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Final Report

An Assessment of Sea Scallop Abundance and Distribution in Georges Bank Closed Area I and II and Surrounds

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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 from 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 stratified random survey of the Georges Bank Closed Area I (CAI) and Closed Area II (CAII), as well as the southern flank south of CAII in the summer of 2018 and 2019. The primary objective of these surveys was to assess the abundance and distribution of sea scallops in this area, culminating with spatially explicit annual estimates of total and exploitable biomass by Scallop Area Management Simulator (SAMS) Area. Secondary project objectives for each survey year 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. Sea scallop dredge performance (commercial and survey dredges).

Survey results were presented to the Sea Scallop Plan Development Team (PDT) to inform management decisions for fishing years (FY) 2019 and 2020 (i.e., access to rotational closed areas and catch allocation). Survey data were provided to the Northeast Fisheries Science Center (NEFSC) in 2018 and 2019 for use in projections for Days-at-Sea (DAS) and catch allocation calculations for FY 2019 and 2020. No recruitment was observed in CAI in either year, although exploitable biomass in 2018 was high enough to support commercial effort. The exploitable biomass in 2019 was also an indication that a conservative controlled re-opening could occur in FY 2020. A relatively large recruitment event was observed in the CAII access area, as well as the open area in the southern flank. Exploitable biomass estimates for 2019 in the CAII access area showed the access area could be re-opened for harvest in FY 2020. There was limited overlap between the recruits and adult biomass observed in the CAII access area. Gear performance of the New Bedford style dredge was consistent with previous results for the gear in terms of relative efficiency and selectivity. Catch data, biomass estimates, and spatial distribution of yellowtail flounder caught in CAII were presented as a paper and presentation at the 2018 and 2019 Transboundary Resources Assessment Committee (TRAC) meetings.

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 recent management measures intended to bring stability and sustainability. These measures include: limiting the number of participants, total effort (days-at-sea), 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 in both the Mid-Atlantic Bight (MAB) and Georges Bank (GB) resource areas. 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 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. In recent years, spatial management on GB has become more adaptive and conducted at finer spatial scales (i.e., NL Extension Closure and the GB CAII 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 that area is a key component of that determination. The collection of abundance and length distribution information 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.

In order to effectively manage the fishery and carry out a robust rotational area management strategy, current and detailed information regarding the abundance and distribution of sea scallops in the CAI and CAII access areas, as well as the open area along the southern flank are essential. This information forms the basis for both the establishment of a closed area and dictates the timing and intensity of a subsequent re-opening to fishing. 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 age structure of the population within that area is a key component of that determination. The collection of abundance and age distribution information 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.

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 appropriate Total Allowable Catches (TAC) in the subsequent re-openings of the closed 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 involve stakeholders in the management of the resource.

In addition to collecting data to assess the abundance and distribution of sea scallops in the areas surveyed, 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 standard New Bedford style dredge (NBD). This paired design, using one non-selective gear (NMFS) and one selective gear (NBD), allowed for the estimation of the size selective characteristics of the NBD. While gear performance (i.e., size selectivity and relative efficiency) information for the NBD has been documented (Yochum and DuPaul, 2008; NEFSC 2014), continuing to evaluate the performance of this gear will allow for changes in selectivity and efficiency to be monitored and quantified. Understanding time varying changes for the NBD is beneficial for two reasons. First, it could be an important consideration for the stock assessment for scallops in that it provides the size selectivity characteristics of the most recent gear configuration. In addition, selectivity analyses using the SELECT method provide insight to the relative efficiency of the two gears used in the study (Millar, 1992). The relative efficiency measure from this experiment can be used to refine existing absolute efficiency estimates for the NBD.

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 is routinely gathered by both the NEFSC 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.

For this study, we pursued multiple objectives. The primary objective was to collect information to characterize the abundance and distribution of sea scallops within CAI, CAII, and the southern flank open 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 for the adult resource and to monitor scallop disease/parasite prevalence. Sea scallop shells were also collected to supplement the NMFS shell collection for ageing. Finfish bycatch data were also collected to inform potential bycatch management and catch of yellowtail flounder were presented as a paper and presentation at the 2018 and 2019 TRAC meetings.

Methods

Survey Area and Sampling Design

Sampling stations for the surveys were selected using a stratified random sampling design with the strata consisting of the NMFS shellfish strata that have been used since the 1970s. Station locations were determined 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 CAII and VIMS 2018 survey of CAI and CAII. Data from 2017 were used to inform station selection for 2018 in the CAII survey domain, and 2018 survey data were then used for station allocation in 2019 in both CAI and CAII. For CAI, stratum area was used in 2018 to allocate stations. To assure that all strata had some representation of stations, a minimum of two stations were allocated to each stratum to allow for variance to be calculated. A portion of the total pool of samples is allocated proportionally based on stratum areas. The remaining samples are allocated using Neyman allocation that allocates samples based upon the biomass and number of animals observed in the prior year's survey. In 2018, 189 stations were occupied and station locations for the survey are shown in Figure 1. Out of the proposed 200 stations, 11 were dropped due to hangs or bottom type. All 200 proposed stations were completed in 2019. The station locations completed during the 2019 survey are shown in Figure 2.

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 15 ft. (2018) or 13 ft. (2019) NBD 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 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 3). Data from the DST sensor were 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. These catch data were also used to calculate biomass for both dredges and to 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. These predators, that included mainly crabs and starfish were identified to the genus or species level and enumerated.

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. In 2018, only adductor muscle weight was taken. In 2019, gonad wet weight was included in the sampling process. First, shell height was measured to the nearest mm. Then each scallop was carefully shucked and the adductor muscle and gonad were separated from the remaining soft tissue in 2019. In 2018, the adductor muscle was carefully shucked. Both were individually weighed at sea with a Marel™ motion compensating scale. In 2018, the adductor muscle weights were taken using a Marel M1100 motion compensating scale to the nearest 0.5 gram. In 2019, adductor muscle and gonad weights were taken with a Marel M2200 to the nearest 0.01 gram. 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 and shell 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 Area (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:

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

Variance Equation 3

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

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. In both 2018 and 2019 SARC 65 or in some cases relationships generated from collected survey data were applied (NEFSC, 2018). Exploitable biomass, defined as the 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 15 or 13 ft. for the commercial dredge and 8 ft. for the survey dredge.) 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 Miller et al. (2019) and SARC 65 (NEFSC, 2018) efficiency (q) estimates for the NMFS survey dredge (41%) and the NBD (65%) were used to scale relative biomass to absolute biomass where appropriate. 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 NL SAMS Areas for the entire survey domain, including area outside of the SAMS Areas that were surveyed (Figures 4-7). Area surveyed outside the pre-determined SAMS Areas was referred to as VIMS SAMS Areas in each survey domain. SAMS Areas within each survey domain were similar between years, but were referred to by different names in each year.

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 (R Core Team, 2016). 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 NBD 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 40%), 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. 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 NBD for the survey. This was done for each year and for both years combined.

The SELECT method is one of the preferred methods 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 is 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 fishing 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:

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

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

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

where 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-hauls approach may be more appropriate (Millar *et al*., 2004).

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 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 value (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 15 ft. (2018) and 13 ft. (2019) commercial dredge was used with expected split parameter of 0.652 and 0.619 respectively. 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 65% for a New Bedford style dredge.

Additional Analysis

Additional analysis of CAII survey data was completed at the request of the Scallop PDT in 2019 in an effort to delineate a boundary between recruits and adult biomass in the CAII_Access SAMS Area. This information was provided to the Scallop PDT and NEFMC staff for use in the drafting of spatial boundaries to be used in potential management measures for FY 2020.

The catch of yellowtail flounder was also provided to the Scallop PDT and NEFMC staff for use in drafting potential management measures for CAII in FY 2020. The total number and weight of yellowtail flounder observed from 2017-2019 were provided in tabular form. Maps of the spatial distribution of yellowtail flounder catches in CAII from 2017-2019 were also provided. Catch in number, length distributions, and spatial distribution of yellowtail flounder from CAII by year for 2016-2018 were presented as a working paper and presentation at the 2018 TRAC Committee meeting in Woods Hole, MA (Appendix E). Yellowtail data in number of fish, length distributions, biomass estimates, and spatial distribution from CAII and surrounds by year from 2005–2019 were also presented as a working paper and presentation at the 2019 TRAC meeting in St. Andrews, New Brunswick, Canada (Appendix F).

Results

Abundance and Distribution

The CAI, CAII, and southern flank survey was conducted from June 8-16 of 2018 and June 7-17 of 2019. In 2018, 189 stations were occupied onboard the *F/V Arcturus* (referred to as CruiseID 201803). In 2019, 200 stations were completed onboard the *F/V Polaris* (referred to as CruiseID 201907). Boxplots depicting the estimated linear distances covered per tow over the entire survey by year are shown in Figure 8. The mean tow length in 2018 was 1,698.77 m with a standard deviation of 100.16 m. The mean tow length in 2019 was 1,484.95 m with a standard deviation of 158.69 m.

Relative length frequency distributions for scallops captured during the survey by SAMS Area in 2018 are shown in Figure 9. Relative length frequency distributions for scallops captured in CAI by SAMS Area in 2019 are shown in Figure 10, while the relative length distributions for CAII and the southern flank area are shown in Figure 11. Maps depicting the spatial distribution of scallop catch by size class for the survey dredge and year (< 35mm, 35-75 mm, and > 75 mm) are shown in Figures 12-13. Total and exploitable biomass calculated using the area-specific shell height:meat weight coefficients described above for 2018 and 2019, along with confidence intervals, by gear type and SAMS Area are shown in Tables 1-4 (total biomass from the commercial dredge is not estimated due to the selective properties of the commercial gear). An estimate of the total and exploitable number of animals by year, gear type, and SAMS Area are shown in Tables 5-6. Shell height:meat weight relationships were estimated by SAMS Area within the survey domain. The resulting parameters estimated by year and area (i.e., Closed Area I or Closed Area II and the southern flank) are shown in Tables 7-8. The predicted shell height:meat weight relationships for the Closed Area I SAMS Areas by year are shown in Figure 14, and Closed Area II and southern flank SAMS Areas are shown in Figure 15. Catch per unit of effort for finfish bycatch for the survey is shown in Table 9. Length frequency distributions for finfish bycatch with sufficient sample sizes are shown in Figures 16-17 by gear and year.

Size Selectivity

The catch data were evaluated by the SELECT method with a variety of functional forms (e.g. logistic, Richards) 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. 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, 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 by year are shown in Table 10. Observed versus predicted fits and deviance residuals by year are shown in Figures 18-19. The predicted selectivity curves by year are shown in Figures 20-21.

Parameter estimates by year and across years were relatively consistent and agreed with the observed and predicted selectivity curves. The estimated p parameters of 0.85 and 0.86 were greater than reported in Yochum and DuPaul (2008) for the NBD dredge (0.77), indicating that in this area the NBD is more efficient (Table 10). Parameter estimates from this study were similar to those reported by Roman and Rudders (2019) for the NBD for the time period of 2015-2017. The L_{50} values were slightly greater than the 2008 estimate of 110.7 mm and the 2019 value of 108.2 mm, but the split parameter values were consistent. The difference between the results from this study, in conjunction with the Roman and Rudders (2019) findings may indicate time varying changes in selectivity for the NBD.

Meat Quality and Shell Blisters

A total of 4,425 scallops were sampled at shell height:meat weight stations over the two-year period. In 2018, 2,075 scallops were sampled, and in 2019, 2,350 scallops were processed. A total of 2,337 gonad weights were taken in 2019. Summary information on sex, market category, color, texture, and blister disease stage are provided in Table 11. Table 12 provides the classifications for market category, color, texture, and blister codes. Seventy-five percent of scallops in 2018 and 98 percent of scallops in 2019 were classified as marketable with no texture or color deviations. Less than one percent of scallops assessed showed signs of shell blister disease, regardless of sex, across both years.

Nematode Monitoring

All scallops assessed for meat quality and shell blisters were also assessed for nematode infections. No scallops were observed to be infected.

Scallop Shells

A total of 258 shells were aged in 2018, and 596 shells were aged in 2019. A representative subset of shells was archived at VIMS.

Outreach

As part of the outreach component of this project, a presentation detailing the annual results of each survey was compiled. These presentations were delivered to the Sea Scallop PDT at their meeting in Falmouth, MA, during August 28-29, 2018 and in Woods Hole, MA, from August 27-28, 2019. Presentations are included as Appendices A and B, respectively. An annual industry report was generated to summarize results from VIMS 2018 and 2019 survey efforts and distributed to stakeholders (Appendices C and D). In 2018 and 2019, a working paper and presentation on yellowtail flounder catches were presented to the Transboundary Resources Assessment Committee (Appendices E and F). The 2019 working paper also provided swept area biomass estimates.

Presentations

Several other presentations were given that included information regarding these surveys and survey results:

- 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
- Transboundary Resources Assessment Committee (TRAC) Assessment Meeting, St. Andrews, New Brunswick, Canada. July 9-11, 2019
  - Georges Bank Yellowtail Flounder Estimates from VIMS Industry-Based Scallop Dredge Surveys of Closed Area II and Surrounds. Sally Roman and Dave Rudders
- September 4, 2019 Scallop PDT Meeting, New Bedford, MA
  - VIMS Survey Data Treatment Updates. Sally Roman and Dave Rudders

Discussion

Surveys of important resource areas like the CAI, CAII, and the southern flank are an important endeavor. These surveys provide information about a critical component of the resource unit that includes 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 time 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.

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. However, since this survey is designed to estimate exploitable biomass, this is not a critical issue.

Our results suggest that significant biomass exists in the CAII Access Area SAMS Area. Within this area, there are high levels of adult biomass, as well as a recruitment event that was observed for the first time in 2019. There is minimal overlap between the adult biomass and recruitment event, but a precautionary approach may provide the resource and fishery an opportunity to increase future yield per recruit if an adaptive management approach is taken to provide protection from fishing mortality for this newly observed cohort. The recruitment event was observed not only in the CAII Access Area SAMS Area, but also the SF SAMS Area, which is open area. Again, providing protection for this cohort in the open area should increase future yield per recruit. Adult biomass in the CAI Silver SAMS Area remained at high levels in 2019, despite being open to harvest in FY 2019. This SAMS Area may be able to sustain a lower level of harvest in FY 2020. No recruitment was observed in the CAI Access Area in either 2018 or 2019.

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 NBD based on information collected in 2018 and 2019. Selectivity of the NBD was estimated by Yochum and DuPaul (2008) and Roman and Rudders (2019), and while the expectation is that the selectivity of the NBD would not change over time, the utilization of this survey to estimate selectivity for this gear is beneficial for examining potential shifts in selectivity over time. Results varied compared to those estimated by Yochum and DuPaul (2008) and were similar to the results presented in Roman and Rudders (2019). The estimated *p* parameter and relative efficiency estimates indicated the NBD was more efficient than expected and that efficiency had increased since first estimated in 2008. The L_{50} estimate in each year was greater than that estimated by Yochum and DuPaul (2008) and Roman and Rudders (2019). The increase may be an indication of time varying selectivity of this dredge, but more data would be required in future years to determine if this variability is a consistent trend or related to current resource conditions.

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. Shell height:meat weight relationships estimated from these two surveys were consistent with SARC 65 (2018) information. Continued monitoring of spatially-explicit shell height:meat weight data from these areas will be a benefit and aid in determining if spatial-explicit relationships may need to be applied in the future. Area and time specific shell height:meat weight parameters are another topic that merits continued study, especially for this area.

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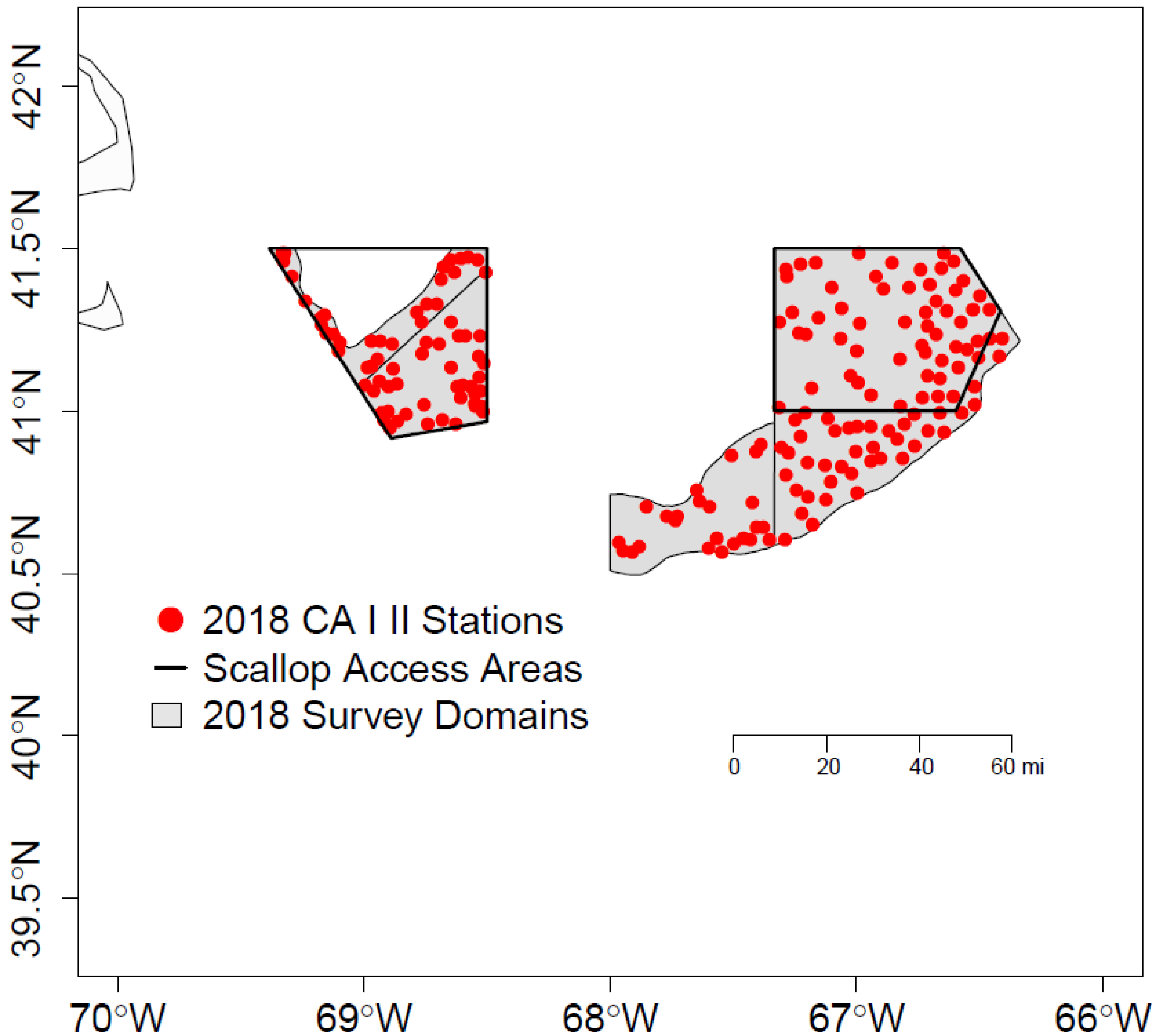
Figure 1 Locations of sampling stations for the 2018 survey of Closed Area I, Closed Area I, and open area along the southern flank of Georges Bank.



<u>Figure 2</u> Locations of sampling stations for the 2019 survey of Closed Area I, Closed Area I, and open area along the southern flank of Georges Bank.

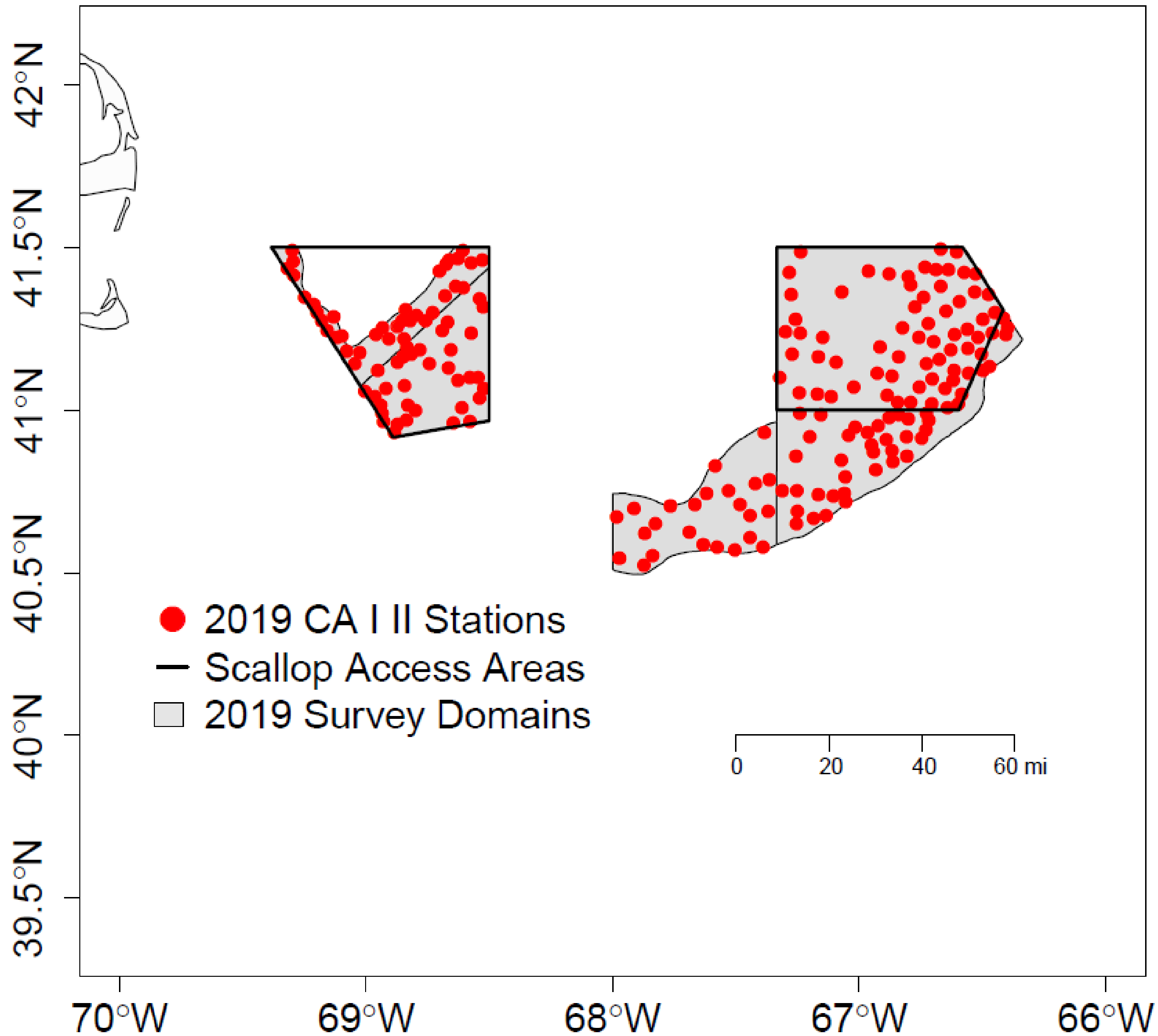


Figure 3 An example of the output from the Star-Oddi™ DST sensor. Arrows indicate the interpretation of the start and end of the dredge tow.

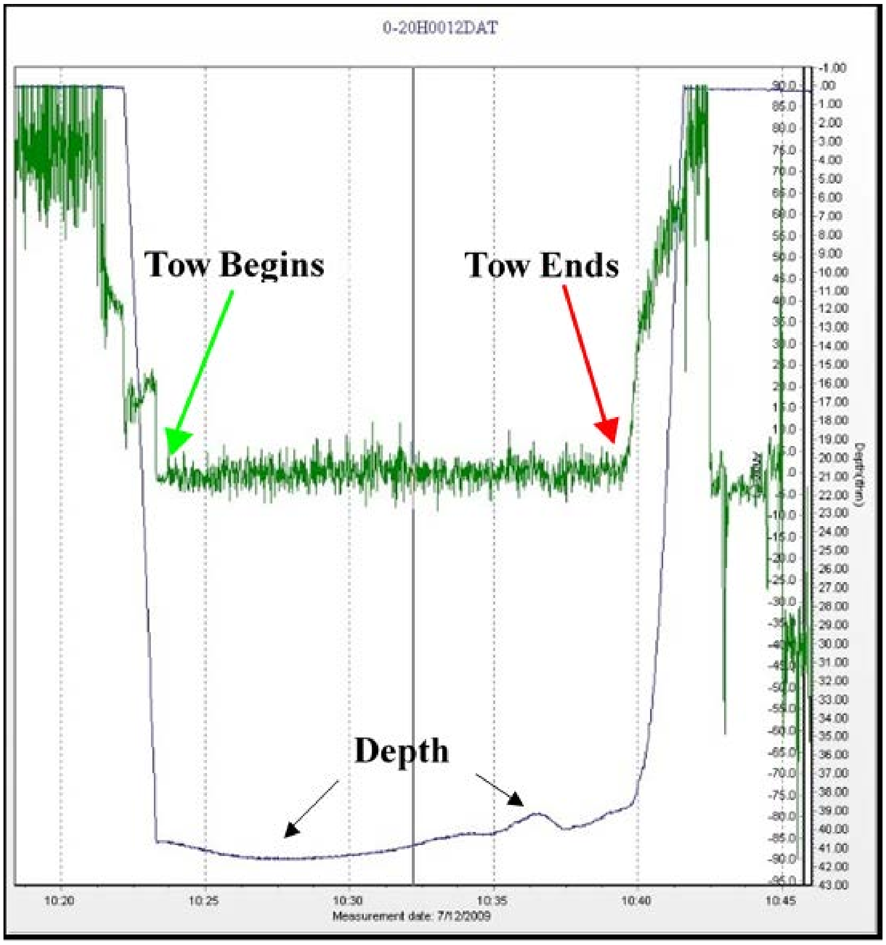


Figure 4 Map of the 2018 survey domain for the survey of Closed Area I with the SAMS Area designations and NMFS and VIMS extents (grey and blue).

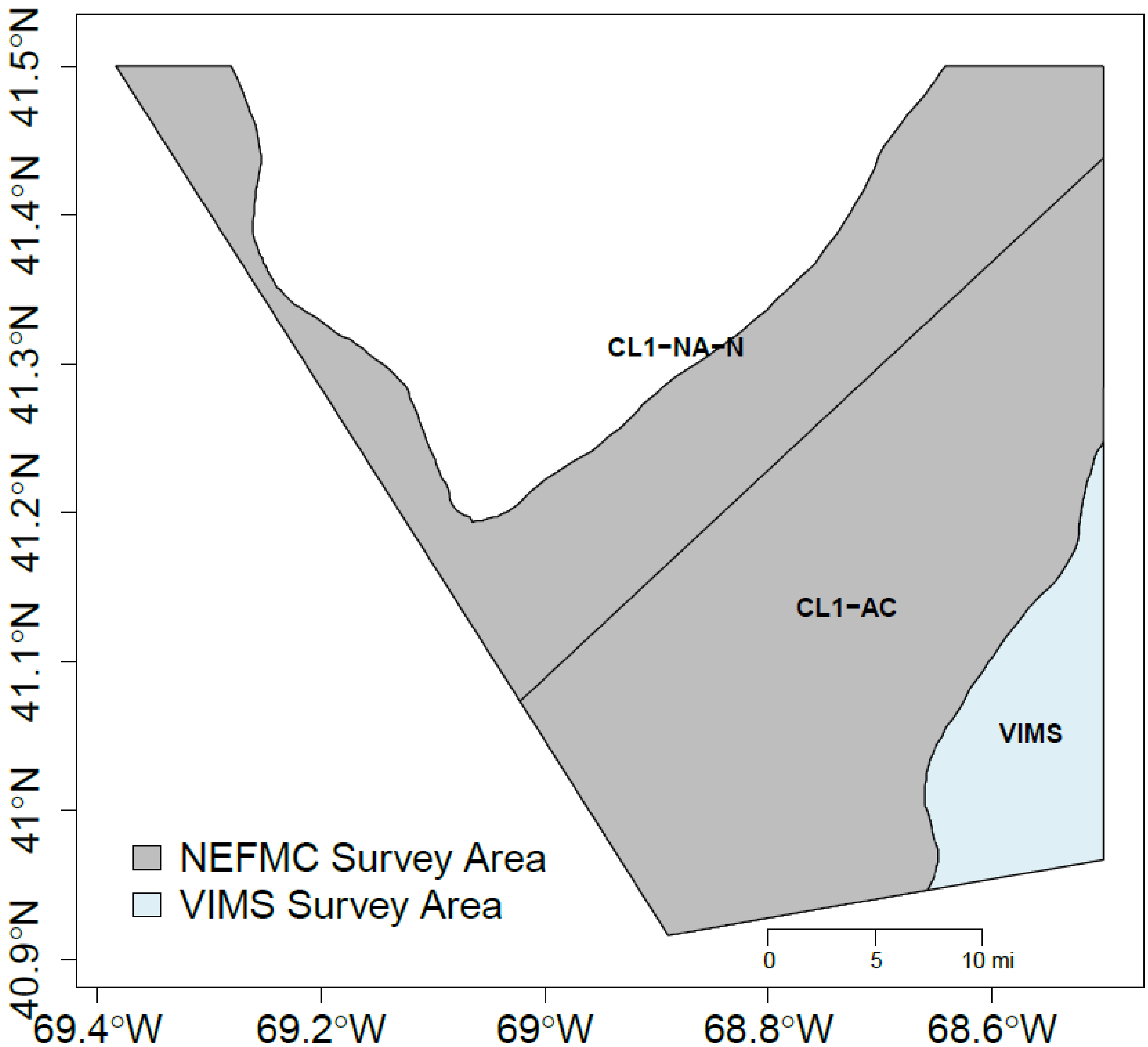
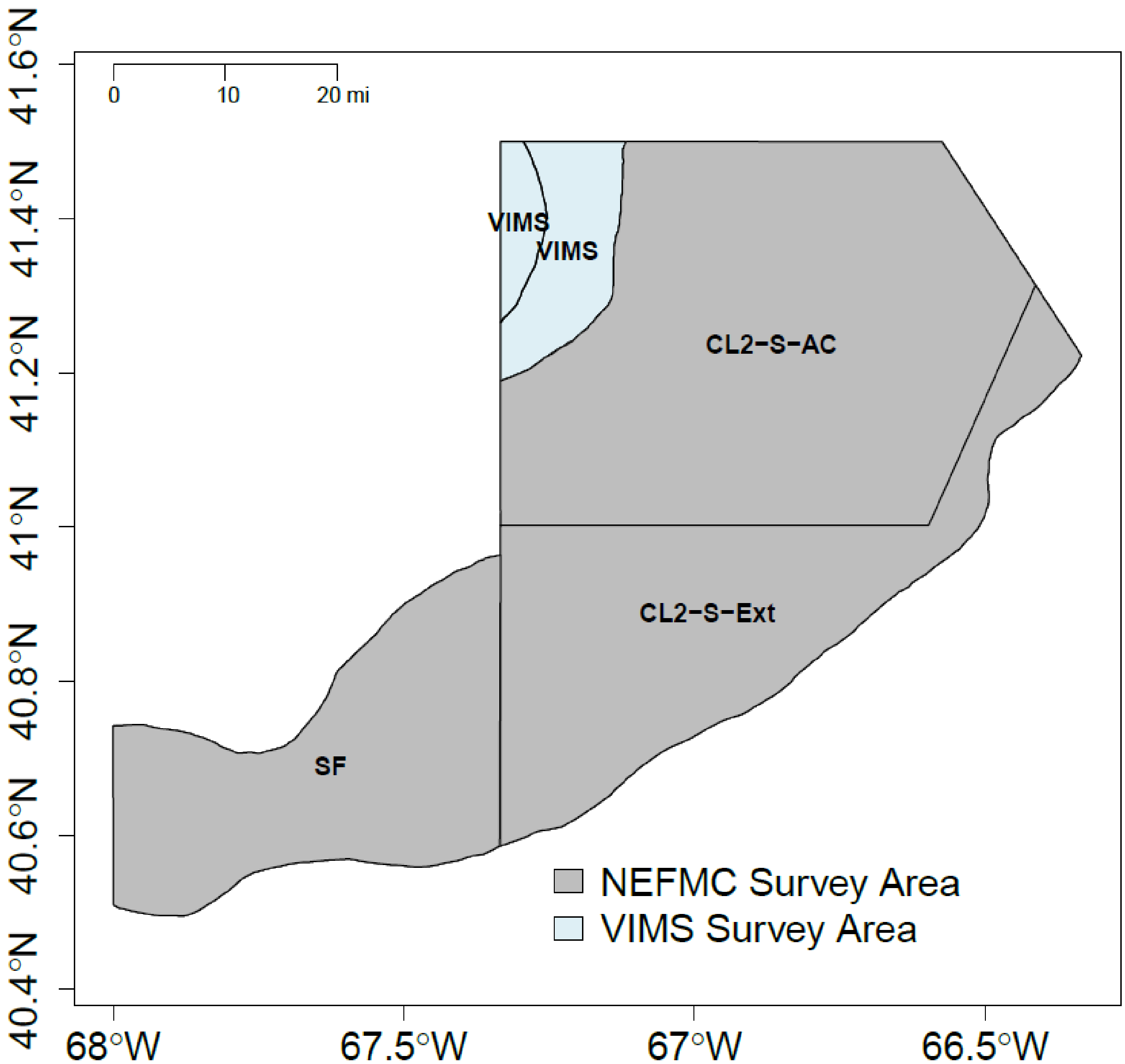


Figure 5 Map of the 2018 survey domain for the survey of Closed Area II with the SAMS Area designations and NMFS and VIMS extents (grey and blue).



<u>Figure 6</u> Map of the 2019 survey domain for the survey of Closed Area I with the SAMS Area designations and NMFS and VIMS extents (grey and blue).

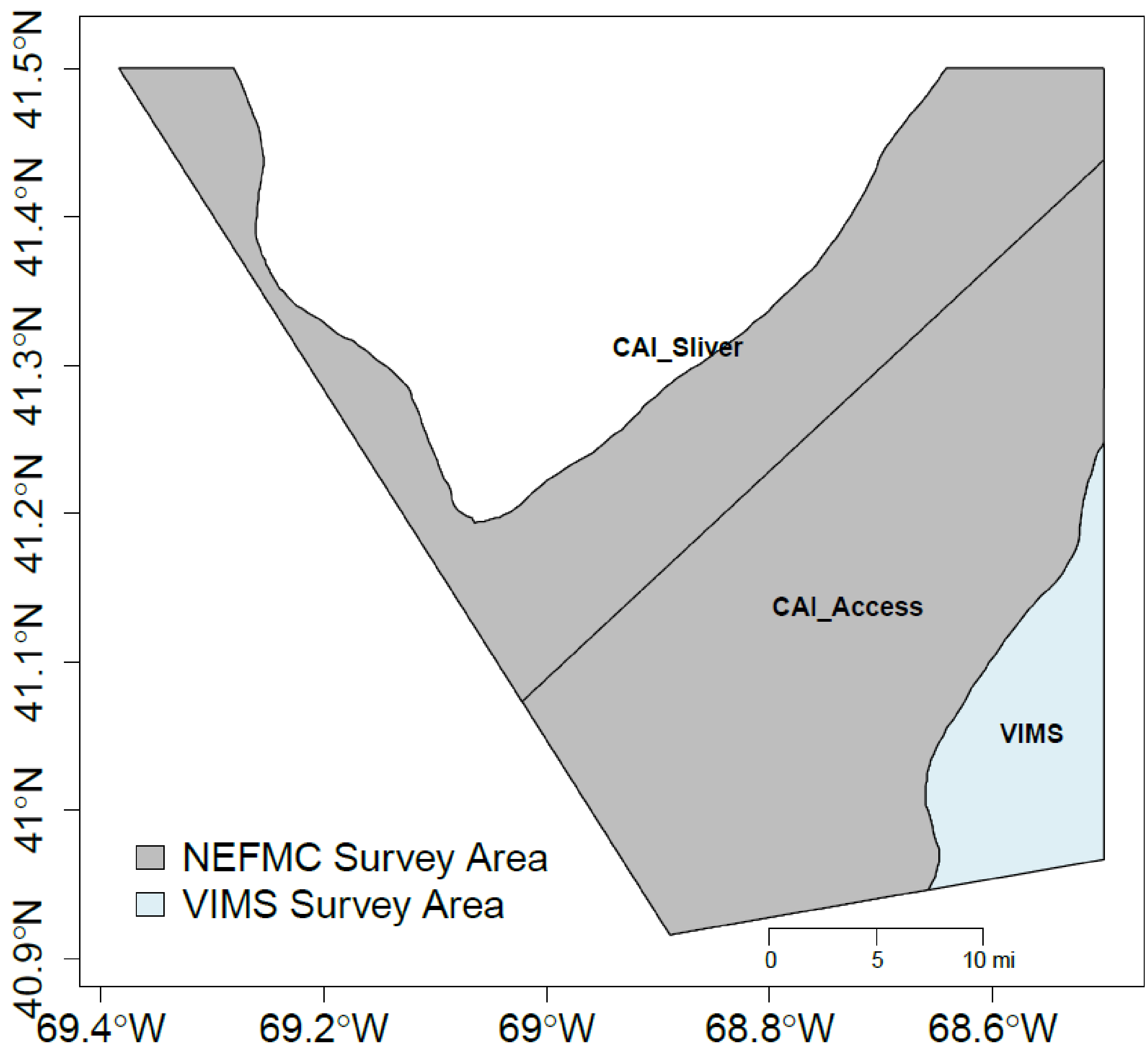


Figure 7 Map of the 2019 survey domain for the survey of Closed Area II with the SAMS Area designations and NMFS and VIMS extents (grey and blue).

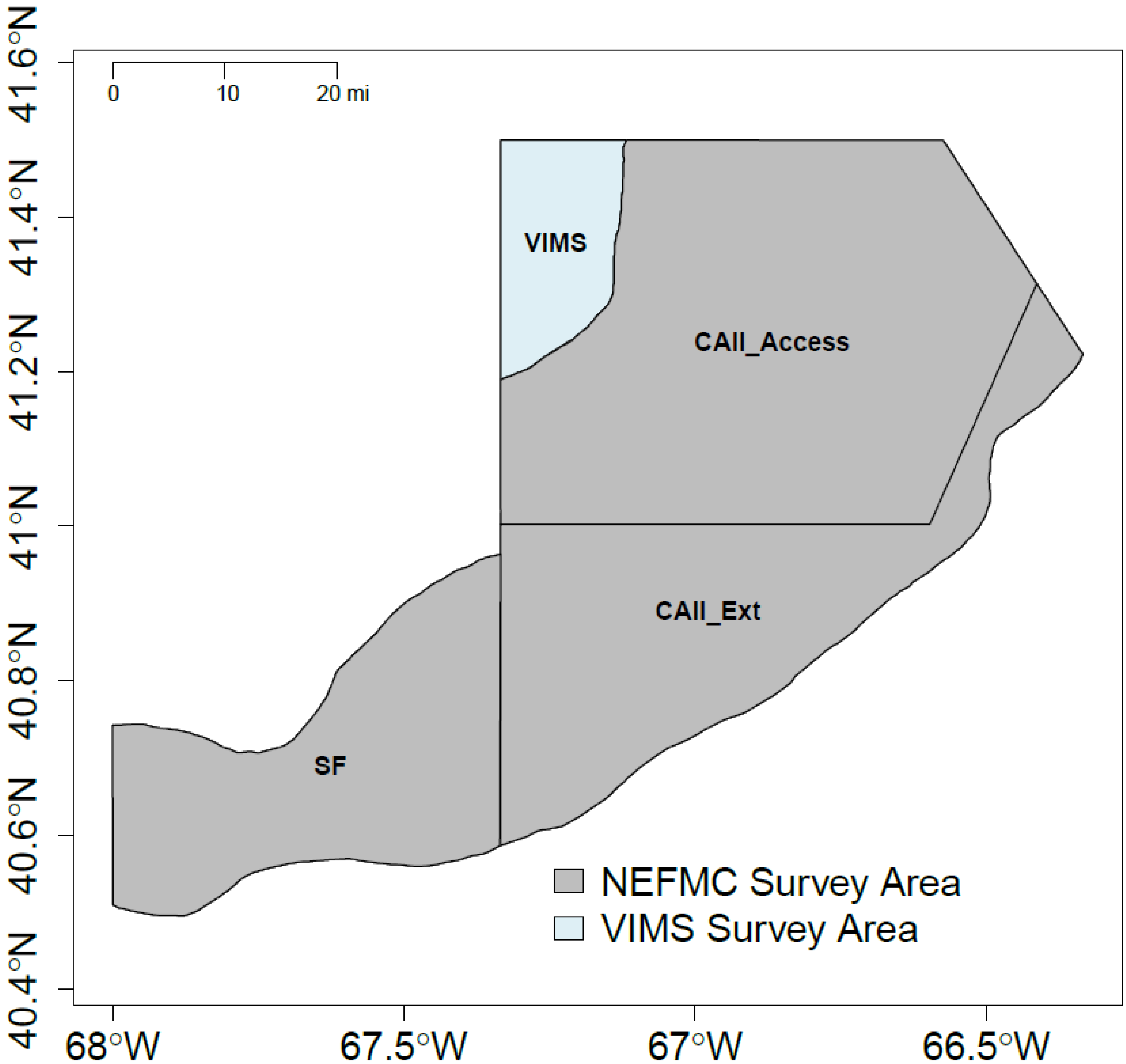


Figure 8 Boxplots of calculated tow lengths from the 2018 and 2019 surveys of the Georges Bank survey domains.

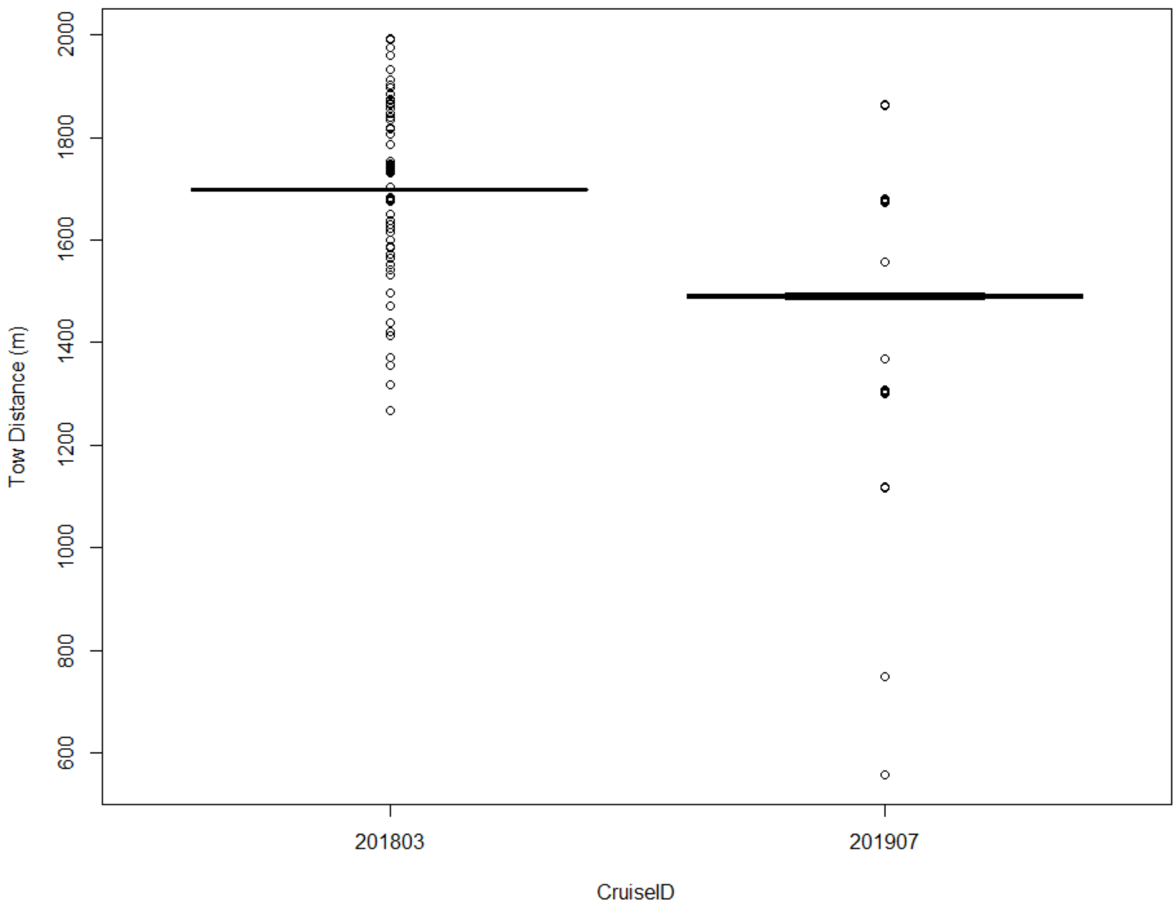
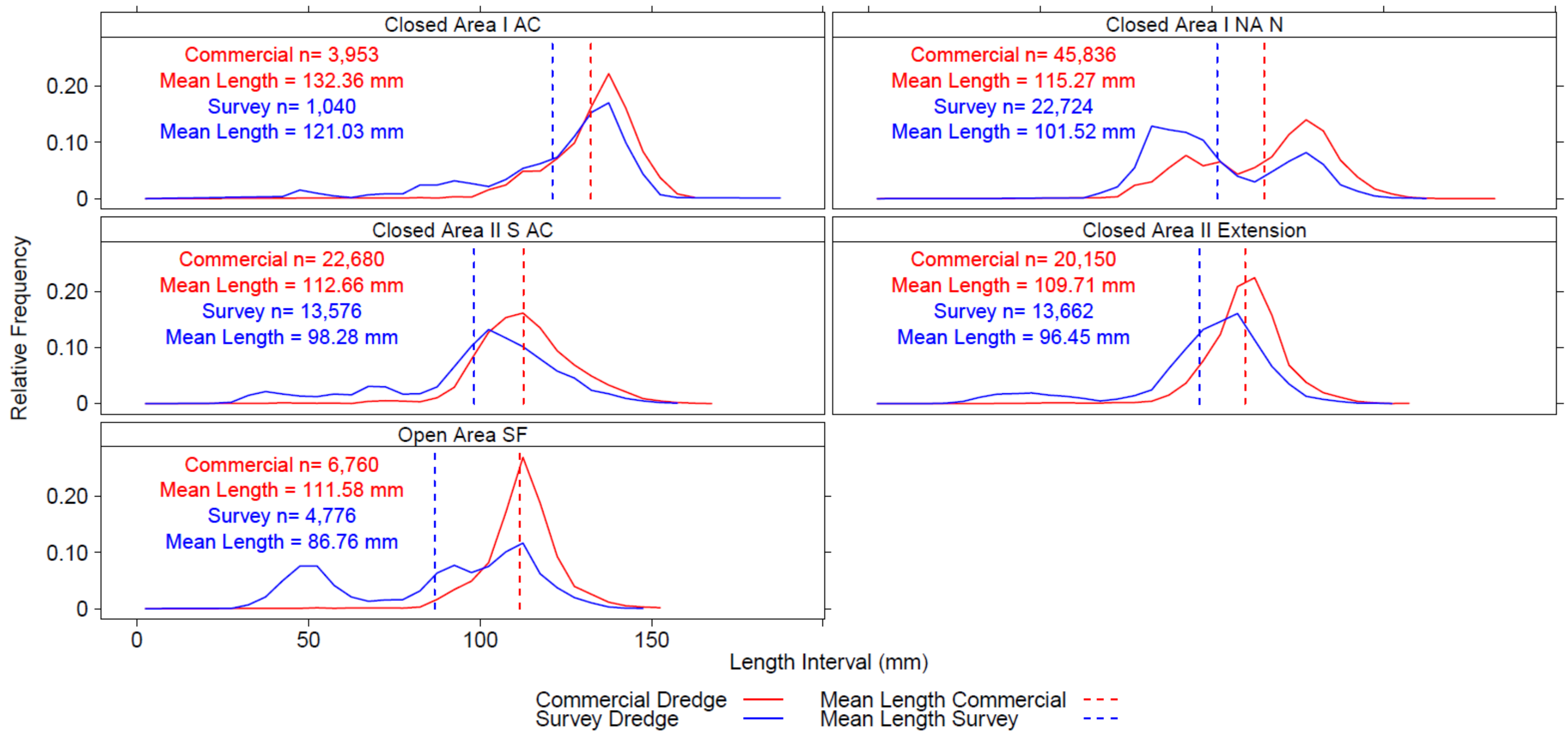
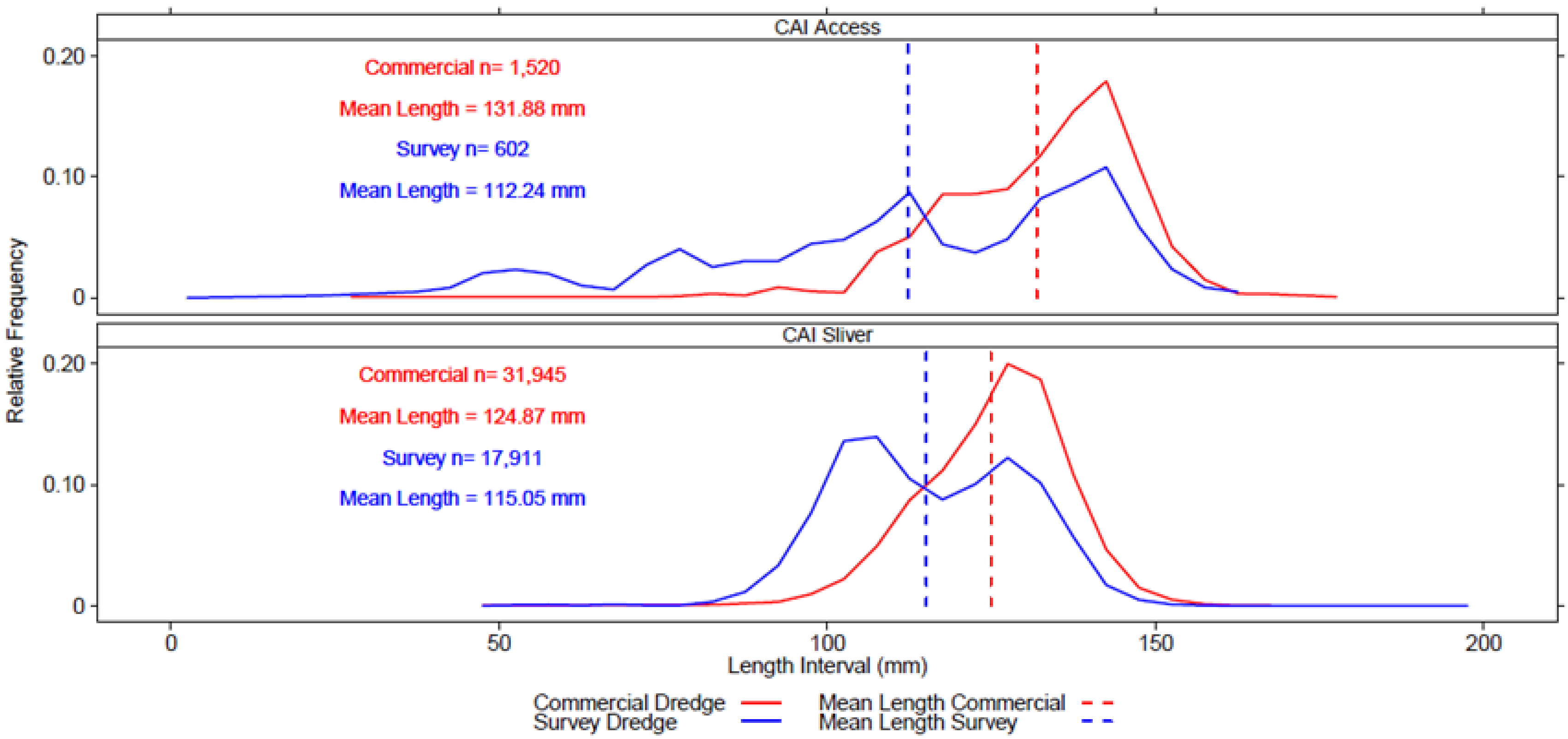


Figure 9 Scallop relative length frequency distributions generated from catch data obtained from both the survey and the commercial dredges during the VIMS/Industry cooperative survey of the Georges Bank Closed Area I, Closed Area II, and surrounds in June 2018 by SAMS Area. Number of scallops (n) measured and mean length by gear are also included.



<u>Figure 10</u> Scallop relative length frequency distributions generated from catch data obtained from both the survey and the commercial dredges during the VIMS/Industry cooperative survey of the Georges Bank Closed Area in June 2019 by SAMS Area. Number of scallops (n) measured and mean length by gear are also included.



<u>Figure 11</u> Scallop relative length frequency distributions generated from catch data obtained from both the survey and the commercial dredges during the VIMS/Industry cooperative survey of the Georges Bank Closed Area II access area and surrounds in June 2019 by SAMS Area. Number of scallops (n) measured and mean length by gear are also included.

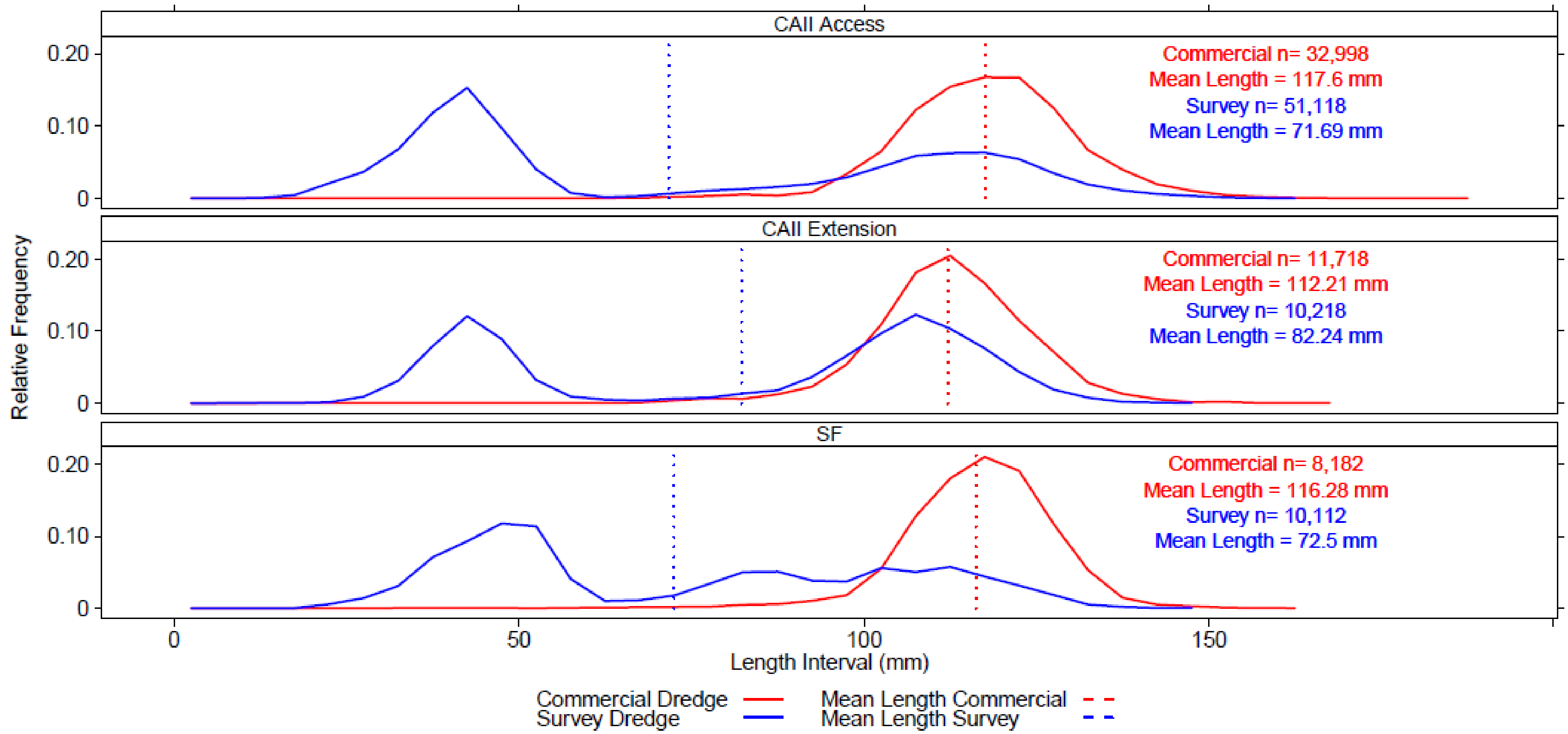


Figure 12 Spatial distribution of the number of sea scallops caught per m^2 in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Georges Bank Closed Area I, Closed Area II, and the southern flank in 2018. This figure represents the catch of pre-recruit sea scallops (< 35mm (top), 35mm-75mm (middle), and > 75mm (bottom)).

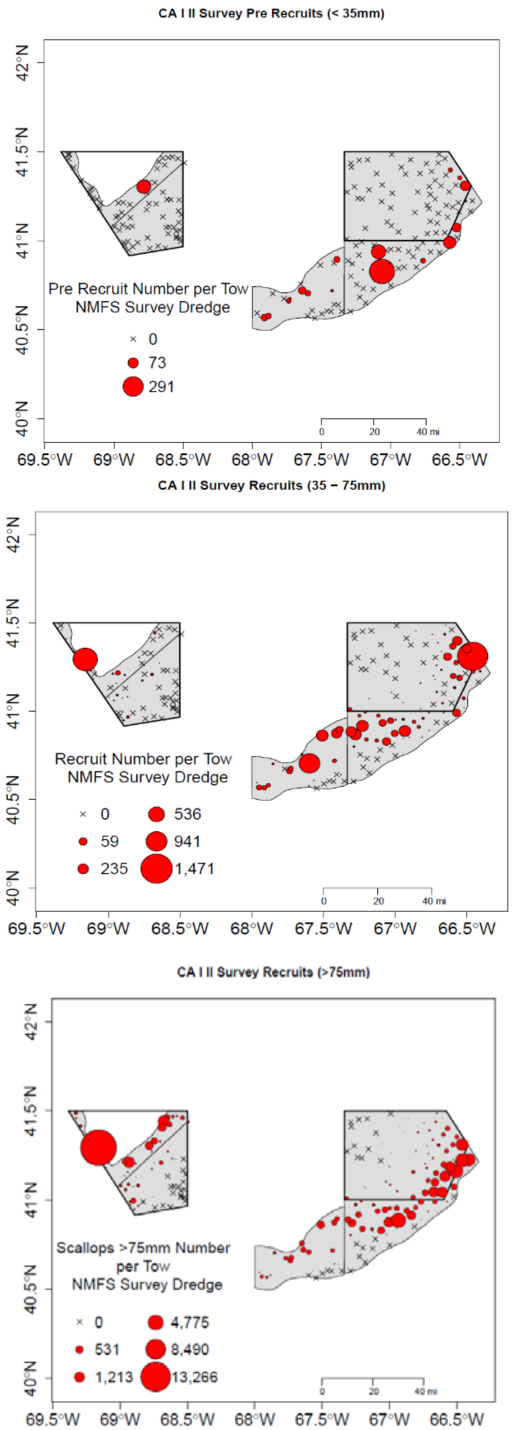


Figure 13 Spatial distribution of the number of sea scallops caught per m^2 in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Georges Bank Closed Area I, Closed Area II, and the southern flank in 2019. This figure represents the catch of pre-recruit sea scallops (< 35mm (top), 35mm-75mm (middle), and > 75mm (bottom)).

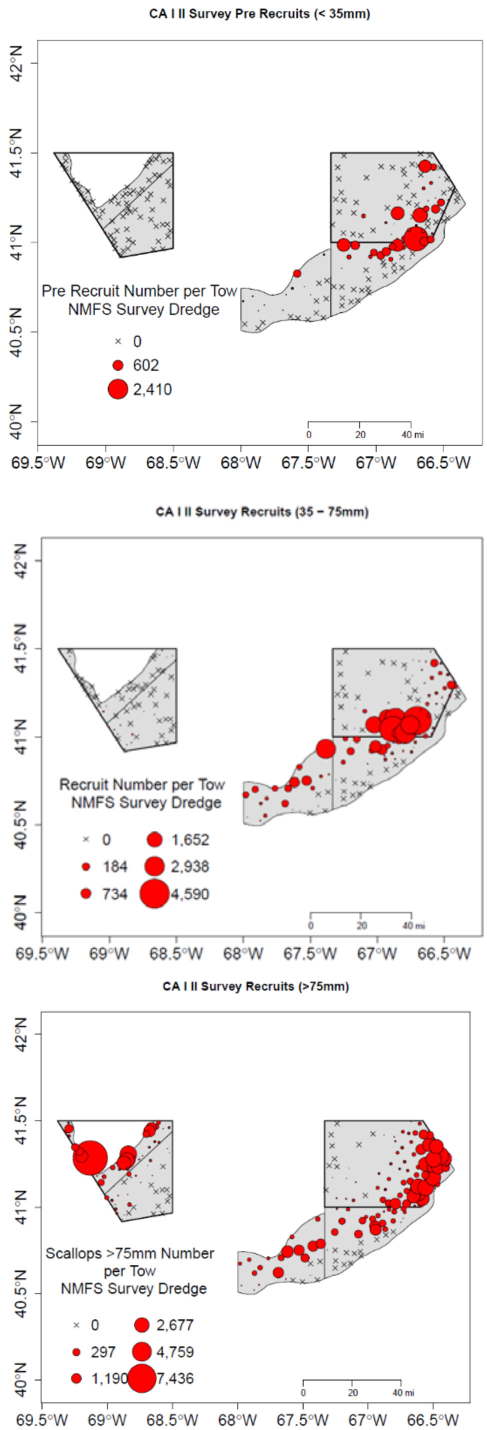


Figure 14 Predicted shell height:meat weight relationships by SAMS Area estimated from scallops sampled in Closed Area I in 2018 (A) and 2019 (B).

