Dredge-Based Sea Scallop Assessment in the Northern Gulf of Maine

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Executive Summary

The Maine Department of Marine Resources (DMR) has completed the Northern Gulf of Maine (NGOM) dredge-based sea scallop (*Placopecten magellanicus*) survey and data analysis for year 2 of this project. This survey covered 289 stations between Machias Seal Island and Southern Stellwagen Bank (Figure 1). Sampling occurred May 5th through June 3rd, 2025, over 12 vessel days. The data was analyzed after full quality control check of the data in preparation for the standardized survey report for the August Scallop Plan Development Team (PDT) meeting. Specific parameters may be adjusted based upon input from the PDT for final results utilized in the specification setting process.

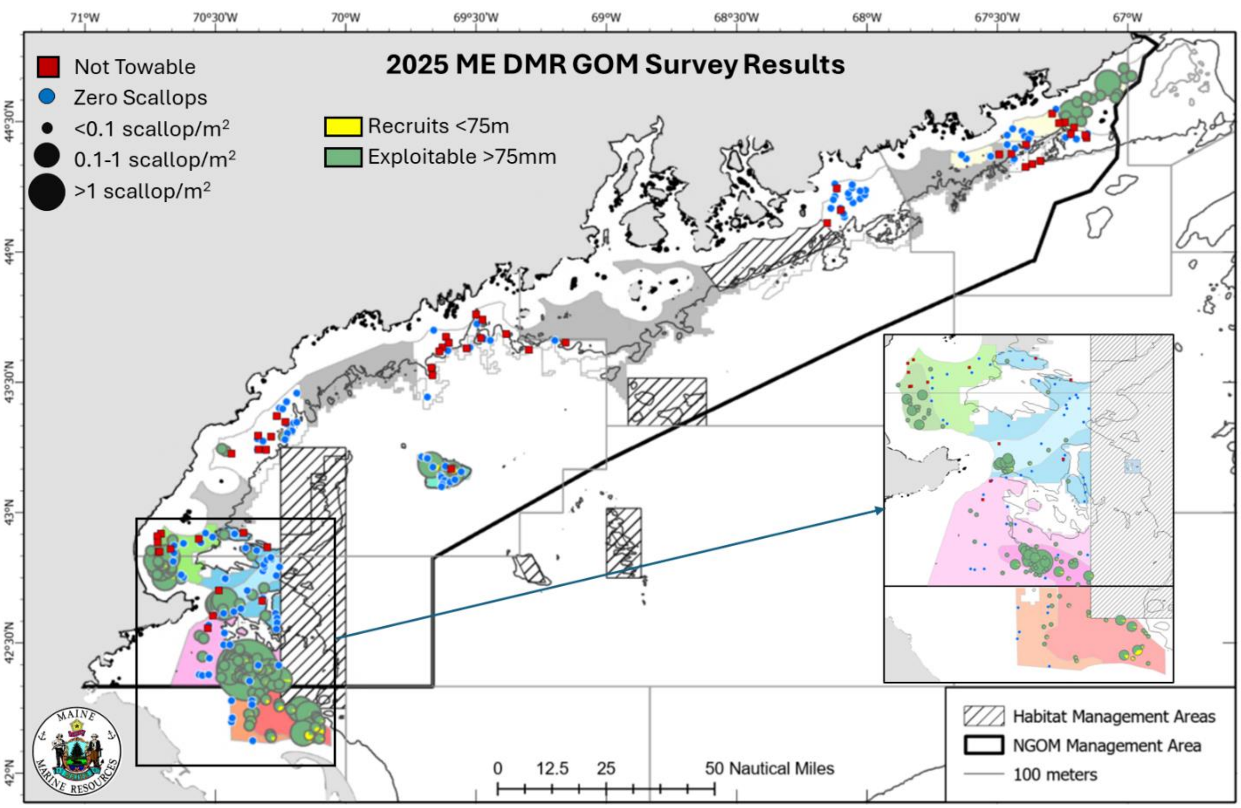

Figure 1. Bubble plot of the 2025 Maine DMR Northern Gulf of Maine scallop dredge survey. The size of each circle is representative of the density of scallop catch and the proportion of each color is representative of proportion of each size bin.

Project Objectives

The goal of this project is to provide estimates of total and exploitable scallop biomass across the NGOM management area and Southern Stellwagen Bank to be utilized in season setting decisions beginning in August each year. These estimates will be calculated with a dredge-based scallop survey which will produce annual density estimates, size frequencies, and shell height meat weight relationships by area.

Methods & Results

Survey Domain: The survey domain covers the range of the NGOM covering all depths between 30 and 120 m (16-65 ftm) and extends into the fishing grounds on southern Stellwagen Bank in the open fishing area. The total area of each survey subarea was delineated based on depth ranging between 30 and 120m, as depth influences many important aspects of habitat quality (e.g. water temperature, salinity, food availability), and thus, abundance and distribution of marine species (Smith et al. 1994). The survey domain does not include habitat management areas closed to mobile scallop gear (Fig 2).

