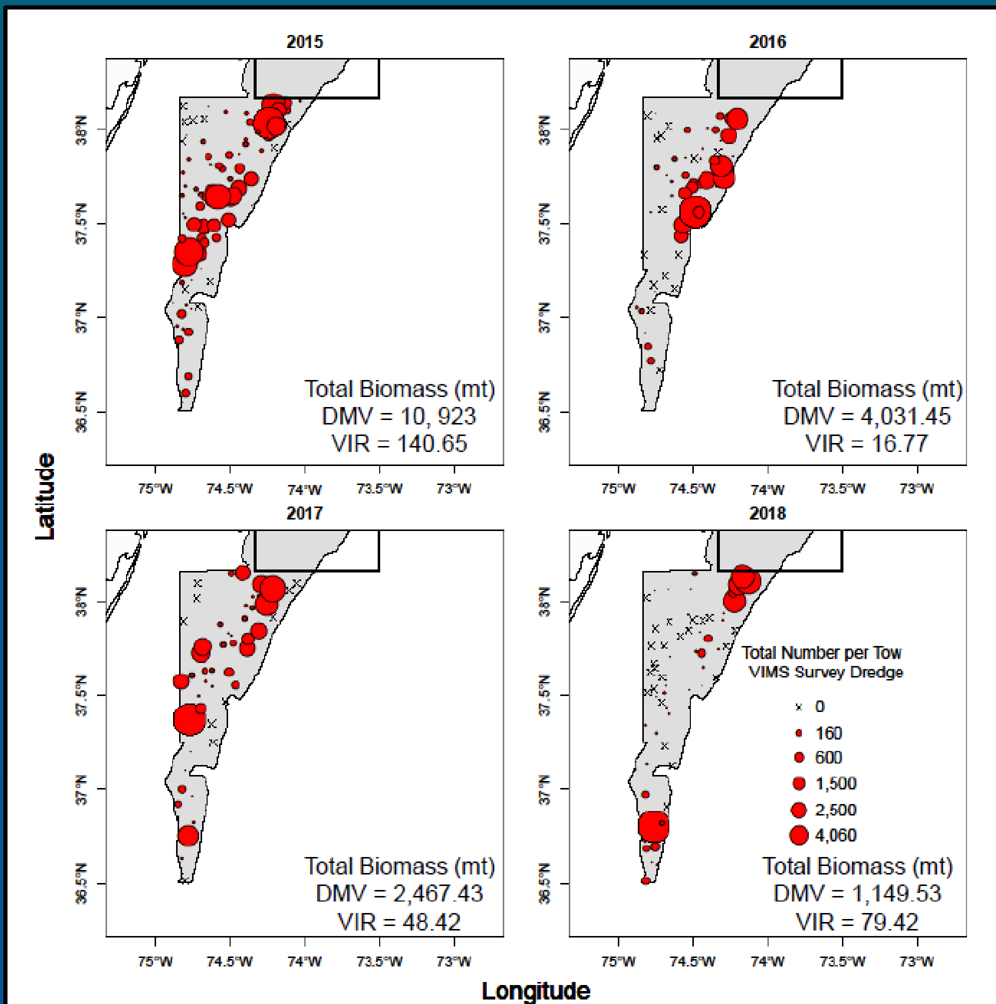


2010-18 Fishing Effort

- Aggregate annual fishing effort.
- MAAA effort centered upon “flex and HC portions.
- Very little effort in Southern ET and DelMarVa.
- Potentially influenced by product quality issues?

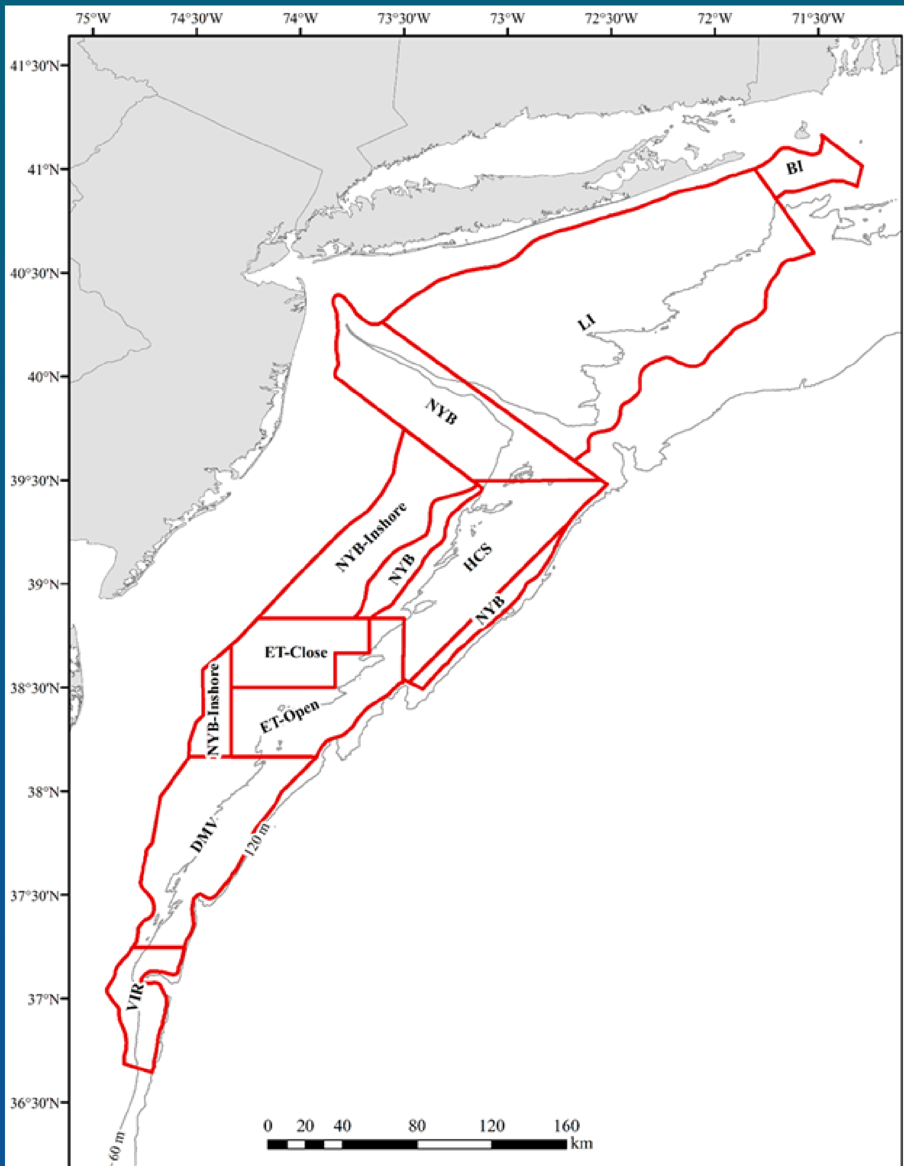


The demise of the DMV



- We assume that the nematode does not contribute to scallop mortality.....but
- Scallop biomass in the DMV had been reduced by an order of magnitude over 3 years in the absence of significant fishing.

Stock assessment/management considerations



- The assessment model is not designed to consider sub-lethal effects.
- Forward projection model (SAMS) can at least be forced to account for some of the observed effects on the spatial distribution of effort and resulting effects on F.

Summary

- Data suggests that nematode distribution appeared quickly, but has been relatively stable over the time series.
- Southern areas of the resource (i.e. DMV, ETCA) are most affected.
- Distribution in affected areas is patchy.
- Larger scallops appear to be more likely to be affected.
- Contributing to elevated mortality???
- Nematodes appear to be affecting the distribution of fishing effort.

Concluding thoughts

- Disease/parasites can represent a significant driver.
- For scallops grey meats and nematodes have the potential to shape how we view the resource.
- Indirect effects can be important
  - Elevated levels of F (from discards)
  - Redistribution of fishing effort.
- Effective biomass may be an appropriate framework.
  - All scallops may not be equal, but more nuanced that dead/alive.

Appendix C

Length Frequency and SHMW Relationships for ET and NL

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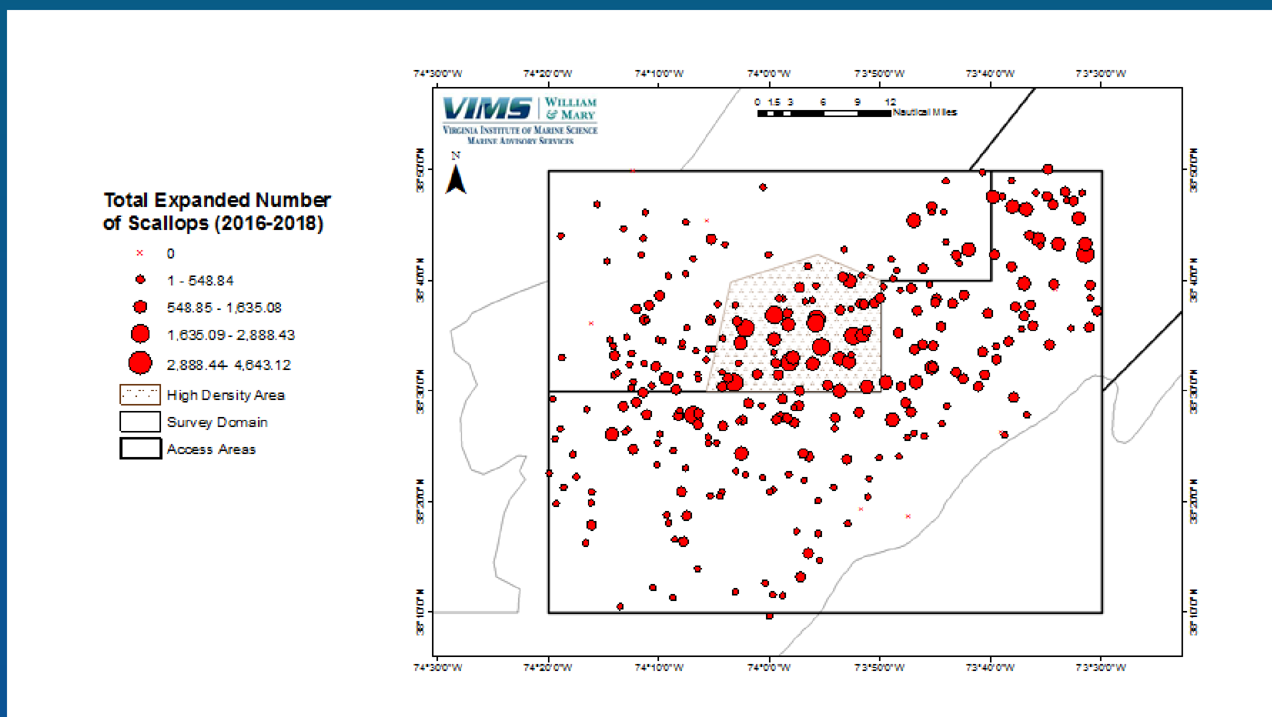
Virginia Institute of Marine Science

Sea Scallop Plan Development Team
Falmouth, MA
August 28-29, 2018

Preliminary – PDT use only.

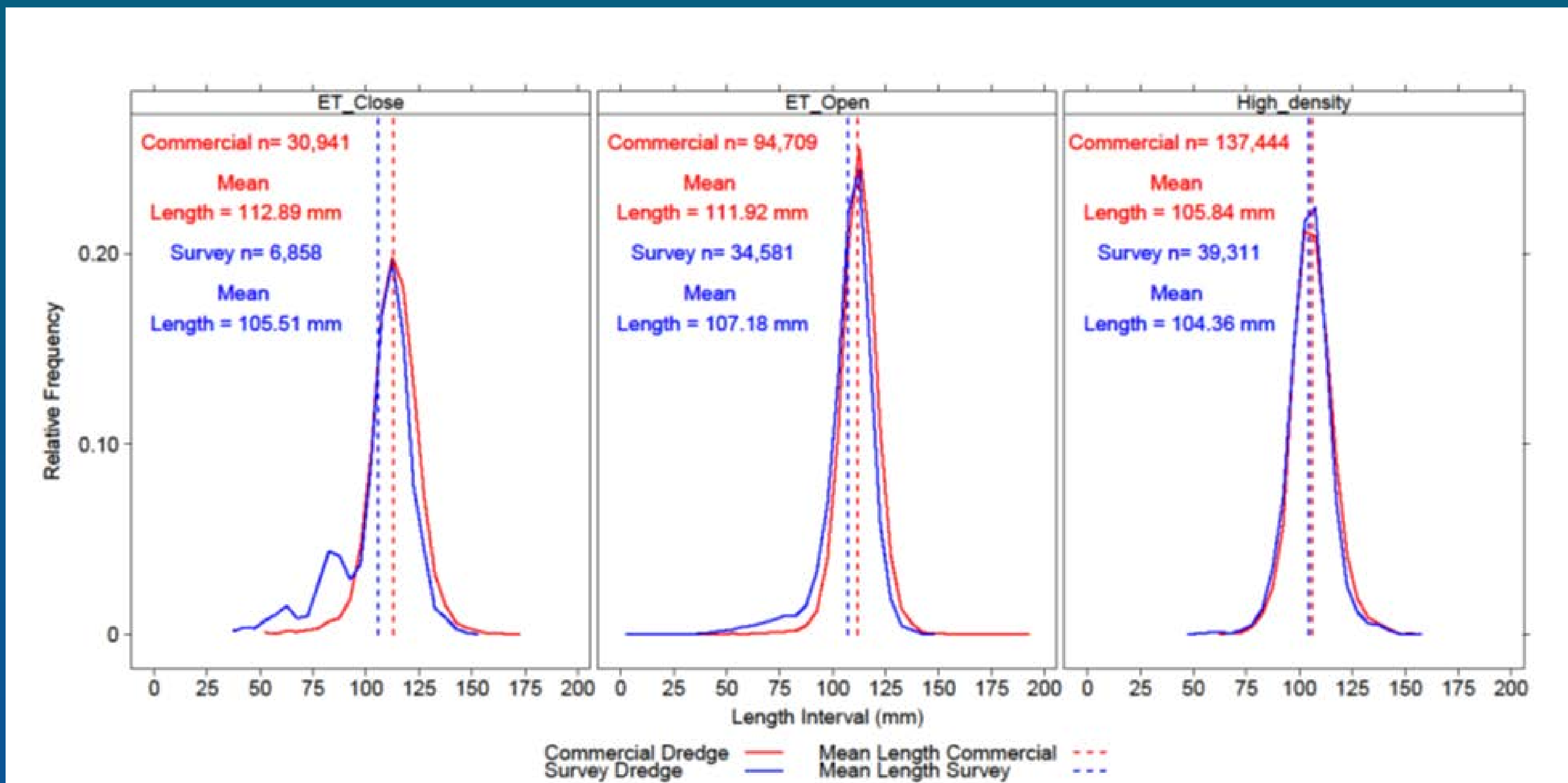
ET

- ET Flex SAMS area was separated into a High Density Area and the remainder of the ET Flex area.
- ET was also divided into the same High Density Area and the rest of the ET (ET Flex and ET Open combined).
- Data are from the VIMS 2018 survey for both the survey and commercial dredges.
- SHMW relationships and length frequency data



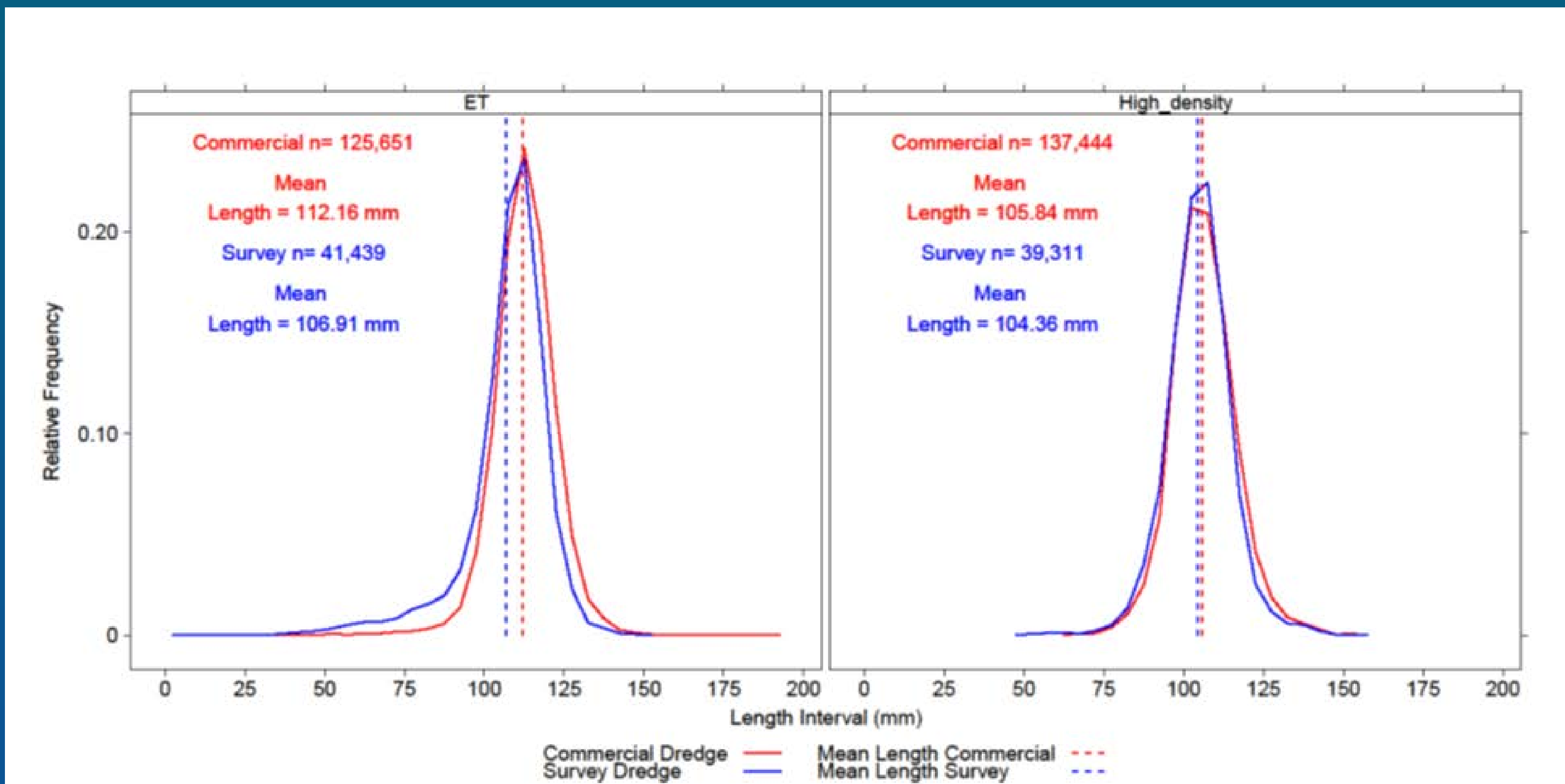
ET Length Frequencies

- Relative length frequencies by gear and area

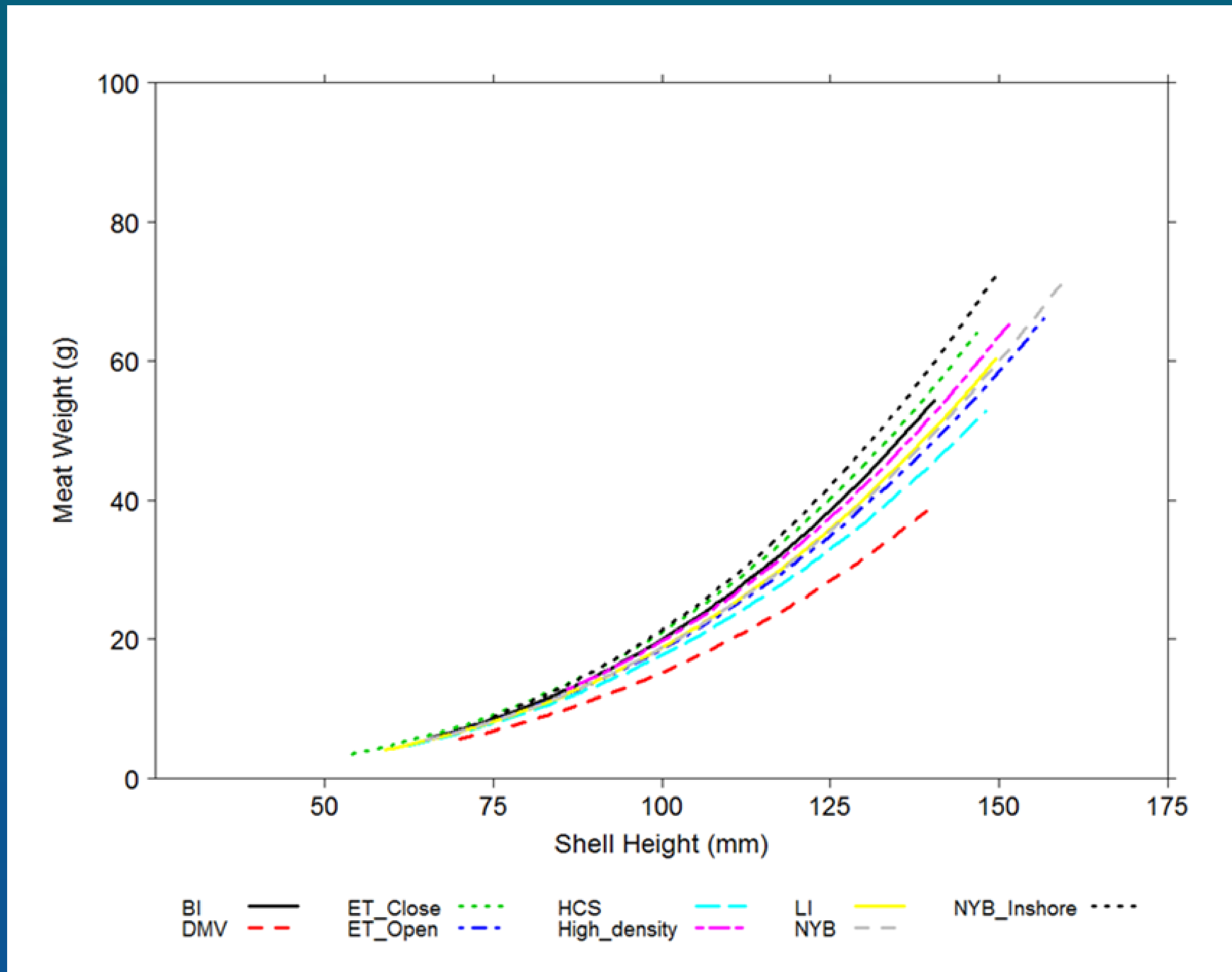


ET Length Frequencies

- Relative length frequencies by gear and area



ET SHMW



Meat Weight (g)
100
80
60
40
20
0
50
75
100
125
150
175
Shell Height (mm)
BI
DMV
ET_Close
ET_Open
HCS
High_density
LI
NYB
NYB_Inshore

ET

- Partitioning the ET_Flex SAMS area into two distinct SAMS Areas (High Density and ET_Flex) may not be appropriate.

