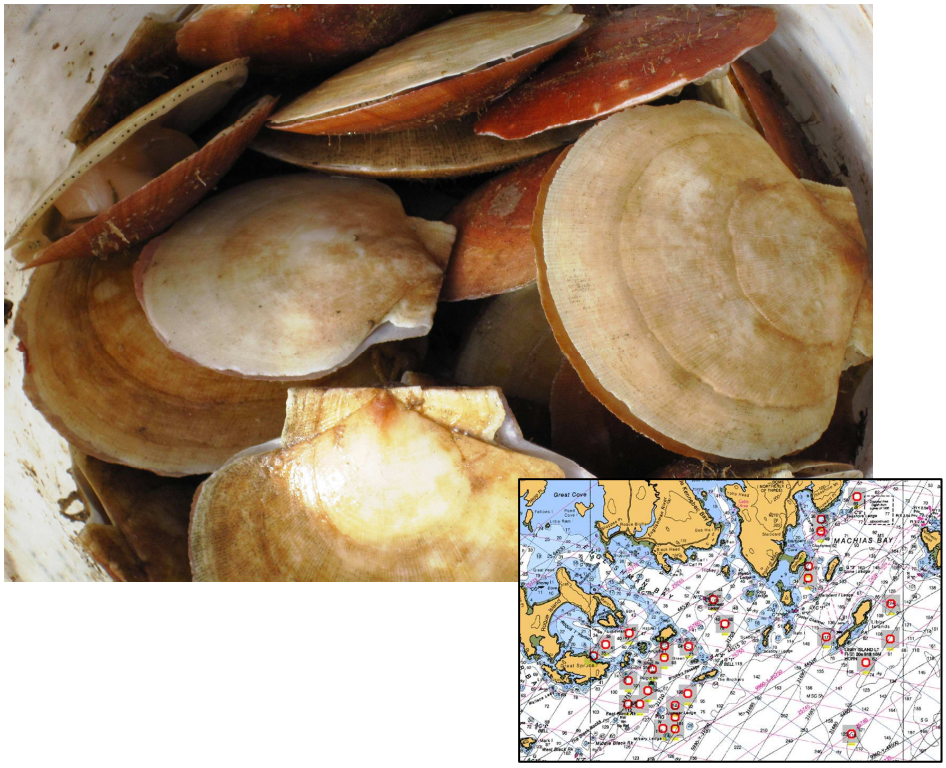
# Results from the Spring 2014 Maine Sea Scallop Survey




**Kevin H. Kelly**
**Maine Department of Marine Resources**
**P.O. Box 8**
**W. Boothbay Harbor, ME 04575**

**December 7, 2014**

## Executive Summary

A sea scallop survey was carried out in April 2014 in management zone 2 (eastern Maine coast between W. Quoddy Head and upper Penobscot Bay). The survey was directed into the seven (7) rotational areas scheduled to be open to fishing in the 2014-15 season. A total of 139 tows were completed on the survey. Some highlights were:

- Harvestable ($\geq$ 4 in. shell height) scallop density was significantly higher in the Bold Coast rotational area in 2014 than in the adjacent open area in 2013. Sublegal (2.5-3.9 in. shell height) density also was greater than in the adjacent open area in 2013. Seed (<2.5 in. shell height) density remained at a relatively high level, comparable to 2013.

- Density of harvestable scallops was higher in the Little Kennebec/Englishman Bay rotational area in 2014 than in the adjacent open area in 2013. Seed and sublegal densities were less than in 2013 however. This area contained mostly harvestable scallops.

- The five other (Addison, Frenchmans Bay, Swan's Island, Isle au Haut Bay, upper Penobscot Bay) rotational areas had poor scallop abundance. The highest density of harvestables was in Isle au Haut Bay but this was only in a limited part of the survey area.

- Aside from Bold Coast and Little Kennebec/Englishman Bay there was very little sign of recruitment (seed and sublegals).

- Only 38 scallops were caught in 18 tows in the Upper Penobscot Bay rotational area.

## Introduction

The sea scallop (*Placopecten magellanicus*) currently supports a 50-70 day commercial fishery along coastal Maine during December-March each year. Maine 2013 landings of scallop meats were approximately 0.42 million lbs. with an ex-vessel value of $5.19 million (Fig. 1). The primary gear type is the dredge, although Maine also permits commercial and non-commercial harvest of scallops by diving.

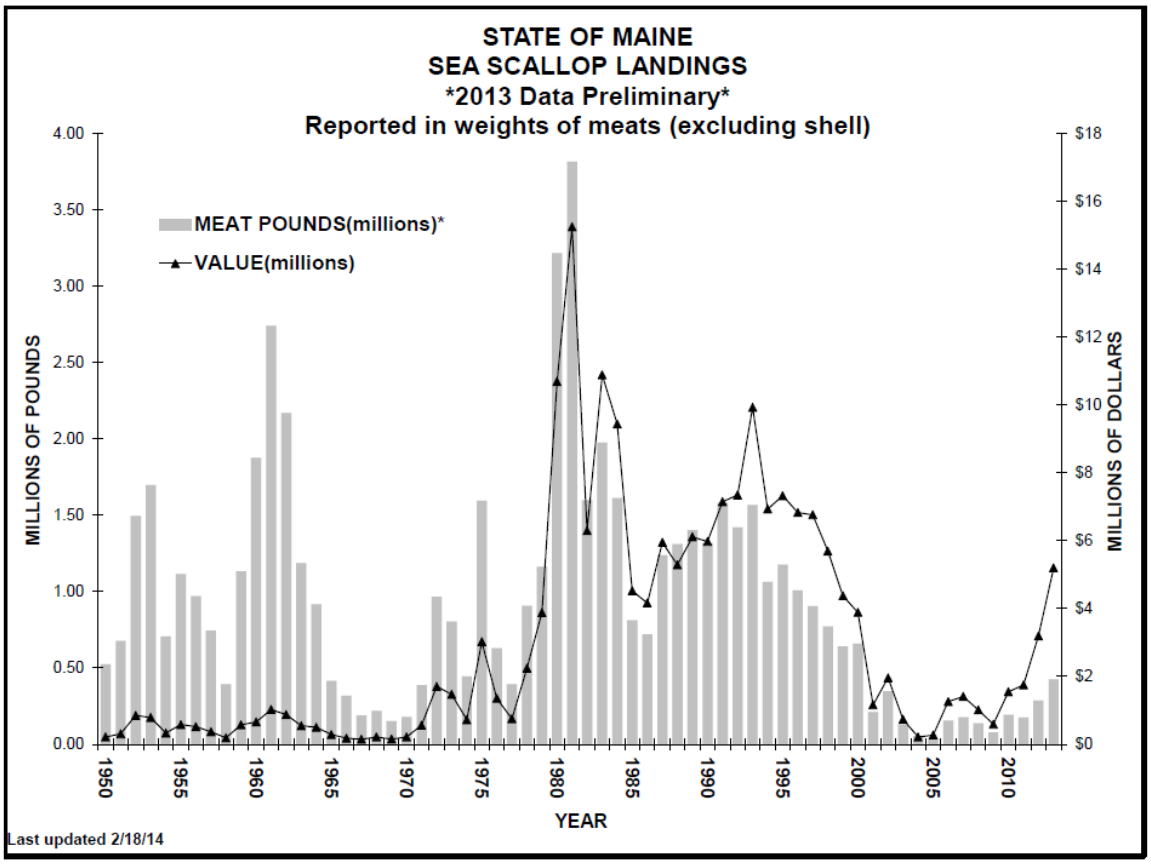



**Figure 1. Maine scallop landings 1950-2013 (source: Maine Department of Marine Resources (DMR)).**

An areal rotation scallop management plan was implemented by Maine DMR prior to the 2012-13 season. This plan is in effect for 10 years (until 2020-21) in management zone 2 which covers the eastern Maine coast between W. Quoddy Head and eastern Penobscot Bay. Management zone 2 is divided into multiple sections so that in any given season roughly one-third of the coast is open to fishing while the other two-thirds is closed to fishing to allow rebuilding.

***Purpose and extent of survey***

An annual dredge-based fishery-independent survey by DMR of the scallop resource within Maine state waters has been conducted since 2002 (with the exception of 2004). A spring (as opposed to fall) survey was conducted for the first time in 2013.

The purpose of the survey is to characterize and monitor the sea scallop resource within Maine's coastal waters, and to compare results to previous years' surveys in light of regulatory and environmental changes. It is necessary to monitor changes in abundance and stock size from year to year to evaluate effects of the fishery, document recruitment events and determine what is available for harvest. The survey provides information needed to evaluate management strategies such as harvest limits and rotational closures. The survey provides information on geographic distribution, relative abundance, population size structure, meat yield and occurrence of seed and sublegal scallops as well as estimates of harvestable biomass.

For the first two years (2002-03) the entire coast was surveyed. During 2005-12 one of three major sections of the coast (1. Western Penobscot Bay to New Hampshire border, 2. W. Quoddy Head to eastern Penobscot Bay, and 3. Cobscook Bay/St. Croix River) was surveyed each year on a rotating basis (Table 1). All 2002-12 surveys were conducted in the fall, prior to the opening of the fishing season. In 2013, a spring survey of the 2012-13 and 2013-14 limited access and open sections of the eastern Maine coast (management zone 2) was completed. The change to the spring allowed for time to enact management actions for the upcoming season based on survey results. The limited access areas in management zone 2 were phased out following the 2013-14 season and became part of the regular 10-year rotation.

**Table 1. Chronology of Maine DMR scallop survey, 2002-14.**

| Area | Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Cobscook Bay/St. Croix R.** | **S** | **S** | NS | NS | **S (begin higher intensity survey)** | **S** | NS | **S** | **S** | NS | **S** | **S (fall)** | scheduled |
| | **Eastern Maine** | **S** | **S** | NS | NS | **S (begin higher intensity survey)** | NS | **S** | **S (Machias Seal Is. and Mt. Desert Rock only)** | NS | **S (incl. closures 4A-8C)** | **S (Machias Seal Is. and Mt. Desert Rock only)** | **S (spring - all open areas in mgt. Zone 2)** | **S (spring - all open areas in mgt. Zone 2)** |
| | **Western Maine** | **S** | **S** | NS | **S** | NS | NS | NS | **S** | NS | **S (closures 1-3 only)** | NS | NS | NS |

**S** = surveyed
NS = not surveyed

## Methods

### *Survey design*

A subset of the coastal zones (or "strata") defined for the 2002-03 surveys (Fig. 2) were used in subsequent surveys, including 2014, with some modification.