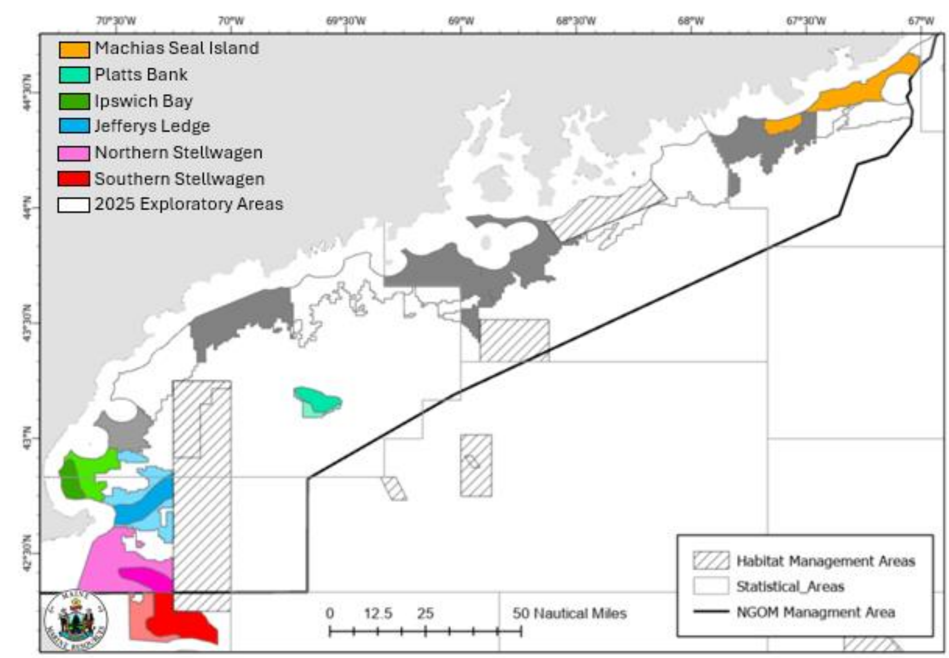

Figure 2. Survey domain for the 2025 ME DMR NGOM survey with each survey area shaded a unique color. Different shading in the subareas represents overlap of other RSA dedicated scallop surveys.

Survey design: Similar to previous surveys, a stratified random sampling design was used to allocate effort within the survey subareas. This method is an effective and widely used tool to estimate the abundance and distribution of different fish species (Cochran 1977, Doubleday 1981). This type of design tends to be cost-effective and produces estimates of abundance with relatively higher precision compared to other sampling designs under similar level of effort.

The total effort for each subarea was allocated based on area size and previous survey results for each area (Table 1). The exploratory areas with no historic survey data were allocated 100 stations per year divided into 20 stations for each subarea.

Table 1. Allocations of total stations for each priority area of the 2025 ME DMR NGOM survey.

Areas of Interest	Allocated Stations
Machias Seal Island	25
Platts Bank	15
Ipswich Bay	32
Southern Jeffery's Ledge	46
Northern Stellwagen	57
Southern Stellwagen (Open Area)	29
Total	204

In 2009 the ME DMR and University of Maine overlaid a 1 km grid across the Gulf of Maine waters to stratify the area by expected density of scallops into three categories low, medium, and high density (Truesdell 2014). This survey grid has been updated over the years as new survey data has become available. The stratification of density for each area was 50% randomly selected, 25% stratified by using the Neyman allocation based on variance in biomass, and 25% stratification using the Neyman allocation based on the variance in abundance. Where the Neyman equation: $n_h = n\frac{W_h S_h}{\sum_{h=1}^{H} W_h S_h}$ where n is the total number of sampling stations for the survey area, H is the total number of strata, W_h is the proportion of stratum h area over the survey area, and S_h is the estimated standard deviation of historical data in stratum h.

Data collection: The ME DMR NGOM federal waters survey occurred on one of two collaborating scallop vessels between May 5th through June 3rd, 2025, taking 12 vessel days to complete (Table 2). Each vessel was approximately 40 ft LOA specifically rigged for commercial scallop fishing in the Gulf of Maine with a dredge similar sized to the survey dredge. Each survey captain has many years of experience scalloping in these waters and joined for a survey day on the other survey vessel to ensure standardization.

Table 2. Sampling dates and areas covered for the 2025 dredge survey and the number of stations sampled per day.

Date	Stations	Area	Area Label	Avg Bottom Temp (C)	Vessel
5/5/2025	15	Ipswich Bay	IB	4.6	F/V Whitney & Ashely
5/6/2025	24	Stellwagen Bank	NS	5.1	F/V Whitney & Ashely
5/7/2025	33	Southern Stellwagen Bank	SS	4.8	F/V First Impression II
5/8/2025	23	Jefferys Ledge	SJ	4.5	F/V First Impression II
5/12/2025	37	Jefferys Ledge/Ipswich Bay	SJ/IB	4.6	F/V Whitney & Ashely
5/13/2025	26	Stellwagen Bank	NS	4.7	F/V First Impression II
5/15/2025	23	Exploratory Area 7	Ex 7	6.7	F/V Whitney & Ashely
5/16/2025	22	Platts Bank	PB	4.9	F/V First Impression II
5/17/2025	19	Exploratory Area 5	Ex 5	4.9	F/V First Impression II
5/26/2025	21	Exploratory Area 3	Ex 3	NA	F/V First Impression II
5/30/2025	26	Machias Seal Island	MSI	6.1	F/V Whitney & Ashely
6/3/2025	20	Exploratory Area 1	Ex 1	6.3	F/V Whitney & Ashely

The survey dredge was identical to the dredges used on previous NGOM scallop surveys carried out by ME DMR. The Department owns four standardized 7 ft. wide New Bedford-style chain sweep dredges with 2 inch rings, 1¾ inch head bale, 5 inch twine top and 10 inch pressure plate. Each dredge is equipped with rock chains and unlined. Throughout the survey, the participating captains and lead scientist ensured that the dredges were rigged and fishing correctly. These are the same specifications for survey dredges used since 2009 in state and federal waters of the GOM. Use of this survey dredge configuration in NGOM has proven successful for the often rocky and cobble substrates encountered in the area.