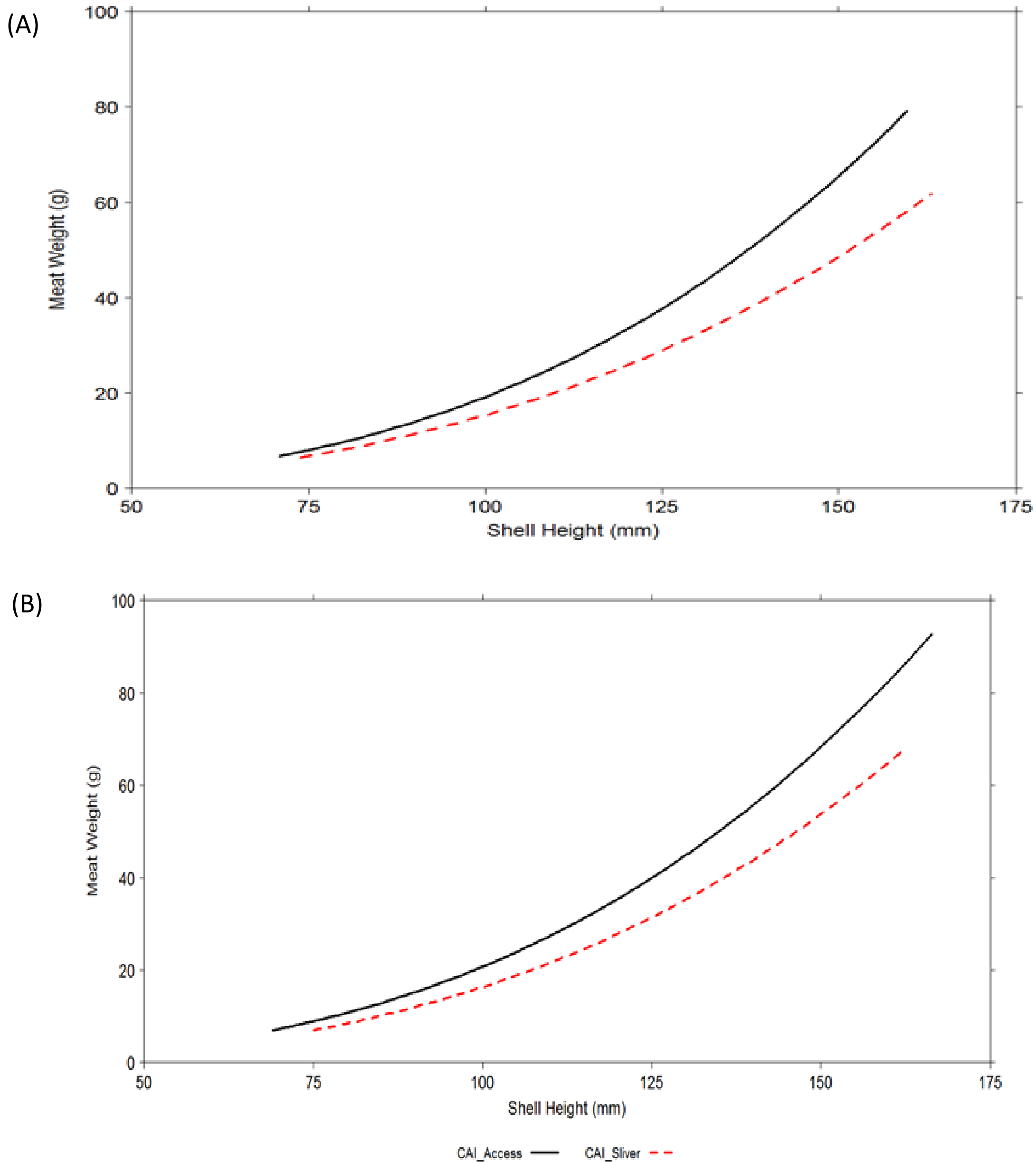
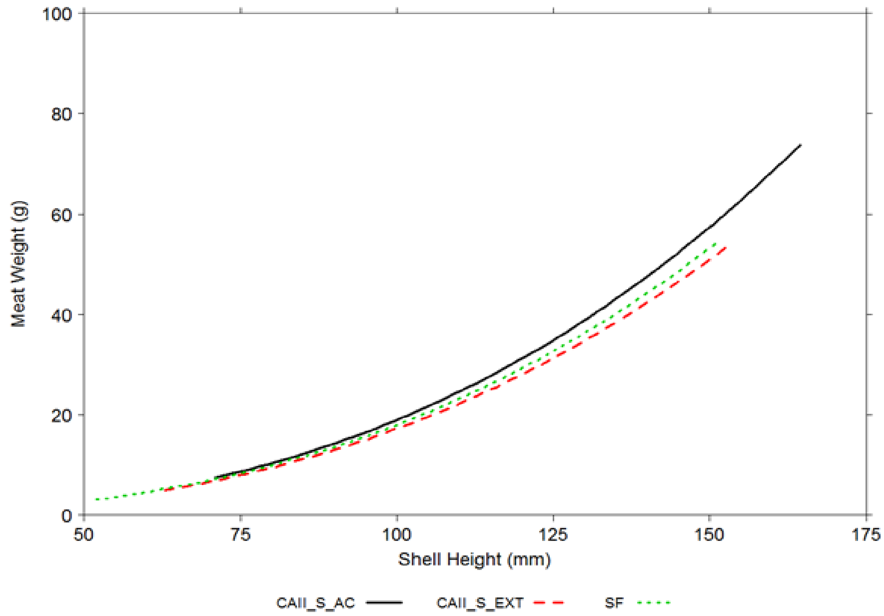


Figure 15 Predicted shell height:meat weight relationships by SAMS Area estimated from scallops sampled in Closed Area II and the southern flank in 2018 (A) and 2019 (B).

(A)



(B)

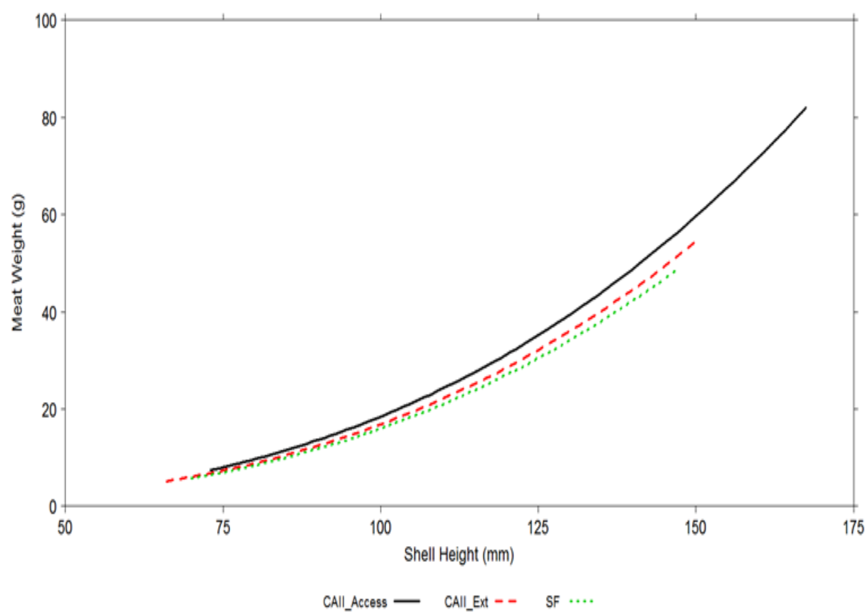


Figure 16 Length frequency distributions of bycatch for the NMFS survey dredge with sufficient sample sizes for the Closed Area I, Closed Area II, and southern flank surveys conducted in 2018 (CruiseID 201803) and 2019 (CruiseID 201907).

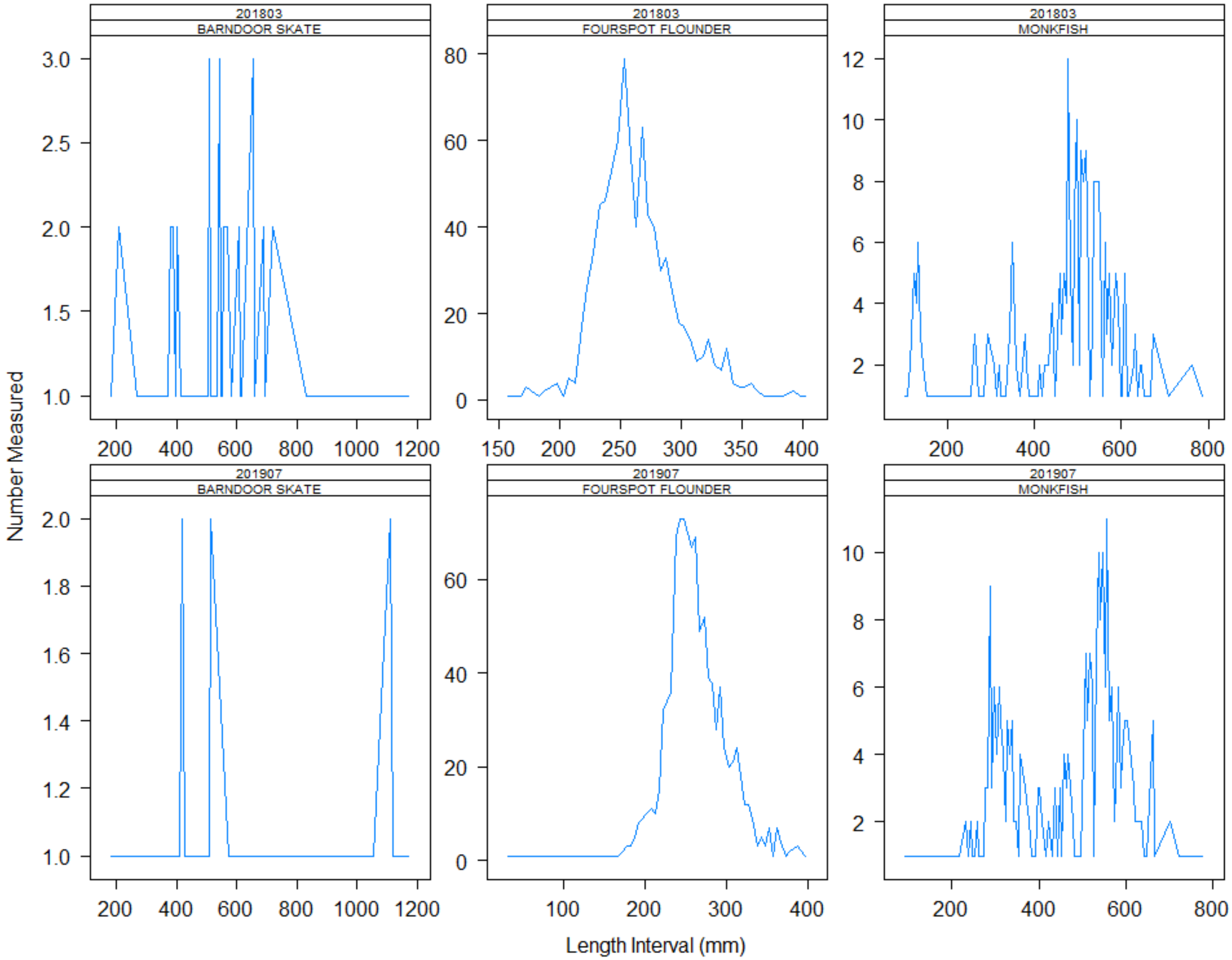
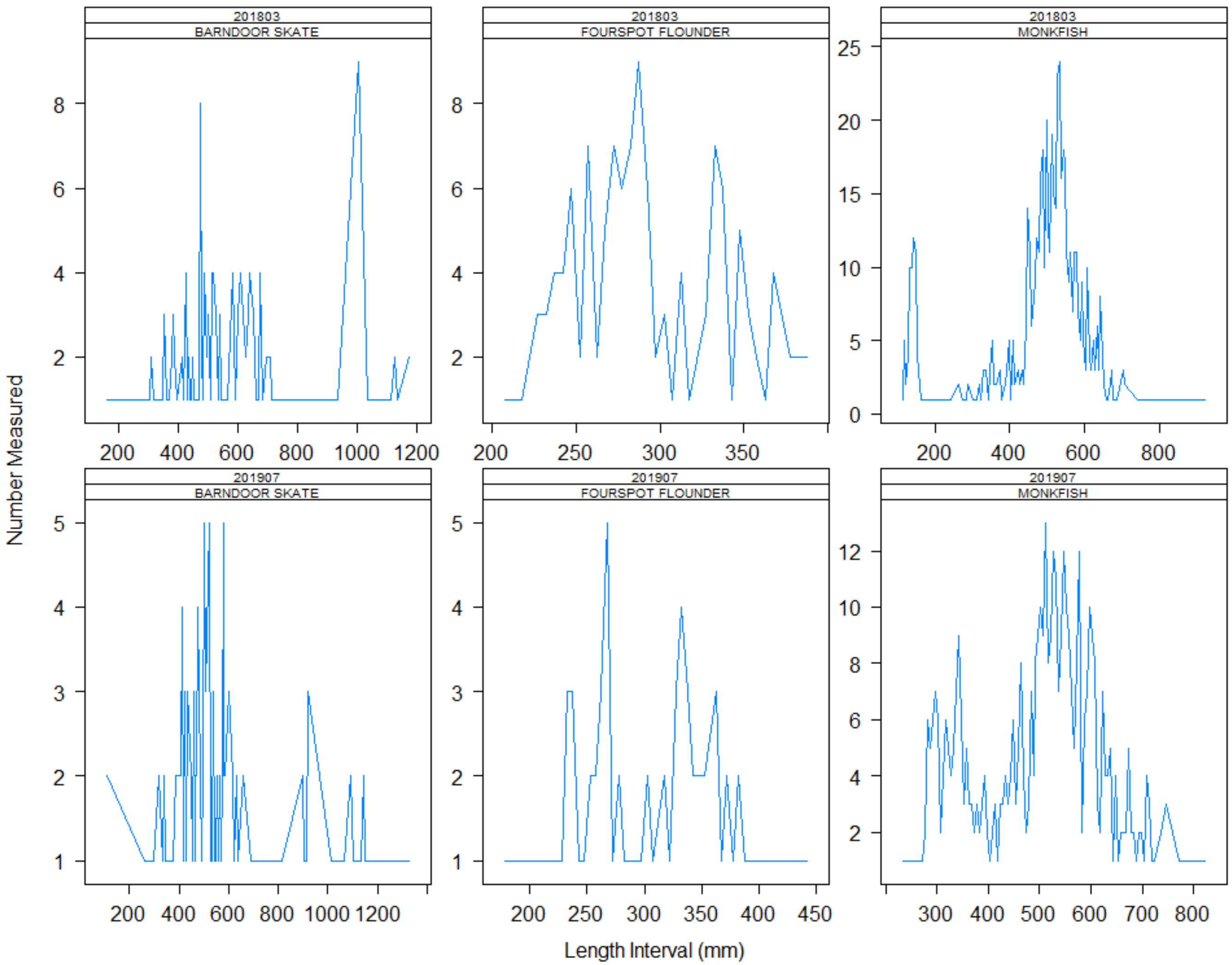


Figure 17 Length frequency distributions of bycatch for the New Bedford style commercial dredge with sufficient sample sizes for the Closed Area I, Closed Area II, and southern flank surveys conducted in 2018 (CruiseID 201803) and 2019 (CruiseID 201907).



<u>Figure 18</u> Logistic SELECT curve fit to the proportion of the total catch in the New Bedford style commercial dredge relative to the total catch (survey and commercial) for the survey domain in 2018. <u>Left:</u> Observed and predicted retention probability. <u>Right</u>: Deviance residuals for the model fit.

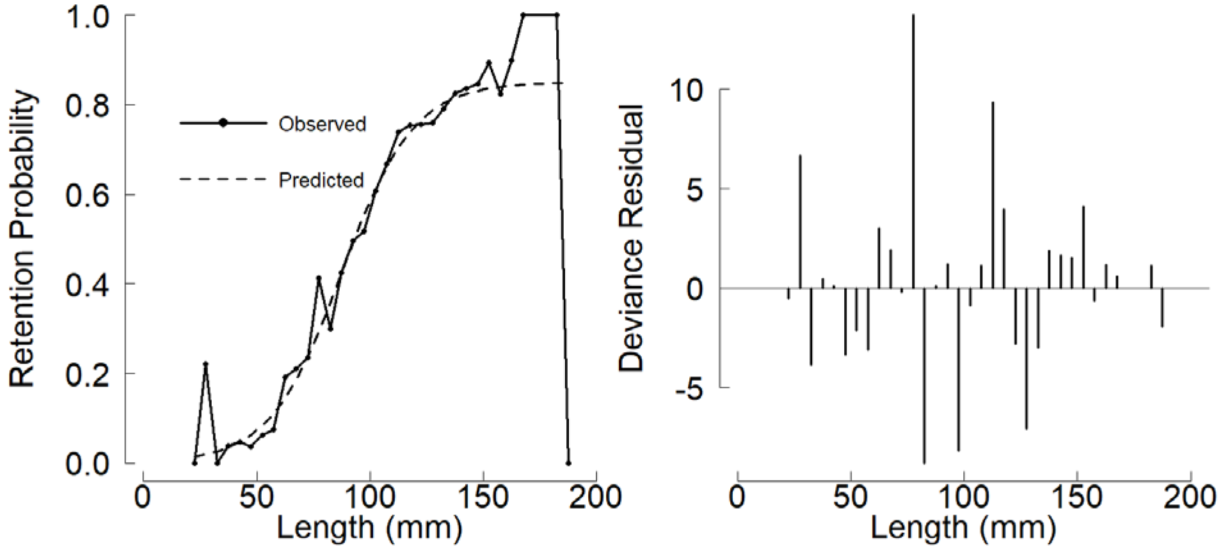


Figure 19 Logistic SELECT curve fit to the proportion of the total catch in the New Bedford style commercial dredge relative to the total catch (survey and commercial) for the survey domain in 2019. Left: Observed and predicted retention probability. Right: Deviance residuals for the model fit.

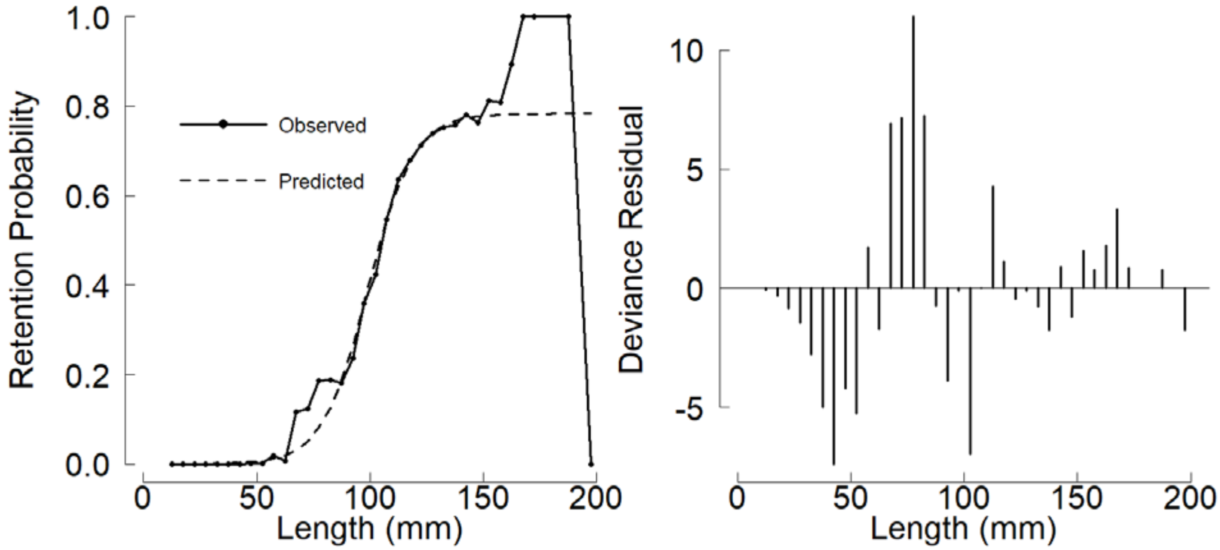


Figure 20 Estimated selectivity curve for the New Bedford style commercial dredge based on data from the 2018 survey. The middle dashed line represents the length at 50% retention probability. The upper and lower dashed lines represent the lengths at 25% and 75% retention probability.

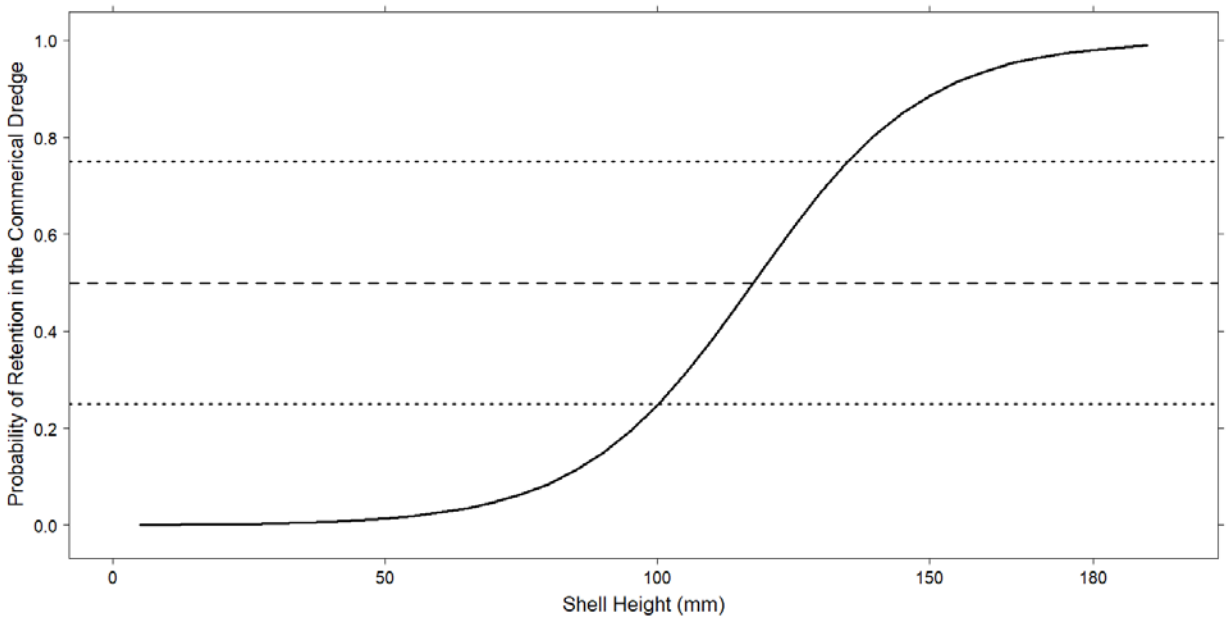


Figure 21 Estimated selectivity curve for the New Bedford style commercial dredge based on data from the 2019 survey. The middle dashed line represents the length at 50% retention probability. The upper and lower dashed lines represent the lengths at 25% and 75% retention probability.

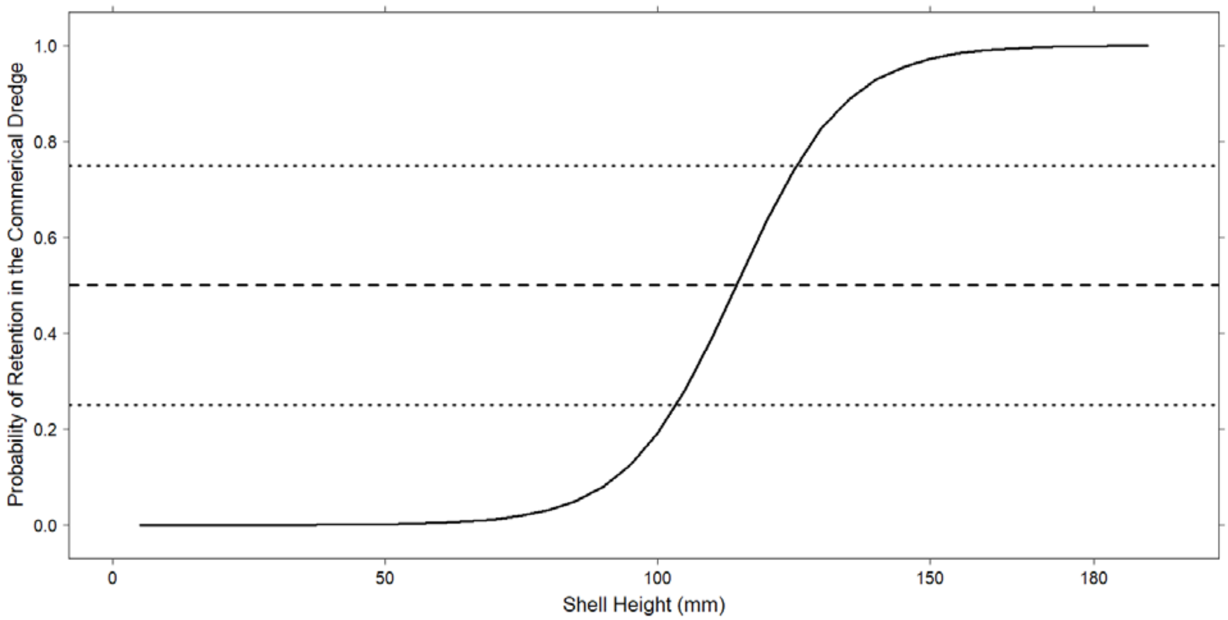


Table 1 Estimated total and exploitable biomass for the NMFS survey dredge for the survey domain in 2018 by SAMS Area. 95% confidence intervals, average density (scallops/m^2), and average meat weight (grams) are also provided.

	SAMS Area	Total Biomass (mt)	95% CI	Lower Bound 95% CI	Upper Bound 95% CI	Density (scal/m^2)	Avg MW (g)
Total Biomass	CAI_AC	1,137.34	271.09	866.25	1,408.43	0.03	43.23
	CAI_NA_N	8,888.71	2,807.4	6,081.3	11,696.11	0.46	26.2
	CAII_S_AC	8,875.33	1,348.39	7,526.94	10,223.71	0.17	24.8
	CAII_S_EXT	7,230.23	1,348.56	5,881.67	8,578.78	0.21	19.33
	SF	3,447.58	606.37	2,841.21	4,053.95	0.11	16.71
	VIMS_CAII	0	0	0	0	0	0
	VIMS_CLI	0	0	0	0	0	0
Exploitable Biomass	CAI_AC	1,003.69	233.57	770.12	1,237.27	0.02	48.64
	CAI_NA_N	5,949.09	1,292.27	4,656.83	7,241.36	0.23	33.13
	CAII_S_AC	6,164.89	825.65	5,339.24	6,990.54	0.09	32.13
	CAII_S_EXT	4,433.65	858.10	3,575.55	5,291.76	0.1	24.01
	SF	2,112.21	375.39	1,736.82	2,487.61	0.04	26.57
	VIMS_CAII	0	0	0	0	0	0
	VIMS_CLI	0	0	0	0	0	0

Table 2 Estimated exploitable biomass for the New Bedford style commercial dredge in the survey domain in 2018 by SAMS Area. 95% confidence intervals, average density (scallops/m^2), and average meat weight (grams) are also provided.

	SAMS Area	Total Biomass (mt)	95% CI	Lower Bound 95% CI	Upper Bound 95% CI	Density (scal/m^2)	Avg MW (g)
Exploitable Biomass	CAI_AC	1,551.35	487.58	1,063.77	2,038.93	0.03	52.9
	CAI_NA_N	6,986.45	1,684.25	5,302.20	8,670.70	0.22	37.75
	CAII_S_AC	5,202.97	955.03	4,247.94	6,158.01	0.07	35.33
	CAII_S_EXT	3,649.74	1,063.12	2,586.63	4,712.86	0.07	27.76
	SF	2,011.38	706.66	1,304.71	2,718.04	0.04	30.25
	VIMS_CAII	0.37	0.44	-0.06	0.81	0	37.56
	VIMS_CLI	0	0	0	0	0	0

Table 3 Estimated total and exploitable biomass for the NMFS survey dredge in the survey domain in 2019 by SAMS Area. 95% confidence intervals, average density (scallops/m^2), and average meat weight (grams) are also provided.

	SAMS Area	Total Biomass (mt)	95% CI	Lower Bound 95% CI	Upper Bound 95% CI	Density (scal/m^2)	Avg MW (g)
Total Biomass	CAI_Access	693.4	163.76	529.64	857.16	0.02	35.57
	CAI_Sliver	6,095.0	1,182.26	4,912.75	7,277.26	0.2	36.76
	CAII_Access	20,689.43	2,212.85	18,476.58	22,902.28	0.56	15.49
	CAII_Ext	5,567.79	1,108.48	4,459.31	6,676.28	0.17	17.49
	SF	6,437.53	1,268.02	5,169.52	7,705.55	0.29	12.15
	VIMS_CAI	0	0	0	0	0	0
	VIMS_CAII	0	0	0	0	0	0
Exploitable Biomass	CAI_Access	593.56	139.65	453.91	733.21	0.012	45.27
	CAI_Sliver	5,462.16	1,081.81	4,380.35	6,543.98	0.172	38.02
	CAII_Access	13,741.41	1,479.82	12,261.59	15,221.22	0.175	35.01
	CAII_Ext	3,637.74	717.63	2,920.11	4,355.73	0.066	29.06
	SF	3,556.24	727.85	2,828.39	4,284.09	0.072	26.67
	VIMS_CAI	0	0	0	0	0	0
	VIMS_CAII	0	0	0	0	0	0

Table 4 Estimated exploitable biomass for the New Bedford style commercial dredge in the survey domain in 2019 by SAMS Area. 95% confidence intervals, average density (scallops/m^2), and average meat weight (grams) are also provided.

	SAMS Area	Total Biomass (mt)	95% CI	Lower Bound 95% CI	Upper Bound 95% CI	Density (scal/m^2)	Avg MW (g)
Exploitable Biomass	CAI_Access	957.27	266.53	690.74	1,223.8	0.01	51.91
	CA1_Sliver	6,427.55	2,122.87	4,304.69	8,550.42	0.19	40.15
	CAII_Access	9,690.29	1,603.1	8,087.19	11,293.39	0.11	0.11
	CAII_Ext	3,258.13	953.56	2,304.57	4,211.69	0.05	0.05
	SF	4,193.63	1,379.99	2,813.64	5,573.62	0.07	0.07
	VIMS_CAI	0.4	0.41	-0.02	0.81	0	0
	VIMS_CAII	0	0	0	0	0	0

Table 5 Estimated total and exploitable number of scallops by gear 2018 by SAMS Area.

	SAMS Area	Survey Dredge	Commercial Dredge
		Number	Number
Total	CA_Access	26,382,669	-
	CAI_Sliver	324,965,631	-
	CAII_Access	344,346,037	-
	CAII_Ext	375,172,617	-
	SF	206,330,069	-
	VIMS_CAI	0	-
	VIMS_CAII	0	-
Exploitable	CA_Access	20,570,022	28,985,404
	CAI_Sliver	175,033,057	183,166,619
	CAII_Access	184,198,349	140,890,700
	CAII_Ext	183,009,790	130,468,711
	SF	79,484,292	66,483,411
	VIMS_CAI	0	9,977
	VIMS_CAII	0	0

Table 6 Estimated total and exploitable number of scallops by gear 2018 by SAMS Area

	SAMS Area	Survey Dredge	Commercial Dredge
		Number	Number
Total	CA_Access	18,434,122	-
	CAI_Sliver	165,364,333	-
	CAII_Access	1,670,993,750	-
	CAII_Ext	312,054,690	-
	SF	529,788,692	
	VIMS_CAI	0	
	VIMS_CAII	0	-
Exploitable	CA_Access	12,517,283	18,194,175
	CAI_Sliver	143,200,146	159,491,470
	CAII_Access	380,856,513	244,325,929
	CAII_Ext	125,840,417	100,845,369
	SF	133,356,748	127,630,804
	VIMS_CAI	0	9,343
	VIMS_CAII	0	0

Table 7 Shell height:meat weight parameters estimated from scallops sampled in Closed Area I in 2018 and 2019. ln(Shell Height)* ln(Depth) indicates an interaction term between shell height and depth.

Year	Parameter	Parameter Estimate
2018	Intercept	-25.26
	ln(Shell Height)	5.87
	ln(Depth)	3.39
	CAI_NA_N	-0.30
	ln(Shell Height)*ln(Depth)	-0.67
2019	Intercept	-9.84
	ln(Shell Height)	2.95
	ln(Depth)	-0.16
	CAI_Sliver	-0.21

Table 8 Shell height:meat weight parameters estimated from scallops sampled in Closed Area II and the southern flank in 2018 and 2019. ln(Shell Height)* ln(Depth) indicates an interaction term between shell height and depth.

Year	Parameter	Parameter Estimate
2018	Intercept	-16.60
	ln(Shell Height)	4.17
	ln(Depth)	1.64
	CAII_S_Ext	-0.11
	SF	-0.07
	ln(Shell Height)*ln(Depth)	-0.34
2019	Intercept	-23.61
	ln(Shell Height)	2.90
	Latitude	0.32
	CAII_Ext	-0.01
	SF	0.02

Table 9 Total catch (number of animals) and catch per unit effort for bycatch for the 2018 and 2019 surveys for the NMFS survey dredge and the New Bedford style commercial dredge.

Survey	Common Name	Commercial Gear Catch (Number)	Commercial Gear CPUE	Survey Gear Catch (Number)	Survey Gear CPUE
201803	AMERICAN LOBSTER	19	0.101	5	0.026
201803	ILLEX SQUID	1	0.005	10	0.053
201803	GREY SOLE	14	0.074	18	0.095
201803	BLACKBACK FLOUNDER	8	0.042	14	0.074
201803	BARNDOOR SKATE	151	0.799	65	0.344
201803	RED HAKE	25	0.132	2,228	11.788
201803	GULFSTREAM FLOUNDER	3	0.016	377	1.995
201803	ATLANTIC COD	3	0.016	2	0.011
201803	WHITE HAKE	1	0.005	2	0.011
201803	HADDOCK	1	0.005	45	0.238
201803	MONKFISH	528	2.794	264	1.397
201803	FOURSPOT FLOUNDER	175	0.926	856	4.529
201803	SILVER HAKE	7	0.037	349	1.847
201803	YELLOWTAIL FLOUNDER	11	0.058	14	0.074
201803	UNCLASSIFIED SKATES	2,149	11.37	2,348	12.423
201803	SPOTTED HAKE	1	0.005	38	0.201
201803	SUMMER FLOUNDER	27	0.143	3	0.016
201803	LONGHORN SCULPIN	1	0.005	62	0.328
201803	WINDOWPANE FLOUNDER	38	0.201	82	0.434
201803	CONGER EEL	0	0	1	0.005
201803	HORSESHOE CRAB	0	0	1	0.005
201803	OCEAN POUT	0	0	91	0.481
201803	BUTTERFISH	0	0	2	0.011
201803	FAWN CUSK EEL	0	0	16	0.085
201803	SPINY DOGFISH	0	0	5	0.026
201803	NORTHERN SEAROBIN	0	0	2	0.011
201803	ARMORED SEAROBIN	0	0	1	0.005
201803	SEA RAVEN	0	0	3	0.016
201803	TORPEDO RAY	0	0	1	0.005
201907	SPINY DOGFISH	3	0.015	6	0.03
201907	AMERICAN PLAICE	2	0.01	38	0.19
201907	BLACKBACK FLOUNDER	15	0.075	11	0.055
201907	LONGHORN SCULPIN	2	0.01	88	0.44
201907	BARNDOOR SKATE	156	0.78	48	0.24
201907	GREY SOLE	26	0.13	28	0.14
201907	MONKFISH	457	2.285	277	1.385
201907	UNCLASSIFIED SKATES	1,922	9.61	1,319	6.595
201907	ATLANTIC COD	2	0.01	1	0.005
201907	AMERICAN LOBSTER	13	0.065	10	0.05
201907	HADDOCK	3	0.015	137	0.685
201907	WINDOWPANE FLOUNDER	14	0.07	43	0.215
201907	FOURSPOT FLOUNDER	63	0.315	1,034	5.17
201907	SEA RAVEN	2	0.01	9	0.045
201907	TORPEDO RAY	1	0.005	0	0
201907	ILLEX SQUID	1	0.005	37	0.185
201907	YELLOWTAIL FLOUNDER	15	0.075	74	0.37
201907	SILVER HAKE	11	0.055	385	1.925
201907	SUMMER FLOUNDER	15	0.075	7	0.035
201907	RED HAKE	21	0.105	3,014	15.07
201907	LOLIGO SQUID	0	0	3	0.015
201907	GULFSTREAM FLOUNDER	0	0	163	0.815
201907	NORTHERN SEAROBIN	0	0	1	0.005
201907	OCEAN POUT	0	0	126	0.63
201907	SPOTTED HAKE	0	0	64	0.32
201907	WHITE HAKE	0	0	5	0.025
201907	FAWN CUSK EEL	0	0	4	0.02

<u>Table 10</u> Selectivity analysis parameter values estimated with a logistic curve and estimated split parameter (*p*) by cruise for the 2018 and 2019 surveys.

Year	Parameter	Parameter Estimate	S.E.
2018	a	-7.44	-
	b	0.06	-
	p	0.85	0.01
	L25	100.23	2.56
	L50	117.59	3.37
	L75	134.95	4.23
	SR	34.72	1.91
	REP Factor	13.34	
2019	a	-11.43	-
	b	0.1	-
	p	0.86	0.02
	L25	103.43	1.14
	L50	114.43	1.49
	L75	125.43	1.92
	SR	21.99	1.02
	REP Factor	15.47	

Table 11 Summary for scallops assessed for marketability, color, texture, and blister disease at shell height:meat weight stations by sex during the 2018 and 2019 surveys by year.

Year	Sex	Market Classification			
		1	2	3	4
2018	Female	7	18	222	701
	Male	5	29	200	799
	Unknown	0	1	20	73
2019	Female	1	1	20	1,172
	Male	0	1	16	1,133
	Unknown	0	0	0	6
		Color Classification			
		1	2	3	4
2018	Female	0	3	15	930
	Male	0	4	14	1,015
	Unknown	0	0	1	93
2019	Female	0	1	1	1,192
	Male	0	0	2	1,148
	Unknown	0	0	0	6
		Texture Classification			
		1	2	3	4
2018	Female	5	13	219	711
	Male	3	26	187	817
	Unknown	0	1	18	75
2019	Female	0	1	20	1,173
	Male	0	1	13	1,136
	Unknown	0	0	0	6
		Disease Classification			
		1	2	3	4
2018	Female	3	5	3	937
	Male	1	0	5	1,027
	Unknown	0	0	0	94
2019	Female	1	1	4	1,188
	Male	0	3	4	1,143
	Unknown	0	0	0	6

Table 12 Description of marketability, color, texture, and blister codes for Table 11.

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

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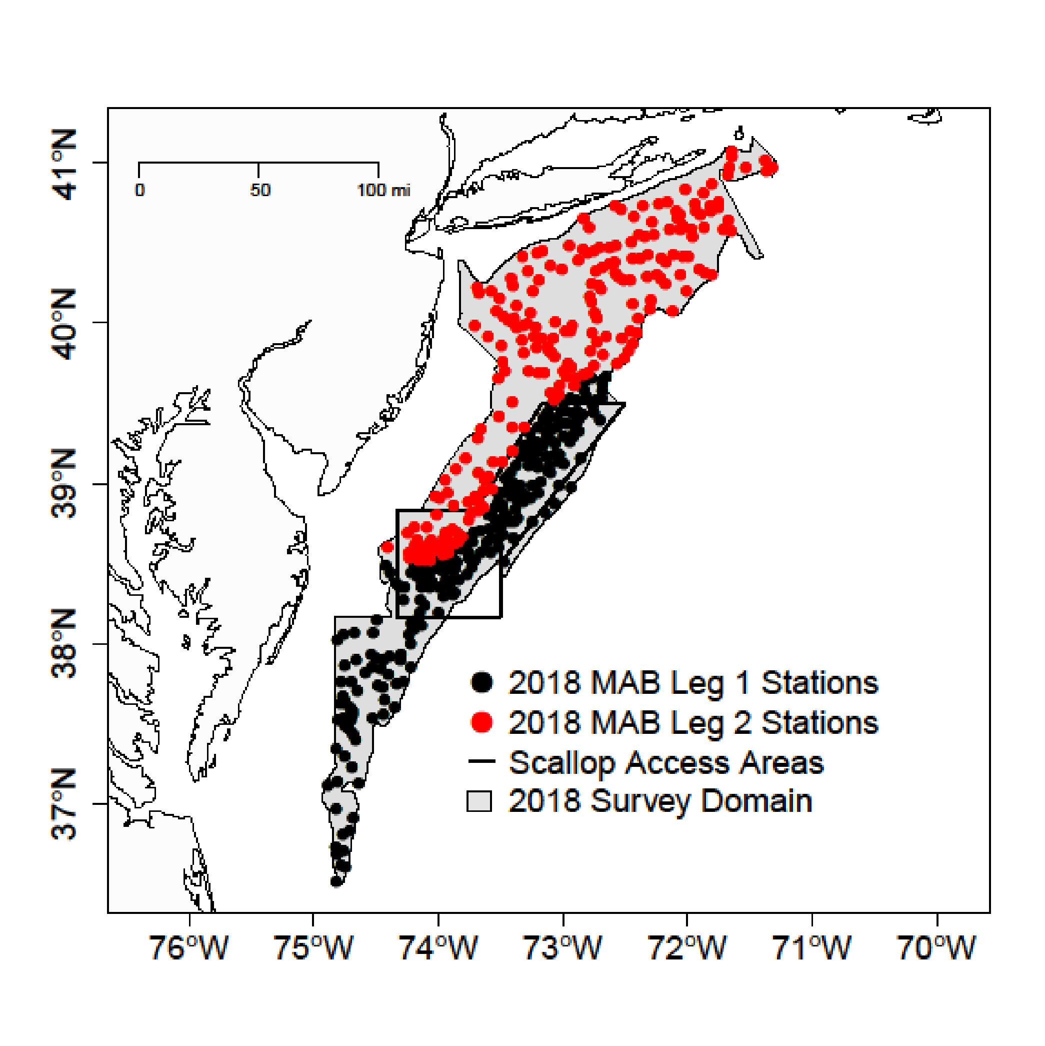
Sea Scallop Plan Development Team

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

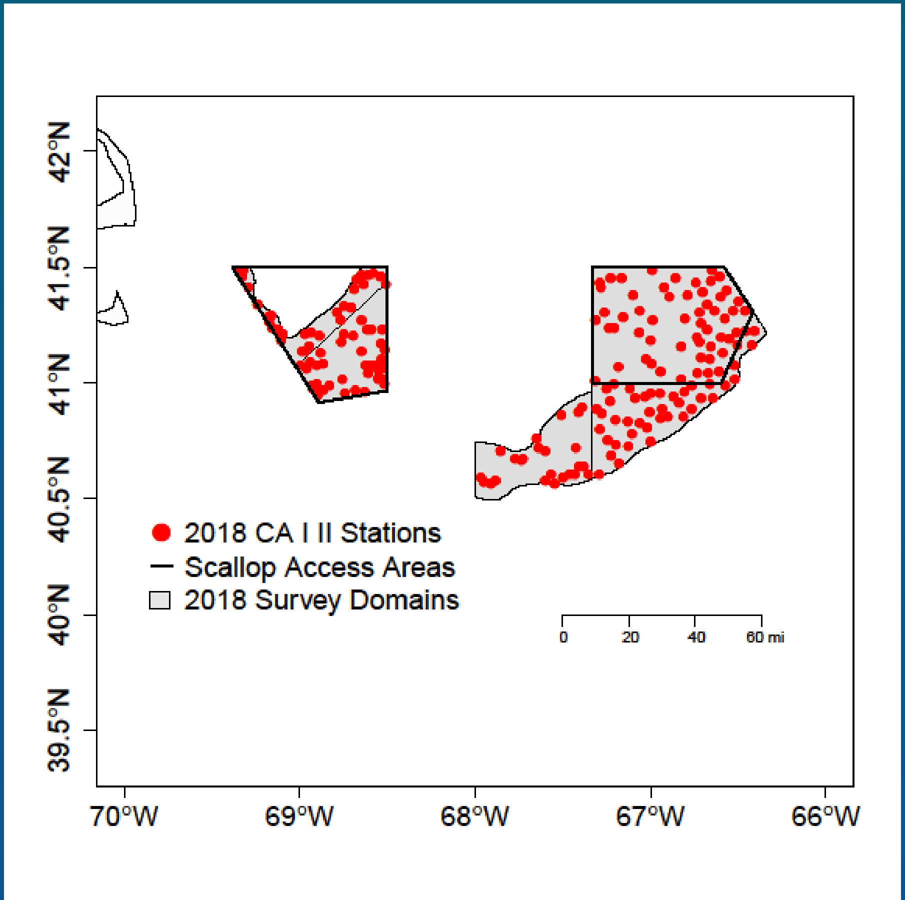
Second Leg

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

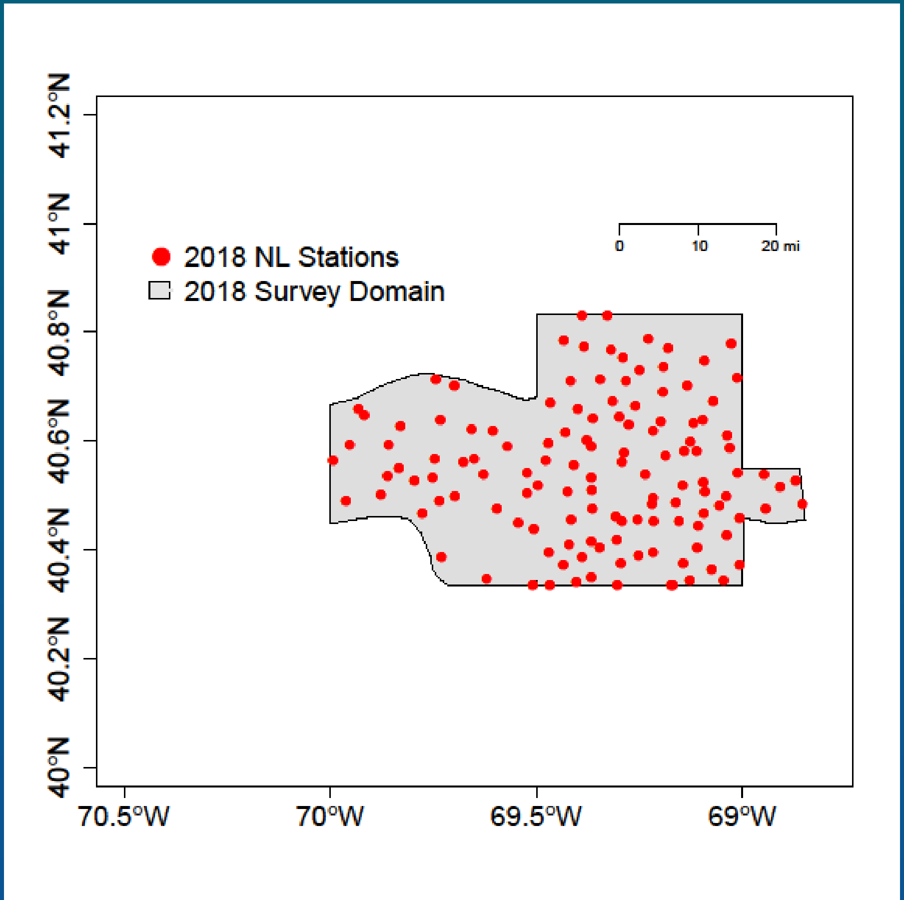
Total

- 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

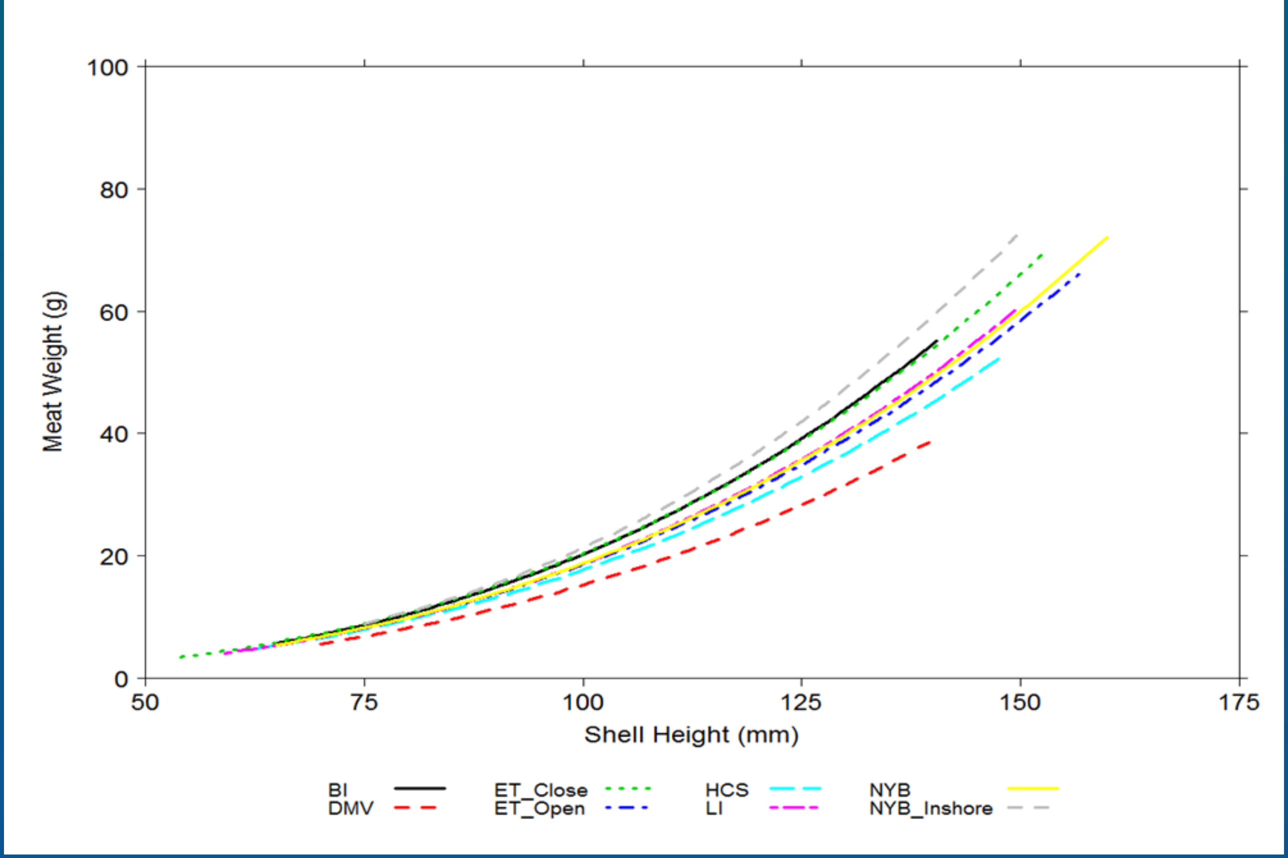
- SH:MW samples were taken from all stations that had scallops (15/station):
  - MAB Survey: 5,413 (380 stations)
  - CA I II Survey: 1,971 (157 stations)
  - NL Survey: 1,831 (113 stations)

- 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.

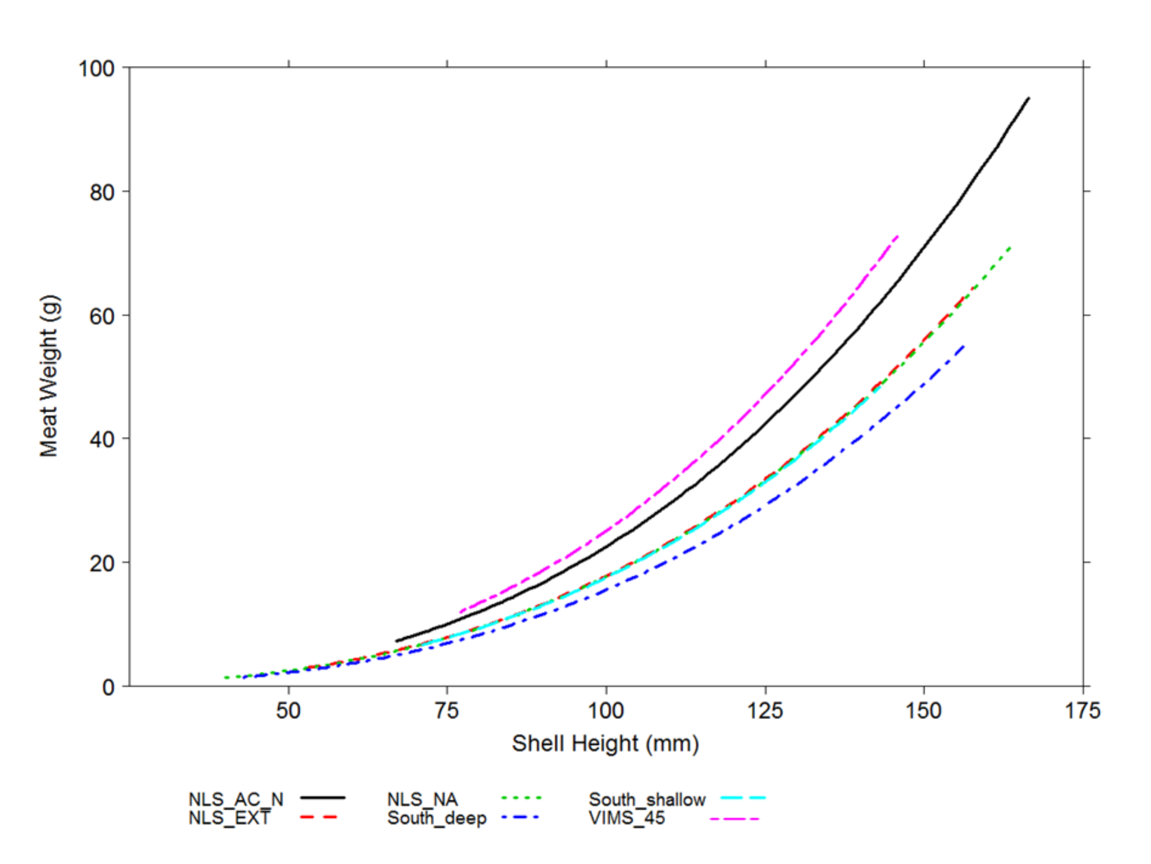
2018 VIMS-Industry Cooperative MAB Survey
SHMW Results



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

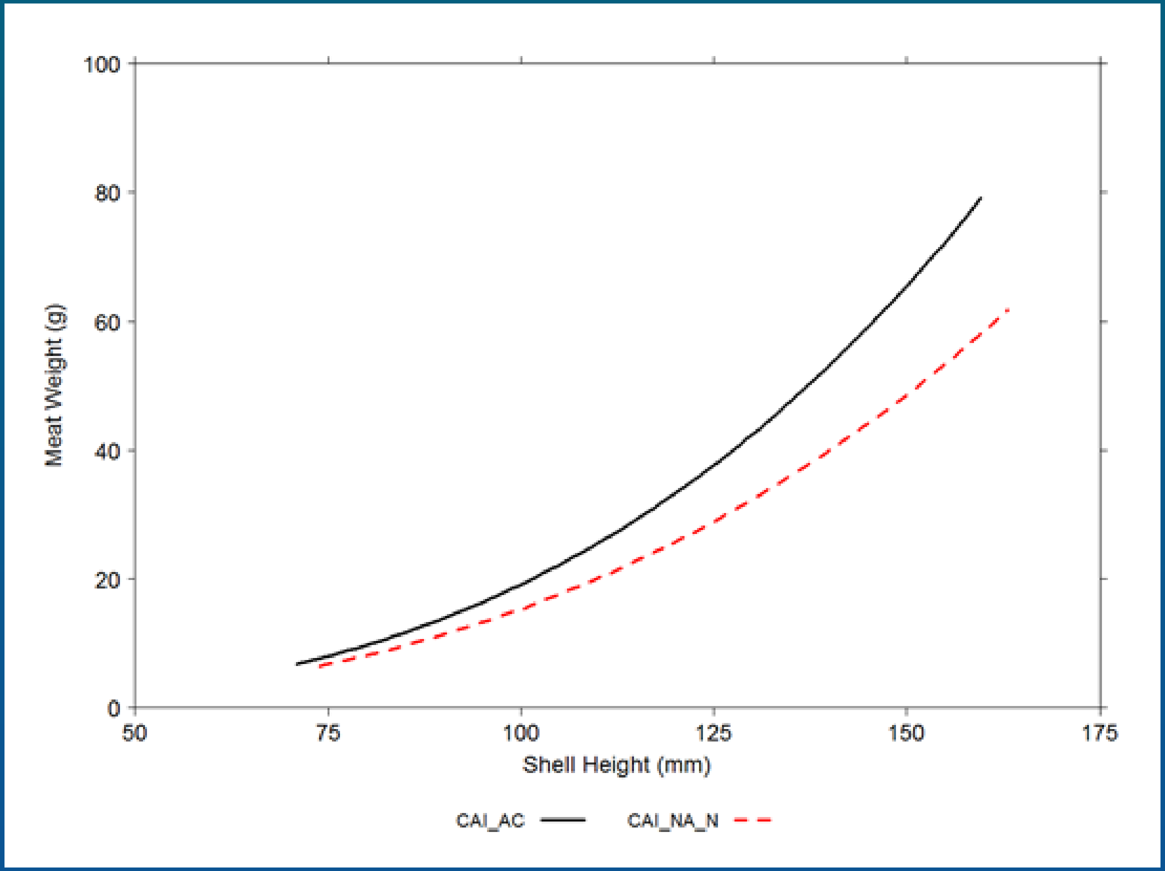
2016-2018 VIMS-Industry Cooperative NLCA Survey

SHMW Results



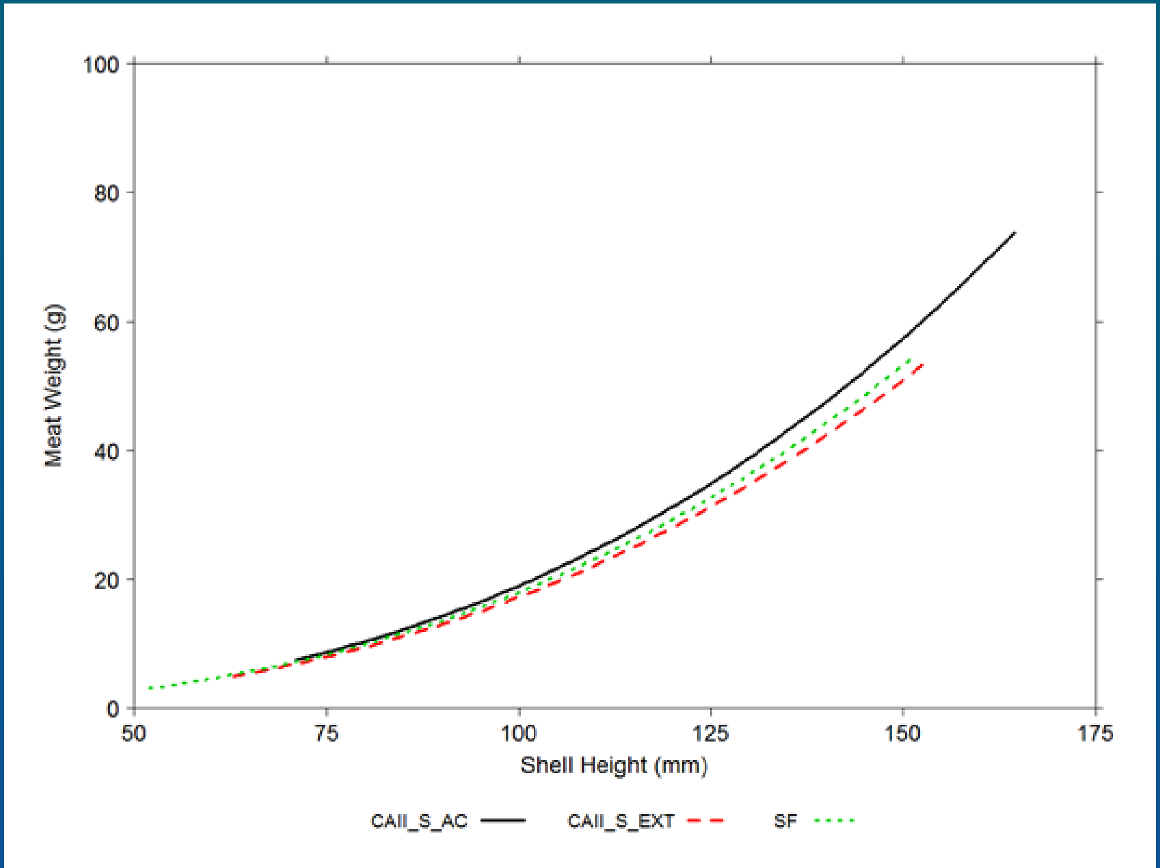
- Significantly different relationships for all SAMS Area except VIMS 45 compared to the Northern SAMS Area.