- Predicted SHMW relationships for the MAB, with the addition of the High Density SAMS area, did not indicate the High Density SAMS area had significantly lower growth compared to the current SAMS areas.

- The predicted SHMW relationship for the High Density SAMS area was consistent with the other SHMW relationships in the MAB and the ET area.

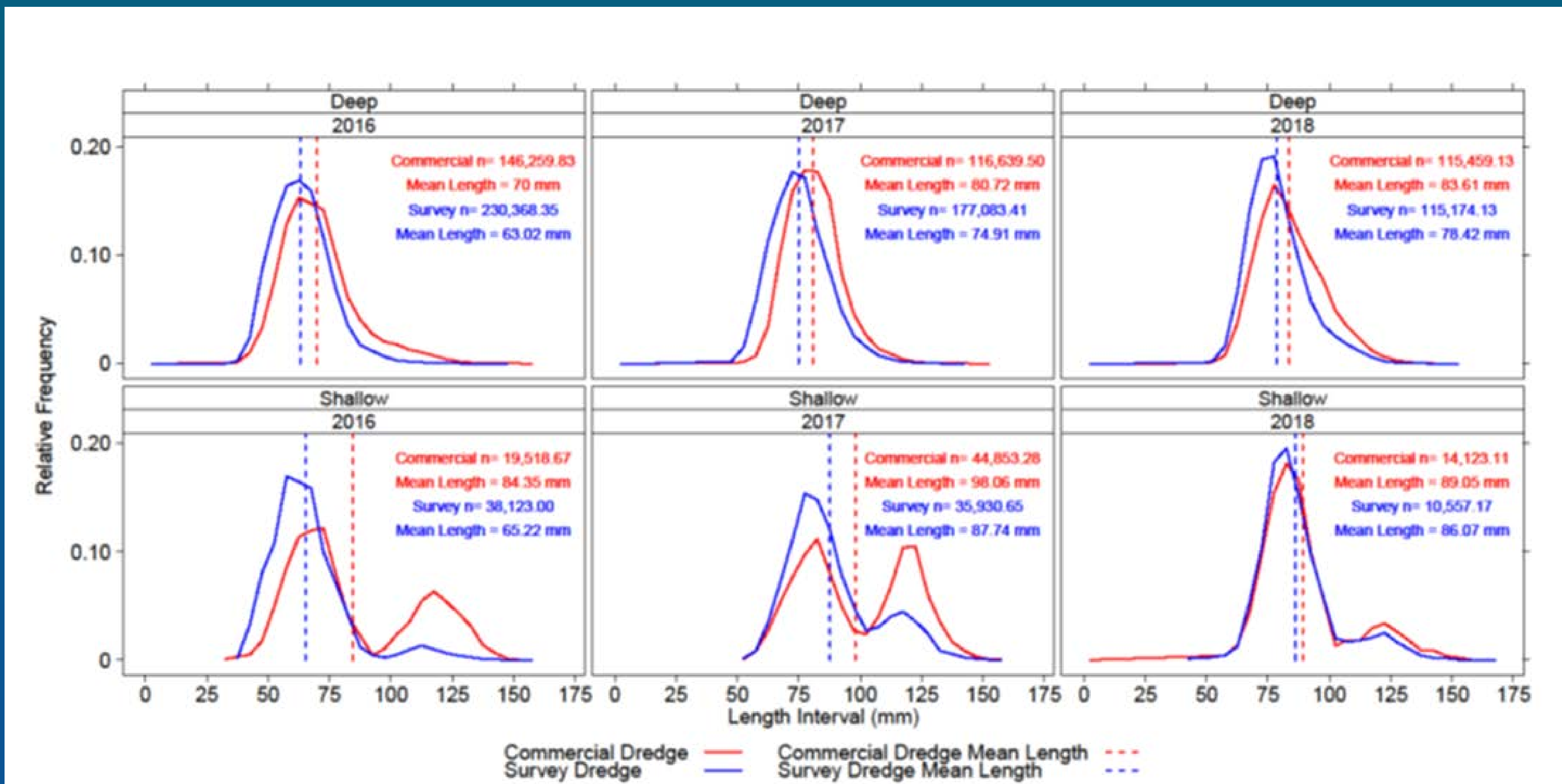
- Growth of scallops in the ET_Flex SAMS area increased in 2018 compared to 2017. The mean length of scallops observed in the survey dredge in 2017 was 91.41mm, compared to a mean length of 104.53 mm in 2018.

NL

- The NL Southern SAMS Area was divided into Shallow and Deep areas based on depth – 70 m depth contour
- Data used were from the VIMS 2016 – 2018 surveys for both the survey and commercial dredges.
- SHMW relationships and length frequency data

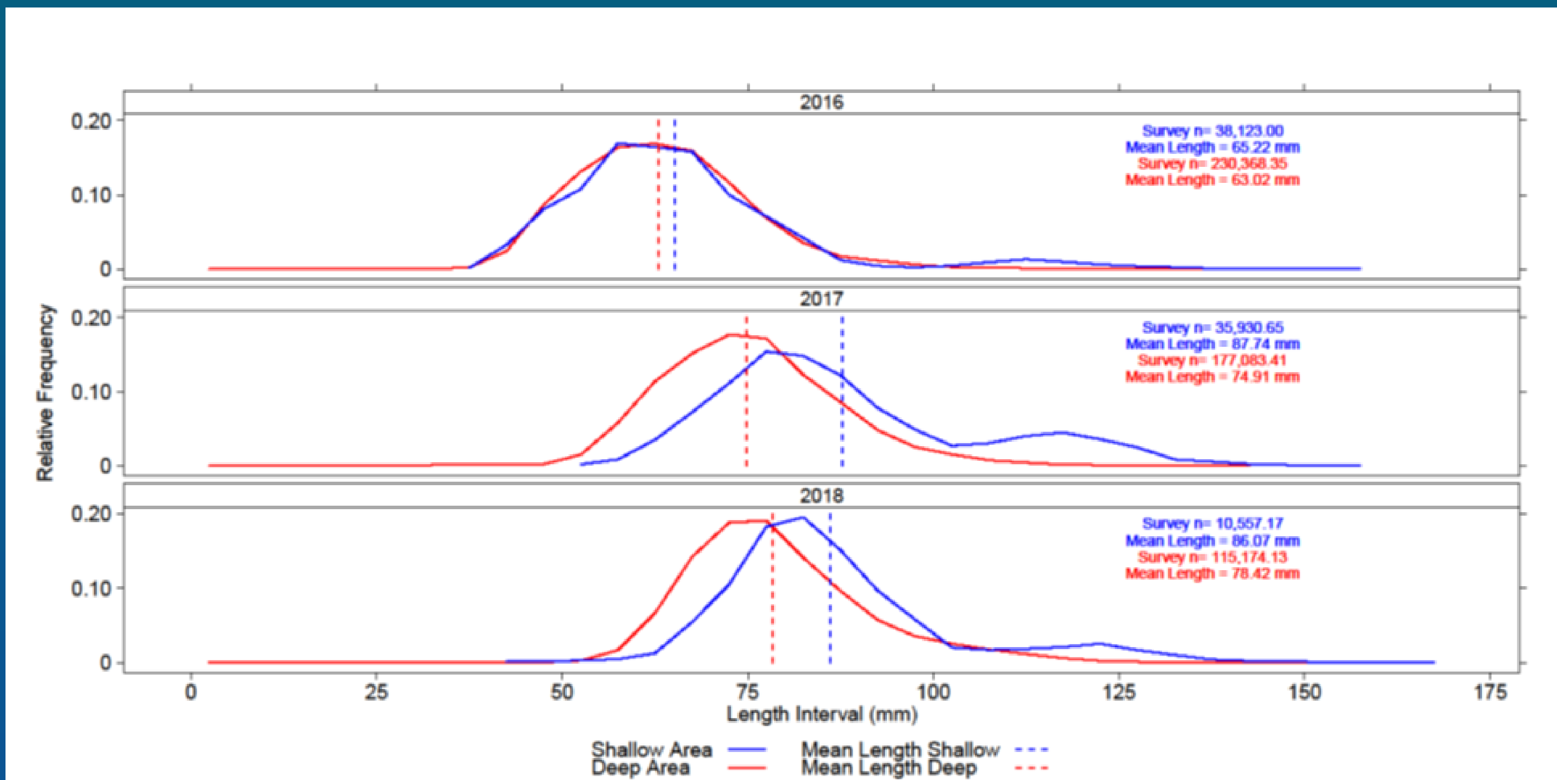
NL Length Frequencies

- Relative length frequencies by year and gear

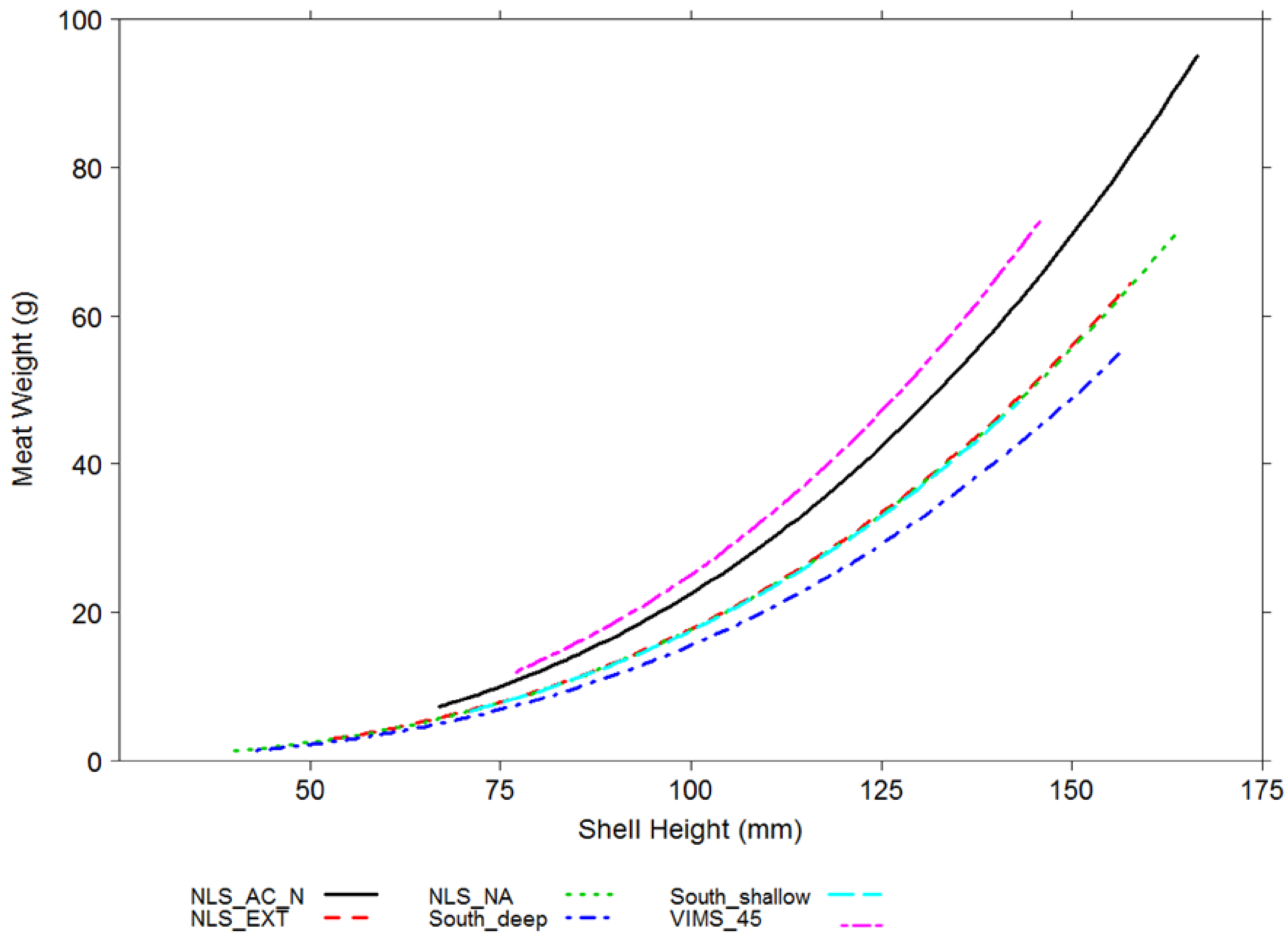


NL Length Frequencies

- Relative length frequencies by year for the survey gear



NL SHMW



Meat Weight (g)
0
20
40
60
80
100
50
75
100
125
150
175
Shell Height (mm)
NLS_AC_N
NLS_EXT
NLS_NA
South_deep
South_shallow
VIMS_45

Appendix D

Results for the 2018 VIMS Industry Cooperative Surveys of the Mid-Atlantic, Nantucket Lightship Closed Area, Closed Area I, and Closed Area II Resource Areas

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The Virginia Institute of Marine Science (VIMS) conducted high resolution sea scallop dredge surveys of the entire Mid-Atlantic (MAB) sea scallop resource area, the Nantucket Lightship (NLCA) area and the Closed Area I (CAI) and II (CAII) areas during May-July of 2018 (Figure 1). These surveys were funded by the Sea Scallop Research Set-Aside Program (RSA). Exploitable biomass for each survey is shown in Table 1 and for each spatially explicit SAMS (Scallop Area Management Simulator) area in figures 2-4. SAMS areas represent management relevant spatial subunits of the resource and explicitly account for differences in recruitment, vital rates, and fishing effort in the forward projection of survey information. At the time of the surveys, exploitable biomass estimated from the commercial dredge was 12,194 mt or 26.9 million pounds for the Open Elephant Truck (ET-Open) SAMS area and 18,9692 mt or 41.2 million pounds in Elephant Trunk Flex (ET-Flex) SAMS area. For open area in the Long Island (LI) SAMS area, exploitable biomass was estimated at 8,888 mt or 19.6 million pounds. In the western NLCA area (NLS_NA), the exploitable biomass was 26,245 mt or 57.9 million pounds. The southern SAMS area from 2017 (NLS_AC_S) was split into two areas based on depth: NLS_AC_Shallow (<70m) and NLS_AC_Deep (>70m), which had 533 mt (1.2 million pounds) and 4,279 mt (9.4 million pounds), respectively. Exploitable biomass in the CAII access area (CAII_S_AC) was 5,203 mt or 11.5 million pounds. We estimated an exploitable biomass of 1,551 mt or 3.4 million pounds for the CAI access area (CAI_AC)

The MAB survey was conducted aboard two commercial vessels: F/V *Carolina Capes II* and F/V *Italian Princess* during May 2018. Each vessel completed one survey leg and occupied approximately 225 stations throughout the MAB survey area. The CAI and CAII surveys were conducted onboard the F/V *Arcturus* in June of 2018 and a total of 189 stations were completed. The F/V *Celtic* conducted the NLCA survey during July of 2018 and occupied a total of 130 survey stations. All vessels towed a NMFS 8 foot survey dredge along with either a 14 foot Coonamessett Farm Turtle Deflector Dredge (CFTDD) equipped with a 10 inch diamond mesh twine top with a 1.76 hanging ratio (60 meshes, 34 rings) and 8.5 meshes on the side, or a 14 or 15 foot New Bedford style commercial dredge. While the comparison of catches between the survey dredge and the commercial dredge are informative on a relative basis, for the purposes of this report, we present only the catch data from the commercial dredges obtained during a 15 minute survey tow at 3.8-4.0 kts with a 3:1 scope (Table 2). We present the data from the commercial dredge only as this information is more applicable to the resource conditions that the industry is likely to encounter.

Catch data in tabular form is shown in Table 2. The density and number of scallops caught in three size classes (<35mm, 35-75mm, and >75mm) for each tow is shown in Figures 6-8. In Figures 9-11, the shell height frequency distribution from both dredges (survey and commercial for the different surveys and SAMS areas. Figure 12 depicts the estimated meat count (meats per pound) for the NLCA survey.

In addition to the catch data that informed our understanding of scallop abundance and biomass, we also monitored meat quality during each survey. This protocol allowed us to the prevalence and intensity of a parasitic nematode observed in the scallop meat. Infected scallops typically present with a rust colored lesions on the exterior of the adductor muscle, typically opposite the sweet meat. Nematode infected scallops were observed only during the MAB survey with a typical number of nematodes observed per scallop meat ranging from 1-6. The spatial distribution of the nematode prevalence (% of sampled scallops at a given station with at least one lesion) by year is shown in Figure 13. Overall, the extent of nematode prevalence still covers the majority of the southern range for these surveys. In Figures 14-15, the spatial distribution of nematode prevalence in sampled scallops is displayed by year and size class. Smaller scallops appear to be less infected over time. However, prevalence of nematodes in scallops less than 100 mm in size increased in the southern most portion of the MAB survey area from 2017 to 2018, as well as a potentially slight increase in some areas in the northern portion of the MAB.

Table 1. Exploitable biomass for scallops captured in the commercial during the VIMS/Industry cooperative surveys by survey, gear, and SAMS Area during May-July 2018.

Survey	SAMS Area	Gear	Exploitable Biomass (mt)	95% CI Lower Bound	95% CI Upper Bound
MAB	DMV	COMM	679.36	345.76	1,012.96
	ET-Open	COMM	12,193.59	10,415.86	13,971.31
	ET-Flex	COMM	18,692.46	14,765.71	22,619.20
	HCS	COMM	7,350.24	5,764.46	8,936.02
	NYB	COMM	3,541.49	2,965.37	4,117.61
	NYB-Inshore	COMM	949.22	241.51	1,656.93
	VIR	COMM	0	0	0
	BI	COMM	474.72	334.61	614.83
	LI	COMM	8,888.05	7,594.60	10,181.49
NLCA	NLS_AC_N	COMM	2,538.31	2,096.86	2,979.76
	NLS_AC_Shallow	COMM	532.76	297.46	768.06
	NLS_AC_Deep	COMM	1,426.40	994.54	1,858.25
	NLS_EXT	COMM	65.77	47.25	79.83
	NLS_NA	COMM	3,996.58	2,511.64	5,481.52
	VIMS_45	COMM	5.75	2.49	9.01
CA II	CAII_S_AC	COMM	5,202.97	4,247.94	6,158.01
	CAII_S_Ext	COMM	3,649.74	2,586.63	4,712.86
	SF	COMM	2,011.38	1,304.71	2,718.04
CA I	CAI_NA_N	COMM	6,986.45	5,302.20	8,670.70
	CAI_AC	COMM	1,551.35	1,063.77	2,038.93

Table 2. Catch data for the commercial dredge from the VIMS/Industry cooperative surveys completed during May-July 2018. Nematode prevalence (% of scallops sampled at a given station infected with nematodes) is also provided for each station.