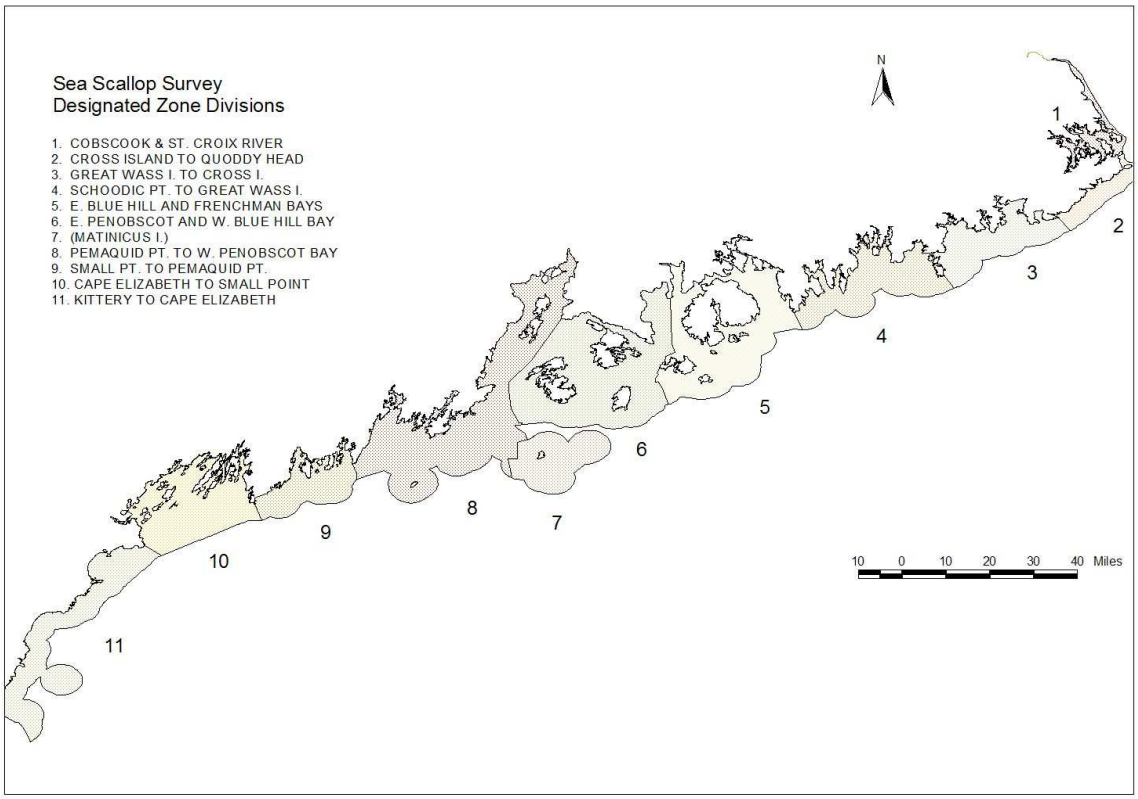



**Figure 2. Designated strata for Maine DMR scallop survey.**

Strata were sized to provide a manageable balance between area and sampling intensity. Scallop grounds within the strata were mapped based on fisher information (including a summary of industry input relative to limited access areas provided by Penobscot Bay Resource Center in 2011), prior survey data, surficial sediment maps http://megisims.state.me.us/metadata/surf.htm) and coastal wildlife inventory maps (http://megisims.state.me.us/metadata/shell.htm) (Schick and Feindel 2005).

The main priority of the spring 2014 survey was to provide assessments of the seven (7) management zone 2 areas (Bold Coast, Little Kennebec/Englishman Bay, Addison,

Frenchmans Bay, Swans Island, Isle au Haut Bay, Upper Penobscot Bay) which will be open to fishing in 2014-15 (Figs. 3-4). Station locations were based on random selection from a 500 m grid overlaying known and potential scallop grounds within each. Depth criteria were 6-43 m. The 500 m grid accommodated an average tow length of approximately 300 m. There were 139 tows completed on the spring 2014 survey.

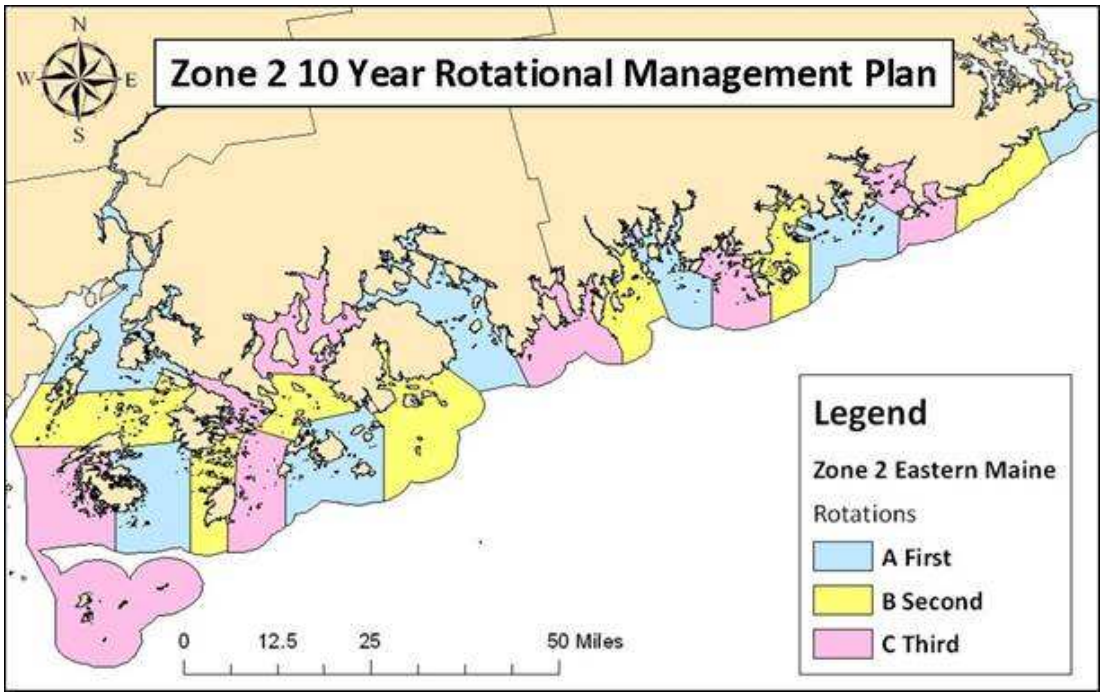



**Figure 3. Areal rotation plan for eastern Maine (management zone 2) scallop fishery. Blue areas will be open to fishing in 2014-15 season while pink and yellow areas will be closed (source: www.maine.gov/dmr/rm/scallops/management).**

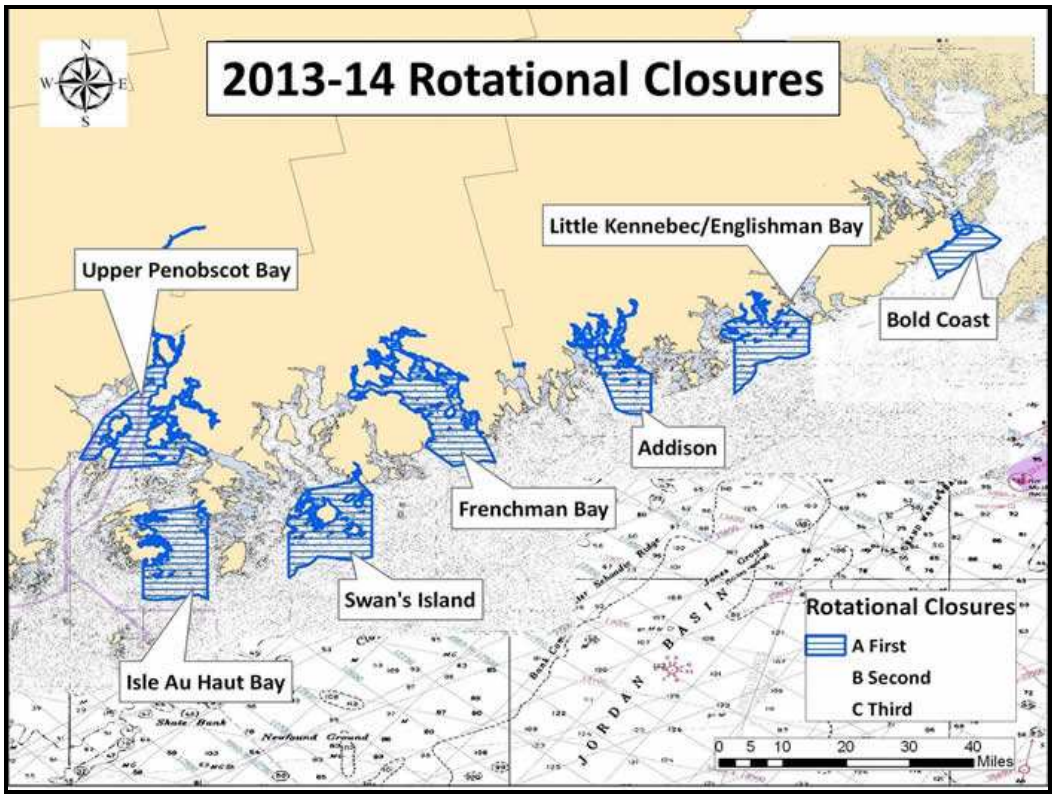



**Figure 4. Rotational areas which were surveyed in spring 2014 and will be open to fishing in 2014-15 (source: [www.maine.gov/dmr/rm/scallops/management](www.maine.gov/dmr/rm/scallops/management)).**

The survey was conducted during 21 April-2 May aboard the 40 ft. *F/V Bad Company* from Cutler. The survey gear was a 7 ft. wide New Bedford-style chain sweep dredge with 2 inch rings, 1¾ inch head bale, 3 inch twine top (double hung) and 10 inch pressure plate. The dredge was equipped with rock chains and was not lined. The survey dredge was constructed in 2009 (Fig. 5; also see Kelly (2010)).


**Figure 5. View of survey drag constructed in 2009.**

***Sampling procedure***

Stations to be sampled were plotted using Capn Voyager™ navigational software. An onboard computer displaying station location was used to position the vessel for the start of each tow. Location and time were recorded at three points (dredge in, tow start and haulback) for each station. A Juniper Allegro™ ruggedized handheld computer with aninternal GPS unit recorded time/date/location information. Stations were sampled by a straight line tow at an average speed of 3.5-4 knots for 2½ minutes.