2018 VIMS-Industry Cooperative CA I Survey
SHMW Results



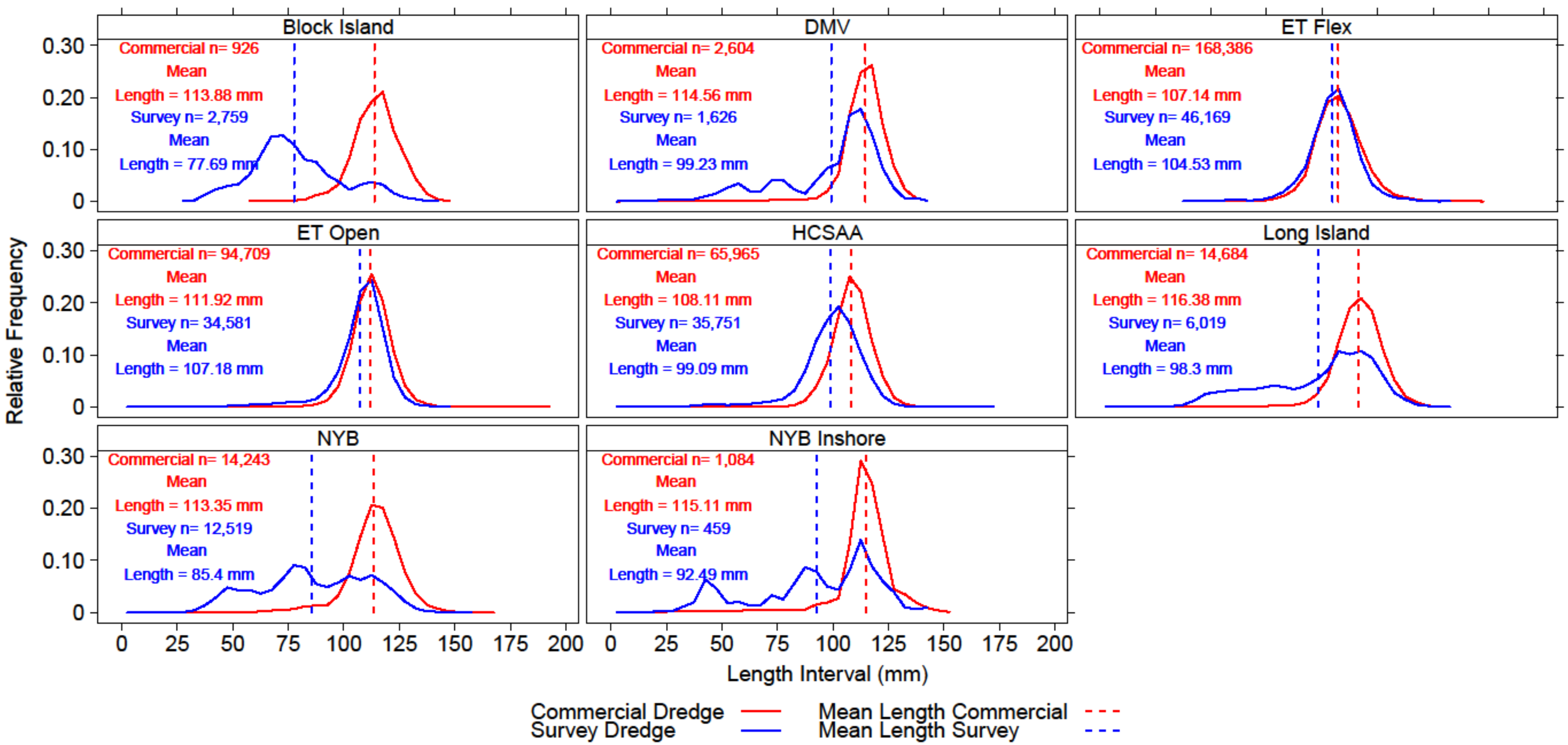
- Southern SAMS SHMW curve is greater than the Northern Area
- Likely a function of average depths for each of subarea, as well as the temporal spread of the sampling

2018 VIMS-Industry Cooperative CA II Survey
SHMW Results



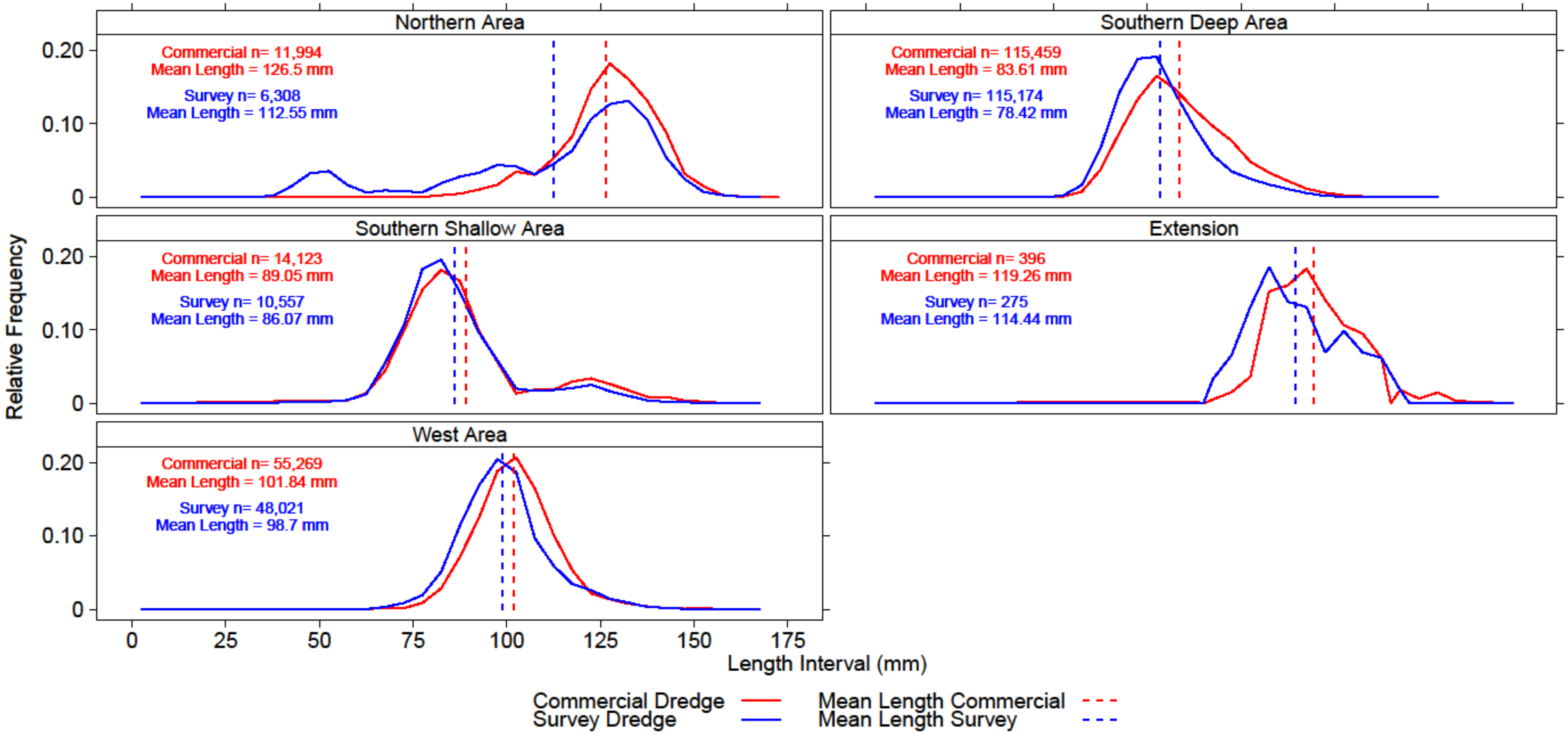
- Extension and Open Area SF SHMW curves are lower than the Northern Access Area

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

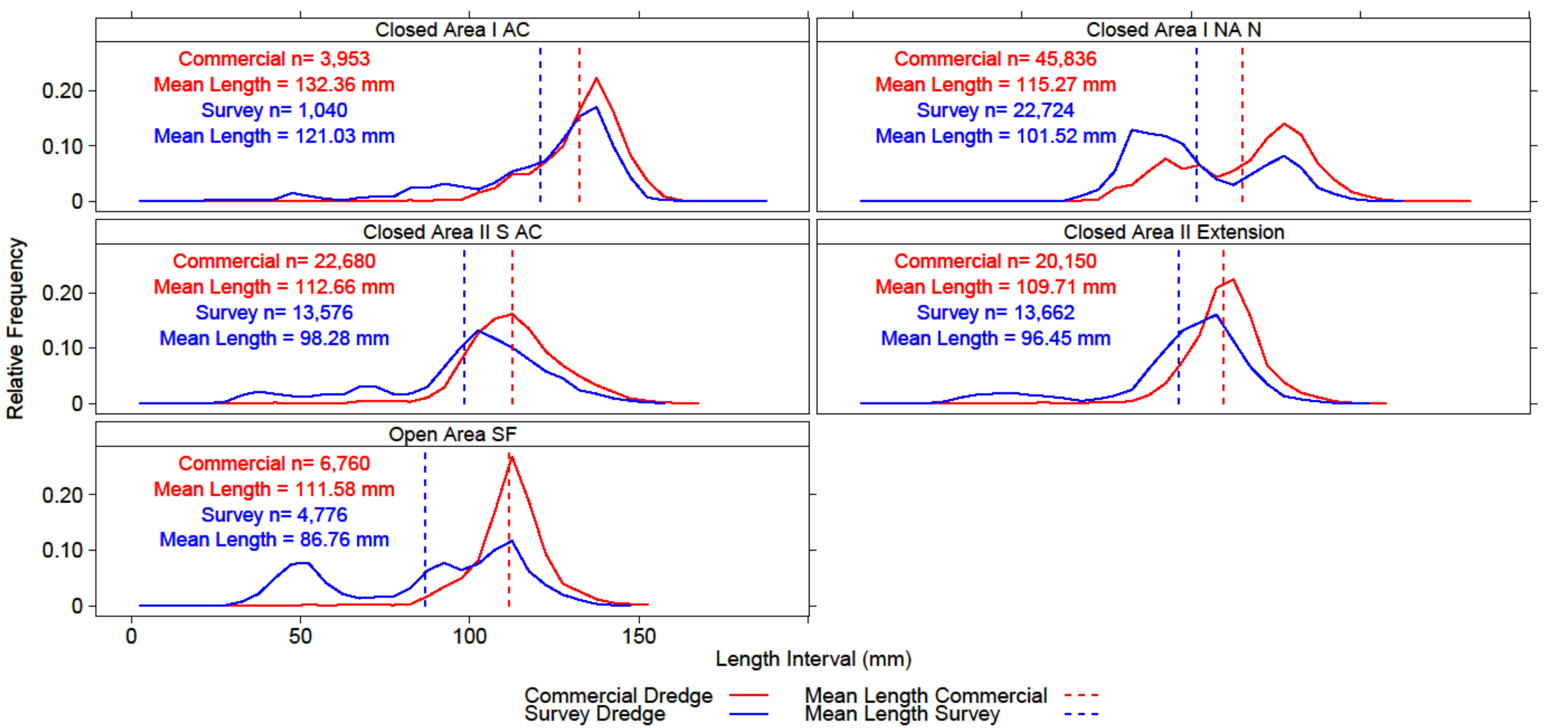


2018 VIMS-Industry Cooperative NLCA Survey

Length Frequency- SAMS Areas

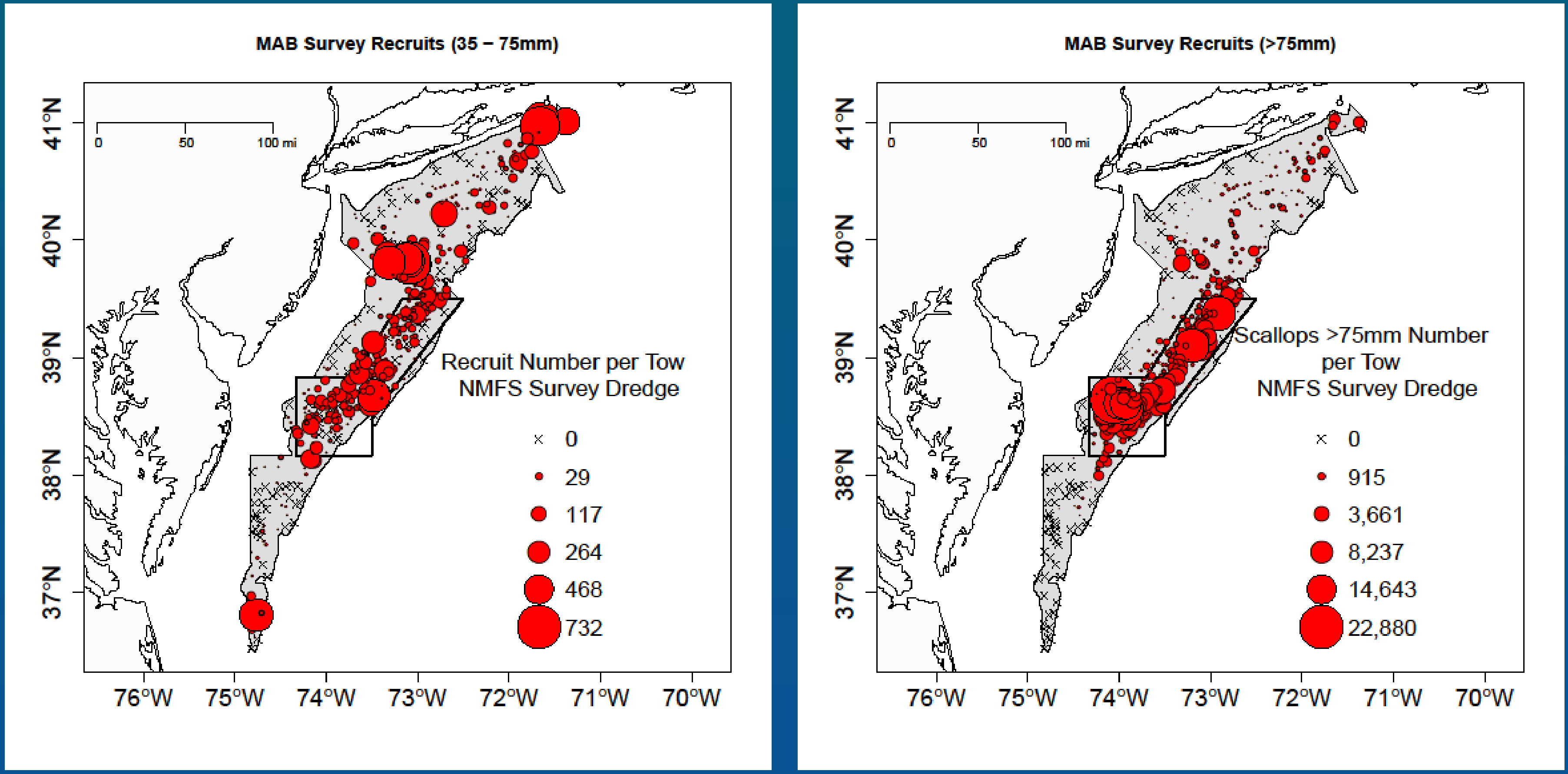


2018 VIMS-Industry Cooperative CA I II Survey
Length Frequency- SAMS Areas



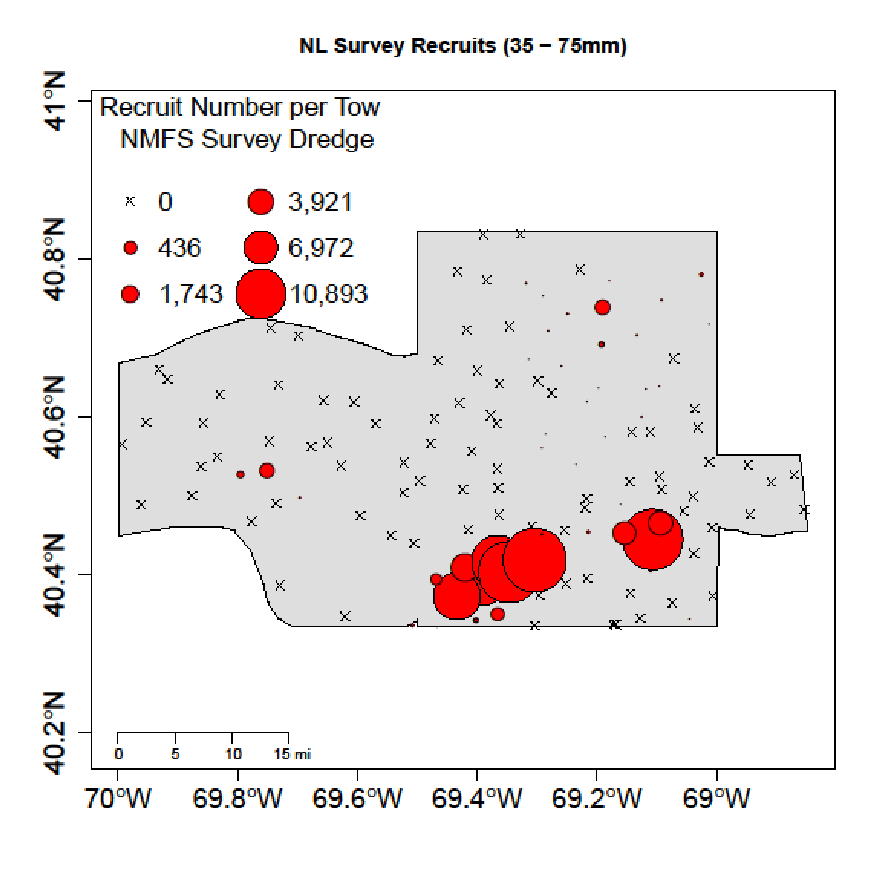
2018 VIMS-Industry Cooperative MAB Survey

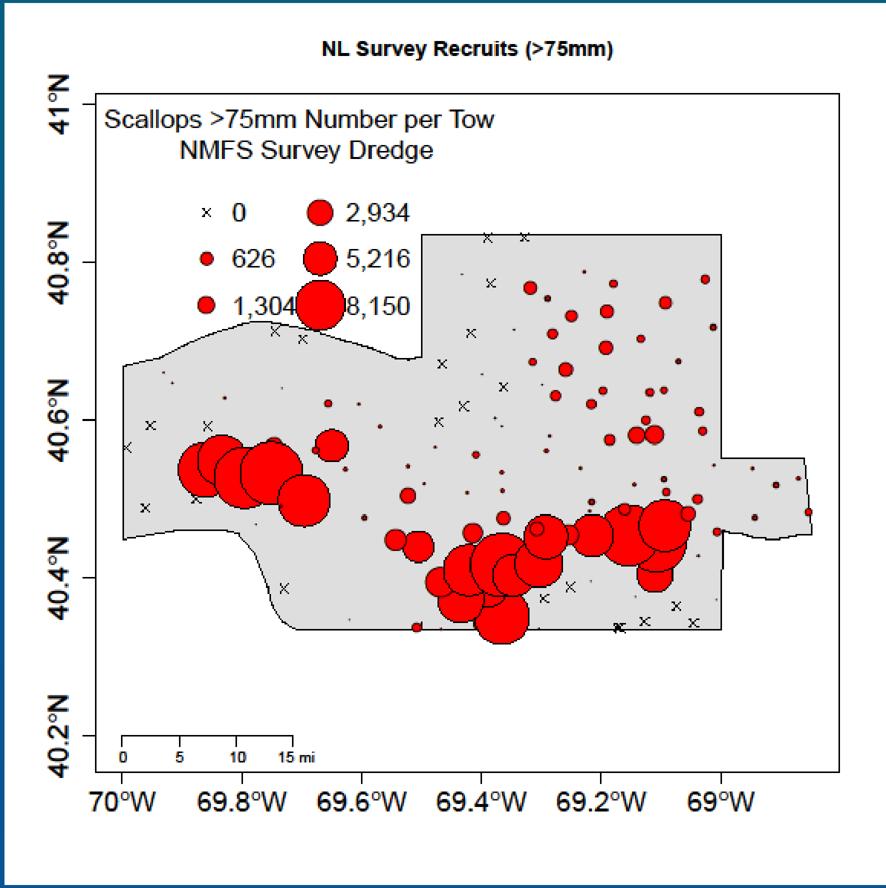
Scallop Distribution



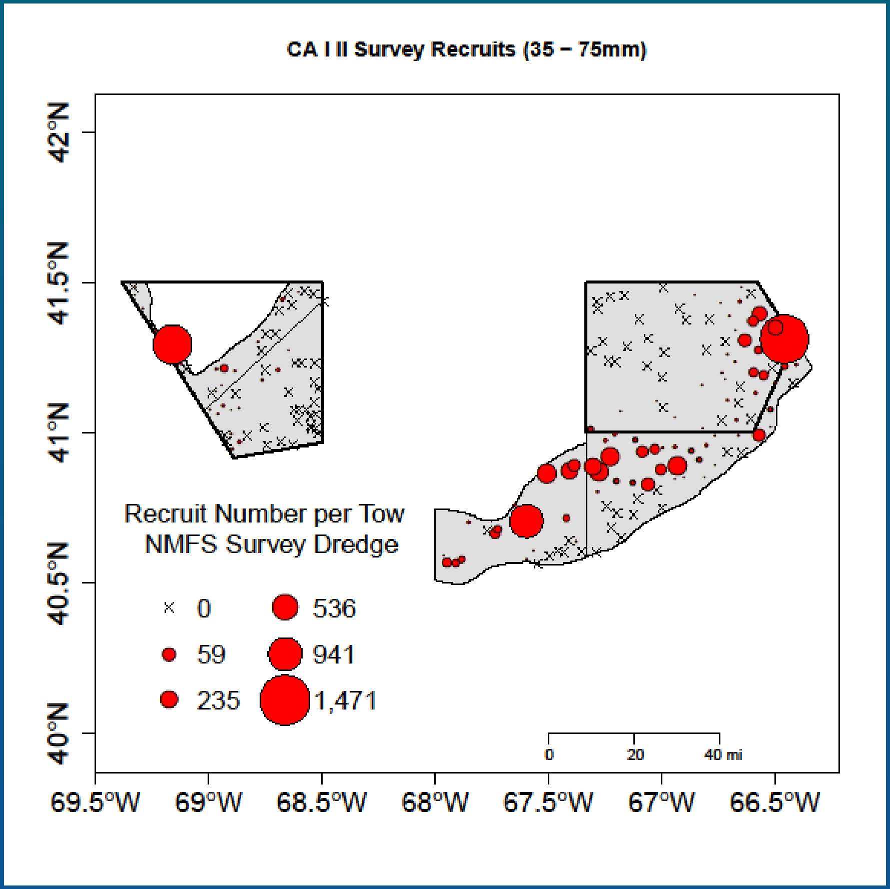
2018 VIMS-Industry Cooperative NLCA

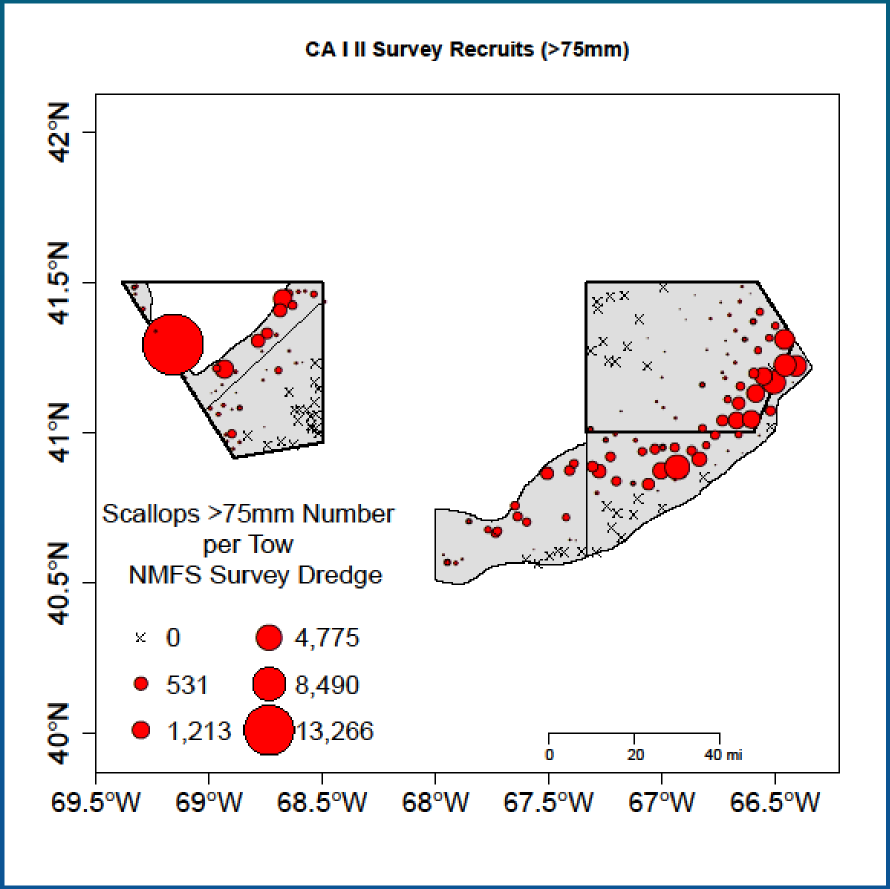
Surveys Scallop Distribution





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

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

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

David B. Rudders

Sally Roman

Erin Mohr

Kaitlyn Clark

Virginia Institute of Marine Science

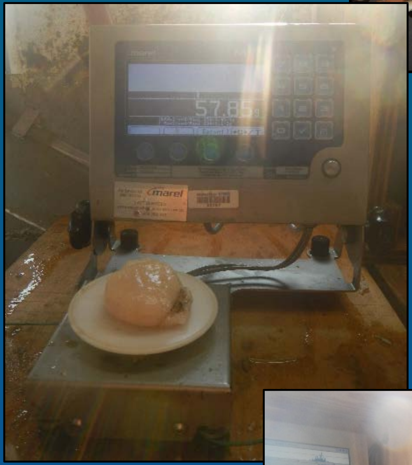
Sea Scallop Plan Development Team

Woods Hole, MA

August 27-28, 2019

Preliminary – PDT use only.

2019 VIMS-Industry Cooperative Surveys
Project Objectives



<u>Primary Objectives</u>

- Assess the abundance and distribution of scallops in the Mid-Atlantic Bight, NL, CAI & CAII by SAMS Area
- Estimate total & exploitable biomass

<u>Secondary Objectives</u>

- Gear performance
  - Selectivity of commercial gear
- Scallop Biology & Product Quality
  - Assess marketability, growth, disease & SHMW
- Finfish Bycatch
- Scallop Predators

2019 VIMS-Industry Cooperative Surveys

- Sampling design
  - Stratified random design
    - NMFS shellfish strata plus SAMS areas included in survey domains
  - Allocation
    - Area, prior year catch data (biomass, number)
- Automated Data acquisition system
- Survey dredge performance monitored
- All other protocols remained the same
  - Tow a survey dredge & commercial dredge simultaneously
    - Survey dredge – 8 ft in width, 2 in rings & 1.5 in diamond mesh liner
    - Commercial dredge – varies by vessel and area

Biomass Estimation

- **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 65 or determined by PDT)**
  - **Selectivity (Yochum and DuPaul, 2008)**
- **Efficiency (E_s)**
  - **Values from SARC 2014**
    - **65%Commercial Dredge**
    - **40% NMFS Survey Dredge**

$L =$ # 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 in stratum h

Stratified mean biomass per tow in stratum and subarea of interest

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

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

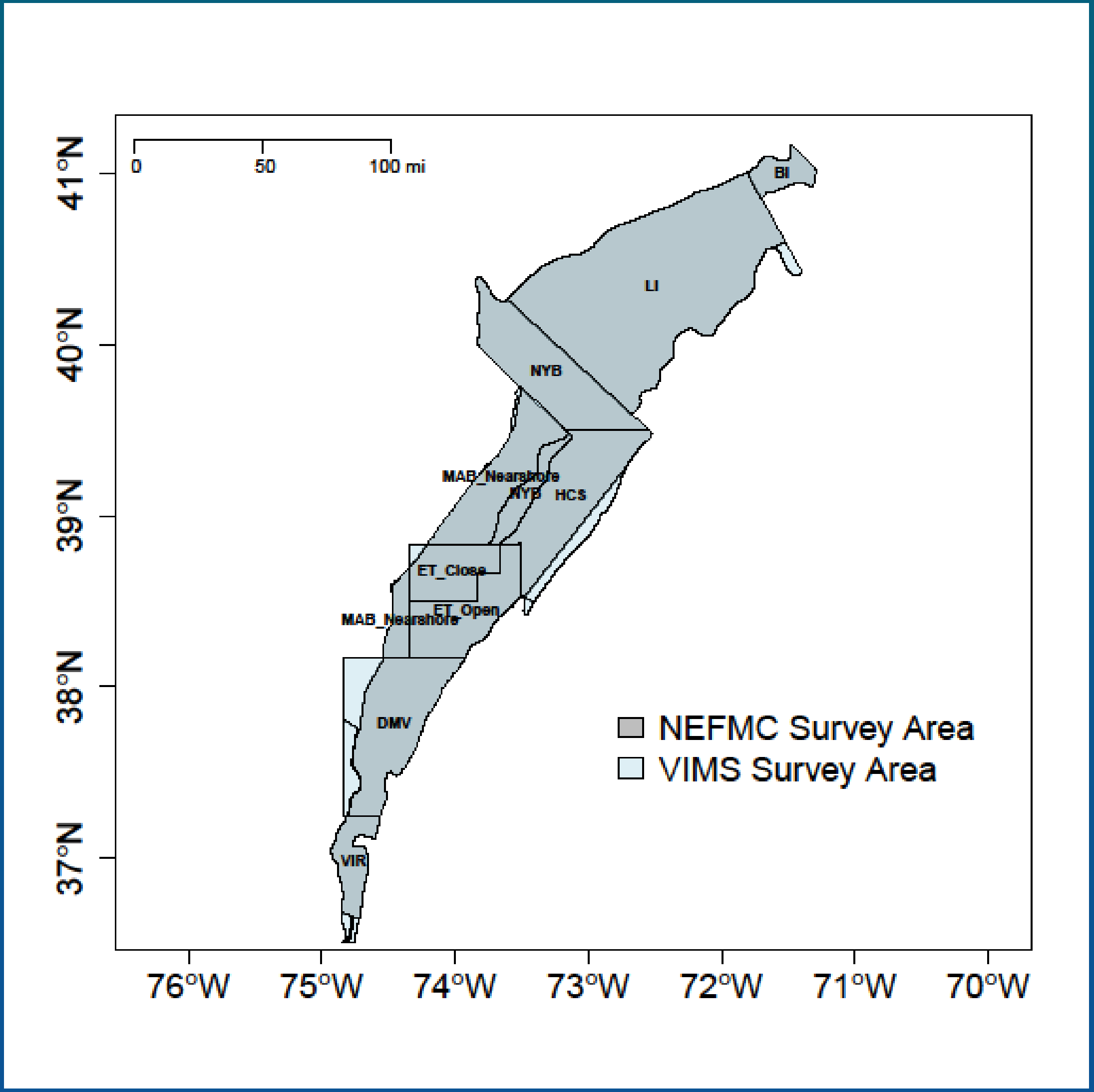
Stratified mean biomass per tow in subarea of interest

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

Total biomass in subarea of interest

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

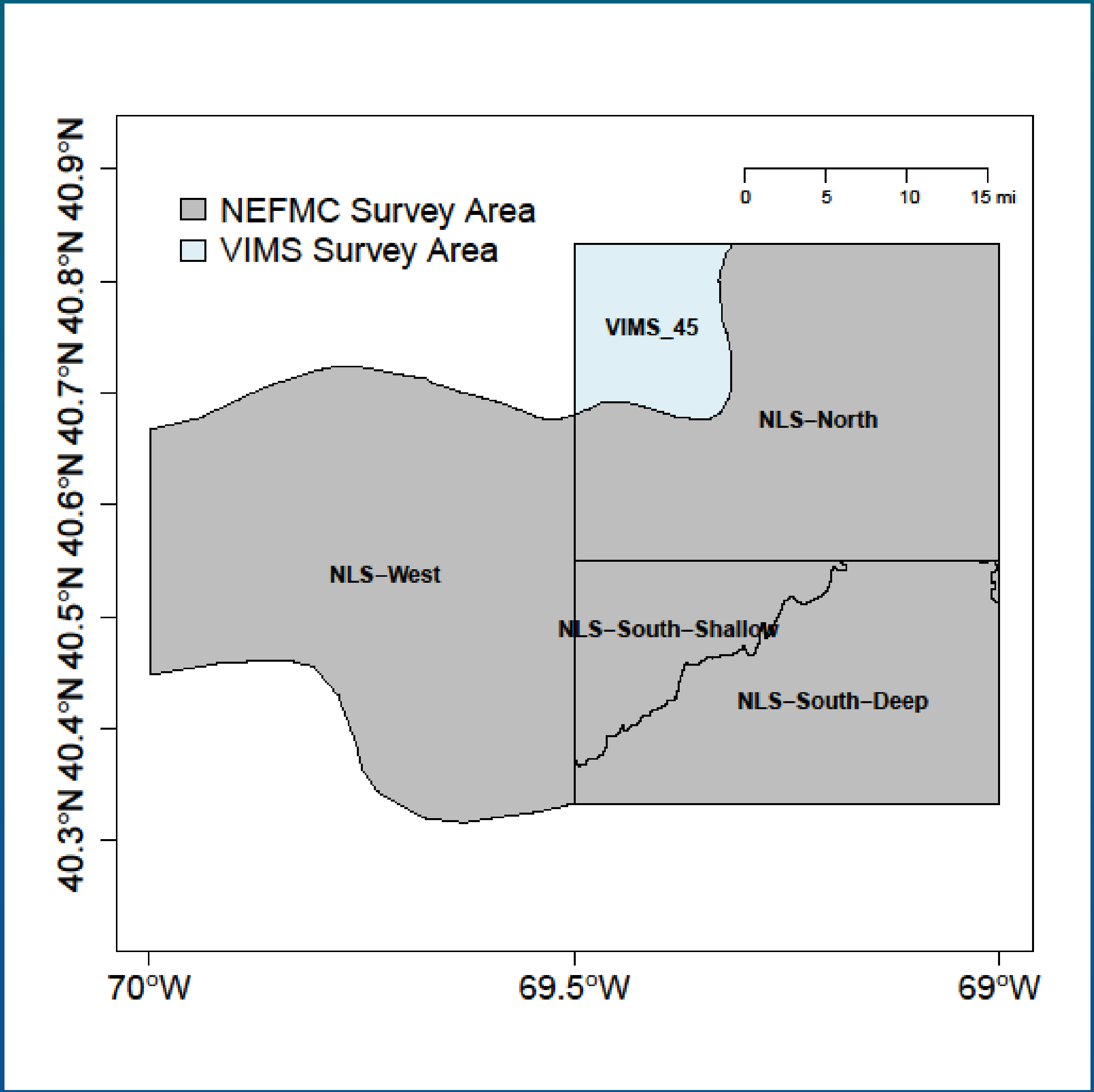
2019 SAMS Areas



MAB Survey

- **9 SAMS Areas**
- **Only minor changes to some area names**
- **VIMS surveys outside of areas & biomass in VIMS areas is included in the closest SAMS Area**

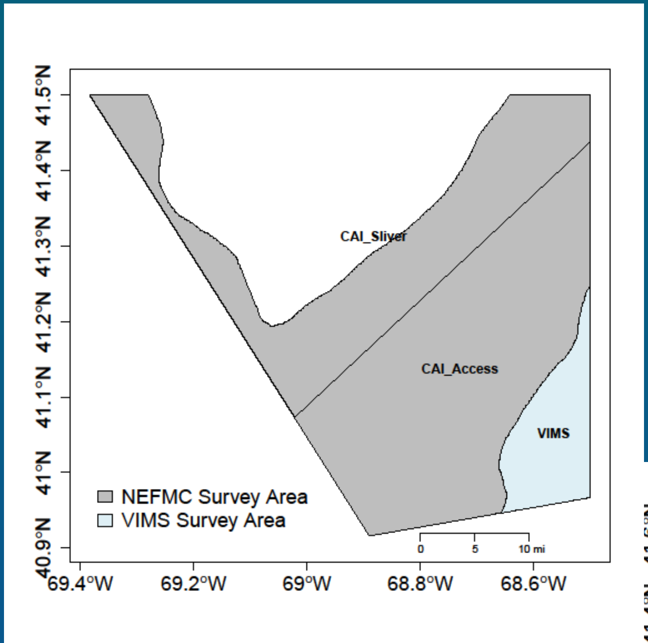
2019 SAMS Areas

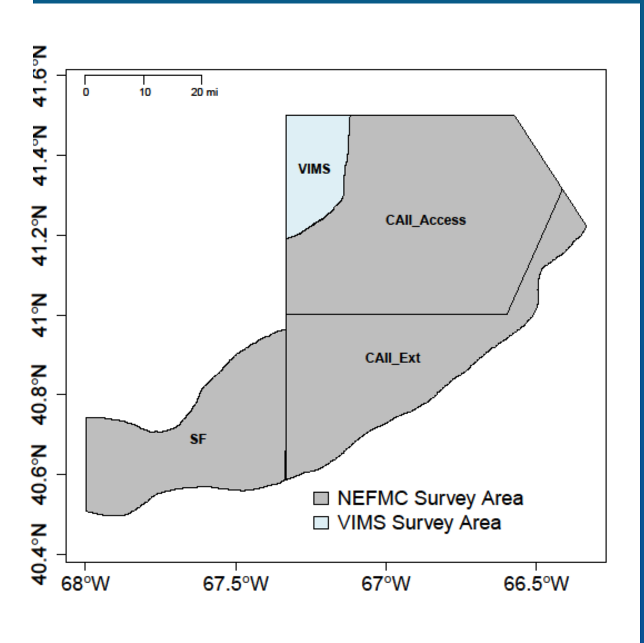


NL Survey

- **4 SAMS Areas**
- **2018 Ext SAMS Area included in GSC**
- **VIMS surveys outside of areas & biomass in VIMS areas is calculated as a separate area**

2019 SAMS Areas





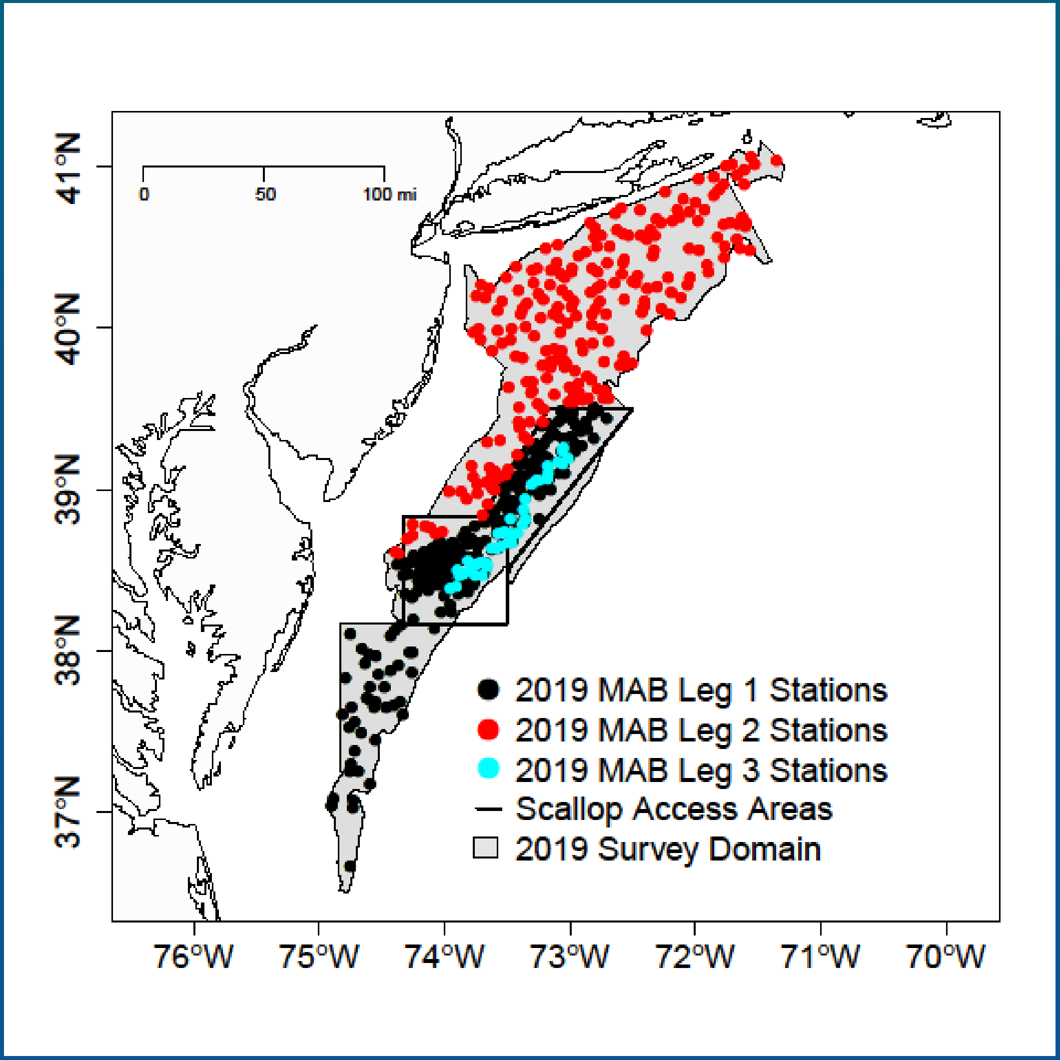
<u>CAI II Survey</u>

- **CAI - 2 SAMS Areas**
- **CAII - 3 SAMS Areas**

- **Only changes to names**

- **VIMS surveys outside of areas & biomass in VIMS areas is calculated as separate areas**

2019 VIMS-Industry Cooperative Surveys
MAB



First Leg

- F/V Italian Princess
- 5/10/19 – 5/19/19
- 225 Stations

Second Leg

- F/V Carolina Capes II
- 5/22/19 – 6/2/19
- 225 Stations

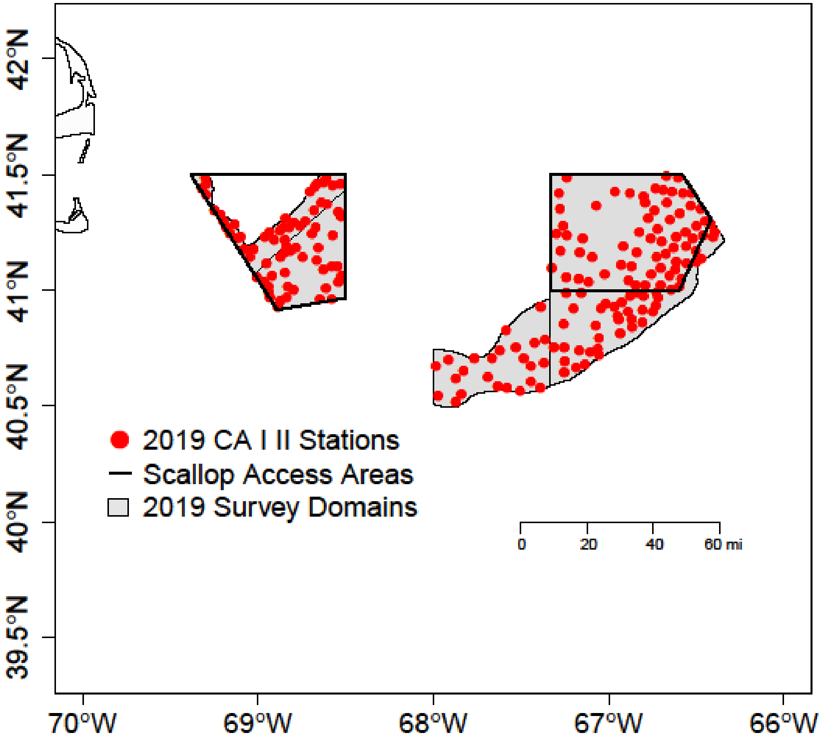
Third Leg

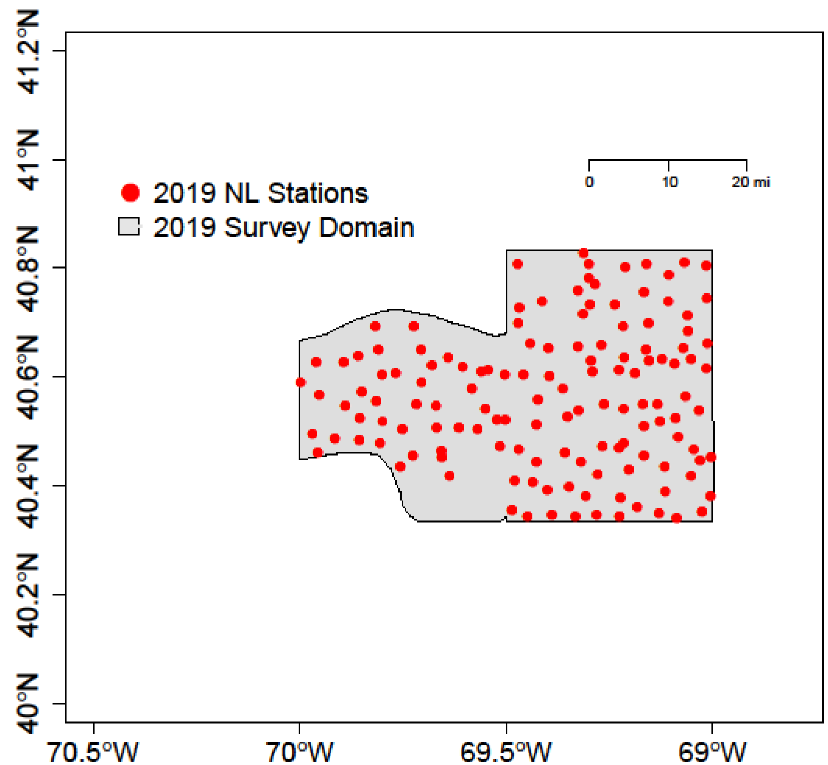
- F/V Anticipation
- 8/12/19 – 8/15/19
- 39 Stations reoccupied from Leg 1

Total

- 450 Stations

2019 VIMS-Industry Cooperative Surveys
CA I II and NL

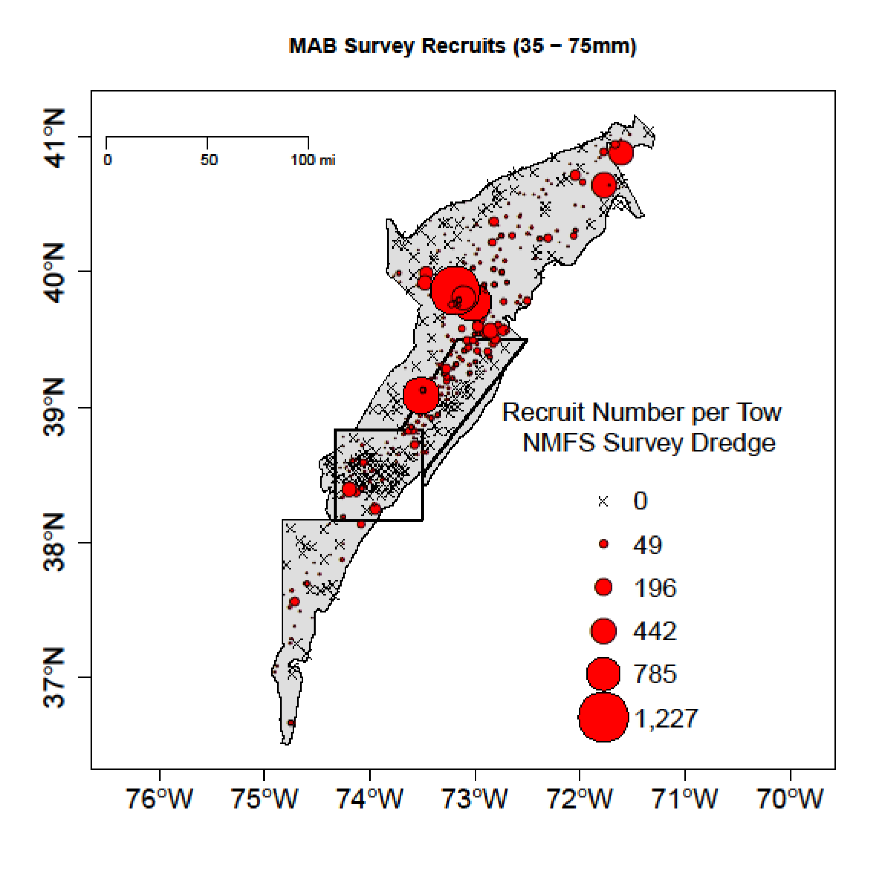


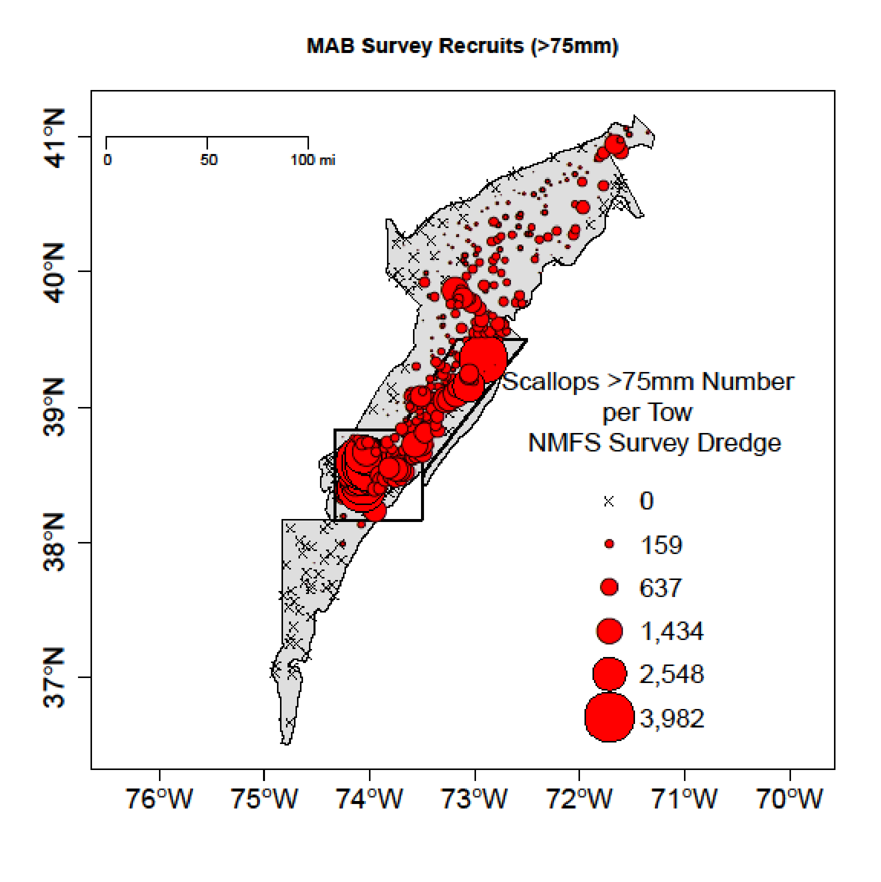


- **F/V Polaris**
- **6/7/19 - 6/14/19**
- **200 Stations**

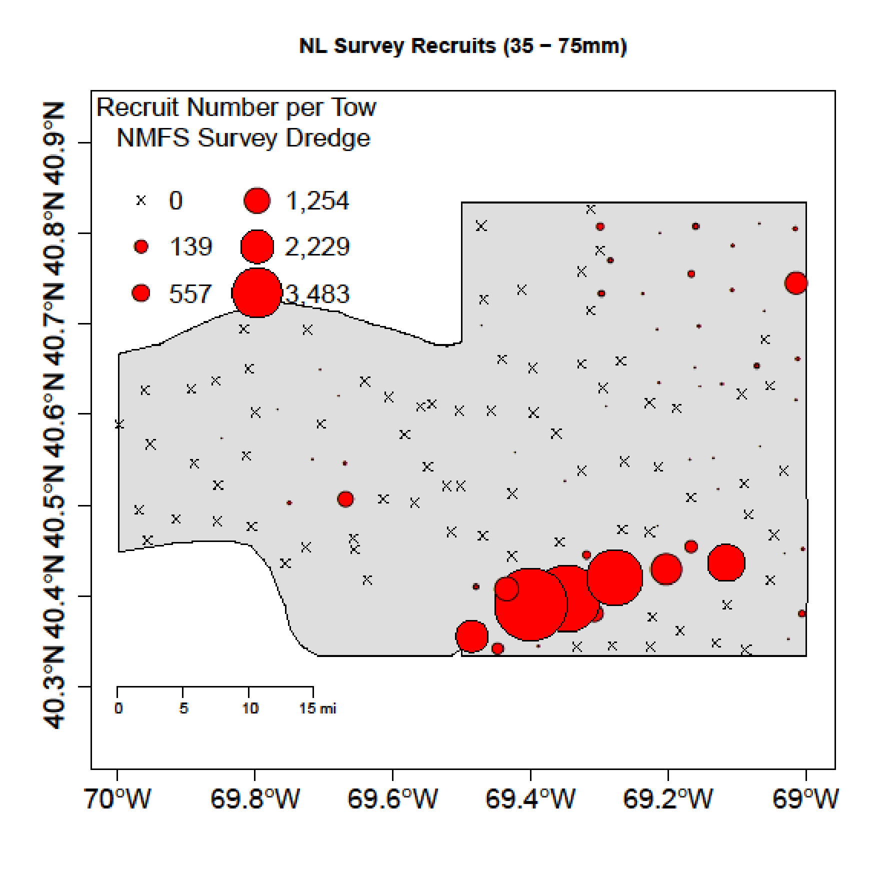
- **F/V Socetean**
- **7/24/19 - 7/31/19**
- **135 Stations**

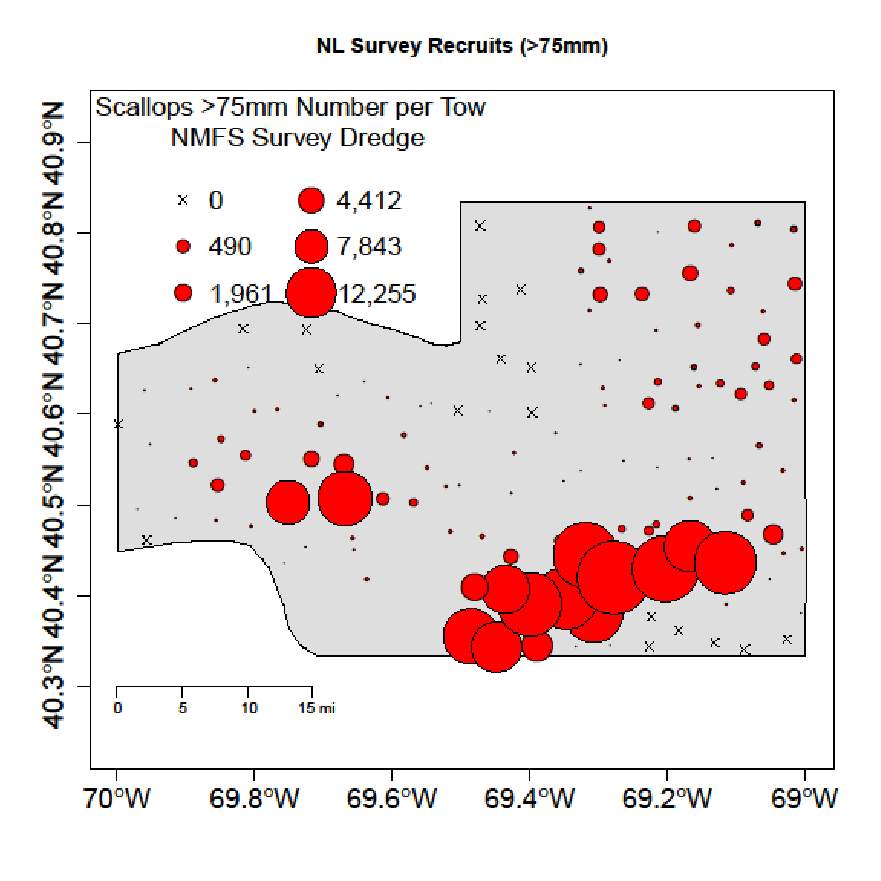
2019 MAB Survey
Scallop Distribution



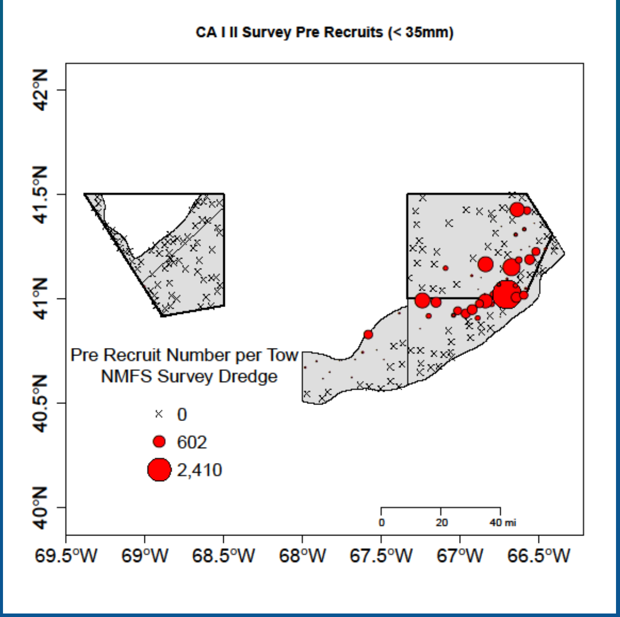


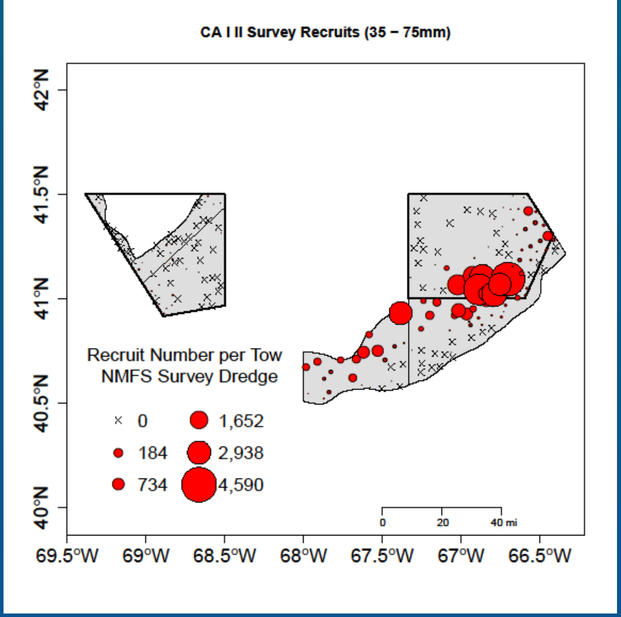
2019 NL Survey
Scallop Distribution

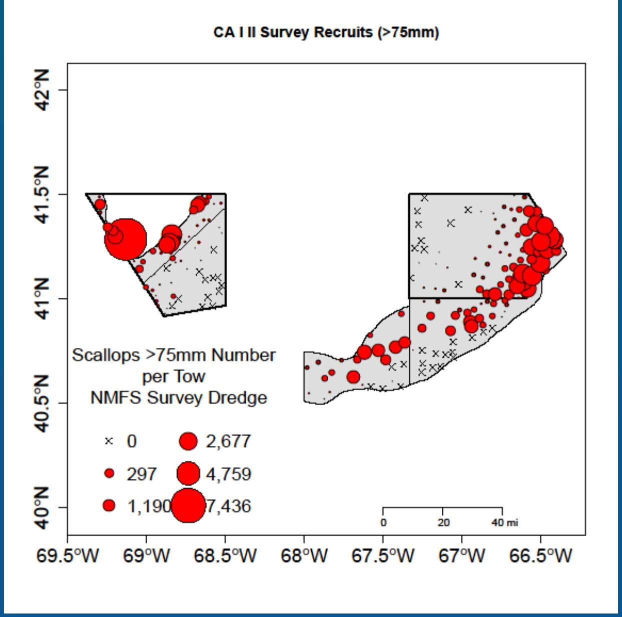




2019 CA I II Survey
Scallop Distribution





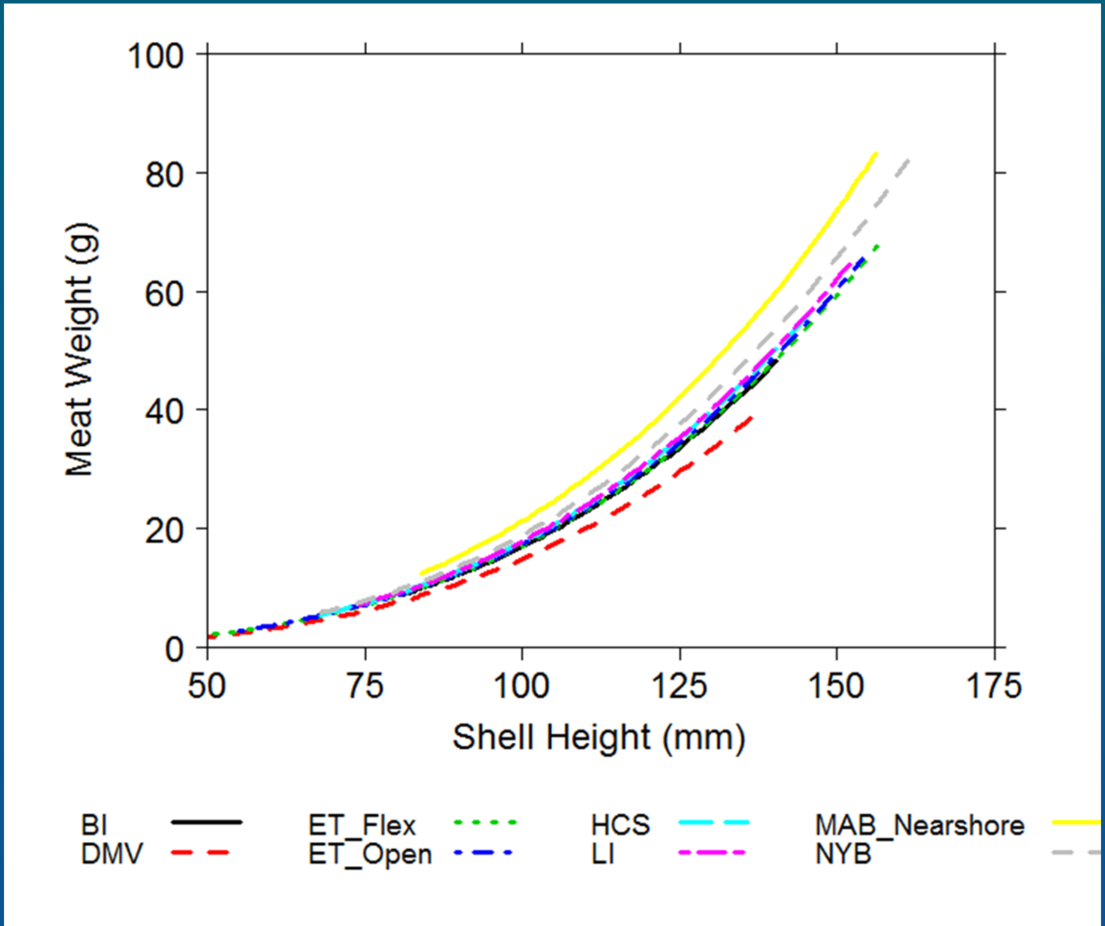


VIMS

SHMW Relationship

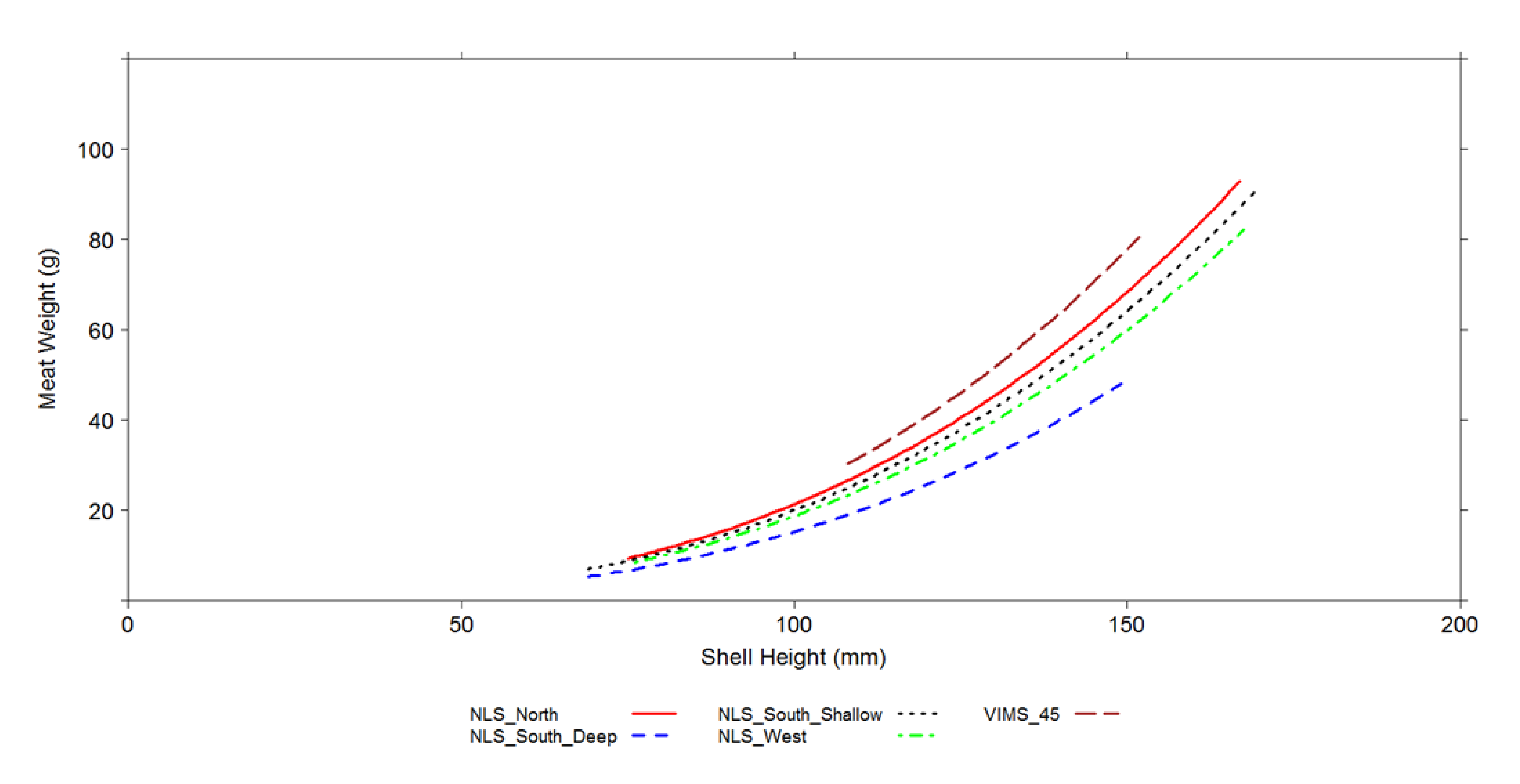
- SHMW samples (meat & gonad weight) were taken from all stations that had scallops (15/station):
  - MAB Survey: 5,510 (377 stations)
  - CA I II Survey: 2,350 (174 stations)
  - NL Survey: 1,989 (124 stations)
- The objective is to construct a model to predict meat weight based on a suite of potential 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

