Results from the 2013 Cobscook Bay Sea Scallop Survey

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Executive Summary

The fall 2013 Maine Department of Marine Resources (DMR) sea scallop survey was carried out in October (prior to the December 2 opening of the fishery) in survey strata 1 (Cobscook Bay) and 1a (St. Croix River). This survey covered the subareas of Whiting Bay/Dennys Bay, South Bay, East Bay, Pennamaquan River, Johnson Bay and Moose Island. In total 91 tows were completed, at a rate of 2 tows per km² in Cobscook Bay.

Some key findings were:

- In 2013 Cobscook Bay had the second highest amount of harvestable ($\geq$ 4 in. shell height) meat biomass (452,200 $\pm$ 27,200 lbs.) observed since the survey began in 2002. Meat weight in relation to shell height was slightly greater than the previous survey (2012) of Cobscook Bay and the highest since 2002-03.
- Harvestable biomass in the Whiting Bay/Dennys Bay limited access area decreased 13% between 2012 and 2013 but was still the second highest of the time series. Whiting Bay/Dennys Bay had the highest density (0.331 per m²) of harvestable scallops in Cobscook Bay in 2013.
- South Bay had the largest proportion (53%) of harvestable biomass in Cobscook Bay in 2013. Harvestable density decreased in South Bay in 2013 but was still the second highest of the time series.
- Highest densities of both seed (0.101 per m²) and sublegals (0.333 per m²) were in Johnson Bay.
- Scallop abundance was variable within the St. Croix River. There was a low abundance of harvestable scallops. One tow had a large presence of sublegal scallops.

Introduction

Scallops have been harvested along the Maine coast since the late 1800's (Wallace 1997; Schick and Feindel 2005). The scallop fishery in the Gulf of Maine occurs primarily in state waters. At times the dollar value of the fishery in Maine has been second only to lobster. The fishery has been characterized by wide fluctuations in abundance with fishing pressure increasing rapidly in times when scallops were more plentiful (Walton 1980; Alden and Perkins 2001; Schick and Feindel 2005).

The sea scallop resource currently supports a December-March commercial and recreational fishery along coastal Maine. 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. There were 547 dragger and 84 dive licenses issued by ME DMR in 2013.

DMR conducts a fishery-independent dredge-based scallop survey and fishery-dependent port and sea sampling programs as its primary resource assessment methods. The dredge survey has been conducted annually since 2002 (with the exception of 2004).

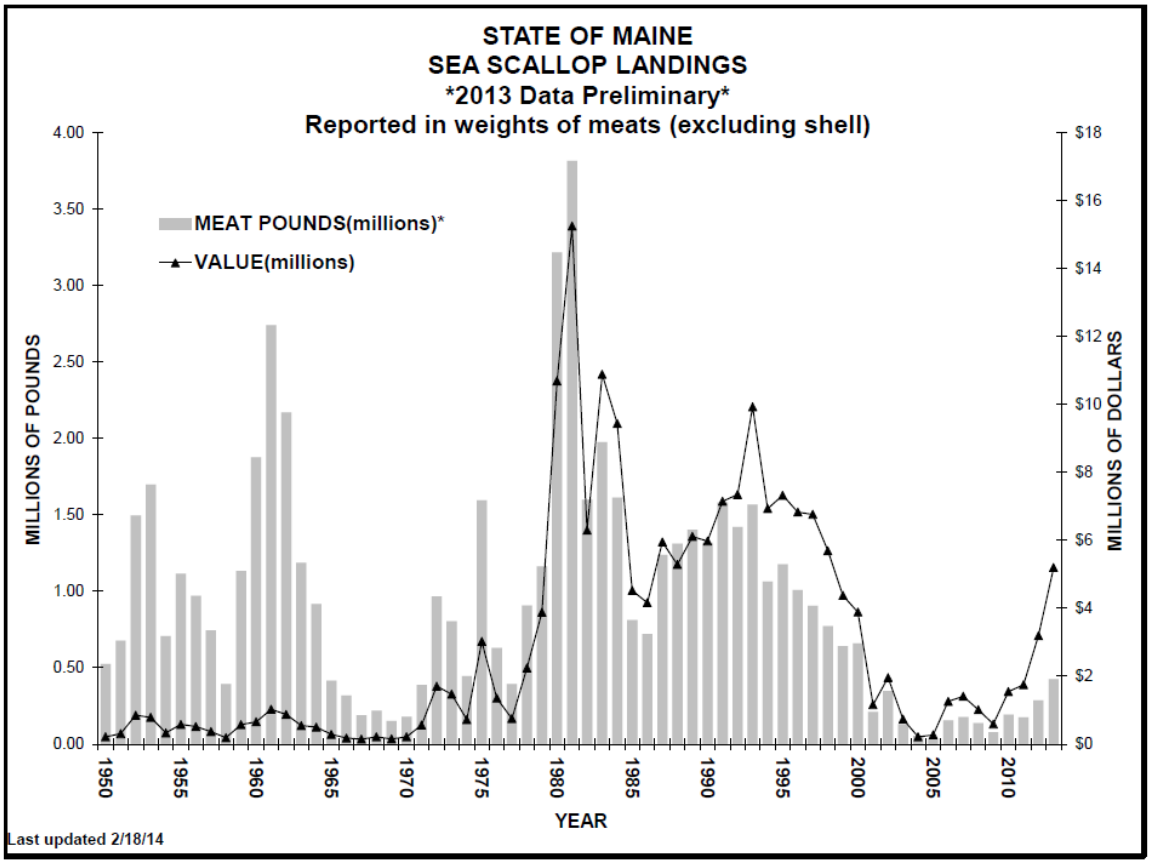


Figure 1. Maine scallop landings 1950-2013 (source: Maine Department of Marine Resources (DMR)).

Purpose and extent of survey

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 area 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.

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 eastern Maine (management Zone 2) rotational areas was added. The 2013 Cobscook Bay/St. Croix R. survey was conducted in the fall.

Methods

The Cobscook Bay/St. Croix R. survey was conducted during 22-26 October 2013 aboard the 39 ft. *F/V Kristin Lee* from Eastport. 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. 2; also see Kelly 2010).

Table 1 . Chronology of Maine DMR scallop survey, 2002-13.

Area		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	Cobscook Bay/St. Croix R.	**S**	**S**	NS	NS	**S (begin higher intensity survey)**	**S**	NS	**S**	**S**	NS	**S**	**S (fall)**
	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)**
	Western Maine	**S**	**S**	NS	**S**	NS	NS	NS	**S**	NS	**S (closures 1-3 only)**	NS	NS

S = surveyed
NS = not surveyed

Figure 2. View of survey drag constructed in 2009.

Survey design

A subset of the coastal zones (or "strata") defined for the 2002-03 surveys (Fig. 3) were used in subsequent surveys, including 2013, with some modification (e.g., St. Croix River (stratum 1A), Machias Seal Is. (stratum 2A), Mt. Desert Rock (stratum 5A)).

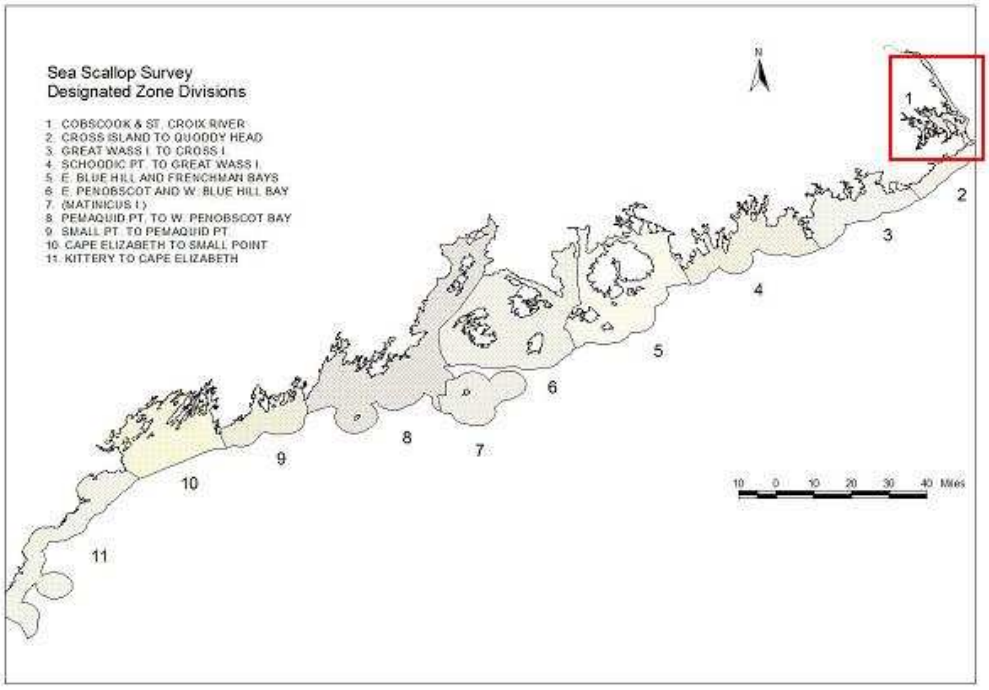


Figure 3. Survey strata - ME DMR scallop survey (with Cobscook Bay area highlighted).

Strata were sized to provide a manageable balance between area and sampling intensity. Scallop areas within the strata were mapped based on fisher information, 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).

Cobscook Bay (Fig. 4) has the most productive scallop fishery within Maine waters and is thus sampled with the most frequency and with the highest intensity of the survey zones. A direct assessment of scallop abundance for this stratum was made by using a systematic grid design.

Figure 4. Cobscook Bay and surrounding area (source: Cobscook Bay Resource Center).

Six survey substrata (South Bay, Pennamaquan River, East Bay, Whiting Bay/Dennys Bay, Johnson Bay and Moose Island) within Cobscook Bay representing spatially contiguous fished areas were determined in consultation with fishing industry members prior to the 2002 survey and have been repeated in subsequent surveys with slight modification. The total number of stations sampled was increased by 31% from previous surveys beginning in 2006.

Cobscook Bay tow locations were based on a 500 m grid overlaying each substratum and all stations were sampled along this grid (Figs. 5-7). The grid accommodated an average tow length of approximately 300 m. There were 83 tows completed in the 2013 Cobscook Bay survey.