There were 239 valid tows. All tows were in a straight line, for a target time of 5 minutes in length at a target speed of 3.5-4 kts. Positional location (tow start and haul back) and exact speed and tow times were recorded on board with a ruggedized tablet computer equipped with GPS. A continuous GPS track was recorded as a backup to ensure data accuracy. An onboard marine navigation program was used to chart tow locations. Pitch and roll of the drag, as well as depth and water temperature, were measured using Star-Oddi™ sensors mounted to the neck of the survey drag. The tow distance utilized for area swept analysis was calculated from the GPS log by summing the distance between points using the haversin equation.

The DMR and vessel captains took advantage of the long history of cooperation with the lobster harvesters in this region to minimize conflicts with fixed gear utilizing industry outreach prior to the survey and VHF communication at sea. Despite this outreach, there were still concentrated areas of high densities of fixed gear. When possible in these high gear areas, alternative tow paths were located or shortened tows were required, yet occasionally no towable areas were identified and the stations were abandoned (Table 3).

Table 3. Number of tows for each survey area, where short tows were between 2.5 minutes and 4 minutes long.

Area	Regular Tow	Short Tow	No Sample Fixed Gear	No Sample Bad Bottom
MSI	19 (73%)	3 (12%)	3 (12%)	1 (4%)
E1	11 (55%)	0 (0%)	4 (20%)	5 (25%)
E3	17 (81%)	1 (5%)	3 (14%)	0 (0%)
E5	6 (27%)	3 (14%)	4 (18%)	9 (41%)
E7	14 (61%)	2 (9%)	0 (0%)	7 (30%)
PB	17 (89%)	1 (5%)	1 (5%)	0 (0%)
IB	20 (63%)	5 (16%)	5 (16%)	2 (6%)
SJ	28 (70%)	8 (20%)	3 (8%)	1 (3%)
NS	51 (89%)	4 (7%)	2 (4%)	0 (0%)
SS	29 (100%)	0 (0%)	0 (0%)	0 (0%)

Biological samples: All scallops in each tow were counted (n=7,803), sorted into bushel baskets for an estimated volume, and then weighed. If less than 100 scallops were caught, all were measured for shell height (SH), otherwise a subsample of 100 were measured. If more than 1,000 scallops were caught at a given station, 10% were measured. The scallops selected for measuring were randomly chosen during the sorting of the catch to ensure accurate representation of the catch. An electronic measuring board (Zebra-Tech LTD) was used for rapid and accurate entry (±0.5 mm) of shell height measurements. All clappers (dead scallops with an intact hinge) were counted and were measured for SH at each station.

To determine shell height-meat weight relationships for each subarea, which are necessary to generate biomass estimates, eight representative scallops were selected for meat weights at each station which caught scallops. These scallops were measured for shell height, shell depth and shell width and then shucked and visually examined for meat quality, common diseases/infections and other abnormalities (Fig 3). If the conditions were appropriate for accurate weights scallops were weighed at sea using a motion compensated scale (M1100 PL2262 ±0.5 g). Occasionally the weather was too rough for an accurate weight and the scallops were stored in plastic containers in a cooler until conditions improved or returning to port for weighing.

Figure 3: Examples of the meat quality categories used by the DMR based on texture, color and relative size of the abductor muscle.

All remaining catch including bycatch, shells, and substrate were estimated by volume by lowest practical type as described by DMR scallop survey protocol (Kelly 2012, 2013; Schick and Feindel 2005). In addition, for fish species of interest that present potential bycatch issues for the fishery, abundance, biomass, and the total length was recorded.

Data analysis: To improve comparison between our survey the other scallop dedicated survey in the region, the drop camera survey conducted by the School of Marine Science and Technology, University of Massachusetts Dartmouth (SMAST), the PDT recommended that we conduct analysis for the overlapping areas of interest (AOIs) and outside these areas for each survey area, totals for the subareas are then calculated by summing the AOIs and non-AOIs.

The meat size for a given shell height is known to vary regionally, thus shell height-meat weight relationships (SHMW) were modeled individually for each sampling area using a generalized linear mixed model (GLMM) with sampling station as a random effect and depth, longitude, and latitude as candidate covariates (Hennen and Hart 2012). Using the swept area method, total and exploitable stock biomass/abundance were estimated for each survey area, accounting for the efficiency of the dredge and the approximate selectivity. After appropriate quality control procedures, the total catch of scallops by weight for pre-recruits <35mm, recruits 35-75mm and scallops >75mm was calculated for each valid tow by applying the appropriate SHMW relationship as recommended by the scallop PDT in 2024 (Appendix). The area swept was calculated based on the dredge width and the distance calculated between the tow start and end points. These points were verified using the timestamps recorded on the tilt sensor. The biomass estimates were calculated using an assumed dredge efficiency of 0.4 for our standard dredge.

For each survey area, identified in table 1 above, the overall average abundance of swept area was estimated as: $\bar{X} = \sum_{h=1}^{H} W_h \bar{X}_h$ where $\bar{X}_h$ is the average abundance of swept area for stratum h, H is the total number of strata, and W_h is proportion of the area of stratum h with respect to the survey area.

Catch Results:

Scallops were by far the dominant catch despite there being a decline in abundance from our 2024 survey for all areas besides Platts Bank (Fig. 4). Newly discarded shells were observed in all areas which were open in the 2025 season. Northern Stellwagen Bank was the only area where scallops were observed in high densities (>1/m^2). All priority areas had patches of scallops of moderate density (0.1-1/m^2), and low density (<0.1 /m^2). There also were many areas outside of the overlap of the SMAST survey which caught scallops. Jeffereys Ledge and Northern Stellwagen Bank had the highest number of exploitable scallops (Fig. 5). No scallops smaller than 75mm (3 inches) were observed in the Machias Seal Island area, but many were observed in the other areas with the highest concentration on southern Stellwagen Bank (Fig. 6).