2019 MAB Survey
SHMW Results



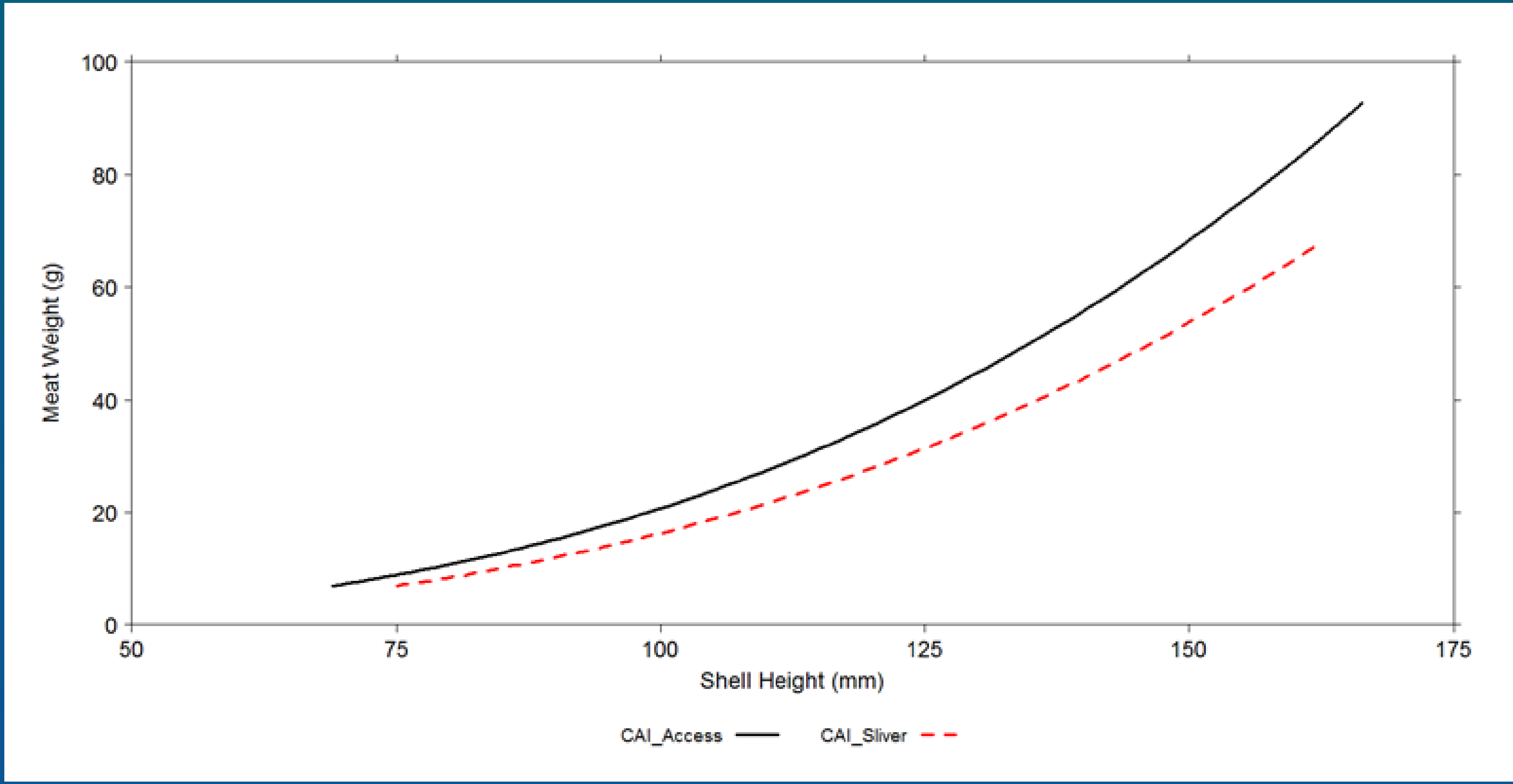
- Majority of SAMS Areas have similar SHMW relationship
- DMV has the smallest meat weight at a given shell height

2019 NL Survey
SHMW Results



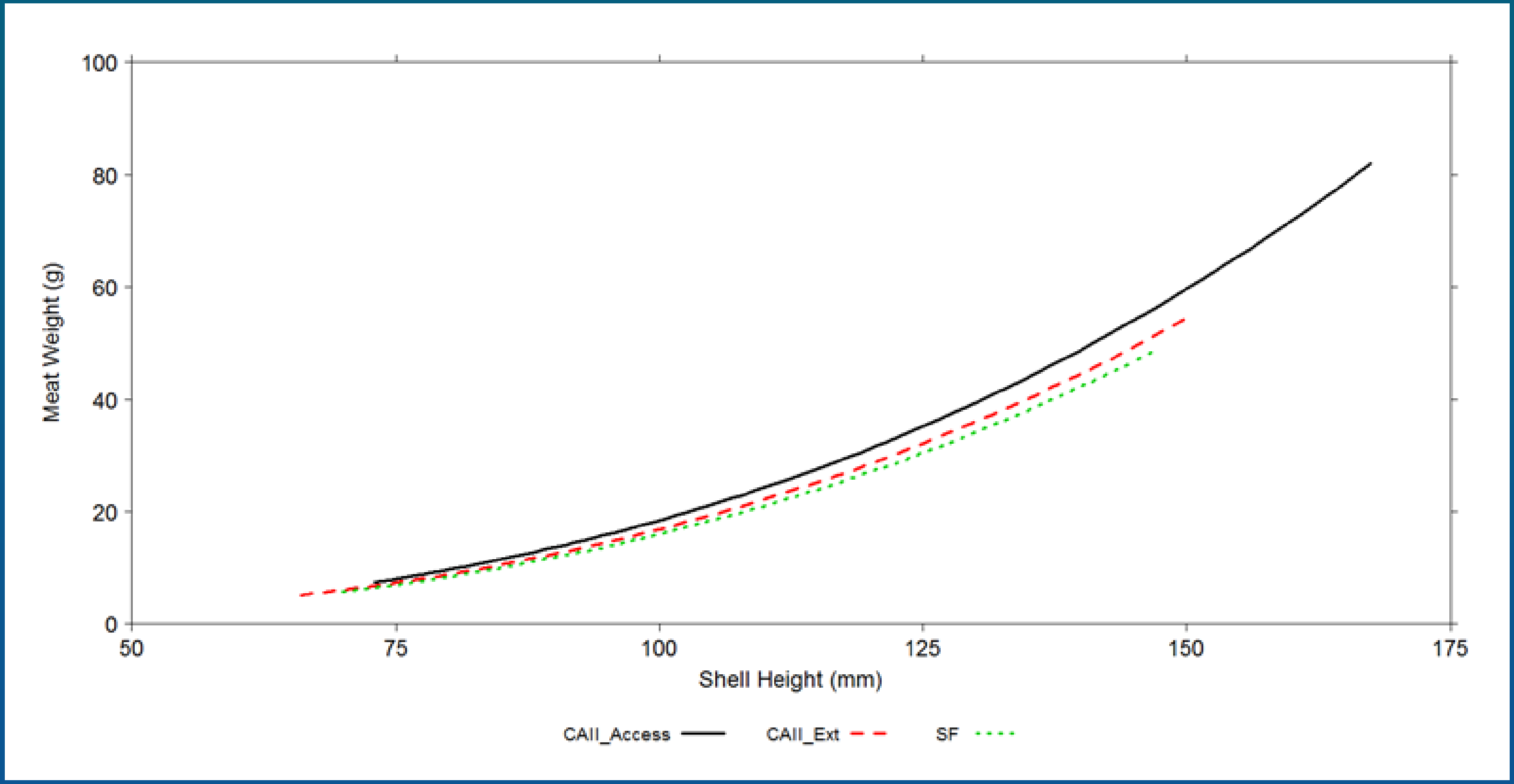
- **Similar trend to previous years for the South Deep SAMS Area having the lowest meat weight at shell height**
- **South Deep SAMS only area significantly different than reference area: NLS-North**

2019 CA I Survey
SHMW Results



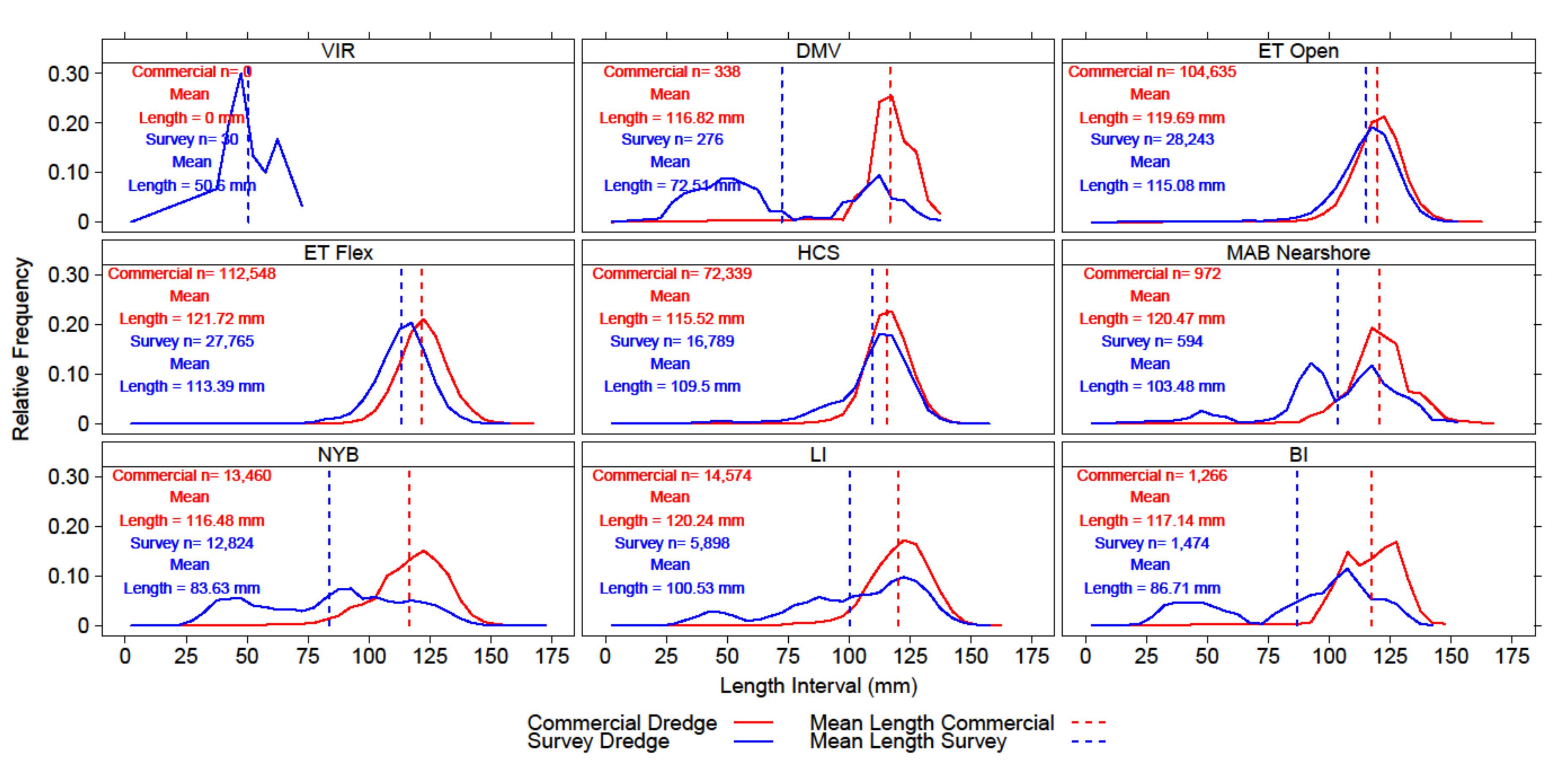
- **CAI Access SAMS Areas significantly different from Sliver SAMS Area**
- **Likely a function of average depths for each subarea, as well as the temporal spread of the sampling**

2019 CAII Survey
SHMW Results

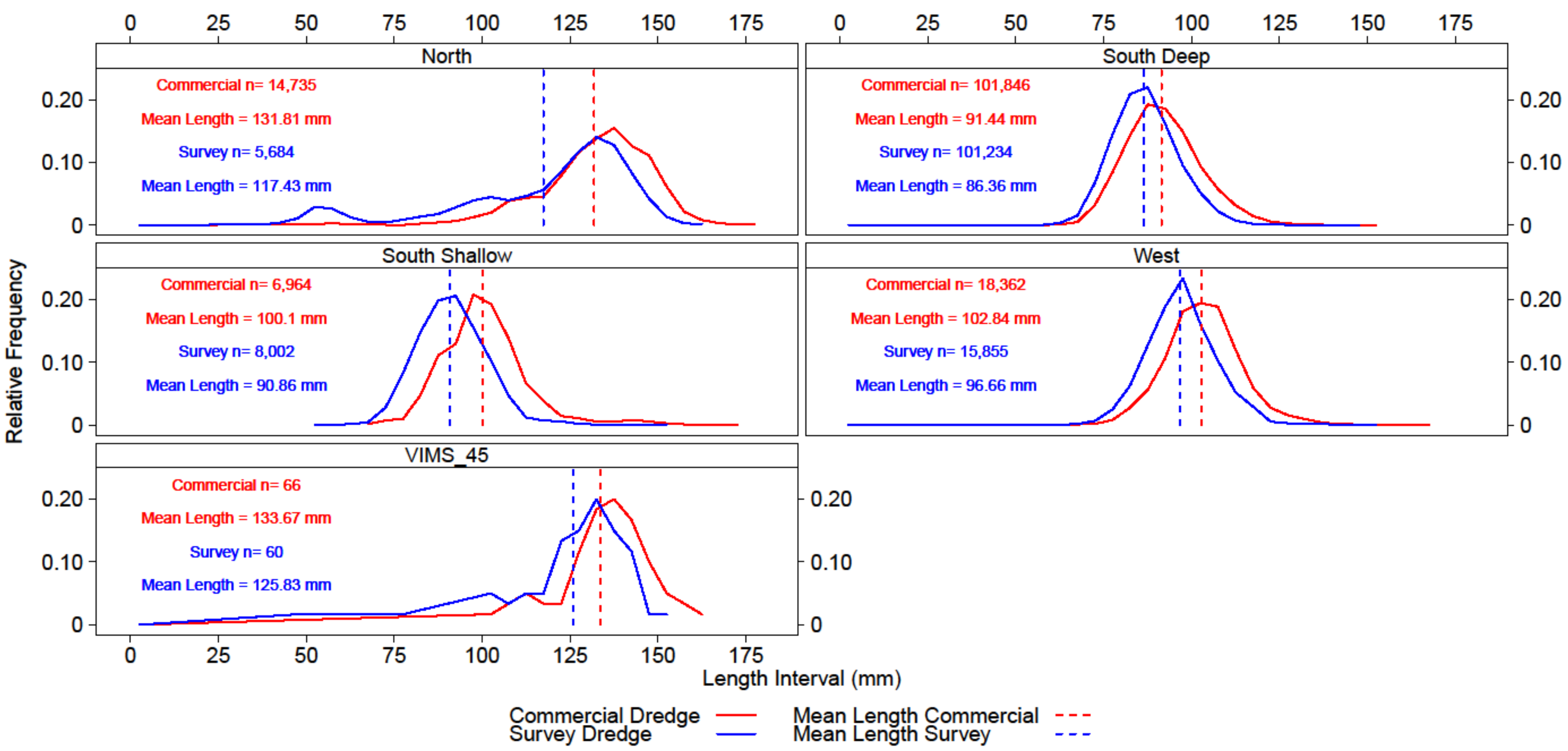


- **Extension and Open Area SF SHMW curves are lower than the Northern Access Area**

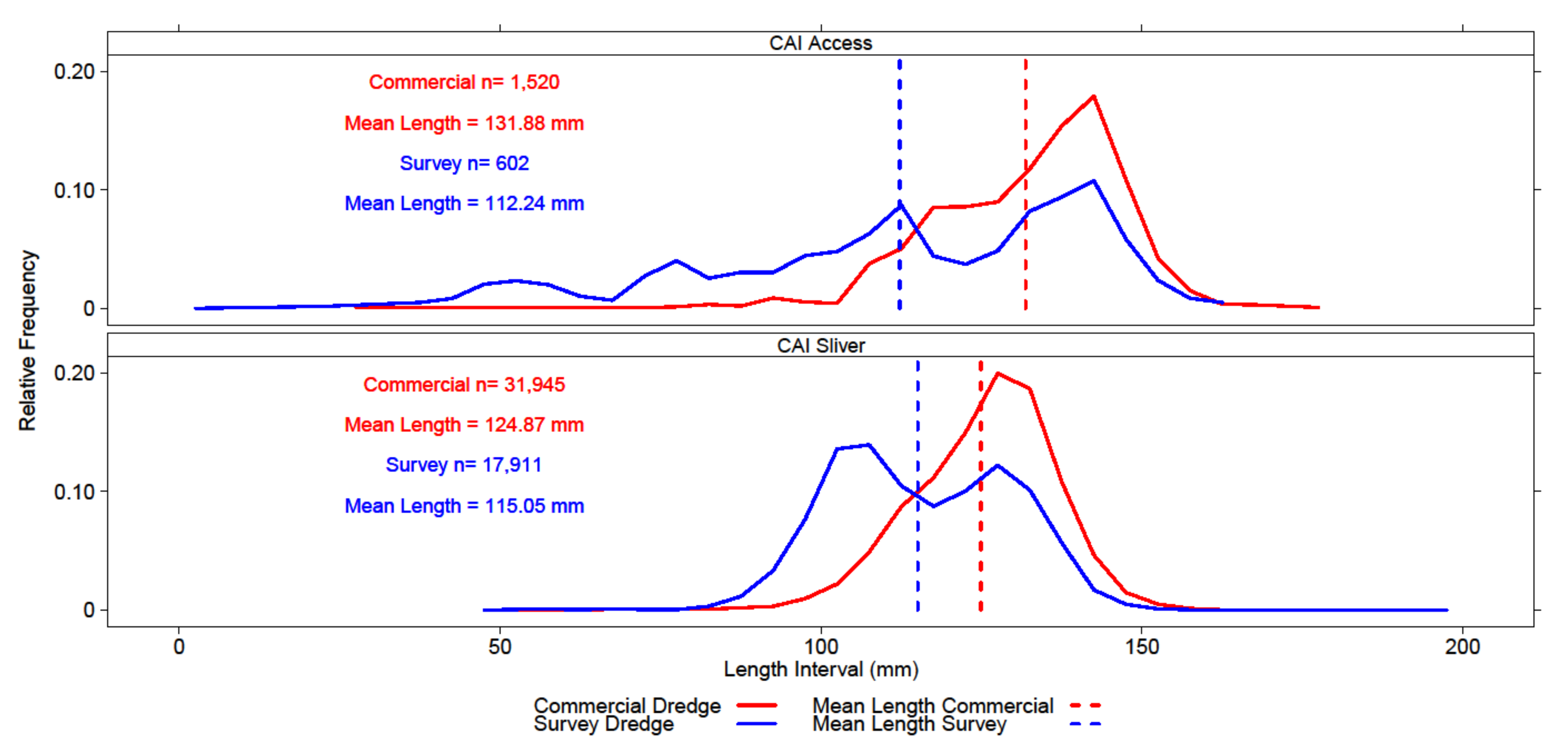
2019 MAB Survey
Length Frequency- SAMS Areas



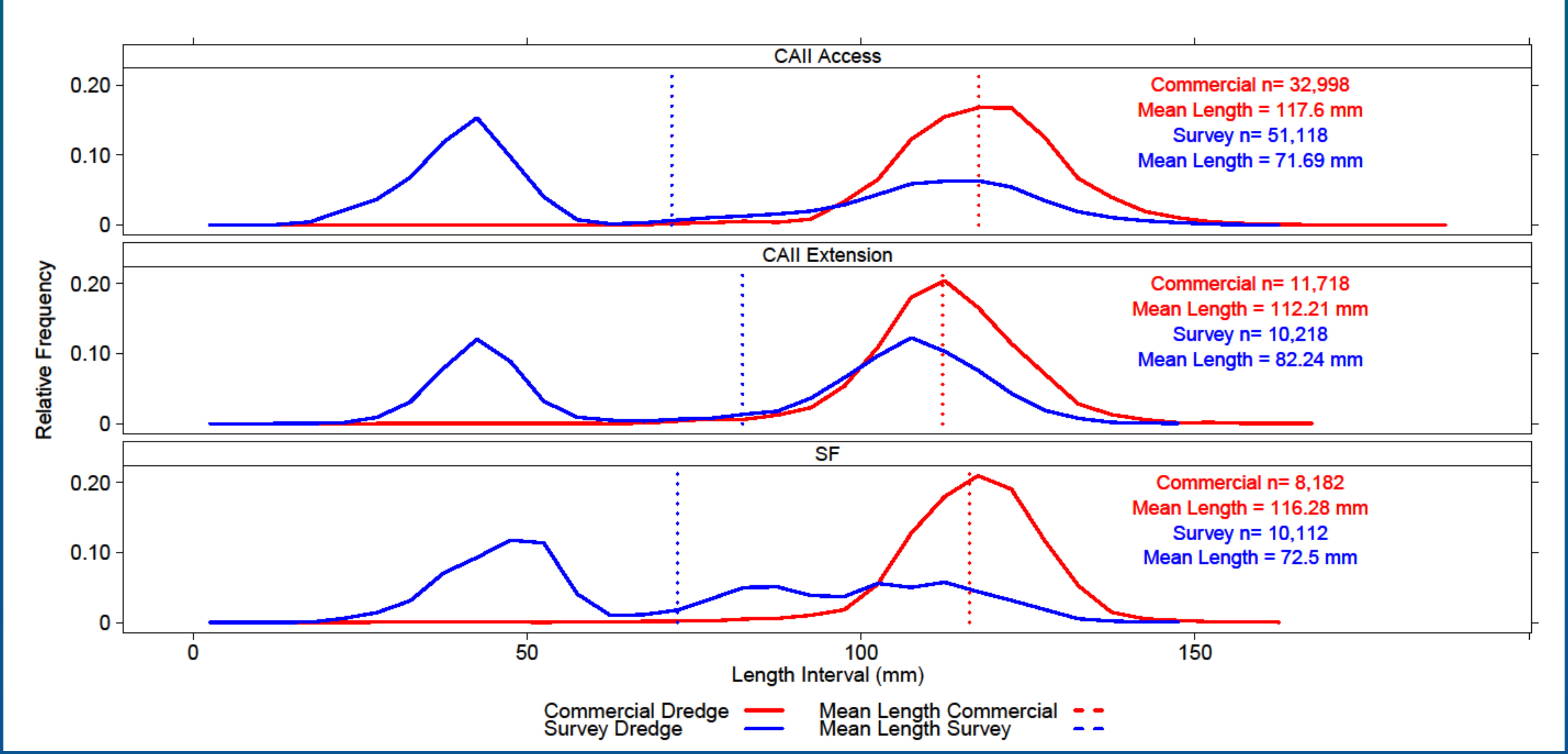
2019 NL Survey
Length Frequency- SAMS Areas



2019 CA I Survey
Length Frequency- SAMS Areas



2019 CA II Survey
Length Frequency- SAMS Areas



2019 CA II Survey
Recruitment

2019 VIMS-Industry Cooperative Surveys

Total Biomass Survey Gear – SAMS Areas

SAMS Area	Total Biomass (mt)	SE Biomass (mt)	CV Biomass (mt)	Density (scal/m^2)	Avg MW (g)	Total Number
VIR	13.76	1.12	20.29	0.00	2.98	4,182,976
DMV	203.02	43.41	53.46	0.01	10.48	20,305,939
ET Open	15,104.89	896.65	14.84	0.30	25.84	592,011,891
ET Flex	13,528.87	1,174.25	21.70	0.44	25.46	523,603,853
HCS	8,544.00	774.62	22.67	0.13	22.63	380,404,883
MAB Nearshore	1,264.53	180.52	35.69	0.02	23.67	53,427,827
NYB	7,424.97	522.70	17.60	0.12	14.84	537,825,315
LI	9,079.02	349.85	9.63	0.03	22.44	407,307,126
BI	1,514.65	254.05	41.93	0.11	17.33	94,885,840
NLS North	3,368.23	209.81	15.57	0.08	41.26	81,516,050
NLS South Deep	11,897.84	1,181.65	24.83	1.62	10.11	1,176,063,622
NLS South Shallow	1,721.07	425.60	61.82	0.40	14.64	117,563,486
NLS West	3,276.12	663.54	50.63	0.20	16.68	195,268,579
VIMS 45	82.57	29.51	89.33	0.01	49.51	1,667,620
CAI Access	693.40	83.55	30.12	0.02	35.57	18,434,122
CAI Sliver	7,856.85	911.86	29.01	0.32	29.54	258,991,330
CAII Access	20,689.43	1,129.01	13.64	0.56	15.49	1,670,993,750
CAII Ext	5,567.79	565.55	25.39	0.17	17.49	312,054,690
SF	6,437.53	646.95	25.12	0.29	12.15	529,788,692

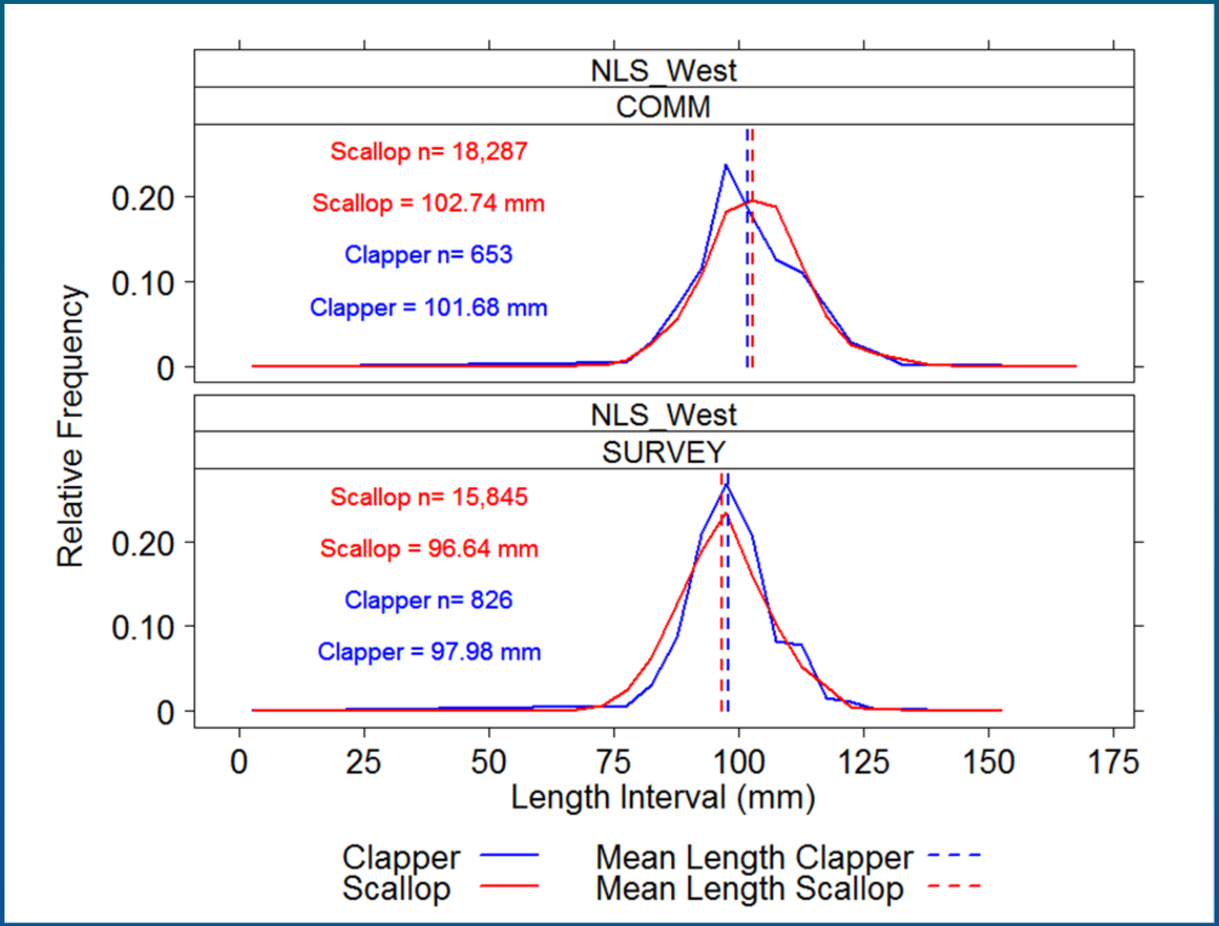
2019 VIMS-Industry Cooperative Surveys
Exploitable Biomass Commercial Gear - SAMS Areas

SAMS Area	Exp Biomass (mt)	SE Biomass (mt)	CV Biomass (mt)	Density (scal/m^2)	Avg MW (g)	Exp Number
VIR	0.00	0.00	0.00	0.00	0.00	0.00
DMV	173.98	66.99	59.24	0.00	26.38	6,574,359.16
ET Open	18,883.50	1,437.89	11.71	0.37	29.10	639,647,357.29
ET Flex	18,691.29	2,682.01	22.08	0.54	31.25	601,828,611.86
HCS	10,986.92	1,122.82	15.72	0.16	25.79	428,387,241.60
MAB Nearshore	861.19	192.73	34.43	0.01	34.06	25,293,944.23
NYB	3,880.14	264.69	10.49	0.03	31.02	127,356,560.41
LI	9,437.00	546.96	8.92	0.02	33.50	282,714,230.41
BI	705.68	128.19	27.95	0.03	32.26	21,781,182.10
NLS North	4,118.83	339.75	12.69	0.07	54.68	75,192,779
NLS South Deep	2,200.75	396.60	27.73	0.21	14.63	150,332,552
NLS South Shallow	448.49	115.78	39.72	0.07	23.26	19,279,540
NLS West	1,080.04	308.25	43.91	0.05	22.19	47,986,968
VIMS_45	37.93	21.70	88.02	0.00	58.85	644,404
CAI Access	957.27	135.98	21.85	0.01	51.91	18,194,175
CAI Sliver	6,438.48	1,076.98	25.73	0.20	39.34	162,369,294
CAII Access	9,690.29	817.91	12.99	0.11	38.06	244,325,929
CAII Ext	3,258.13	486.51	22.97	0.05	32.06	100,845,369
SF	4,193.63	704.08	25.83	0.07	32.86	127,630,804

SARC 65 Total Biomass Estimates Compared to VIMS 2016-19 Estimates NL

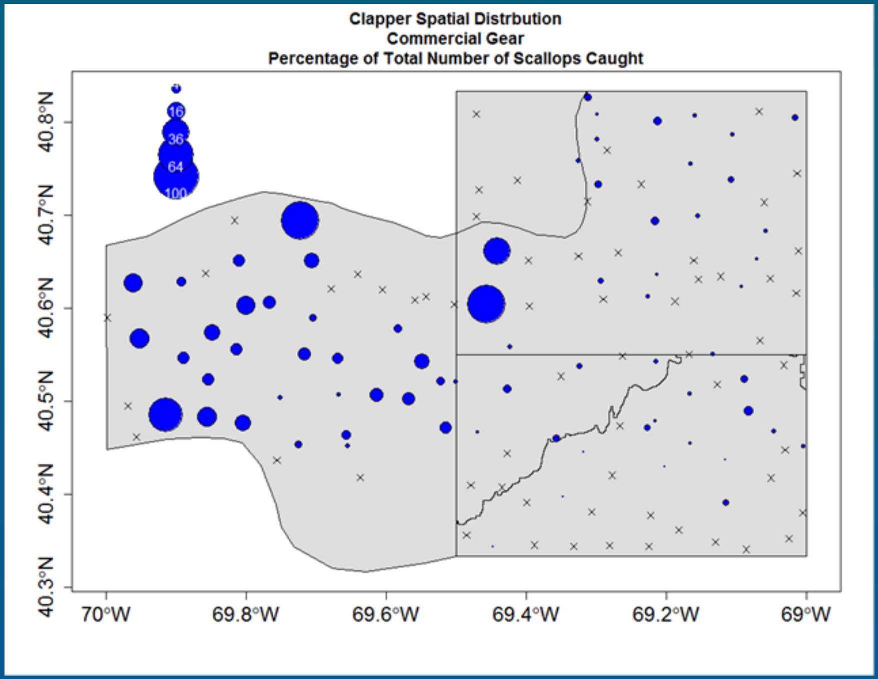
SAMS Area	Total Biomass (mt)-SARC 65	Total Biomass (mt) VIMS 2016-19
NLS North	3,613.91	3,368.23
NLS South Deep	11,955.05	11,987.84
NLS South Shallow	2,402.17	1,721.06
NLS West	4,732.83	3,276.12
VIMS 45	90.47	82.58

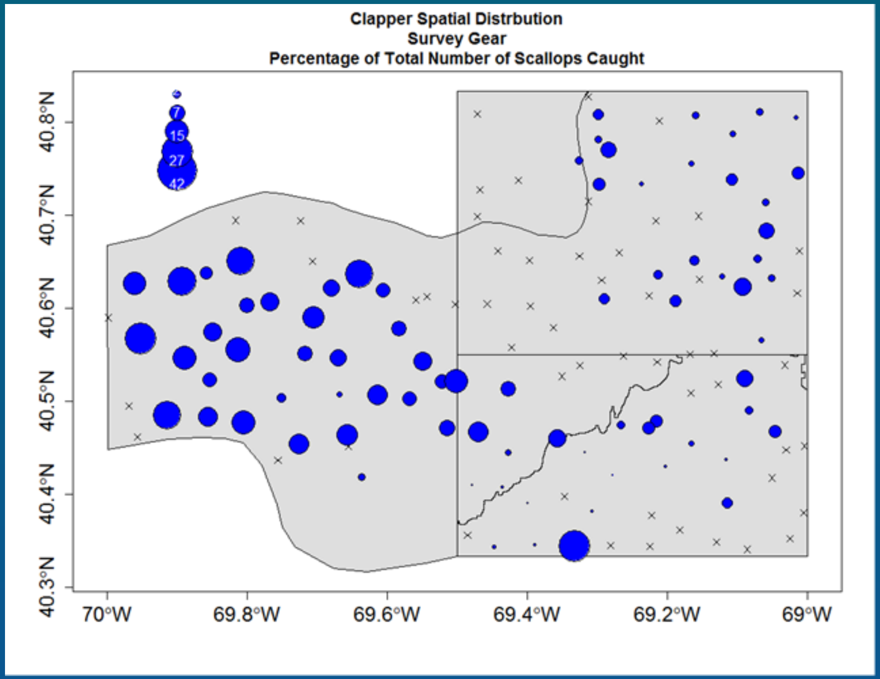
NLS West Clappers



- Observed large quantities of clappers in the NLS-West SAMS Area
- Maybe an indication of higher than expected discard and/or incidental mortality.
- This information may provide insight into potential fishery behavior in the South Deep SAMS Area in the future, due to the size range of scallops in this SAMS Area.

NLS West Clappers





- The percentage of clappers in the catch was greatest in the NLS-West SAMS Area for both gears
- Percentage of clappers in both dredges ranged from 1 to 26%.

Acknowledgements

- The owners, captains and crews:
  - *F/V Carolina Capes II*
  - *F/V Italian Princess*
  - *F/V Polaris*
  - *F/V Socetean*
- Scientific Staff:
  - Lee Rollins, Kelly Lewis, Victoria Thomas, and Sarah Borsetti
- Reidar's Manufacturing Inc.
- Support from NMFS NEFSC: Dvora Hart and Pete Chase.
- Funding through Sea Scallop RSA program.

Appendix C

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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Submitted to:
Sea Scallop Fishing Industry

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MARINE ADVISORY SERVICES

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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
MAB	201801073	38	22.71	74	3.01	200	11.78	2.00	0.0384	53
MAB	201801074	38	24.04	73	56.41	2237	119.14	27.00	0.4278	29
MAB	201801075	38	23.77	73	52.99	147	7.94	1.50	0.0281	13
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
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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
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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
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NLCA	201804039	40	20.64	69	7.61	1	0.03	0.10	0.0001	0
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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
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NLCA	201804076	40	28.83	69	3.30	710	51.47	13.50	0.1361	0
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NLCA	201804099	40	34.81	69	8.45	1480	149.43	25.50	0.2867	0
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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
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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
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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
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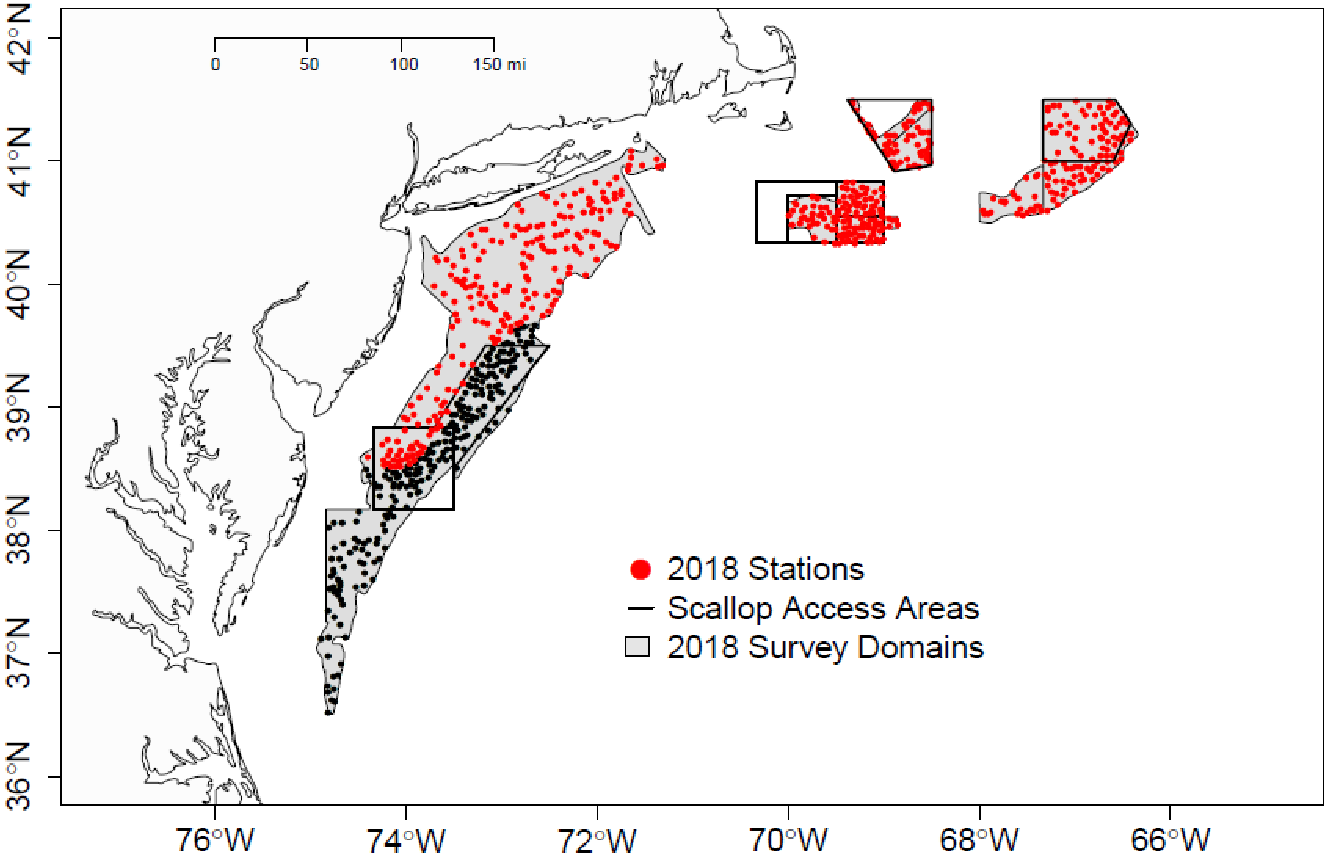

Figure 1. Survey domains with station locations for the VIMS/Industry cooperative surveys of the Mid-Atlantic sea scallop resource area, Nantucket Lightship Closed Area, Closed Area I, and Closed Area II completed during May-July 2018. Within the Mid-Atlantic survey domain, black dots represent the first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

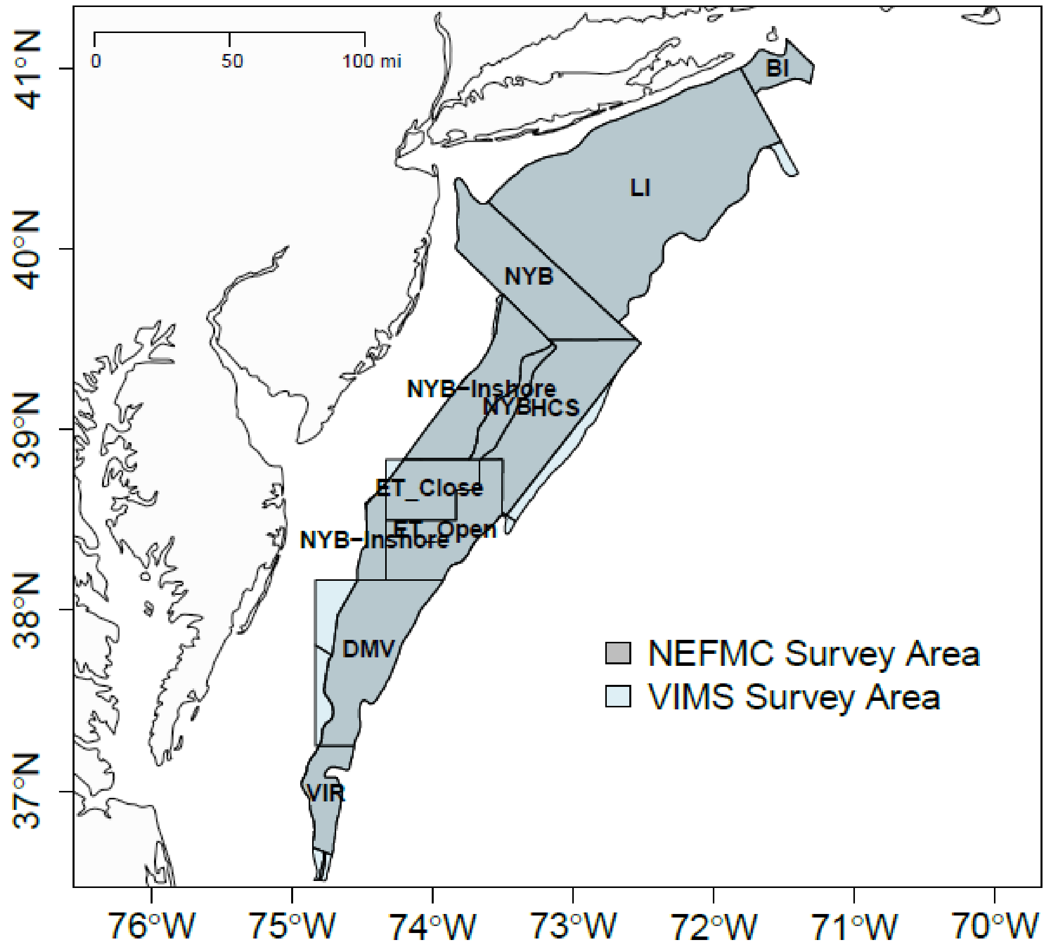

Figure 2. SAMS areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Mid-Atlantic sea scallop resource during May 2018.

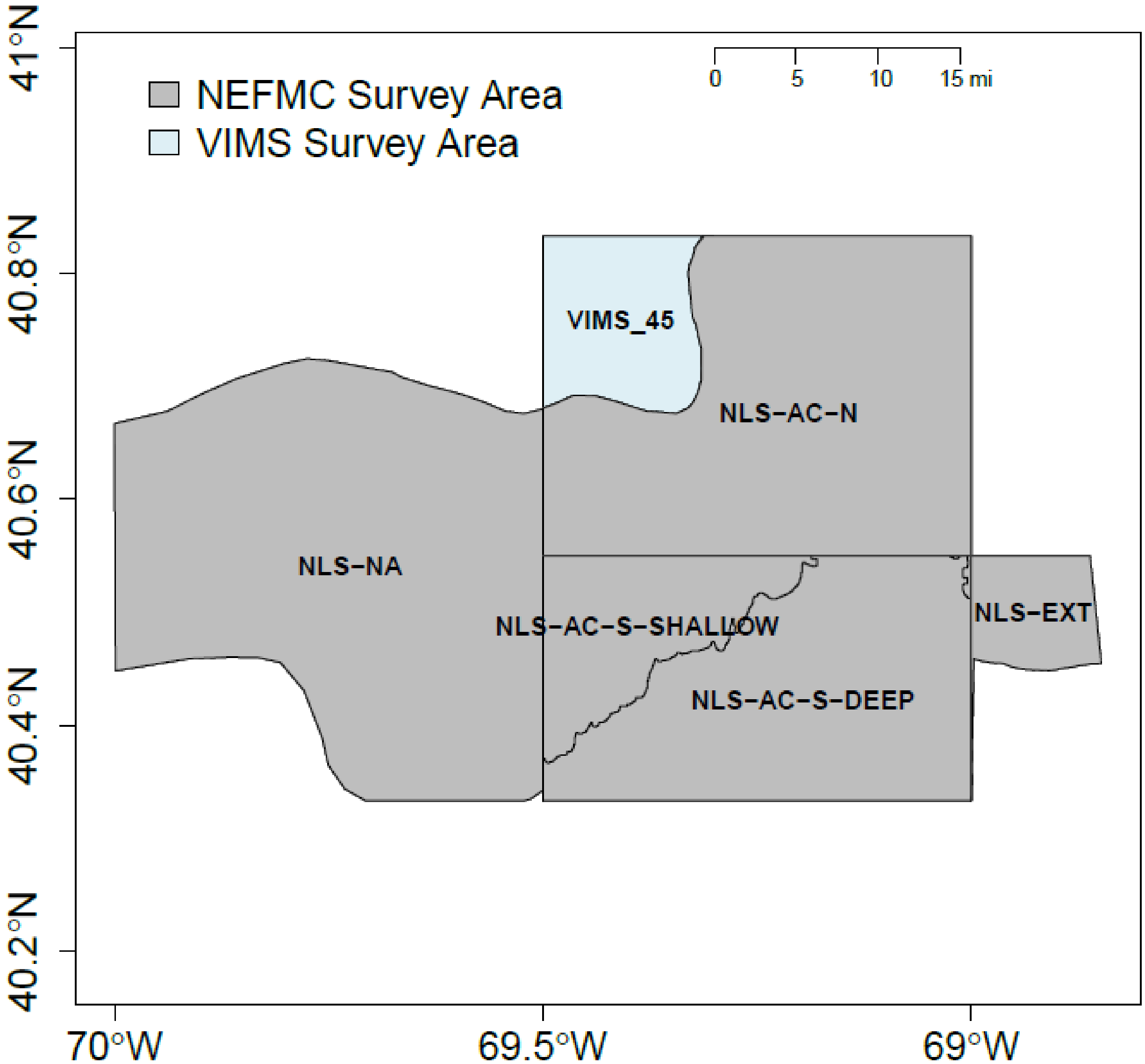

Figure 3. SAMS areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Nantucket Lightship access area and surrounds resource during July 2018.

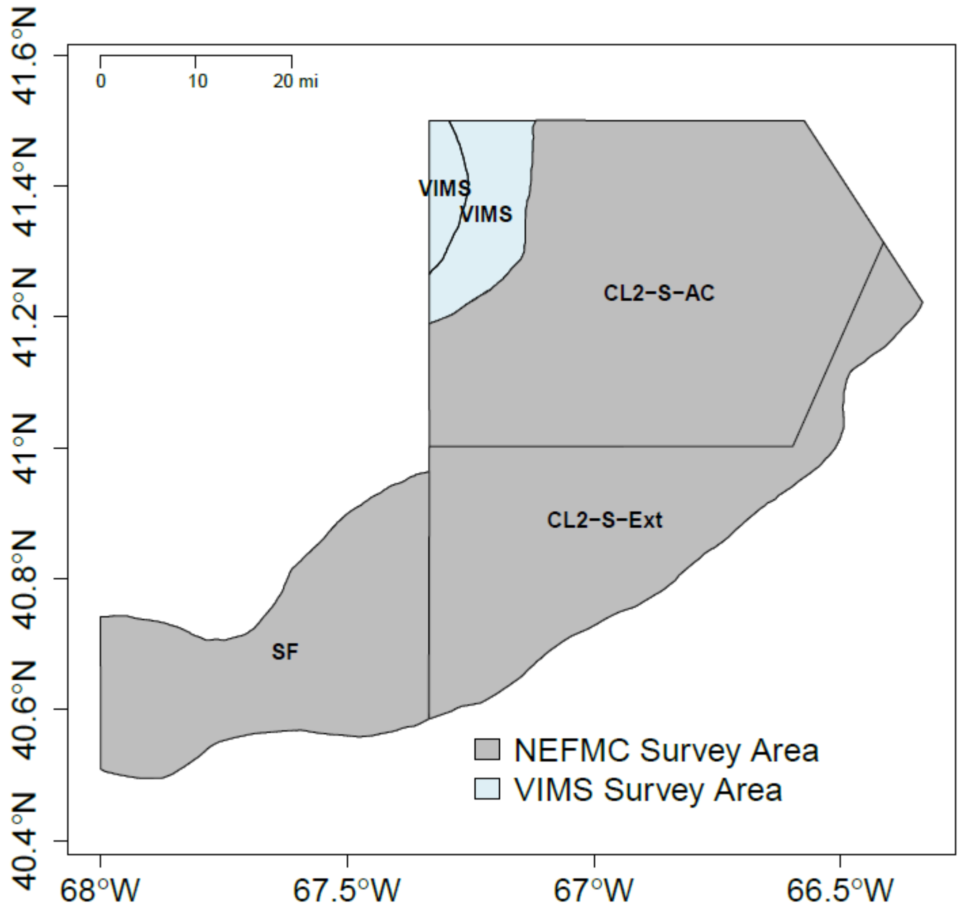

Figure 4. SAMS areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Closed Area II access area and open area along the southern flank during June 2018.

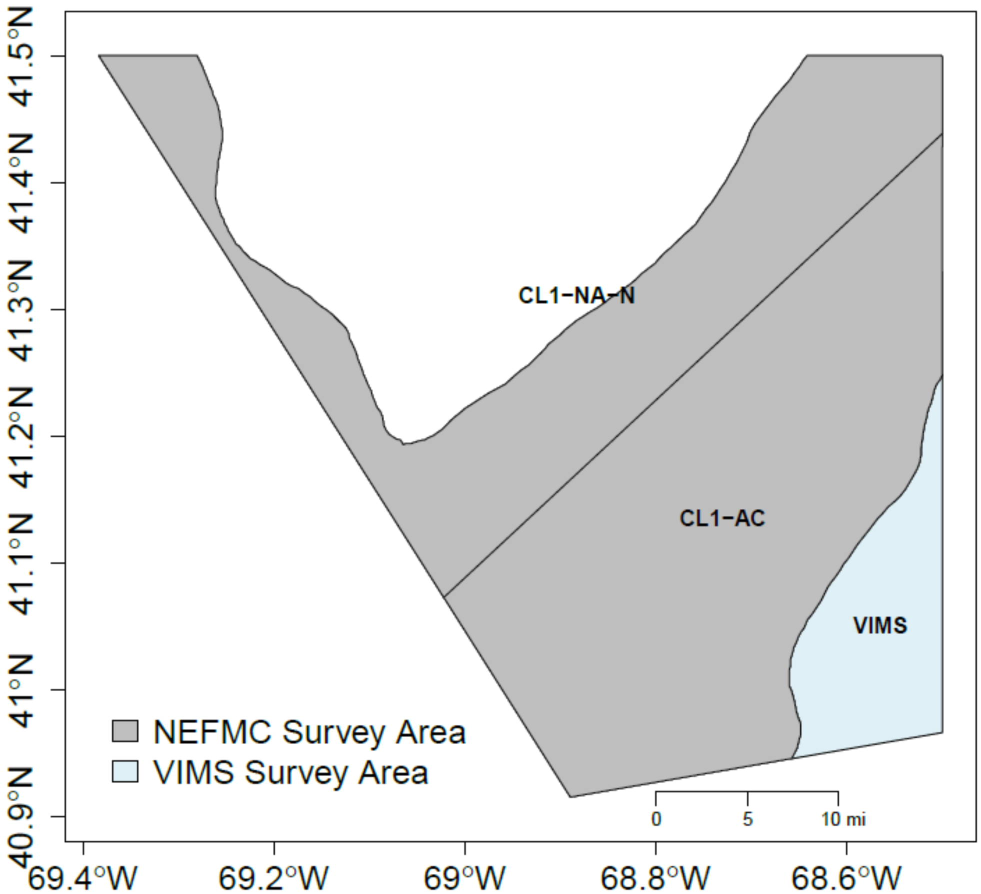

Figure 5. SAMS areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Closed Area I access area during June 2018.

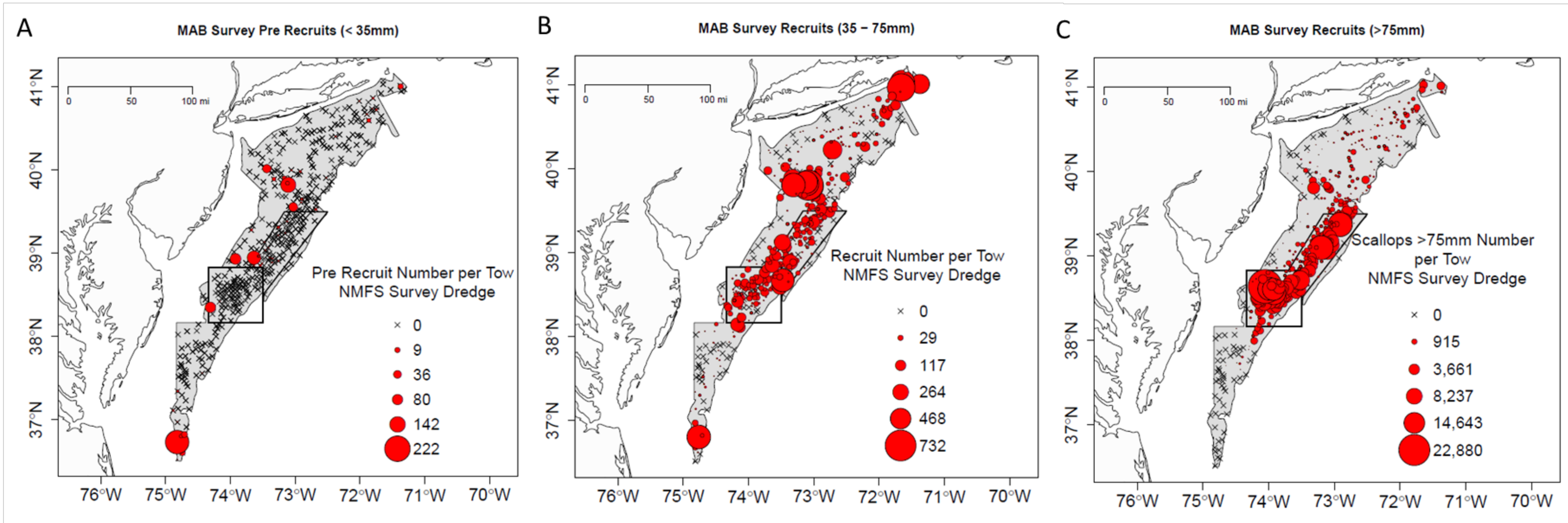

Figure 6. Number of scallops under 35 mm (A), 35-75 mm (B), and greater than 75 mm (C) caught in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Mid-Atlantic sea scallop resource during May 2018.