The handheld computer was interfaced with digital calipers to facilitate rapid entry of shell measurements and other information while sampling. Data entry screens for the sampling programs and survey were configured using Data Plus Professional™ software, which aided in standardizing data entry, providing error checks and minimizing subsequent data auditing and keying (Schick and Feindel 2005).

The following sampling protocol was employed for each tow:

1.) Station information (location, time, depth) was entered from the wheelhouse.

2.) Bottom type was recorded as combinations of mud, sand, rock, and gravel based on sounder information and dredge contents. For example "Sg" designated a primarily sand substratum with some gravel (after Kelley et. al.1998).

3.) Once the drag was emptied, a digital picture of the haul was taken.

4.) Scallops, sea cucumbers (*Cucumaria frondosa*) and ocean quahogs (*Arctica islandica*) were culled from the drag contents for subsequent measurement. Catches of the latter species were quantified because of their importance in other drag fisheries. While the survey gear is not suitable for formally sampling ocean quahogs their presence in the catch does suggest the existence of a bed below the sediment.

5.) Bycatch was enumerated using a 0-5 qualitative abundance scale corresponding to "absent", "present", "rare", "common", "abundant", and "very abundant".

6.) Total number of scallops was recorded. The total weight and volume of the scallop, sea cucumber, and ocean quahog catch was recorded.

7.) The shell height (SH; distance from the umbo to the outer edge, perpendicular to the hinge line) of individual scallops was measured. All scallops from catches of 100 animals or less were measured for SH. If >100 scallops were present at least 100 were measured. Where n > 1,000 a subsample of 10% was measured.

8.) On selected tows (normally every third or fourth tow) a subsample of 24 scallops, chosen to represent the catch of scallops ≥ 3½ in. shell height, were measured (shell length, width and height) and shucked for meat weight determination. Meats were placed in a compartmentalized box in the order that the animals were measured and later individually weighed on shore (using an Ohaus Navigator™ balance interfaced with the ruggedized handheld computer) and matched to the corresponding shell measurements.

***Data analysis***

Area swept per tow was determined from tow distance (tow start to haulback) and drag width (7 ft., or 2.1 m). Tow distance was determined using either ArcView™ or Capn Voyager™ software. The scallop catch for each tow was standardized to density (number of scallops per square meter). Total scallop catch was divided into the following size categories:

- **seed**: < 2½ in. (<63.5 mm) SH
- **sublega**l: 2½ in. to < 4 in. (63.5 – <101.6 mm) SH
- **harvestable:** ≥ 4 in. (≥101.6 mm) SH

Estimates of total abundance for each of the three size classes were calculated using the classic Cochran (1977) approach. For each of the six survey substrata identified above, the overall average abundance by area swept 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 substratum h, H is the total number of substrata, and $W_h$ is proportion of the area of substratum h with respect to the survey area. The associated standard error can be calculated as:

$$\textbf{\textit{std error}}(\bar{X}) = \sqrt{\sum_{h=1}^{H} W_h^2 \frac{1 - f_h}{n_h} S_h^2}$$

where $S_h^2$ is the variance estimated for substratum h, $f_h = \frac{n_h}{N_h}$ is the finite population correction for substratum h, and $n_h$ and $N$ are the number of stations sampled and the total number of stations available for sampling, respectively, in substratum h. The finite population correction factor was ignored since the proportion of area sampled was small compared to the total area of each substratum.

**RESULTS:**

**Bold Coast rotational closure**

Nine (9) stations were sampled in this area in 2014 (Fig. 6). One (1) tow contained no scallops. Seed density (0.019 per $m^2$) (Figs. 7-8) remained at a relatively high level, comparable to the 2013 estimate (0.018 per $m^2$) of the adjacent area (open portion Stratum 2).

Harvestable scallop density was significantly ($p < 0.05$) higher in the Bold Coast in 2014 (0.048 per $m^2$) than in the adjacent open area in 2013 (0.011 per $m^2$) (Figs. 7-8). Sublegal density also was higher in the Bold Coast in 2014 (0.054 per $m^2$) than in the open portion of Stratum 2 in 2013 (0.023 per $m^2$).

Highest overall catch rate and highest seed, sublegal and harvestable density was near Morton Ledge.

Scallop harvestable ($\geq$ 4 inch SH) biomass (by meat weight) was calculated by applying the shell height-meat weight relationship for combined Strata 2-3 from fall 2011 (Kelly 2012). Spring 2014 size frequencies were projected to December 1 using von Bertalanffy parameters (Serchuk et al. 1982) on a tow-by-tow basis to determine mean harvestable biomass (g) per $m^2$. That value (adjusted with a dredge efficiency factor of 0.429 (Kelly 2013)) was then expanded to the total survey area (20,580 $km^2$) within the Bold Coast rotation to obtain a projected total harvestable biomass estimate of 67,300 $\pm$ 13,400 lbs.