Few pre-recruits (<35mm) were observed in the 2025 survey. The growth of the now 3-year-old scallops for Ipswich Bay, Platts Bank and Stellwagen Bank can be observed by comparing the size frequency with the 2024 survey. The comparison between the two years also indicates that the larger scallops may have been harvested from most southern areas in 2025 (Figs 7&8).

Yellowtail flounder (n=250) and winter flounder (n=112) were the most common fish bycatch species with the highest catches occurring on Stellwagen bank (Table 4).

Outreach and Education

This project supported two contract sea technician positions providing invaluable field experience for early career professionals. One of these positions was filled by a recent graduate from Boston University, the second was an early career scientist and the ME DMR. These will also be shared with scallop fleet members prior to the August PDT meeting and be available on our website (https://www.maine.gov/dmr/science/species-information/scallop).

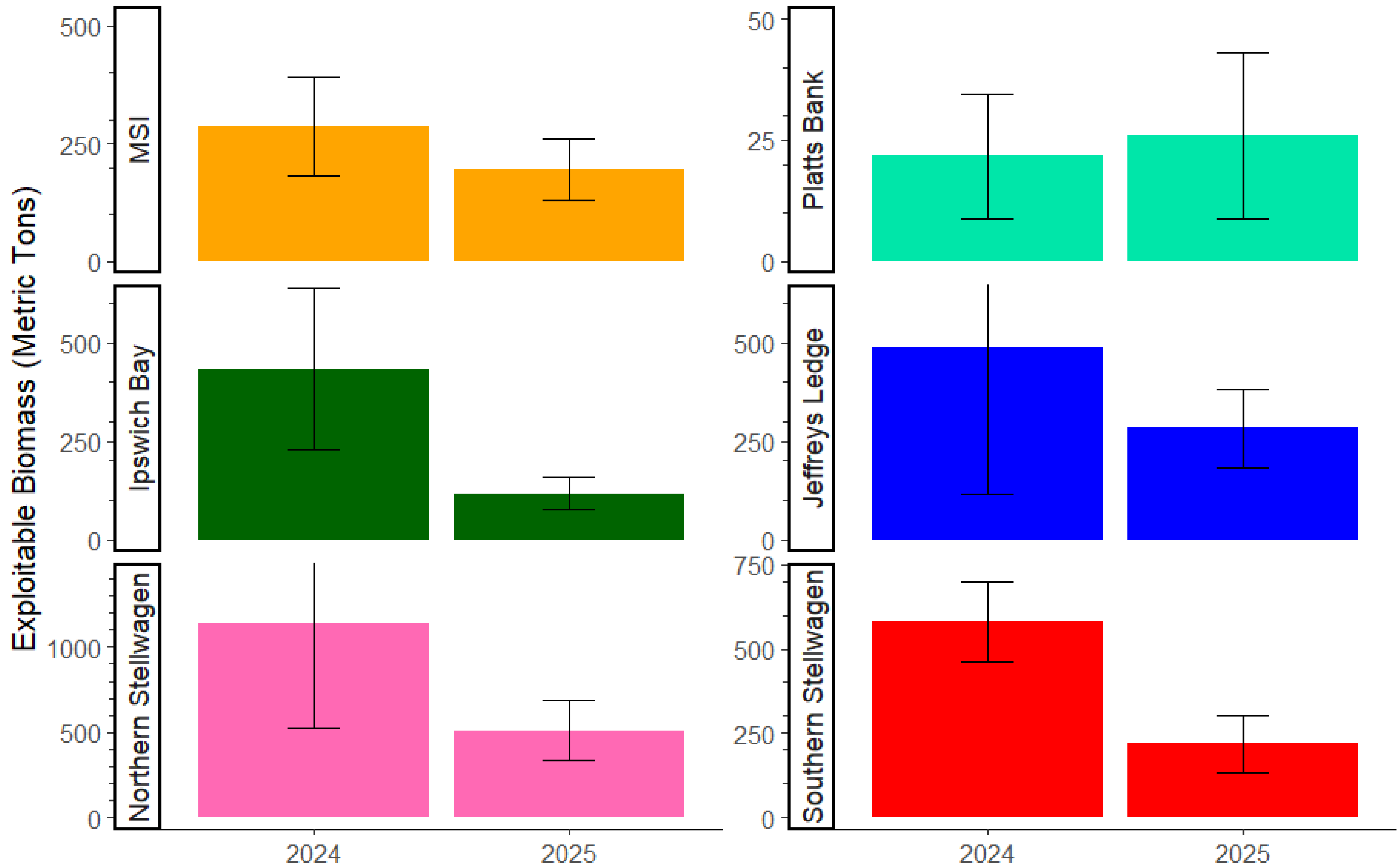

Figure 4. Estimates of exploitable biomass with associated standard error for the 2024 and 2025 ME DMR GOM scallop dredge survey. These estimates were calculated using the latest recommendations for SHMW relationships for each subarea (Appendix). Estimates were calculated separately for areas overlapping with the SMAST survey and the remainder of the domain and then added together for each subarea. These data have not been reviewed by the PDT and are preliminary.