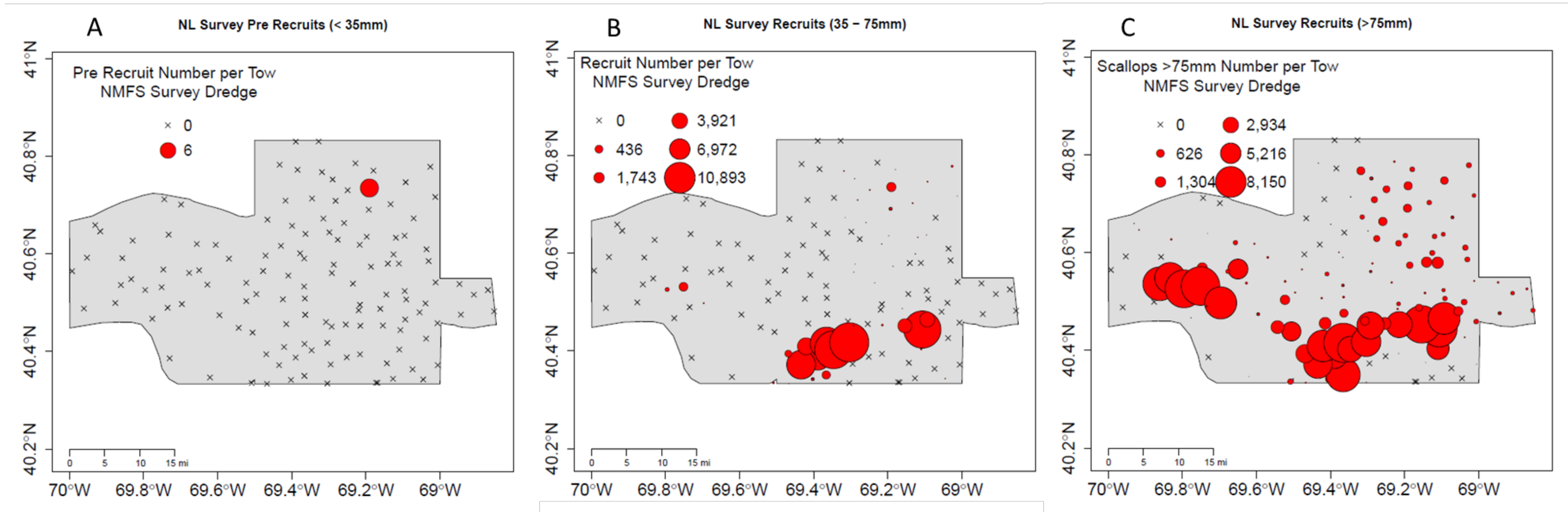

Figure 7. Number of scallops under 35 mm (A), 35-75 mm (B), and greater than 75 mm (C) caught in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Nantucket Lightship access area during July 2018.

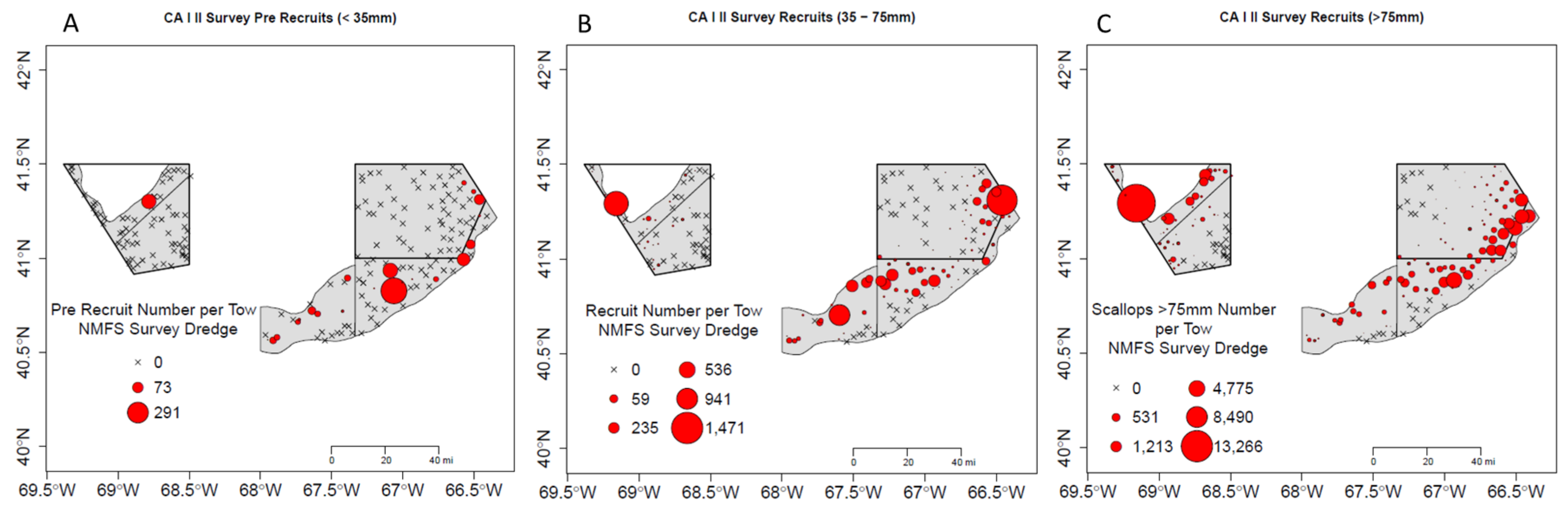

Figure 8. Number of scallops under 35 mm (A), 35-75 mm (B), and greater than 75 mm (C) caught in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Closed Area I and II access areas during June 2018.

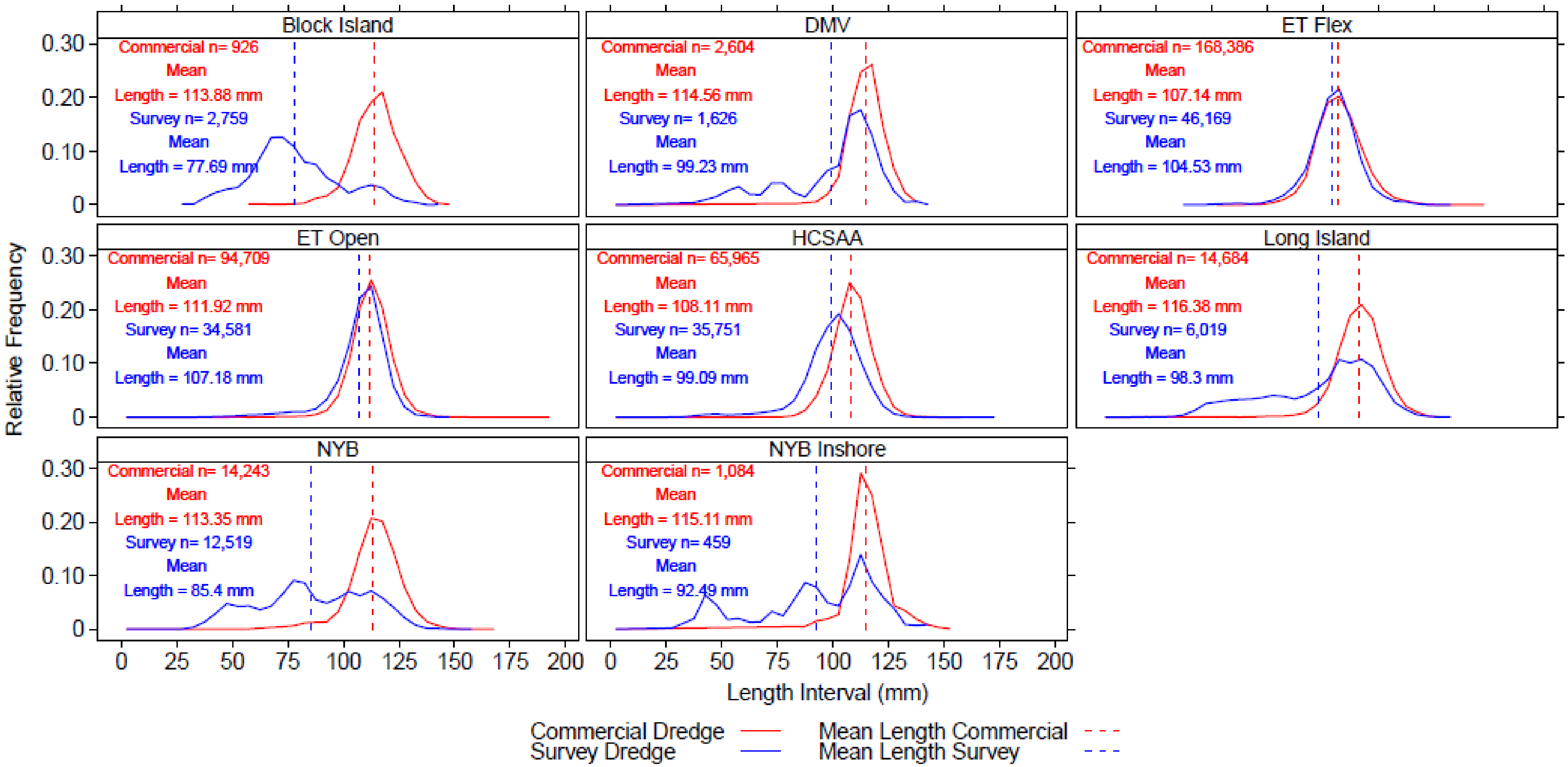

Figure 9. Scallop length frequency distributions generated from catch data obtained from both the survey and commercial dredges during the VIMS/Industry cooperative survey of the Mid-Atlantic sea scallop resource area in May 2018 by SAMS area. Number of scallops (n) measured and mean length by gear are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

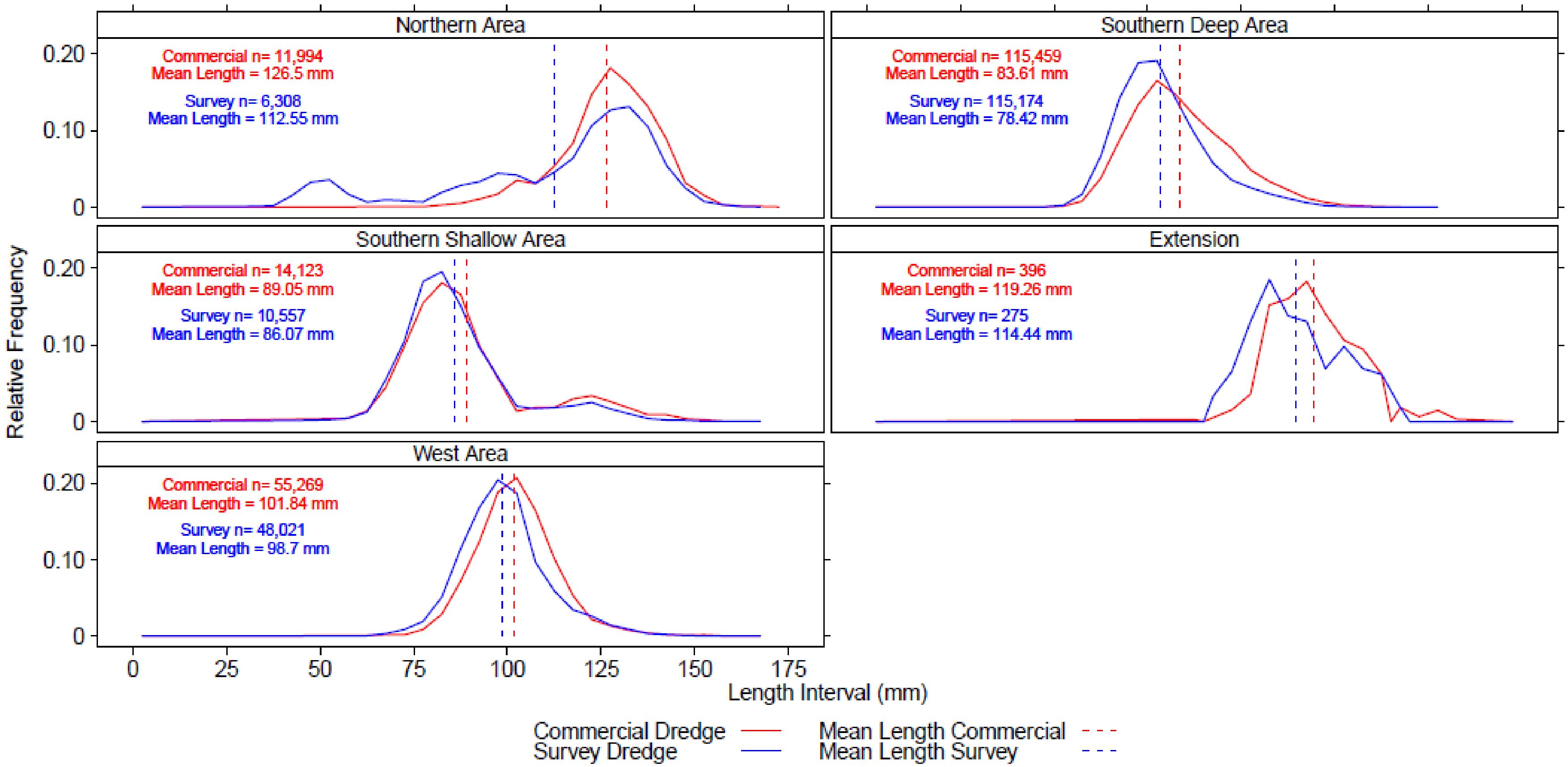

Figure 10. Scallop length frequency distributions generated from catch data obtained from both the survey and commercial dredges during the VIMS/Industry cooperative survey of the Nantucket Lightship access area and surrounds in July 2018 by SAMS area. Number of scallops (n) measured and mean length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

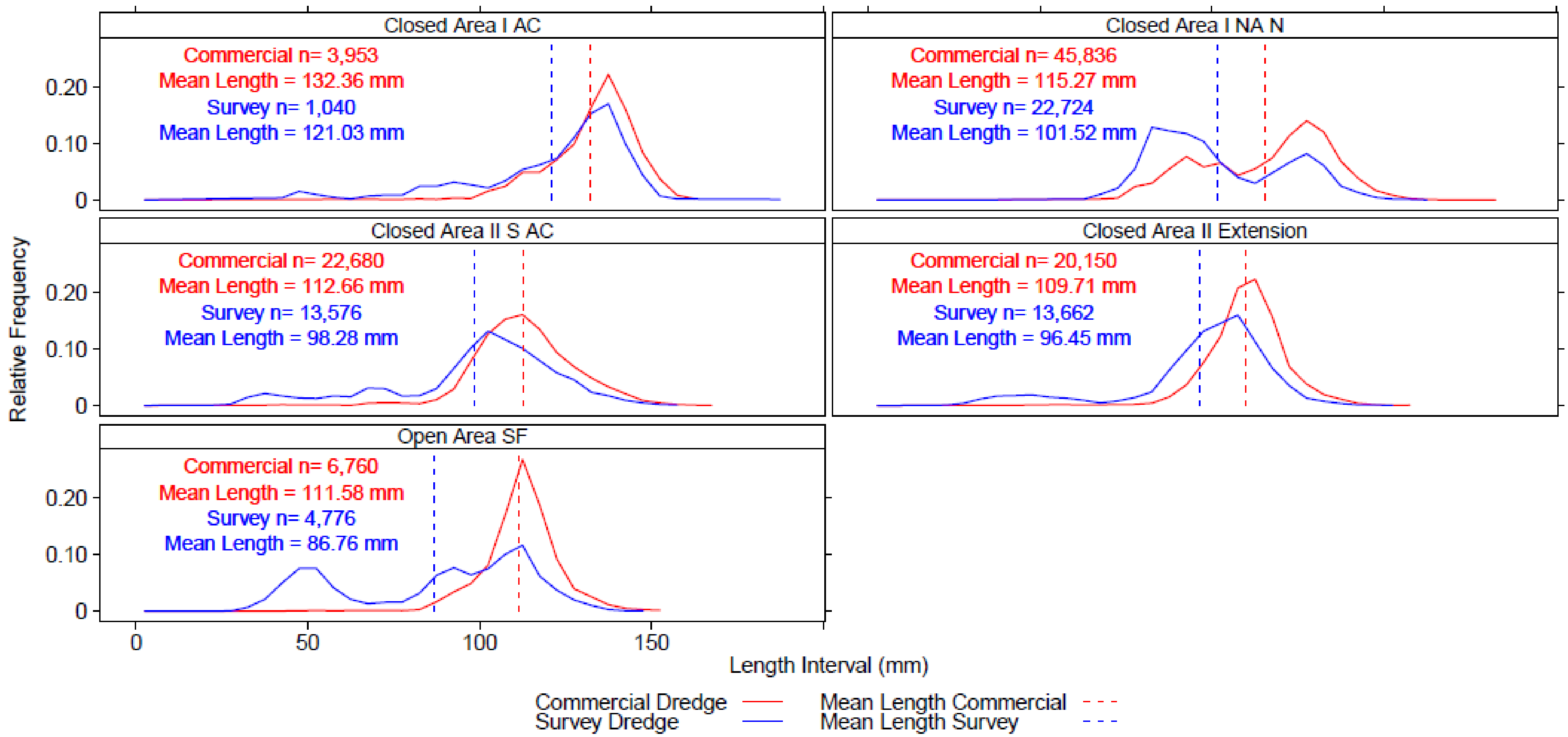

Figure 11. Scallop length frequency distributions generated from catch data obtained from both the survey and commercial dredges during the VIMS/Industry cooperative survey of the Closed Area I (top row) and Closed Area II (middle and bottom rows) in June 2018 by SAMS area. Number of scallops (n) measured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

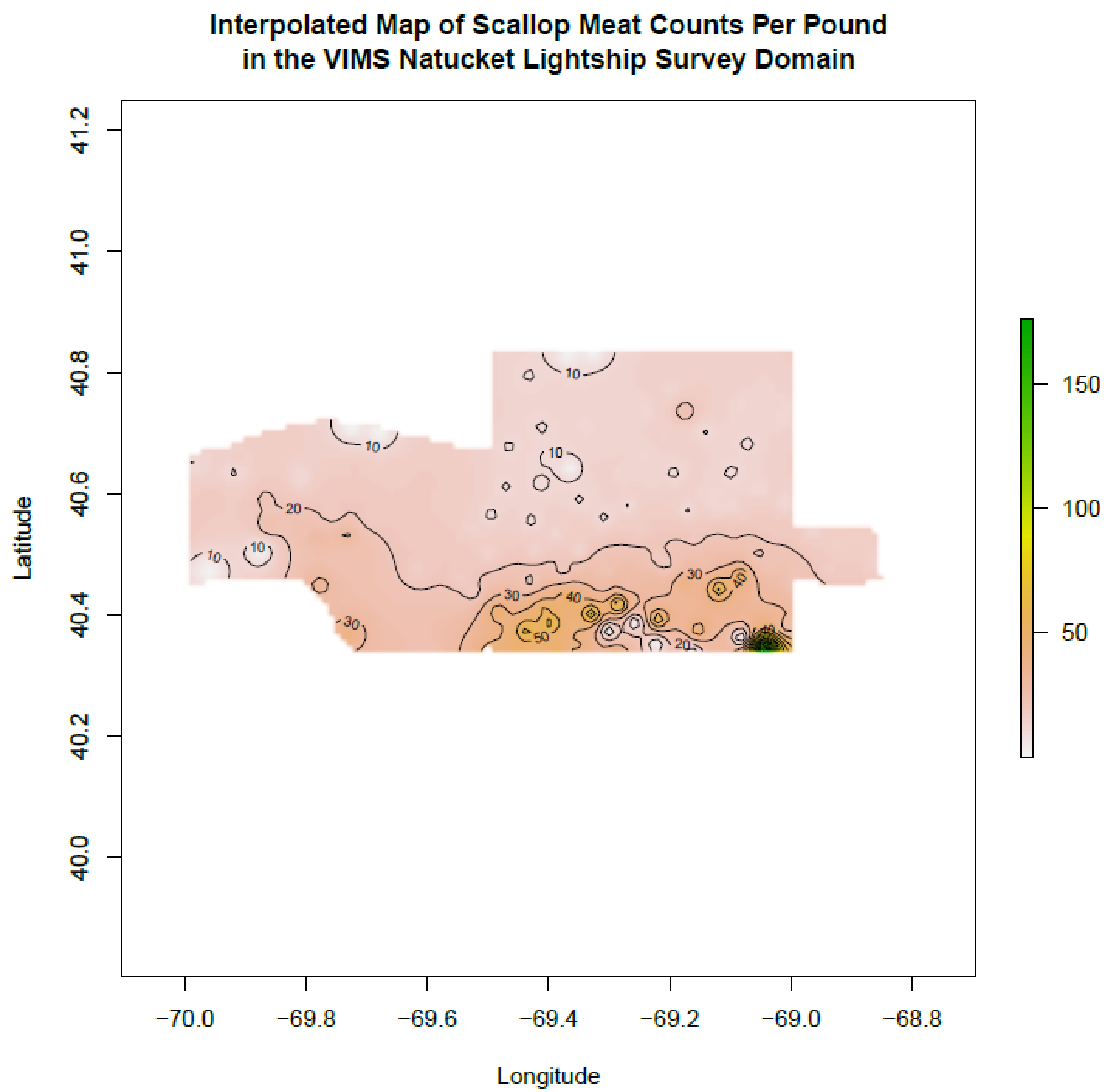

Figure 12. Estimated meat count (meats per pound) across the VIMS Nantucket Lightship survey domain.

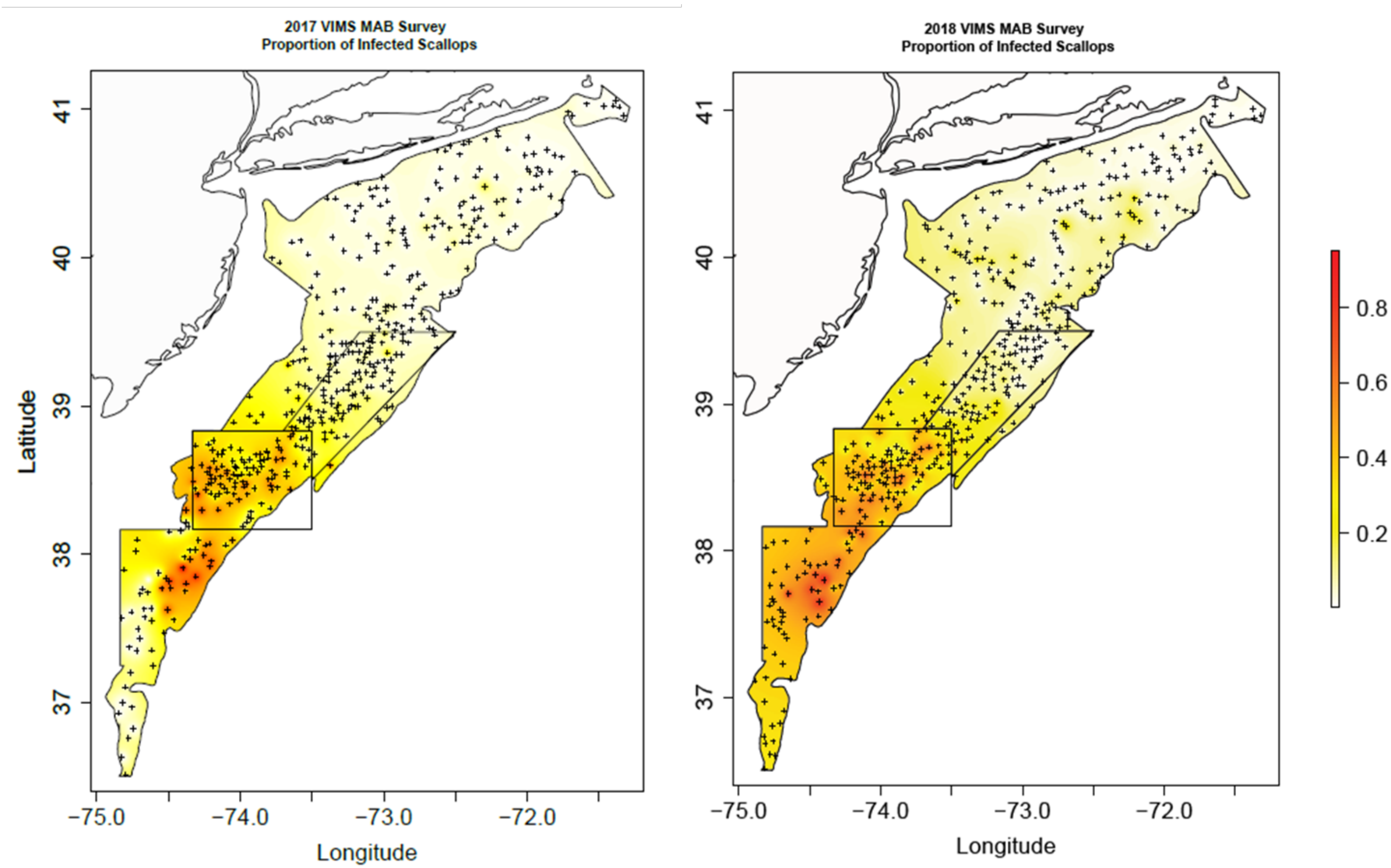

Figure 13. Spatial distribution of the prevalence of the nematode parasite in sampled scallops from 2017 and 2018 for the MAB resource area. Crosses indicate VIMS survey station locations.

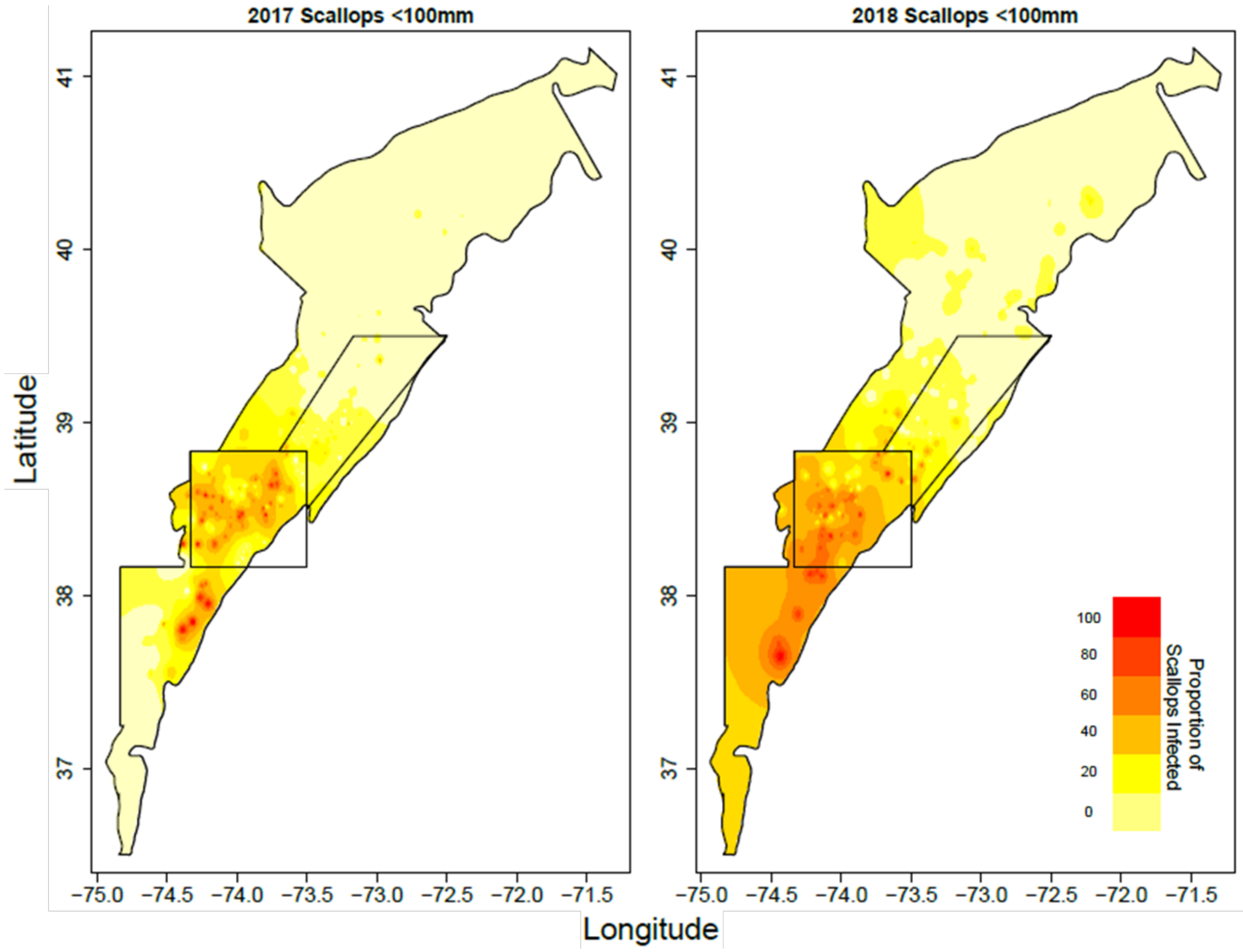

Figure 14. Spatial distribution of the prevalence of the nematode parasite in sampled scallops smaller than 100 mm in 2017 and 2018 for the MAB resource area.

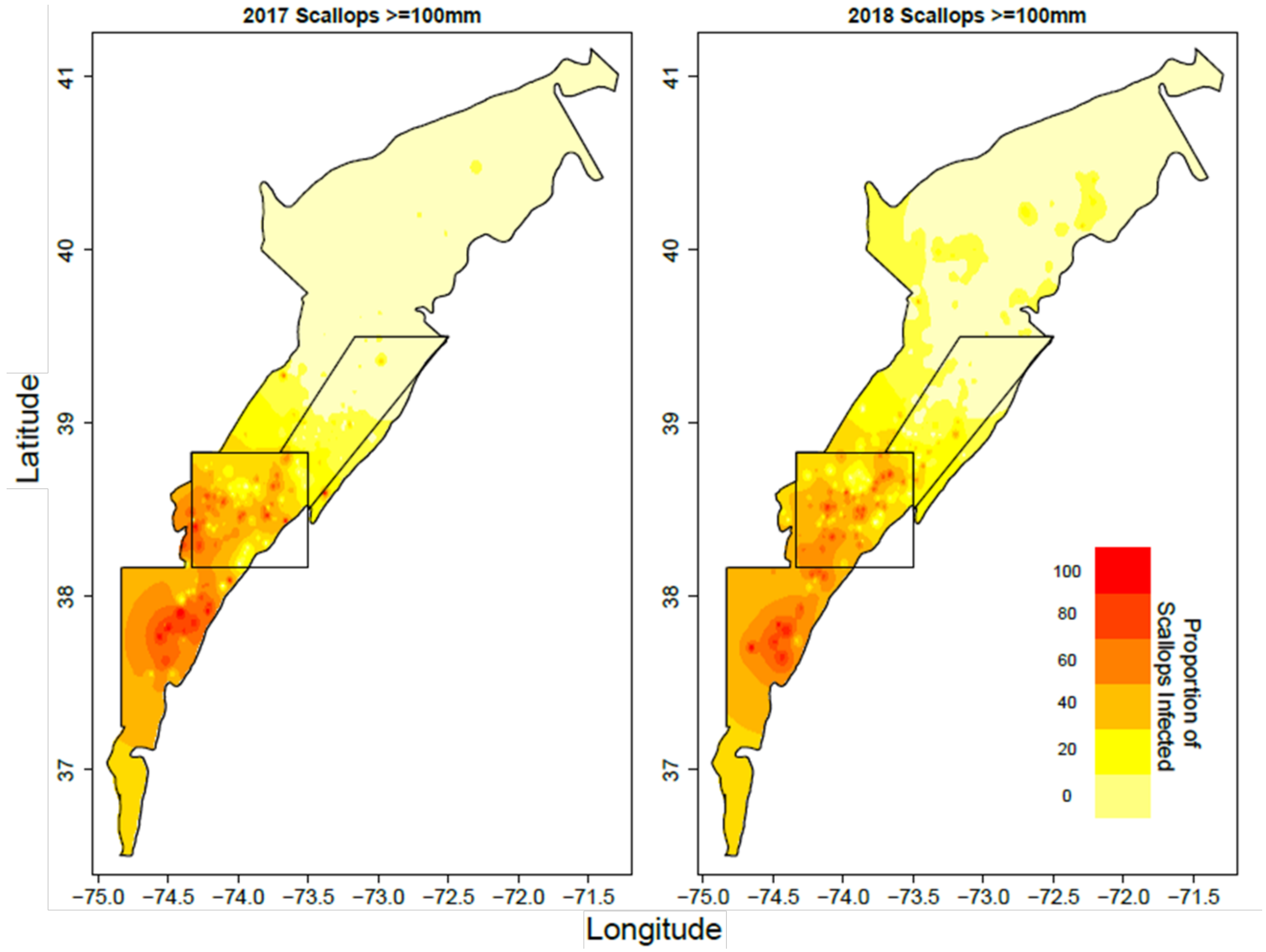

Figure 15. Spatial distribution of the prevalence of the nematode parasite in sampled scallops larger than 100 mm in 2017 and 2018 for the MAB resource area.

Appendix D

Results for the 2019 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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Submitted to:

Sea Scallop Fishing Industry

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VIMS Marine Resource Report No. 2019-7

VIMS | WILLIAM & MARY
VIRGINIA INSTITUTE OF MARINE SCIENCE
MARINE ADVISORY PROGRAM

September 19, 2019

The Virginia Institute of Marine Science (VIMS) conducted high resolution sea scallop dredge surveys of the entire Mid-Atlantic (MAB), the Nantucket Lightship (NLCA), Closed Area I (CAI), and Closed Area II (CAII) during May–July 2019. These surveys were funded by the Sea Scallop Research Set-Aside Program (RSA). Exploitable biomass for each survey is shown in Table 1 for each spatially explicit SAMS Area (Scallop Area Management Simulator). 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. Maps of SAMS Areas are provided in Figures 1-5. At the time of the surveys, exploitable biomass estimated from the commercial dredge was 18,884 mt or 41.6 million pounds for the Open Elephant Truck (ET-Open) SAMS Area and 18,691 mt or 41.2 million pounds in the Elephant Trunk Flex (ET-Flex) SAMS Area. For open bottom in the Long Island (LI) SAMS Area, exploitable biomass was estimated at 9,437 mt or 20.8 million pounds. In the western NLCA SAMS Area (NLS-West), the exploitable biomass was 1,052 mt or 2.3 million pounds.

The MAB survey was conducted aboard two commercial vessels: *F/V Italian Princess* and *F/V Carolina Capes II* during May 2019. Each vessel completed one survey leg and occupied a total of 450 stations throughout the MAB survey area. The CAI and CAII survey was conducted onboard the *F/V Polaris* in May 2019 and a total of 200 stations were completed. The *F/V Socatean* conducted the NLCA survey during July 2019 and occupied a total of 135 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 13- or 14-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 as this information is more applicable to the resource conditions that the industry is likely to encounter. Dredge data were obtained during 15-minute survey tows at 3.8–4.0 kts with a 3:1 scope (Table 2).

Catch data in tabular form is shown in Table 2. The density and number of scallops caught in three size classes ($<$35 mm, 35–75 mm, and $>$75 mm) 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 are shown.

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 determine the prevalence and intensity of a parasitic nematode observed in the scallop meat. Infected scallops typically present with rust colored lesions on the exterior of the adductor muscle, often 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 1–11. The spatial distribution of the nematode prevalence (percent of sampled scallops at a given station with at least one lesion) by year is shown in Figure 12. In 2019, the prevalence of nematodes declined compared to previous survey years, with high numbers of infected scallops present in only the ET-Open and ET-Flex SAMS Areas.

Table 1: Exploitable biomass for scallops captured in the commercial dredges during the VIMS/Industry cooperative surveys by survey and SAMS Area during May–August 2019.

Survey	SAMS Area	Exploitable Biomass (mt)	95% CI Lower Bound	95% CI Upper Bound
MAB	BI	705.68	454.43	956.93
	DMV	173.98	42.68	305.28
	ET_Flex	18,691.29	13,434.55	23,948.03
	ET_Open	18,883.50	16,065.23	21,701.77
	HCS	10,986.92	8,786.19	13,187.65
	LI	9,437.00	8,364.96	10,509.04
	MAB_Nearshore	861.19	483.44	1,238.94
	NYB	3,880.14	3,361.35	4,398.93
	VIR	0.00	0.00	0.00
NL	NLS_North	4,030.00	3,385.16	4,674.84
	NLS_South_Deep	2,279.00	1,483.24	3,074.76
	NLS_South_Shallow	356.00	167.84	544.16
	NLS_West	1,052.00	456.16	1,647.84
	VIMS_45	37.00	0.00	78.16
CA I II	CAI_Access	957.27	690.74	1,223.80
	CAI_Sliver	6,438.48	4,327.59	8,549.37
	CAII_Access	9,690.29	8,087.19	11,293.39
	CAII_Ext	3,258.13	2,304.57	4,211.69
	SF	4,193.63	2,813.64	5,573.62