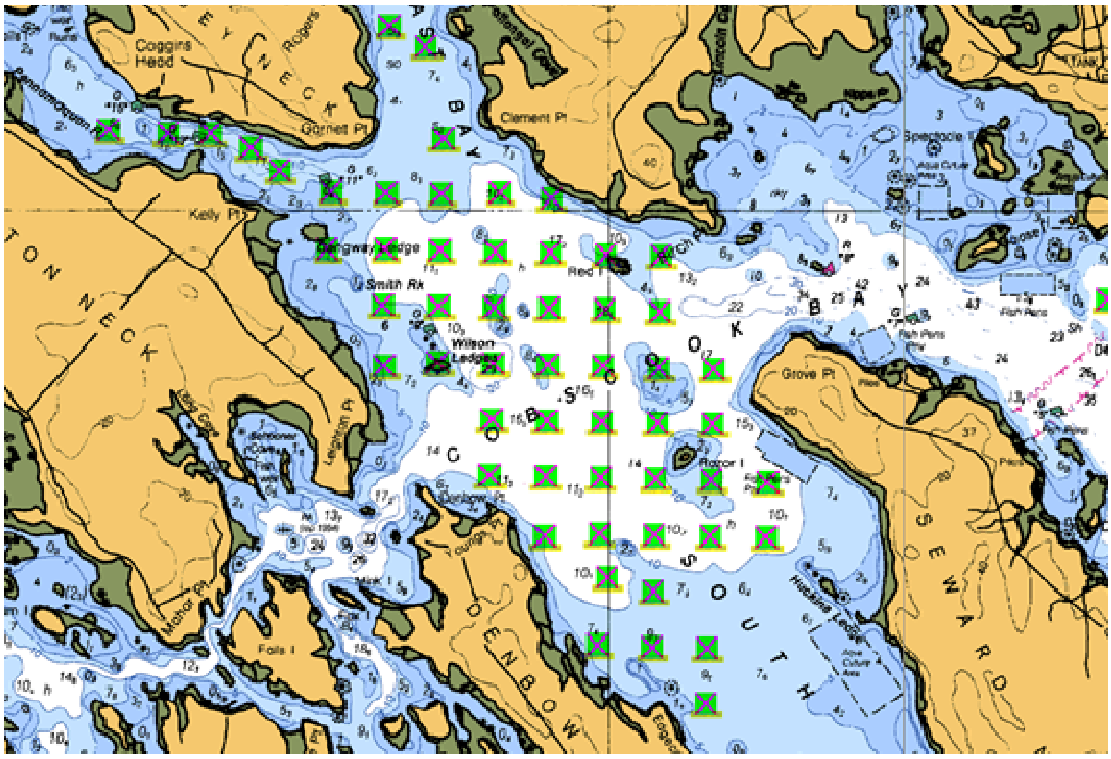


Figure 5. Sampling stations for South Bay, Pennamaquan River and East Bay.

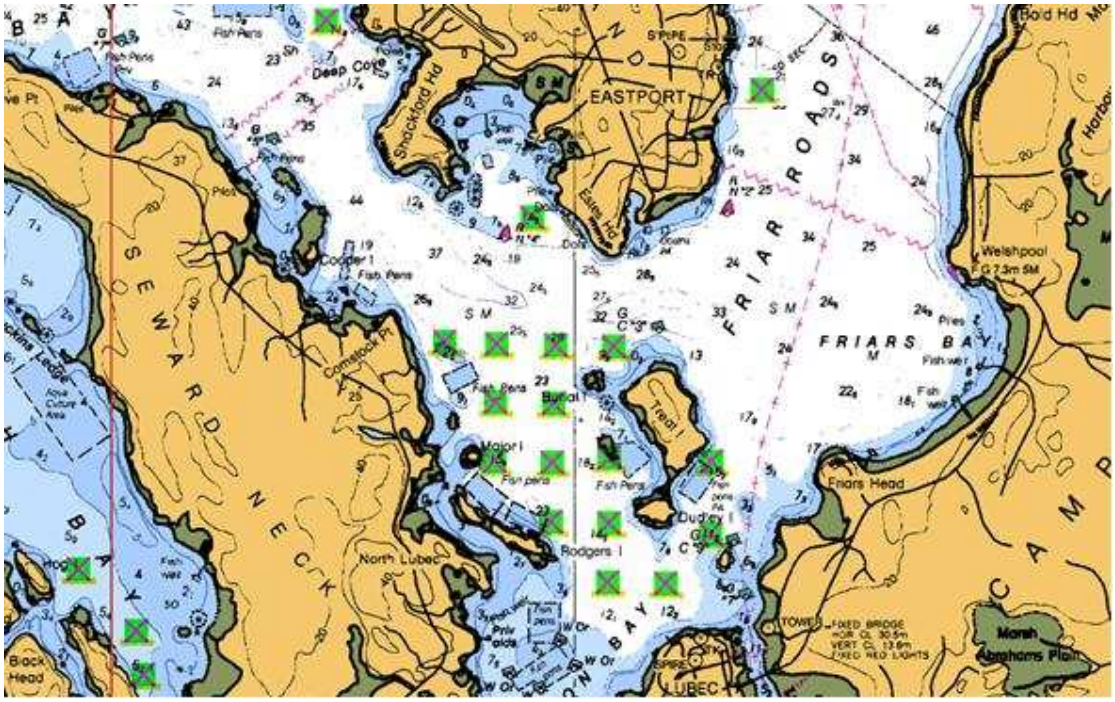


Figure 6. Sampling stations for Johnson Bay and Moose Island.

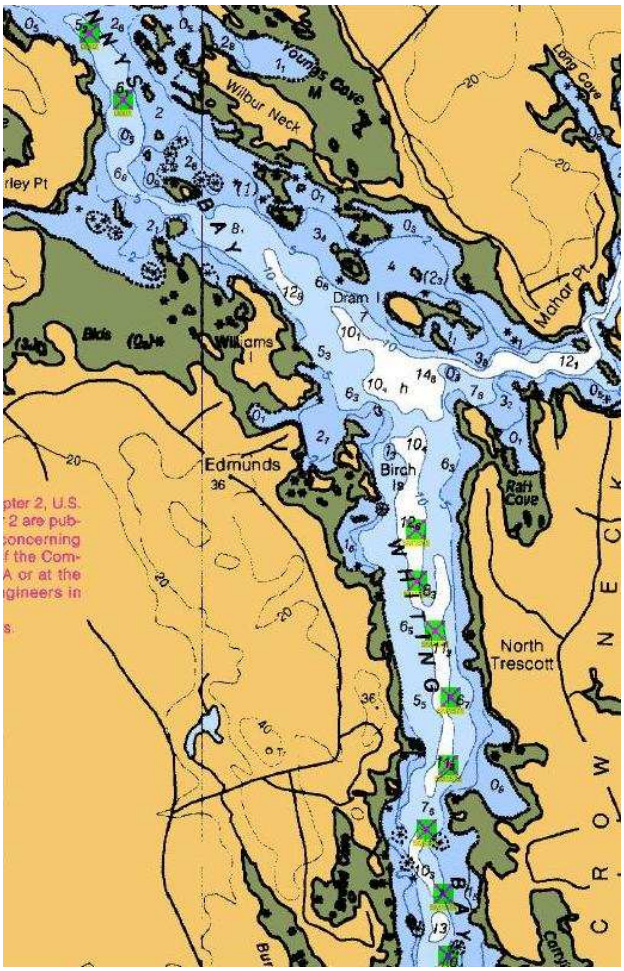


Figure 7. Sampling stations for Whiting Bay/Dennys Bay (one station at lower end of Whiting Bay not visible).

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 an internal 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 were culled from the drag contents, enumerated and set aside for measurement.

5.) Bycatch was enumerated using a 0-5 qualitative abundance scale corresponding to "absent", "present", "rare", "common", "abundant", and "very abundant". Numbers of sea cucumbers (*Cucumaria frondosa*) were recorded along with their weight and volume in order to provide information which may be helpful in the evaluation of this resource.

6.) 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.

7.) 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 the navigation 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
- **sublegal**: 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.

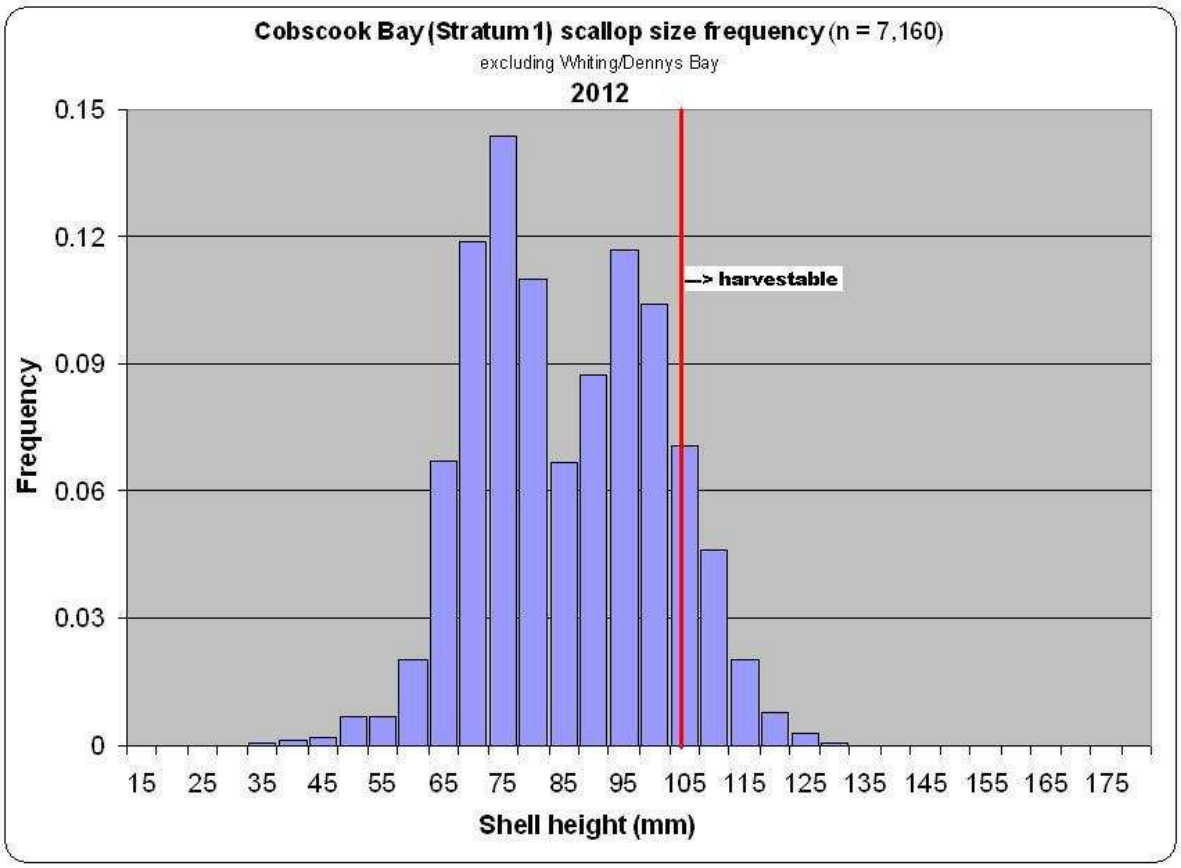
Results

Stratum 1 (Cobscook Bay)

The 2013 survey comprised 83 total tows within the six (6) substrata of Cobscook Bay. Approximately 36,100 scallops were caught and counted, 9,000 were measured for shell height and an additional 630 were sampled for shell size-meat weight determination. The smallest individual sampled was 15.1 mm (0.6 in.) SH and the largest was 144.7 mm (5.7 in.) SH. The largest number of scallops in a single tow was 766 in Whiting Bay.