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m^2)	Nematode Prevalence (%)
MAB	201801001	36	30.96	74	48.90	0	0.00	0.00	0.0000	0
MAB	201801002	36	36.14	74	44.52	0	0.00	0.00	0.0000	0
MAB	201801003	36	36.90	74	46.62	0	0.00	0.00	0.0000	0
MAB	201801004	36	41.15	74	48.77	0	0.00	0.00	0.0000	0
MAB	201801005	36	42.13	74	45.40	0	0.00	0.00	0.0000	0
MAB	201801006	36	43.92	74	49.35	0	0.00	0.00	0.0000	0
MAB	201801007	36	48.32	74	45.75	0	0.00	0.00	0.0000	0
MAB	201801008	36	49.49	74	42.56	0	0.00	0.00	0.0000	0
MAB	201801009	36	54.71	74	40.75	0	0.00	0.00	0.0000	0
MAB	201801010	36	58.26	74	49.10	0	0.00	0.00	0.0000	0
MAB	201801011	37	6.79	74	53.16	0	0.00	0.00	0.0000	0
MAB	201801012	37	8.10	74	48.50	0	0.00	0.00	0.0000	0
MAB	201801013	37	7.69	74	38.27	0	0.00	0.00	0.0000	0
MAB	201801014	37	13.91	74	41.42	0	0.00	0.00	0.0000	0
MAB	201801015	37	17.87	74	44.87	0	0.00	0.00	0.0000	0
MAB	201801016	37	20.58	74	49.02	0	0.00	0.00	0.0000	0
MAB	201801017	37	24.11	74	39.67	0	0.00	0.00	0.0000	0
MAB	201801018	37	26.16	74	40.88	0	0.00	0.00	0.0000	0
MAB	201801019	37	28.00	74	42.82	0	0.00	0.00	0.0000	0
MAB	201801020	37	29.52	74	45.00	0	0.00	0.00	0.0000	0
MAB	201801021	37	31.08	74	48.07	0	0.00	0.00	0.0000	0
MAB	201801022	37	32.04	74	45.62	0	0.00	0.00	0.0000	0
MAB	201801023	37	31.01	74	41.90	0	0.00	0.00	0.0000	0
MAB	201801024	37	33.27	74	41.23	0	0.00	0.00	0.0000	0
MAB	201801025	37	34.83	74	41.25	0	0.00	0.00	0.0000	0
MAB	201801026	37	35.94	74	42.65	0	0.00	0.00	0.0000	0
MAB	201801027	37	37.69	74	46.97	0	0.00	0.00	0.0000	0
MAB	201801028	37	38.94	74	45.17	0	0.00	0.00	0.0000	0
MAB	201801029	37	40.26	74	45.78	0	0.00	0.00	0.0000	0
MAB	201801030	37	32.09	74	31.60	0	0.00	0.00	0.0000	0
MAB	201801031	37	33.31	74	26.27	0	0.00	0.00	0.0000	0
MAB	201801032	37	35.81	74	20.78	0	0.00	0.00	0.0000	0
MAB	201801033	37	39.12	74	25.85	10	0.64	0.10	0.0023	83
MAB	201801034	37	42.39	74	38.94	0	0.00	0.00	0.0000	0
MAB	201801035	37	45.78	74	46.64	0	0.00	0.00	0.0000	0
MAB	201801036	37	45.94	74	41.71	0	0.00	0.00	0.0000	0
MAB	201801037	37	44.21	74	29.00	6	0.44	0.01	0.0014	80
MAB	201801038	37	43.43	74	26.48	72	4.31	0.70	0.0163	60

MAB	201801039	37	44.82	74	19.77	2	0.12	3.00	0.0004	33
MAB	201801040	37	45.66	74	16.78	0	0.00	0.00	0.0000	0
MAB	201801041	37	50.95	74	13.24	0	0.00	0.00	0.0000	0
MAB	201801042	37	48.18	74	23.90	29	1.82	0.25	0.0071	86
MAB	201801043	37	50.28	74	27.52	1	0.05	1.00	0.0002	100
MAB	201801044	37	50.96	74	31.87	0	0.00	0.00	0.0000	0
MAB	201801045	37	49.14	74	35.02	0	0.00	0.00	0.0000	0
MAB	201801046	37	51.51	74	45.03	0	0.00	0.00	0.0000	0
MAB	201801047	37	53.60	74	39.45	0	0.00	0.00	0.0000	0
MAB	201801048	37	55.63	74	32.10	0	0.00	0.00	0.0000	0
MAB	201801049	37	54.24	74	29.97	0	0.00	0.00	0.0000	0
MAB	201801050	37	53.88	74	26.19	0	0.00	0.00	0.0000	0
MAB	201801051	37	54.92	74	23.28	3	0.20	3.00	0.0006	0
MAB	201801052	37	53.84	74	18.29	0	0.00	0.00	0.0000	0
MAB	201801053	37	56.07	74	17.81	5	0.31	0.05	0.0010	71
MAB	201801054	38	0.11	74	13.27	593	32.64	6.00	0.1135	53
MAB	201801055	38	3.17	74	14.11	68	3.93	1.00	0.0130	29
MAB	201801056	38	5.68	74	11.84	356	19.76	3.75	0.0680	33
MAB	201801057	38	6.89	74	7.84	538	30.50	6.00	0.1029	71
MAB	201801058	38	7.63	74	12.97	0	0.00	0.00	0.0000	0
MAB	201801059	38	8.49	74	10.26	325	18.10	3.00	0.0622	69
MAB	201801060	38	11.26	74	8.70	394	20.29	4.20	0.1109	53
MAB	201801061	38	11.53	73	59.65	7	0.32	0.10	0.0014	27
MAB	201801062	38	13.89	74	6.48	675	37.27	7.10	0.1784	53
MAB	201801063	38	16.55	74	8.55	336	19.60	4.00	0.0643	69
MAB	201801064	38	17.28	73	57.53	322	16.33	3.50	0.0615	40
MAB	201801065	38	17.98	73	52.91	5	0.23	0.05	0.0010	60
MAB	201801066	38	19.24	73	51.80	1	0.04	0.05	0.0002	0
MAB	201801067	38	21.24	73	54.18	13	0.70	0.10	0.0029	60
MAB	201801068	38	21.89	73	56.83	630	33.61	8.00	0.1218	40
MAB	201801069	38	21.05	73	59.61	63	3.63	0.75	0.0121	64
MAB	201801070	38	20.83	74	4.29	284	16.40	3.50	0.0544	80
MAB	201801071	38	20.87	74	7.94	1446	77.88	14.80	0.3641	60
MAB	201801072	38	22.98	74	7.55	499	26.61	6.30	0.0964	60
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MAB	201801074	38	24.04	73	56.41	2237	119.14	27.00	0.4278	29
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MAB	201801076	38	23.94	73	50.04	123	7.18	1.50	0.0236	33
MAB	201801077	38	25.88	73	45.97	782	48.65	9.00	0.1631	0
MAB	201801078	38	28.61	73	43.91	333	17.01	3.50	0.0637	7
MAB	201801079	38	31.05	73	42.45	1251	67.09	15.00	0.2393	60
MAB	201801080	38	32.10	73	45.20	1525	89.39	24.00	0.2916	60
MAB	201801081	38	34.06	73	45.18	2110	119.67	30.00	0.4034	20
MAB	201801082	38	34.02	73	39.48	1148	62.94	14.00	0.2606	13

MAB	201801083	38	35.56	73	37.17	699	36.87	8.50	0.1336	27
MAB	201801084	38	34.13	73	34.66	854	41.72	10.00	0.1632	27
MAB	201801085	38	30.44	73	28.33	4	0.17	0.05	0.0008	17
MAB	201801086	38	35.71	73	31.06	797	39.71	9.00	0.1524	7
MAB	201801087	38	37.75	73	36.38	1237	70.67	12.50	0.2646	27
MAB	201801088	38	39.62	73	34.26	974	51.02	9.00	0.2331	60
MAB	201801089	38	39.54	73	30.95	1267	64.94	12.80	0.2740	20
MAB	201801090	38	40.43	73	28.70	548	27.67	5.70	0.1396	53
MAB	201801091	38	39.33	73	23.57	2	0.07	0.05	0.0004	21
MAB	201801092	38	45.39	73	14.57	0	0.00	0.00	0.0000	0
MAB	201801093	38	49.04	73	8.47	0	0.00	0.00	0.0000	0
MAB	201801094	38	52.32	73	3.76	0	0.00	0.00	0.0000	0
MAB	201801095	38	58.62	72	55.86	0	0.00	0.00	0.0000	0
MAB	201801096	38	59.35	73	1.94	0	0.00	0.00	0.0000	0
MAB	201801097	39	0.51	73	10.69	74	3.82	0.90	0.0157	33
MAB	201801098	39	3.68	73	6.01	1811	79.60	22.20	0.5009	0
MAB	201801099	39	4.82	73	7.11	173	8.68	2.00	0.0383	13
MAB	201801100	39	6.90	73	6.44	763	32.84	9.00	0.1917	0
MAB	201801101	39	7.77	73	2.05	1394	61.48	18.00	0.2964	0
MAB	201801102	39	7.35	72	59.61	14	0.65	0.10	0.0027	0
MAB	201801103	39	9.35	72	51.25	0	0.00	0.00	0.0000	0
MAB	201801104	39	15.15	72	56.53	45	2.15	0.50	0.0087	7
MAB	201801105	39	17.55	72	59.56	319	16.57	4.00	0.0872	0
MAB	201801106	39	17.44	72	54.81	7	0.33	0.05	0.0013	0
MAB	201801107	39	18.97	72	54.21	767	32.18	8.50	0.1467	0
MAB	201801108	39	19.53	72	52.25	13	0.65	0.10	0.0024	0
MAB	201801109	39	23.38	72	41.97	0	0.00	0.00	0.0000	0
MAB	201801110	39	26.55	72	44.88	11	0.56	0.10	0.0022	0
MAB	201801111	39	29.31	72	45.66	466	23.60	4.75	0.1259	7
MAB	201801112	39	31.19	72	44.14	363	19.43	4.20	0.0779	13
MAB	201801113	39	31.82	72	41.03	34	1.60	0.30	0.0082	13
MAB	201801114	39	34.58	72	40.80	28	1.42	0.30	0.0054	7
MAB	201801115	39	37.52	72	40.93	1	0.06	0.05	0.0002	0
MAB	201801116	39	40.17	72	39.05	20	1.10	0.10	0.0038	13
MAB	201801117	39	39.50	72	45.95	113	5.74	1.30	0.0205	0
MAB	201801118	39	38.59	72	48.92	134	7.20	1.30	0.0256	7
MAB	201801119	39	37.49	72	51.38	248	13.13	3.00	0.0493	20
MAB	201801120	39	34.99	72	49.82	272	14.97	2.70	0.0520	14
MAB	201801121	39	32.17	72	48.59	500	25.08	4.90	0.0957	0
MAB	201801122	39	30.89	72	53.46	114	7.06	1.40	0.0218	0
MAB	201801123	39	31.68	72	56.22	263	16.25	2.70	0.0504	7
MAB	201801124	39	30.83	72	58.62	216	13.50	2.50	0.0429	13
MAB	201801125	39	28.77	73	5.72	58	3.50	0.80	0.0119	7
MAB	201801127	39	27.08	73	0.60	250	14.45	2.75	0.0543	7

MAB	201801128	39	26.88	72	58.63	229	13.50	2.75	0.0523	0
MAB	201801129	39	26.25	72	55.16	376	24.21	4.00	0.0863	0
MAB	201801130	39	27.35	72	52.95	189	10.66	2.10	0.0428	0
MAB	201801131	39	25.49	72	50.44	1170	53.91	11.50	0.2237	0
MAB	201801132	39	23.34	72	52.44	2463	116.37	22.00	0.5151	0
MAB	201801133	39	22.57	72	54.69	5556	253.88	51.00	1.0556	0
MAB	201801134	39	22.56	72	58.05	182	9.73	2.00	0.0485	0
MAB	201801135	39	22.39	73	0.52	145	8.89	1.50	0.0299	0
MAB	201801136	39	24.36	73	2.69	192	10.88	2.10	0.0367	0
MAB	201801137	39	26.15	73	7.46	199	12.90	2.00	0.0380	0
MAB	201801138	39	24.45	73	9.54	103	6.65	1.20	0.0197	0
MAB	201801139	39	23.36	73	7.73	265	16.05	2.50	0.0544	0
MAB	201801140	39	20.94	73	3.00	150	8.25	1.75	0.0286	0
MAB	201801141	39	20.45	73	5.18	183	11.65	2.10	0.0466	13
MAB	201801142	39	19.88	73	8.26	241	14.93	2.50	0.0591	7
MAB	201801143	39	21.17	73	12.09	84	4.38	0.90	0.0178	13
MAB	201801144	39	18.91	73	15.67	181	11.22	1.90	0.0346	20
MAB	201801145	39	16.30	73	14.94	148	9.06	1.60	0.0282	8
MAB	201801146	39	15.14	73	12.53	146	8.23	1.50	0.0418	7
MAB	201801147	39	14.42	73	9.39	440	22.05	4.10	0.0842	13
MAB	201801148	39	16.60	73	7.69	275	13.96	3.00	0.0554	7
MAB	201801149	39	16.47	73	5.66	668	33.34	7.00	0.1264	7
MAB	201801150	39	14.57	73	3.68	252	11.39	2.80	0.0481	13
MAB	201801151	39	11.01	73	1.62	1784	75.75	16.50	0.3412	0
MAB	201801152	39	10.43	73	3.93	461	24.57	4.90	0.0882	0
MAB	201801153	39	10.07	73	7.84	1143	58.81	11.70	0.2239	20
MAB	201801154	39	12.10	73	12.25	244	13.92	2.50	0.0453	0
MAB	201801155	39	13.07	73	15.94	169	10.11	1.80	0.0324	7
MAB	201801156	39	13.89	73	18.76	213	13.27	3.00	0.0436	13
MAB	201801157	39	10.78	73	20.68	527	32.53	5.50	0.1008	7
MAB	201801158	39	10.13	73	19.35	805	47.48	8.10	0.1547	0
MAB	201801159	39	10.35	73	16.16	184	10.29	2.00	0.0351	7
MAB	201801160	39	8.30	73	12.70	402	20.65	4.50	0.0738	7
MAB	201801161	39	6.06	73	12.10	1290	50.16	13.20	0.3447	7
MAB	201801162	39	6.30	73	16.40	320	17.98	3.50	0.0613	13
MAB	201801163	39	6.80	73	22.54	408	25.45	4.50	0.0897	7
MAB	201801164	39	4.01	73	25.14	152	8.95	2.10	0.0383	7
MAB	201801165	39	2.01	73	27.87	191	11.31	2.50	0.0365	0
MAB	201801166	39	1.17	73	27.02	206	12.68	2.25	0.0535	0
MAB	201801167	39	0.04	73	23.80	576	28.88	7.00	0.1245	20
MAB	201801168	38	59.09	73	20.46	1014	53.40	5.25	0.2374	27
MAB	201801168	38	59.09	73	20.46	1014	53.40	3.00	0.2374	27
MAB	201801169	38	58.81	73	14.54	9	0.42	0.05	0.0022	9
MAB	201801170	38	56.26	73	11.82	19	1.10	0.20	0.0055	47

MAB	201801171	38	54.48	73	15.62	17	0.89	0.20	0.0033	20
MAB	201801172	38	55.85	73	18.46	777	40.70	9.00	0.1485	7
MAB	201801173	38	56.31	73	21.35	376	18.38	4.50	0.1050	0
MAB	201801174	38	56.92	73	23.67	146	7.52	2.00	0.0330	13
MAB	201801175	38	58.45	73	25.87	201	11.08	2.50	0.0384	20
MAB	201801176	38	56.45	73	31.28	140	8.41	1.40	0.0392	0
MAB	201801177	38	56.25	73	28.92	220	11.87	2.20	0.0421	7
MAB	201801178	38	54.99	73	24.89	804	38.13	8.00	0.1899	13
MAB	201801179	38	53.67	73	21.60	937	46.15	9.60	0.1740	13
MAB	201801180	38	53.20	73	19.07	935	51.16	11.80	0.1787	33
MAB	201801181	38	50.09	73	22.80	4535	215.35	29.00	1.0446	40
MAB	201801182	38	51.31	73	28.82	208	10.76	2.00	0.0618	33
MAB	201801183	38	52.76	73	30.88	356	20.40	3.50	0.0688	31
MAB	201801184	38	51.12	73	32.36	224	12.45	2.30	0.0428	13
MAB	201801185	38	47.90	73	35.89	194	10.98	2.20	0.0372	33
MAB	201801186	38	47.21	73	33.09	766	41.17	8.30	0.1465	33
MAB	201801187	38	48.46	73	27.55	3102	147.46	32.00	0.5931	7
MAB	201801188	38	46.79	73	21.52	106	5.05	1.00	0.0236	13
MAB	201801189	38	45.61	73	23.36	13	0.63	0.10	0.0038	13
MAB	201801190	38	45.23	73	25.65	9	0.42	0.10	0.0018	58
MAB	201801191	38	45.05	73	29.07	643	30.42	7.90	0.1230	13
MAB	201801192	38	43.26	73	31.41	4897	248.53	47.00	1.3812	27
MAB	201801193	38	43.10	73	35.48	1875	101.19	20.50	0.3586	47
MAB	201801194	38	42.32	73	39.62	4082	226.84	48.00	0.7806	80
MAB	201801195	38	41.52	73	42.82	2835	161.07	32.50	0.5421	73
MAB	201801196	38	39.60	73	45.49	2249	137.30	25.00	0.4301	67
MAB	201801197	38	37.89	73	43.40	2781	148.08	34.00	0.5318	47
MAB	201801198	38	37.22	73	46.61	2434	140.69	28.00	0.4457	73
MAB	201801199	38	35.25	73	48.33	1737	99.01	19.00	0.3960	40
MAB	201801200	38	34.98	73	51.54	3603	180.56	50.00	0.6889	53
MAB	201801201	38	32.89	73	53.65	2201	109.04	29.00	0.4208	27
MAB	201801202	38	31.41	73	59.18	2398	113.18	27.50	0.5395	33
MAB	201801203	38	29.98	73	57.27	2139	114.75	28.50	0.4090	47
MAB	201801204	38	29.96	73	53.63	3072	183.71	38.00	0.5874	73
MAB	201801205	38	30.33	73	51.16	5168	305.32	57.00	0.9817	80
MAB	201801206	38	28.05	73	51.87	3144	168.87	39.00	0.6549	73
MAB	201801207	38	27.52	73	54.04	1924	105.19	31.00	0.3679	60
MAB	201801208	38	27.12	73	57.73	1704	96.83	19.50	0.3553	40
MAB	201801209	38	27.61	73	58.97	1926	106.57	31.50	0.3684	53
MAB	201801210	38	28.64	74	0.65	899	44.96	9.30	0.1719	20
MAB	201801212	38	26.79	74	4.17	4792	230.58	49.50	0.9164	20
MAB	201801213	38	25.79	74	5.54	543	27.63	7.00	0.1038	27
MAB	201801214	38	27.94	74	6.38	2014	96.65	24.50	0.4334	67
MAB	201801215	38	27.72	74	8.22	2084	111.89	23.00	0.3999	20