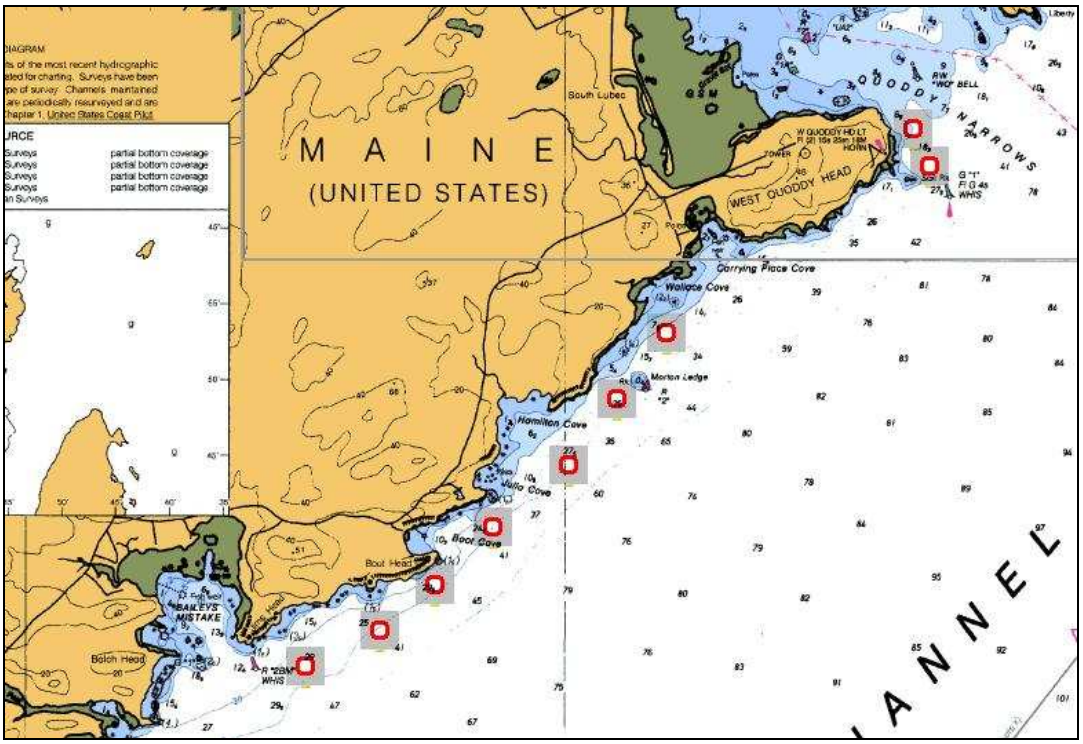



**Figure 6. Location of 2014 survey stations (Bold Coast).**

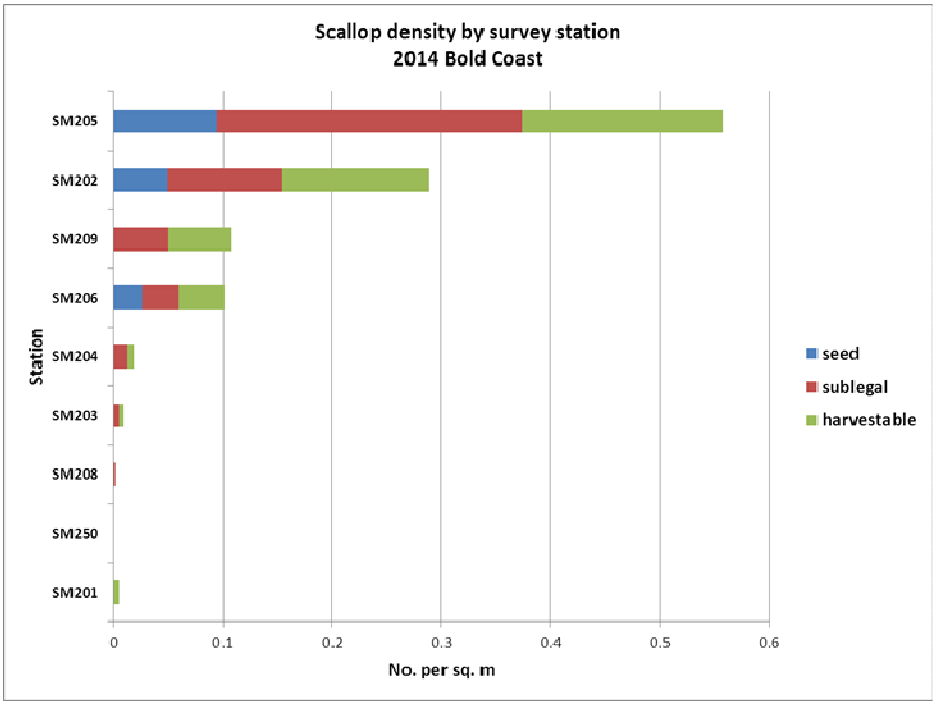



**Figure 7. Density of scallops and size class composition by tow (Bold Coast), 2014 survey.**

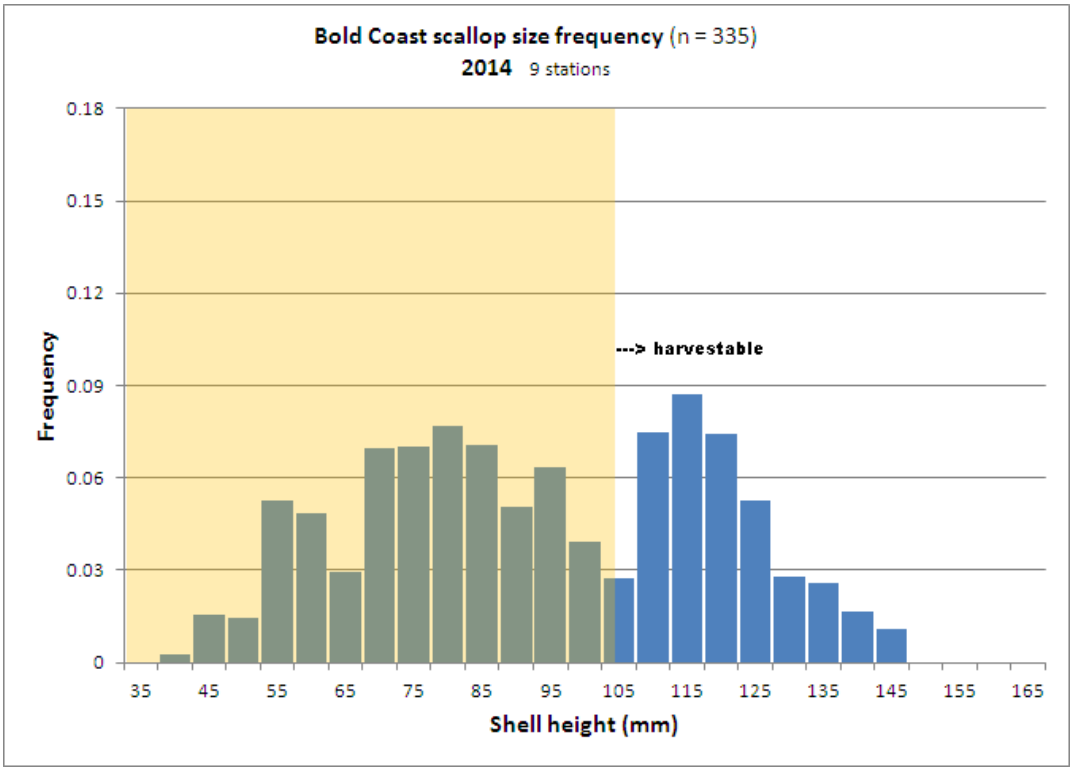



**Figure 8. Size frequency (5 mm increments) of scallops in Bold Coast rotational closure (2014).**

**Little Kennebec/Englishman Bay rotational closure**

There were 29 stations completed in 2014 in this area (Fig. 9). Five (5) tows contained no scallops.

The predominant size group was harvestables which occurred at a higher density (0.039 per m²) than 2013 in the adjacent open portion of Stratum 3 (0.022 per m²) (Figs. 10-11). In 2011 the harvestable density in this area was 0.014 per m².

Sublegal density (0.032 per $m^2$) however was less than in the adjacent area in 2013 (0.045 per $m^2$) Seed density remained low (0.003 per m²) comparable to 2013 (0.005 per m²).

Highest catch rate of harvestables was near Lakeman Is. Highest catch rate of seed and sublegals was off Shag Rock.

Harvestable biomass was calculated by applying the fall 2011 shell height-meat weight relationship of combined strata 2-3 to spring 2014 survey size frequency data. Spring 2014 size frequencies were projected to December 1 using von Bertalanffy parameters (Serchuk et al. 1982) on a tow-by-tow basis to determine mean harvestable biomass (g) per m². Expansion of that value to the total survey area (28,300 km²) within the Little Kennebec/Englishman rotation resulted in a projected estimate of 68,500 $\pm$ 7,600 lbs.

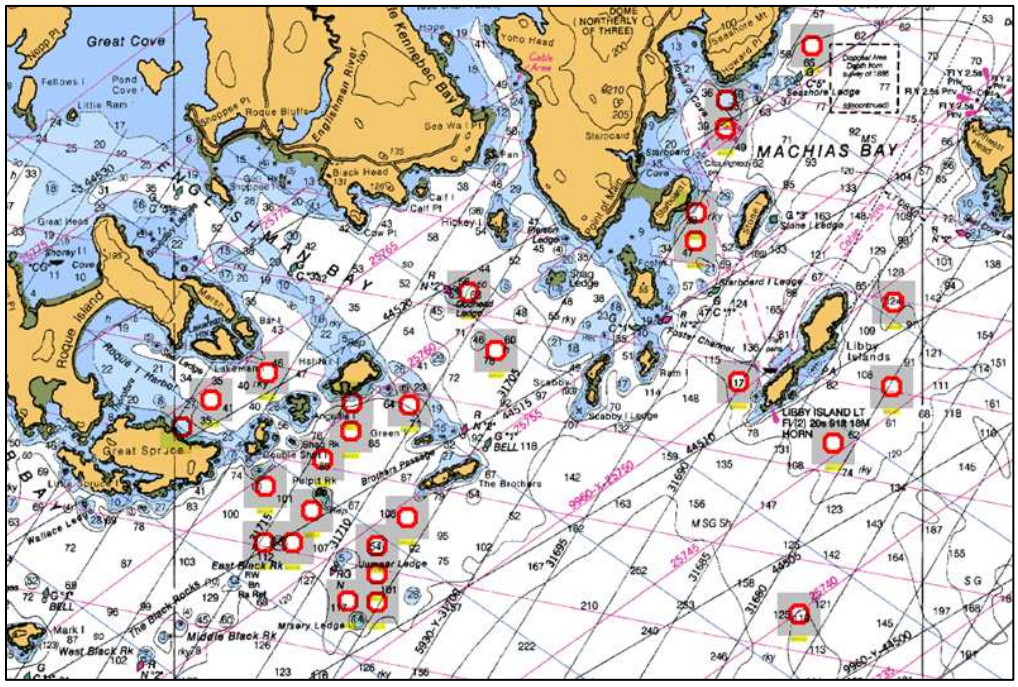



**Figure 9. Location of 2014 survey stations (Little Kennebec/Englishman Bay).**

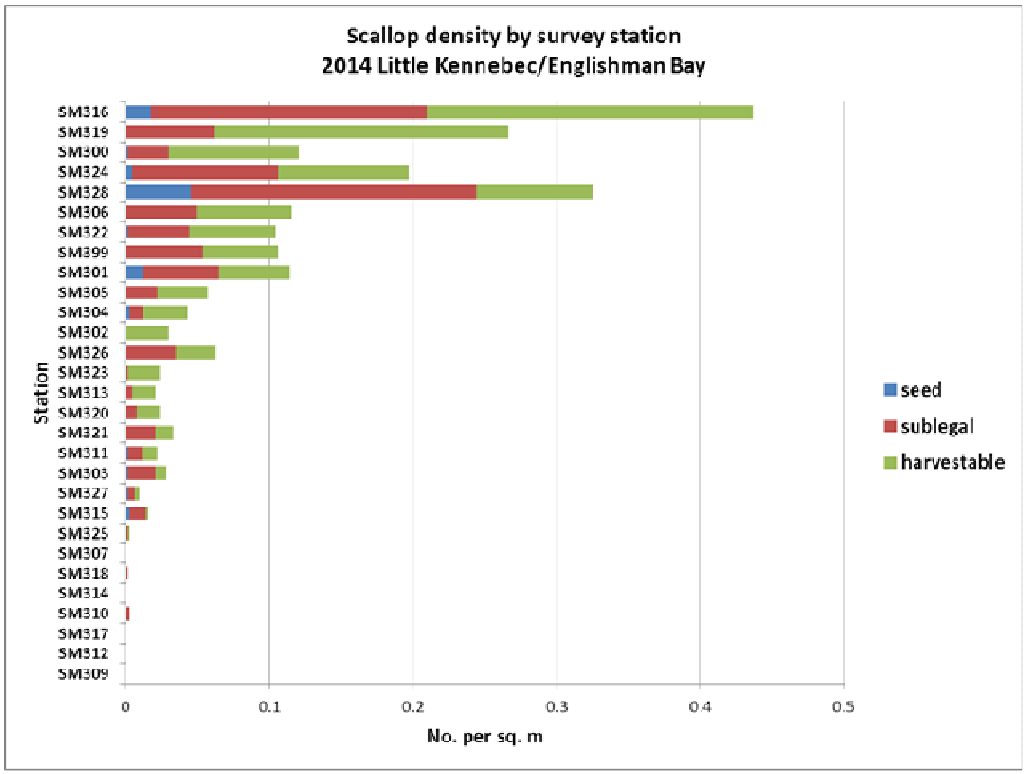



**Figure 10. Density of scallops and size class composition by tow (Little Kennebec/Englishman Bay), 2014 survey.**

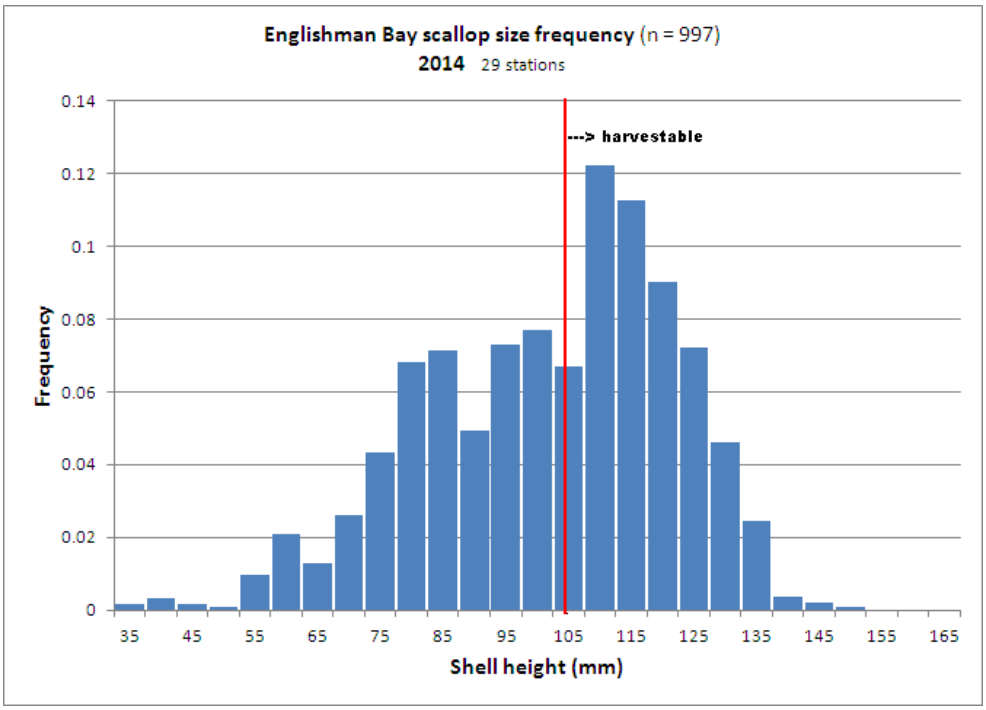



**Figure 11. Size frequency (5 mm increments) of scallops in Little Kennebec/Englishman Bay rotational closure (2014).**

**Addison rotational closure**

There were 19 tows completed in this area in 2014 (Fig. 12). Six (6) tows had no scallops.