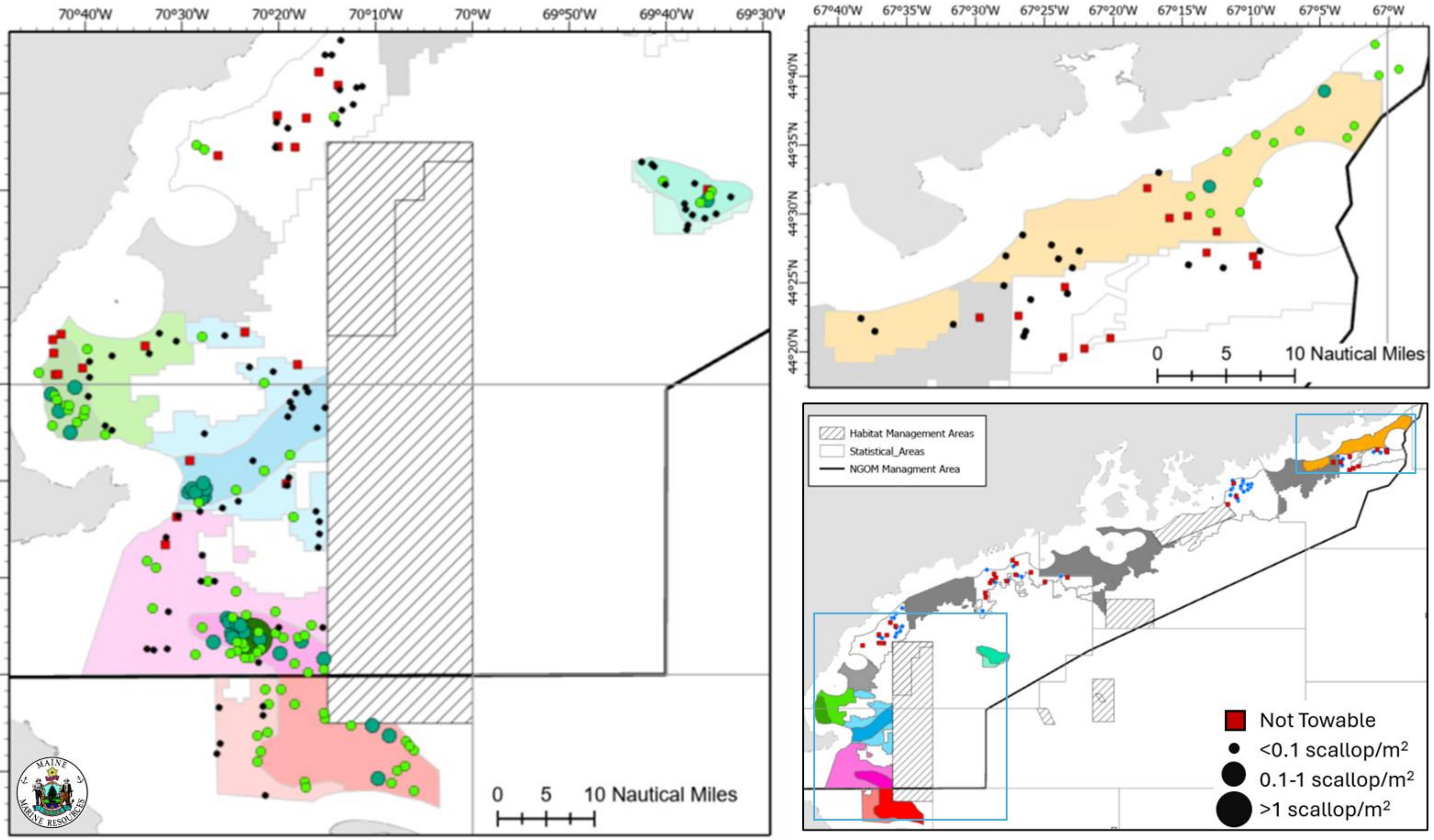

Figure 5. Map of the number of harvestable scallops per square meter for the scallops larger than 75mm shell height, the smaller shaded areas within each subarea are areas overlapping with the SMAST survey.