Size frequency

A significant feature of Cobscook Bay in 2013 was the dominance of the 86-100 mm size group (Fig. 8). This size group comprised 40% of the total measured catch. Scallops which were newly-recruited to harvestable size (101-110 mm SH) were also prominent (22%). Although Cobscook Bay was dominated by scallops either just below or above minimum legal size there was also a presence of seed with 6% of the measured catch at 36-50 mm SH.



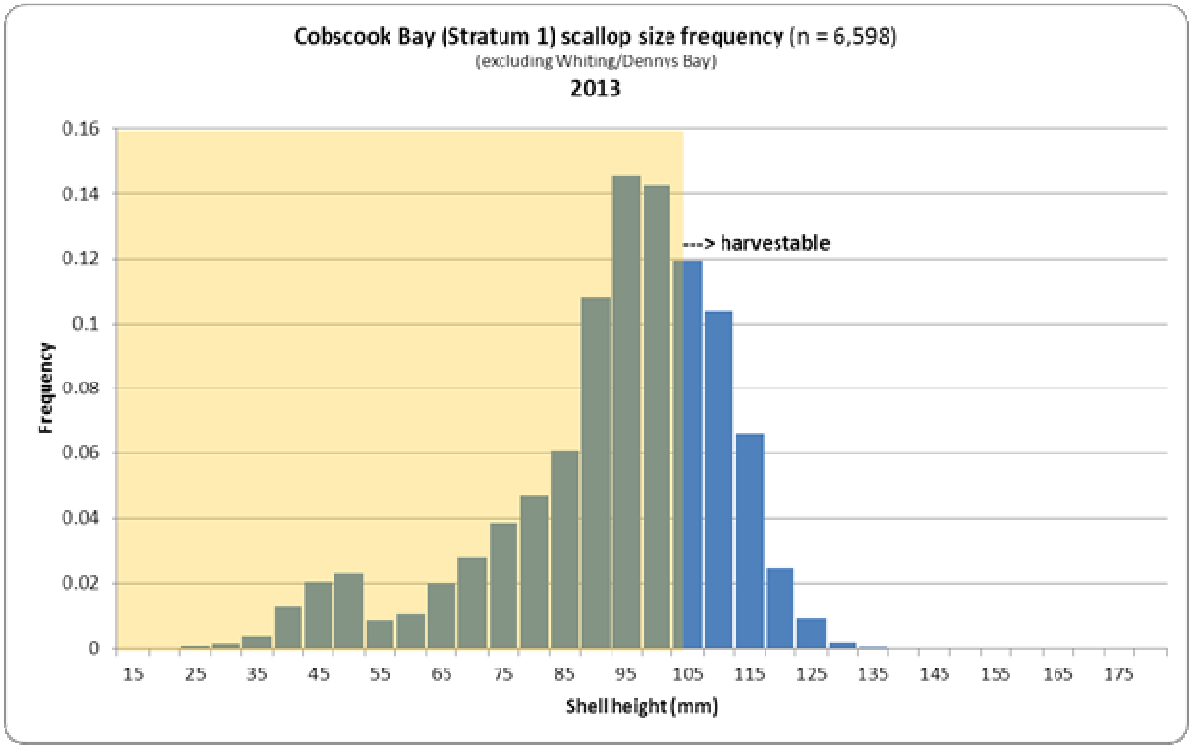


Figure 8. Size frequency (5 mm increments) of scallops in Cobscook Bay, 2012 and 2013.

Cobscook Bay proper

In South Bay, the largest substratum (49 stations), the density of harvestable scallops was lower in 2013 (0.157 per m²) than 2012 (0.192 per m²) but still was the second highest since 2003 (Figs. 9-11).

Sublegal scallop density in South Bay was significantly ($p < 0.001$) less in 2013 (0.300 per m²) than 2012 (1.023 per m²) (Fig.11). Seed density in South Bay decreased from 0.087 per m² in 2012 to 0.037 per m² in 2013.

Johnson Bay (13 stations) had the highest harvestable density (0.104 per m²) since 2009 (0.115 per m²) (Figs. 9, 12-13). Sublegal density (0.333 per m²) declined significantly ($p < 0.001$) from 2012 (0.867 per m²) but was still the second-highest of the time series (Fig. 13). Seed density (0.101 per m²) increased to the highest level of the time series but the estimate was influenced by one large tow.

Pennamaquan River (5 stations) had a decrease in density of harvestable scallops between 2012 (0.116 per m²) and 2013 (0.086 per m²) but 2013 was still the second highest density of the time series (Figs. 9, 14-15). Sublegal density declined significantly ($p < 0.001$) from 0.769 per m² in 2012 to 0.180 per m² in 2013 (Fig. 15). There was also a significant ($p < 0.001$) decrease in seed abundance between 2012 (0.110 per m²) and 2013 (0.010 per m²).

Moose Island consists of three (3) stations (Eastport breakwater, Broad Cove and Deep Cove). Harvestable density (0.155 per m²) increased slightly from 2012 (0.140 per m²) (Figs. 9, 16-17). Sublegal density (0.318 per m²) declined significantly ($p < 0.001$) from 2012 (0.671 per m²) but was still the second-highest of the time series (Fig. 17). Seed abundance was very low (0.008 per m²).

East Bay is a small (2 stations) substratum that had significantly ($p < 0.001$) greater harvestable density between 2012 (0.068 per m²) and 2013 (0.179 per m²) (Figs. 9, 18-19). Sublegal density declined very slightly (Fig. 19). Seed density declined from 0.008 per m² in 2012 to 0.003 per m² in 2013.

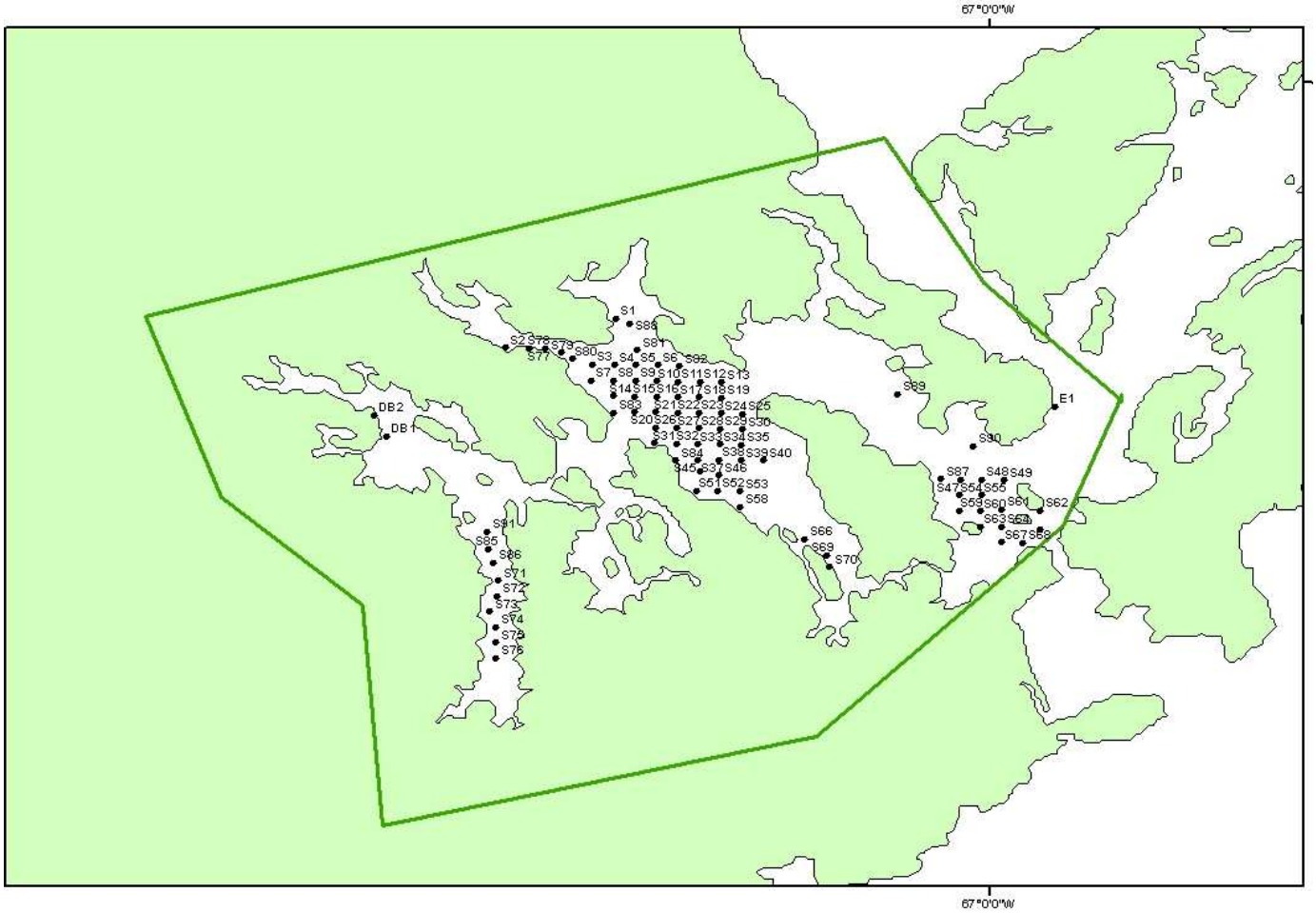


Figure 9. ME DMR scallop survey stations, Cobscook Bay, 2013.

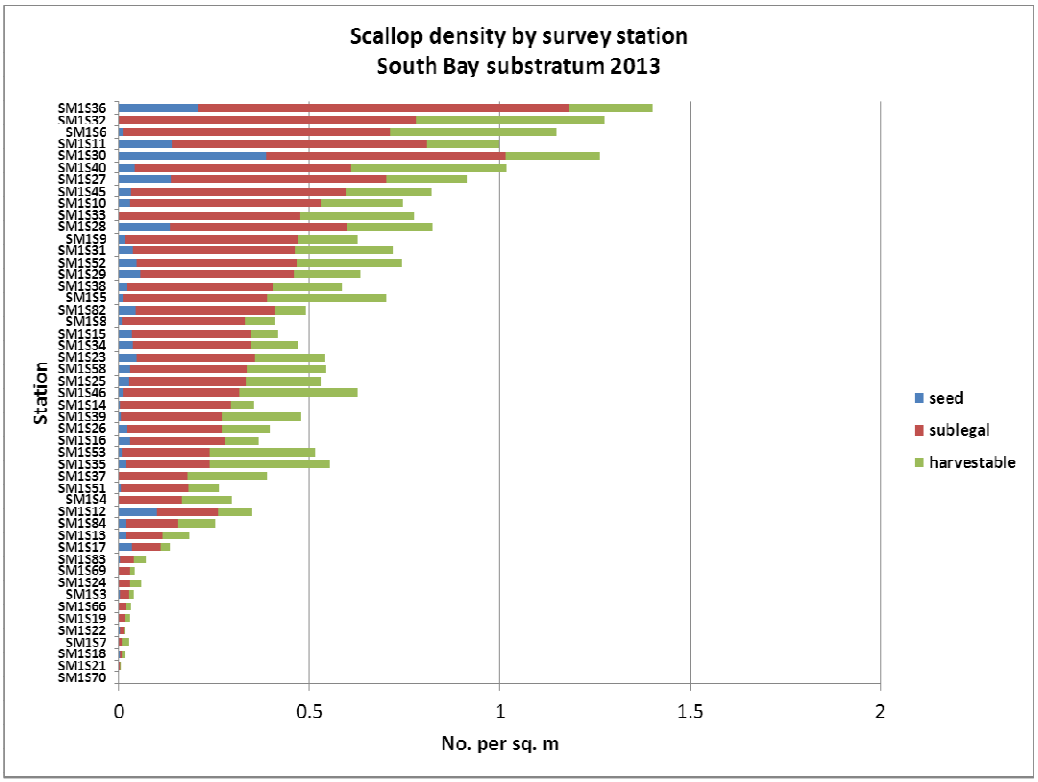


Figure 10. Scallop density by size class and survey station, South Bay substratum of Cobscook Bay, 2013.