Scallop abundance was generally low. The predominant size group was harvestables (0.019 per $m^2$) which were higher than the 2013 estimate in the adjacent open portion of Stratum 4 (0.010 per $m^2$) (Figs. 13-14). Sublegal density (0.008 per $m^2$) was less than the 2013 estimate in the adjacent area (0.015 per $m^2$). Seed density (0.001 per $m^2$) was very low.

Most of the scallops were observed in the Pleasant River and near Strout Is.

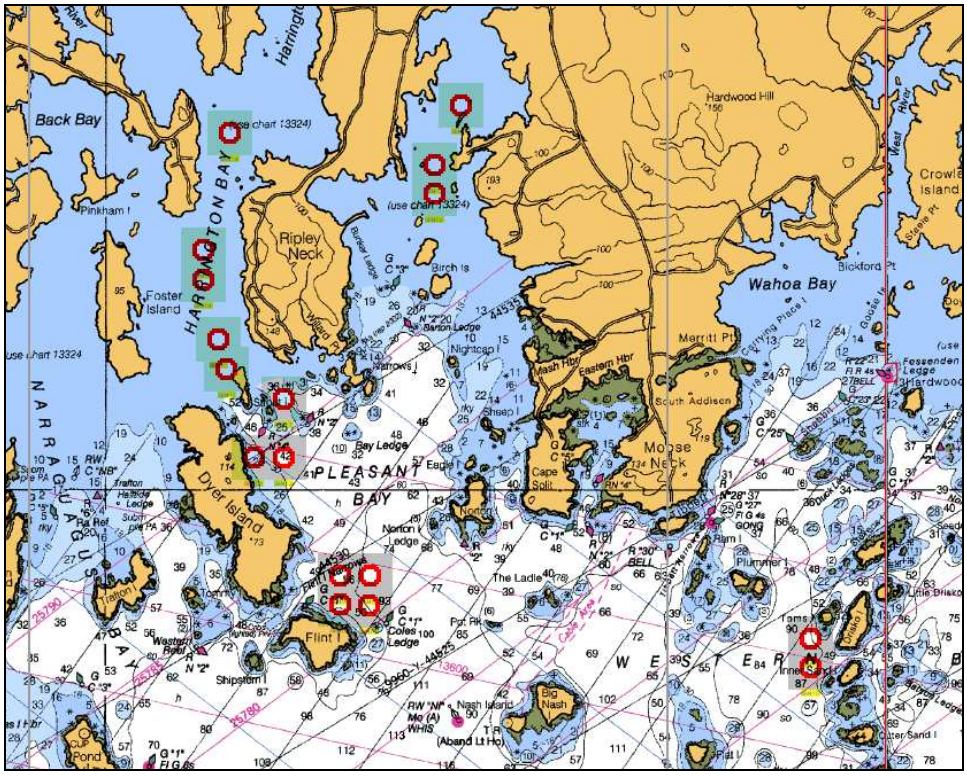



**Figure 12. Location of 2014 survey stations (Addison).**

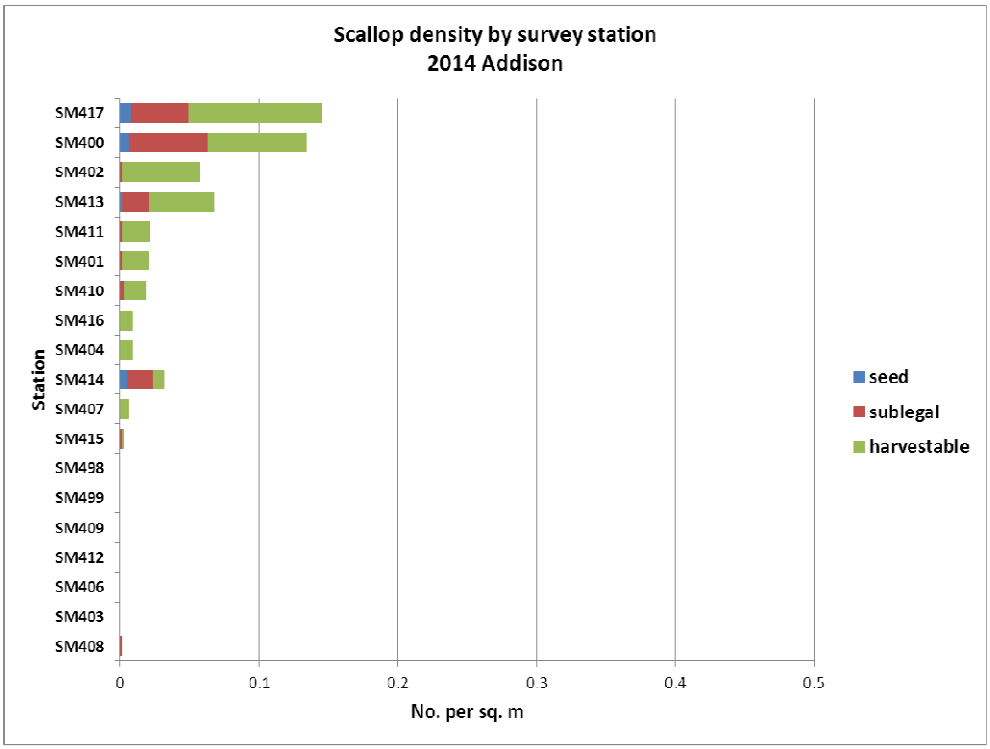



**Figure 13. Density of scallops and size class composition by tow (Addison), 2014 survey.**

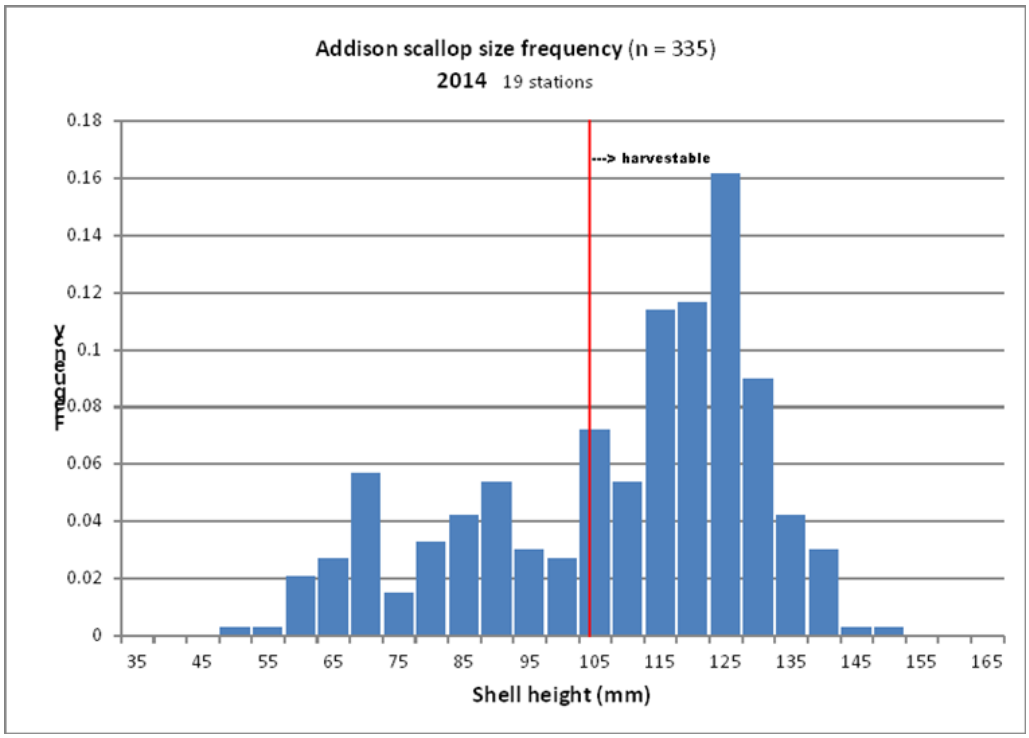



**Figure 14. Size frequency (5 mm increments) of scallops in Addison rotational closure (2014).**

**Frenchman Bay rotational closure**

There were 32 tows conducted on the 2014 survey in this area (Fig.15). Fourteen tows had no scallops.

Scallop abundance in this area was low. Harvestable density (0.008 per m²) was similar to 2013 (0.010 per m²) in the adjacent open portion of Stratum 5 (Figs. 16-17). Sublegals were 0.006 per m² in 2014 compared to 0.005 per m² in 2013 in the adjacent area. There was barely a trace (<0.001 per m²) of seed in this closure, same as in 2013 in the adjacent open portion.

Highest scallop densities of harvestable and sublegal scallops were in the Skillings River area but quantities of both were small.