MAB	201801216	38	25.26	74	10.08	714	38.30	8.50	0.1365	21
MAB	201801217	38	26.24	74	13.03	205	12.23	2.90	0.0392	40
MAB	201801218	38	29.82	74	11.40	1996	127.30	25.00	0.3816	40
MAB	201801219	38	29.43	74	25.08	3	0.17	0.10	0.0006	20
MAB	201801220	38	26.64	74	23.22	1	0.06	0.10	0.0002	0
MAB	201801221	38	22.52	74	19.87	0	0.00	0.00	0.0000	0
MAB	201801222	38	21.25	74	18.57	2	0.19	0.10	0.0004	50
MAB	201801223	38	20.83	74	16.05	151	8.76	1.70	0.0349	40
MAB	201801224	38	16.24	74	16.59	186	12.90	2.00	0.0387	60
MAB	201801225	38	8.79	74	29.56	2	0.09	0.02	0.0004	50
MAB	201801226	38	4.15	74	31.15	0	0.00	0.00	0.0000	0
MAB	201801227	38	3.85	74	40.15	0	0.00	0.00	0.0000	0
MAB	201801228	38	3.47	74	45.47	0	0.00	0.00	0.0000	0
MAB	201801229	38	1.48	74	48.56	0	0.00	0.00	0.0000	0
MAB	201802001	38	36.02	74	24.13	0	0.00	0.00	0.0000	0
MAB	201802002	38	34.03	74	14.08	953	63.17	11.75	0.2218	33
MAB	201802003	38	31.63	74	13.71	42	3.22	0.50	0.0097	53
MAB	201802004	38	32.46	74	11.29	77	5.27	1.00	0.0178	45
MAB	201802005	38	31.10	74	9.27	3091	182.17	35.50	0.7191	60
MAB	201802006	38	31.02	74	6.40	163	10.04	2.00	0.0380	82
MAB	201802007	38	31.15	74	3.74	1484	64.03	13.60	0.3452	67
MAB	201802008	38	32.97	73	57.85	5790	250.95	61.00	1.3471	57
MAB	201802009	38	33.95	73	55.27	5039	217.09	51.50	1.1723	57
MAB	201802010	38	35.98	73	58.27	4070	222.79	43.50	0.9470	77
MAB	201802011	38	34.61	73	59.57	6852	333.92	77.00	1.5942	45
MAB	201802012	38	34.31	74	2.58	3927	171.80	44.00	0.9137	40
MAB	201802013	38	33.78	74	5.06	1102	56.76	12.80	0.2565	48
MAB	201802014	38	34.33	74	7.86	73	5.21	1.00	0.0170	38
MAB	201802015	38	36.39	74	11.29	4672	224.84	37.00	1.0870	40
MAB	201802016	38	38.60	74	9.92	1622	102.47	18.50	0.3395	47
MAB	201802017	38	36.37	74	5.30	4488	220.38	35.00	1.1967	59
MAB	201802018	38	38.48	74	3.34	11011	460.98	110.00	2.4578	14
MAB	201802019	38	36.83	73	59.54	6917	345.71	66.00	1.6094	13
MAB	201802020	38	36.45	73	55.70	10650	563.66	106.00	2.4780	9
MAB	201802021	38	37.38	73	52.60	1424	81.35	16.50	0.3314	4
MAB	201802022	38	37.91	73	50.50	2400	135.54	25.00	0.5852	14
MAB	201802023	38	40.13	73	48.79	1052	69.65	19.00	0.2328	7
MAB	201802024	38	41.14	73	50.85	661	43.36	6.25	0.1539	7
MAB	201802025	38	42.75	73	53.21	296	18.54	3.00	0.0689	8
MAB	201802026	38	41.22	73	56.51	2065	127.39	25.00	0.4804	5
MAB	201802027	38	39.46	73	55.76	1922	120.87	22.00	0.4473	7
MAB	201802028	38	39.31	73	57.25	6906	414.71	75.00	1.6069	22
MAB	201802029	38	41.69	74	14.65	19	1.13	0.20	0.0043	14
MAB	201802030	38	43.76	74	11.40	5	0.39	0.05	0.0012	42

MAB	201802031	38	43.67	74	5.23	601	35.43	9.50	0.1399	8
MAB	201802032	38	48.38	74	0.56	158	11.99	2.00	0.0368	50
MAB	201802033	38	46.10	73	45.30	201	13.41	2.00	0.0467	47
MAB	201802034	38	48.94	73	44.02	289	20.10	3.00	0.0673	60
MAB	201802035	38	49.72	73	40.70	258	15.87	2.20	0.0667	53
MAB	201802036	38	51.21	73	38.33	947	56.99	9.00	0.2202	0
MAB	201802037	38	53.21	73	40.35	537	33.75	4.80	0.1249	40
MAB	201802038	38	53.14	73	45.59	40	2.57	0.40	0.0092	20
MAB	201802039	38	55.31	73	41.89	540	32.84	5.25	0.1257	33
MAB	201802040	38	56.81	73	38.13	183	11.60	1.80	0.0425	40
MAB	201802041	38	57.71	73	34.03	190	12.45	1.80	0.0441	0
MAB	201802042	39	1.21	73	37.49	102	6.12	1.00	0.0277	13
MAB	201802043	39	3.79	73	40.67	51	3.95	0.75	0.0111	27
MAB	201802044	39	2.80	73	35.59	259	14.93	2.50	0.0603	40
MAB	201802045	39	8.30	73	33.50	306	18.20	3.00	0.0712	20
MAB	201802046	39	8.05	73	28.94	310	19.48	3.00	0.0721	0
MAB	201802047	39	11.95	73	24.26	109	7.80	1.25	0.0253	7
MAB	201802048	39	20.82	73	24.23	131	9.34	1.50	0.0305	7
MAB	201802049	39	20.86	73	18.35	170	11.18	2.00	0.0395	0
MAB	201802050	39	31.28	73	4.12	132	9.93	1.75	0.0308	0
MAB	201802051	39	32.95	73	4.65	0	0.00	0.00	0.0000	0
MAB	201802052	39	34.13	73	5.91	109	9.62	1.50	0.0254	0
MAB	201802053	39	33.13	73	1.92	182	11.32	2.10	0.0422	0
MAB	201802054	39	36.87	73	1.58	0	0.00	0.00	0.0000	0
MAB	201802055	39	36.58	72	54.46	234	14.28	2.25	0.0545	0
MAB	201802056	39	39.28	72	54.04	156	9.28	1.50	0.0362	0
MAB	201802057	39	39.78	72	58.26	149	9.76	1.60	0.0348	0
MAB	201802058	39	42.19	72	59.59	45	3.57	0.50	0.0102	0
MAB	201802059	39	44.96	72	57.41	77	4.89	1.00	0.0167	0
MAB	201802060	39	43.56	72	55.60	259	15.91	2.75	0.0603	0
MAB	201802061	39	40.95	72	50.12	56	3.32	0.50	0.0131	7
MAB	201802062	39	41.33	72	47.70	310	19.18	2.75	0.0722	20
MAB	201802063	39	44.16	72	44.84	52	3.11	0.60	0.0121	20
MAB	201802064	39	49.68	72	46.63	90	6.59	1.00	0.0209	0
MAB	201802065	39	48.41	72	40.49	102	6.96	1.00	0.0237	7
MAB	201802066	39	44.77	72	33.94	15	0.90	0.20	0.0038	13
MAB	201802067	39	46.69	72	30.50	28	1.52	0.20	0.0054	20
MAB	201802069	39	49.59	72	28.29	138	7.42	1.33	0.0320	7
MAB	201802070	39	51.95	72	26.32	8	0.35	0.05	0.0021	0
MAB	201802071	39	56.32	72	24.20	44	2.42	0.40	0.0102	7
MAB	201802072	39	56.85	72	27.33	98	5.58	1.00	0.0228	7
MAB	201802073	39	54.51	72	31.52	374	20.67	3.50	0.0779	13
MAB	201802074	39	55.20	72	39.00	124	10.20	1.40	0.0290	7
MAB	201802075	39	53.22	72	43.55	147	10.58	1.60	0.0343	0

MAB	201802076	39	56.45	72	45.69	169	13.09	2.00	0.0368	0
MAB	201802077	40	2.01	72	43.37	175	11.44	1.90	0.0407	0
MAB	201802078	40	3.89	72	44.50	244	16.42	2.50	0.0506	0
MAB	201802079	40	7.89	72	45.97	197	13.01	2.25	0.0459	0
MAB	201802080	40	10.05	72	46.89	193	13.10	2.25	0.0449	0
MAB	201802081	40	14.79	72	46.23	127	8.80	1.50	0.0295	0
MAB	201802082	40	13.97	72	42.69	26	2.03	0.40	0.0061	27
MAB	201802083	40	12.72	72	41.36	17	1.22	0.30	0.0039	27
MAB	201802084	40	7.20	72	26.41	47	3.53	0.50	0.0108	13
MAB	201802085	40	1.76	72	23.62	27	1.82	0.30	0.0064	7
MAB	201802087	40	5.50	72	18.02	4	0.34	0.05	0.0010	0
MAB	201802088	40	8.37	72	17.44	4	0.29	0.01	0.0008	33
MAB	201802089	40	4.54	72	7.06	6	0.29	0.05	0.0013	0
MAB	201802090	40	12.08	72	0.34	53	3.31	0.50	0.0123	0
MAB	201802091	40	18.27	71	48.02	0	0.00	0.00	0.0000	0
MAB	201802092	40	19.11	71	51.34	0	0.00	0.00	0.0000	0
MAB	201802093	40	20.36	71	54.30	1	0.07	0.01	0.0003	0
MAB	201802094	40	18.27	72	3.14	259	17.07	2.75	0.0740	0
MAB	201802095	40	14.79	72	10.43	70	5.04	0.90	0.0162	13
MAB	201802096	40	16.61	72	12.90	266	15.40	3.00	0.0619	27
MAB	201802097	40	18.36	72	14.50	190	13.26	2.00	0.0441	20
MAB	201802098	40	17.74	72	19.39	212	14.02	2.25	0.0492	7
MAB	201802099	40	16.21	72	27.33	125	7.89	2.50	0.0324	0
MAB	201802100	40	16.17	72	30.55	135	8.92	1.40	0.0314	13
MAB	201802101	40	17.57	72	33.30	217	14.28	2.20	0.0505	0
MAB	201802102	40	18.98	72	34.73	166	10.37	1.75	0.0386	0
MAB	201802103	40	19.52	72	44.14	205	13.06	2.00	0.0476	0
MAB	201802104	40	20.60	72	40.74	125	8.11	1.40	0.0314	0
MAB	201802105	40	21.91	72	37.49	116	6.77	1.20	0.0269	0
MAB	201802106	40	23.08	72	35.02	125	7.87	1.25	0.0292	7
MAB	201802107	40	23.95	72	26.34	224	16.43	2.20	0.0521	0
MAB	201802108	40	24.30	72	22.73	103	7.42	1.15	0.0239	7
MAB	201802109	40	25.65	72	19.02	40	2.96	0.50	0.0092	13
MAB	201802110	40	24.14	72	12.54	48	3.98	0.75	0.0112	27
MAB	201802111	40	22.63	72	10.34	26	1.94	0.40	0.0059	0
MAB	201802112	40	25.66	72	6.73	27	2.02	0.30	0.0052	0
MAB	201802113	40	25.07	72	2.04	53	3.75	0.75	0.0123	0
MAB	201802114	40	24.61	71	59.37	18	1.15	0.20	0.0042	7
MAB	201802115	40	32.12	71	57.33	417	28.34	4.50	0.0971	0
MAB	201802116	40	35.46	71	58.10	340	20.93	4.20	0.0772	0
MAB	201802117	40	35.89	71	51.94	161	10.47	2.00	0.0376	0
MAB	201802118	40	35.43	71	42.55	2	0.09	0.01	0.0004	0
MAB	201802119	40	34.40	71	38.81	0	0.00	0.00	0.0000	0
MAB	201802120	40	38.84	71	40.35	0	0.00	0.00	0.0000	0

MAB	201802121	40	42.21	71	48.65	237	16.70	2.50	0.0552	0
MAB	201802122	40	40.45	71	53.69	330	22.19	3.25	0.0767	0
MAB	201802123	40	41.75	71	55.62	351	21.61	3.33	0.0816	0
MAB	201802124	40	44.85	71	56.23	132	8.50	1.33	0.0324	7
MAB	201802125	40	44.08	71	48.91	57	3.41	0.60	0.0134	0
MAB	201802126	40	43.30	71	44.95	182	11.21	1.80	0.0422	0
MAB	201802127	40	45.62	71	44.79	841	55.01	8.00	0.2394	7
MAB	201802128	40	58.06	71	31.68	30	1.95	0.30	0.0069	0
MAB	201802129	40	57.01	71	21.95	107	6.89	1.10	0.0282	0
MAB	201802130	40	58.27	71	19.00	108	8.26	1.10	0.0252	0
MAB	201802131	41	0.87	71	22.60	162	10.68	1.67	0.0376	0
MAB	201802132	41	4.52	71	38.54	9	0.60	0.10	0.0021	0
MAB	201802133	41	2.05	71	38.61	160	9.75	1.60	0.0395	0
MAB	201802134	40	58.36	71	39.76	77	4.74	0.80	0.0223	0
MAB	201802135	40	55.40	71	40.56	41	3.29	0.50	0.0096	0
MAB	201802136	40	51.99	71	48.04	55	3.75	0.60	0.0128	0
MAB	201802137	40	49.04	71	52.24	100	7.17	1.20	0.0233	0
MAB	201802138	40	49.83	72	0.80	147	9.56	1.60	0.0343	0
MAB	201802139	40	45.46	72	9.83	15	1.03	0.20	0.0035	0
MAB	201802140	40	44.53	72	13.89	5	0.28	0.05	0.0011	0
MAB	201802141	40	43.65	72	21.29	1	0.09	0.01	0.0003	0
MAB	201802142	40	44.22	72	34.77	0	0.00	0.00	0.0000	0
MAB	201802143	40	42.47	72	31.69	1	0.04	0.01	0.0002	0
MAB	201802144	40	39.59	72	25.71	14	1.00	0.10	0.0033	0
MAB	201802145	40	37.82	72	16.91	42	3.19	0.50	0.0099	0
MAB	201802146	40	41.92	72	5.29	276	16.92	3.00	0.0643	0
MAB	201802147	40	40.58	72	3.50	165	10.88	1.75	0.0383	0
MAB	201802148	40	38.89	72	4.81	86	5.93	1.00	0.0201	0
MAB	201802149	40	36.80	72	2.17	56	4.08	0.75	0.0130	0
MAB	201802150	40	35.25	72	3.32	52	4.20	0.70	0.0121	0
MAB	201802151	40	34.80	72	8.38	60	4.62	0.75	0.0123	0
MAB	201802152	40	33.04	72	16.20	15	1.25	0.15	0.0034	0
MAB	201802154	40	32.65	72	20.50	84	5.69	1.00	0.0195	0
MAB	201802155	40	33.17	72	23.27	14	0.84	0.10	0.0037	0
MAB	201802156	40	30.04	72	26.72	23	1.39	0.20	0.0053	0
MAB	201802157	40	29.27	72	34.33	37	2.26	0.33	0.0086	0
MAB	201802158	40	28.46	72	37.30	116	7.36	1.20	0.0270	0
MAB	201802159	40	28.33	72	42.40	85	5.87	1.25	0.0198	0
MAB	201802160	40	35.59	72	47.22	5	0.32	0.05	0.0011	0
MAB	201802161	40	39.12	72	49.77	0	0.00	0.00	0.0000	0
MAB	201802162	40	39.12	72	49.77	0	0.00	0.00	0.0000	0
MAB	201802163	40	27.01	72	44.78	115	7.46	1.25	0.0267	0
MAB	201802164	40	26.52	72	48.14	137	9.56	1.50	0.0318	0
MAB	201802165	40	27.90	72	50.23	200	14.52	2.50	0.0402	7

MAB	201802166	40	29.29	72	56.98	4	0.24	0.01	0.0008	0
MAB	201802167	40	23.27	72	52.39	185	13.11	2.00	0.0430	0
MAB	201802168	40	20.39	73	0.35	134	9.79	1.50	0.0252	0
MAB	201802169	40	21.32	73	5.90	10	0.80	0.10	0.0022	0
MAB	201802170	40	26.90	73	9.80	0	0.00	0.00	0.0000	0
MAB	201802171	40	26.32	73	12.34	1	0.04	0.01	0.0002	0
MAB	201802172	40	24.58	73	19.37	0	0.00	0.00	0.0000	0
MAB	201802173	40	19.24	73	16.79	4	0.30	0.01	0.0008	0
MAB	201802174	40	16.04	73	11.39	7	0.63	0.05	0.0017	0
MAB	201802175	40	12.18	73	14.48	9	0.68	0.10	0.0020	8
MAB	201802176	40	13.80	73	23.85	5	0.49	0.03	0.0011	0
MAB	201802177	40	16.91	73	24.98	1	0.09	0.01	0.0003	0
MAB	201802178	40	13.22	73	41.27	0	0.00	0.00	0.0000	0
MAB	201802179	40	11.56	73	40.14	0	0.00	0.00	0.0000	0
MAB	201802180	40	11.78	73	34.44	0	0.00	0.00	0.0000	0
MAB	201802181	40	8.96	73	30.32	88	7.54	1.00	0.0204	7
MAB	201802182	40	6.72	73	22.17	45	3.47	0.50	0.0105	7
MAB	201802183	40	3.63	73	15.50	32	2.49	0.33	0.0082	7
MAB	201802184	40	0.20	73	3.61	119	8.74	1.33	0.0278	20
MAB	201802185	39	59.14	72	55.49	128	9.36	1.33	0.0272	0
MAB	201802186	39	56.88	72	56.32	84	6.72	1.00	0.0196	0
MAB	201802187	39	57.15	72	58.72	74	5.46	0.90	0.0205	13
MAB	201802188	39	58.03	73	12.93	8	0.67	0.10	0.0019	25
MAB	201802189	39	59.70	73	16.82	172	13.34	2.00	0.0401	13
MAB	201802190	39	59.31	73	19.04	8	0.68	0.05	0.0019	27
MAB	201802191	39	58.04	73	22.30	3	0.24	0.01	0.0008	0
MAB	201802192	40	0.12	73	24.20	1	0.06	0.01	0.0002	0
MAB	201802193	40	2.01	73	23.30	18	1.46	0.20	0.0041	7
MAB	201802194	40	1.07	73	26.26	185	12.14	2.32	0.0430	13
MAB	201802195	40	2.40	73	28.47	14	1.13	0.15	0.0033	20
MAB	201802196	40	4.19	73	31.93	3	0.17	0.01	0.0006	0
MAB	201802197	39	58.91	73	42.26	0	0.00	0.00	0.0000	0
MAB	201802198	39	55.17	73	35.93	0	0.00	0.00	0.0000	0
MAB	201802199	39	51.51	73	29.54	0	0.00	0.00	0.0000	0
MAB	201802200	39	53.42	73	19.67	413	25.16	4.50	0.0962	0
MAB	201802201	39	54.98	73	13.90	10	0.76	0.10	0.0022	0
MAB	201802202	39	54.00	73	10.00	579	38.50	7.50	0.1348	0
MAB	201802203	39	54.20	73	4.35	76	5.73	1.10	0.0176	13
MAB	201802204	39	47.74	73	3.85	160	10.31	2.00	0.0372	7
MAB	201802205	39	48.53	73	5.21	209	0.00	2.00	0.0583	7
MAB	201802206	39	49.40	73	6.35	107	6.78	1.00	0.0208	13
MAB	201802207	39	50.58	73	7.10	140	8.84	1.50	0.0325	13
MAB	201802208	39	51.06	73	12.63	334	19.26	5.00	0.0776	13
MAB	201802209	39	48.60	73	18.80	255	16.03	2.50	0.0576	0