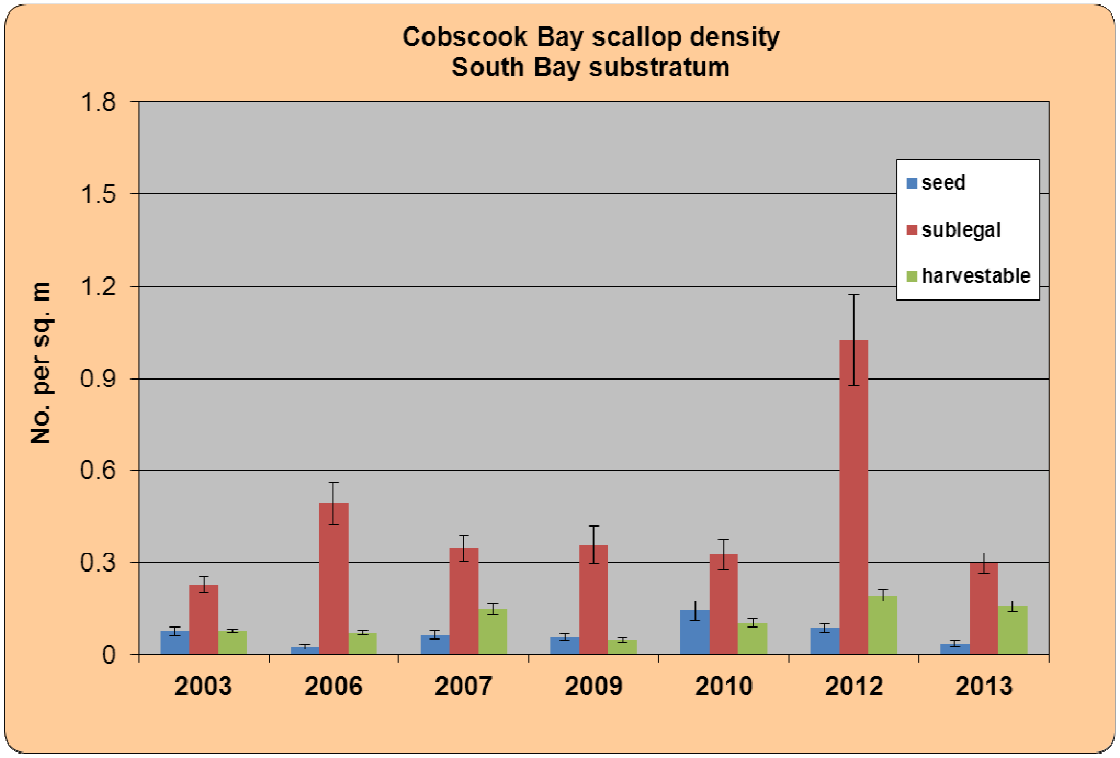


Figure 11. Mean scallop density (with standard error, unadjusted for dredge efficiency) by size class, South Bay substratum of Cobscook Bay, 2003-13.

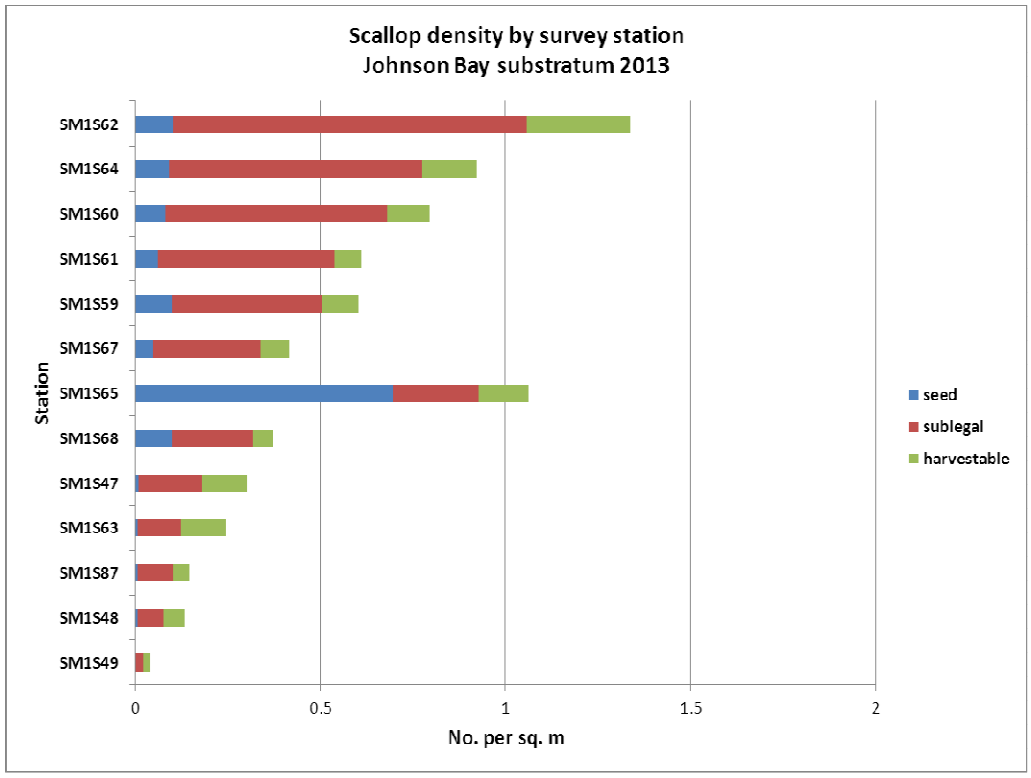


Figure 12. Scallop density by size class and survey station, Johnson Bay substratum of Cobscook Bay, 2013.

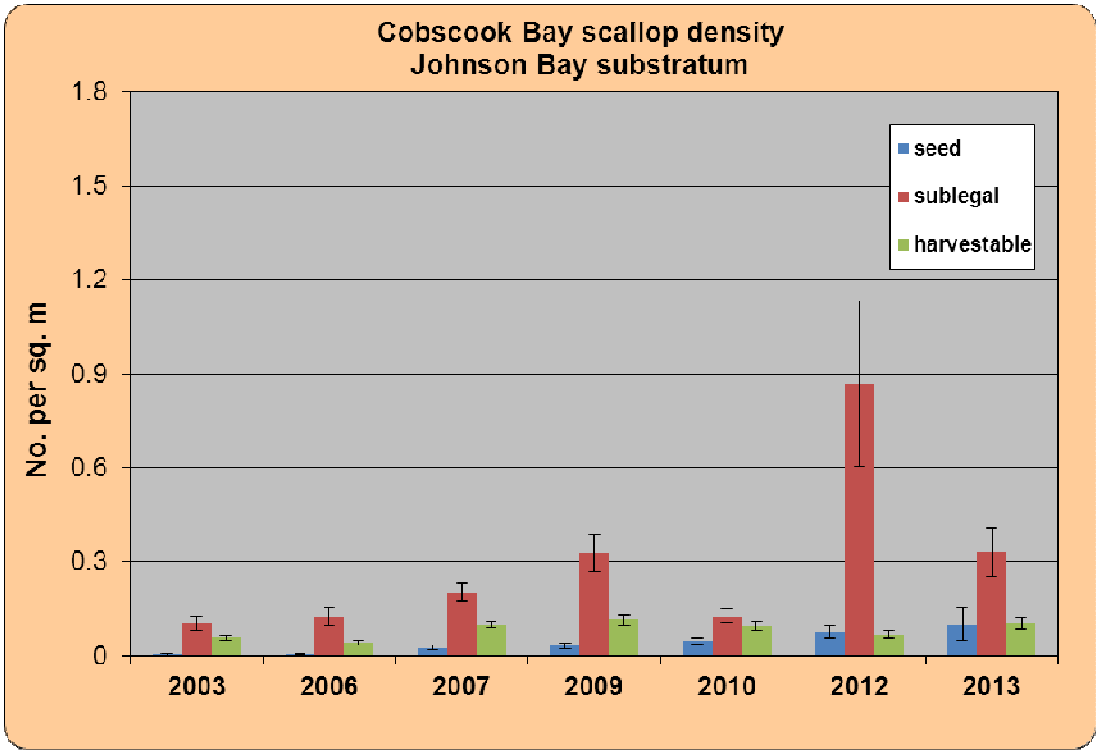


Figure 13. Mean scallop density (with standard error, unadjusted for dredge efficiency) by size class, Johnson Bay substratum of Cobscook Bay, 2003-13.

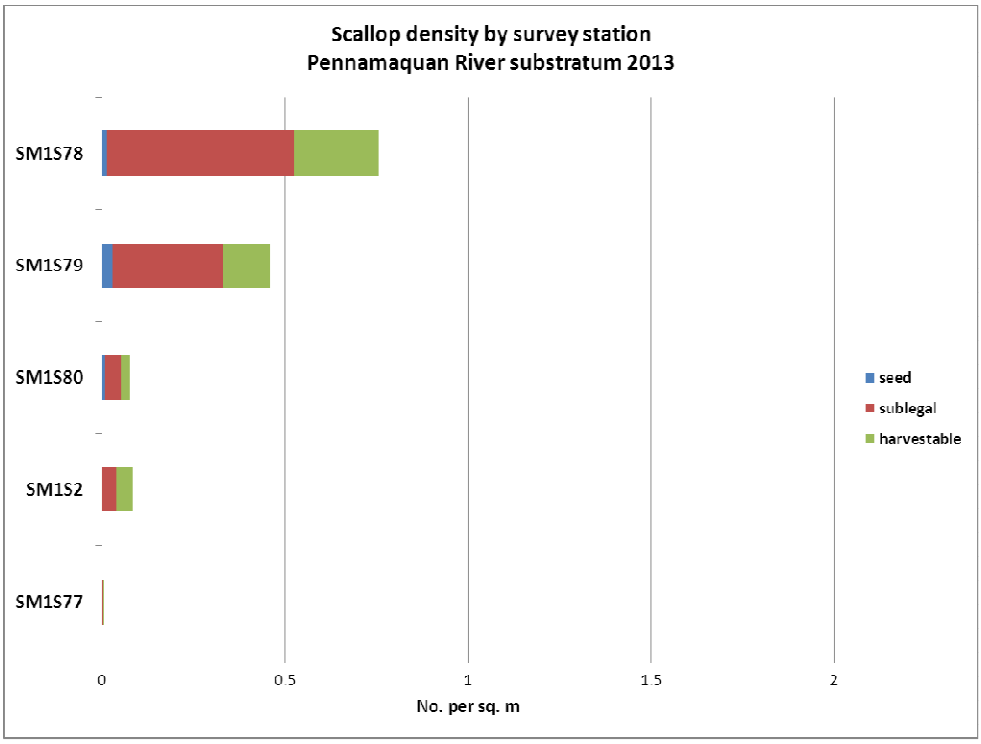


Figure 14. Scallop density by size class and survey station, Pennamaquan R. substratum of Cobscook Bay, 2013.