Table 2: Catch data for the commercial dredges from the VIMS/Industry cooperative surveys completed during May–August 2019. Nematode prevalence (percentage 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 (m2)	Nematode Prevalence
MAB	201905001	36	39.87	74	45.00	0	0.00	0.00	0.00	0
MAB	201905002	37	1.07	74	43.90	0	0.00	0.00	0.00	0
MAB	201905003	37	2.04	74	54.02	0	0.00	0.00	0.00	0
MAB	201905004	37	4.91	74	53.05	0	0.00	0.00	0.00	0
MAB	201905005	37	4.38	74	43.58	0	0.00	0.00	0.00	0
MAB	201905006	37	10.23	74	35.74	0	0.00	0.00	0.00	0
MAB	201905007	37	14.96	74	41.09	0	0.00	0.00	0.00	0
MAB	201905008	37	14.84	74	45.25	0	0.00	0.00	0.00	0
MAB	201905009	37	17.42	74	44.74	0	0.00	0.00	0.00	0
MAB	201905010	37	22.43	74	43.01	0	0.00	0.00	0.00	0
MAB	201905011	37	26.63	74	32.95	0	0.00	0.00	0.00	0
MAB	201905012	37	29.57	74	39.77	0	0.00	0.00	0.00	0
MAB	201905013	37	31.11	74	45.59	0	0.00	0.10	0.00	0
MAB	201905014	37	33.57	74	42.84	0	0.00	0.00	0.00	0
MAB	201905015	37	36.33	74	48.76	0	0.00	0.00	0.00	0
MAB	201905016	37	38.52	74	44.24	0	0.00	0.00	0.00	0
MAB	201905017	37	41.91	74	37.14	0	0.00	0.00	0.00	0
MAB	201905018	37	41.62	74	35.69	0	0.00	0.00	0.00	0
MAB	201905019	37	40.77	74	33.10	0	0.00	0.00	0.00	0
MAB	201905020	37	38.99	74	33.47	0	0.00	0.00	0.00	0
MAB	201905021	37	38.57	74	27.78	0	0.00	0.00	0.00	0
MAB	201905022	37	36.34	74	20.03	0	0.00	0.00	0.00	0
MAB	201905023	37	39.81	74	24.31	0	0.00	0.00	0.00	0
MAB	201905024	37	41.16	74	21.00	0	0.00	0.00	0.00	0
MAB	201905025	37	46.06	74	28.61	0	0.00	0.00	0.00	0
MAB	201905026	37	46.36	74	35.71	0	0.00	0.00	0.00	0
MAB	201905027	37	49.79	74	47.31	0	0.00	0.00	0.00	0
MAB	201905028	37	55.10	74	38.01	0	0.00	0.00	0.00	0
MAB	201905029	37	50.93	74	31.55	0	0.00	0.00	0.00	0
MAB	201905030	37	52.40	74	25.64	0	0.00	0.00	0.00	0
MAB	201905031	37	51.90	74	15.54	4	0.25	0.10	0.00	0
MAB	201905032	37	54.66	74	21.95	1	0.06	0.10	0.00	0
MAB	201905034	37	59.40	74	15.14	118	7.13	1.10	0.03	27
MAB	201905035	37	59.19	74	16.74	2	0.14	0.10	0.00	100
MAB	201905036	37	58.00	74	32.79	1	0.06	0.10	0.00	100
MAB	201905037	37	58.78	74	36.14	0	0.00	0.00	0.00	0
MAB	201905038	38	0.61	74	39.37	0	0.00	0.00	0.00	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201905039	38	6.19	74	45.00	0	0.00	0.00	0.00	0
MAB	201905040	38	5.67	74	25.81	0	0.00	0.00	0.00	0
MAB	201905041	38	7.64	74	23.61	0	0.00	0.00	0.00	0
MAB	201905042	38	9.71	74	20.74	3	0.21	0.10	0.00	67
MAB	201905044	38	11.54	74	15.02	11	0.58	0.20	0.00	0
MAB	201905045	38	8.01	74	4.67	143	7.94	1.50	0.03	7
MAB	201905046	38	14.13	74	1.64	2	0.14	0.10	0.00	0
MAB	201905048	38	14.46	73	56.72	1357	84.44	13.75	0.38	0
MAB	201905049	38	16.80	73	57.18	95	5.73	1.25	0.02	0
MAB	201905050	38	20.53	74	0.20	70	4.47	1.00	0.02	0
MAB	201905051	38	22.19	74	7.56	1500	96.22	17.00	0.36	0
MAB	201905052	38	19.65	74	15.59	457	28.60	5.00	0.10	13
MAB	201905054	38	21.15	74	18.84	2	0.17	0.10	0.00	50
MAB	201905055	38	21.73	74	13.14	518	33.80	6.00	0.13	20
MAB	201905056	38	23.60	74	11.69	1372	79.93	22.00	0.33	27
MAB	201905057	38	24.58	74	8.90	1391	91.25	17.00	0.34	33
MAB	201905058	38	24.25	74	5.71	710	41.14	9.25	0.15	53
MAB	201905059	38	24.22	74	4.36	5002	292.29	56.00	1.21	47
MAB	201905060	38	24.39	74	2.06	3951	256.61	46.00	0.96	13
MAB	201905061	38	26.44	74	3.68	8258	487.23	84.00	2.28	19
MAB	201905062	38	27.08	74	8.10	444	29.16	5.50	0.10	44
MAB	201905063	38	25.79	74	12.75	377	27.08	4.00	0.08	23
MAB	201905064	38	28.08	74	19.53	15	1.01	0.10	0.00	56
MAB	201905065	38	28.79	74	17.26	6	0.41	0.10	0.00	0
MAB	201905066	38	27.93	74	13.20	1646	116.79	21.00	0.40	33
MAB	201905067	38	29.36	74	10.60	124	7.97	1.20	0.03	57
MAB	201905069	38	28.64	74	6.08	3972	240.75	40.00	0.85	39
MAB	201905070	38	28.81	74	3.83	4340	265.30	52.00	0.93	33
MAB	201905071	38	27.73	74	0.47	4365	272.10	58.00	1.20	60
MAB	201905072	38	26.74	74	0.02	2789	166.49	36.00	0.67	40
MAB	201905073	38	28.49	73	58.35	5142	327.21	60.00	1.24	40
MAB	201905074	38	29.52	74	1.38	3319	200.17	38.00	0.71	14
MAB	201905075	38	31.16	73	55.78	5620	348.12	64.00	1.21	43
MAB	201905076	38	31.81	73	58.70	6682	379.03	66.00	1.29	33
MAB	201905077	38	31.20	74	2.82	3246	174.86	62.00	0.78	53
MAB	201905078	38	32.58	74	5.26	173	11.03	2.00	0.04	39
MAB	201905079	38	31.89	74	7.47	624	43.47	12.00	0.13	23
MAB	201905080	38	32.05	74	12.06	140	10.82	2.00	0.03	50
MAB	201905081	38	31.77	74	22.44	4	0.28	0.10	0.00	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201905082	38	33.10	74	20.77	2	0.14	0.10	0.00	0
MAB	201905083	38	32.87	74	16.70	28	2.60	0.50	0.01	0
MAB	201905085	38	33.47	74	13.61	126	10.49	1.75	0.03	37
MAB	201905087	38	33.27	74	9.37	422	31.75	7.00	0.09	7
MAB	201905088	38	33.91	74	7.53	153	14.75	2.00	0.03	53
MAB	201905089	38	34.49	74	11.49	212	19.30	2.50	0.05	20
MAB	201905090	38	35.09	74	14.53	90	8.35	1.10	0.02	20
MAB	201905092	38	36.35	74	9.66	239	19.71	2.50	0.05	20
MAB	201905093	38	36.65	74	8.21	1023	89.50	13.50	0.22	7
MAB	201905095	38	35.09	74	4.73	2751	219.05	29.00	0.67	13
MAB	201905096	38	35.31	74	3.51	7790	544.03	80.00	1.88	30
MAB	201905097	38	35.00	74	0.84	10122	726.47	90.00	2.80	27
MAB	201905098	38	34.14	73	58.83	11914	866.09	115.00	2.88	37
MAB	201905099	38	34.30	73	56.39	3070	214.44	32.00	0.74	40
MAB	201905100	38	35.38	73	51.58	7201	474.32	90.00	1.74	71
MAB	201905101	38	34.66	73	47.25	2339	156.81	42.00	0.57	0
MAB	201905102	38	35.24	73	44.30	3766	298.75	42.00	0.91	73
MAB	201905103	38	38.64	73	43.92	2040	152.11	25.00	0.56	47
MAB	201905104	38	39.87	73	43.42	1387	108.32	21.00	0.33	57
MAB	201905105	38	40.82	73	40.25	1489	117.61	20.00	0.36	50
MAB	201905106	38	40.38	73	46.03	385	28.45	4.50	0.09	33
MAB	201905107	38	39.48	73	49.29	320	28.82	3.25	0.08	33
MAB	201905108	38	38.27	73	53.54	485	40.92	6.00	0.13	31
MAB	201905109	38	37.77	73	57.85	7365	548.14	77.00	2.04	21
MAB	201905110	38	37.64	74	0.32	6289	403.48	78.00	1.73	27
MAB	201905111	38	37.73	74	5.75	1541	102.95	20.00	0.33	0
MAB	201905112	38	39.06	74	3.41	9616	678.59	96.00	2.33	27
MAB	201905113	38	39.98	74	1.48	4103	263.12	46.00	0.99	0
MAB	201905114	38	39.23	73	56.41	336	24.76	4.00	0.08	27
MAB	201905115	38	40.22	73	56.02	177	12.71	2.00	0.04	7
MAB	201905116	38	41.85	73	51.19	272	20.07	3.50	0.07	23
MAB	201905117	38	41.54	73	46.98	422	32.41	6.50	0.09	0
MAB	201905118	38	44.41	73	49.94	156	11.98	2.10	0.04	13
MAB	201905119	38	46.11	73	45.52	143	10.81	2.10	0.03	7
MAB	201905120	38	47.86	73	40.59	179	13.09	3.00	0.04	0
MAB	201905121	38	46.00	73	35.01	719	52.33	10.00	0.17	0
MAB	201905122	38	48.56	73	32.40	438	32.50	6.75	0.12	0
MAB	201905123	38	49.14	73	35.30	208	14.80	3.00	0.04	13
MAB	201905124	38	49.42	73	37.99	407	30.33	6.25	0.10	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201905125	38	51.27	73	36.01	393	29.14	5.00	0.08	0
MAB	201905126	38	52.58	73	37.78	204	16.38	2.50	0.05	0
MAB	201905128	38	53.48	73	32.77	239	18.36	3.00	0.05	0
MAB	201905130	38	51.75	73	29.11	274	18.62	3.50	0.08	33
MAB	201905131	38	52.29	73	27.77	348	24.50	4.50	0.10	25
MAB	201905132	38	55.10	73	24.75	345	20.70	3.70	0.10	7
MAB	201905133	38	55.99	73	27.58	277	19.06	3.20	0.07	0
MAB	201905134	38	55.97	73	30.95	161	11.86	1.90	0.03	7
MAB	201905135	38	58.68	73	31.27	127	9.19	1.80	0.04	20
MAB	201905136	39	1.16	73	31.32	173	11.96	2.00	0.04	0
MAB	201905137	39	0.84	73	27.44	241	17.63	2.90	0.06	13
MAB	201905138	38	59.25	73	23.78	580	36.01	6.20	0.14	20
MAB	201905139	39	2.65	73	23.35	264	16.69	2.90	0.06	7
MAB	201905140	39	3.25	73	27.90	197	14.28	2.50	0.05	7
MAB	201905141	39	4.77	73	26.46	214	15.66	2.90	0.06	13
MAB	201905142	39	5.26	73	23.67	205	13.22	2.50	0.05	7
MAB	201905143	39	4.16	73	21.31	257	16.64	2.80	0.06	7
MAB	201905144	39	5.63	73	19.02	506	31.87	5.50	0.11	27
MAB	201905145	39	6.00	73	15.12	280	16.77	3.00	0.07	7
MAB	201905146	39	8.57	73	14.83	211	14.13	2.80	0.05	13
MAB	201905147	39	8.82	73	18.10	77	4.95	1.00	0.02	0
MAB	201905148	39	9.01	73	20.54	224	14.87	2.50	0.05	20
MAB	201905149	39	9.28	73	24.84	205	13.72	2.60	0.04	0
MAB	201905150	39	12.98	73	22.37	85	6.30	1.10	0.02	0
MAB	201905151	39	11.54	73	16.09	193	12.51	2.50	0.05	33
MAB	201905152	39	11.45	73	10.28	912	52.51	9.50	0.22	13
MAB	201905153	39	12.80	73	12.75	204	12.99	3.00	0.05	0
MAB	201905154	39	13.82	73	16.10	274	18.59	4.00	0.06	7
MAB	201905155	39	14.65	73	17.82	425	28.32	4.75	0.10	0
MAB	201905156	39	16.84	73	16.40	261	18.40	4.00	0.06	0
MAB	201905157	39	16.96	73	12.20	38	2.45	0.75	0.01	7
MAB	201905158	39	18.75	73	10.67	127	8.10	2.00	0.03	0
MAB	201905159	39	18.87	73	3.18	472	26.31	6.50	0.10	0
MAB	201905160	39	19.85	72	59.59	643	33.06	8.00	0.14	0
MAB	201905161	39	20.56	73	6.75	132	8.99	2.00	0.03	0
MAB	201905162	39	22.42	73	8.87	345	22.06	4.00	0.08	0
MAB	201905163	39	23.36	73	13.53	120	8.10	1.50	0.03	0
MAB	201905164	39	24.60	73	10.62	41	2.66	0.50	0.01	0
MAB	201905165	39	25.08	73	5.69	129	8.09	1.75	0.03	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201905166	39	26.65	73	3.50	260	16.65	3.10	0.06	7
MAB	201905167	39	29.33	73	4.27	264	16.96	3.00	0.06	0
MAB	201905168	39	29.49	73	0.91	252	17.34	3.00	0.07	7
MAB	201905169	39	28.11	72	58.53	350	21.62	3.80	0.08	0
MAB	201905170	39	27.84	72	49.43	614	34.29	6.20	0.15	7
MAB	201905171	39	30.16	72	48.48	311	17.35	3.00	0.08	0
MAB	201905172	39	29.40	72	45.98	431	23.28	5.00	0.08	7
MAB	201905173	39	26.26	72	42.34	5	0.24	0.10	0.00	0
MAB	201905174	39	24.88	72	52.65	234	10.70	2.90	0.05	0
MAB	201905175	39	25.50	72	58.57	349	22.08	4.00	0.08	0
MAB	201905176	39	23.90	72	57.13	351	21.35	4.00	0.07	7
MAB	201905177	39	22.52	72	51.54	153	6.19	2.00	0.03	0
MAB	201905178	39	21.33	72	54.73	6026	297.58	68.00	1.17	0
MAB	201905179	39	18.68	72	48.49	12	0.60	0.10	0.00	0
MAB	201905180	39	15.92	72	54.26	9	0.43	0.10	0.00	0
MAB	201905181	39	16.57	72	57.37	230	11.48	3.00	0.05	0
MAB	201905182	39	15.29	73	2.08	1715	85.11	17.50	0.47	0
MAB	201905183	39	14.27	73	4.12	1516	76.85	17.00	0.33	0
MAB	201905184	39	14.28	72	57.41	12	0.58	0.10	0.00	0
MAB	201905185	39	11.95	72	59.96	359	19.62	4.00	0.08	20
MAB	201905186	39	9.33	73	2.60	4230	224.11	45.00	0.91	0
MAB	201905187	39	9.97	73	4.69	929	50.66	13.00	0.22	7
MAB	201905188	39	9.38	73	10.57	1338	80.45	15.00	0.37	7
MAB	201905189	39	6.80	73	10.77	3381	176.63	37.00	0.81	0
MAB	201905190	39	6.02	73	5.11	32	1.52	0.50	0.01	7
MAB	201905191	39	5.61	73	2.44	7	0.39	0.10	0.00	7
MAB	201905192	39	3.71	73	9.79	1107	53.57	13.50	0.31	0
MAB	201905193	39	3.95	73	13.36	4011	199.09	44.00	0.97	0
MAB	201905194	39	4.02	73	15.53	1813	103.79	22.00	0.44	0
MAB	201905195	39	2.64	73	17.85	1882	110.11	24.00	0.52	0
MAB	201905196	38	59.59	73	17.44	511	30.25	7.00	0.12	0
MAB	201905197	39	0.13	73	15.18	75	4.19	1.00	0.02	13
MAB	201905198	39	0.05	73	12.38	84	4.35	1.00	0.02	0
MAB	201905199	38	59.98	73	9.15	5	0.27	0.10	0.00	0
MAB	201905200	38	57.43	73	14.24	1	0.04	0.10	0.00	0
MAB	201905201	38	56.87	73	21.04	616	36.15	7.00	0.15	19
MAB	201905202	38	52.20	73	23.27	1146	68.56	16.00	0.25	33
MAB	201905203	38	49.90	73	21.34	686	37.26	9.00	0.15	0
MAB	201905205	38	49.03	73	14.58	19	0.89	0.30	0.00	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201905206	38	47.33	73	21.77	243	12.69	4.00	0.06	0
MAB	201905207	38	48.42	73	27.43	2691	156.89	31.00	0.65	27
MAB	201905208	38	44.28	73	25.87	145	8.32	2.00	0.04	14
MAB	201905209	38	43.58	73	28.85	1116	69.98	14.00	0.27	7
MAB	201905210	38	44.67	73	31.91	2286	139.28	28.00	0.55	0
MAB	201905211	38	43.44	73	34.97	636	41.83	16.00	0.14	20
MAB	201905212	38	40.93	73	27.17	581	31.35	10.00	0.11	0
MAB	201905213	38	40.04	73	28.73	941	52.82	11.00	0.26	7
MAB	201905214	38	39.57	73	32.27	1121	71.70	15.00	0.24	7
MAB	201905215	38	38.07	73	34.04	912	57.67	12.00	0.22	0
MAB	201905216	38	37.52	73	37.37	935	63.37	13.00	0.26	31
MAB	201905218	38	32.82	73	40.22	1034	68.51	14.00	0.25	50
MAB	201905220	38	31.10	73	39.66	1434	83.23	17.00	0.40	33
MAB	201905221	38	31.16	73	39.91	1448	85.59	18.00	0.40	0
MAB	201905222	38	31.81	73	42.21	1270	87.33	17.00	0.31	20
MAB	201905223	38	32.32	73	45.03	2010	141.87	27.00	0.49	60
MAB	201905224	38	33.06	73	49.08	2269	152.00	28.00	0.49	40
MAB	201905225	38	32.94	73	52.69	0	0.00	0.00	0.00	0
MAB	201905226	38	29.11	73	53.24	2898	176.67	36.00	0.70	27
MAB	201905228	38	27.13	73	53.45	3067	194.43	36.00	0.74	40
MAB	201905230	38	28.84	73	49.92	2526	166.64	43.00	0.54	7
MAB	201905231	38	29.36	73	47.07	923	62.17	17.00	0.20	33
MAB	201905232	38	28.37	73	40.90	512	27.19	5.50	0.11	0
MAB	201905233	38	27.54	73	44.30	909	57.23	12.00	0.20	14
MAB	201905234	38	25.52	73	45.41	54	3.05	0.50	0.01	0
MAB	201905235	38	24.37	73	46.22	20	1.05	0.50	0.00	38
MAB	201905236	38	24.38	73	49.47	313	18.39	4.00	0.07	0
MAB	201905237	38	24.26	73	53.55	1440	91.60	20.40	0.31	47
MAB	201905238	38	24.73	73	57.46	928	60.72	24.00	0.18	40
MAB	201905239	38	22.83	73	57.90	894	57.33	12.00	0.19	67
MAB	201905240	38	20.91	73	53.51	6	0.38	0.10	0.00	86
MAB	201905241	38	21.96	73	48.63	5	0.31	0.10	0.00	83
MAB	201906001	38	36.37	74	23.36	0	0.00	0.00	0.00	0
MAB	201906002	38	35.99	74	21.87	0	0.00	0.00	0.00	0
MAB	201906003	38	41.27	74	17.77	0	0.00	0.00	0.00	0
MAB	201906004	38	42.97	74	15.14	2	0.18	0.10	0.00	25
MAB	201906005	38	46.73	74	15.23	0	0.00	0.00	0.00	0
MAB	201906006	38	46.29	74	9.25	237	14.59	2.30	0.05	0
MAB	201906007	38	45.63	74	6.54	246	16.53	2.80	0.05	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201906008	38	43.34	74	4.13	292	19.32	3.00	0.06	7
MAB	201906009	38	44.15	74	0.90	453	31.82	5.20	0.10	15
MAB	201906010	38	50.22	73	41.70	702	57.83	9.20	0.15	0
MAB	201906011	38	54.61	73	39.21	60	4.87	1.00	0.01	7
MAB	201906012	38	56.36	73	49.43	4	0.28	0.10	0.00	0
MAB	201906013	38	59.17	73	57.83	0	0.00	0.00	0.00	0
MAB	201906014	38	59.07	73	52.02	0	0.00	0.00	0.00	0
MAB	201906015	38	58.58	73	44.11	6	0.43	0.10	0.00	0
MAB	201906016	38	59.84	73	35.89	148	10.80	2.00	0.04	0
MAB	201906017	39	0.76	73	36.95	229	16.48	2.50	0.05	0
MAB	201906018	39	2.32	73	39.85	19	1.49	0.10	0.00	13
MAB	201906019	39	1.93	73	44.32	6	0.52	0.10	0.00	17
MAB	201906020	39	4.31	73	46.00	4	0.32	0.01	0.00	0
MAB	201906021	39	8.60	73	47.02	0	0.00	0.00	0.00	0
MAB	201906022	39	7.75	73	38.23	15	1.02	0.10	0.00	0
MAB	201906023	39	6.81	73	35.62	145	11.50	1.75	0.04	7
MAB	201906024	39	5.00	73	37.12	256	18.57	3.00	0.05	13
MAB	201906025	39	4.24	73	35.94	168	12.22	2.00	0.04	0
MAB	201906026	39	4.39	73	33.55	274	19.94	3.20	0.06	0
MAB	201906027	39	5.15	73	30.59	378	25.30	4.50	0.08	0
MAB	201906028	39	7.54	73	29.52	158	11.02	1.75	0.04	0
MAB	201906029	39	12.61	73	25.19	65	4.73	0.75	0.01	0
MAB	201906030	39	17.22	73	39.38	0	0.01	0.10	0.00	0
MAB	201906031	39	18.00	73	33.25	90	6.82	1.50	0.02	0
MAB	201906032	39	18.50	73	20.01	197	16.80	2.60	0.05	7
MAB	201906033	39	19.64	73	21.98	230	17.36	3.50	0.05	0
MAB	201906034	39	22.90	73	23.94	61	4.86	0.90	0.01	0
MAB	201906035	39	25.02	73	24.45	11	0.73	0.10	0.00	0
MAB	201906036	39	24.77	73	18.99	282	21.29	3.80	0.07	29
MAB	201906037	39	25.20	73	12.80	78	5.36	1.00	0.02	0
MAB	201906038	39	29.58	73	12.56	56	4.26	0.90	0.01	0
MAB	201906039	39	31.82	73	15.37	31	2.33	0.40	0.01	0
MAB	201906040	39	35.03	73	7.27	116	9.24	1.60	0.02	0
MAB	201906041	39	32.76	73	0.27	278	17.29	3.00	0.06	0
MAB	201906042	39	32.24	72	57.98	250	18.00	2.75	0.05	0
MAB	201906043	39	33.03	72	53.66	146	10.54	1.75	0.03	0
MAB	201906044	39	33.99	72	50.99	216	14.90	2.75	0.05	0
MAB	201906045	39	34.09	72	43.89	356	22.21	4.75	0.08	7
MAB	201906046	39	33.62	72	41.47	69	3.76	0.75	0.01	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201906047	39	36.83	72	43.07	181	10.21	2.00	0.04	0
MAB	201906048	39	37.09	72	46.65	327	19.73	4.50	0.07	0
MAB	201906049	39	35.76	72	55.48	218	15.19	2.50	0.05	0
MAB	201906050	39	36.08	72	58.03	183	12.57	2.10	0.04	0
MAB	201906051	39	38.00	72	59.95	164	12.59	2.10	0.04	7
MAB	201906052	39	39.30	72	55.74	328	21.19	4.00	0.07	0
MAB	201906053	39	40.38	72	49.60	155	9.81	1.75	0.03	0
MAB	201906054	39	42.33	72	51.64	36	2.27	0.50	0.01	0
MAB	201906055	39	44.00	72	57.44	267	16.87	3.10	0.06	0
MAB	201906056	39	45.74	73	2.36	245	15.57	2.75	0.05	0
MAB	201906057	39	46.64	73	1.50	268	18.14	3.00	0.06	7
MAB	201906058	39	47.24	72	43.53	182	13.94	2.40	0.04	7
MAB	201906059	39	46.37	72	35.84	292	20.68	3.20	0.06	0
MAB	201906060	39	45.82	72	33.13	166	10.53	2.00	0.04	0
MAB	201906061	39	47.02	72	30.04	2	0.08	0.10	0.00	0
MAB	201906062	39	49.41	72	34.03	147	11.18	2.20	0.03	7
MAB	201906063	39	51.58	72	53.72	87	7.55	1.30	0.02	0
MAB	201906064	39	54.46	72	54.53	136	11.09	1.80	0.03	0
MAB	201906065	39	54.13	72	48.88	100	7.81	1.30	0.02	0
MAB	201906066	39	55.29	72	41.53	98	8.37	1.50	0.02	0
MAB	201906067	39	59.55	72	44.49	102	8.39	1.50	0.02	0
MAB	201906068	40	0.99	72	49.32	127	10.98	2.00	0.03	7
MAB	201906069	40	4.40	72	56.91	151	12.34	2.00	0.03	0
MAB	201906070	40	5.12	72	49.38	137	11.86	2.00	0.03	0
MAB	201906071	40	6.95	72	47.66	201	17.11	3.00	0.04	0
MAB	201906072	40	5.28	72	42.63	157	12.25	2.00	0.03	0
MAB	201906073	39	59.31	72	22.99	4	0.21	0.10	0.00	0
MAB	201906074	40	4.94	72	12.40	1	0.03	0.01	0.00	0
MAB	201906075	40	7.43	72	16.14	0	0.00	0.00	0.00	0
MAB	201906076	40	5.93	72	25.38	141	9.94	1.75	0.03	0
MAB	201906077	40	7.67	72	24.48	41	2.99	0.75	0.01	0
MAB	201906078	40	10.16	72	24.34	0	0.00	0.00	0.00	0
MAB	201906079	40	10.37	72	33.85	114	9.43	1.50	0.02	0
MAB	201906080	40	10.02	72	45.58	97	8.07	1.50	0.02	0
MAB	201906081	40	13.24	72	49.92	249	20.12	3.10	0.05	7
MAB	201906082	40	14.59	72	46.84	234	18.87	3.00	0.05	7
MAB	201906083	40	15.82	72	44.79	229	17.76	3.40	0.05	0
MAB	201906084	40	16.57	72	38.49	139	10.58	1.80	0.03	0
MAB	201906085	40	17.15	72	29.74	155	11.79	2.00	0.03	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201906086	40	16.54	72	28.20	236	18.26	3.20	0.05	0
MAB	201906087	40	14.65	72	22.85	254	20.27	3.10	0.05	0
MAB	201906088	40	15.57	72	18.06	210	15.01	2.50	0.05	0
MAB	201906089	40	13.34	72	11.53	16	1.14	0.40	0.00	0
MAB	201906090	40	11.05	72	6.75	22	1.26	0.20	0.00	13
MAB	201906091	40	16.32	72	3.59	228	15.37	3.00	0.05	0
MAB	201906092	40	18.72	72	2.46	398	27.74	4.90	0.08	0
MAB	201906093	40	18.47	72	12.83	229	16.66	3.00	0.05	0
MAB	201906094	40	19.68	72	27.45	247	16.72	3.00	0.05	0
MAB	201906095	40	20.17	72	34.98	147	9.72	1.50	0.03	0
MAB	201906096	40	20.81	72	46.60	209	14.25	2.75	0.04	0
MAB	201906097	40	22.06	72	49.16	304	19.04	4.00	0.07	0
MAB	201906098	40	24.37	72	42.12	102	6.91	1.25	0.02	0
MAB	201906099	40	24.50	72	34.41	288	18.36	3.00	0.06	0
MAB	201906100	40	25.59	72	33.80	236	14.80	2.75	0.05	7
MAB	201906101	40	26.82	72	20.07	137	10.83	1.75	0.03	20
MAB	201906102	40	29.29	72	19.57	52	3.82	0.50	0.01	0
MAB	201906103	40	29.93	72	2.63	183	11.71	2.00	0.04	0
MAB	201906104	40	28.96	71	57.99	368	23.07	4.30	0.09	0
MAB	201906105	40	23.69	71	54.30	5	0.27	0.10	0.00	0
MAB	201906106	40	21.17	71	53.72	0	0.00	0.00	0.00	0
MAB	201906107	40	26.44	71	46.11	0	0.00	0.00	0.00	0
MAB	201906108	40	30.22	71	45.76	0	0.00	0.00	0.00	0
MAB	201906109	40	29.80	71	38.64	0	0.00	0.00	0.00	0
MAB	201906110	40	29.25	71	33.82	0	0.00	0.00	0.00	0
MAB	201906111	40	32.95	71	39.84	0	0.00	0.00	0.00	0
MAB	201906112	40	33.45	71	49.21	5	0.26	0.10	0.00	0
MAB	201906113	40	38.48	71	46.27	346	24.19	4.00	0.07	0
MAB	201906114	40	39.01	71	43.27	1	0.05	0.10	0.00	0
MAB	201906115	40	38.63	71	39.48	0	0.00	0.00	0.00	0
MAB	201906116	40	37.56	71	35.84	0	0.00	0.00	0.00	0
MAB	201906117	40	39.33	71	35.48	0	0.00	0.00	0.00	0
MAB	201906118	40	41.37	71	37.41	0	0.00	0.00	0.00	0
MAB	201906119	40	49.52	71	50.91	82	6.28	1.00	0.02	0
MAB	201906120	40	51.15	71	48.61	386	28.65	4.00	0.09	0
MAB	201906121	40	53.24	71	46.35	295	23.30	3.50	0.06	7
MAB	201906122	40	53.82	71	36.36	320	22.39	4.00	0.07	0
MAB	201906123	40	56.73	71	39.86	360	23.54	4.25	0.08	0
MAB	201906124	40	58.87	71	36.56	146	11.73	1.50	0.04	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201906125	41	0.96	71	31.51	124	9.73	1.50	0.03	0
MAB	201906126	41	2.17	71	20.94	12	0.92	0.10	0.00	0
MAB	201906128	41	3.47	71	33.38	31	2.29	0.25	0.01	0
MAB	201906129	41	1.19	71	42.36	6	0.38	0.10	0.00	0
MAB	201906130	41	0.43	71	45.31	0	0.00	0.00	0.00	0
MAB	201906131	40	55.96	71	50.93	7	0.50	0.10	0.00	0
MAB	201906132	40	55.31	71	58.36	0	0.00	0.00	0.00	0
MAB	201906133	40	51.11	72	14.28	0	0.00	0.00	0.00	0
MAB	201906134	40	47.90	72	5.68	216	14.64	2.30	0.05	0
MAB	201906135	40	46.46	71	59.81	258	17.50	2.80	0.06	0
MAB	201906136	40	44.14	71	55.44	295	20.00	3.40	0.06	0
MAB	201906137	40	40.22	71	58.49	182	13.68	2.00	0.04	0
MAB	201906138	40	43.06	72	2.74	226	15.69	2.50	0.05	0
MAB	201906139	40	43.68	72	8.60	16	1.23	0.20	0.00	0
MAB	201906140	40	41.27	72	7.21	28	2.16	0.40	0.01	0
MAB	201906141	40	40.15	72	10.91	4	0.31	0.10	0.00	0
MAB	201906142	40	39.09	72	16.40	4	0.27	0.10	0.00	0
MAB	201906143	40	40.80	72	18.46	42	2.86	0.25	0.01	7
MAB	201906144	40	44.29	72	26.17	0	0.00	0.10	0.00	0
MAB	201906145	40	44.63	72	35.23	0	0.00	0.00	0.00	0
MAB	201906146	40	42.91	72	38.17	0	0.00	0.00	0.00	0
MAB	201906147	40	36.33	72	37.34	4	0.27	0.10	0.00	0
MAB	201906148	40	34.85	72	34.45	20	1.67	0.25	0.00	0
MAB	201906149	40	34.62	72	31.78	59	4.42	0.75	0.01	0
MAB	201906150	40	34.69	72	26.11	72	4.82	0.75	0.02	0
MAB	201906151	40	36.50	72	21.28	38	2.75	0.50	0.01	0
MAB	201906152	40	34.27	72	19.33	19	1.39	0.10	0.00	0
MAB	201906153	40	32.87	72	23.21	33	2.17	0.50	0.01	7
MAB	201906154	40	30.49	72	40.71	63	5.10	0.75	0.02	0
MAB	201906155	40	34.47	72	44.88	2	0.20	0.10	0.00	0
MAB	201906156	40	37.36	72	47.73	0	0.00	0.00	0.00	0
MAB	201906157	40	39.02	72	50.15	0	0.00	0.00	0.00	0
MAB	201906158	40	33.44	72	48.04	3	0.18	0.10	0.00	0
MAB	201906159	40	30.61	72	47.01	42	3.63	0.50	0.01	0
MAB	201906160	40	28.49	72	52.46	23	1.83	0.40	0.00	0
MAB	201906161	40	26.93	72	55.74	27	2.34	0.50	0.01	0
MAB	201906162	40	30.99	73	5.62	0	0.00	0.00	0.00	0
MAB	201906163	40	29.46	73	11.33	0	0.00	0.00	0.00	0
MAB	201906164	40	23.99	73	6.27	2	0.13	0.10	0.00	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201906165	40	21.90	72	58.82	162	13.62	2.00	0.03	0
MAB	201906166	40	20.95	72	59.26	70	5.61	0.90	0.01	0
MAB	201906167	40	18.90	73	2.41	142	11.05	1.50	0.03	0
MAB	201906168	40	20.03	73	4.37	55	4.73	0.90	0.01	0
MAB	201906169	40	21.51	73	8.78	2	0.15	0.10	0.00	0
MAB	201906170	40	22.18	73	15.44	0	0.00	0.00	0.00	0
MAB	201906171	40	21.71	73	17.92	0	0.00	0.00	0.00	0
MAB	201906172	40	22.60	73	25.59	0	0.00	0.00	0.00	0
MAB	201906173	40	18.75	73	30.32	0	0.00	0.00	0.00	0
MAB	201906174	40	16.46	73	17.28	19	1.58	0.10	0.00	0
MAB	201906175	40	15.97	73	9.47	47	3.79	0.75	0.01	0
MAB	201906176	40	14.20	73	3.49	96	7.17	1.10	0.02	0
MAB	201906177	40	11.75	73	0.80	95	7.25	1.10	0.02	0
MAB	201906178	40	10.16	72	57.96	203	15.04	3.00	0.05	0
MAB	201906179	40	7.87	72	59.29	173	12.78	2.00	0.04	7
MAB	201906180	40	7.62	73	5.54	99	7.75	1.10	0.02	0
MAB	201906181	40	10.55	73	12.53	29	1.86	0.50	0.01	0
MAB	201906182	40	12.36	73	15.06	10	1.08	0.10	0.00	0
MAB	201906183	40	13.98	73	24.55	2	0.24	0.10	0.00	0
MAB	201906184	40	14.65	73	38.31	0	0.00	0.00	0.00	0
MAB	201906185	40	16.00	73	42.42	0	0.00	0.00	0.00	0
MAB	201906186	40	12.29	73	44.62	0	0.00	0.00	0.00	0
MAB	201906187	40	11.43	73	40.36	0	0.00	0.00	0.00	0
MAB	201906188	40	6.58	73	34.43	0	0.00	0.00	0.00	0
MAB	201906189	40	9.66	73	32.51	0	0.00	0.00	0.00	0
MAB	201906190	40	9.22	73	20.32	9	0.92	0.10	0.00	0
MAB	201906191	40	7.36	73	22.62	7	0.61	0.10	0.00	0
MAB	201906192	40	5.48	73	23.50	12	1.22	0.10	0.00	0
MAB	201906193	40	4.10	73	13.79	132	10.10	1.50	0.03	0
MAB	201906195	40	4.93	73	6.41	161	12.38	2.00	0.03	0
MAB	201906196	40	4.06	73	4.94	119	8.91	1.50	0.03	0
MAB	201906197	40	1.48	73	1.09	157	13.01	1.90	0.03	0
MAB	201906198	39	58.37	73	4.52	65	5.55	1.00	0.01	0
MAB	201906199	39	56.78	73	16.84	1	0.04	0.01	0.00	0
MAB	201906200	40	0.52	73	21.04	15	1.40	0.10	0.00	0
MAB	201906201	39	59.71	73	27.71	18	1.22	0.10	0.00	0
MAB	201906202	39	58.86	73	34.50	0	0.00	0.00	0.00	0
MAB	201906203	39	59.91	73	43.36	0	0.00	0.00	0.00	0
MAB	201906204	39	58.42	73	46.12	0	0.00	0.00	0.00	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
MAB	201906205	39	55.39	73	42.57	0	0.00	0.00	0.00	0
MAB	201906206	39	51.82	73	36.99	0	0.00	0.00	0.00	0
MAB	201906207	39	53.98	73	32.29	0	0.00	0.00	0.00	0
MAB	201906208	39	55.30	73	28.46	12	0.78	0.10	0.00	0
MAB	201906209	39	49.74	73	25.66	13	0.70	0.10	0.00	0
MAB	201906210	39	49.16	73	22.65	67	3.89	0.75	0.02	0
MAB	201906211	39	51.75	73	11.13	494	28.04	6.50	0.11	0
MAB	201906212	39	52.20	73	7.47	161	11.69	2.00	0.03	7
MAB	201906213	39	51.69	73	3.78	11	1.06	0.10	0.00	0
MAB	201906214	39	48.44	73	2.86	292	19.52	3.50	0.06	0
MAB	201906215	39	48.48	73	6.43	270	14.61	3.00	0.06	0
MAB	201906216	39	47.71	73	9.13	131	9.77	1.50	0.03	0
MAB	201906217	39	46.43	73	11.66	243	15.53	2.50	0.05	0
MAB	201906218	39	45.86	73	13.29	161	11.62	2.00	0.03	0
MAB	201906219	39	45.42	73	9.05	337	25.23	4.20	0.07	0
MAB	201906220	39	41.52	73	10.75	171	11.82	2.00	0.04	0
MAB	201906221	39	39.78	73	17.94	122	8.79	1.50	0.03	0
MAB	201906222	39	39.71	73	20.60	9	0.62	0.10	0.00	0
MAB	201906223	39	38.14	73	29.25	2	0.09	0.10	0.00	0
MAB	201906224	39	36.62	73	17.94	55	3.80	0.70	0.01	0
MAB	201906225	39	35.92	73	18.34	75	5.43	1.00	0.02	0
MAB	201906226	39	30.61	73	24.27	17	1.21	0.20	0.00	0
CAI_II	201907001	41	3.35	69	0.24	69	6.84	1.00	0.02	0
CAI_II	201907002	41	2.29	68	57.80	63	6.86	1.10	0.02	0
CAI_II	201907003	41	0.84	68	56.39	16	1.79	0.30	0.00	0
CAI_II	201907004	40	59.37	68	56.13	237	30.66	4.30	0.05	0
CAI_II	201907005	40	57.90	68	55.71	61	7.21	1.00	0.02	0
CAI_II	201907006	40	55.65	68	53.11	16	1.82	0.20	0.00	0
CAI_II	201907007	40	57.21	68	52.23	25	2.91	0.50	0.01	0
CAI_II	201907008	40	57.94	68	50.15	17	1.58	0.25	0.00	0
CAI_II	201907009	40	59.92	68	47.90	2	0.25	0.10	0.00	0
CAI_II	201907010	41	0.85	68	49.82	188	21.74	3.20	0.05	0
CAI_II	201907011	41	3.91	68	55.04	67	9.58	1.10	0.02	0
CAI_II	201907012	41	4.43	68	50.62	11	1.28	0.10	0.00	0
CAI_II	201907013	41	8.50	68	44.57	18	2.16	0.20	0.01	0
CAI_II	201907014	41	10.92	68	39.27	4	0.38	0.10	0.00	0
CAI_II	201907015	41	7.65	68	39.88	36	3.47	0.50	0.01	0
CAI_II	201907016	41	5.37	68	37.59	1	0.08	0.10	0.00	0
CAI_II	201907017	41	5.95	68	34.71	0	0.00	0.00	0.00	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
CAI_II	201907018	41	6.04	68	32.65	0	0.00	0.00	0.00	0
CAI_II	201907019	41	3.86	68	31.35	0	0.00	0.00	0.00	0
CAI_II	201907020	41	2.09	68	32.33	0	0.00	0.00	0.00	0
CAI_II	201907021	41	0.32	68	36.58	0	0.00	0.00	0.00	0
CAI_II	201907022	40	57.63	68	38.76	0	0.00	0.00	0.00	0
CAI_II	201907023	40	57.82	68	34.70	0	0.00	0.00	0.00	0
CAI_II	201907024	40	40.26	67	58.98	291	28.07	3.00	0.08	0
CAI_II	201907025	40	32.63	67	58.26	4	0.27	0.10	0.00	0
CAI_II	201907026	40	31.24	67	52.33	0	0.00	0.00	0.00	0
CAI_II	201907027	40	33.11	67	50.25	1	0.15	0.10	0.00	0
CAI_II	201907028	40	37.10	67	52.19	74	4.39	0.75	0.02	0
CAI_II	201907029	40	38.95	67	49.61	340	26.38	3.80	0.09	0
CAI_II	201907030	40	41.87	67	54.71	123	11.47	1.50	0.03	0
CAI_II	201907031	40	42.25	67	45.91	82	7.52	1.00	0.02	0
CAI_II	201907032	40	42.39	67	39.91	201	15.15	1.90	0.05	0
CAI_II	201907033	40	44.50	67	37.11	388	29.51	4.00	0.10	0
CAI_II	201907034	40	37.32	67	41.29	413	39.63	4.00	0.10	0
CAI_II	201907035	40	35.11	67	37.88	15	0.96	0.10	0.00	0
CAI_II	201907036	40	34.61	67	34.61	4	0.23	0.10	0.00	0
CAI_II	201907037	40	34.03	67	30.16	6	0.41	0.10	0.00	0
CAI_II	201907038	40	34.71	67	23.37	1	0.06	0.10	0.00	0
CAI_II	201907039	40	36.33	67	26.50	0	0.00	0.00	0.00	0
CAI_II	201907040	40	40.36	67	26.47	0	0.00	0.00	0.00	0
CAI_II	201907041	40	41.14	67	22.10	0	0.00	0.00	0.00	0
CAI_II	201907042	40	42.40	67	29.00	567	33.39	5.80	0.15	0
CAI_II	201907043	40	45.13	67	31.73	1184	72.82	6.00	0.31	0
CAI_II	201907044	40	49.60	67	34.99	339	26.56	2.50	0.10	0
CAI_II	201907045	40	46.32	67	25.28	892	57.70	7.75	0.23	0
CAI_II	201907046	40	47.19	67	21.80	1284	91.11	12.00	0.34	0
CAI_II	201907047	40	45.16	67	18.69	5	0.30	0.10	0.00	0
CAI_II	201907048	40	45.07	67	15.12	1	0.09	0.10	0.00	0
CAI_II	201907049	40	41.35	67	14.93	0	0.00	0.00	0.00	0
CAI_II	201907050	40	38.84	67	15.14	0	0.00	0.10	0.00	0
CAI_II	201907051	40	40.08	67	11.01	1	0.03	0.10	0.00	0
CAI_II	201907052	40	40.53	67	8.05	0	0.00	0.00	0.00	0
CAI_II	201907053	40	44.19	67	9.93	0	0.00	0.00	0.00	0
CAI_II	201907054	40	43.92	67	6.23	0	0.00	0.00	0.00	0
CAI_II	201907055	40	43.11	67	3.17	0	0.00	0.00	0.00	0
CAI_II	201907056	40	44.56	67	3.55	0	0.00	0.00	0.00	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
CAI_II	201907057	40	47.63	67	3.28	0	0.00	0.00	0.00	0
CAI_II	201907058	40	50.75	67	4.38	715	50.11	7.25	0.21	0
CAI_II	201907059	40	51.32	67	15.27	170	15.37	1.40	0.04	0
CAI_II	201907060	40	55.81	67	23.08	224	20.03	2.00	0.06	0
CAI_II	201907061	40	55.08	67	11.98	349	31.84	3.75	0.09	0
CAI_II	201907062	40	55.20	67	2.49	464	34.32	6.00	0.12	0
CAI_II	201907063	40	53.43	66	56.89	160	10.70	2.00	0.04	0
CAI_II	201907064	40	52.24	66	56.43	894	57.21	12.00	0.23	0
CAI_II	201907065	40	48.76	66	55.95	2	0.12	0.10	0.00	0
CAI_II	201907066	40	50.37	66	51.82	11	0.83	0.10	0.00	0
CAI_II	201907067	40	51.43	66	48.37	0	0.00	0.00	0.00	0
CAI_II	201907068	40	52.36	66	52.04	278	15.15	2.70	0.06	0
CAI_II	201907069	40	54.36	66	53.38	256	22.44	3.00	0.07	0
CAI_II	201907070	40	55.75	66	57.92	417	33.05	4.60	0.11	0
CAI_II	201907071	40	56.64	67	0.92	282	20.14	3.00	0.07	0
CAI_II	201907072	40	59.18	67	9.21	155	13.09	2.00	0.04	0
CAI_II	201907073	40	59.26	67	14.37	93	8.64	1.30	0.02	0
CAI_II	201907074	41	5.92	67	19.36	12	1.25	0.10	0.00	0
CAI_II	201907075	41	3.14	67	14.51	15	2.15	0.20	0.00	0
CAI_II	201907076	41	2.78	67	10.15	85	10.08	1.30	0.02	0
CAI_II	201907077	41	2.29	67	6.75	109	12.49	1.20	0.03	0
CAI_II	201907078	40	56.92	66	55.41	326	25.76	2.75	0.11	0
CAI_II	201907079	40	55.04	66	48.42	714	43.30	7.00	0.25	0
CAI_II	201907080	40	54.64	66	44.73	24	2.01	0.20	0.01	0
CAI_II	201907081	40	56.24	66	43.74	0	0.00	0.00	0.00	0
CAI_II	201907082	40	58.05	66	43.05	21	1.73	0.20	0.01	0
CAI_II	201907083	40	59.33	66	43.58	201	15.72	2.00	0.05	0
CAI_II	201907084	40	58.38	66	47.93	201	15.54	2.00	0.05	0
CAI_II	201907085	40	59.15	66	50.36	104	8.46	1.00	0.03	0
CAI_II	201907086	40	58.52	66	52.67	137	10.53	1.25	0.03	0
CAI_II	201907087	41	4.04	67	1.27	84	11.08	1.20	0.02	0
CAI_II	201907088	41	8.74	67	5.56	51	7.45	0.75	0.02	0
CAI_II	201907089	41	9.84	67	9.87	5	0.70	0.10	0.00	0
CAI_II	201907090	41	10.15	67	16.32	3	0.48	0.10	0.00	0
CAI_II	201907091	41	14.41	67	17.87	0	0.00	0.00	0.00	0
CAI_II	201907092	41	16.73	67	15.43	0	0.00	0.00	0.00	0
CAI_II	201907093	41	14.08	67	14.29	0	0.00	0.00	0.00	0
CAI_II	201907094	41	13.39	67	8.76	1	0.15	1.00	0.00	0
CAI_II	201907095	41	11.56	66	54.97	75	10.05	1.30	0.02	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
CAI_II	201907096	41	6.63	66	55.58	89	11.84	1.50	0.02	0
CAI_II	201907097	41	6.09	66	52.00	126	15.02	2.00	0.03	0
CAI_II	201907098	41	2.60	66	53.17	459	42.63	5.00	0.12	0
CAI_II	201907099	41	1.31	66	50.57	380	37.01	4.60	0.10	0
CAI_II	201907100	41	1.30	66	47.43	1010	100.53	11.00	0.23	0
CAI_II	201907101	41	1.18	66	42.22	663	75.68	8.00	0.17	0
CAI_II	201907102	41	0.25	66	38.49	11	0.87	0.10	0.00	0
CAI_II	201907103	41	0.98	66	35.74	92	5.64	1.00	0.02	0
CAI_II	201907104	41	2.98	66	35.03	1312	89.74	16.00	0.34	0
CAI_II	201907105	41	5.32	66	37.07	2202	184.10	30.00	0.51	0
CAI_II	201907106	41	3.85	66	39.03	1073	95.61	16.00	0.28	0
CAI_II	201907107	41	5.57	66	42.14	308	29.03	3.85	0.07	0
CAI_II	201907108	41	4.07	66	45.31	358	33.46	4.20	0.09	0
CAI_II	201907109	41	9.78	66	50.33	119	14.05	1.80	0.03	0
CAI_II	201907110	41	8.58	66	43.57	284	24.73	3.00	0.07	0
CAI_II	201907111	41	9.20	66	40.43	286	26.13	3.00	0.09	0
CAI_II	201907112	41	7.27	66	36.89	1930	168.77	23.75	0.50	0
CAI_II	201907113	41	6.76	66	33.29	1388	93.88	13.25	0.36	0
CAI_II	201907114	41	7.16	66	29.88	0	0.00	0.00	0.00	0
CAI_II	201907115	41	8.08	66	28.28	56	2.56	0.40	0.02	0
CAI_II	201907116	41	10.37	66	30.14	1356	110.82	12.60	0.40	0
CAI_II	201907117	41	11.22	66	33.52	1416	132.84	16.20	0.37	0
CAI_II	201907118	41	11.11	66	37.68	343	27.35	3.40	0.09	0
CAI_II	201907119	41	12.54	66	41.81	104	10.80	1.40	0.03	0
CAI_II	201907120	41	13.22	66	45.44	60	6.69	0.90	0.02	0
CAI_II	201907121	41	14.98	66	49.45	24	2.78	0.40	0.01	0
CAI_II	201907122	41	15.76	66	43.18	51	5.73	0.80	0.01	0
CAI_II	201907123	41	13.93	66	36.82	120	10.10	1.30	0.03	0
CAI_II	201907124	41	14.90	66	33.61	1393	101.99	15.80	0.36	0
CAI_II	201907125	41	13.41	66	31.12	1448	106.13	15.00	0.38	0
CAI_II	201907126	41	14.07	66	27.59	1718	95.88	17.50	0.45	0
CAI_II	201907127	41	13.73	66	24.21	353	20.26	4.00	0.09	0
CAI_II	201907128	41	15.06	66	23.74	840	44.33	8.00	0.19	0
CAI_II	201907129	41	16.91	66	24.86	1213	92.84	12.00	0.28	0
CAI_II	201907130	41	17.81	66	26.94	564	38.77	5.00	0.13	0
CAI_II	201907131	41	16.56	66	29.88	744	51.01	14.00	0.16	0
CAI_II	201907132	41	18.22	66	38.84	110	10.28	1.50	0.03	0
CAI_II	201907133	41	18.83	66	46.45	52	6.24	1.00	0.01	0
CAI_II	201907134	41	20.65	66	44.25	56	8.41	1.00	0.01	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
CAI_II	201907135	41	22.88	66	47.41	77	10.02	1.30	0.02	0
CAI_II	201907136	41	22.65	66	40.08	77	8.76	1.20	0.02	0
CAI_II	201907137	41	19.97	66	35.55	378	37.36	5.00	0.10	0
CAI_II	201907138	41	21.70	66	31.81	662	69.24	13.00	0.15	0
CAI_II	201907139	41	21.15	66	28.49	1467	98.61	14.00	0.34	0
CAI_II	201907140	41	24.96	66	31.58	341	37.15	6.00	0.09	0
CAI_II	201907141	41	25.22	66	34.48	427	35.24	9.00	0.11	0
CAI_II	201907142	41	25.67	66	38.22	181	17.46	3.25	0.05	0
CAI_II	201907143	41	29.04	66	36.17	164	15.16	3.50	0.04	0
CAI_II	201907144	41	29.71	66	40.16	17	1.75	0.40	0.00	0
CAI_II	201907145	41	25.73	66	41.25	62	7.43	1.50	0.02	0
CAI_II	201907146	41	26.18	66	43.93	135	16.80	2.75	0.03	0
CAI_II	201907147	41	24.43	66	47.96	26	4.41	0.40	0.01	0
CAI_II	201907148	41	25.09	66	52.66	3	0.33	0.10	0.00	0
CAI_II	201907149	41	25.44	66	57.72	0	0.00	0.00	0.00	0
CAI_II	201907150	41	21.69	67	4.18	0	0.00	0.00	0.00	0
CAI_II	201907151	41	21.26	67	16.53	0	0.00	0.00	0.00	0
CAI_II	201907152	41	25.15	67	16.98	0	0.00	0.00	0.00	0
CAI_II	201907153	41	29.06	67	14.23	0	0.00	0.00	0.00	0
CAI_II	201907154	41	27.53	68	31.63	10	1.73	0.20	0.00	0
CAI_II	201907155	41	27.11	68	34.33	152	16.19	3.10	0.04	0
CAI_II	201907156	41	29.24	68	36.37	351	27.42	6.00	0.09	0
CAI_II	201907157	41	27.92	68	37.59	874	92.17	14.00	0.23	0
CAI_II	201907158	41	27.68	68	39.76	1387	91.33	20.00	0.32	0
CAI_II	201907159	41	26.70	68	40.56	2445	183.24	36.00	0.64	0
CAI_II	201907160	41	25.42	68	42.13	235	16.08	2.00	0.05	0
CAI_II	201907161	41	22.61	68	38.18	84	7.90	1.50	0.02	0
CAI_II	201907162	41	22.42	68	36.21	60	7.33	1.50	0.02	0
CAI_II	201907163	41	20.38	68	32.30	14	1.58	0.33	0.00	0
CAI_II	201907164	41	18.89	68	31.42	5	0.63	0.10	0.00	0
CAI_II	201907165	41	20.86	68	40.76	40	4.85	1.30	0.01	0
CAI_II	201907166	41	18.45	68	50.42	2884	177.21	43.00	0.75	0
CAI_II	201907167	41	17.29	68	47.66	94	10.91	1.50	0.02	0
CAI_II	201907168	41	17.76	68	43.75	71	6.95	0.80	0.02	0
CAI_II	201907169	41	16.11	68	40.09	55	6.83	1.20	0.01	0
CAI_II	201907170	41	14.09	68	34.39	15	1.79	4.00	0.00	0
CAI_II	201907171	41	14.47	68	41.44	6	0.73	0.10	0.00	0
CAI_II	201907172	41	16.44	68	45.42	28	3.66	0.20	0.01	0
CAI_II	201907173	41	16.33	68	49.27	1344	164.63	17.00	0.35	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
CAI_II	201907174	41	16.31	68	51.20	3777	319.06	49.00	0.99	0
CAI_II	201907175	41	15.43	68	52.34	3970	493.94	56.00	1.04	0
CAI_II	201907176	41	15.20	68	55.98	48	5.72	0.60	0.02	0
CAI_II	201907177	41	13.80	68	57.58	1562	136.94	22.00	0.41	0
CAI_II	201907178	41	13.01	68	54.42	128	11.46	1.80	0.04	0
CAI_II	201907179	41	13.15	68	50.71	64	5.53	1.00	0.02	0
CAI_II	201907180	41	11.48	68	50.04	195	17.51	2.40	0.06	0
CAI_II	201907181	41	10.91	68	46.86	77	10.17	1.20	0.03	0
CAI_II	201907182	41	10.24	68	48.96	112	12.20	1.75	0.03	0
CAI_II	201907183	41	9.84	68	50.89	41	4.52	0.70	0.01	0
CAI_II	201907184	41	8.69	68	52.29	21	2.31	0.35	0.01	0
CAI_II	201907185	41	7.10	68	57.07	11	1.15	0.10	0.00	0
CAI_II	201907186	41	8.47	69	2.75	1048	83.34	14.00	0.27	0
CAI_II	201907187	41	10.43	69	1.42	1405	118.98	18.80	0.33	0
CAI_II	201907188	41	10.74	69	4.69	49	4.24	0.90	0.01	0
CAI_II	201907189	41	13.42	69	7.09	185	16.38	2.30	0.05	0
CAI_II	201907190	41	13.65	69	5.83	276	15.75	3.50	0.07	0
CAI_II	201907191	41	14.54	69	9.38	25	2.12	0.30	0.01	0
CAI_II	201907192	41	16.26	69	10.74	757	64.99	11.00	0.20	0
CAI_II	201907193	41	17.06	69	7.91	1240	59.68	14.00	0.29	0
CAI_II	201907194	41	17.84	69	11.86	1139	93.81	20.00	0.26	0
CAI_II	201907195	41	19.52	69	12.69	506	37.59	9.00	0.12	0
CAI_II	201907196	41	20.75	69	14.87	667	55.72	16.00	0.15	0
CAI_II	201907197	41	24.70	69	17.65	77	6.61	1.50	0.02	0
CAI_II	201907198	41	26.15	69	19.10	132	13.11	2.00	0.03	0
CAI_II	201907199	41	27.36	69	17.70	624	46.55	10.00	0.14	0
CAI_II	201907200	41	29.31	69	17.93	211	20.34	4.60	0.05	0
NL	201908001	40	35.37	69	59.85	0	0.00	0.00	0.00	0
NL	201908002	40	37.61	69	57.61	12	0.89	0.20	0.00	0
NL	201908003	40	37.69	69	53.55	13	1.50	0.20	0.00	0
NL	201908004	40	38.24	69	51.47	30	2.98	0.50	0.01	0
NL	201908005	40	39.05	69	48.55	8	0.72	0.20	0.00	0
NL	201908006	40	41.65	69	48.99	10	0.84	0.10	0.00	0
NL	201908007	40	41.63	69	43.41	0	0.00	0.00	0.00	0
NL	201908008	40	39.01	69	42.37	4	0.38	0.10	0.00	0
NL	201908009	40	37.23	69	40.73	30	2.66	0.50	0.01	0
NL	201908010	40	38.18	69	38.43	8	0.60	0.10	0.00	0
NL	201908011	40	37.15	69	36.33	34	2.48	0.50	0.01	0
NL	201908012	40	36.50	69	33.56	8	0.78	0.10	0.00	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
NL	201908013	40	36.72	69	32.59	5	0.35	0.10	0.00	0
NL	201908014	40	36.23	69	30.21	1	0.11	0.10	0.00	0
NL	201908015	40	36.26	69	27.45	0	0.00	0.00	0.00	0
NL	201908016	40	36.13	69	23.74	5	0.51	0.10	0.00	0
NL	201908018	40	33.45	69	25.36	66	8.56	1.25	0.01	0
NL	201908019	40	34.66	69	34.98	74	4.87	1.00	0.02	0
NL	201908020	40	35.37	69	42.26	73	5.09	1.25	0.02	0
NL	201908021	40	36.37	69	46.03	28	2.13	0.50	0.01	0
NL	201908022	40	36.17	69	47.99	15	1.05	0.25	0.00	0
NL	201908023	40	34.41	69	50.94	48	2.79	0.75	0.01	0
NL	201908024	40	32.78	69	53.33	99	5.59	1.50	0.02	0
NL	201908025	40	34.03	69	57.11	19	1.38	0.25	0.00	0
NL	201908026	40	29.69	69	58.11	6	0.31	0.10	0.00	0
NL	201908027	40	27.65	69	57.39	1	0.05	0.10	0.00	0
NL	201908028	40	29.11	69	54.88	1	0.04	0.10	0.00	0
NL	201908029	40	28.96	69	51.33	22	1.00	0.25	0.00	0
NL	201908030	40	31.35	69	51.23	157	7.80	2.00	0.03	0
NL	201908031	40	33.29	69	48.80	577	33.50	7.25	0.12	0
NL	201908032	40	33.02	69	43.03	183	8.52	2.10	0.04	0
NL	201908033	40	32.76	69	40.18	252	10.80	3.10	0.05	0
NL	201908034	40	32.52	69	32.96	58	4.60	1.00	0.01	0
NL	201908035	40	31.27	69	31.30	63	5.46	1.00	0.01	0
NL	201908036	40	31.29	69	30.10	66	6.29	0.85	0.01	0
NL	201908037	40	30.77	69	25.60	34	3.33	0.50	0.01	0
NL	201908038	40	27.96	69	28.14	104	7.45	1.25	0.02	0
NL	201908039	40	28.26	69	30.90	81	5.34	1.10	0.02	0
NL	201908040	40	30.17	69	34.12	171	10.68	2.25	0.04	0
NL	201908041	40	30.39	69	36.82	248	11.24	3.00	0.05	0
NL	201908042	40	30.44	69	40.11	3220	137.62	48.00	0.69	0
NL	201908043	40	30.18	69	45.07	3557	169.73	43.00	0.78	0
NL	201908045	40	28.59	69	48.32	9	0.41	0.10	0.00	0
NL	201908046	40	26.18	69	45.36	8	0.48	0.10	0.00	0
NL	201908047	40	27.23	69	43.55	14	0.69	0.10	0.00	0
NL	201908048	40	27.81	69	39.44	55	3.32	0.75	0.01	0
NL	201908049	40	27.08	69	39.31	50	3.49	0.75	0.01	0
NL	201908050	40	25.07	69	38.23	27	1.72	0.25	0.01	0
NL	201908051	40	21.32	69	29.12	897	23.19	13.50	0.19	0
NL	201908052	40	20.58	69	26.89	1167	35.58	15.50	0.25	0
NL	201908053	40	20.70	69	23.34	1503	45.07	23.00	0.32	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
NL	201908054	40	20.63	69	19.97	1	0.04	0.10	0.00	0
NL	201908055	40	20.69	69	16.87	0	0.00	0.00	0.00	0
NL	201908056	40	20.64	69	13.54	0	0.00	0.00	0.00	0
NL	201908057	40	21.68	69	10.96	0	0.00	0.00	0.00	0
NL	201908058	40	20.90	69	7.81	0	0.00	0.00	0.00	0
NL	201908059	40	20.43	69	5.20	0	0.00	0.00	0.00	0
NL	201908060	40	21.11	69	1.53	0	0.00	0.00	0.00	0
NL	201908061	40	22.81	69	0.34	2	0.09	0.10	0.00	0
NL	201908062	40	25.03	69	3.08	1	0.06	0.10	0.00	0
NL	201908063	40	23.41	69	6.86	18	0.66	0.25	0.00	0
NL	201908064	40	22.60	69	13.38	1	0.04	0.10	0.00	0
NL	201908065	40	22.85	69	18.41	1880	53.22	25.00	0.40	0
NL	201908066	40	23.83	69	20.85	2257	53.03	41.00	0.47	0
NL	201908067	40	23.44	69	23.98	2875	67.84	50.00	0.60	0
NL	201908068	40	24.42	69	26.10	1535	61.65	25.00	0.32	0
NL	201908069	40	24.58	69	28.76	1249	60.63	17.50	0.26	0
NL	201908070	40	26.63	69	25.62	203	9.86	2.25	0.04	0
NL	201908071	40	27.59	69	21.46	103	6.64	1.25	0.02	0
NL	201908072	40	26.69	69	19.13	6782	264.73	88.00	1.42	0
NL	201908073	40	25.20	69	16.67	3789	90.95	66.25	0.82	0
NL	201908074	40	25.78	69	12.17	4283	134.61	62.00	0.90	0
NL	201908075	40	27.27	69	10.00	2646	92.76	37.00	0.57	0
NL	201908076	40	26.18	69	6.94	2923	82.23	40.50	0.63	0
NL	201908077	40	26.82	69	1.85	30	1.52	0.25	0.01	0
NL	201908078	40	27.09	69	0.28	66	3.94	0.80	0.01	0
NL	201908079	40	28.04	69	2.77	1831	81.57	23.00	0.39	0
NL	201908080	40	29.39	69	4.97	294	13.10	3.25	0.06	0
NL	201908081	40	31.08	69	7.66	46	2.90	0.50	0.01	0
NL	201908082	40	30.49	69	10.01	125	8.43	1.75	0.03	0
NL	201908083	40	28.68	69	12.94	115	5.89	1.40	0.02	0
NL	201908084	40	28.24	69	13.61	188	9.00	2.00	0.04	0
NL	201908085	40	28.40	69	15.99	100	5.18	1.25	0.02	0
NL	201908086	40	31.59	69	21.03	22	2.34	0.25	0.00	0
NL	201908087	40	32.27	69	19.50	44	5.98	0.90	0.01	0
NL	201908088	40	32.90	69	15.81	67	8.98	1.25	0.01	0
NL	201908089	40	32.52	69	12.89	43	4.75	0.75	0.01	0
NL	201908090	40	33.00	69	10.09	68	6.33	1.00	0.01	0
NL	201908091	40	33.06	69	8.05	119	9.54	1.75	0.02	0
NL	201908092	40	31.43	69	5.38	51	2.89	0.75	0.01	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
NL	201908093	40	32.31	69	1.94	89	6.28	1.25	0.02	0
NL	201908094	40	33.91	69	3.98	409	38.82	7.25	0.09	0
NL	201908095	40	36.96	69	0.90	58	6.06	1.00	0.01	0
NL	201908096	40	37.91	69	3.12	464	55.08	6.50	0.10	0
NL	201908097	40	37.38	69	5.56	743	85.10	12.75	0.16	0
NL	201908098	40	38.03	69	7.34	292	35.09	5.10	0.06	0
NL	201908099	40	37.82	69	9.25	363	44.26	5.50	0.08	0
NL	201908100	40	36.42	69	11.28	519	67.49	9.25	0.11	0
NL	201908101	40	36.76	69	13.61	751	89.74	11.00	0.16	0
NL	201908102	40	36.58	69	17.42	72	8.35	1.00	0.02	0
NL	201908103	40	37.78	69	17.64	67	6.90	1.00	0.01	0
NL	201908104	40	39.34	69	19.55	17	1.55	0.20	0.00	0
NL	201908105	40	39.08	69	23.83	4	0.43	0.10	0.00	0
NL	201908106	40	39.66	69	26.50	1	0.04	0.10	0.00	0
NL	201908107	40	41.88	69	28.27	1	0.10	0.10	0.00	0
NL	201908108	40	43.63	69	28.07	0	0.00	0.00	0.00	0
NL	201908109	40	44.24	69	24.77	0	0.00	0.00	0.00	0
NL	201908110	40	48.51	69	28.29	0	0.00	0.00	0.00	0
NL	201908111	40	49.61	69	18.76	22	2.47	0.25	0.00	0
NL	201908112	40	48.46	69	17.95	617	85.84	10.75	0.13	0
NL	201908113	40	48.06	69	12.72	19	2.20	0.20	0.00	0
NL	201908114	40	48.40	69	9.63	443	57.61	7.25	0.09	0
NL	201908115	40	47.18	69	6.37	247	29.90	3.80	0.05	0
NL	201908116	40	48.66	69	4.08	220	29.45	3.50	0.05	0
NL	201908117	40	48.28	69	0.94	190	26.37	3.25	0.04	0
NL	201908118	40	44.67	69	0.83	835	94.29	15.00	0.18	0
NL	201908119	40	42.82	69	3.63	185	24.82	3.25	0.04	0
NL	201908120	40	44.25	69	6.47	394	52.32	7.00	0.08	0
NL	201908121	40	45.34	69	10.00	668	68.89	9.10	0.14	0
NL	201908122	40	43.97	69	14.19	861	113.88	19.25	0.18	0
NL	201908123	40	41.60	69	12.98	55	6.08	1.00	0.01	0
NL	201908124	40	41.92	69	9.34	196	28.25	3.75	0.04	0
NL	201908125	40	40.98	69	3.54	483	62.07	7.25	0.10	0
NL	201908126	40	39.67	69	0.74	376	46.19	6.10	0.08	0
NL	201908127	40	39.16	69	4.28	421	50.67	6.75	0.09	0
NL	201908128	40	39.06	69	9.68	295	38.96	4.50	0.06	0
NL	201908129	40	38.13	69	12.82	557	62.48	7.50	0.12	0
NL	201908130	40	39.56	69	16.16	71	6.89	1.00	0.02	0
NL	201908131	40	42.87	69	18.77	40	3.87	0.50	0.01	0

Table 2: continued

Survey	StationID	Latitude (degrees)	Latitude (minutes)	Longitude (degrees)	Longitude (minutes)	Scallops (number)	Scallops (lbs)	Scallops (baskets)	Scallop density (m2)	Nematode Prevalence
NL	201908132	40	43.99	69	17.83	1452	158.26	29.00	0.31	0
NL	201908133	40	46.17	69	17.07	182	23.05	3.10	0.04	0
NL	201908134	40	46.87	69	17.95	501	63.35	9.25	0.10	0
NL	201908135	40	45.49	69	19.53	60	7.84	1.10	0.01	0

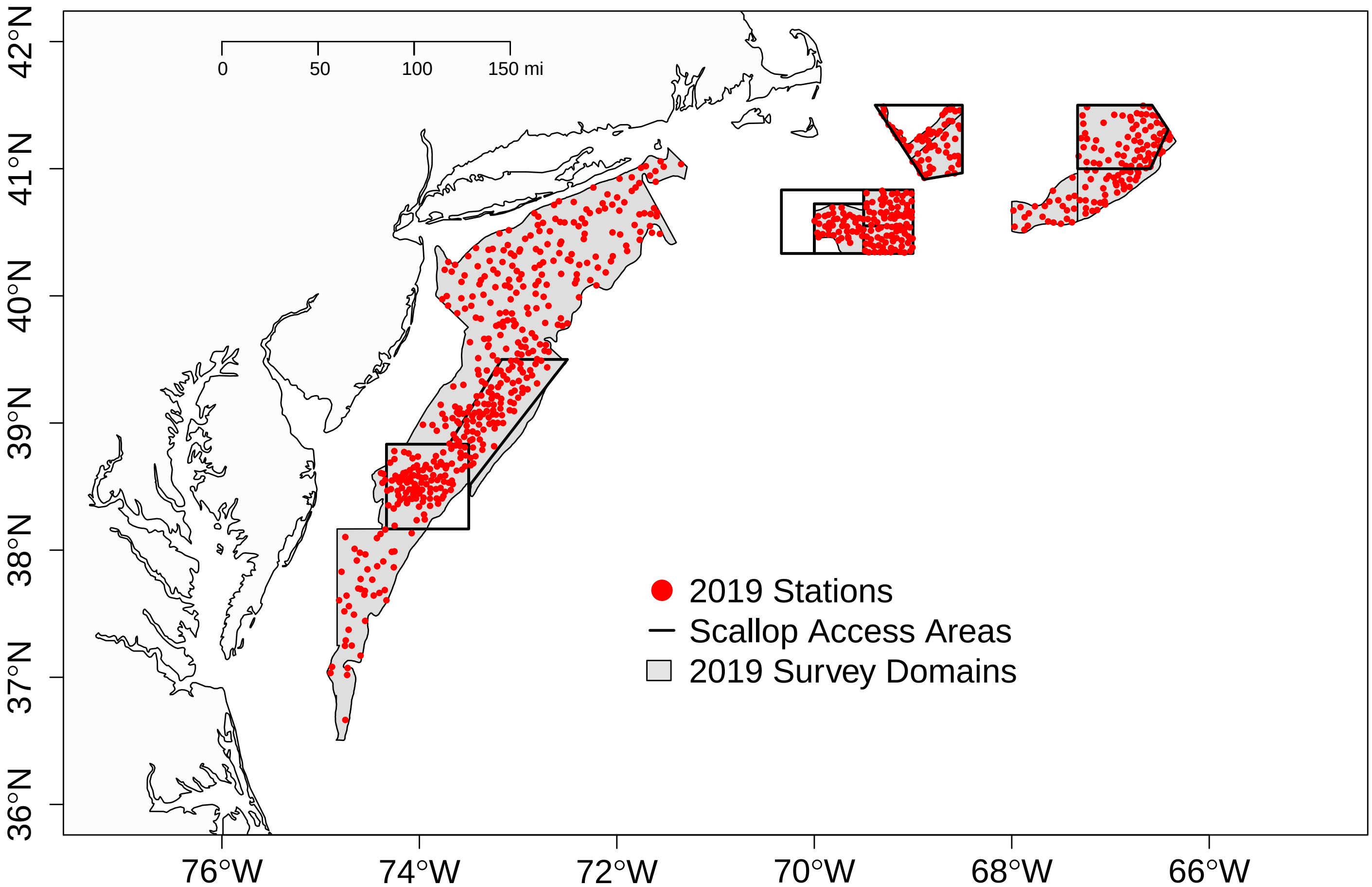


Figure 1: Survey domains with station locations for the VIMS/Industry cooperative surveys of the Mid-Atlantic sea scallop resource area, the Nantucket Lightship Closed Area, Closed Area I, and Closed Area II completed during May–July 2019.

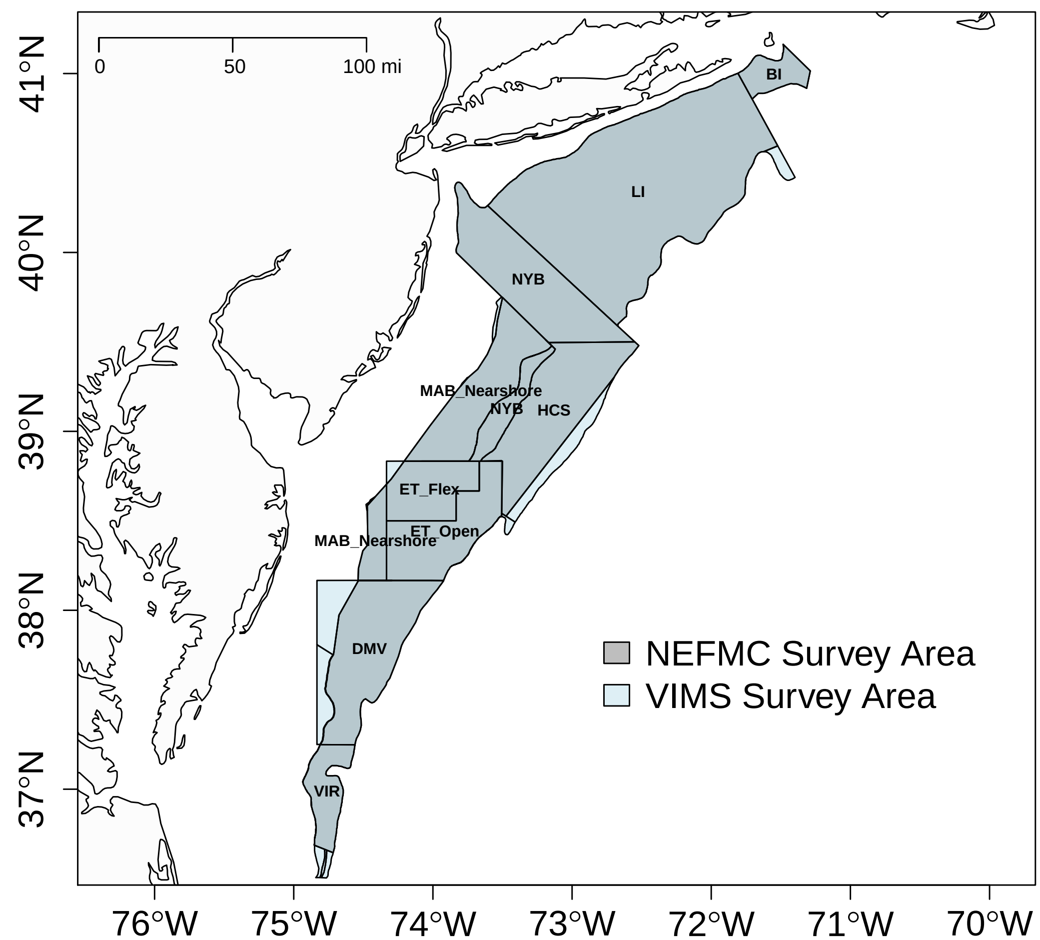


Figure 2: SAMS Areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Mid-Atlantic sea scallop resource during May 2019.

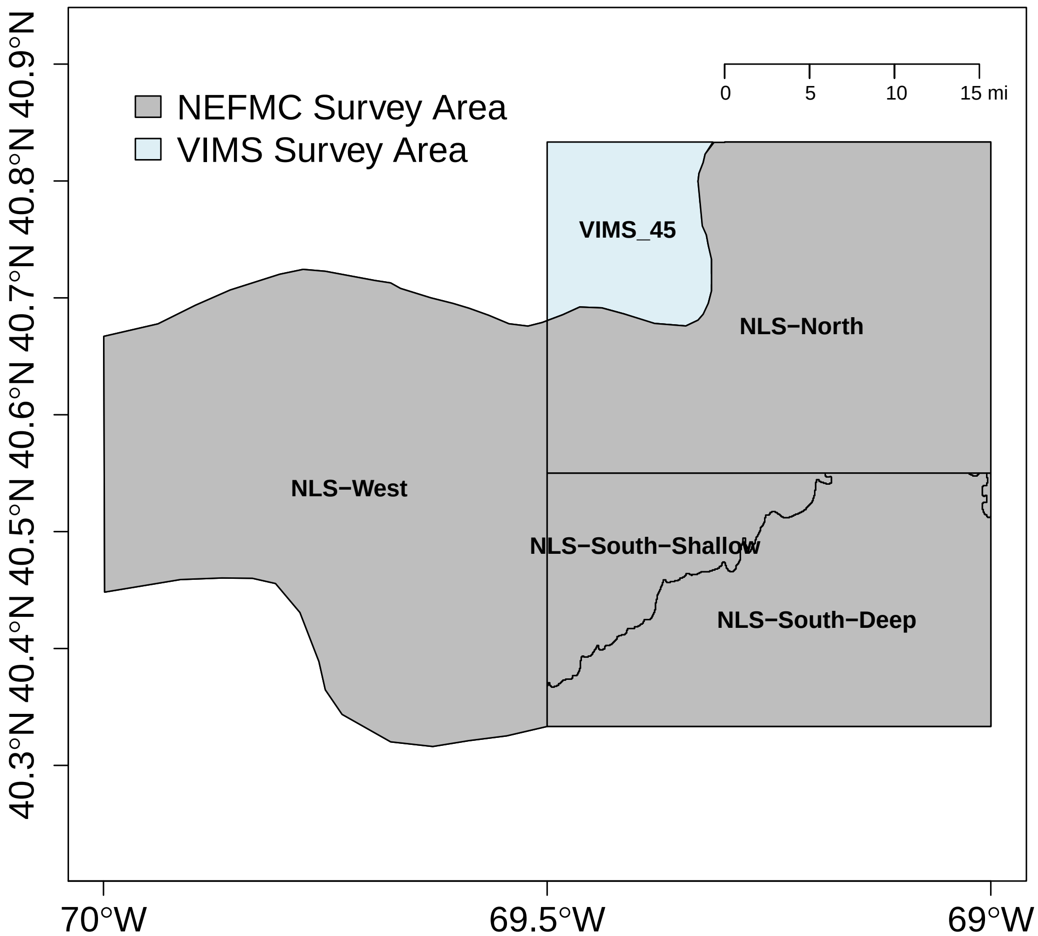


Figure 3: SAMS Areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Nantucket Lightship access area and surrounds resource during July 2019.

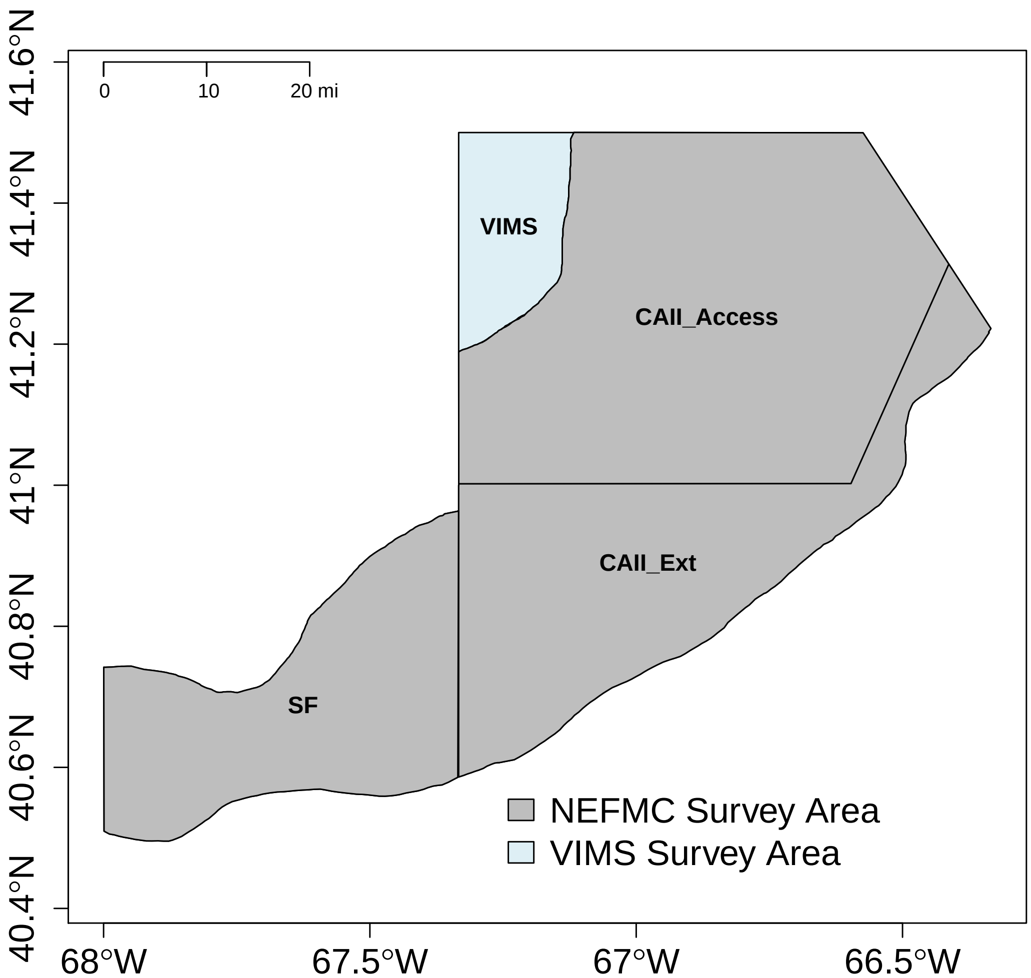


Figure 4: SAMS Areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Closed Area II access area and open area along the southern flank during June 2019.

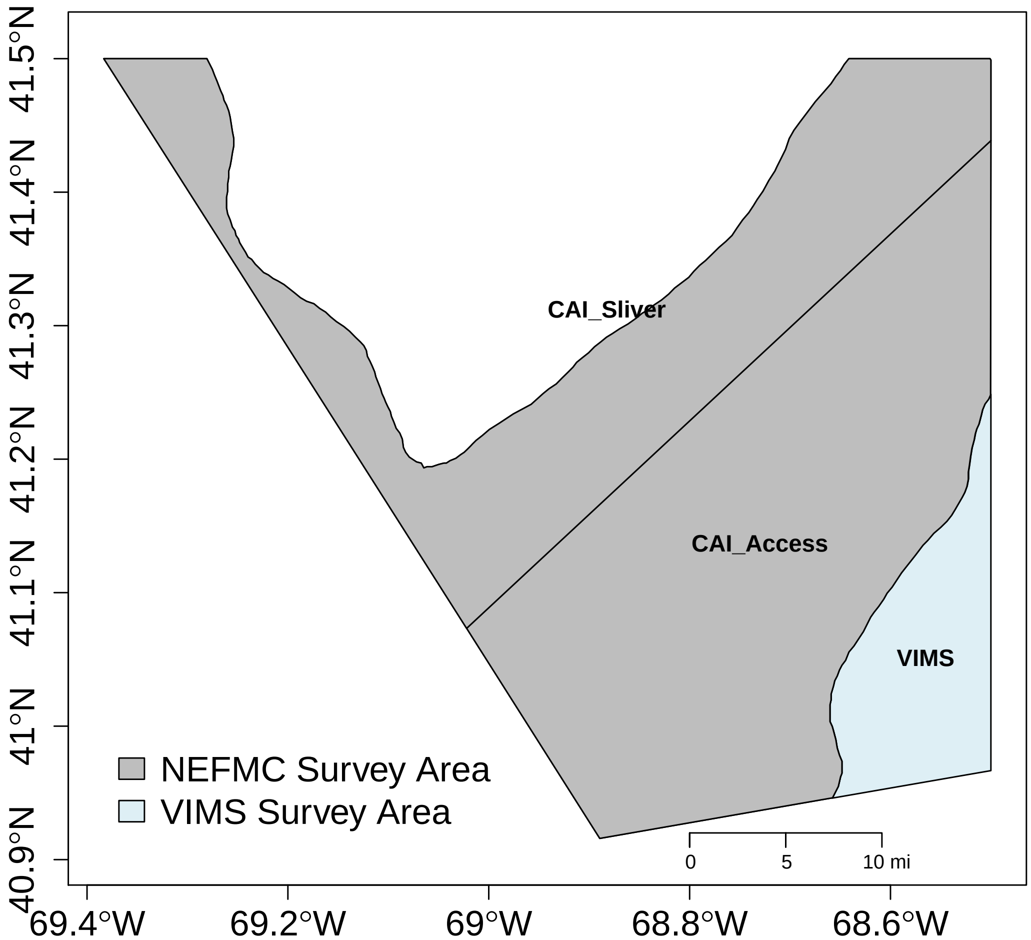


Figure 5: SAMS Areas used to calculate biomass estimates for the VIMS/Industry cooperative survey of the Closed Area I access area during June 2019.