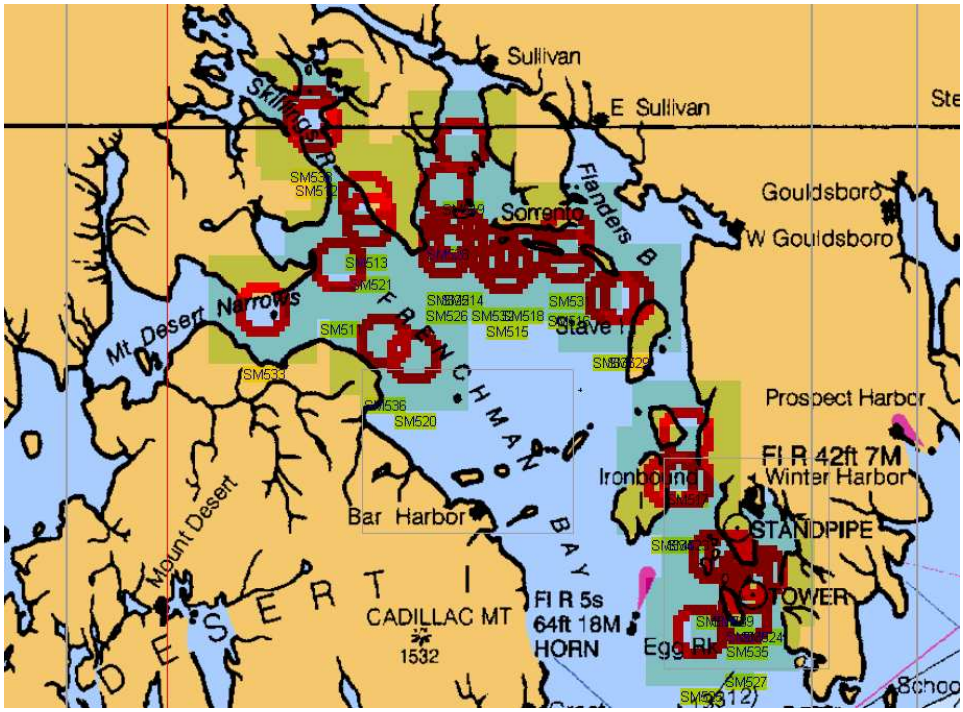



**Figure 15. Location of 2014 survey stations (Frenchman Bay).**

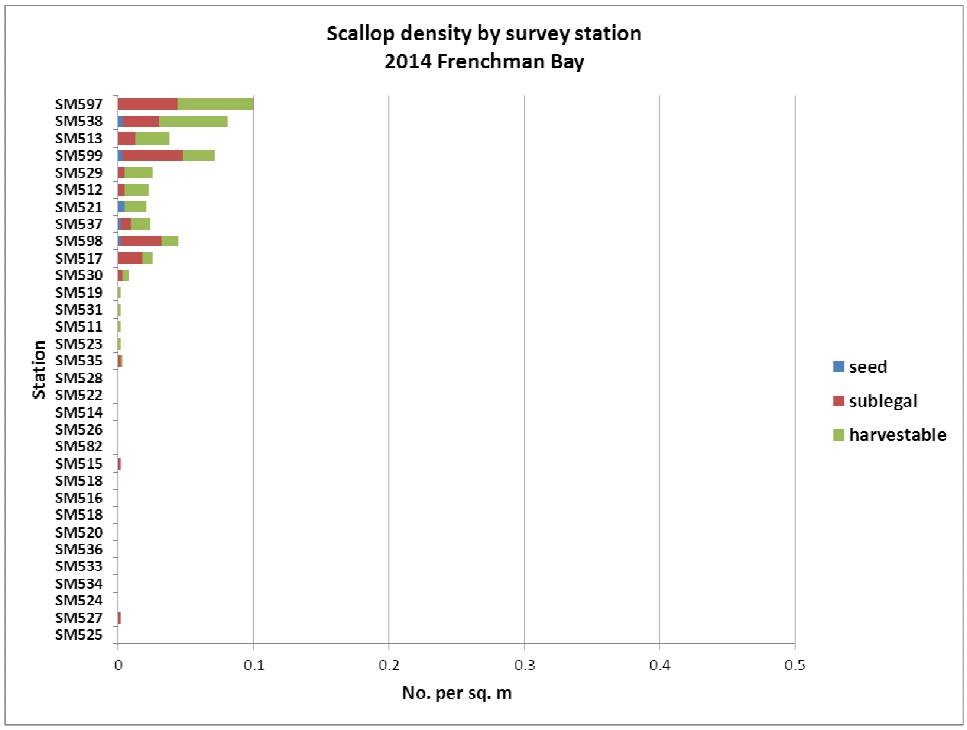



**Figure 16. Density of scallops and size class composition by tow (Frenchman Bay), 2014 survey.**

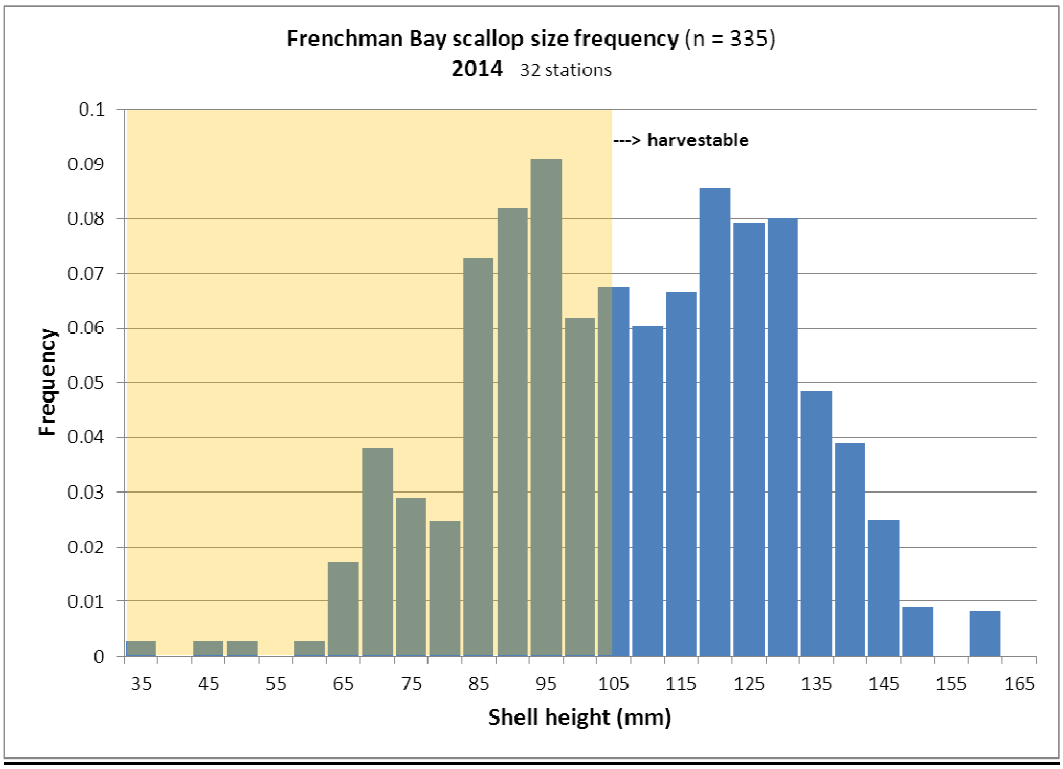



**Figure 17 . Size frequency (5 mm increments) of scallops in Frenchman Bay rotational closure (2014).**

**Swan's Island rotational closure**

There were seventeen (17) tows completed in the closure (Fig. 18). Six (6) tows contained no scallops.

Scallop abundance was poor in this area. The predominant size group was sublegals which were present at a density of only 0.010 per m² (Figs. 19-20). Harvestable and seed densities were low at 0.007 per m² and 0.002 per m² respectively. A small amount of seed was found at Toothacher Bay.