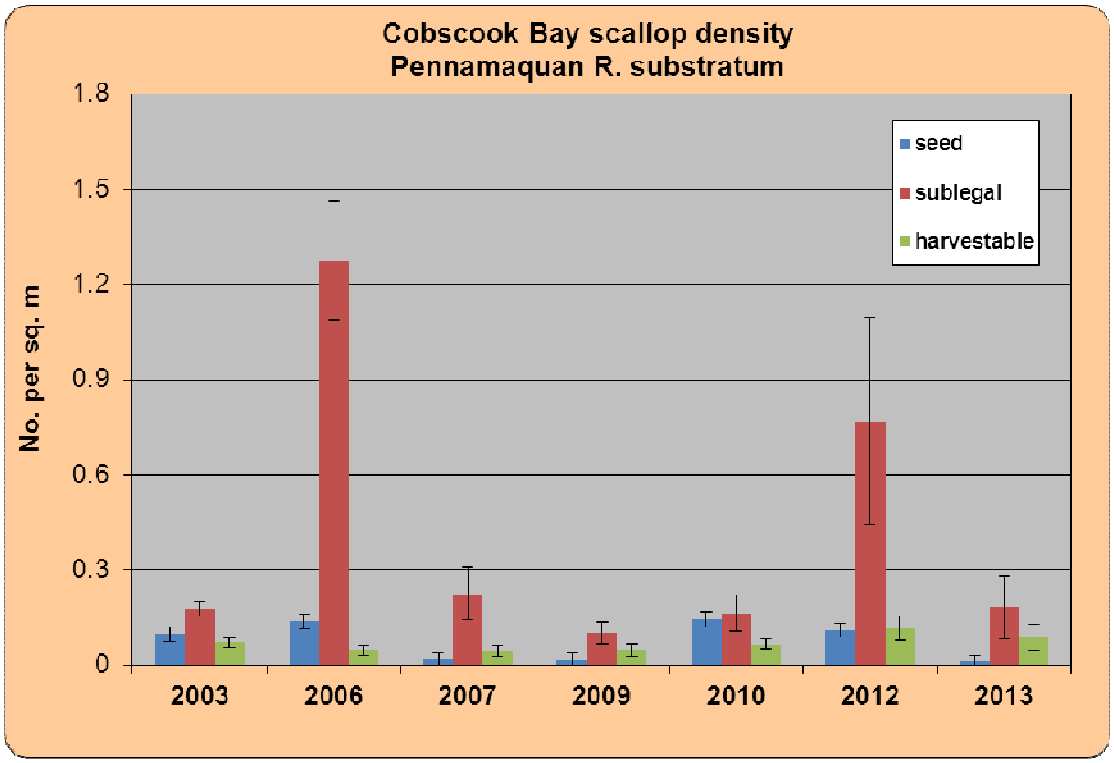


Figure 15. Mean scallop density (with standard error, unadjusted for dredge efficiency) by size class, Pennamaquan R. substratum of Cobscook Bay, 2003-13.

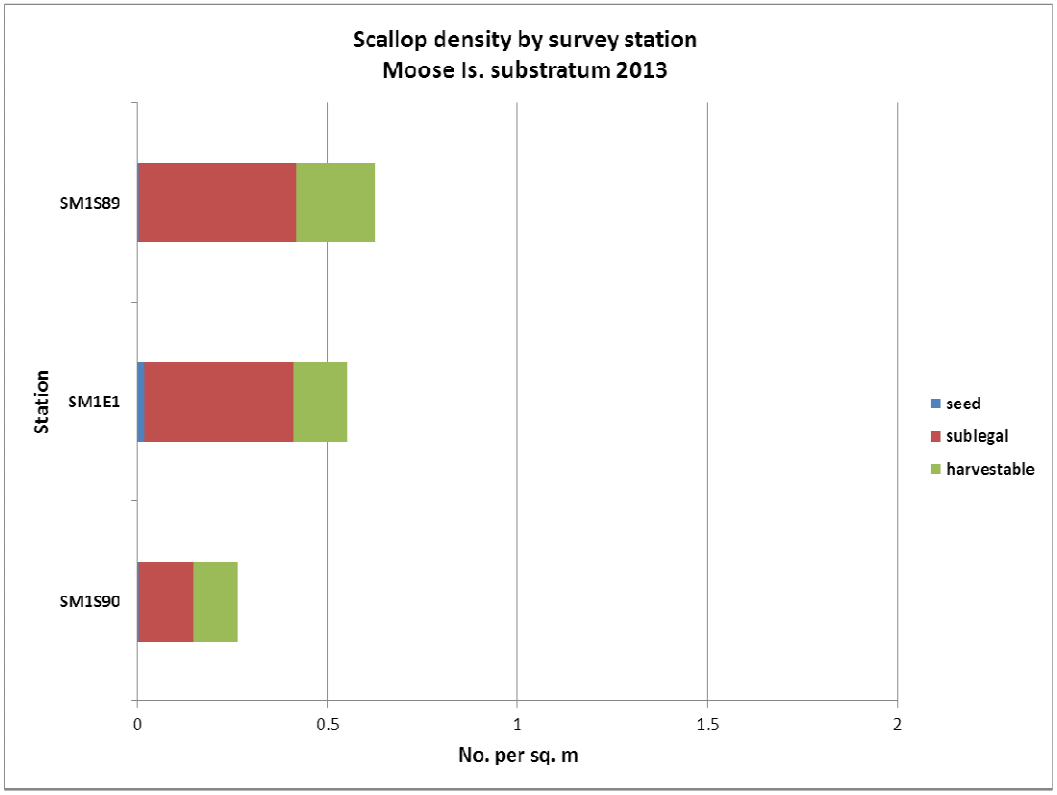


Figure 16. Scallop density by size class and survey station, Moose Is. substratum of Cobscook Bay, 2013.

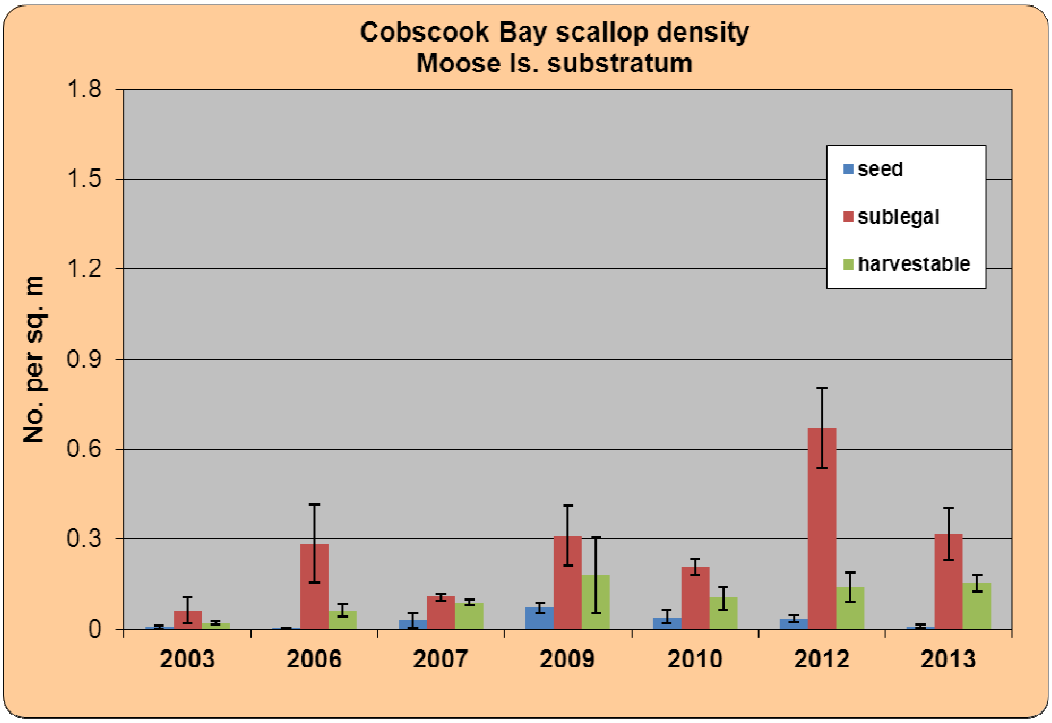


Figure 17. Mean scallop density (with standard error, unadjusted for dredge efficiency) by size class, Moose Is. substratum of Cobscook Bay, 2003-13.

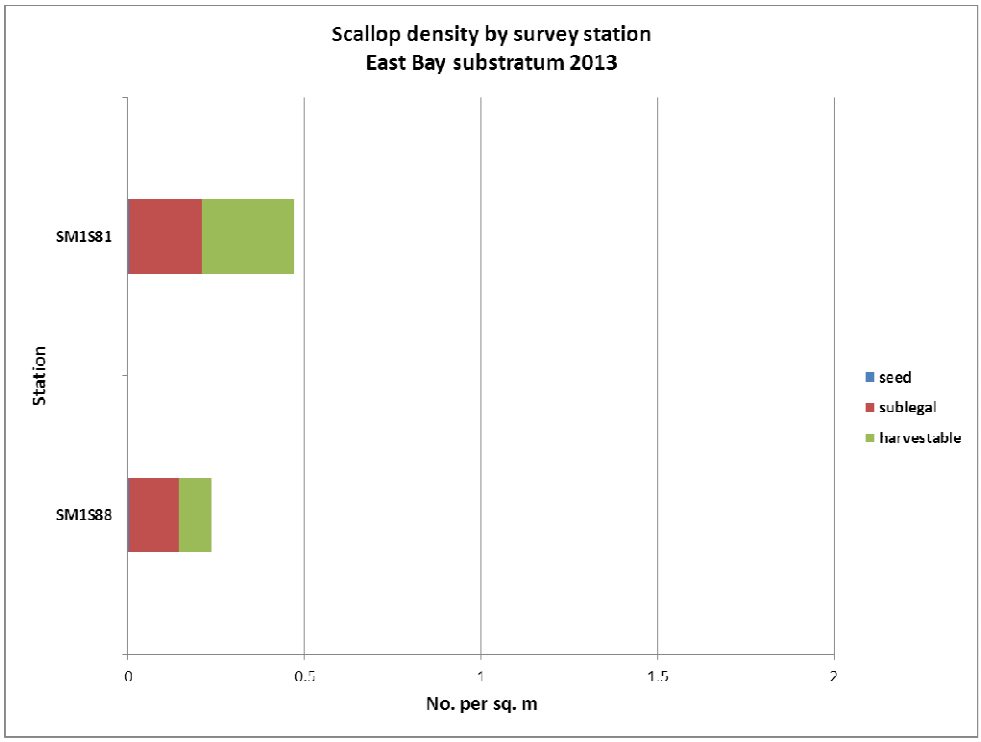


Figure 18. Scallop density by size class and survey station, East Bay substratum of Cobscook Bay, 2013.