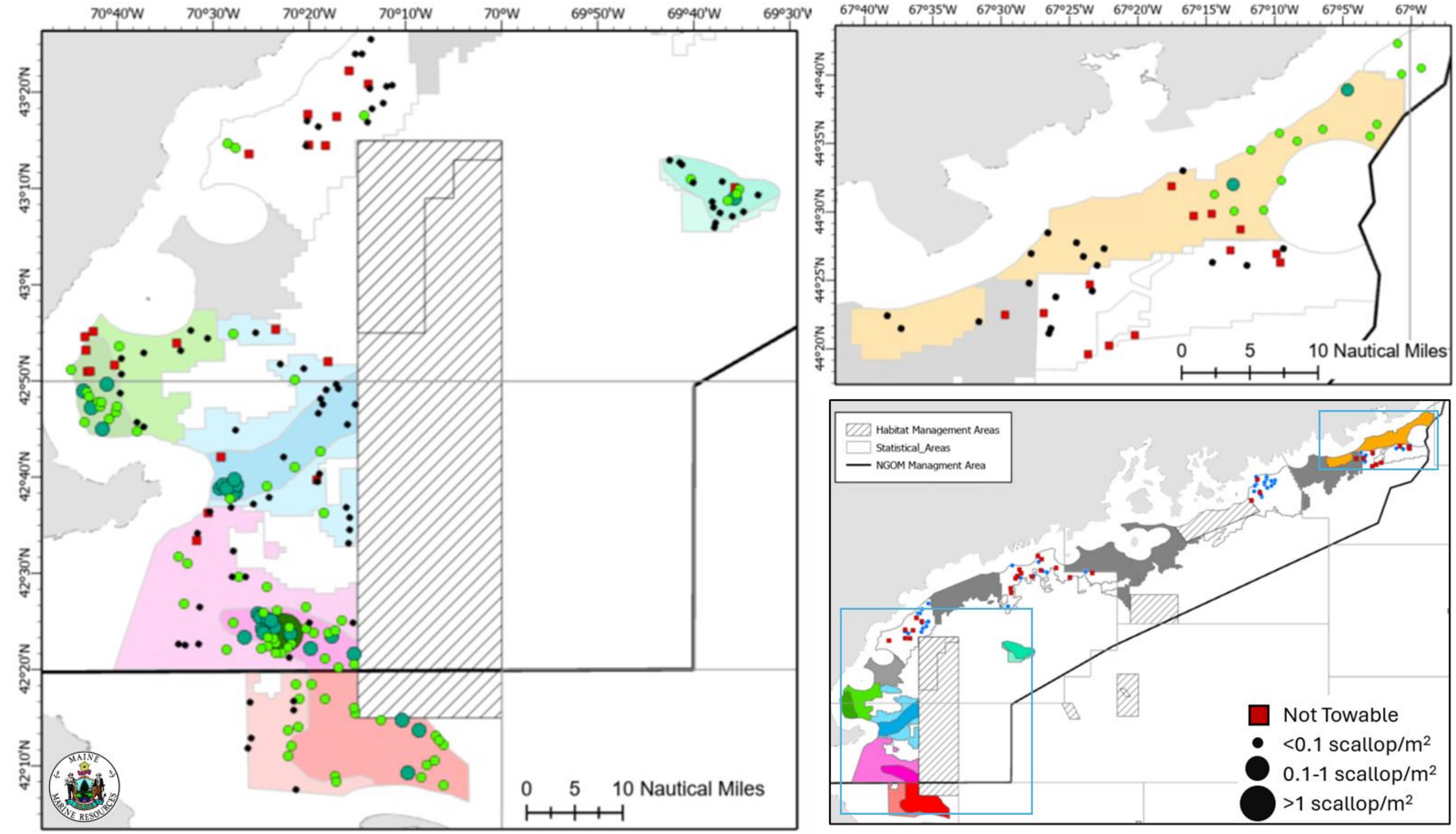

Figure 6. Map of the number of scallops per square meter for the scallops less than 75mm shell height, the smaller shaded areas within each subarea are areas overlapping with the SMAST survey.

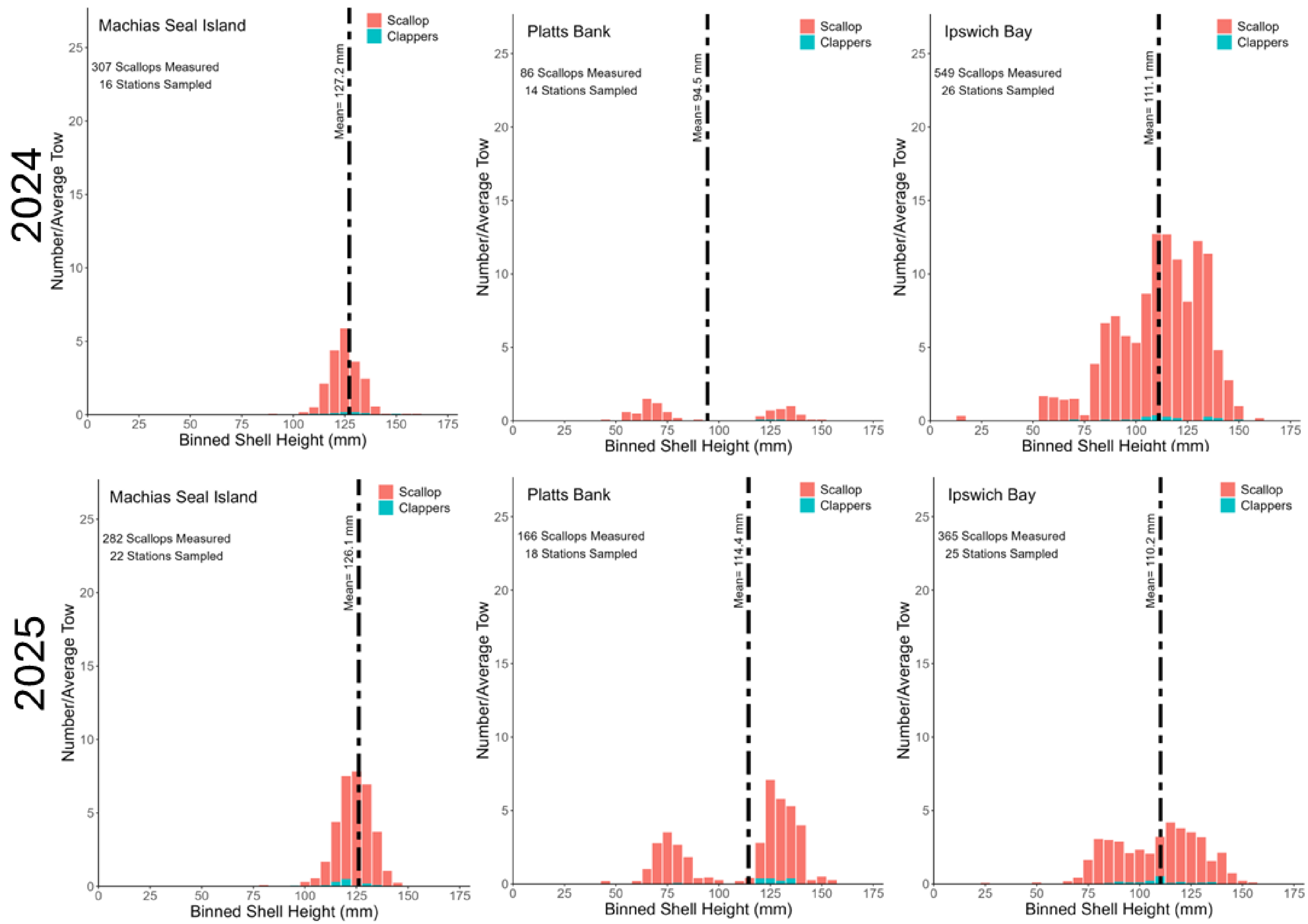

Figure 7. Size frequency plots of scallops and clappers from the northern areas of the 2024 (top) and 2025 (bottom) ME DMR scallop survey. The height of each bar is the average number of scallops (orange) or clappers (blue) for each size bin by tow.