MAB	201802210	39	45.21	73	29.02	24	1.43	0.20	0.0055	7
MAB	201802211	39	42.20	73	27.71	1	0.09	0.01	0.0003	50
MAB	201802212	39	39.57	73	30.93	29	2.19	0.30	0.0066	0
MAB	201802213	39	42.26	73	16.27	15	1.26	0.10	0.0033	0
MAB	201802214	39	41.18	73	11.79	79	5.99	0.90	0.0214	13
MAB	201802215	39	41.05	73	8.84	101	7.58	1.10	0.0235	7
MAB	201802216	39	30.12	73	24.31	17	1.24	0.15	0.0036	7
MAB	201802217	39	24.73	73	30.78	2	0.16	0.01	0.0005	0
MAB	201802218	39	19.97	73	39.34	1	0.07	0.10	0.0002	0
MAB	201802220	39	16.85	73	40.79	0	0.00	0.00	0.0000	0
MAB	201802221	39	9.16	73	46.74	0	0.00	0.00	0.0000	0
MAB	201802222	39	5.03	73	51.40	5	0.46	0.01	0.0012	0
MAB	201802223	39	1.07	73	56.69	0	0.00	0.00	0.0000	0
MAB	201802224	38	56.23	73	55.28	0	0.00	0.00	0.0000	0
MAB	201802225	38	51.82	73	52.55	12	1.01	0.10	0.0027	13
MAB	201802226	38	54.37	73	59.17	7	0.35	0.10	0.0015	33
MAB	201802227	38	54.95	74	1.29	0	0.00	0.00	0.0000	0
CA II	201803001	40	35.59	67	57.85	31	1.70	0.20	0.0062	0
CA II	201803002	40	34.12	67	56.89	10	0.42	0.10	0.0021	0
CA II	201803003	40	33.98	67	54.64	6	0.28	0.10	0.0012	0
CA II	201803004	40	34.75	67	52.98	12	0.66	0.20	0.0024	0
CA II	201803005	40	42.15	67	51.13	177	12.92	1.60	0.0351	0
CA II	201803007	40	40.43	67	46.16	152	11.52	1.40	0.0302	0
CA II	201803008	40	39.83	67	44.11	190	13.52	1.60	0.0377	0
CA II	201803009	40	40.48	67	43.61	260	20.28	2.50	0.0515	0
CA II	201803010	40	45.37	67	38.98	354	24.02	3.00	0.0702	0
CA II	201803011	40	43.26	67	38.24	444	27.44	3.50	0.0879	0
CA II	201803012	40	42.28	67	35.84	331	20.76	3.00	0.0656	0
CA II	201803013	40	36.47	67	34.00	2	0.09	0.10	0.0003	0
CA II	201803014	40	34.63	67	35.99	3	0.17	0.10	0.0006	0
CA II	201803015	40	33.82	67	32.79	0	0.00	0.00	0.0000	0
CA II	201803016	40	35.34	67	29.83	1	0.04	0.10	0.0001	0
CA II	201803017	40	36.31	67	27.51	0	0.00	0.00	0.0000	0
CA II	201803018	40	36.13	67	25.78	0	0.00	0.00	0.0000	0
CA II	201803019	40	38.46	67	24.42	0	0.01	0.10	0.0001	0
CA II	201803020	40	38.37	67	22.71	0	0.00	0.00	0.0000	0
CA II	201803021	40	36.18	67	21.18	0	0.00	0.00	0.0000	0
CA II	201803022	40	36.13	67	17.38	0	0.00	0.00	0.0000	0
CA II	201803023	40	39.02	67	10.74	0	0.00	0.00	0.0000	0
CA II	201803024	40	40.97	67	13.30	0	0.00	0.00	0.0000	0
CA II	201803025	40	43.02	67	25.36	303	14.79	3.00	0.0600	0
CA II	201803027	40	51.71	67	30.43	900	55.84	9.50	0.1749	0
CA II	201803028	40	52.44	67	24.47	760	54.01	7.00	0.1283	0
CA II	201803029	40	53.69	67	23.29	475	35.71	5.00	0.0941	0

CA II	201803030	40	48.03	67	17.20	67	3.97	0.75	0.0133	0
CA II	201803031	40	45.24	67	14.64	1	0.05	1.00	0.0002	0
CA II	201803032	40	43.91	67	11.81	0	0.00	0.00	0.0000	0
CA II	201803033	40	43.64	67	7.49	0	0.00	0.00	0.0000	0
CA II	201803034	40	44.84	66	59.84	1	0.07	0.10	0.0001	0
CA II	201803035	40	46.85	67	6.24	0	0.00	0.00	0.0000	0
CA II	201803036	40	48.46	67	1.18	0	0.00	0.00	0.0000	0
CA II	201803037	40	49.64	67	3.66	356	17.25	4.00	0.0705	0
CA II	201803038	40	50.00	67	7.71	101	5.68	1.50	0.0201	0
CA II	201803039	40	50.33	67	11.99	326	20.50	3.00	0.0646	0
CA II	201803040	40	52.18	67	16.59	1272	81.36	13.50	0.2521	0
CA II	201803041	40	53.21	67	18.34	1075	67.51	11.00	0.2130	0
CA II	201803042	40	55.16	67	13.67	273	16.88	3.40	0.0540	0
CA II	201803043	40	52.41	67	0.20	1236	84.53	14.00	0.2825	0
CA II	201803044	40	53.32	66	55.92	1772	92.58	20.00	0.3513	0
CA II	201803045	40	50.67	66	56.54	17	0.91	0.10	0.0035	0
CA II	201803046	40	51.09	66	54.09	0	0.00	0.00	0.0000	0
CA II	201803047	40	51.08	66	48.76	2	0.14	0.10	0.0004	0
CA II	201803048	40	53.39	66	45.86	0	0.00	0.10	0.0000	0
CA II	201803050	40	54.65	66	50.12	660	32.34	8.00	0.1307	0
CA II	201803051	40	56.31	66	52.11	299	20.33	3.20	0.0593	0
CA II	201803052	40	57.09	66	56.60	1050	62.96	10.25	0.2081	0
CA II	201803053	40	57.12	66	59.82	479	32.28	5.00	0.0949	0
CA II	201803054	40	56.65	67	1.88	1174	86.58	13.00	0.2327	0
CA II	201803055	40	56.20	67	5.20	749	45.34	8.00	0.1484	0
CA II	201803056	40	58.47	67	7.06	67	4.77	0.90	0.0133	0
CA II	201803057	40	59.63	67	12.46	120	13.21	1.60	0.0205	0
CA II	201803058	40	58.40	67	14.96	97	10.21	1.00	0.0191	0
CA II	201803059	41	0.58	67	18.93	217	21.50	2.80	0.0431	0
CA II	201803061	41	4.19	67	10.93	48	5.42	0.75	0.0095	0
CA II	201803062	41	6.32	67	1.45	66	7.94	1.00	0.0131	0
CA II	201803063	41	5.05	66	59.59	0	0.00	0.00	0.0000	0
CA II	201803064	41	2.94	66	56.52	132	14.21	1.75	0.0264	0
CA II	201803065	41	0.79	66	49.33	626	48.15	8.00	0.1240	0
CA II	201803066	40	59.38	66	45.91	427	32.36	4.50	0.0755	0
CA II	201803067	40	57.47	66	48.27	188	13.08	1.90	0.0373	0
CA II	201803068	40	56.20	66	42.62	10	0.57	0.10	0.0024	0
CA II	201803069	40	56.00	66	38.66	1	0.05	0.10	0.0002	0
CA II	201803070	40	59.46	66	34.27	0	0.00	0.00	0.0000	0
CA II	201803071	40	59.49	66	39.66	102	6.34	1.00	0.0230	0
CA II	201803072	41	2.35	66	43.99	421	36.06	5.00	0.0834	0
CA II	201803073	41	2.67	66	40.18	1131	81.06	13.30	0.2242	0
CA II	201803074	41	2.73	66	36.38	434	32.16	5.00	0.0868	0
CA II	201803075	41	1.10	66	31.17	8	0.40	0.10	0.0016	0

CA II	201803076	41	4.44	66	31.29	1	0.05	0.10	0.0002	0
CA II	201803077	41	5.96	66	39.69	694	72.52	8.00	0.1248	0
CA II	201803078	41	6.54	66	42.67	214	18.15	2.50	0.0425	0
CA II	201803079	41	9.50	66	49.38	118	13.11	2.00	0.0233	0
CA II	201803080	41	11.08	66	59.92	56	7.14	0.90	0.0110	0
CA II	201803081	41	13.20	67	3.83	13	1.77	0.20	0.0027	0
CA II	201803082	41	14.08	67	12.28	1	0.14	0.10	0.0002	0
CA II	201803083	41	14.31	67	14.11	1	0.06	0.10	0.0002	0
CA II	201803084	41	16.37	67	18.78	0	0.00	0.00	0.0000	0
CA II	201803085	41	18.16	67	15.65	0	0.00	0.00	0.0000	0
CA II	201803086	41	17.16	67	9.27	0	0.00	0.00	0.0000	0
CA II	201803087	41	18.82	67	3.61	0	0.00	0.00	0.0000	0
CA II	201803088	41	16.03	66	59.21	8	1.23	0.10	0.0016	0
CA II	201803089	41	16.46	66	48.17	49	5.92	0.80	0.0088	0
CA II	201803090	41	11.97	66	44.02	103	11.49	1.50	0.0204	0
CA II	201803091	41	10.78	66	43.28	81	8.53	1.00	0.0161	0
CA II	201803092	41	9.19	66	39.25	144	14.69	1.50	0.0285	0
CA II	201803093	41	7.91	66	35.18	1917	114.63	18.70	0.3800	0
CA II	201803095	41	9.81	66	30.30	1565	73.70	15.00	0.3026	0
CA II	201803096	41	9.90	66	25.22	7	0.34	0.10	0.0013	0
CA II	201803098	41	13.43	66	24.46	383	18.18	4.50	0.0759	0
CA II	201803099	41	13.41	66	27.43	1441	70.92	16.00	0.3829	0
CA II	201803100	41	12.81	66	30.54	1729	137.82	14.70	0.3428	0
CA II	201803101	41	11.33	66	33.04	1340	87.56	16.50	0.2655	0
CA II	201803102	41	11.88	66	35.73	354	28.10	3.90	0.0842	0
CA II	201803104	41	14.00	66	40.61	126	11.31	1.90	0.0250	0
CA II	201803105	41	15.61	66	42.69	99	12.00	1.50	0.0196	0
CA II	201803106	41	18.23	66	43.16	59	7.47	0.90	0.0120	0
CA II	201803107	41	20.29	66	40.56	94	10.86	1.20	0.0187	0
CA II	201803108	41	18.49	66	38.05	123	14.65	1.50	0.0252	0
CA II	201803109	41	16.47	66	34.52	122	12.88	1.50	0.0215	0
CA II	201803111	41	18.74	66	31.63	578	45.92	6.20	0.1145	0
CA II	201803112	41	18.64	66	27.57	1781	129.94	20.00	0.3530	0
CA II	201803113	41	21.21	66	29.95	436	43.34	6.00	0.0791	0
CA II	201803114	41	23.94	66	34.03	412	34.20	6.50	0.0798	0
CA II	201803115	41	22.13	66	35.89	242	25.38	3.20	0.0480	0
CA II	201803116	41	23.33	66	42.13	159	17.57	3.00	0.0350	0
CA II	201803118	41	22.65	66	47.20	78	9.04	1.00	0.0154	0
CA II	201803119	41	22.47	66	53.42	17	2.22	0.20	0.0034	0
CA II	201803120	41	24.73	66	55.26	4	0.43	0.10	0.0007	0
CA II	201803121	41	27.32	66	51.29	9	1.13	0.10	0.0018	0
CA II	201803122	41	26.01	66	44.37	78	8.34	1.10	0.0154	0
CA II	201803123	41	26.19	66	39.30	56	5.98	0.80	0.0098	0
CA II	201803124	41	27.66	66	36.36	131	12.84	1.80	0.0270	0

CA II	201803125	41	29.10	66	38.84	67	7.79	1.00	0.0132	0
CA II	201803126	41	29.05	66	59.40	1	0.14	0.10	0.0002	0
CA II	201803127	41	22.60	67	5.99	2	0.16	0.10	0.0003	0
CA II	201803128	41	27.30	67	9.91	0	0.00	0.00	0.0000	0
CA II	201803129	41	27.10	67	13.58	0	0.00	0.00	0.0000	0
CA II	201803131	41	26.11	67	17.19	0	0.00	0.00	0.0000	0
CA II	201803132	41	24.74	67	16.93	0	0.00	0.00	0.0000	0
CA II	201803133	41	26.19	68	29.48	157	19.38	3.90	0.0310	0
CA I	201803134	41	27.70	68	32.19	203	22.35	3.80	0.0403	0
CA I	201803135	41	28.25	68	34.59	308	27.53	5.00	0.0610	0
CA I	201803136	41	27.99	68	36.41	1279	105.76	20.50	0.2535	0
CA I	201803137	41	27.81	68	38.80	2228	144.27	30.00	0.4415	0
CA I	201803138	41	26.63	68	40.55	4012	269.97	58.00	0.7952	0
CA I	201803140	41	25.52	68	37.96	2509	261.38	40.00	0.4971	0
CA I	201803141	41	24.33	68	41.24	3181	282.87	40.00	0.6305	0
CA I	201803142	41	19.59	68	42.24	217	23.22	2.80	0.0429	0
CA I	201803143	41	19.70	68	44.71	1010	92.90	12.50	0.2001	0
CA I	201803144	41	18.18	68	47.04	1772	201.73	28.00	0.3513	0
CA I	201803145	41	16.24	68	45.89	67	6.85	1.00	0.0132	0
CA I	201803146	41	16.33	68	38.72	98	12.66	1.50	0.0194	0
CA I	201803147	41	13.87	68	36.88	57	6.65	0.90	0.0113	0
CA I	201803148	41	13.84	68	35.31	5	0.54	0.10	0.0009	0
CA I	201803149	41	13.75	68	31.72	1	0.08	0.10	0.0002	0
CA I	201803150	41	10.03	68	31.97	1	0.12	0.10	0.0002	0
CA I	201803151	41	8.69	68	30.76	0	0.00	0.00	0.0000	0
CA I	201803152	41	6.11	68	31.88	0	0.00	0.00	0.0000	0
CA I	201803153	41	3.55	68	31.44	0	0.00	0.00	0.0000	0
CA I	201803154	41	3.18	68	32.94	0	0.00	0.00	0.0000	0
CA I	201803155	41	4.50	68	33.97	0	0.00	0.00	0.0000	0
CA I	201803156	41	4.61	68	35.95	0	0.00	0.00	0.0000	0
CA I	201803157	41	4.45	68	37.27	0	0.00	0.00	0.0000	0
CA I	201803158	41	2.36	68	36.40	0	0.00	0.00	0.0000	0
CA I	201803160	41	1.44	68	32.91	0	0.00	0.00	0.0000	0
CA I	201803161	41	0.93	68	32.82	0	0.00	0.00	0.0000	0
CA I	201803162	41	0.89	68	31.39	0	0.00	0.00	0.0000	0
CA I	201803163	40	59.76	68	30.99	0	0.00	0.00	0.0000	0
CA I	201803164	40	57.54	68	37.65	0	0.00	0.00	0.0000	0
CA I	201803165	40	58.20	68	40.84	0	0.00	0.00	0.0000	0
CA I	201803166	40	57.44	68	44.43	0	0.00	0.00	0.0000	0
CA I	201803168	41	1.01	68	45.37	16	1.52	0.20	0.0030	0
CA I	201803170	40	59.36	68	49.71	0	0.00	0.00	0.0000	0
CA I	201803171	40	57.97	68	51.82	72	6.80	1.00	0.0157	0
CA I	201803172	40	56.79	68	53.68	56	5.67	0.90	0.0112	0
CA I	201803174	40	58.32	68	55.23	41	5.38	0.80	0.0080	0

CA I	201803175	40	59.44	68	55.68	75	8.74	1.30	0.0158	0
CA I	201803176	40	59.76	68	54.03	721	76.48	12.00	0.1771	0
CA I	201803178	41	3.53	68	57.55	407	45.98	7.20	0.0806	0
CA I	201803179	41	4.68	68	59.69	526	52.46	10.50	0.0944	0
CA I	201803181	41	5.36	68	56.25	514	73.23	8.50	0.1018	0
CA I	201803182	41	4.49	68	53.99	35	4.09	0.50	0.0070	0
CA I	201803183	41	4.86	68	51.94	264	31.23	3.60	0.0524	0
CA I	201803184	41	8.03	68	38.77	10	1.13	0.10	0.0019	0
CA I	201803186	41	12.39	68	41.66	439	53.28	7.70	0.0827	0
CA I	201803187	41	12.51	68	44.80	125	16.92	2.00	0.0249	0
CA I	201803188	41	10.45	68	45.75	56	7.59	1.00	0.0111	0
CA I	201803189	41	7.76	68	52.82	114	13.04	2.00	0.0220	0
CA I	201803190	41	7.96	68	59.11	40	4.21	0.90	0.0078	0
CA I	201803191	41	8.30	68	58.12	44	4.61	0.75	0.0087	0
CA I	201803192	41	9.45	68	56.63	605	52.00	1.30	0.1199	0
CA I	201803192	41	9.45	68	56.63	605	52.00	13.00	0.1199	0
CA I	201803193	41	12.19	68	53.08	246	32.94	4.00	0.0441	0
CA I	201803194	41	12.86	68	55.94	1545	130.80	25.00	0.3063	0
CA I	201803195	41	12.68	68	58.07	1012	74.10	16.00	0.2099	0
CA I	201803196	41	11.02	69	6.18	42	3.44	0.60	0.0080	0
CA I	201803197	41	12.62	69	5.80	10	0.77	0.10	0.0020	0
CA I	201803198	41	13.97	69	7.39	1563	143.89	21.00	0.3289	0
CA I	201803199	41	14.40	69	9.23	12	0.96	0.10	0.0023	0
CA I	201803200	41	15.91	69	10.32	103	9.59	1.25	0.0204	0
CA I	201803201	41	17.11	69	10.47	2748	273.42	40.00	0.5446	0
CA I	201803202	41	17.59	69	9.59	5599	324.34	72.00	1.1097	0
CA I	201803203	41	20.24	69	14.19	395	30.20	5.00	0.0856	0
CA I	201803204	41	24.66	69	17.49	369	33.86	6.25	0.0731	0
CA I	201803205	41	27.60	69	19.57	274	30.16	5.00	0.0543	0
CA I	201803207	41	29.13	69	19.31	575	58.51	11.25	0.1140	0
CA I	201803208	41	29.04	69	19.89	628	58.99	12.50	0.1309	0
NLCA	201804001	40	39.24	70	1.96	5	0.73	0.10	0.0013	0
NLCA	201804002	40	39.55	69	55.81	3	0.29	0.10	0.0006	0
NLCA	201804003	40	38.79	69	55.00	35	5.82	0.75	0.0077	0
NLCA	201804004	40	37.66	69	49.75	36	5.09	0.65	0.0075	0
NLCA	201804005	40	38.38	69	43.93	4	0.32	0.10	0.0008	0
NLCA	201804006	40	42.73	69	44.63	0	0.00	0.00	0.0000	0
NLCA	201804007	40	42.10	69	41.91	0	0.00	0.00	0.0000	0
NLCA	201804008	40	37.23	69	39.37	44	4.08	0.80	0.0087	0
NLCA	201804009	40	37.12	69	36.30	7	0.69	0.20	0.0016	0
NLCA	201804012	40	32.46	69	31.36	99	11.10	1.30	0.0190	0
NLCA	201804013	40	32.23	69	37.65	29	2.39	0.50	0.0057	0
NLCA	201804014	40	34.00	69	38.99	2134	172.48	39.00	0.3875	0
NLCA	201804015	40	33.69	69	40.60	42	3.34	0.70	0.0087	0