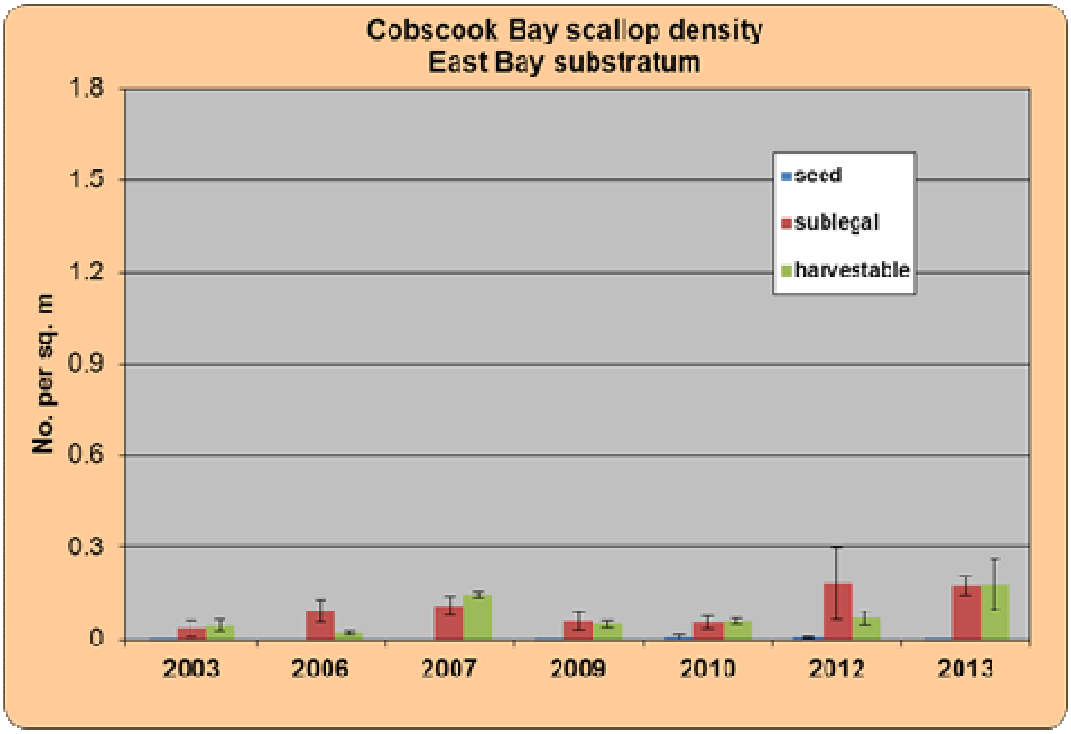


Figure 19. Mean scallop density (with standard error, unadjusted for dredge efficiency) by size class, East Bay substratum of Cobscook Bay, 2003-13.

Limited Access Area (Whiting Bay/Dennys Bay)

There was a small decline in harvestable density (0.331 per m²) in 2013 from the time series high of 2012 (0.386 per m²) (Figs. 9, 20-21). Whiting Bay/Dennys Bay however still produced the highest density of harvestable scallops of all Cobscook Bay substrata as it has since 2010.

Seed abundance (0.035 per m²) remained unchanged from 2012 (Fig. 21). Sublegal abundance (0.0312 per m²) however declined significantly ($p < 0.001$) from the previous year (0.667 per m²).

Size distribution in Whiting Bay/Dennys Bay was fairly similar to Cobscook Bay proper. Of the total measured catch 28% was at 86-100 mm SH (Fig. 22). Whiting Bay/Dennys Bay had a higher proportion and broader distribution of scallops in the harvestable size range however. The measured catch had 31% at 101-110 mm SH and more larger scallops than in Cobscook Bay proper.

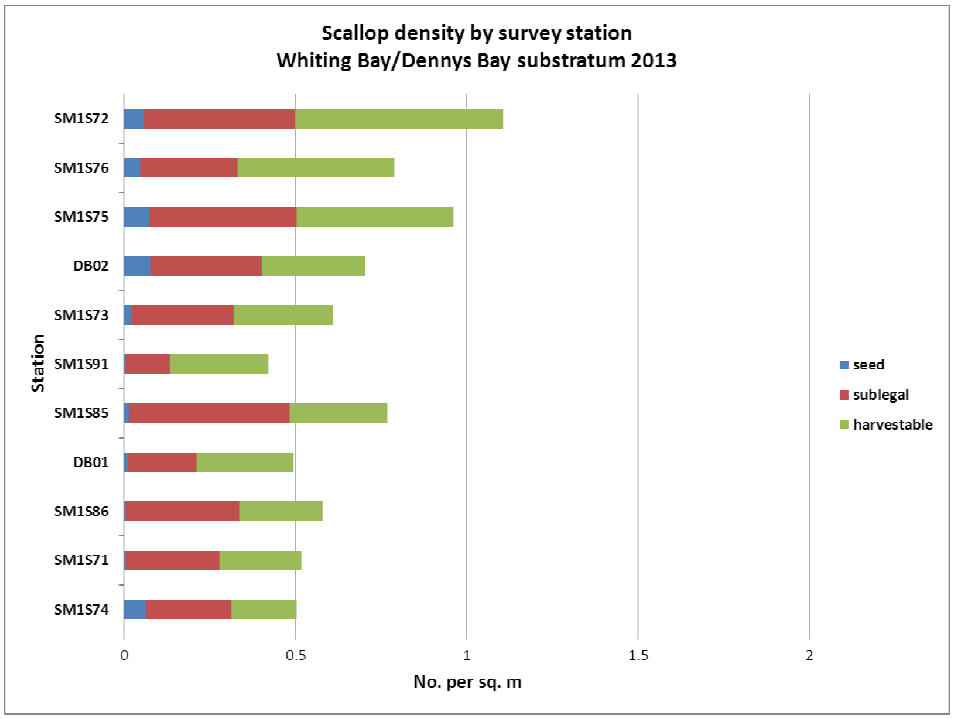


Figure 20. Scallop density by size class by survey station, Whiting Bay/Dennys Bay substratum of Cobscook Bay, 2013.

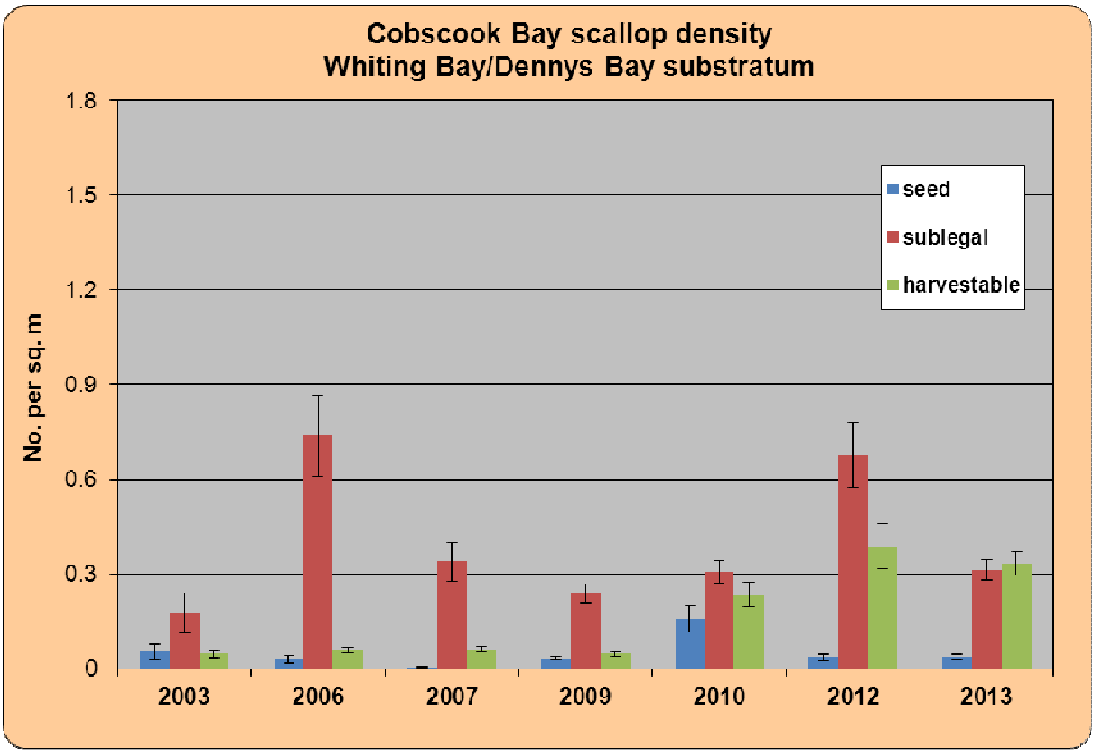


Figure 21. Mean scallop density (with standard error, unadjusted for dredge efficiency) by size class, Whiting Bay/Dennys Bay substratum of Cobscook Bay, 2003-13.