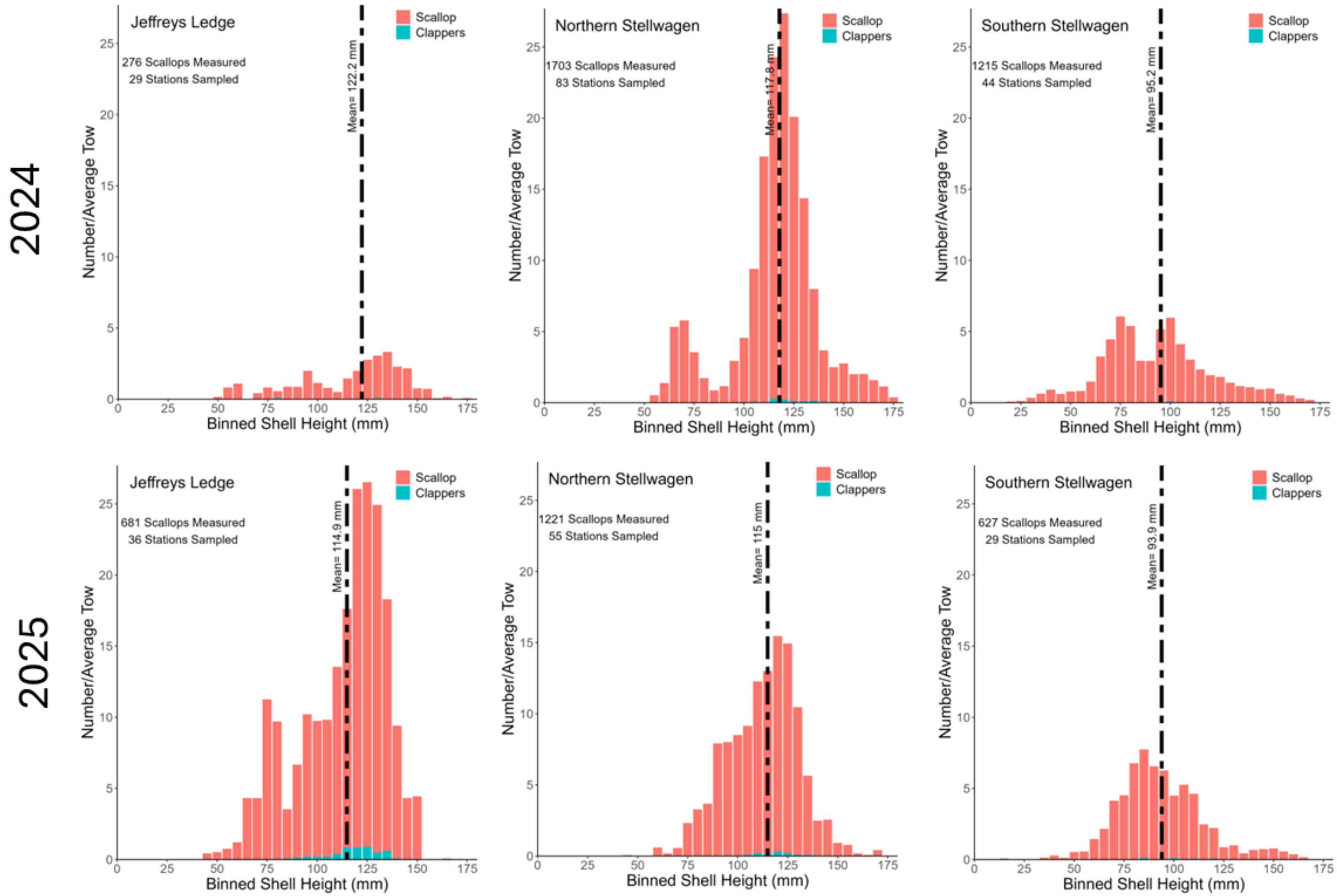

Figure 8. Size frequency plots of scallops and clappers from the Southern areas of the 2024 (top) and 2025 (bottom) ME DMR scallop survey. The height of each bar is the average number of scallops (orange) or clappers (blue) for each size bin by tow.