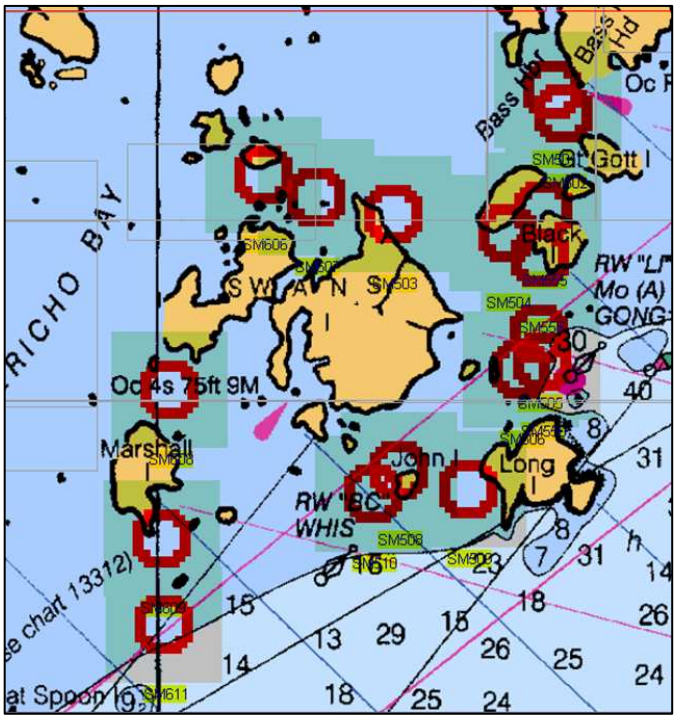



**Figure 18. Location of 2014 survey stations (Swan's Island).**

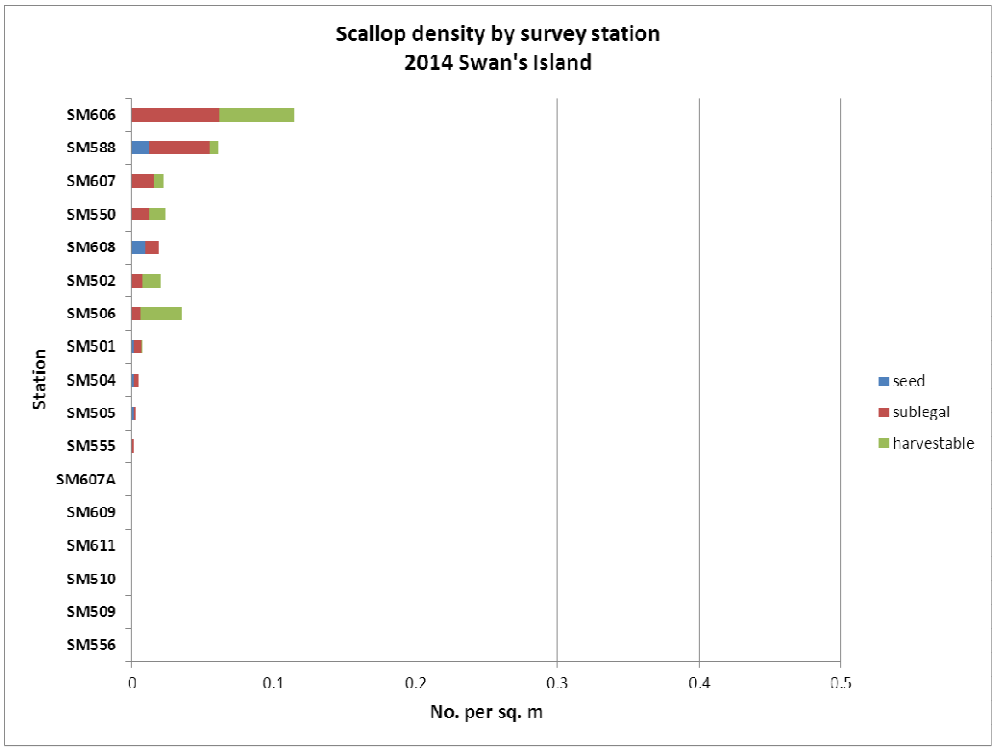



**Figure 19. Density of scallops and size class composition by tow (Swan's Island), 2014 survey.**

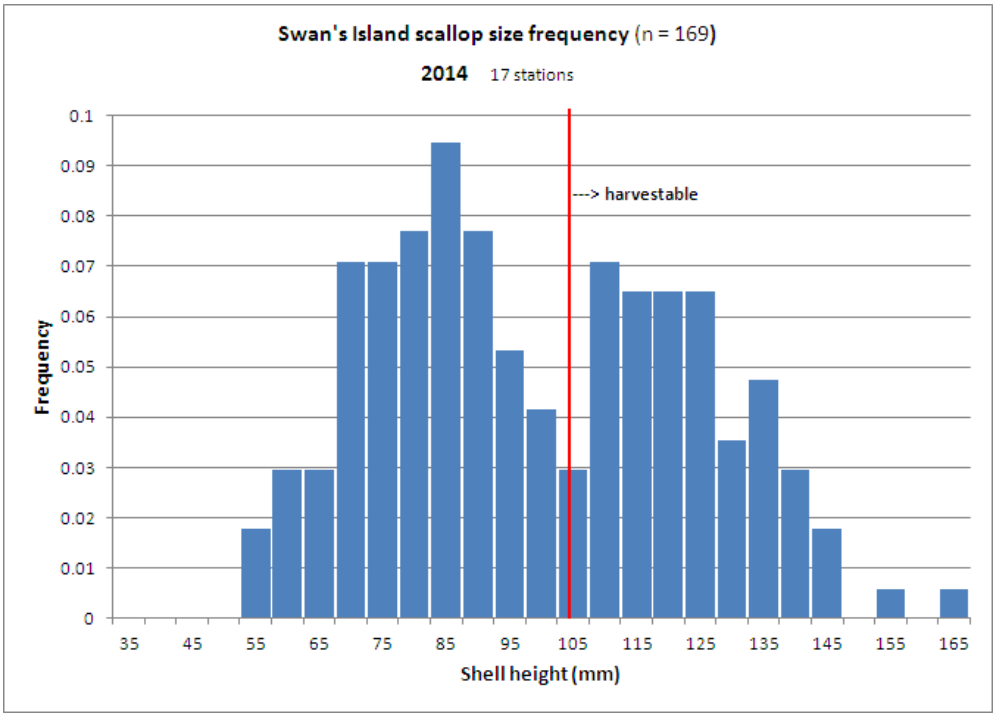



**Figure 20. Size frequency (5 mm increments) of scallops in Swan's Island rotational area (2014).**

**Isle au Haut Bay rotational area**

There were 14 tows conducted on the 2014 survey in this area (Fig. 21). Three (3) tows had no scallops.

Harvestables were in low density (0.021 per $m^2$) but were the most abundant of the size groups (Figs. 22-23). They were found mostly south and west of Carvers Is. Seed were very scarce (<0.001 per $m^2$) and sublegal density was low (0.013 per $m^2$).

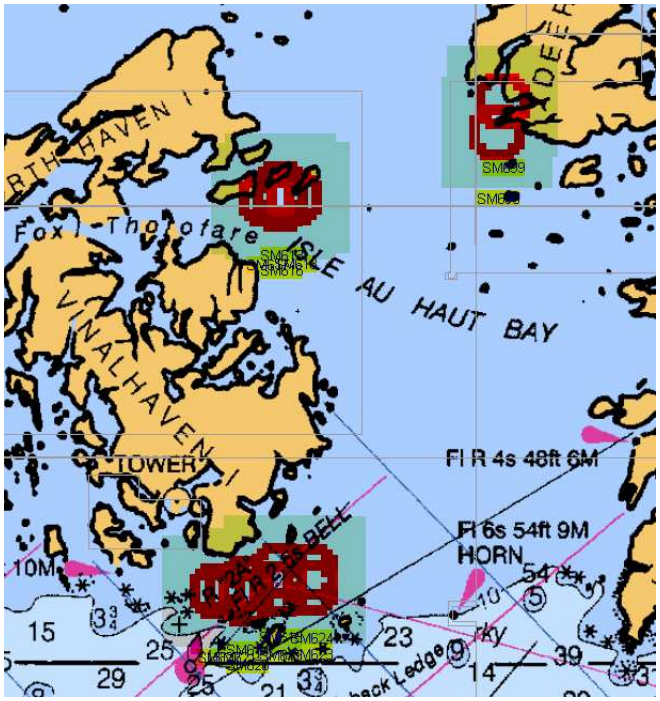



**Figure 21. Location of 2014 survey stations (Isle au Haut Bay).**

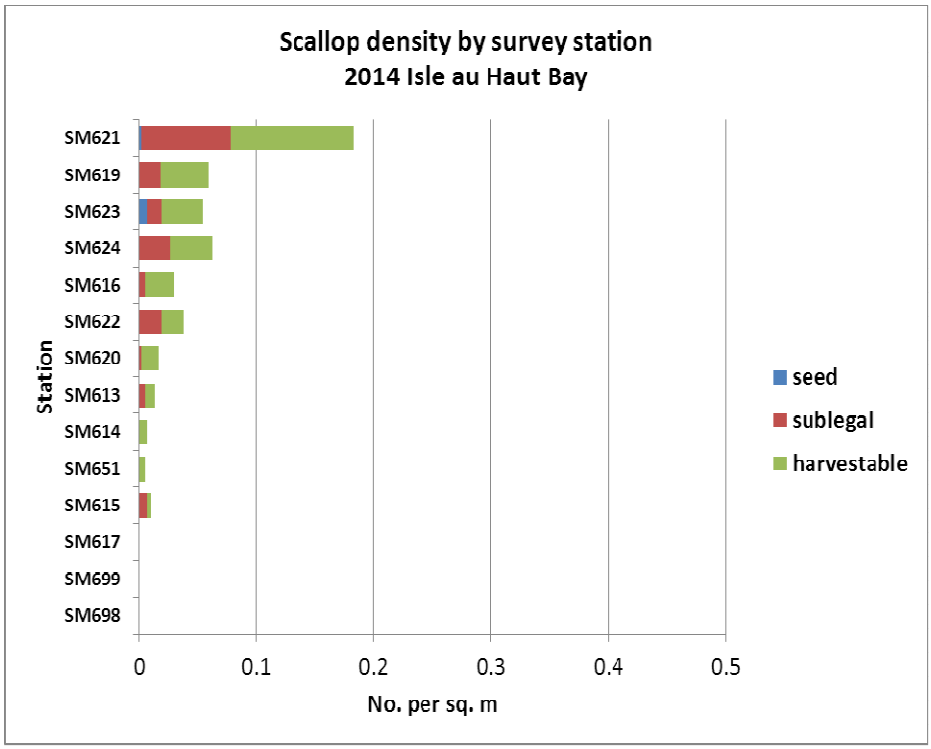



**Figure 22. Density of scallops and size class composition by tow (Isle au Haut Bay), 2014 survey.**

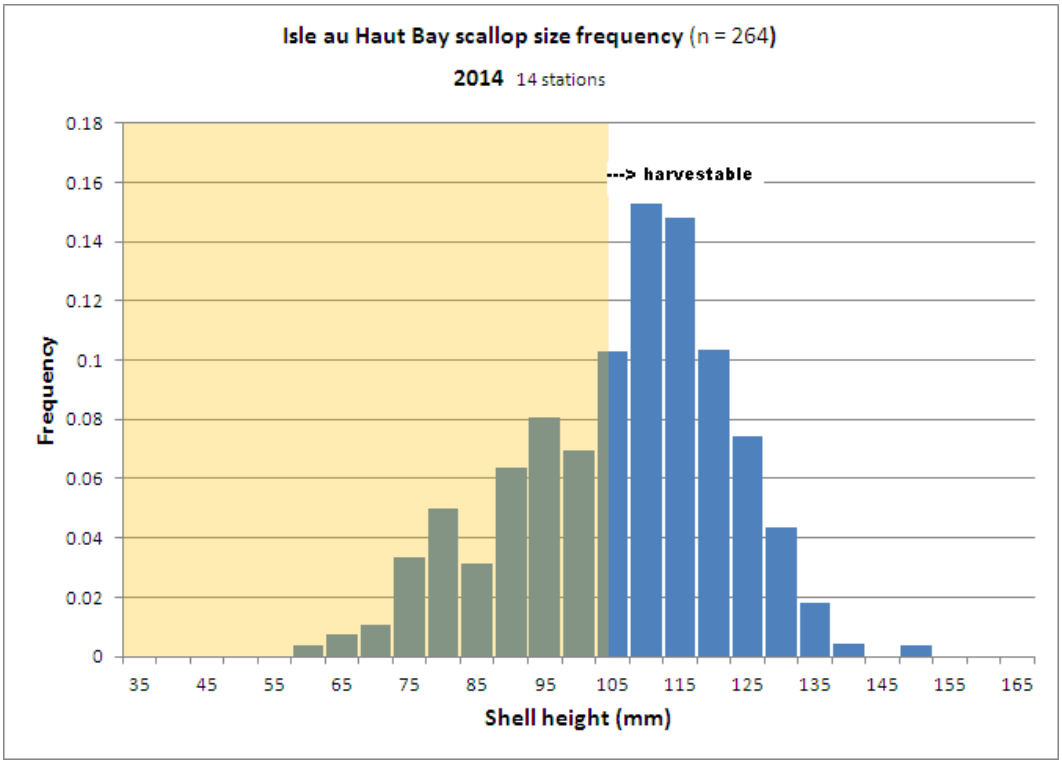



**Figure 23 . Size frequency (5 mm increments) of scallops in Isle au Haut Bay rotational area (2014).**

**Upper Penobscot Bay rotational area**

There were 18 tows completed in Upper Penobscot Bay in 2014 (Fig. 24) and 12 tows contained no scallops.

Scallop abundance was scant; only 38 scallops total were caught in this area. There were no seed and very few sublegals (<0.001 per $m^2$) (Figs. 25-26). A small amount of harvestables was near Condon Pt.