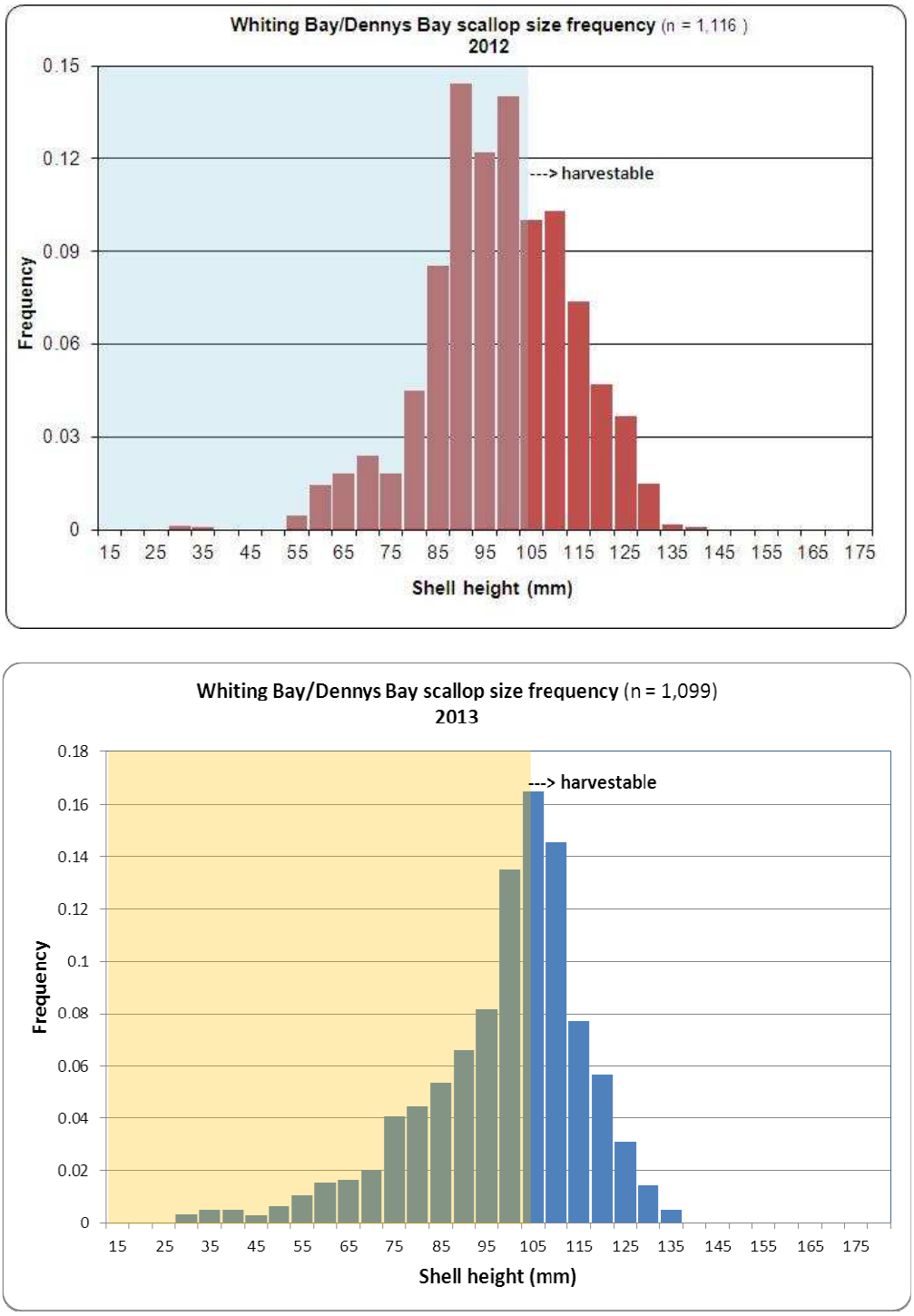


Figure 22. Size frequency (5 mm increments) of scallops in Whiting Bay/Dennys Bay, 2012 and 2013.

Meat weight

A shell height to meat weight relationship (MW = 0.00000990*(SH)$^{3.14167350}$) was calculated based on samples taken in the 2013 survey (Fig. 23). Meat weight was slightly higher than 2012 and was the highest since 2002-03 (Table 2).

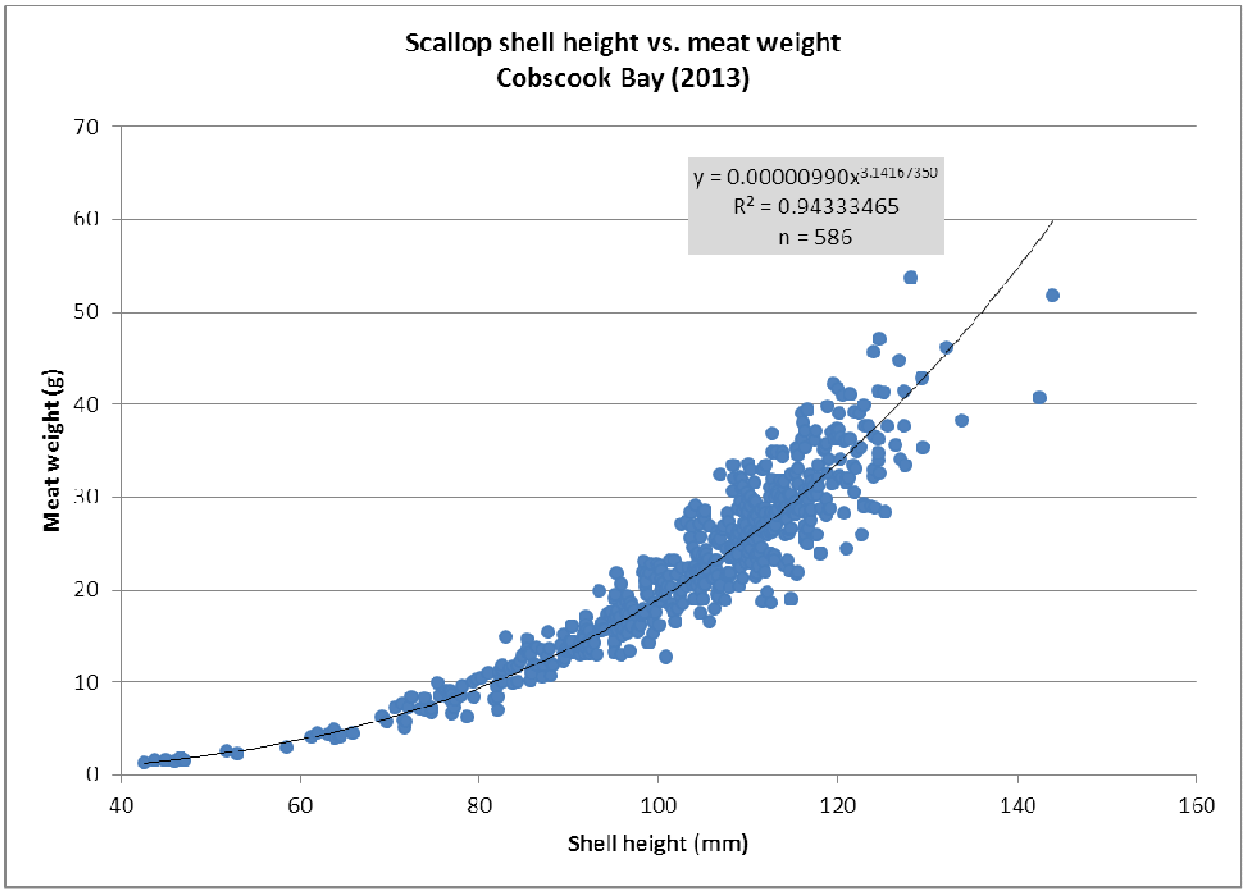


Figure 23. Scallop meat weight (MW) as a function of shell height (SH) for Cobscook Bay, 2013.

Table 2. Predicted scallop meat weight and meat count at size based on 1987/91 (DMR unpubl.) and 2002-03, 2006-07, 2009, 2010, 2012 and 2013 Cobscook Bay survey data.

		Shell height (inches)		
		4.0	4.5	5.0
1987, 1991 (DMR unpublished)	**Meat weight (g)**	14.8	21.7	30.4
	Count per lb.	31	21	15
2002-03 (from Schick and Feindel 2005)	**Meat weight (g)**	21.0	31.2	44.4
	Count per lb.	22	15	10
2006-07	**Meat weight (g)**	17.2	25.4	35.8
	Count per lb.	26	18	13
2009	**Meat weight (g)**	18.2	26.0	35.8
	Count per lb.	25	18	13
2010	**Meat weight (g)**	19.1	27.6	38.2
	Count per lb.	24	17	12
2012	**Meat weight (g)**	19.7	28.2	39.0
	Count per lb.	23	16	12
2013	**Meat weight (g)**	20.0	28.9	40.3
	Count per lb.	23	16	11

Harvestable biomass

Scallop harvestable ($\geq$ 4 in. SH) biomass (by meat weight) was calculated by applying the 2013 shell height-meat weight relationship to survey size frequency data on a tow-by-tow basis. Mean harvestable biomass (g) per m^2 for each substratum was calculated and then expanded to the total area of each substratum to determine the total harvestable biomass per substratum. Total harvestable biomass for Cobscook Bay was the sum of biomass over all six substrata.

In 2013 the mean total harvestable biomass of Cobscook Bay (including Whiting Bay/Dennys Bay) was 205,100 ± 12,300 kg (452,200 ± 27,200 lbs.; Fig. 24). This was less than 2012 but the second highest value of the seven-year time series. South Bay contained 53% of the harvestable biomass followed by Whiting Bay/Dennys Bay (16%) and Moose Is. (13%).

Harvestable biomass in the Whiting Bay/Dennys Bay limited access area decreased 13% from 83,000 lbs. (2012) to 72,100 lbs. (2013) (Figs. 24-25). Despite this decline the value was the second highest of the time series.

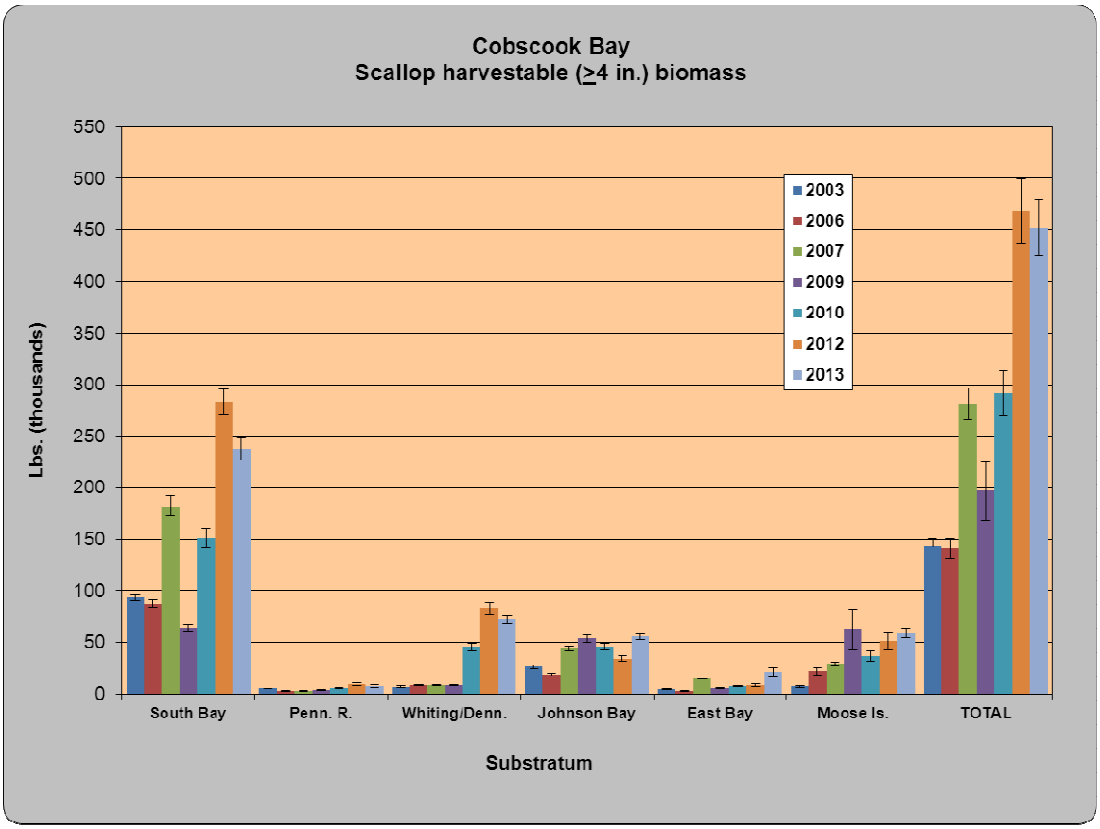


Figure 24. Biomass (meat weight, with standard error) of harvestable (legal-size) scallops in Cobscook Bay, 2003-13.