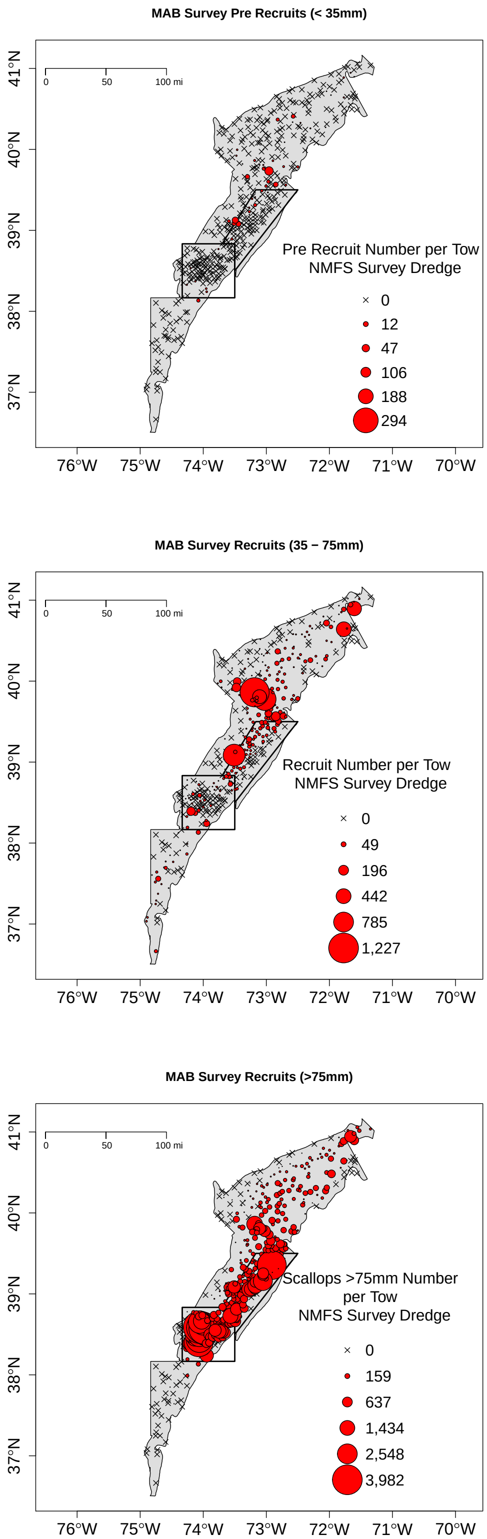


Figure 6: Number of scallops <35 mm, 35–75 mm, and >75 mm caught in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Mid-Atlantic sea scallop resource during May 2019.

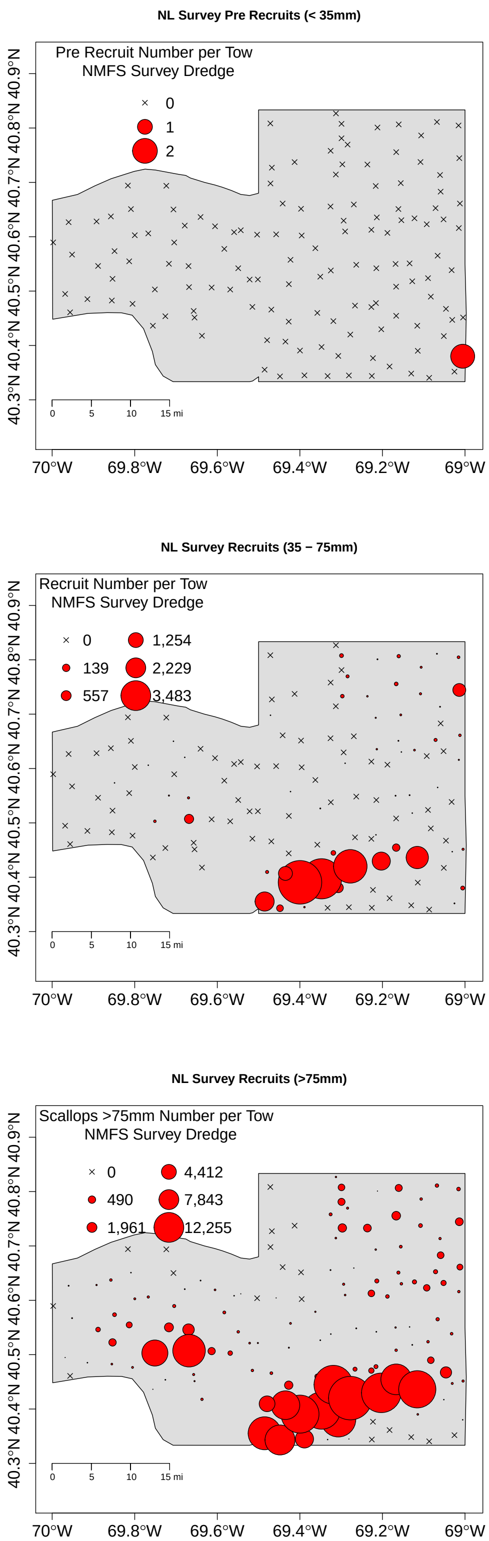
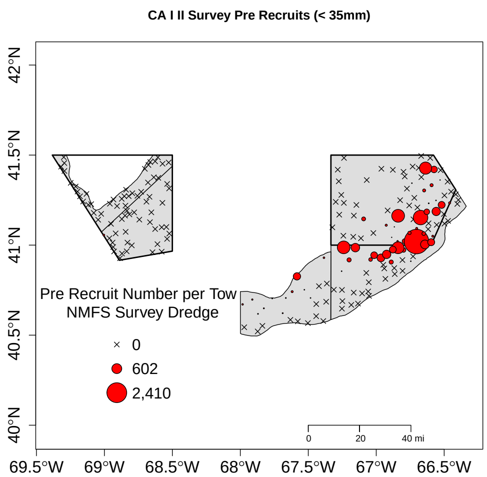
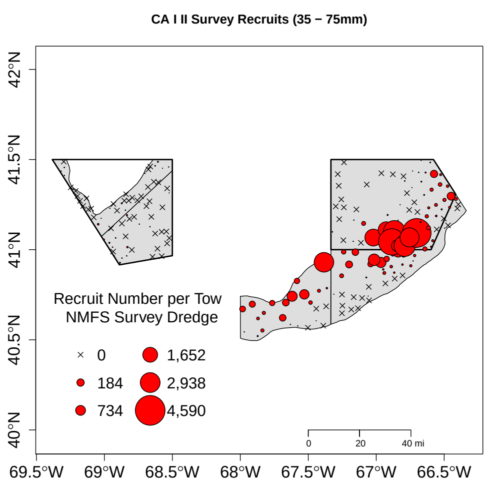


Figure 7: Number of scallops <35 mm, 35–75 mm, and >75 mm caught in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Nantucket Lightship access area during July 2019.





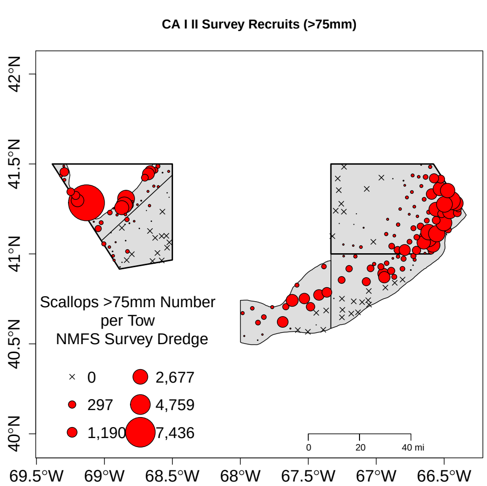


Figure 8: Number of scallops $<$35 mm, 35–75 mm, and $>$75 mm caught in the NMFS survey dredge during the VIMS/Industry cooperative survey of the Closed Area I and II access areas during June 2019.

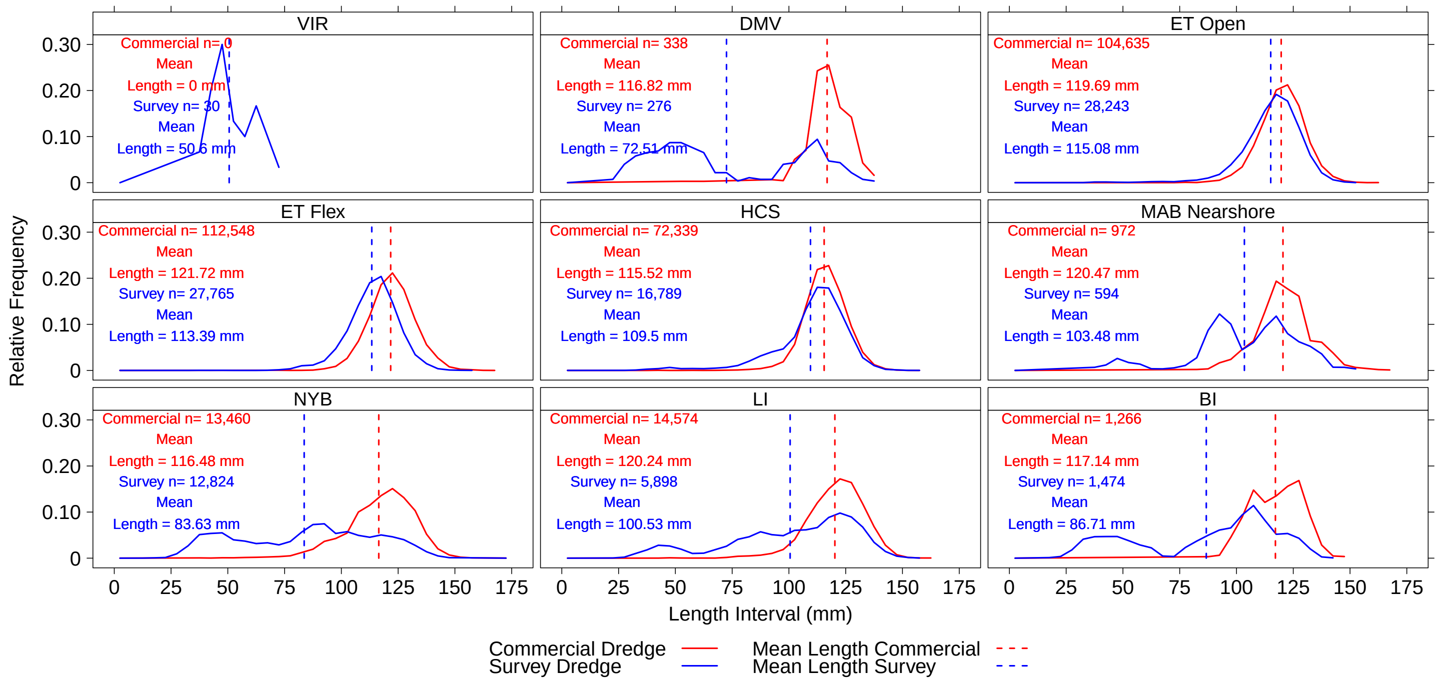


Figure 9: Scallop length frequency distributions generated from catch data obtained from both the survey and commercial dredges during the VIMS/Industry cooperative survey of the Mid-Atlantic sea scallop resource area in May 2019 by SAMS Area. Number of scallops (n) measured and mean length by gear are also included.

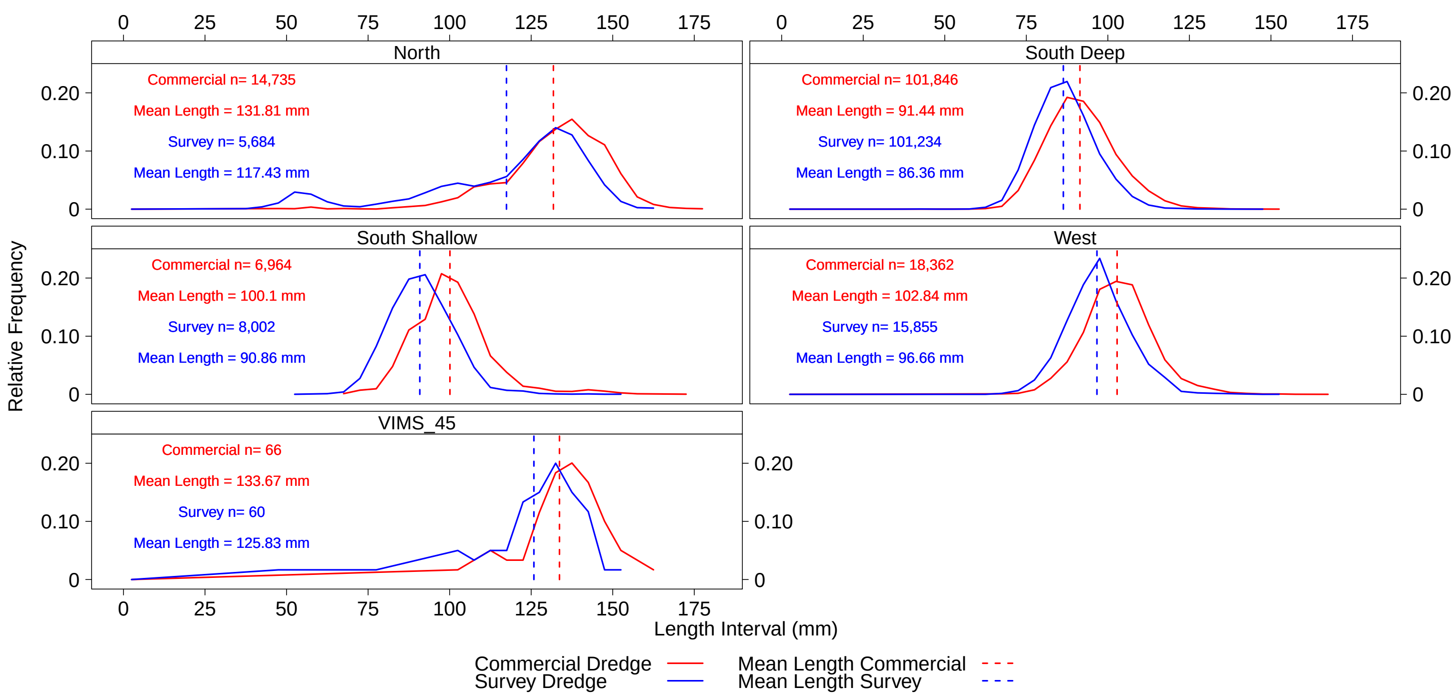


Figure 10: Scallop length frequency distributions generated from catch data obtained from both the survey and commercial dredges during the VIMS/Industry cooperative survey of the Nantucket Lightship access area and surrounds in July 2019 by SAMS Area. Number of scallops (n) measured and mean length by gear are also included.

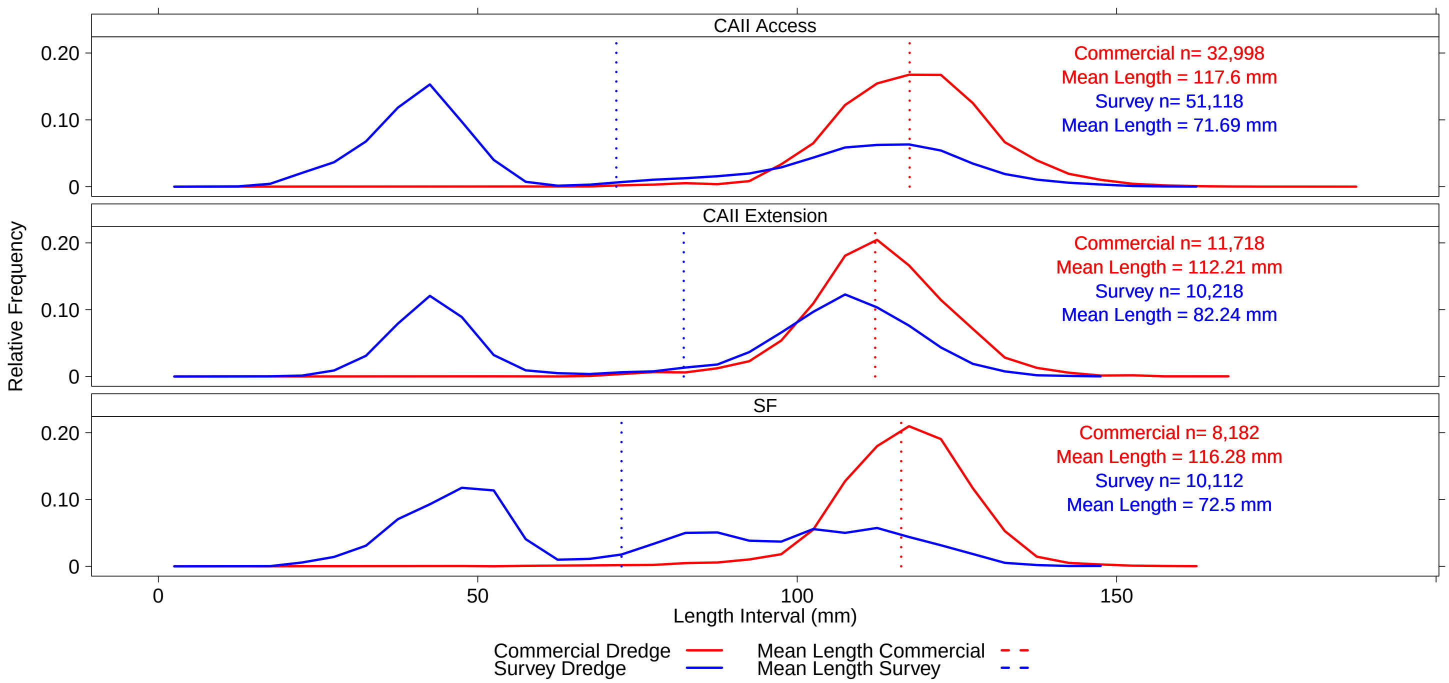


Figure 11: Scallop length frequency distributions generated from catch data obtained from both the survey and commercial dredges during the VIMS/Industry cooperative survey of Closed Area I (top row) and Closed Area II (middle and bottom rows) in June 2019 by SAMS Area. Number of scallops (n) measured and mean length by gear are also included.

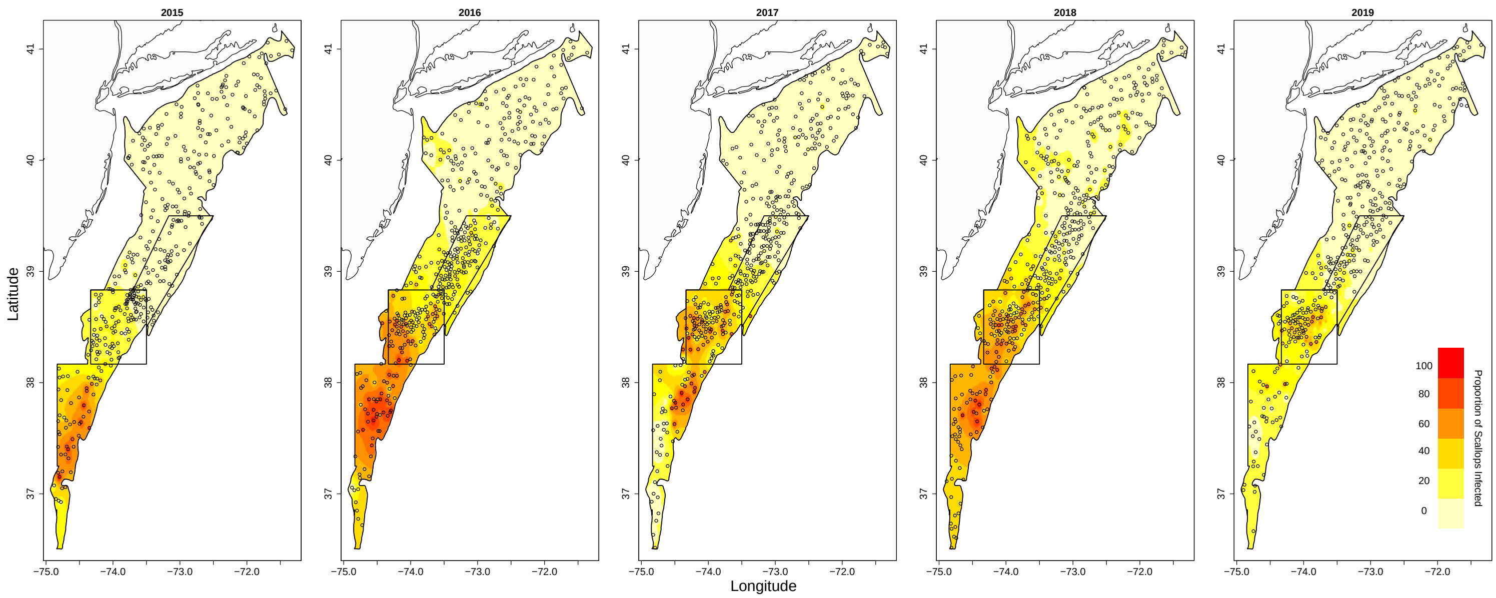


Figure 12: Proportion of scallops infected with nematodes for 2015–2019 in the VIMS/Industry cooperative survey of the Mid-Atlantic sea scallop resource area.

Appendix E

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NOAA FISHERIES
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CERT

Comité d'évaluation des ressources transfrontalières

TRAC

Transboundary Resources Assessment Committee

Working Paper 2018/xx

Yellowtail Flounder Catches in the Virginia Institute of Marine Science Scallop Dredge Survey, 2016-2018

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ABSTRACT

The Virginia Institute of Marine Science (VIMS) conducted a fine scale spatial dredge survey of the Closed Area II (CAII) access area and surrounds in 2016, 2017, and 2018 for the purposes of examining scallop abundance and distribution. In 2018, the survey domain was expanded to cover additional area along the southern flank of Georges Bank (GB). Data were collected on scallops and finfish catch. Survey catches were examined to determine whether there were trends in yellowtail flounder abundance in the surveyed area. Results suggest a decline in yellowtail flounder abundance in the area surveyed over the three-year period.

RÉSUMÉ

Introduction

The stock assessment model for Georges Bank (GB) yellowtail flounder uses an empirical assessment approach, developed at the 2014 GB yellowtail flounder Diagnostic and Empirical Approach Benchmark and subsequent Transboundary Resource Assessment Committee (TRAC) meeting in 2014, and further refined following an intersessional TRAC conference call in June 2017 (i.e., adjusted survey catchability). Three bottom trawl surveys (DFO, NMFS spring, and NMFS fall surveys) are used to create a model-free estimate of population biomass. An exploitation rate is applied to the average of these three surveys to derive catch advice.

Catches of GB yellowtail flounder by the groundfish fishery have been at historic low amounts due to low quotas, resulting in minimal fishery dependent information on the stock. There have also been uncertainties with the research vessel surveys from both the NMFS and DFO. In the case of the R/V *Bigelow* (NMFS survey vessel), there have been several investigations of the catchability used to convert the survey indices into biomass, and in the past year there have been concerns raised about the accuracy of the area swept by the survey vessel at different depths. In the fall of 2017, a different research vessel was used because the R/V *Bigelow* suffered from a mechanical casualty, and the spring DFO survey also used a different vessel than normal. As a result of the uncertainty caused by these factors, additional information on recent abundance trends could be helpful when interpreting the results of the empirical approach.

The U.S. Atlantic Sea Scallop fishery has an extensive research program funded by a set-aside of the annual quota. A key part of this program is the funding of surveys using several different gears: commercial dredges, a standardized sea scallop survey dredge, and cameras. The VIMS dredge survey focuses primarily on areas of sea scallop abundance, but also collects biological information related to finfish and other biota as a secondary objective. Surveys on GB often overlap areas of historic yellowtail founder distribution, such as the VIMS dredge surveys of Closed Area II (CAII) Access Area and surrounds in 2016, 2017, and 2018. Here, the VIMS time series in CAII and surrounds was examined for short-term trends in yellowtail flounder abundance.

Data and Methods

For the years 2016 through 2018, VIMS received scallop research set-aside funding to conduct a high resolution, stratified random dredge survey to sample the GB CAII access area, as well as a rotational closure area south of the access area and additional area on the southern flank of GB (Figure 1). A total of 100 stations were sampled in CAII and surrounds during the 2016 and 2017 survey campaigns.

A total of 123 stations were sampled in 2018 when the survey domain was expanded to the southern flank of GB. While the focus of the survey was to conduct a high-resolution survey of the scallop resource in these areas, a secondary objective was to collect information on finfish catch. Two finfish species of most interest were yellowtail flounder and windowpane flounder because the scallop fishery catches of these species are limited to a small allocation.

As noted above, the CAII survey domain remained the same in 2016 and 2017 (Figure 1), and was expanded in 2018. Stratification is based on the NEFSC shellfish strata. While the survey does not cover all of GB, it does focus on the area of historic yellowtail abundance that corresponds to an area with limited coverage by the NMFS bottom trawl spring and fall surveys in 2016-17 (Figure 2).

Stratification, Allocation and Sample Size

The survey consisted of one annual cruise that sampled survey domains in and around CAII using a stratified random survey design. For a stratified random design, relative gains in precision are realized from a number of different sources. Compared to simple random sampling, effective stratification that accurately reflects scallop abundance and divides the population into homogenous subgroups (strata) is a critical initial step. Additional gains are realized by allocating sampling stations to those strata to result in the minimization of within-strata variance (Cochran, 1977). In 2016, stations were allocated using proportional allocation based on stratum size. In 2017 and 2018, a hybrid approach was used consisting of both proportional and optimal allocation techniques (Neyman allocation) for station allocation (Cochran, 1977). A percentage of stations were allocated based on stratum area, the number of scallops observed in the previous year, and the biomass (grams) of scallops observed in the previous year. To ensure all strata in the survey domains were sampled, all strata were allocated a minimum of two stations.

Catch Data

The project used a commercial sea scallop dredge vessel to conduct 9-day trips in the spring/summer. During the survey cruise, the vessel occupied a total of 100 pre-determined stations in the CAII and surrounds survey domain on an annual basis in 2016 and 2017. In 2018, the survey domain was expanded and 123 stations were completed throughout the survey area. Within the same the survey footprint as the 2016 and 2017 surveys, 100 stations were completed. At each station, the vessel simultaneously towed two dredges. The NMFS sea scallop survey dredge, 2.4 m in width equipped with 5.08 cm rings, 10.16 cm diamond twine top and a 3.8 cm diamond mesh liner was towed on one side of the vessel. On the other side of the vessel, a 4.27 m or 4.57 m commercial scallop dredge equipped with 10.16 cm rings, a 25 cm diamond mesh twine top and no liner was used. In this paired design, it is assumed that the dredges cover a similar area of substrate and sample from the same population of scallops.

The catch data obtained during the survey tows provide information that serves as the basis for analyses of the abundance and distribution of the sea scallop resource in the survey domain. For each paired tow, the dredges were fished for 15 minutes with a towing speed of approximately 3.8-4.0 kts. A tilt sensor (records angle of inclination, temperature, depth) was used to determine dredge bottom contact time and high-resolution navigational logging equipment was used to accurately determine vessel position and speed over ground. Time stamps for both the inclinometer and the navigational log determined both the location and duration fished by the dredges. Bottom contact time and vessel location were integrated to estimate area of gear coverage.

Catch Sampling

Sampling of the catch was conducted in the same manner described by DuPaul and Kirkley (1995) and DuPaul et al. (1989), which has been utilized during all VIMS scallop surveys since 2005. For each paired tow, the entire scallop catch from both the survey and commercial dredges was kept separate and placed in traditional scallop baskets. Total scallop catch, or a subsample depending upon the volume of the catch, was measured in to the nearest millimeter (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. This catch information was also used as the basis to assess biomass and relative efficiencies of both dredges.

Other sampled species included typical sea scallop fishery catch - groundfish, skates, crabs and starfish. All groundfish (flatfish, monkfish, cod, haddock, dogfish) were counted and measured (total length (TL)) to the nearest mm by species for each dredge. The differences in selectivity of the two dredges used can provide a holistic estimate of the age structure of the finfish bycatch population. Barndoor skates were measured (TL) and discarded. All other skates were counted and identified as unclassified skates. Crabs, starfish and snails were identified to the genus or species level and enumerated at random stations for predator monitoring. All station-level data was entered into the data acquisition program Fisheries Environment for Electronic Data (FEED). Collected data includes catch data (scallops, finfish, invertebrates, and trash), length measurements, bridge information and shell height – meat product quality data. Length measurements were recorded using an electronic Ichthystick measuring board integrated with the FEED program that allows for automatic recording of length measurements. The bridge data includes station level information: location, time, tow time (break-set/haul-back), tow speed, water depth, weather, and comments relative to the quality of the tow.

Results

For the three years of the VIMS survey, few yellowtail flounder were caught outside the boundaries of CAII (Figure 3). This is generally consistent with the results of recent bottom trawl surveys in this area, which show yellowtail flounder distribution highest in NMFS bottom trawl stratum 16. While the 2016 and 2017 surveys caught similar numbers of fish in total, the 2018 survey showed a decline (Table 2). The survey dredge showed a decline in yellowtail flounder by numbers of fish each year. The commercial dredge showed a small increase in numbers of fish from 2016 to 2017, note that a different dredge was used that year (4.27 m width rather than the 4.57 m width used in 2016 and 2018). In 2018, the commercial dredge also showed a decline in the number of yellowtail caught. This decline is evident even though there was an increase in the number of stations sampled and area covered in 2018 compared to 2016 and 2018.

The survey dredge retains smaller yellowtail flounder than the commercial dredge, which is expected since the survey dredge uses a 3.8 cm liner that is not used in the commercial dredge. In 2018, the survey dredge did not retain any yellowtail flounder smaller than 300 mm (Figure 4).

Discussion

The VIMS scallop survey provides detailed spatial coverage of a portion of the yellowtail flounder stock area. With its consistent and well-documented methods, it can provide additional information on the status of the GB yellowtail flounder stock – albeit for a limited area at one time of the year. However, the area covered by the survey is an area long-recognized as important for this stock. The information from this survey can be used as ancillary information to assist with the interpretation of the assessment results.

Over the 2016-2018 time period, the VIMS survey reflected a decline in yellowtail flounder abundance in the area of the survey. Unlike the previous two years, the 2018 survey did not catch any fish smaller than 300 mm, which may indicate a lack of recruitment. Given the limited number of fish caught this conclusion, however, is uncertain.

References

Cochran, W. G. 1977. Sampling Techniques (3rd ed.). John Wiley and Sons, New York. 428 pp.

DuPaul, W.D., E.J. Heist, and J.E. Kirkley. 1989. Comparative analysis of sea scallop escapement/retention and resulting economic impacts. College of William & Mary, Virginia Institute of Marine Science, Gloucester Point, VA. VIMS Marine Resource Report 88-10. 70 pp.

DuPaul, W.D. and J.E. Kirkley. 1995. Evaluation of sea scallop dredge ring size. Contract report submitted to NOAA, National Marine Fisheries Service. Grant # NA36FD0131.

Table 1 – Summary of VIMS survey coverage.

Year	Gear	Stations	Total Area Swept (m^2)	Average Tow Distance (m^2)	Comments
2016	Com	100	906,126.60		A 4.27 m commercial dredge was used in 2017. 2016 and 2018 had a 4.57 m commercial dredge.
	Survey		488,569.05	1,854.86	
2017	Com	100	775,880.70		
	Survey		417,055.22	1,695.52	
2018	Com	123	964,212.21		We expanded survey coverage into the southern flank this year.
	Survey		510,106.29	1,700.79	Tow distance is only calculated for survey dredge.

Table 2 – Summary of yellowtail flounder catches (number) in the VIMS scallop survey of CAII by year, 2016-2018.

Species	Year	Com Gear	Survey Gear	Total
Yellowtail Flounder	2016	22	21	43
	2017	25	15	40
	2018	8	6	14
	Total	55	42	97

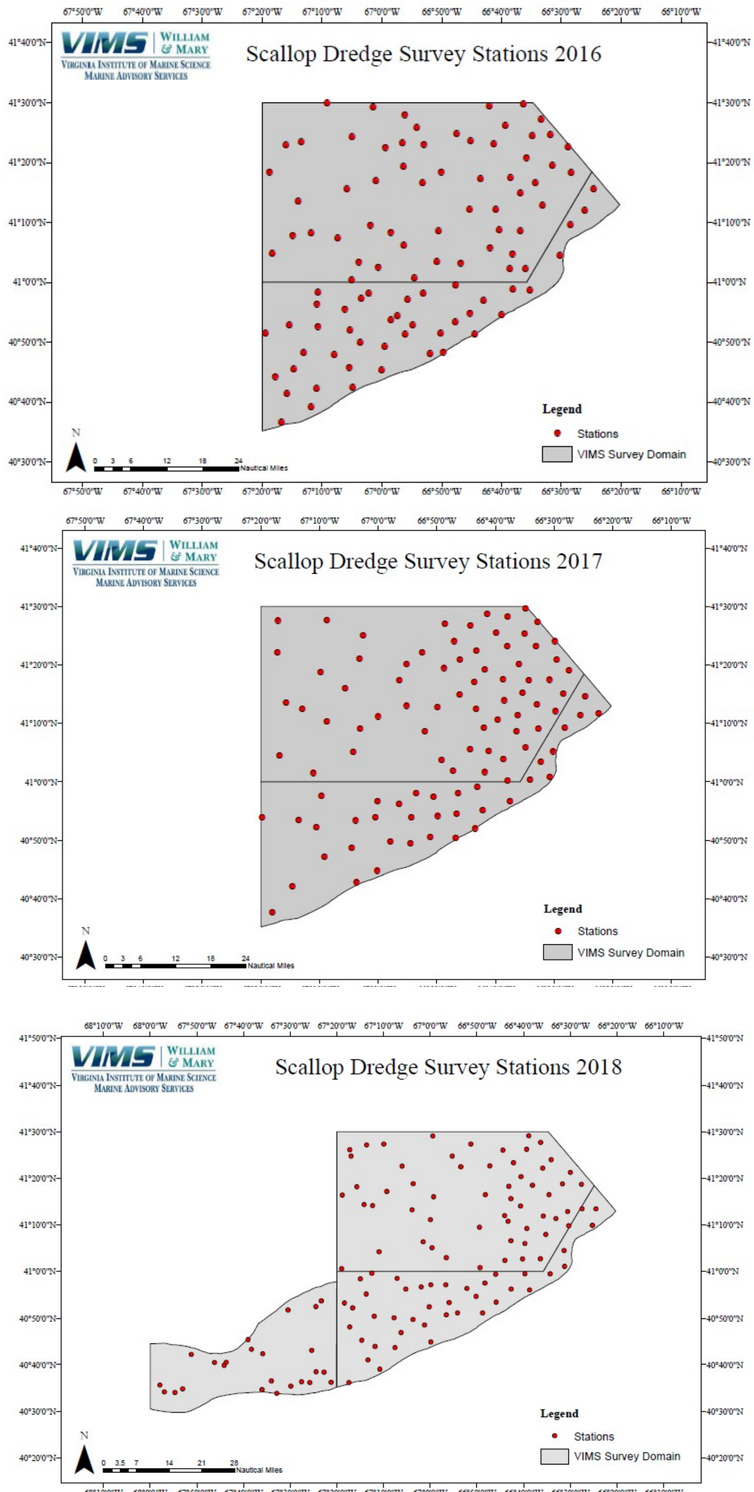

Figure 1 – VIMS survey area (grey) for CAII and surrounds showing stations completed by year.

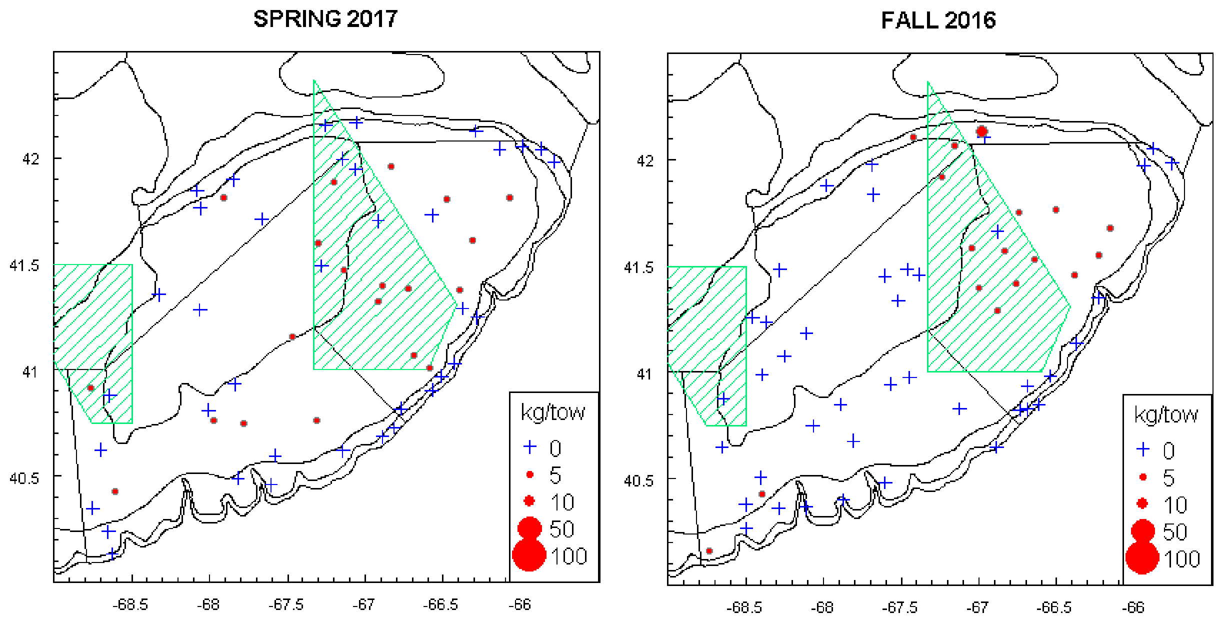

Figure 2 – NMFS spring 2017 and fall 2016 survey catches of yellowtail flounder.

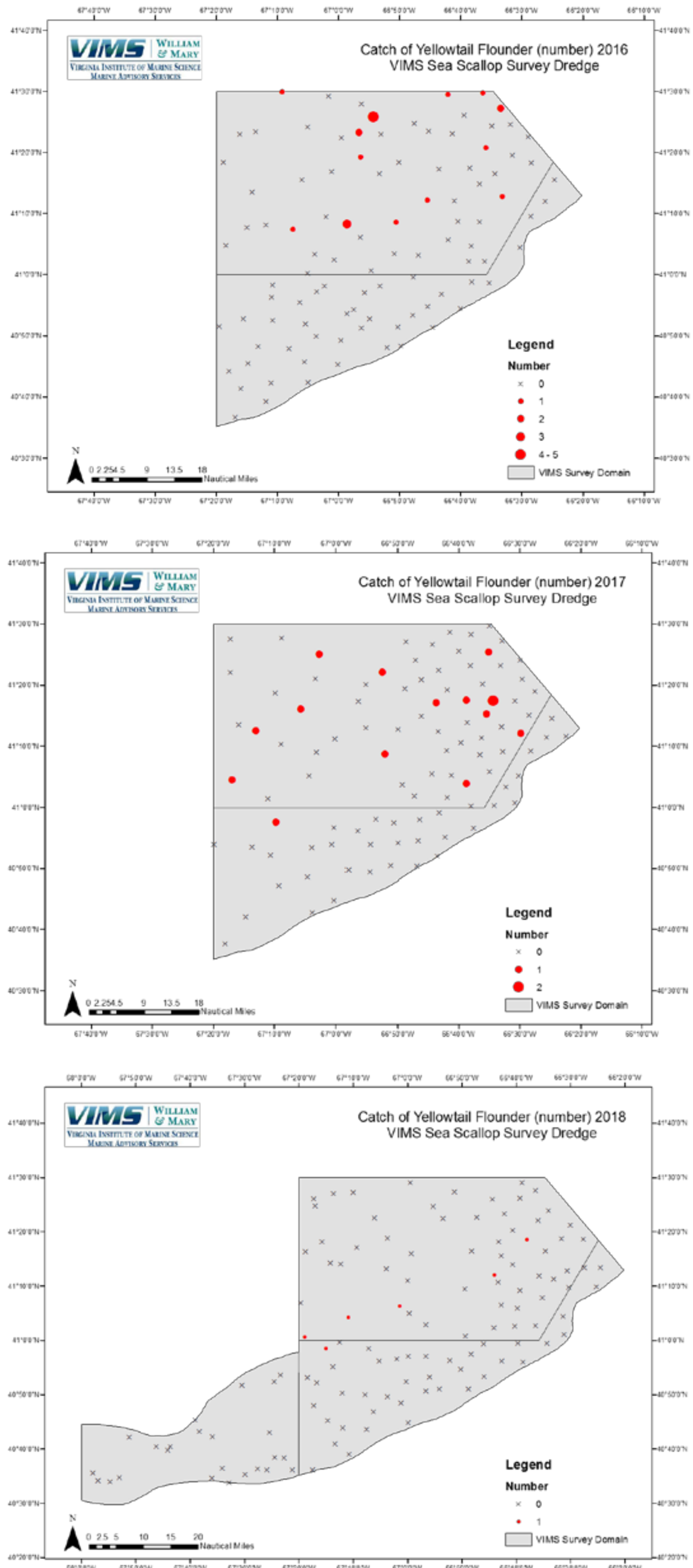

Figure 3 – VIMS scallop survey catches of yellowtail flounder (number), 2016-2018.

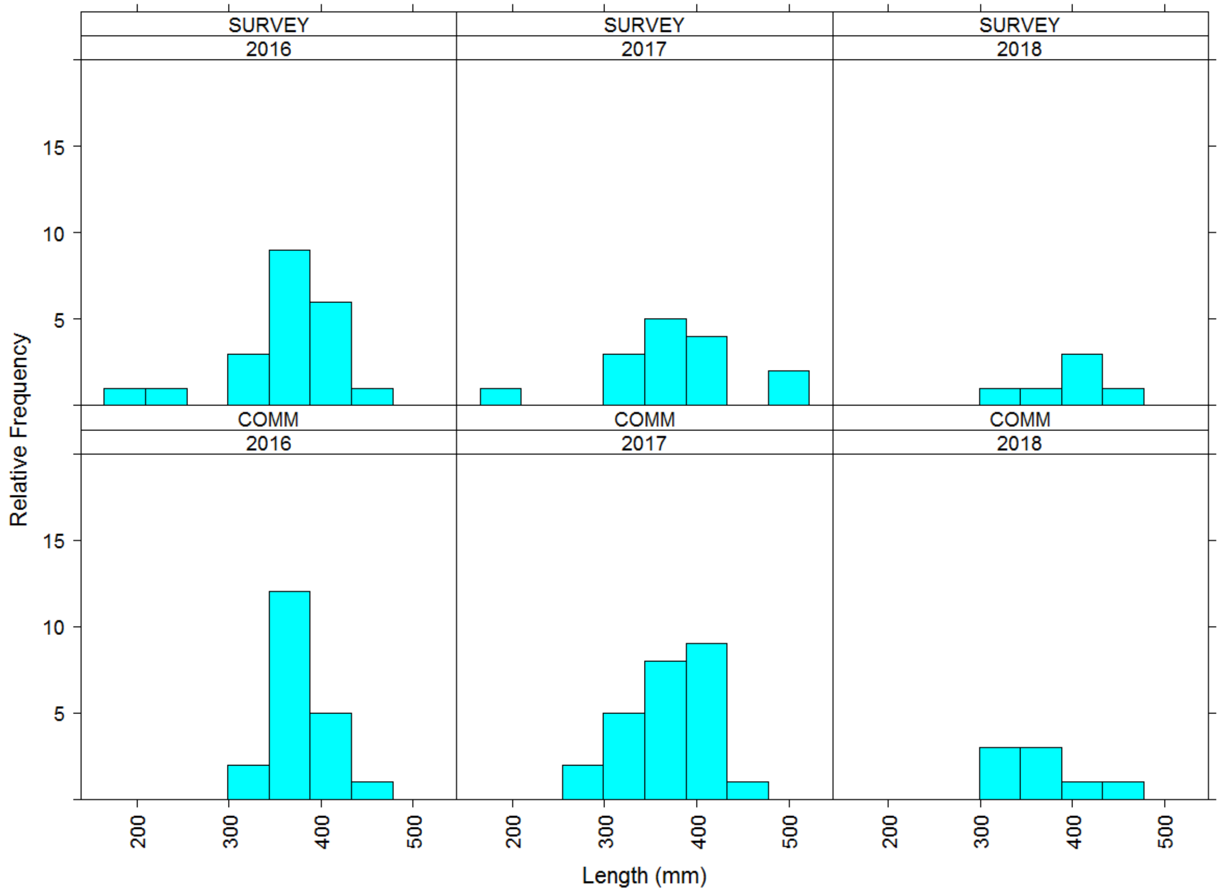

Figure 4 – Relative length-frequencies of yellowtail flounder caught in the VIMS scallop survey by year and gear. Survey gear (top) and commercial gear (bottom).

Appendix F

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Working Paper 2019/xx

Georges Bank Yellowtail Flounder Estimates from VIMS Industry-Based Scallop Dredge Surveys of Closed Area II and Surrounds

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Ce document est disponible sur l'Internet à :

This document is available on the Internet at :

http://www.mar.dfo-mpo.gc.ca/science/TRAC/trac.html

Canada

ABSTRACT

The Virginia Institute of Marine Science (VIMS) conducted fine scale spatial dredge surveys of Closed Area II (CAII) in 2005, 2007, 2008, 2011, 2012, 2013, 2016, 2017, 2018, and 2019 for the purposes of examining scallop abundance and distribution. The spatial extent of surveys varied between years. From 2005 – 2011, the traditional CAII scallop access area was surveyed. In 2012, a portion of the CAII groundfish closure and surrounds on the Northern Edge of Georges Bank (GB) were surveyed. In 2013, area in the Essential Fish Habitat (EFH) and surrounds on the Northern Edge of GB were surveyed again. For 2016 – 2019, the traditional CAII scallop access area and surrounds along the southern flank of GB were surveyed. In 2018 and 2019, the survey domain was expanded to cover additional area along the southern flank of GB. Scallop and finfish catch were enumerated and length measurements were taken. Survey catches were examined to determine whether there were trends in yellowtail flounder abundance in the surveyed area. Results indicated a decline in yellowtail flounder abundance over the time period, as well as a truncation of the size distribution observed.

RÉSUMÉ

Introduction

The stock assessment model for GB yellowtail flounder uses an empirical assessment approach, developed at the 2014 GB yellowtail flounder Diagnostic and Empirical Approach Benchmark and subsequent Transboundary Resource Assessment Committee (TRAC) meeting, and further refined following an intersessional TRAC conference call in June 2017 (i.e., adjusted survey catchability). Three bottom trawl surveys (DFO, NMFS spring, and NMFS fall surveys) are used to create a model-free estimate of population biomass (Legault and McCurdy, 2018). An exploitation rate is applied to the average of these three surveys to derive catch advice.

Catches of GB yellowtail flounder by the groundfish fishery have been at historic low levels due to low quotas, resulting in a decline in fishery dependent information on the stock. There have also been uncertainties associated with the research vessel surveys from both the NMFS and DFO. In the case of the R/V *Bigelow* (NMFS survey vessel), there have been several investigations on the catchability assumptions used to convert relative survey indices into biomass estimates, and in the past few years there have been concerns raised about the accuracy of the area swept by the survey vessel at different depths. In the fall of 2017, a different research vessel was used because the R/V *Bigelow* suffered from a mechanical casualty. The spring DFO survey also used a different vessel than normal in 2017. The NMFS also completed less tows in 2017 and 2018 due to weather and mechanical issues (Legault and McCurdy, 2018). As a result of the uncertainty caused by these factors, additional information on recent abundance trends could be helpful when interpreting the results of the empirical approach.

The U.S. Atlantic sea scallop fishery has an extensive research program, referred to as a research set-aside (RSA) program, funded by a set-aside of the annual fishery quota. A key part of this program is the funding of surveys using several different gears: commercial dredges, a standardized sea scallop survey dredge, and cameras. The VIMS dredge survey focuses primarily on areas of sea scallop abundance, but also collects biological information related to finfish and other biota as a secondary objective. Surveys on GB often overlap areas of historic yellowtail founder distribution, such as the VIMS dredge surveys of the CAII access area, CAII groundfish closed area, and surrounds in 2005, 2007, 2008, 2011, 2012, 2013, 2016, 2017, 2018, and 2019. Here, the VIMS survey data in CAII and surrounds were examined for trends in yellowtail flounder abundance.

Data and Methods

VIMS received scallop RSA funding to conduct high resolution surveys to sample several areas of GB CAII and surrounds. Survey domains varied across the time period examined. Areas surveyed included the CAII scallop access area, CAII groundfish closed area, EFH area, additional area on the Northern Edge of GB, a rotational closure area south of the scallop access area, and additional area on the southern flank of GB (Figures 1 - 10). While the focus of these surveys was to conduct a high-resolution survey of the scallop resource in these areas, a secondary objective was to collect information on finfish catch. One finfish species of interest was yellowtail flounder because the scallop fishery catch of this species is limited to a small allocation. While the survey does not cover all of GB, the majority of survey coverage focuses on the area of historic yellowtail abundance that corresponds to an area with limited coverage by the NMFS bottom trawl spring and fall surveys in more recent years (2016 – 2018) (Figure 11) (Legault and McCurdy, 2017; Legault and McCurdy, 2018).

In addition to changing survey domains, other aspects of the surveys were also variable, including survey design, commercial gear used, and number of stations sampled. Summary information for each survey is provided in Table 1. The number of stations sampled during each survey is provided in Table 2.

Survey Design and Station Allocation

Each survey consisted of one annual cruise that sampled pre-determined stations within a given survey domain. The survey design was changed from a systematic sampling grid design to a stratified random design in 2016. A systematic grid design was used from 2003 – 2013. The methodology to generate the systematic random grid entailed the decomposition of the defined domain of interest into smaller sampling cells. The dimensions of the sampling cells were primarily determined by a sample size analysis conducted using the catch data from survey trips conducted in the same areas during prior years. Since sampling domains were of different dimensions and the total number of stations sampled per survey remained fairly constant, the distance between stations varied. Generally, the distance between stations was roughly 5.5 – 7.4 km. Once the cell dimensions were set, a point within the most northwestern cell was randomly selected. This point served as the starting point and all of the other stations in the grid were based on its coordinates. Since 2016, a stratified random survey design has been employed (Cochran, 1977). In 2016, stations were allocated using proportional allocation based on stratum size. For 2017 - 2019, a hybrid approach consisting of both proportional and optimal allocation techniques (Neyman allocation) determined station allocation (Cochran, 1977). A percentage of stations were allocated based on stratum area, the number of scallops observed in the previous year, and the biomass (grams) of scallops observed in the previous year. To ensure all strata in a survey domain were sampled, each stratum was allocated a minimum of two stations. Stratification was based on the NMFS shellfish strata.

Survey Protocols

All surveys were conducted onboard commercial sea scallop dredge vessels in the spring/summer (Table 1). At each station, the vessel simultaneously towed two dredges. The NMFS sea scallop survey dredge, 2.4 m in width equipped with 5.08 cm rings, 10.16 cm diamond twine top and a 3.8 cm diamond mesh liner was towed on one side of the vessel. On the other side of the vessel, a 3.96 m, 4.27 m or 4.57 m commercial scallop dredge equipped with 10.16 cm rings, a 25 cm diamond mesh twine top and no liner was fished (Table 1). In this paired design, it is assumed that the dredges cover a similar area of substrate and sample from the same population of scallops. For each paired tow, the dredges were fished for 15 minutes with a towing speed of approximately 3.8 - 4.0 kts, and a scope to depth ratio of 3:1. Since 2016, a Star Oddi tilt sensor (records angle of inclination, temperature, depth) has been used to determine dredge bottom contact time and high-resolution navigational logging equipment was used to accurately determine vessel position and speed over ground. Time stamps for both the inclinometer and the navigational log determined the location and duration fished by the dredges. Bottom contact time and vessel location were integrated to estimate the swept area of each gear.

Catch Sampling

Sampling of the catch was conducted in the same manner described by DuPaul and Kirkley (1995) and DuPaul et al. (1989), which has been utilized during all VIMS scallop surveys since 2005. For each paired tow, 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 catch volume, was measured. Prior to 2016 scallops were measured with a NMFS sea scallop measuring boards in 5 centimeter (cm) intervals. Since 2016, scallops have been measured to the nearest millimeter (mm) to determine size frequency.

Other species sampled included typical sea scallop fishery bycatch: groundfish, skates, crabs and starfish. All groundfish (flatfish, monkfish, cod, haddock, dogfish) were counted and measured (total length (TL)) to the nearest centimeter (cm) (prior to 2016) and mm (2016 on) by species for each dredge. Since 2016, all station-level data has been entered into the data acquisition program Fisheries Environment for Electronic Data (FEED). Data collected included number of animals, length measurements, bridge information, and shell height – meat product quality data. Length measurements were recorded using an electronic Ichthystick measuring board integrated with the FEED program that allows for automatic recording of length measurements. The bridge data included station level information including location, time, tow time (break- set/haul-back), tow speed, water depth, weather, and comments relative to the quality of the tow. Data collection has been consistent across years. Before 2016, all data was recorded on paper logs and entered into a database after a cruise was completed.

Scallop Dredge Efficiency

Dredge efficiency estimates for yellowtail flounder for either the survey or commercial dredges is limited, with literature on this topic coming from past TRAC working papers (Barkley et al., 2013; Hennen, 2013; Shank et al., 2013; DeCelles et al., 2014). Shank et al. (2013) and Hennen (2013) each provided several yellowtail flounder efficiency estimates for the survey dredge from data collected by the NMFS' sea scallop Habcam optical survey. Shank et al. (2013) estimated efficiency values of 0.43 for 2010 data, 0.82 for 2012 data, and a mean of 0.62. The authors suggested the 2012 estimate of 0.82 may be more accurate for several reasons related to the timing between the dredge and Habcam surveys, yellowtail flounder seasonal migration patterns, and gear avoidance observed by yellowtail flounder in relation to the Habcam gear (Shank et al., 2013; Shank and Duquette, 2013). Yellowtail flounder migration into CAII has shown to vary seasonally, with yellowtail flounder moving into the area in the late summer/early fall (Barkley et al., 2013; Winton et al., 2017). Hennen (2013) also provided the following efficiency estimates: 0.46, 0.49, 0.77, and 0.83. These values were also estimated with the NMFS Habcam dredge data. The author noted the efficiency estimates "provide some limited information on the efficiency of the scallop survey dredge for YTF [yellowtail flounder]. It is, however, important to incorporate the cv's [CV] of these estimates as they are highly imprecise."

Barkley et al. (2013) and DeCelles et al. (2014) estimated efficiency values for the commercial New Bedford style scallop dredge. These estimates were derived from data collected in 2012 as part of a seasonal bycatch survey conducted by the Coonamesset Farm Foundation in Closed Area I and CAII. A ratio of the efficiency of the survey dredge to the value from a regression through the origin for catch data from the study was used to estimate commercial dredge efficiency. This resulted in efficiency estimates of 0.201 and 0.25 for the commercial dredge from Barkley at al. (2013) and DeCelles et al., (2014), respectively. The ratio presented in both papers could be used to estimate commercial dredge efficiency for a range of survey efficiency estimates.

Biomass Estimation

Yellowtail flounder length data were converted to cm. Length-weight parameters from Wigley et al. (2013) were used to calculate individual yellowtail flounder weight in kg. For trips taken in 2007, 2013, 2016, 2017, 2018, and 2019, spring parameter estimates of ln a = -12.3581 and b = 3.2099 were used. For trips taken in 2005, 2008, 2011, and 2012, the average of spring and autumn estimates were used (ln a = -12.0981 and b = 3.1329), since no estimates for summer months are available (Barkley et al., 2013; DeCelles et al., 2014). The total number per tow and weight per tow was the sum of all individual fish at a given station.

Area swept for each station by gear type was calculated by multiplying the dredge width by the tow distance (km). For trips taken prior to 2016, tow distance was calculated with the geodist function in R, using the start and end coordinates for a station (R Core Team, 2016). For trips after 2016, the Star Oddi sensor informed actual time on bottom. Data from the senor was integrated with the vessel's tow track to calculate tow distance with the same R function. The appropriate dredge width for the commercial dredge by year was used for commercial gear calculations (Table 1). The calculated area swept for each gear prior to 2016 may be slightly overestimated as a result of using the start and end coordinates. This would lead to a minor underestimate of yellowtail flounder density at the station-level, depending on the difference between the realized tow distance and the estimated tow distance.

Swept-area total biomass (kg/tow) and abundance (number/tow) estimates for each year and gear were calculated from station-level density estimates. Density was scaled to estimate absolute biomass or abundance with a range of catchability coefficients (*q*) by gear type. The following *q* values were used for the survey dredge: 0.43, 0.62, 0.83, and 1 (Shank et al., 2013). Hennen's estimates were not considered based on the author's conclusions regarding the values. For the commercial dredge, *q* values applied were 0.25, 0.43, and 1 (DeCelles et al., 2014). The DeCelles' et al. (2014) *q* value was selected over the Barkley et al. (2013) estimate because data issues were found in the Barkley et al. paper (DeCelles, *per. comm.*). A *q* of 1 for either gear represents the minimum area swept biomass estimate and should be considered the lower bound of biomass estimates.

The absolute density of yellowtail flounder (kg/km^2 and number/km^2) for station i, gear g and year y was calculated as:

$$yellowtail\ flounder\ density_{i,g,y} = \frac{yellowtail\ flounder\ _{i,g,y}(kg/number)}{area\ swept_{i,g,y}\ \ (km^2)} * \frac{1}{q_g}$$

Total biomass (mt) or total number for each year and gear was calculated as the mean yellowtail flounder density ($\overline{yellowtail\ flounder\ density_{g,y}}$) in the survey domain multiplied by the survey area:

$$Total\ Biomass_{y,g} = \overline{yellowtail\ flounder\ density_{g,y}} * Survey\ Area_y\ (km^2)$$

The variance and 95 percent confidence intervals were calculated for all estimates.

Stratification of the survey domain for 2016 – 2019 was not considered in biomass estimation, since strata were based on NMFS shellfish strata and the survey design was not consistent across years.

Results

The number and total weight (kg) of yellowtail flounder by year and gear are provided in Table 3. The number and weight of yellowtail flounder caught in either dredge has declined over the time period, although there was an increase in the number of fish observed in both gears in 2019 compared to 2018. This overall decline is evident in the most recent years (2016 – 2019), even though there was an increase in the number of stations and area covered compared to earlier years. The greatest number of fish were observed from 2005 – 2008. The number of fish caught in the survey dredge in 2019 was the greatest recorded since 2013. The increase was more modest in the commercial gear. The commercial gear in 2019 was smaller than previous commercial gears, with a width of 3.96 m compared to larger dredges used in 2017 and 2018.

Length frequency distributions by year and gear are included in Figures 12 - 13. The survey dredge retained smaller yellowtail flounder than the commercial dredge, which is expected since the survey dredge uses a 3.8 cm liner that is not used in the commercial dredge. The selectivity of the commercial dredge also limits the catch of smaller yellowtail flounder (Legault et al., 2010). The size range of yellowtail flounder caught in either dredge has narrowed since 2012, as the number of fish caught as decreased. In 2019, the number of smaller fish caught in the survey dredge increased. The majority of fish sampled were in the 10 to 20 cm length range.

The spatial distribution of yellowtail flounder catches for each year and gear are provided in Figures 14 – 23. Between 2005 and 2011, yellowtail flounder were observed throughout the CAII access area. In 2012 and 2013, surveys focused on the northern portion of CAII, and yellowtail flounder were observed throughout the survey domains in both years. In 2016 and 2017, fish were sampled primarily in the central portion and northeast area of the CAII access area. In 2018 and 2019, yellowtail flounder were mainly observed along the southern and eastern boundaries of the CAII access area.

Absolute biomass and abundance estimates with varying q values are provided in Tables 4 – 7. Biomass and abundance have declined since 2005 for both gears. Biomass estimates for 2018 and 2019 were comparable for the survey dredge, with estimates ranging from 63.90 mt (q = 1) to 150.33 mt (q = 0.43). Estimates for the commercial dredge in 2019 were approximately double the 2018 estimates. Abundance in 2019 was greater than 2018 for the survey dredge due to the increase in the number of small fish observed this year. For the commercial dredge, the 2018 biomass estimates are the lowest for the time period. The lower bound estimate in 2018 was 30.17 mt. Biomass increased slightly in 2019 to 64.64 mt, when assuming the commercial dredge catchability was 1.