NLCA	201804016	40	34.09	69	44.79	480	40.32	8.20	0.0924	0
NLCA	201804017	40	35.49	69	51.44	2	0.14	0.10	0.0004	0
NLCA	201804018	40	35.55	69	57.15	2	0.12	0.10	0.0003	0
NLCA	201804019	40	33.89	69	59.56	2	0.18	0.10	0.0004	0
NLCA	201804020	40	29.29	69	57.65	0	0.00	0.00	0.0000	0
NLCA	201804021	40	29.98	69	52.57	0	0.00	0.00	0.0000	0
NLCA	201804022	40	32.19	69	51.66	3893	256.45	48.00	0.8018	0
NLCA	201804023	40	32.91	69	49.99	3470	233.78	47.00	0.7782	0
NLCA	201804024	40	31.57	69	47.73	2938	173.21	50.00	0.6007	0
NLCA	201804025	40	31.91	69	45.06	3847	211.06	72.00	0.7987	0
NLCA	201804026	40	29.84	69	41.79	4877	315.10	65.00	1.0072	0
NLCA	201804027	40	29.39	69	44.09	23	1.49	0.25	0.0047	0
NLCA	201804029	40	28.03	69	46.58	6	0.29	0.10	0.0012	0
NLCA	201804030	40	23.17	69	43.77	0	0.01	0.10	0.0001	0
NLCA	201804031	40	20.81	69	37.23	0	0.00	0.00	0.0000	0
NLCA	201804032	40	20.12	69	30.49	3	0.15	0.10	0.0006	0
NLCA	201804033	40	20.02	69	28.01	0	0.01	0.01	0.0000	0
NLCA	201804034	40	20.51	69	24.13	4	0.19	0.10	0.0008	0
NLCA	201804035	40	21.01	69	21.96	3253	146.04	48.00	0.6447	0
NLCA	201804036	40	20.06	69	18.23	0	0.00	0.00	0.0000	0
NLCA	201804037	40	20.16	69	10.35	0	0.00	0.00	0.0000	0
NLCA	201804038	40	20.15	69	10.10	0	0.00	0.00	0.0000	0
NLCA	201804039	40	20.64	69	7.61	1	0.03	0.10	0.0001	0
NLCA	201804040	40	20.56	69	2.72	0	0.00	0.00	0.0000	0
NLCA	201804041	40	22.33	69	0.36	0	0.00	0.00	0.0000	0
NLCA	201804042	40	21.81	69	4.45	0	0.00	0.00	0.0000	0
NLCA	201804043	40	22.55	69	8.60	0	0.00	0.00	0.0000	0
NLCA	201804044	40	23.66	69	12.96	0	0.00	0.00	0.0000	0
NLCA	201804045	40	23.28	69	15.10	0	0.00	0.00	0.0000	0
NLCA	201804046	40	22.41	69	17.69	0	0.00	0.00	0.0000	0
NLCA	201804047	40	23.26	69	23.37	546	17.17	14.80	0.1208	0
NLCA	201804048	40	22.32	69	26.05	815	26.13	22.00	0.1759	0
NLCA	201804049	40	23.66	69	28.12	36	2.07	0.70	0.0072	0
NLCA	201804050	40	24.55	69	25.24	2200	86.20	58.53	0.5457	0
NLCA	201804051	40	24.94	69	21.94	4312	174.40	78.30	0.9242	0
NLCA	201804052	40	24.15	69	20.79	1544	43.74	38.00	0.3232	0
NLCA	201804053	40	25.06	69	18.25	1398	43.17	37.00	0.2816	0
NLCA	201804054	40	24.24	69	6.61	2087	102.72	28.00	0.4625	0
NLCA	201804055	40	25.59	69	2.25	7	0.40	0.10	0.0014	0
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NLCA	201804057	40	27.20	69	9.25	2700	126.84	40.00	0.5772	0
NLCA	201804058	40	27.17	69	12.89	1661	100.68	20.00	0.3711	0
NLCA	201804059	40	27.32	69	15.25	605	40.26	9.20	0.1307	0
NLCA	201804060	40	27.06	69	17.54	2671	176.78	36.00	0.5709	0

NLCA	201804061	40	27.63	69	18.46	303	24.29	3.90	0.0661	0
NLCA	201804062	40	28.52	69	21.81	680	68.52	10.00	0.1324	0
NLCA	201804063	40	27.37	69	24.89	921	83.26	13.00	0.1908	0
NLCA	201804064	40	26.34	69	30.35	1211	104.21	17.00	0.2413	0
NLCA	201804065	40	26.92	69	32.59	243	22.23	3.70	0.0468	0
NLCA	201804066	40	28.48	69	35.71	42	3.67	0.80	0.0078	0
NLCA	201804067	40	30.21	69	31.36	891	101.36	22.00	0.1613	0
NLCA	201804068	40	31.06	69	29.74	66	7.17	1.50	0.0133	0
NLCA	201804069	40	30.42	69	25.44	31	3.95	0.90	0.0056	0
NLCA	201804070	40	30.52	69	21.88	165	23.21	2.90	0.0319	0
NLCA	201804072	40	29.75	69	12.97	66	5.80	1.50	0.0122	0
NLCA	201804073	40	29.08	69	13.16	94	7.85	1.40	0.0176	0
NLCA	201804074	40	29.26	69	9.67	286	18.47	4.00	0.0542	0
NLCA	201804075	40	27.94	69	5.63	0	0.00	70.00	0.0000	0
NLCA	201804076	40	28.83	69	3.30	710	51.47	13.50	0.1361	0
NLCA	201804077	40	27.49	69	0.40	181	12.97	2.10	0.0337	0
NLCA	201804078	40	28.54	68	56.63	46	3.10	0.90	0.0098	0
NLCA	201804079	40	28.94	68	51.24	99	9.34	1.25	0.0185	0
NLCA	201804080	40	31.57	68	52.24	44	3.33	0.50	0.0092	0
NLCA	201804081	40	31.00	68	54.51	87	6.94	1.80	0.0178	0
NLCA	201804082	40	32.31	68	56.85	46	4.02	0.50	0.0096	0
NLCA	201804083	40	32.50	69	0.72	87	7.67	1.50	0.0177	0
NLCA	201804084	40	29.92	69	2.35	414	35.01	4.00	0.0847	0
NLCA	201804085	40	30.41	69	5.47	147	9.76	1.50	0.0300	0
NLCA	201804086	40	31.44	69	5.71	190	15.58	2.00	0.0396	0
NLCA	201804087	40	31.00	69	8.69	84	7.27	1.00	0.0170	0
NLCA	201804088	40	32.35	69	14.10	0	0.00	0.00	0.0000	0
NLCA	201804089	40	33.66	69	17.51	67	9.91	1.00	0.0146	0
NLCA	201804090	40	32.01	69	22.00	133	19.53	2.00	0.0272	0
NLCA	201804091	40	33.34	69	24.56	170	25.36	2.80	0.0341	0
NLCA	201804092	40	33.91	69	28.64	43	6.23	1.00	0.0091	0
NLCA	201804093	40	35.80	69	28.24	15	1.90	0.25	0.0032	0
NLCA	201804094	40	37.01	69	25.74	2	0.29	0.10	0.0004	0
NLCA	201804095	40	36.08	69	22.64	12	1.27	0.25	0.0025	0
NLCA	201804096	40	35.44	69	21.98	49	6.72	0.75	0.0101	0
NLCA	201804097	40	34.70	69	17.20	77	9.82	1.10	0.0159	0
NLCA	201804098	40	34.44	69	11.17	804	93.68	11.00	0.1712	0
NLCA	201804099	40	34.81	69	8.45	1480	149.43	25.50	0.2867	0
NLCA	201804100	40	34.82	69	6.65	1135	106.10	28.75	0.2211	0
NLCA	201804101	40	35.13	69	1.86	137	14.08	2.90	0.0253	0
NLCA	201804102	40	36.58	69	2.19	642	68.11	12.80	0.1198	0
NLCA	201804104	40	35.95	69	7.54	241	25.12	5.00	0.0453	0
NLCA	201804105	40	37.14	69	13.00	443	45.29	8.00	0.0847	0
NLCA	201804106	40	37.76	69	16.55	157	16.61	2.50	0.0294	0

NLCA	201804107	40	38.67	69	17.91	5	0.41	0.10	0.0009	0
NLCA	201804108	40	38.48	69	21.78	0	0.00	0.00	0.0000	0
NLCA	201804109	40	39.47	69	23.95	2	0.28	0.10	0.0004	0
NLCA	201804110	40	40.23	69	27.93	1	0.12	0.10	0.0002	0
NLCA	201804111	40	42.57	69	25.01	1	0.12	0.10	0.0002	0
NLCA	201804112	40	42.84	69	20.71	2	0.20	0.10	0.0003	0
NLCA	201804113	40	40.36	69	18.88	32	3.33	0.30	0.0063	0
NLCA	201804114	40	39.81	69	15.54	441	48.35	6.50	0.0829	0
NLCA	201804115	40	38.12	69	11.86	305	41.45	4.50	0.0577	0
NLCA	201804116	40	38.00	69	7.14	618	71.88	13.00	0.1246	0
NLCA	201804117	40	38.25	69	5.74	174	19.06	3.00	0.0318	0
NLCA	201804118	40	40.38	69	4.27	67	7.59	1.40	0.0124	0
NLCA	201804119	40	42.13	69	8.00	189	23.97	5.50	0.0351	0
NLCA	201804120	40	41.45	69	11.54	668	67.13	9.50	0.1320	0
NLCA	201804121	40	42.55	69	16.90	188	20.70	2.50	0.0388	0
NLCA	201804122	40	43.85	69	14.96	585	63.46	14.00	0.1159	0
NLCA	201804123	40	44.19	69	11.45	228	20.95	3.00	0.0476	0
NLCA	201804124	40	44.83	69	5.56	400	40.40	6.50	0.0850	0
NLCA	201804125	40	43.02	69	0.76	123	12.38	2.25	0.0257	0
NLCA	201804126	40	46.73	69	1.57	147	15.29	2.00	0.0311	0
NLCA	201804127	40	46.26	69	10.78	92	9.73	1.25	0.0225	0
NLCA	201804128	40	47.16	69	13.69	21	2.17	0.50	0.0046	0
NLCA	201804129	40	45.18	69	17.39	166	17.75	2.25	0.0365	0
NLCA	201804130	40	46.08	69	19.11	598	66.54	9.25	0.1245	0
NLCA	201804131	40	46.36	69	23.06	8	0.89	0.10	0.0016	0
NLCA	201804132	40	46.98	69	25.96	5	0.59	0.10	0.0009	0
NLCA	201804133	40	49.83	69	23.34	0	0.00	0.00	0.0000	0
NLCA	201804134	40	49.85	69	19.63	0	0.00	0.00	0.0000	0

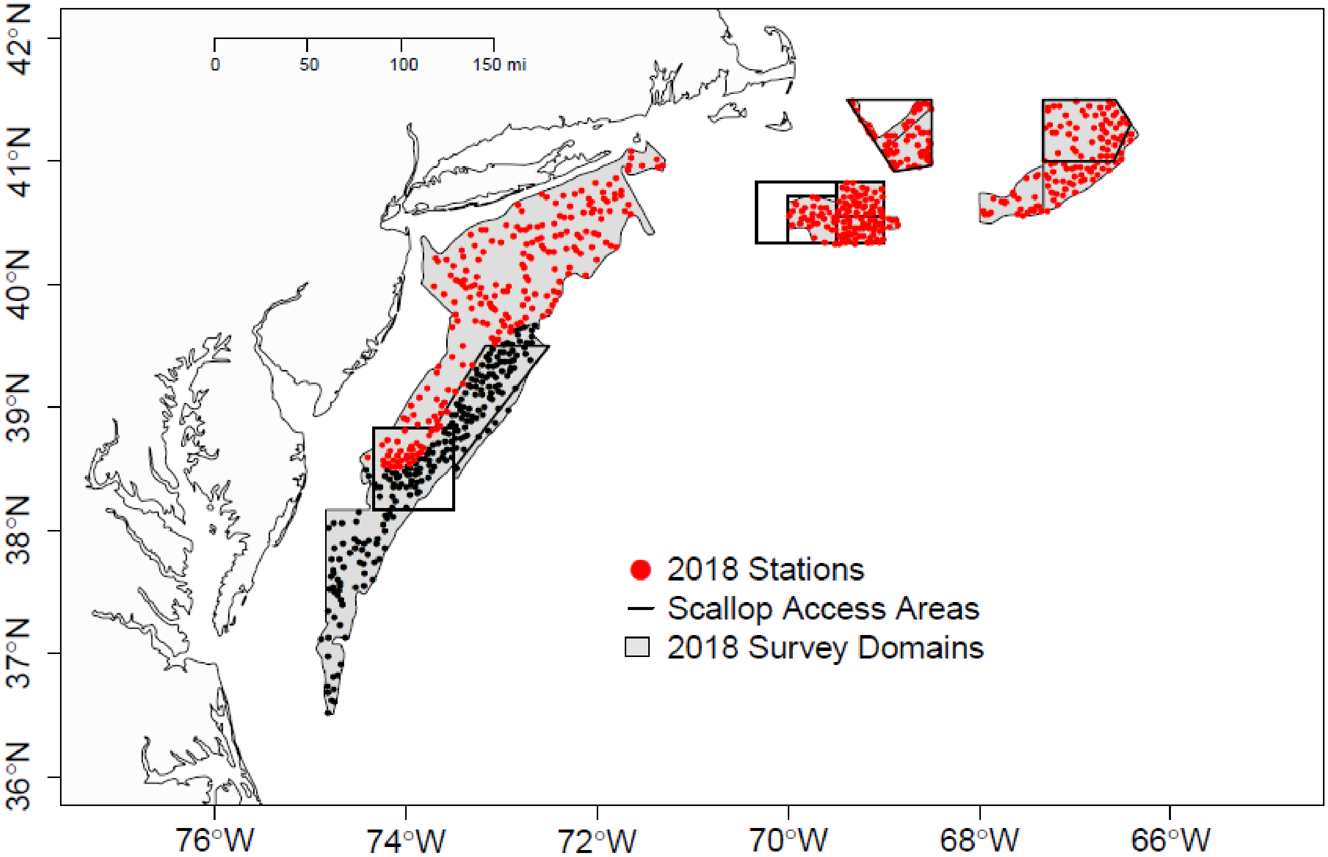

Figure 1. Survey domains with station locations for the VIMS/Industry cooperative surveys of the Mid-Atlantic sea scallop resource area, Nantucket Lightship Closed Area, Closed Area I, and Closed Area II completed during May-July 2018. Within the Mid-Atlantic survey domain, black dots represent the first leg of the survey while red represent the second leg.

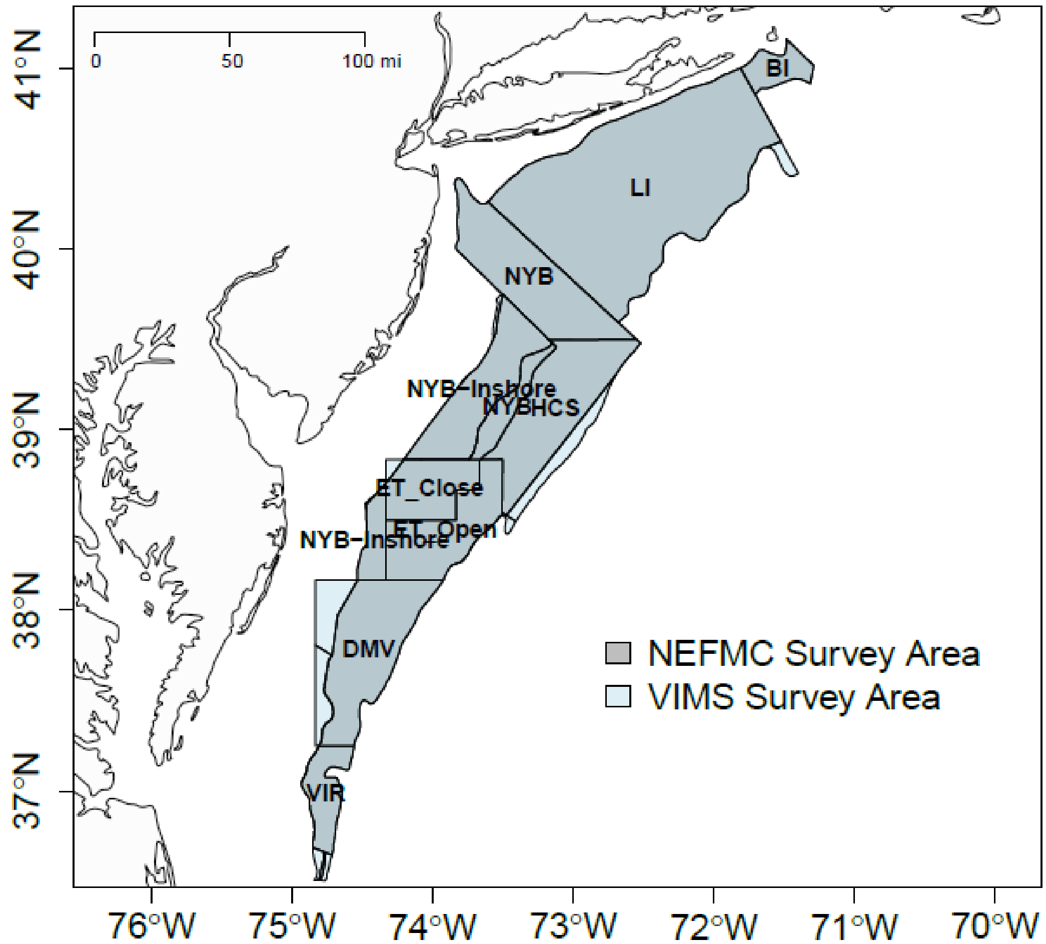

Figure 2. SAMS areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Mid-Atlantic sea scallop resource during May 2018.

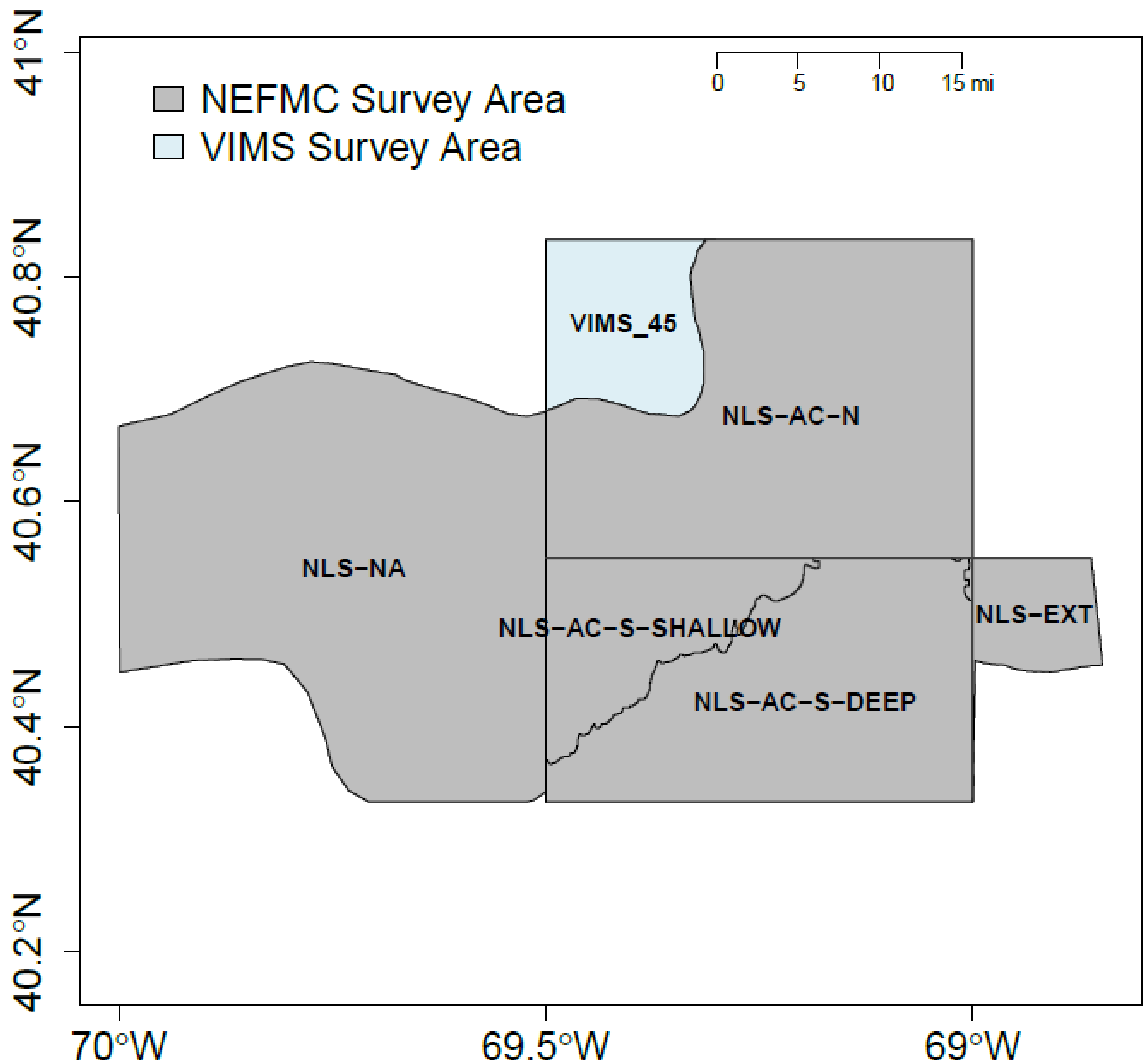

Figure 3. SAMS areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Nantucket Lightship access area and surrounds resource during July 2018.