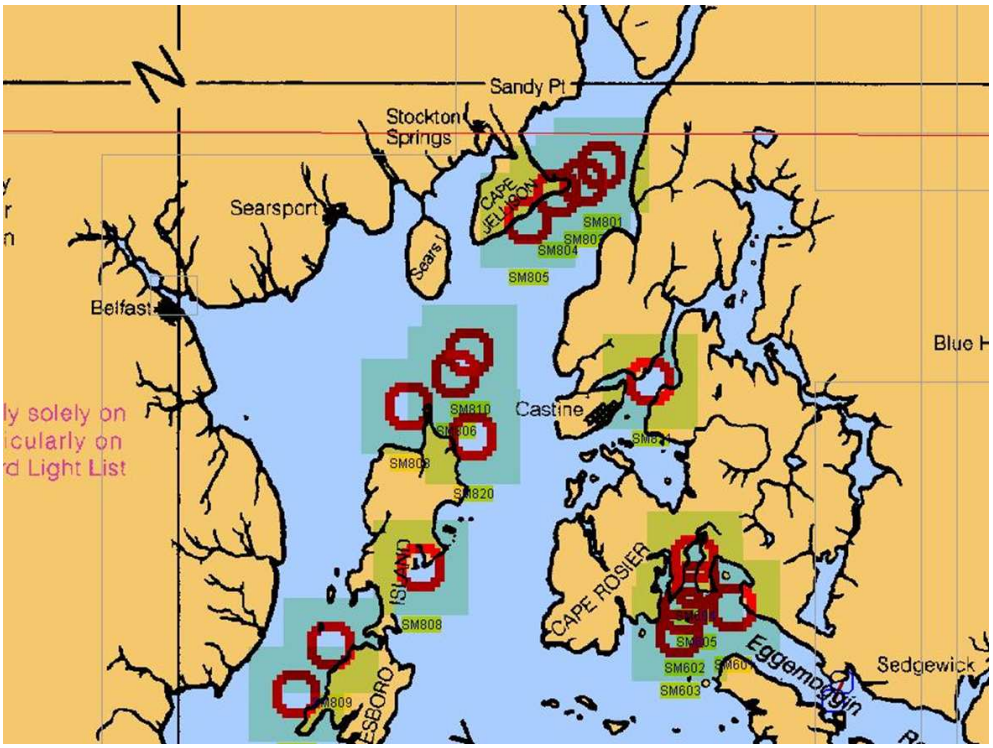



**Figure 24. Location of 2014 survey stations (Upper Penobscot Bay).**

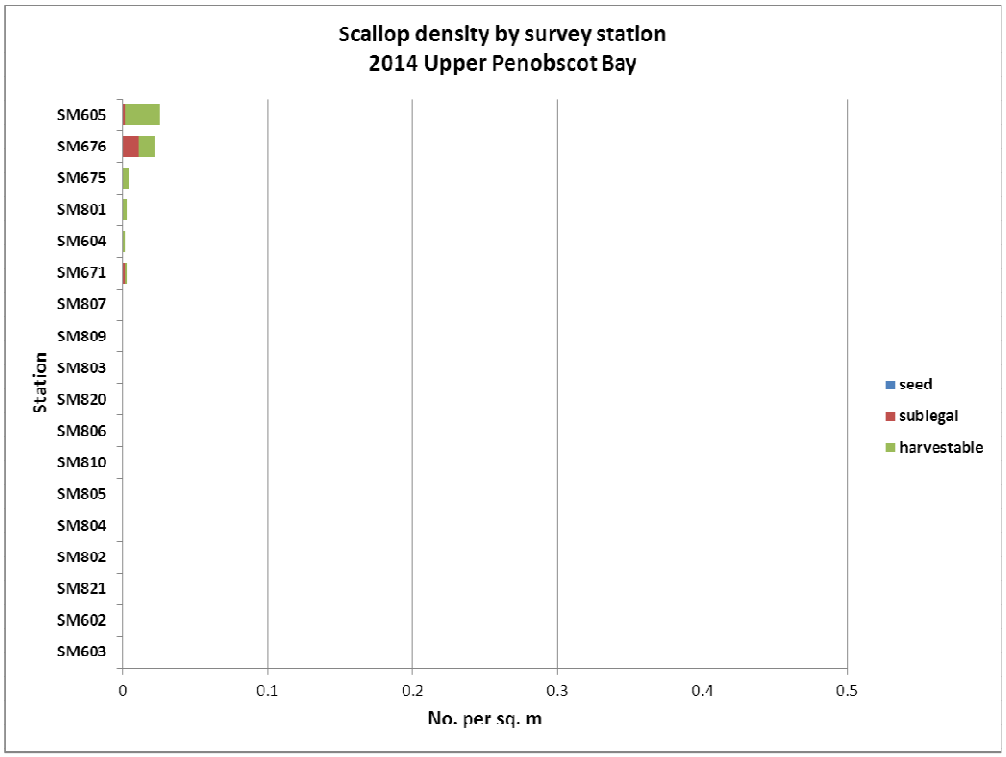



**Figure 25. Density of scallops and size class composition by tow (Upper Penobscot Bay), 2014 survey.**

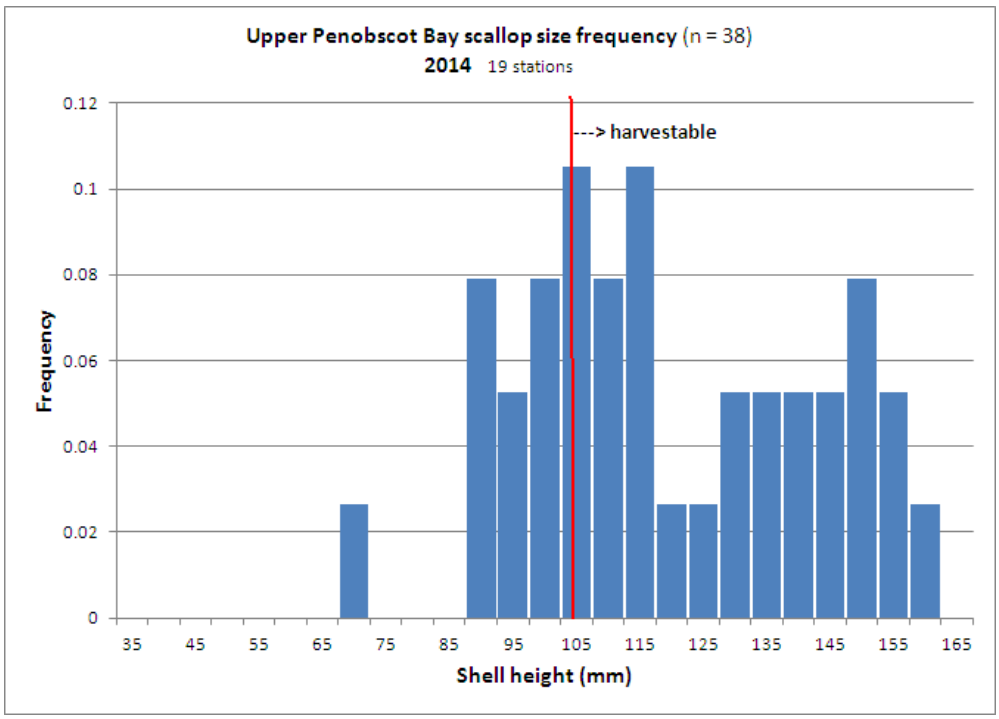



**Figure 26. Size frequency (5 mm increments) of scallops in Upper Penobscot Bay rotational area (2014).**

## Conclusions

There were seven (7) scallop rotational areas surveyed by ME DMR in spring 2014 prior to these areas being re-opened to fishing for the 2014-15 season (these areas were closed after the 2011-12 season). Harvestable abundance was highest in the Bold Coast and Little Kennebec/Englishman Bay areas. The other five (5) areas were poor however with only scattered areas of harvestable and/or sublegal/seed scallops.

Harvestable scallop density was greatest in the Bold Coast area. Density of harvestable scallops increased by nearly 2.5X in this area since 2011.

The highest estimate of harvestable biomass was in Little Kennebec/Englishman Bay (the larger of the two areas). Harvestable density increased nearly 3X in this area since 2011.

Little Kennebec/Englishman Bay and Bold Coast in 2014 continued the positive trend in scallop abundance seen in survey strata 2-3 (W. Quoddy Head to Great Wass Is.) since 2011. Increases in recruitment along with implementation of rotational management designed to improve yield seem to have significantly benefited this portion of the coast.

## Acknowledgements

Appreciation is extended to Capt. Bruce Porter (*F/V Bad Company*) and crew Owen, Shaun and Josh. Lisa Leighton provided field assistance along with Joe Wodjenski who led the western portion of the survey.

The survey was funded under NOAA Fisheries Scallop Research Set-Aside Project 11-SCA-04. Wally Gray (*F/V Foxy Lady II*) and Gary Hatch (*F/V Shearwater*) harvested the research TAC allocated to the project.

## References

Cochran, W.G. 1977. Sampling techniques, 3rd ed. John Wiley & Sons, New York. 428 p.

Kelley, J.T., W.A. Barnhardt, D.F. Belknap, S.M. Dickson and A.R. Kelley. 1998. The seafloor revealed: the geology of the northwestern Gulf of Maine inner continental shelf. Open-File 96-6 Maine Geological Survey Natural Resources Information and Mapping Center.

Kelly, K.H. 2010. Results from the 2009 Maine sea scallop survey. Maine Department of Marine Resources, Research Reference Document, 41 p.

Kelly, K.H. 2012. Results from the 2011 Maine sea scallop survey. Maine Department of Marine Resources, Research Reference Document, 66 p.

Kelly, K.H. 2013. Results from the 2012 Cobscook Bay sea scallop survey. Maine Department of Marine Resources, Research Reference Document, 31 p.

Schick, D.F. and S.C. Feindel. 2005. Maine scallop fishery: monitoring and enhancement. *Final Report to the Northeast Consortium (Sept. 1, 2005)*, 72 p.

Serchuk, F.M., P.W. Wood, Jr. and R.S. Rak. 1982. Review and assessment of the Georges Bank, Mid-Atlantic and Gulf of Maine Atlantic Sea Scallop (*Placopecten magellanicus*) resources. *National Marine Fisheries Service, Woods Hole Laboratory Reference Document* No. 82-06, 132 p.