Table 4. Total number of scallops, clappers, lobsters and fish caught in each survey area. Total weight (kg) is included for the priority species

Common Name	Scientific Name	Southern Stellwagen	Northern Stellwagen	Jefferys Ledge	Ipswich Bay	Platts Bank	Machias Seal Island	Exploratory Areas	**Total Count**	**Total whole weight (kg)**
Sea Scallops	Placopecten magellanicus	1003	3206	2410	438	230	429	87	7803	2071
Yellowtail Flounder	Limanda ferruginea	26	115	41	55	4		9	250	44
American Lobster	Homarus americanus	5	14	17	33	6	40	66	181	66
scallop clapper	scallop clapper	10	27	59	21	9	17	2	145	
Winter Flounder	Pseudopleuronectes americanus	5	29	19	12	0	14	33	112	28
skate little	Leucoraja erinacea	50	6	0	18	5	3	0	82	9
American Plaice	Hippoglossoides platessoides	6	10	6	8	2		18	50	18
Grey Sole	Glyptocephalus cynoglossus	4	5	2	8	11		1	31	7
Monkfish	Lophius americanus	2	2	3	5	6		8	26	26
Windowpane Flounder	Scophthalmus aquosus	2	2	5	5			1	15	2
Fourspot Flounder	Paralichthys oblongus	4	3						8	4
Haddock	Melanogrammus aeglefinus		1	3		1			5	
Lumpfish	Cyclopterus lumpus						1	1	2	
Sea Raven	Hemitripterus americanus		2						2	
Cunner	Tautogolabrus adspersus			1					1	
Longhorn Sculpin	Myoxocephalus octodecemspinosus		1						1	

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Appendix-SHMW Relationships

SHMW Equation-Stellwagen, Jefferys & Ipswich Bay Estimated from combined DMR and SMAST data 2016-2024

$W=\exp(-10.09+3.0*\ln(SH\_mm) -0.239*\ln(Depth\_M) + 0.00156*LatitudeDD + Area$

Areas: Sellwagen=0.082, Ipswich=0.095 Jeffreys =0.007

SHMW Equation-Platts Bank & MSI Estimated from DMR data 2016-2024

$W=\exp(1.284+2.94*\ln(SH\_mm) -0.2098*\ln(Depth\_M) – 0.2655*LatitudeDD + Area$

Areas: MSI=0.668, Platts Bank= -0.026

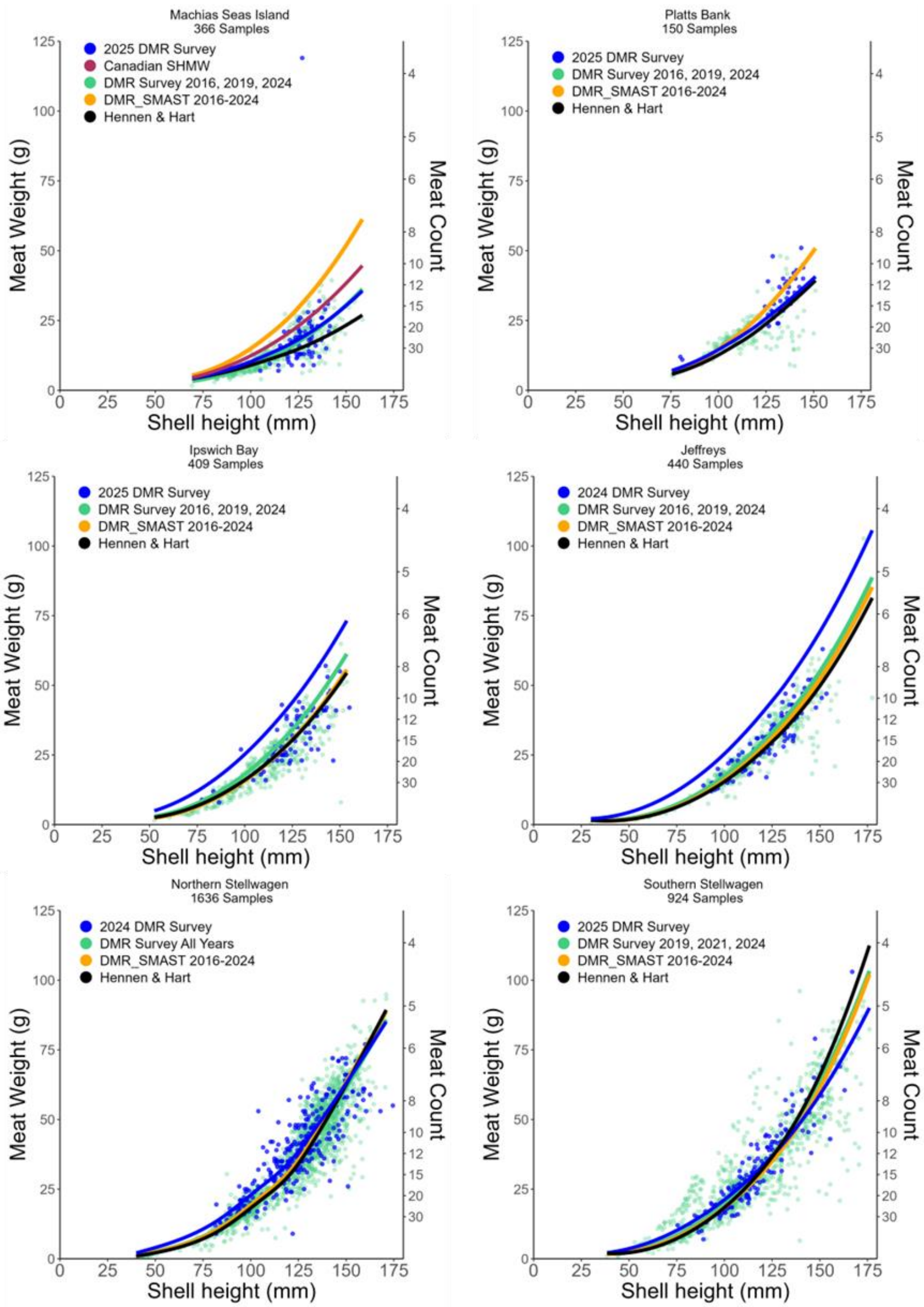

Figure A.1 Recorded meat weight to shell height data (blue points) and the fitted relationships for the 2025 survey (blue line) compared with past years data and other SHMW relationships for each survey area.