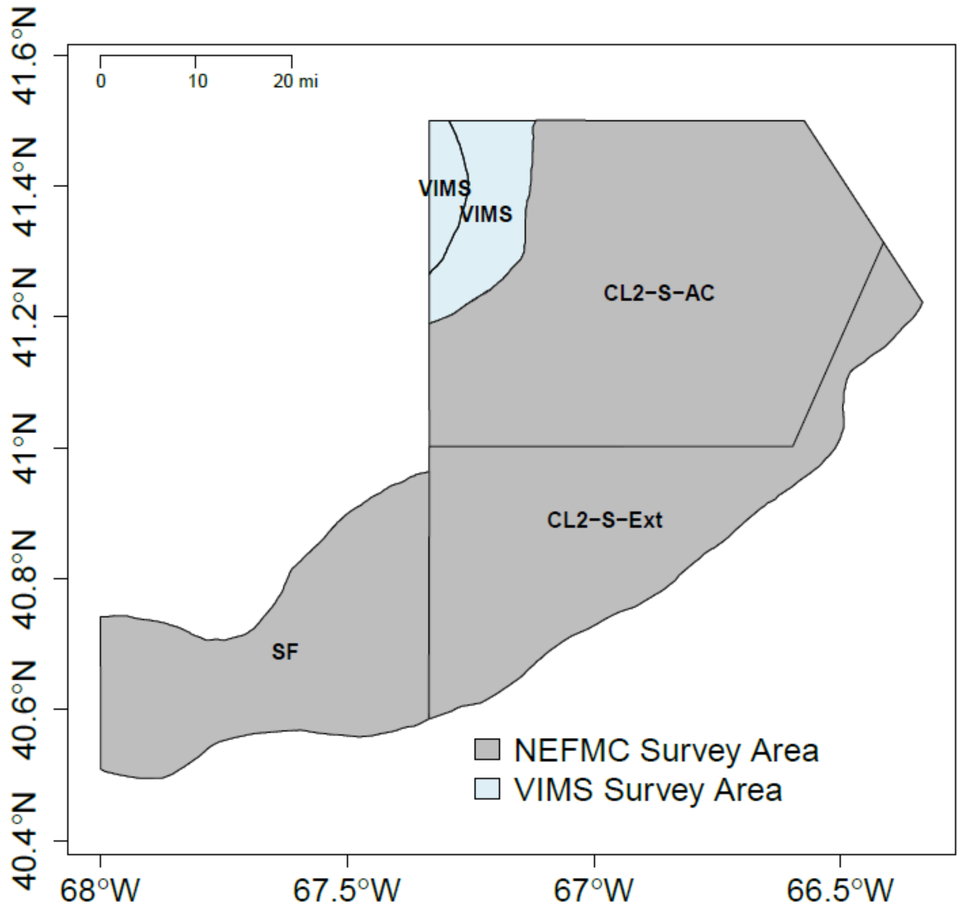

Figure 4. SAMS areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Closed Area II access area and open area along the southern flank during June 2018.

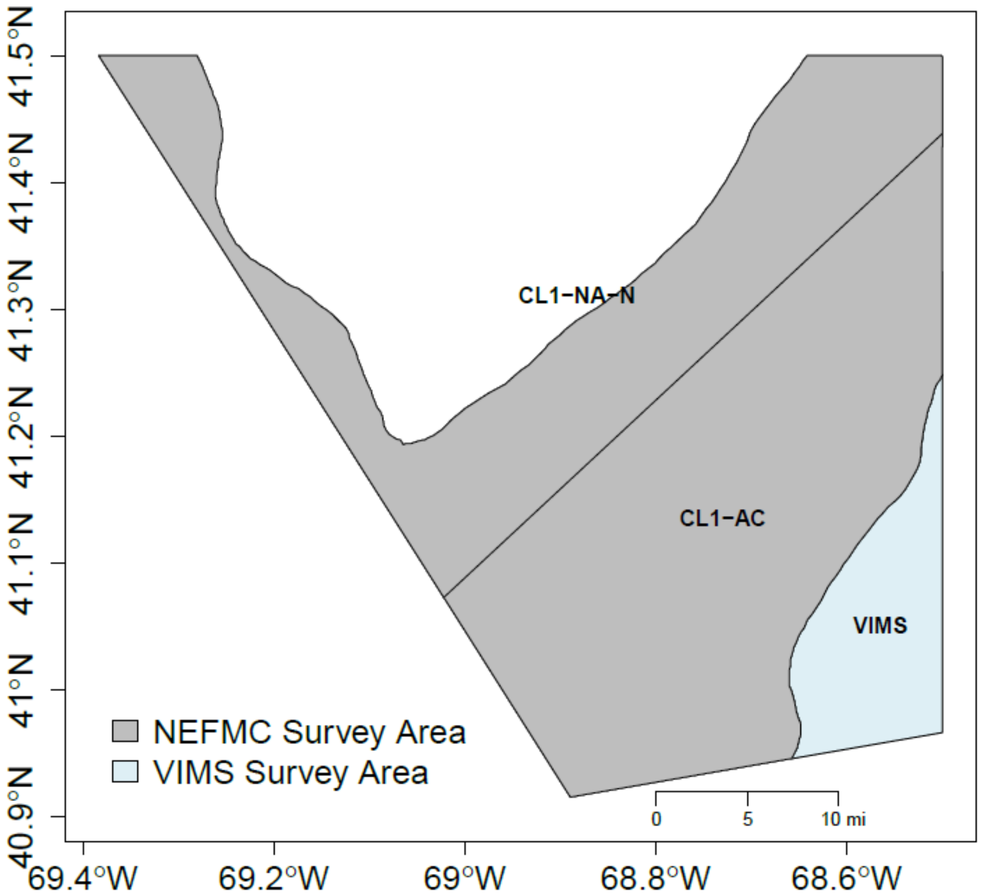

Figure 5. SAMS areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Closed Area I access area during June 2018.

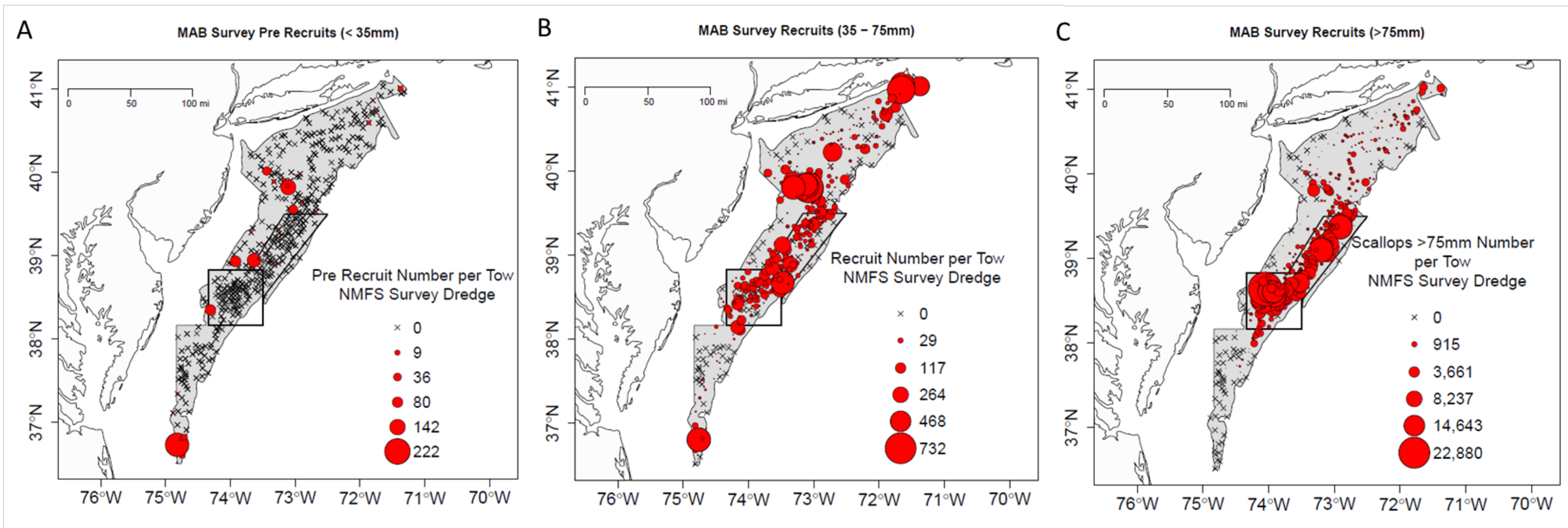

Figure 6. Number of scallops under 35 mm (A), 35-75 mm (B), and greater than 75 mm (C) caught in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Mid-Atlantic sea scallop resource during May 2018.

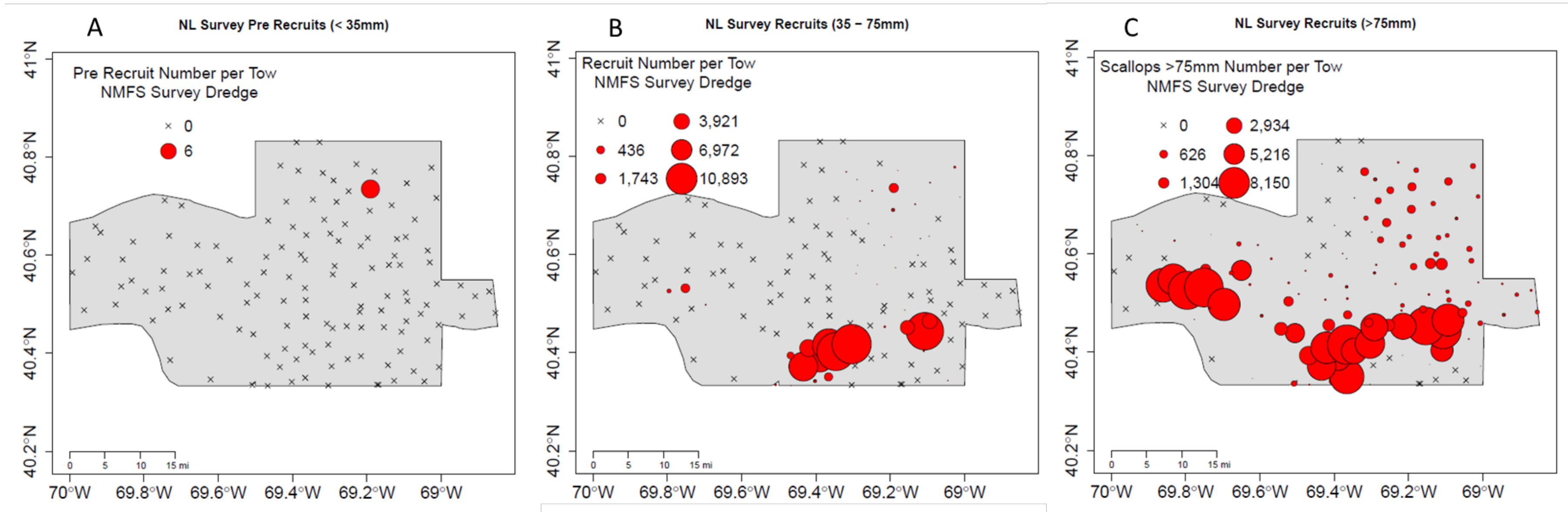

Figure 7. Number of scallops under 35 mm (A), 35-75 mm (B), and greater than 75 mm (C) caught in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Nantucket Lightship access area during July 2018.

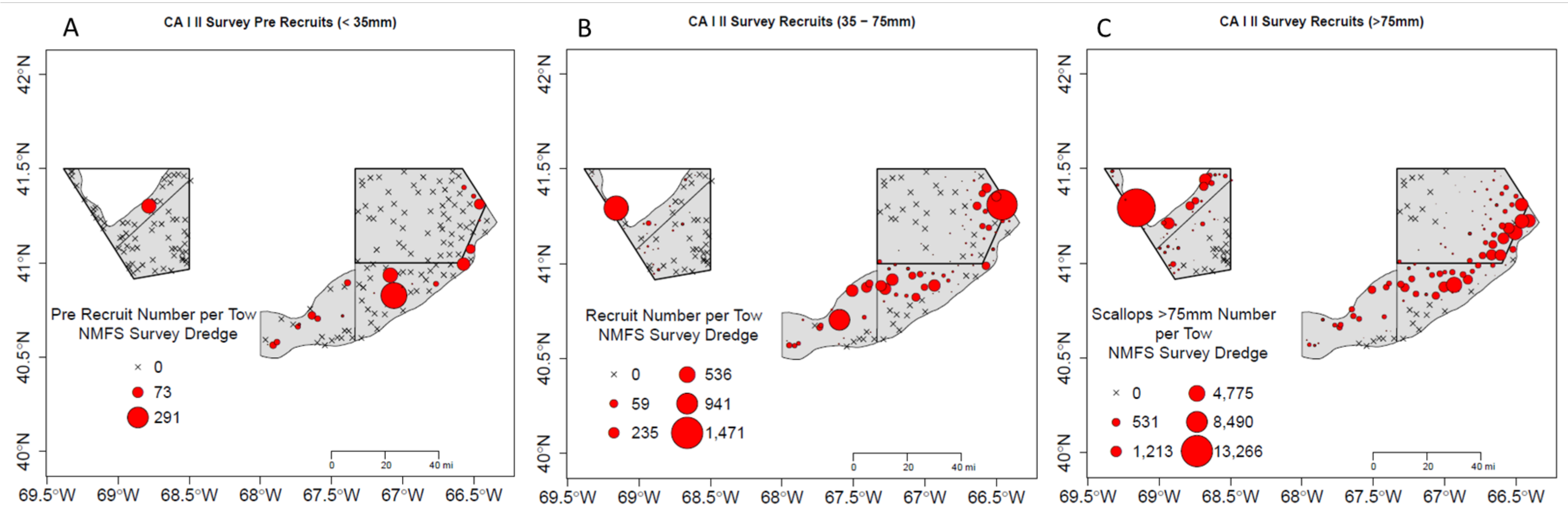

Figure 8. Number of scallops under 35 mm (A), 35-75 mm (B), and greater than 75 mm (C) caught in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Closed Area I and II access areas during June 2018.

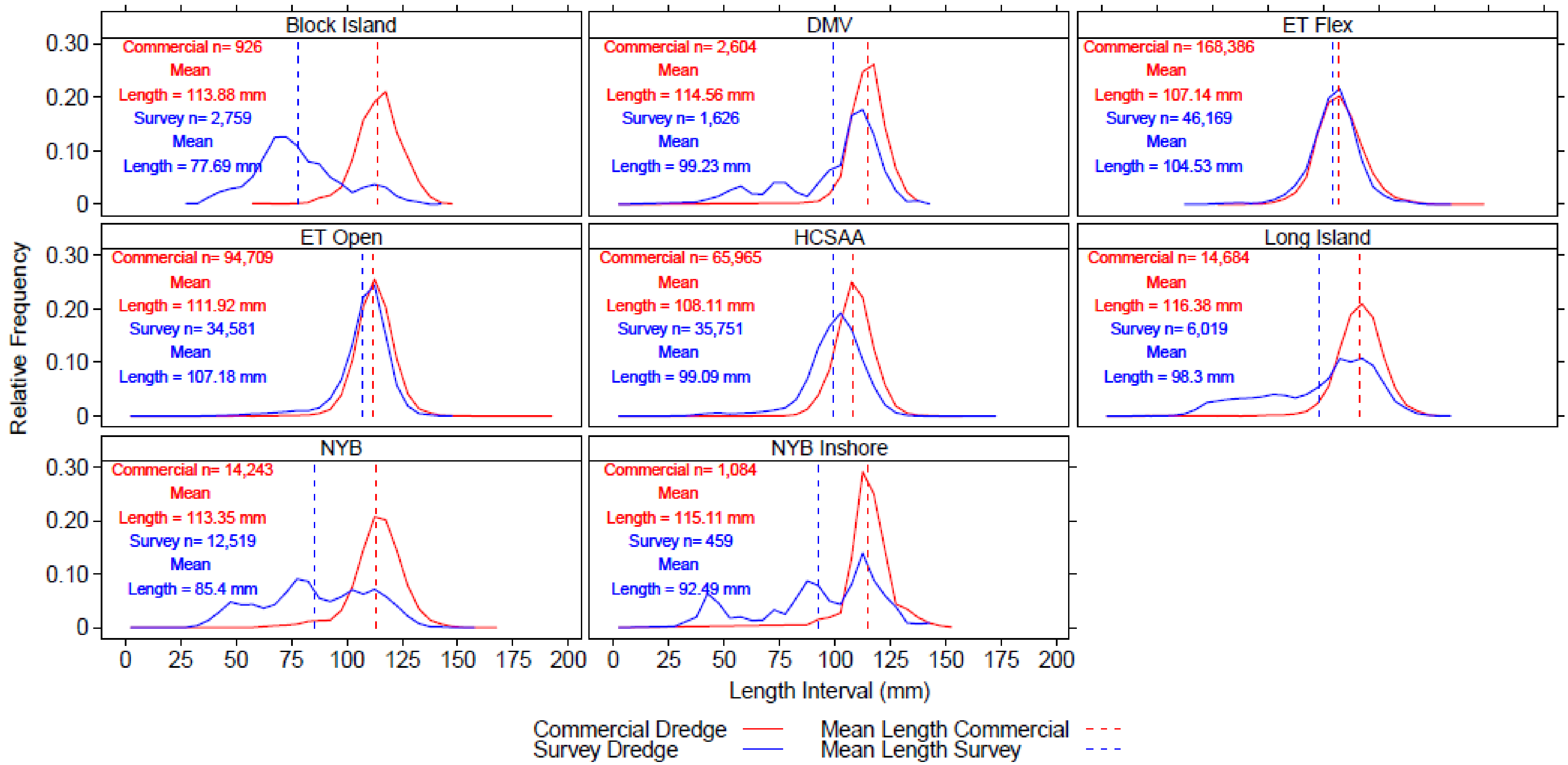

Figure 9. Scallop length frequency distributions generated from catch data obtained from both the survey and commercial dredges during the VIMS/Industry cooperative survey of the Mid-Atlantic sea scallop resource area in May 2018 by SAMS area. Number of scallops (n) measured and mean length by gear are also included.

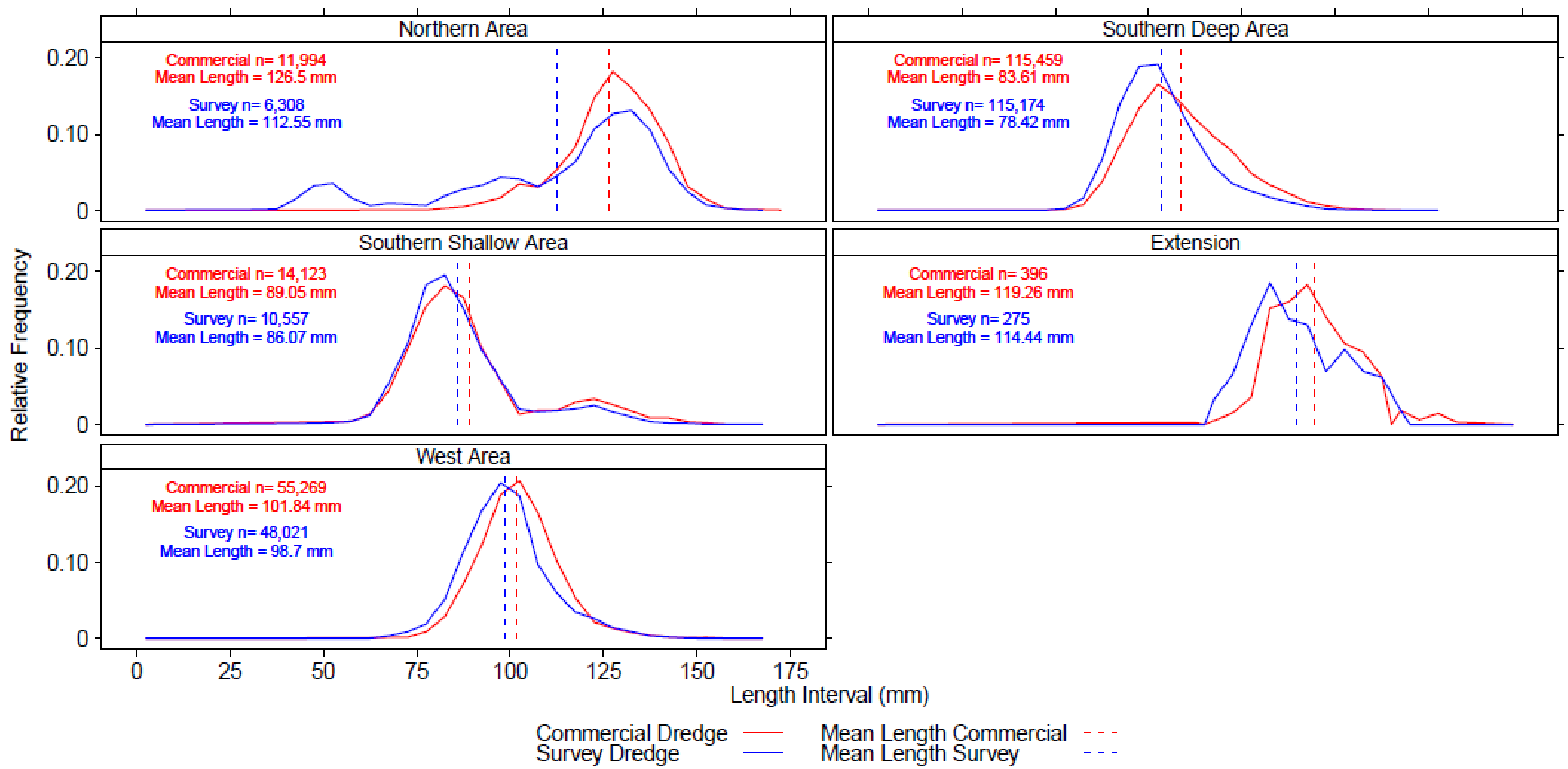

Figure 10. Scallop length frequency distributions generated from catch data obtained from both the survey and commercial dredges during the VIMS/Industry cooperative survey of the Nantucket Lightship access area and surrounds in July 2018 by SAMS area. Number of scallops (n) measured and mean length by gear are also included.