Discussion

The VIMS scallop surveys provide detailed spatial coverage of a portion of the yellowtail flounder stock area. With its consistent and well-documented methods, it can provide additional information on the status of the GB yellowtail flounder stock – albeit for a limited area at one time of the year. However, the area covered by the surveys is an area long-recognized as important for this stock. The information from this survey can be used as ancillary information to assist with the interpretation of assessment results and trends from surveys traditionally used for management.

Over the time period the surveys were conducted, biomass estimates reflect a decline in yellowtail flounder abundance in the areas monitored. The decline in biomass in 2007, followed by an increase in 2008, is probably related to the timing of the surveys and yellowtail flounder migration into the survey area. In 2007, the survey was conducted in the spring, while the 2005 and 2008 surveys were conducted in the summer. The spring time period may be too early to monitor yellowtail flounder that have not begun to migrate into the CAII access area. The 2018 and 2019 estimates are the lowest in the time period for both gears. The 2018 results are similar to the biomass indices from the 2018 DFO and spring NMFS trawl surveys in terms of being the lowest estimates during the time period (Legault and McCurdy, 2018). The overall reduction in biomass may be related to a lack of recruitment, as illustrated by the contraction of the length distribution of fish observed over the time period and a decline in the number of fish caught. Given the limited number of fish caught in the latter years this conclusion; however, is uncertain. The increase in the number of small fish observed in 2019 also contributes to the uncertainty regarding recruitment.

Biomass values are comparable to previous estimates provided by VIMS to the TRAC in 2014 for the 2005, 2007, 2008, and 2011 surveys (Rudders and Legault, 2014). Rudders and Legault (2014) estimated absolute biomass with catchability coefficients of 0.46 and 1. While the catchability coefficient of 0.43 is slightly lower than the value used in 2014, the difference between estimates in small. The minimum swept area estimates, assuming a catchability coefficient of 1, were also equivalent for all years. There is a similar signal of declining biomass over time from both sets of estimates. When comparing the 2019 estimate to previous estimates, the 2019 lower bound estimates of 64.64 mt for the survey gear and 61.24 mt for the commercial dredge are considerably lower than any estimate provided by Rudders and Legault (2014) for either gear. The lowest minimum estimate provided by Rudders and Legault (2014) for the survey dredge was 901.21 mt and 782.60 mt for the commercial dredge.

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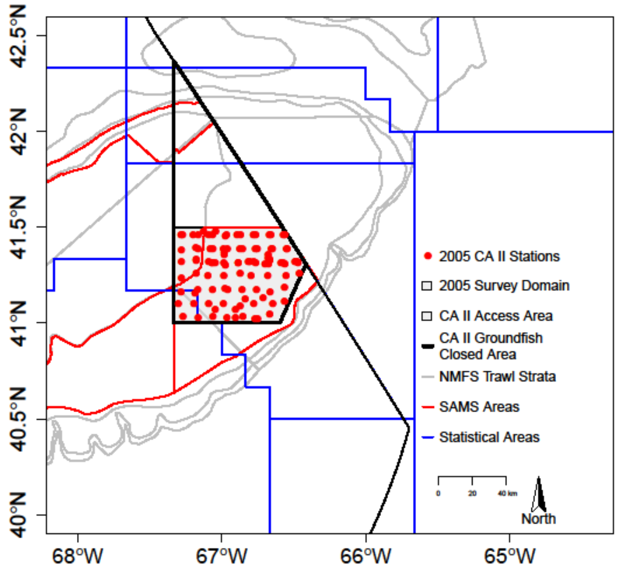

Figure 1. VIMS 2005 survey domain (light gray) and stations sampled (red circles). The map also includes the CAII scallop access area, CAII groundfish closed area, NMFS trawl survey strata, scallop area management simulator areas (SAMS) for 2019, and NMFS statistical areas.

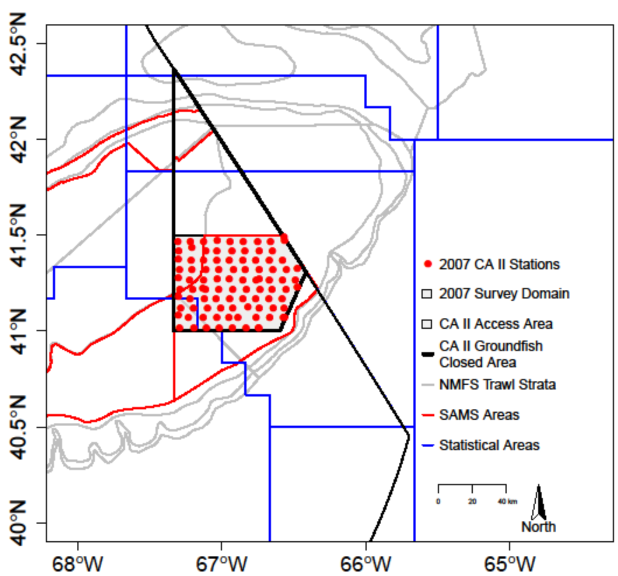

Figure 2. VIMS 2007 survey domain (light gray) and stations sampled (red circles). The map also includes the CAII scallop access area, CAII groundfish closed area, NMFS trawl survey strata, scallop area management simulator areas (SAMS) for 2019, and NMFS statistical areas.

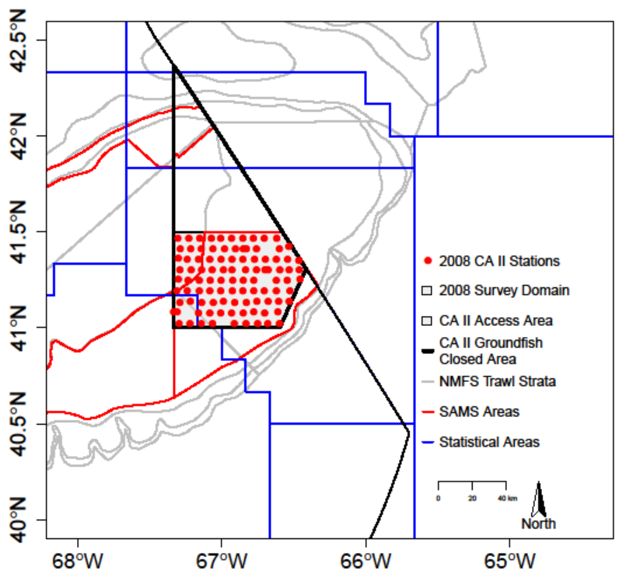

Figure 3. VIMS 2008 survey domain (light gray) and stations sampled (red circles). The map also includes the CAII scallop access area, CAII groundfish closed area, NMFS trawl survey strata, scallop area management simulator areas (SAMS) for 2019, and NMFS statistical areas.

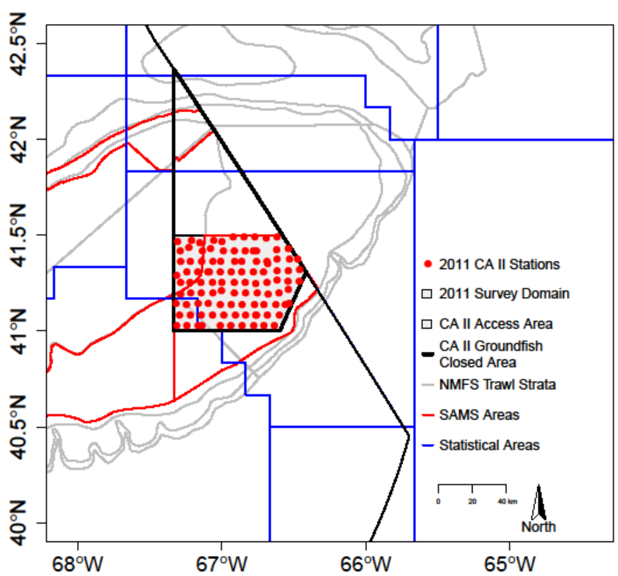

Figure 4. VIMS 2011 survey domain (light gray) and stations sampled (red circles). The map also includes the CAII scallop access area, CAII groundfish closed area, NMFS trawl survey strata, scallop area management simulator areas (SAMS) for 2019, and NMFS statistical areas.

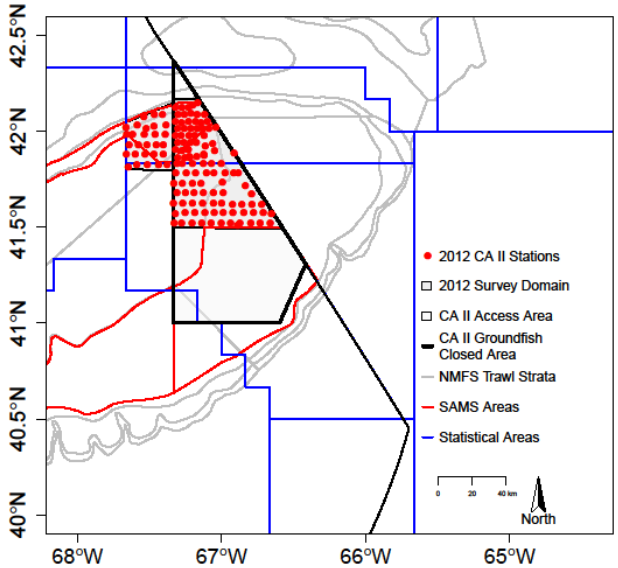

Figure 5. VIMS 2012 survey domain (light gray) and stations sampled (red circles). The map also includes the CAII scallop access area, CAII groundfish closed area, NMFS trawl survey strata, scallop area management simulator areas (SAMS) for 2019, and NMFS statistical areas.

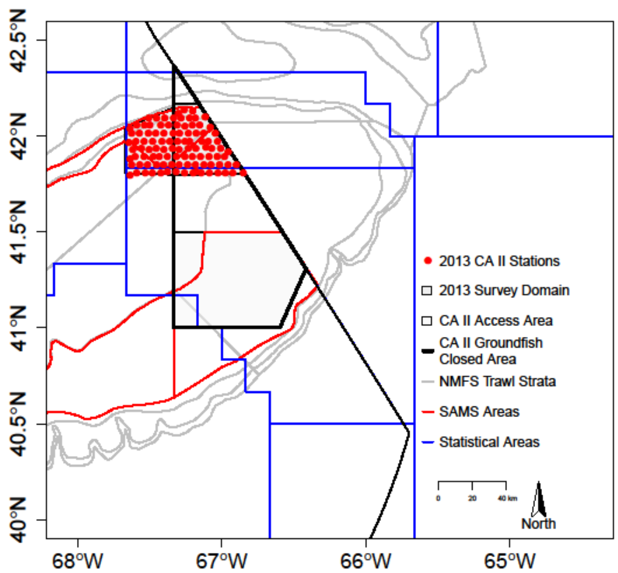

Figure 6. VIMS 2013 survey domain (light gray) and stations sampled (red circles). The map also includes the CAII scallop access area, CAII groundfish closed area, NMFS trawl survey strata, scallop area management simulator areas (SAMS) for 2019, and NMFS statistical areas.

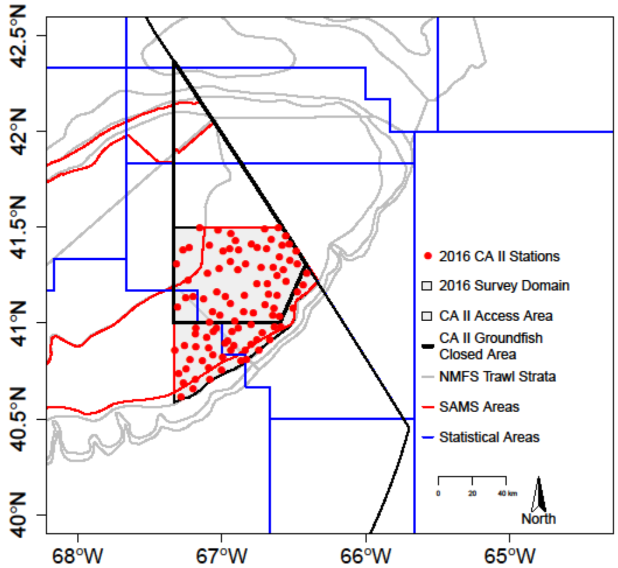

Figure 7. VIMS 2016 survey domain (light gray) and stations sampled (red circles). The map also includes the CAII scallop access area, CAII groundfish closed area, NMFS trawl survey strata, scallop area management simulator areas (SAMS) for 2019, and NMFS statistical areas.

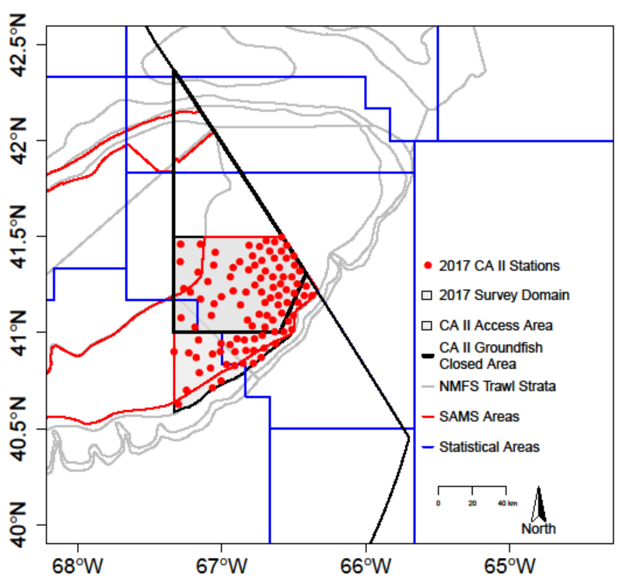

Figure 8. VIMS 2017 survey domain (light gray) and stations sampled (red circles). The map also includes the CAII scallop access area, CAII groundfish closed area, NMFS trawl survey strata, scallop area management simulator areas (SAMS) for 2019, and NMFS statistical areas.

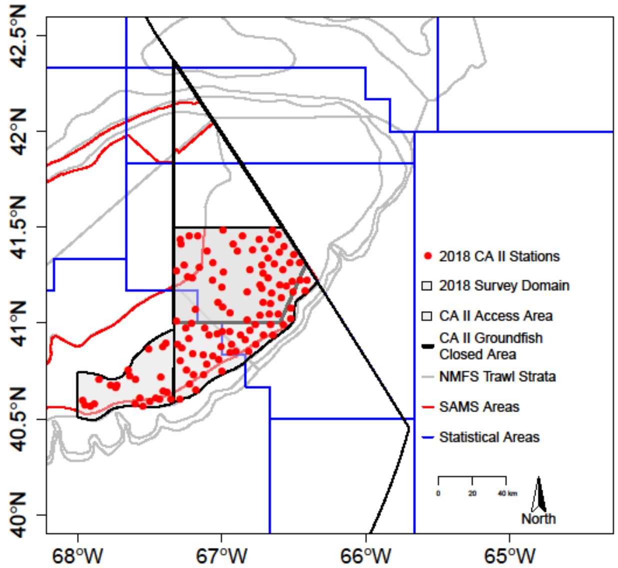

Figure 9. VIMS 2018 survey domain (light gray) and stations sampled (red circles). The map also includes the CAII scallop access area, CAII groundfish closed area, NMFS trawl survey strata, scallop area management simulator areas (SAMS) for 2019, and NMFS statistical areas.

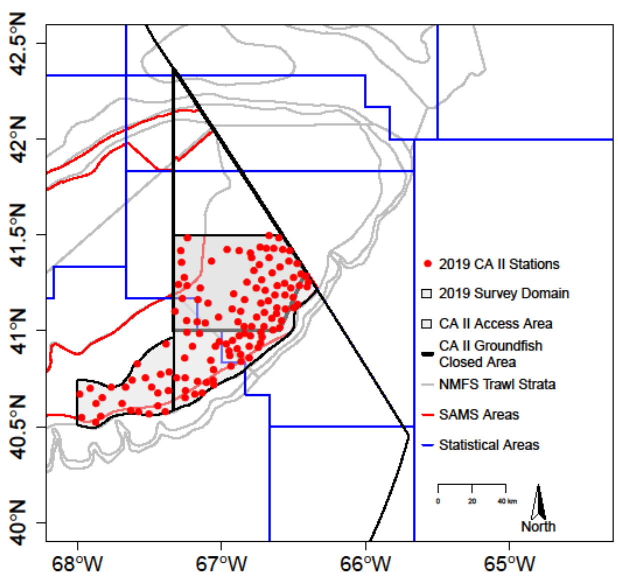

Figure 10. VIMS 2019 survey domain (light gray) and stations sampled (red circles). The map also includes the CAII scallop access area, CAII groundfish closed area, NMFS trawl survey strata, scallop area management simulator areas (SAMS) for 2019, and NMFS statistical areas.

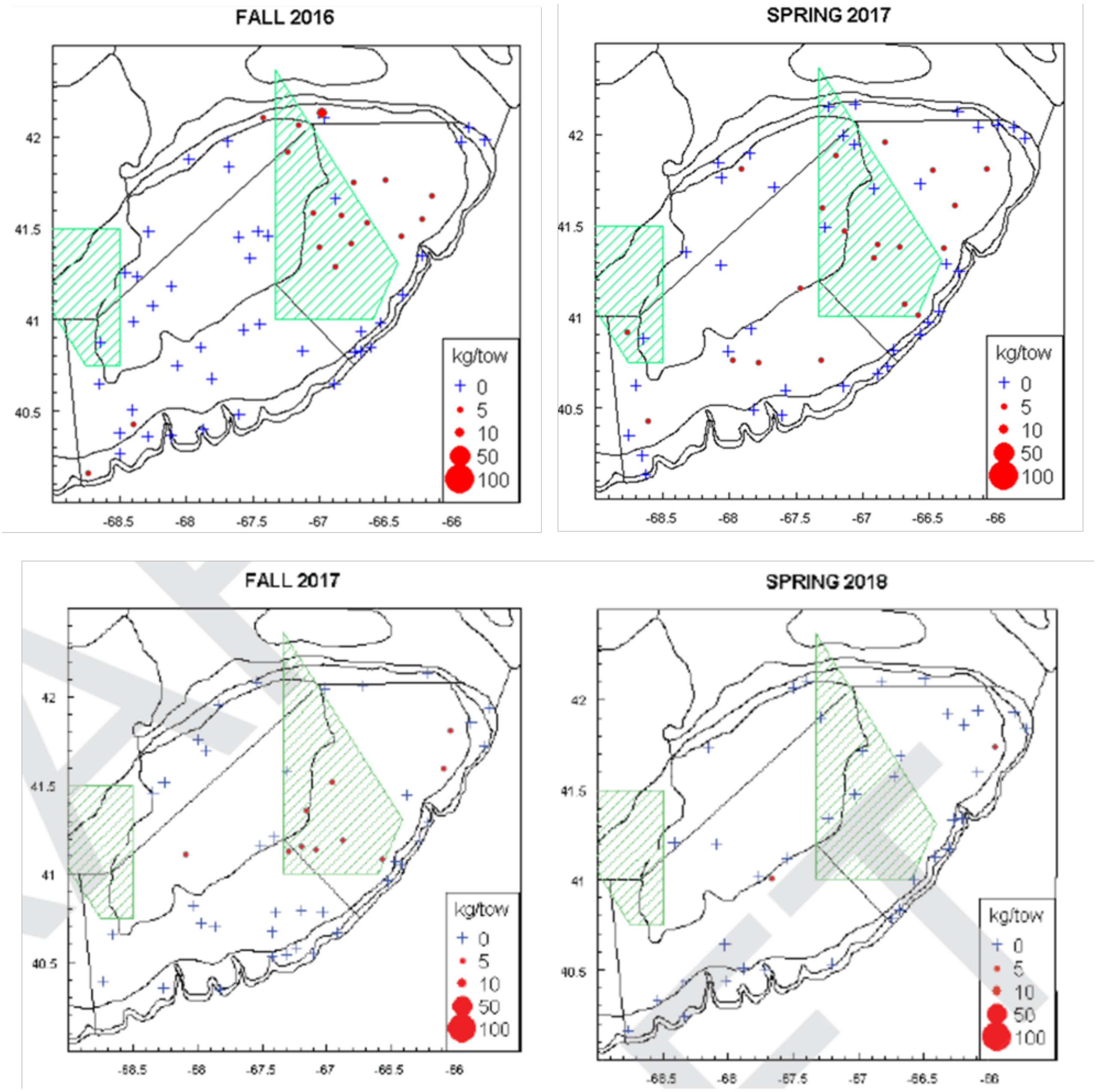

Figure 11. NMFS fall 2016, spring 2017, fall 2017, and spring 2018 survey catches of yellowtail flounder (Legault and McCurdy, 2017; Legault and McCurdy, 2018).

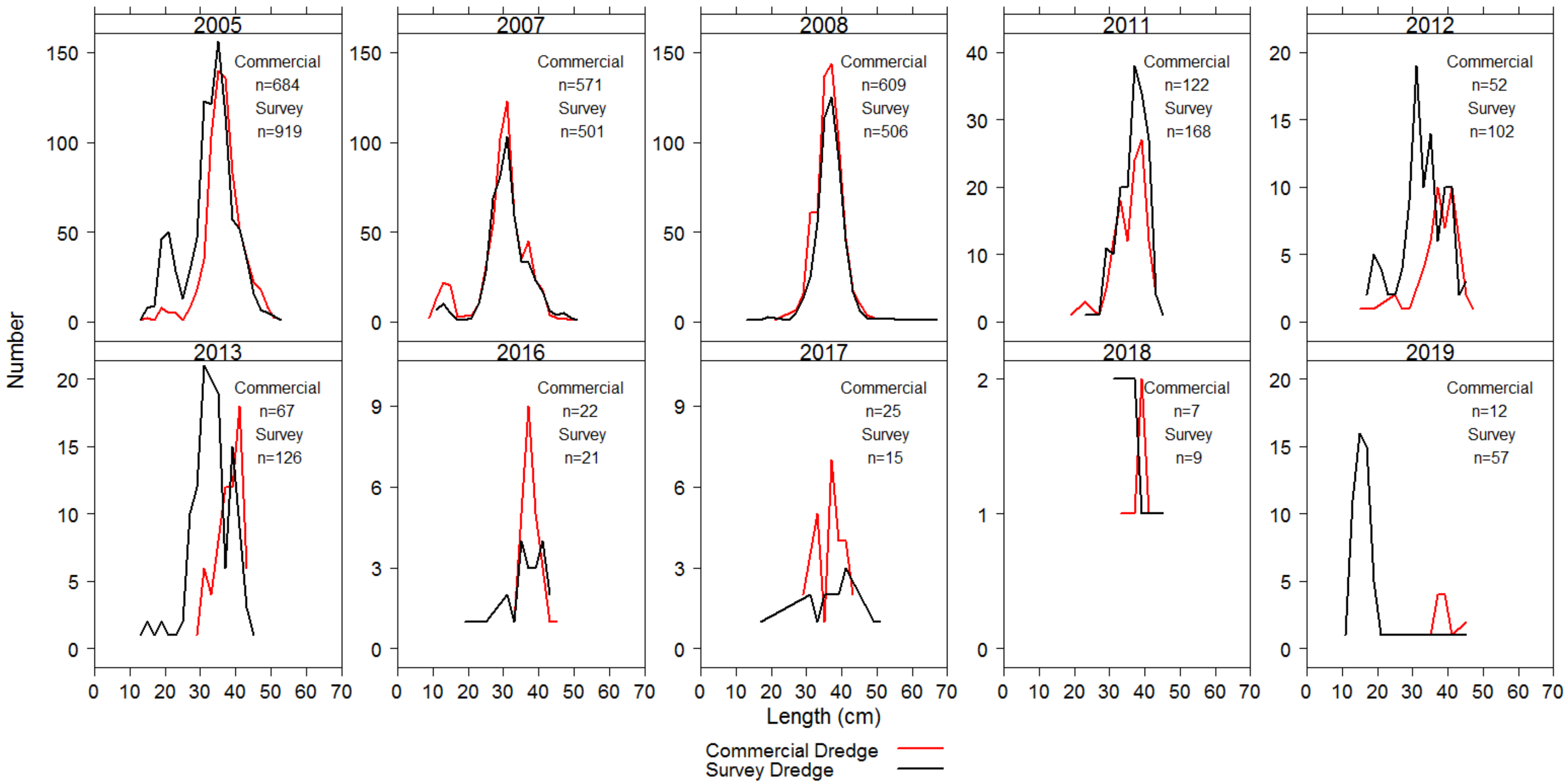

Figure 12. Length frequency distributions of yellowtail flounder measured during the VIMS surveys for the survey and commercial gears by year. Number of yellowtail flounder caught in either dredge by year is also provided in each panel.

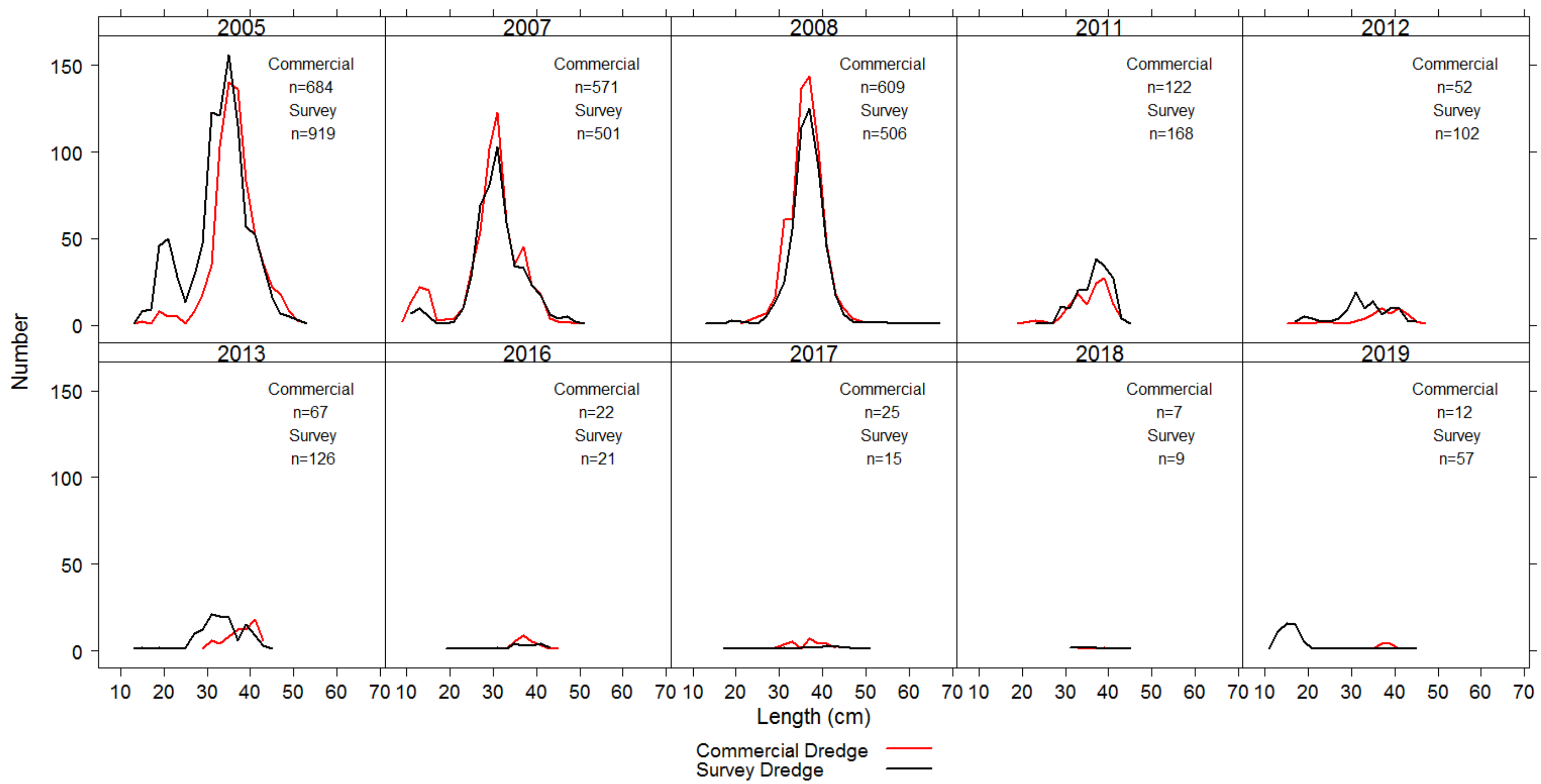

Figure 13. Length frequency distributions of yellowtail flounder measured during the VIMS surveys for the survey and commercial gears by year with the y axis on the same scale. Number of yellowtail flounder caught in either dredge by year is also provided in each panel.

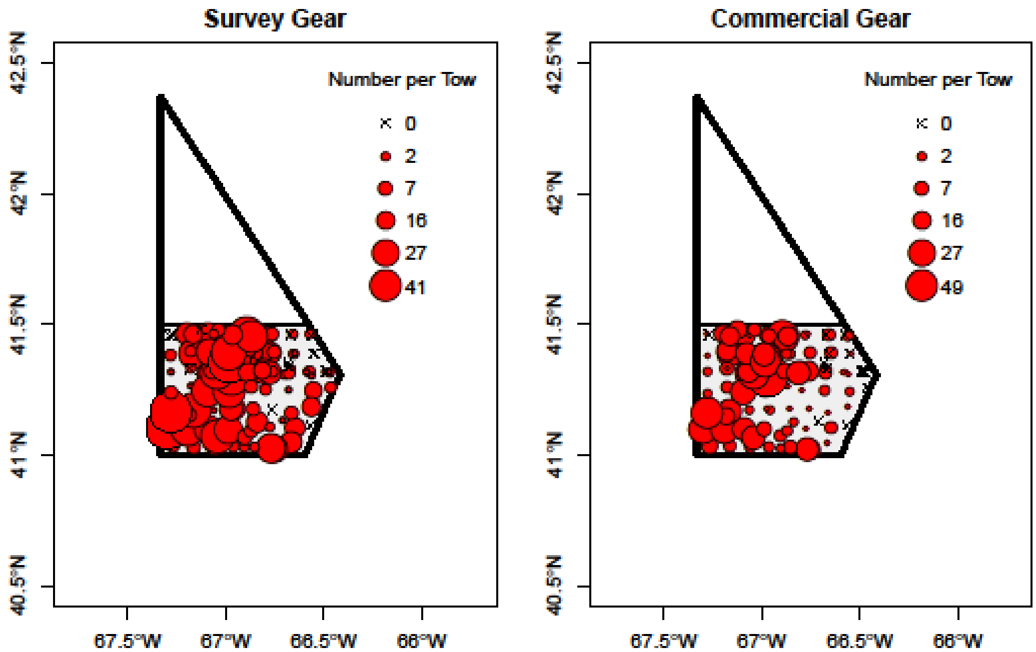

Figure 14. Spatial distribution of the number of yellowtail flounder caught in the VIMS 2005 survey by gear.

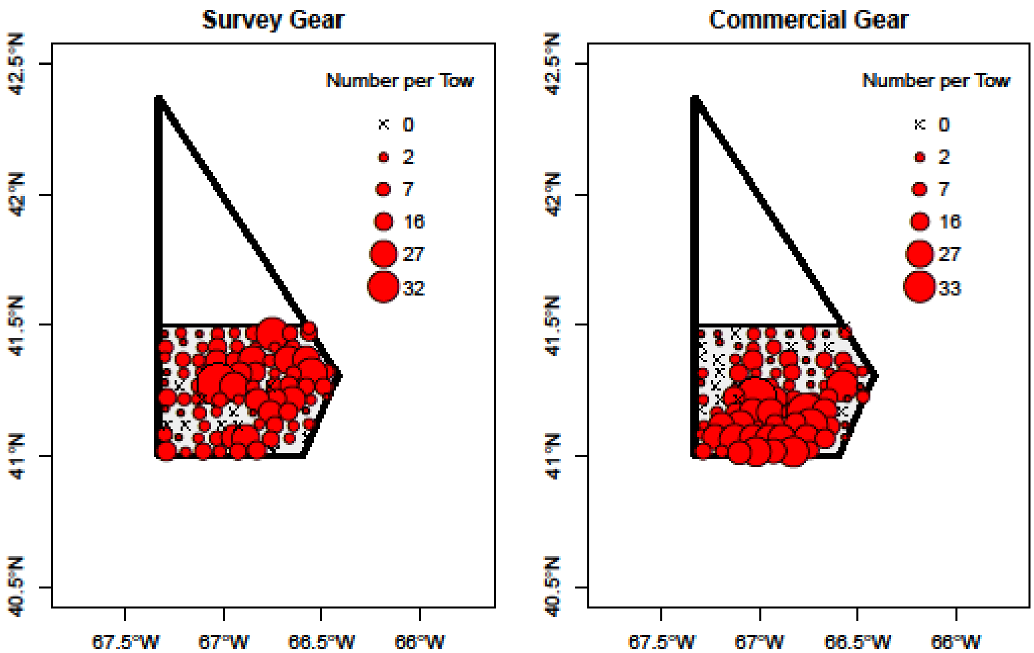

Figure 15. Spatial distribution of the number of yellowtail flounder caught in the VIMS 2007 survey by gear.

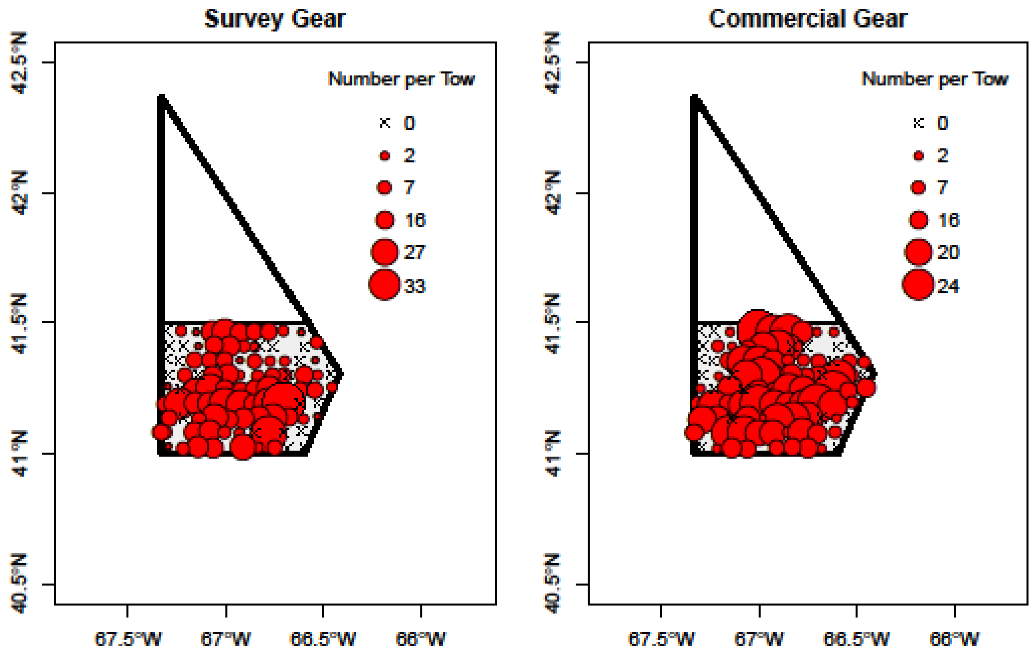

Figure 16. Spatial distribution of the number of yellowtail flounder caught in the VIMS 2008 survey by gear.

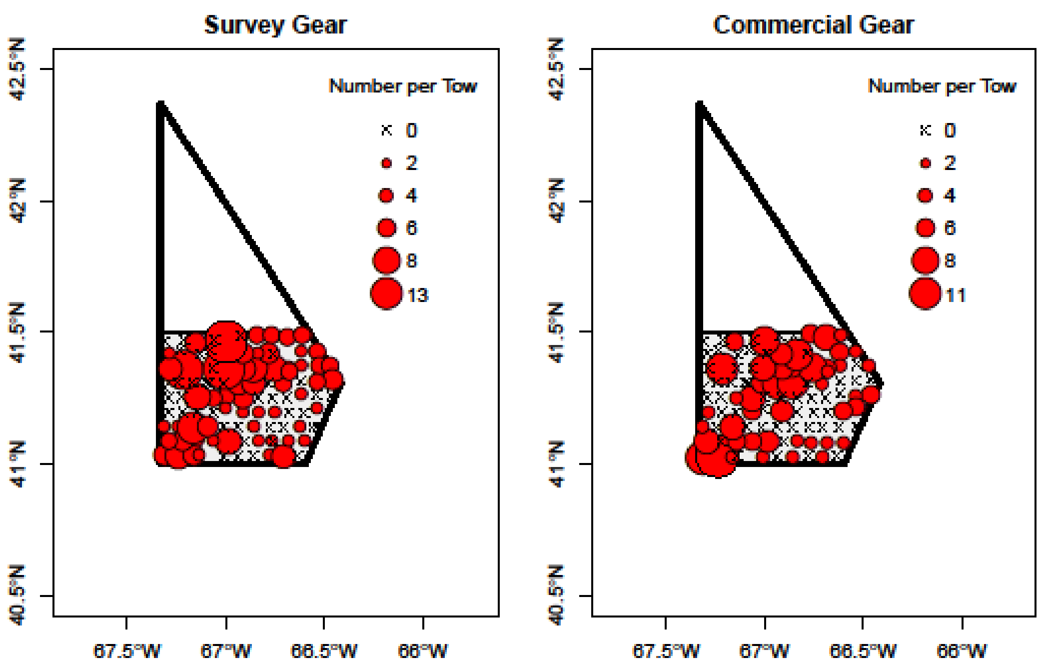

Figure 17. Spatial distribution of the number of yellowtail flounder caught in the VIMS 2011 survey by gear.

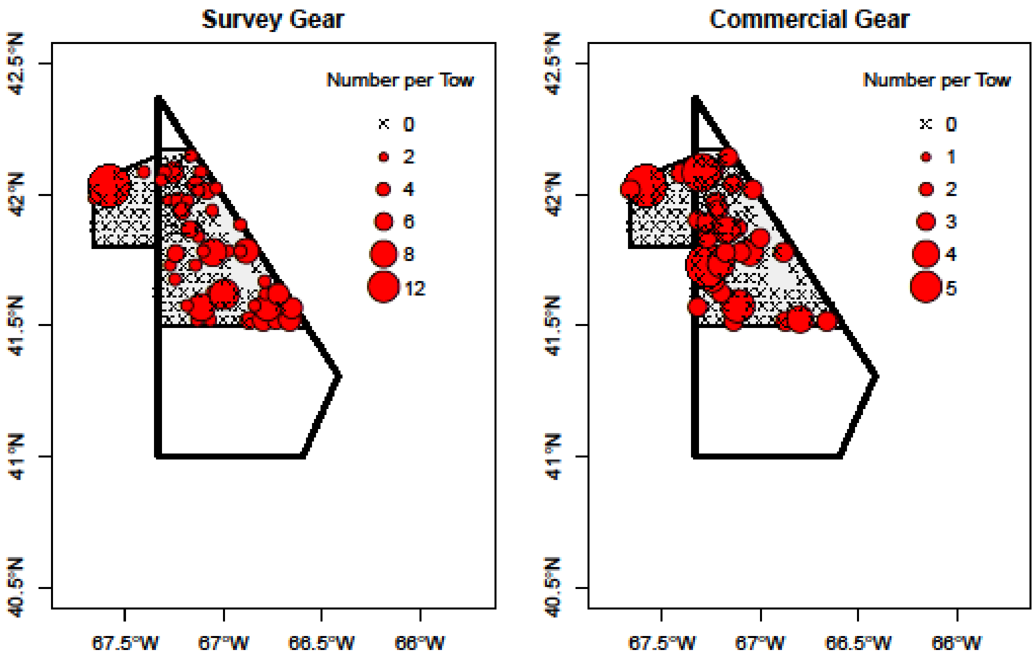

Figure 18. Spatial distribution of the number of yellowtail flounder caught in the VIMS 2012 survey by gear.

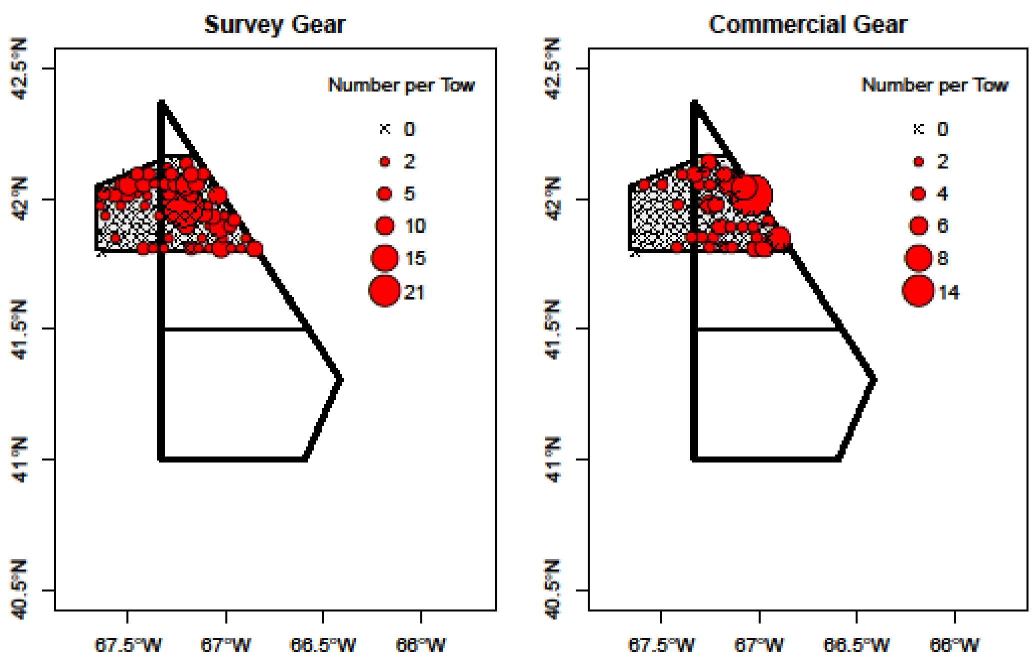

Figure 19. Spatial distribution of the number of yellowtail flounder caught in the VIMS 2013 survey by gear.

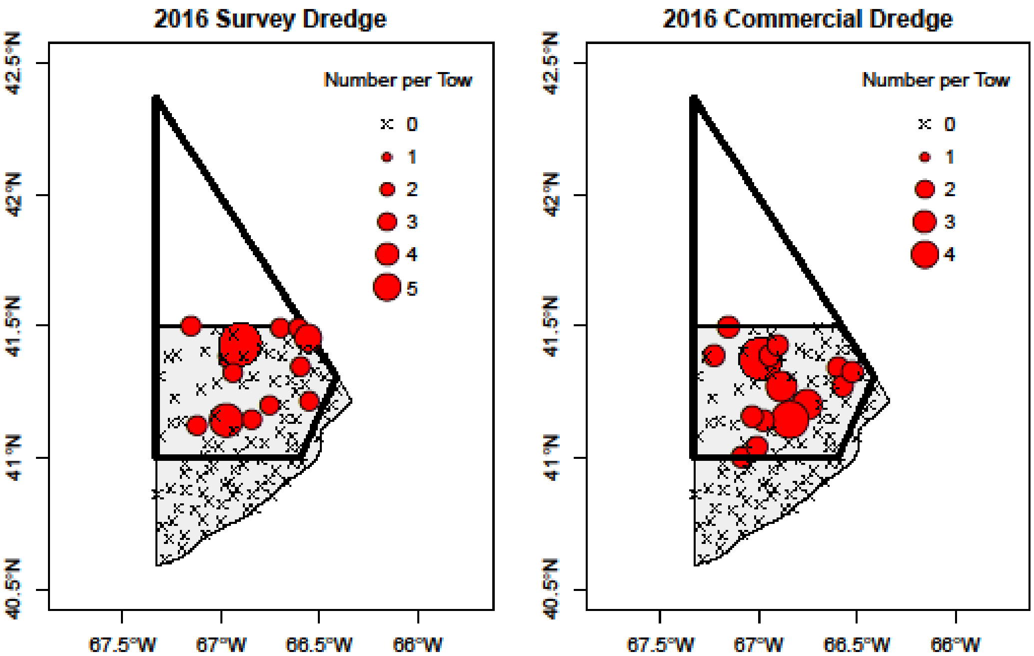

Figure 20. Spatial distribution of the number of yellowtail flounder caught in the VIMS 2016 survey by gear.

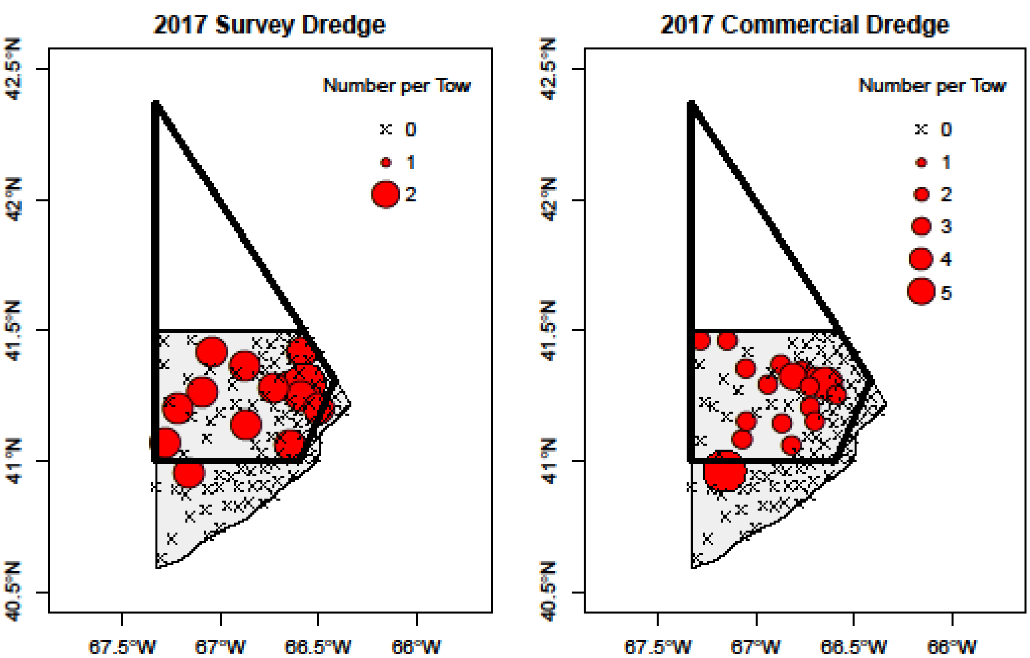

Figure 21. Spatial distribution of the number of yellowtail flounder caught in the VIMS 2017 survey by gear.

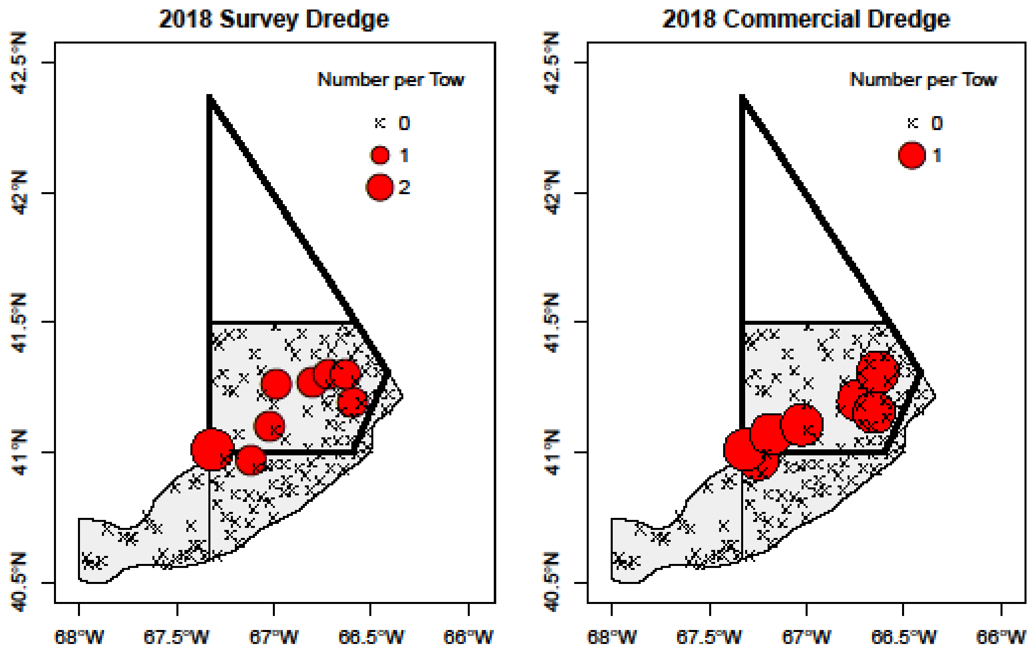

Figure 22. Spatial distribution of the number of yellowtail flounder caught in the VIMS 2018 survey by gear.

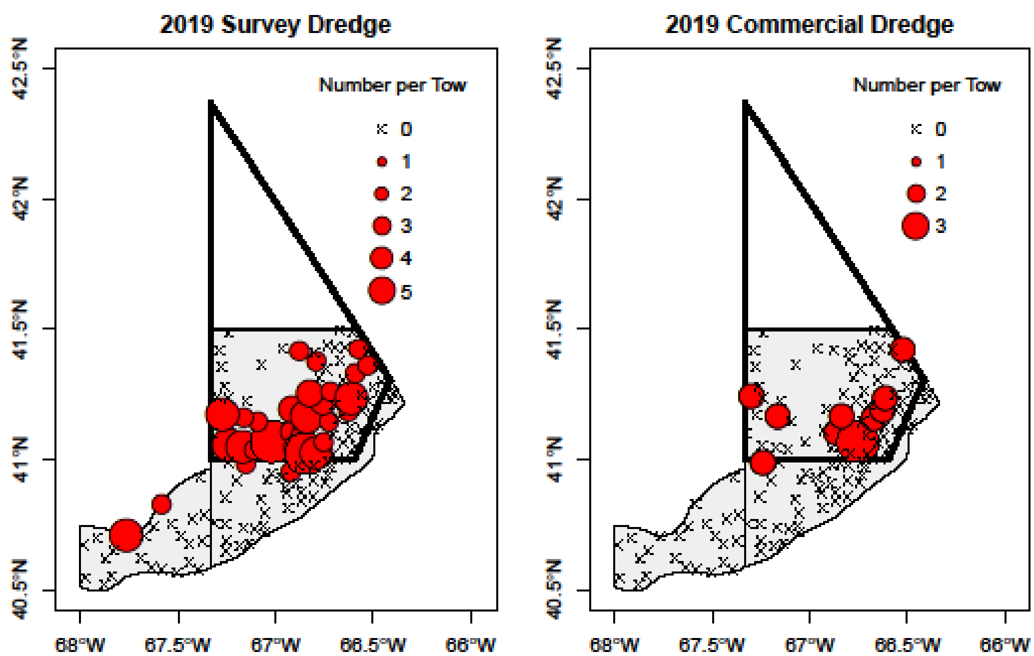

Figure 23. Spatial distribution of the number of yellowtail flounder caught in the VIMS 2019 survey by gear.

Table 1. Summary information for the VIMS surveys including vessel, commercial dredge width (m), survey area (km^2), and survey design.

Year	Vessel	Dates	Commercial Dredge Width (m)	Survey Area (km^2)	Survey Design
2005	Celtic	8/18 -8/23/2005	4.27	3,865	Systematic Grid
2007	Celtic	5/24-5/31/2007	4.27	3,865	Systematic Grid
2008	Celtic	7/19-7/24/2008	4.27	3,865	Systematic Grid
2011	Celtic	5/6-5/15/2011	4.27	3,865	Systematic Grid
2012	Regulus	7/17-7/25/2012	4.57	7,592	Systematic Grid
2013	Celtic	5/27-5/31/2013	4.27	2,040	Systematic Grid
2016	KATE	6/21-6/29/2016	4.57	6,407	Stratified Random
2017	Flavian S	6/16-6/24/2017	4.27	6,407	Stratified Random
2018	Arcturus	6/8-6/16/2018	4.57	7,553	Stratified Random
2019	Polaris	6/7-6/14/2019	3.96	7,553	Stratified Random

Table 2. Number of stations competed for the VIMS surveys by year and gear. Total area swept (km^2) and the average area swept (m^2) calculated from the survey dredge are also provided.

Year	Gear	Number of Stations	Total Area Swept (km^2)	Average Area Swept (m^2)
2005	Commercial	103	7,115.27	
	Survey	103	4,065.87	1,618.87
2007	Commercial	112	7,754.20	
	Survey	116	4,589.22	1,622.47
2008	Commercial	101	6,771.68	
	Survey	101	3,869.53	1,619.30
2011	Commercial	100	6,910.46	
	Survey	103	4,067.00	1,619.32
2012	Commercial	136	10,119.85	
	Survey	136	5,397.26	1,627.53
2013	Commercial	101	7,022.84	
	Survey	101	4,013.05	1,629.48
2016	Commercial	100	9,061.27	
	Survey	100	4,885.69	1,854.86
2017	Commercial	100	7,758.81	
	Survey	100	4,170.55	1,695.52
2018	Commercial	122	9,642.12	
	Survey	122	5,101.06	1,700.79
2019	Commercial	130	8,335.22	
	Survey	130	5,132.47	1,619.12

Table 3. Number and weight (kg) of yellowtail flounder caught in the VIMS survey by year and gear along with totals.

Year	Commercial Gear		Survey Gear		Total Number	Total Weight (kg)
	Number	Weight (kg)	Number	Weight (kg)		
2005	684	304.04	919	312.00	1,603	616.05
2007	571	145.99	501	141.90	1,072	287.89
2008	609	257.64	506	220.75	1,115	478.39
2011	122	49.65	168	72.28	290	121.92
2012	52	24.75	102	34.22	154	58.97
2013	67	34.69	126	43.96	193	78.65
2016	22	10.87	21	9.60	43	20.47
2017	25	11.90	15	7.84	40	19.74
2018	7	3.77	9	4.11	16	7.88
2019	12	6.75	57	4.38	69	11.13
Total	2,171	850	2,424	851	4,595	1,701.09

Table 4. Absolute biomass (mt) estimates for the VIMS survey dredge by year with varying catchability coefficients, as well as lower (LCI) and upper (UCI) 95 percent confidence intervals.

Year	q = 0.43			q = 0.62			q = 0.83			q = 1		
	Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI
2005	6,890.16	5,317.28	8,463.04	4,778.66	3,687.79	5,869.53	3,613.13	2,788.33	4,437.93	2,962.77	2,286.43	3,639.11
2007	2,785.14	2,220.94	3,349.34	1,931.63	1,540.33	2,322.93	1,460.50	1,164.64	1,756.36	1,197.61	955.00	1,440.22
2008	4,975.53	3,811.82	6,139.24	3,450.77	2,643.68	4,257.86	2,609.12	1,998.88	3,219.36	2,139.48	1,639.08	2,639.87
2011	1,595.89	1,106.02	2,085.77	1,106.83	767.08	1,446.58	836.87	579.99	1,093.76	686.23	475.59	896.88
2012	1,036.56	641.13	1,431.98	718.90	444.65	993.15	543.56	336.20	750.92	445.72	275.69	615.75
2013	520.07	315.23	724.92	360.70	218.63	502.77	272.72	165.30	380.14	223.63	135.55	311.72
2016	322.00	119.25	524.75	223.32	82.71	363.94	168.85	62.53	275.17	138.46	51.28	225.64
2017	294.69	116.10	473.28	204.38	80.52	328.24	154.53	60.88	248.19	126.72	49.92	203.51
2018	148.60	40.05	257.16	103.06	27.78	178.35	77.93	21.00	134.85	63.90	17.22	110.58
2019	150.33	61.59	239.06	104.26	42.71	165.80	78.83	32.30	125.36	64.64	26.48	102.80

Table 5. Absolute abundance for the VIMS survey dredge by year with varying catchability coefficients, as well as lower (LCI) and upper (UCI) 95 percent confidence intervals.

Year	q = 0.43			q = 0.62			q = 0.83			q = 1		
	Number	LCI	UCI	Number	LCI	UCI	Number	LCI	UCI	Number	LCI	UCI
2005	20,297,239.63	15,921,948.33	24,672,530.94	14,077,117.81	11,042,641.59	17,111,594.04	10,643,674.44	8,349,314.37	12,938,034.52	8,727,813.04	6,846,437.78	10,609,188.30
2007	9,820,336.07	7,862,704.83	11,777,967.31	6,810,878.24	5,453,166.25	8,168,590.23	5,149,688.43	4,123,125.70	6,176,251.15	4,222,744.51	3,380,963.08	5,064,525.94
2008	11,404,480.45	8,879,720.13	13,929,240.78	7,909,559.02	6,158,515.57	9,660,602.47	5,980,398.29	4,656,438.60	7,304,357.97	4,903,926.59	3,818,279.65	5,989,573.53
2011	3,710,210.39	2,685,536.07	4,734,884.72	2,573,210.44	1,862,549.21	3,283,871.66	1,945,598.13	1,408,268.91	2,482,927.36	1,595,390.47	1,154,780.51	2,036,000.43
2012	3,145,702.20	2,049,336.86	4,242,067.54	2,181,696.69	1,421,314.28	2,942,079.10	1,649,575.54	1,074,652.26	2,224,498.83	1,352,651.95	881,214.85	1,824,089.04
2013	1,490,430.74	941,277.85	2,039,583.63	1,033,685.83	652,821.73	1,414,549.94	781,567.34	493,596.92	1,069,537.76	640,885.22	404,749.47	877,020.96
2016	701,727.34	259,307.65	1,144,147.04	486,681.87	179,842.40	793,521.33	367,978.97	135,978.40	599,979.54	301,742.76	111,502.29	491,983.23
2017	553,833.88	270,462.24	837,205.52	384,110.60	187,578.65	580,642.54	290,425.08	141,827.76	439,022.41	238,148.57	116,298.76	359,998.38
2018	319,083.96	96,008.58	542,159.34	221,300.17	66,586.59	376,013.74	167,324.52	50,345.96	284,303.07	137,206.10	41,283.69	233,128.52
2019	1,950,887.63	1,210,014.94	2,691,760.32	1,353,034.97	839,203.91	1,866,866.03	1,023,026.44	634,520.03	1,411,532.85	838,881.68	520,306.42	1,157,456.94

Table 6. Absolute biomass (mt) for the VIMS commercial dredge by year with varying catchability coefficients, as well as lower (LCI) and upper (UCI) 95 percent confidence intervals.

Year	q = 0.25			q = 0.43			q = 1		
	Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI
2005	6,650.63	5,019.47	8,281.79	3,835.71	2,894.95	4,776.47	1,649.36	1,244.83	2,053.88
2007	2,936.77	2,336.56	3,536.97	1,693.76	1,347.60	2,039.93	728.32	579.47	877.17
2008	5,753.20	4,601.67	6,904.73	3,318.13	2,653.99	3,982.26	1,426.79	1,141.21	1,712.37
2011	1,119.17	735.72	1,502.62	645.47	424.32	866.62	277.55	182.46	372.65
2012	732.36	384.19	1,080.53	422.39	221.58	623.19	181.63	95.28	267.97
2013	406.86	216.94	596.78	234.65	125.12	344.19	100.90	53.80	148.00
2016	335.20	154.73	515.67	193.32	89.24	297.41	83.13	38.37	127.89
2017	430.43	188.11	672.74	248.25	108.49	388.00	106.75	46.65	166.84
2018	121.67	30.56	212.78	70.17	17.62	122.72	30.17	7.58	52.77
2019	246.95	74.00	419.90	142.43	42.68	242.18	61.24	18.35	104.14

Table 7. Absolute abundance for the VIMS commercial dredge by year with varying catchability coefficients, as well as lower (LCI) and upper (UCI) 95 percent confidence intervals.

Year	q = 0.25			q = 0.43			q = 1		
	Number	LCI	UCI	Number	LCI	UCI	Number	LCI	UCI
2005	14,964,118.80	11,448,423.51	18,479,814.10	8,630,468.52	6,602,811.70	10,658,125.34	3,711,101.46	2,839,209.03	4,582,993.90
2007	11,485,950.82	8,985,566.57	13,986,335.07	6,624,455.36	5,182,373.28	8,066,537.44	2,848,515.80	2,228,420.51	3,468,611.10
2008	13,599,572.40	10,932,847.36	16,266,297.44	7,843,474.31	6,305,456.15	9,381,492.48	3,372,693.95	2,711,346.15	4,034,041.76
2011	2,750,251.74	1,877,169.55	3,623,333.92	1,586,191.70	1,082,646.62	2,089,736.77	682,062.43	465,538.05	898,586.81
2012	1,542,883.01	927,550.79	2,158,215.23	889,848.81	534,959.52	1,244,738.09	382,634.99	230,032.60	535,237.38
2013	785,945.49	404,763.30	1,167,127.67	453,289.49	233,444.88	673,134.10	194,914.48	100,381.30	289,447.66
2016	680,216.64	300,349.01	1,060,084.28	392,310.99	173,224.55	611,397.44	168,693.73	74,486.55	262,900.90
2017	906,202.51	435,636.03	1,376,769.00	522,647.03	251,250.54	794,043.52	224,738.22	108,037.73	341,438.71
2018	226,255.27	63,509.17	389,001.37	130,491.41	36,628.54	224,354.28	56,111.31	15,750.27	96,472.34
2019	438,920.21	144,152.20	733,688.22	253,144.68	83,138.95	423,150.42	108,852.21	35,749.75	181,954.68