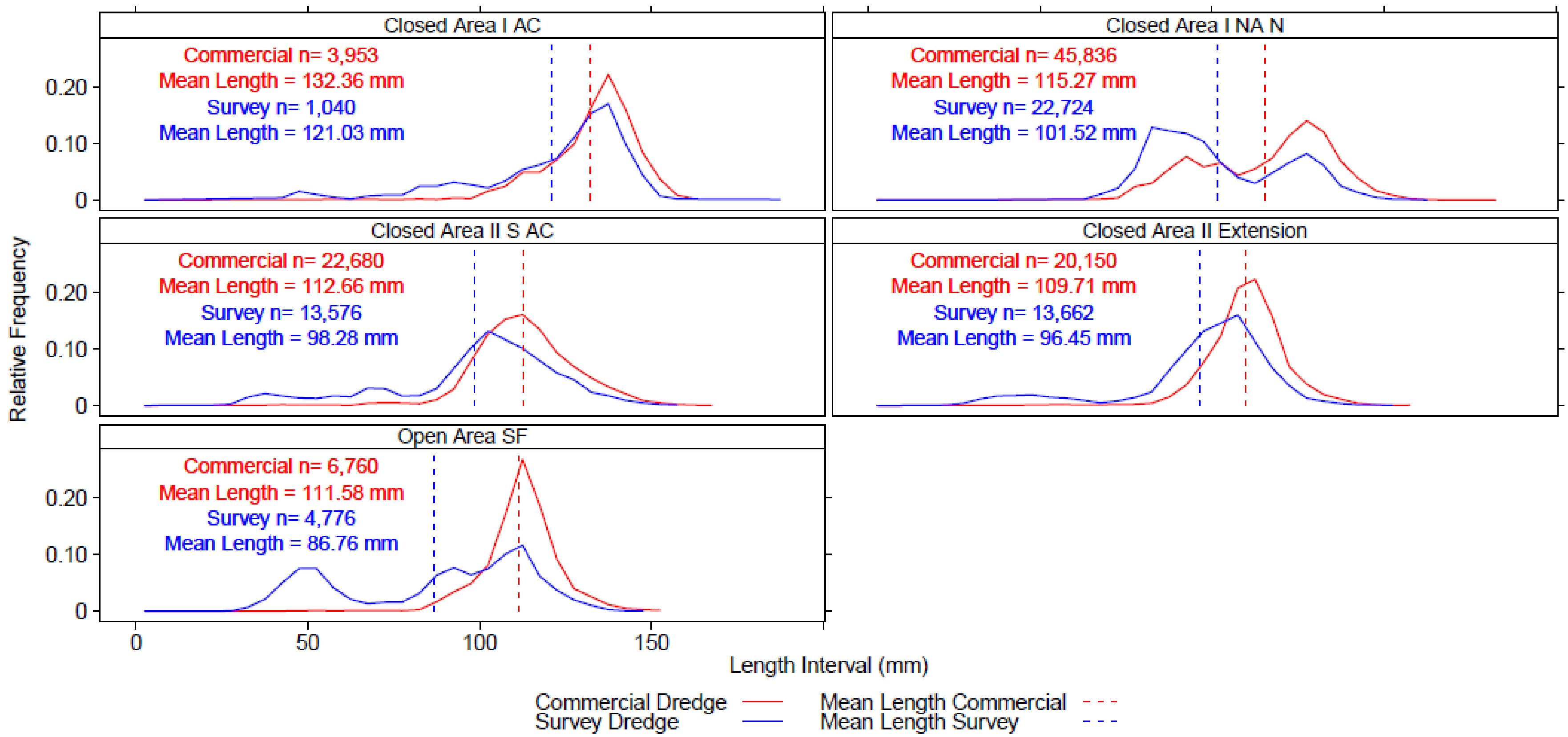

Figure 11. Scallop length frequency distributions generated from catch data obtained from both the survey and commercial dredges during the VIMS/Industry cooperative survey of the Closed Area I (top row) and Closed Area II (middle and bottom rows) in June 2018 by SAMS area. Number of scallops (n) measured and mean length by gear are also included.

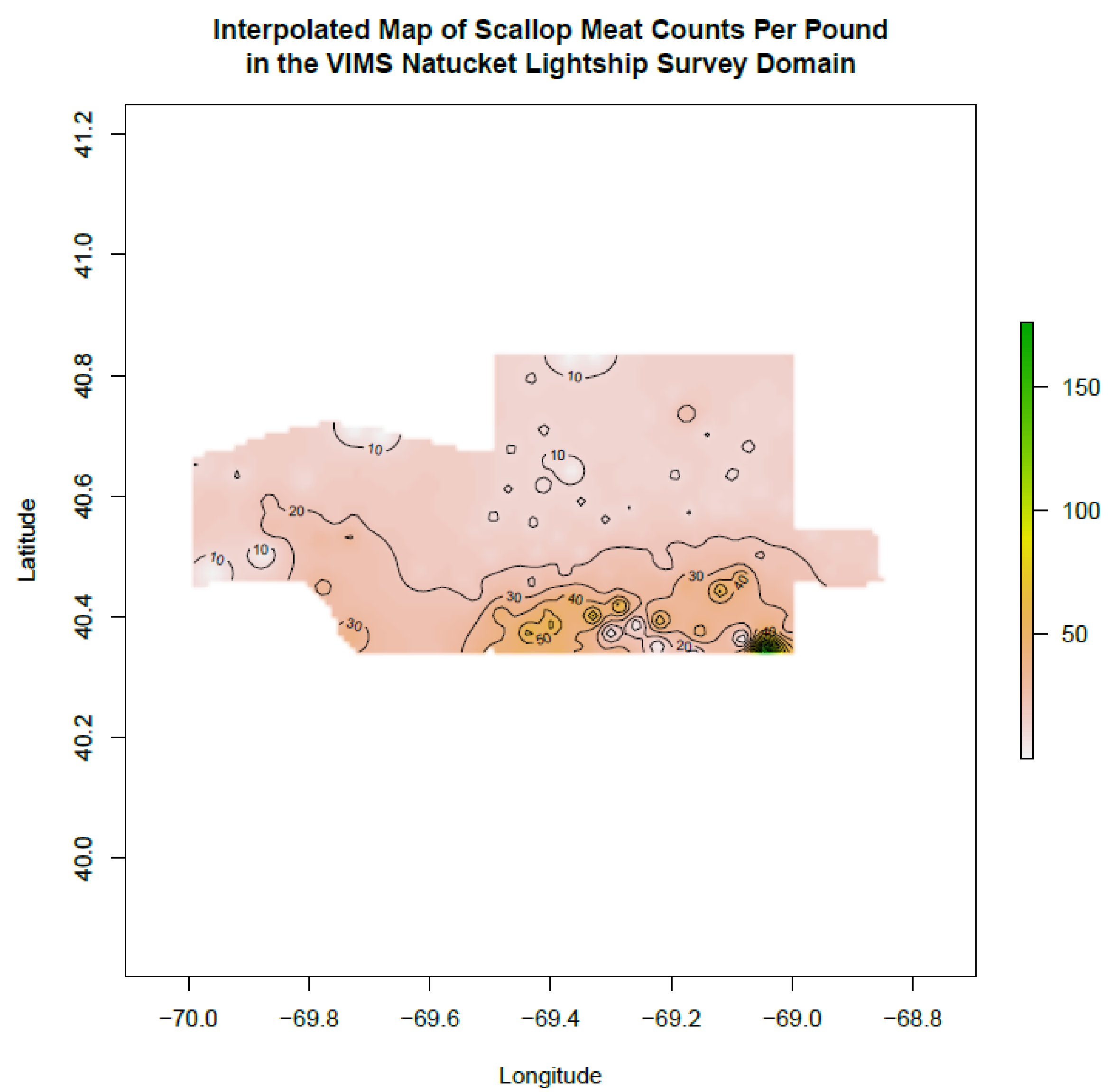

Figure 12. Estimated meat count (meats per pound) across the VIMS Nantucket Lightship survey domain.

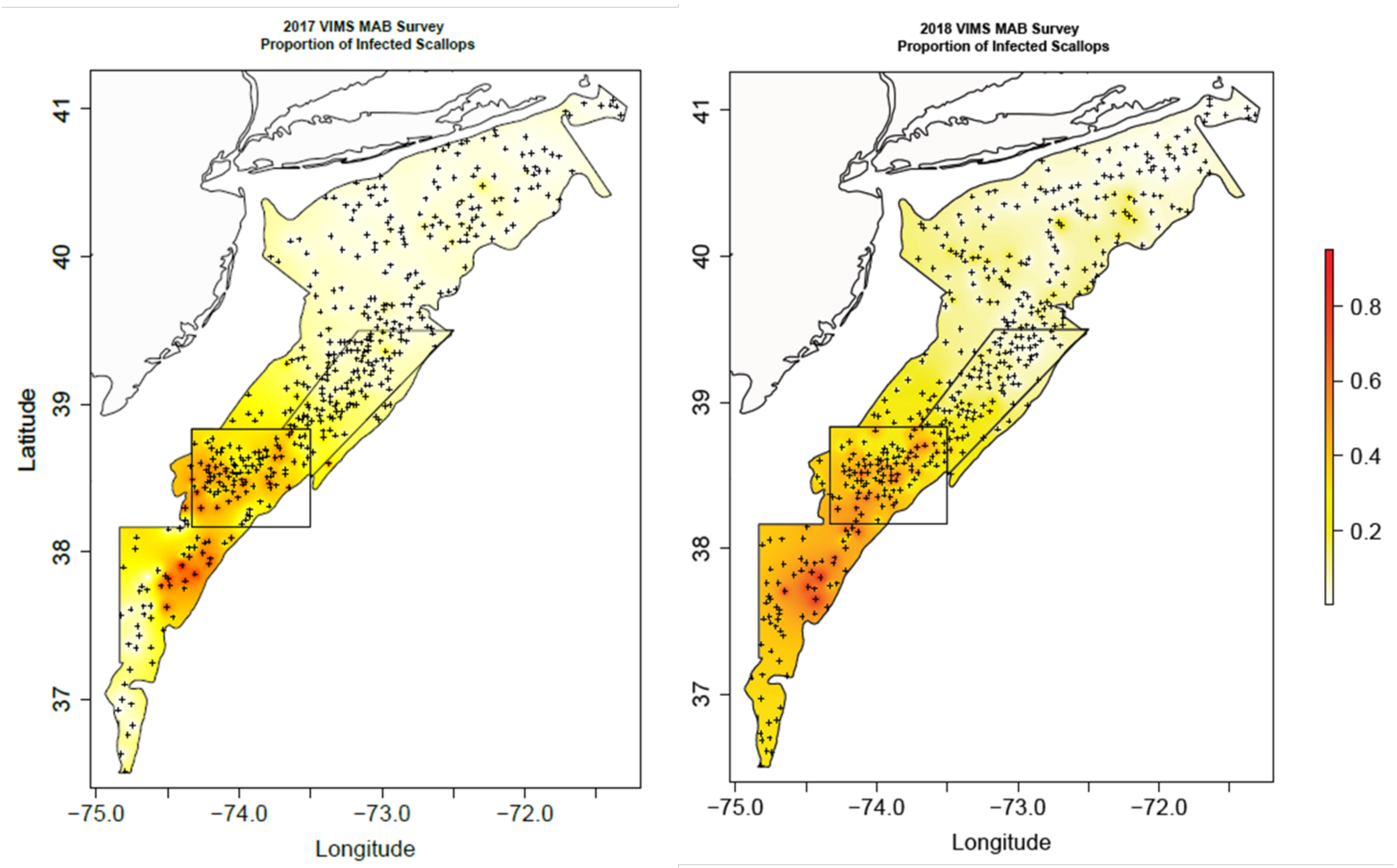

Figure 13. Spatial distribution of the prevalence of the nematode parasite in sampled scallops from 2017 and 2018 for the MAB resource area. Crosses indicate VIMS survey station locations.

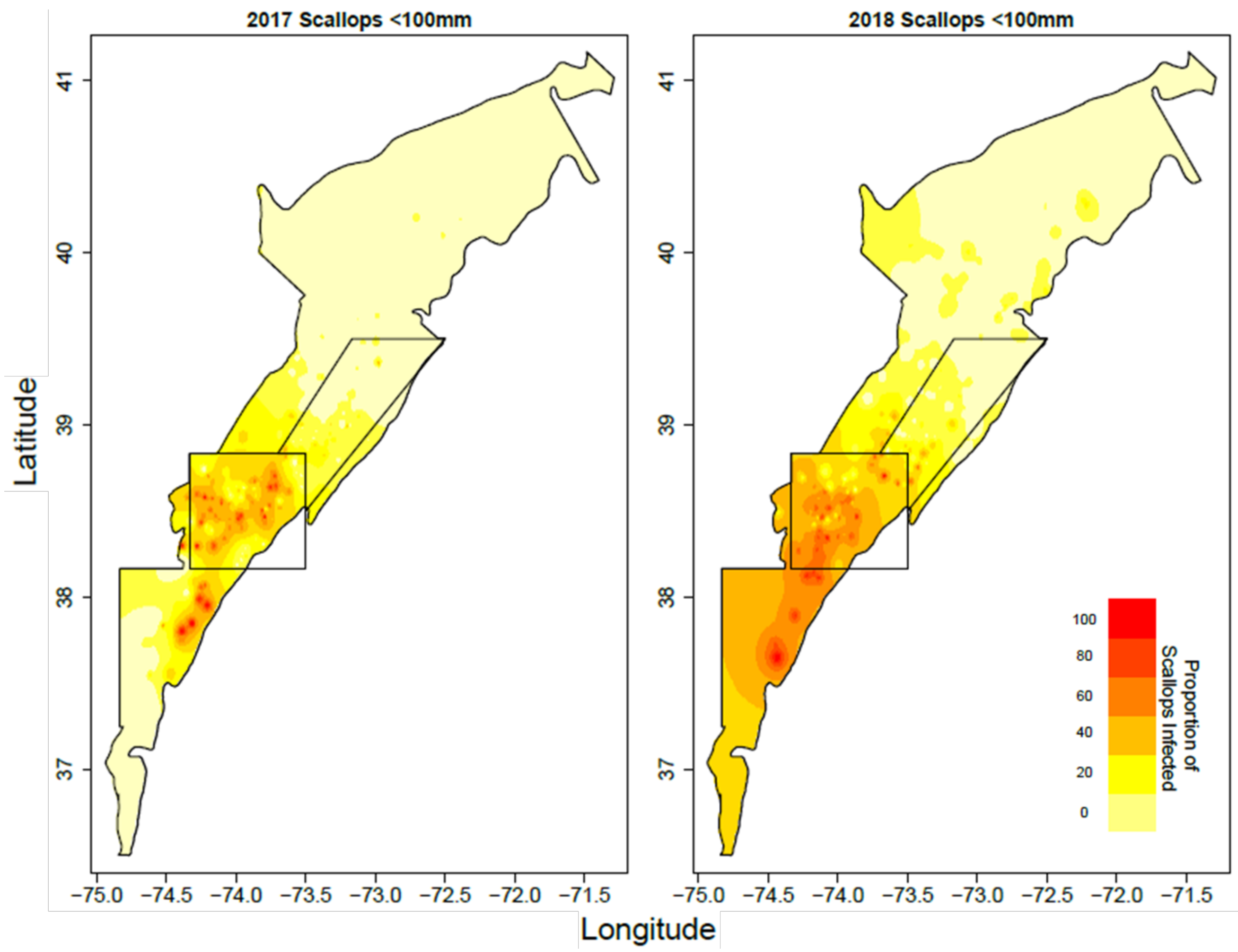

Figure 14. Spatial distribution of the prevalence of the nematode parasite in sampled scallops smaller than 100 mm in 2017 and 2018 for the MAB resource area.

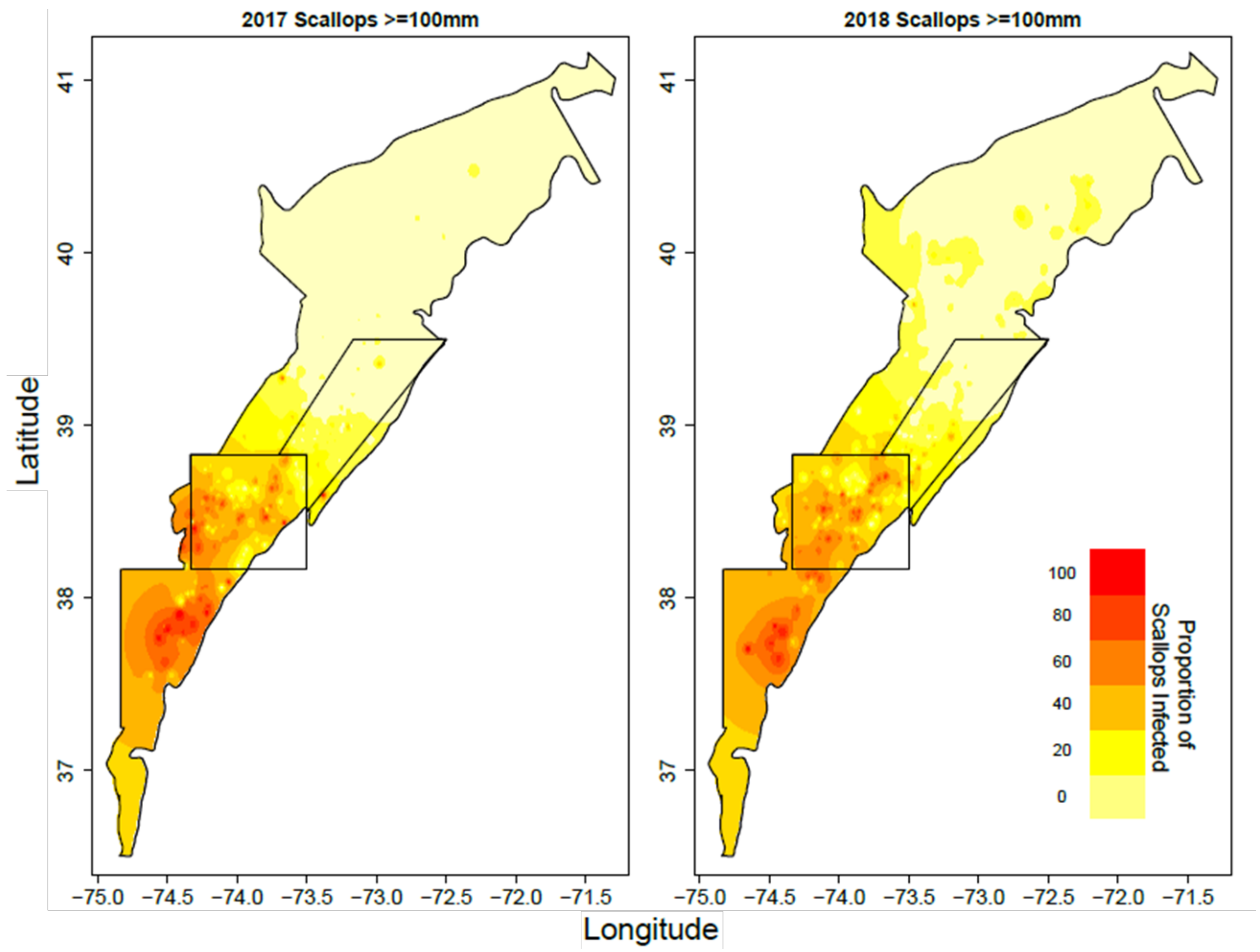

Figure 15. Spatial distribution of the prevalence of the nematode parasite in sampled scallops larger than 100 mm in 2017 and 2018 for the MAB resource area.