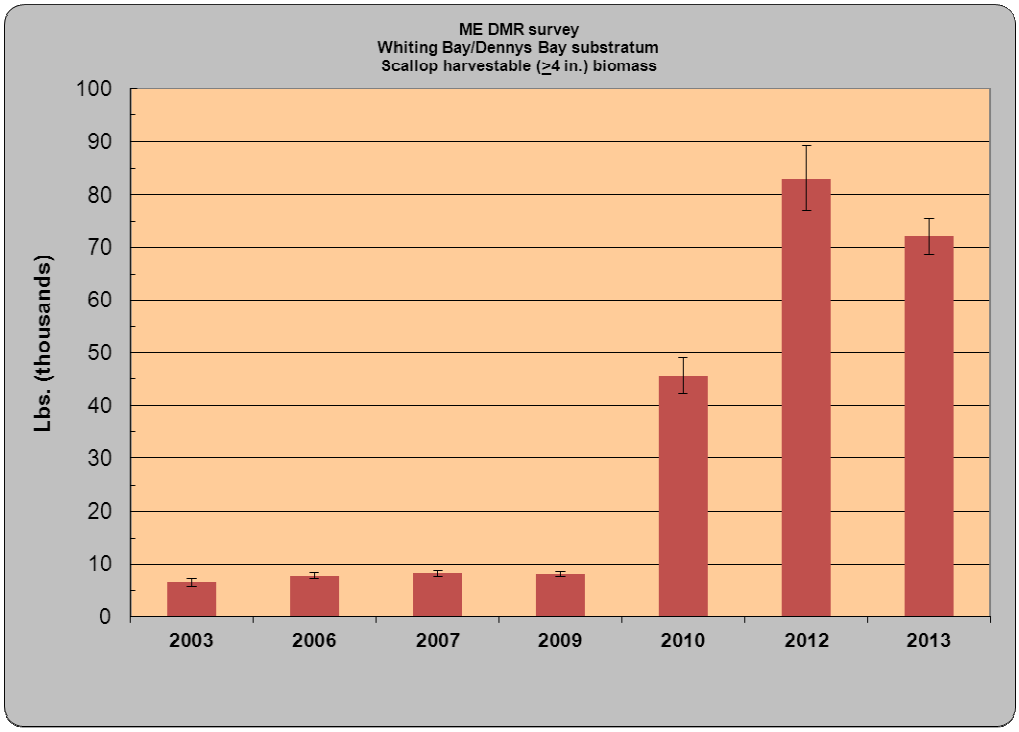


Figure 25. Biomass (meat weight, with standard error) of harvestable (legal-size) scallops in Whiting Bay/Dennys Bay, 2003-13.

Stratum 1A (St. Croix River)

Eight (8) stations were completed between Devils Head and Gleason Point in 2013. Sublegal density in 2013 (0.321 per m²) increased from 2012 (0.268 per m²) and was the highest of the time series (Figs. 26-27). One tow near St. Croix Is. produced a high amount of sublegals (Fig. 26).

Harvestables declined from 0.049 per m² in 2012 to 0.031 per m² in 2013 (Fig. 27). Virtually no seed were present in 2013. The predominant size mode was at 81-95 mm (Fig. 28).

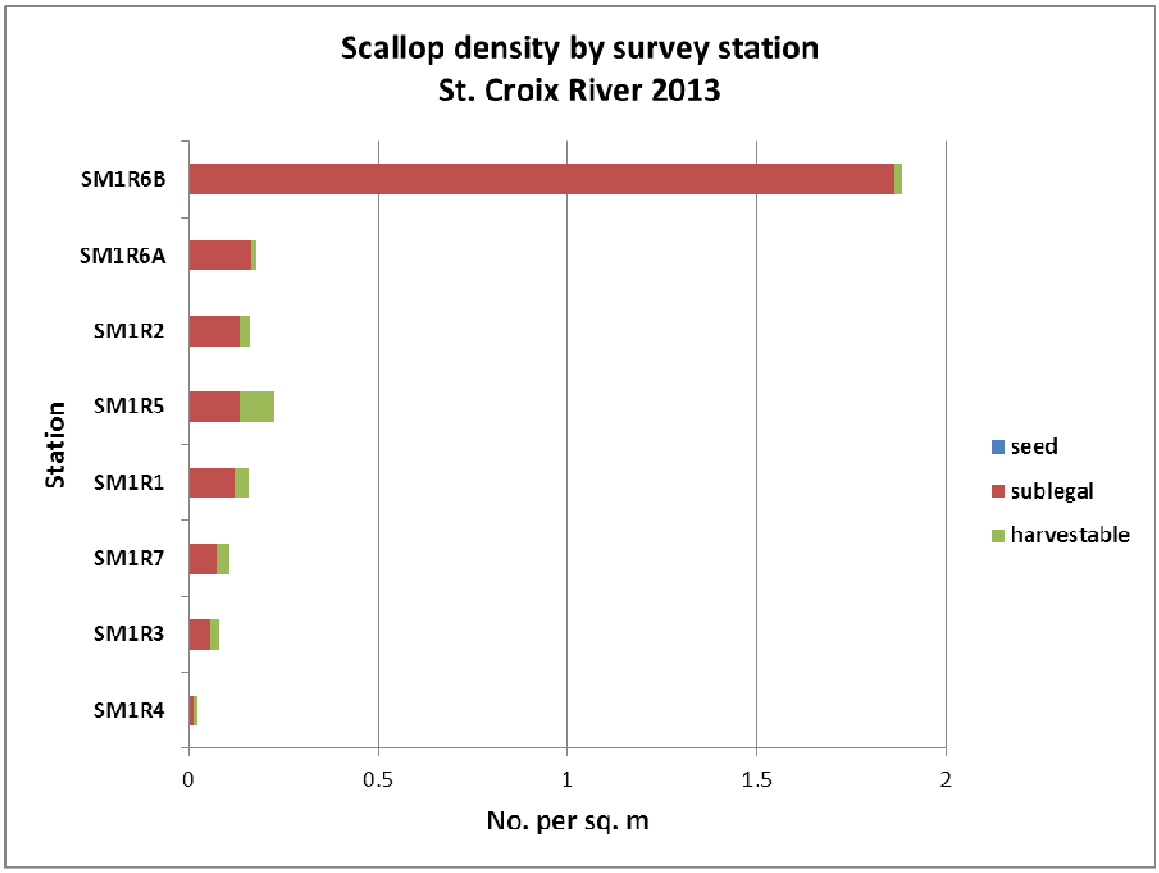


Figure 26. Scallop density by size class and survey station, Stratum 1A, 2013.

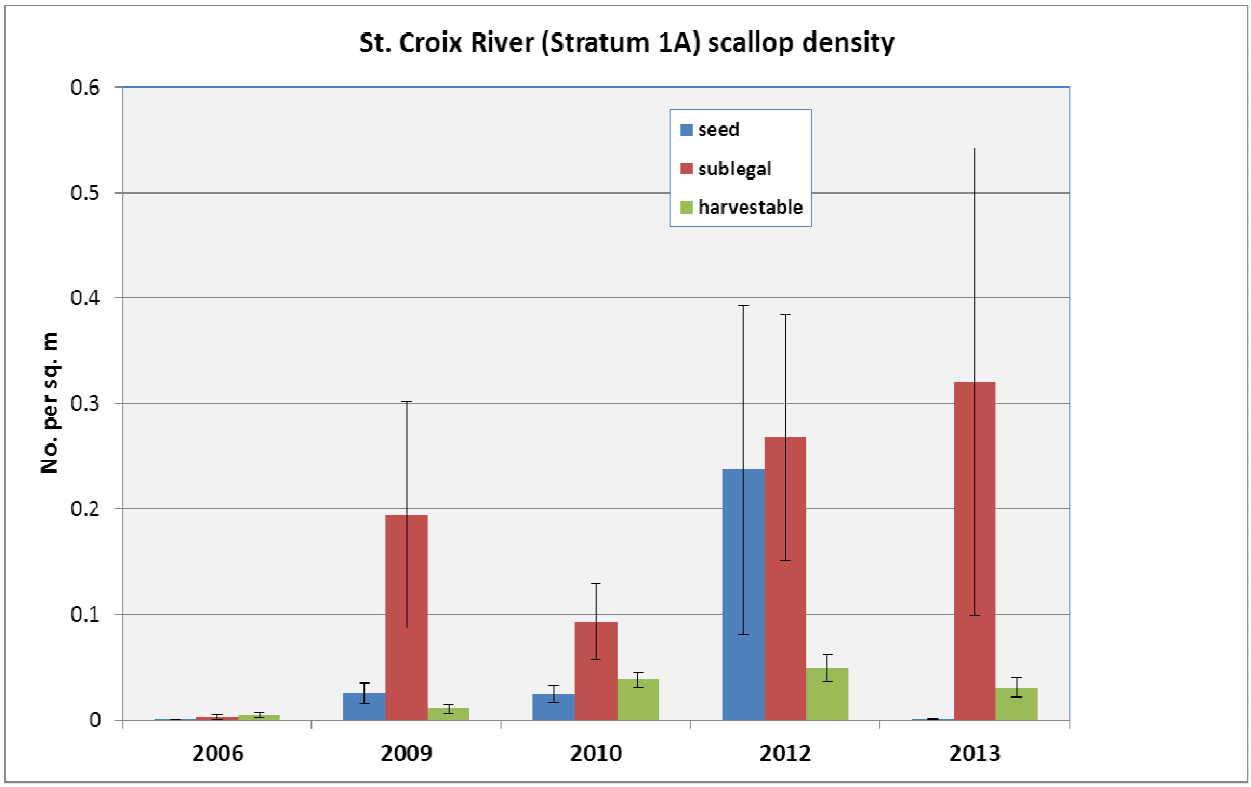


Figure 27. Mean scallop density (with standard error, unadjusted for dredge efficiency) by size class, Stratum 1A, 2006-13.

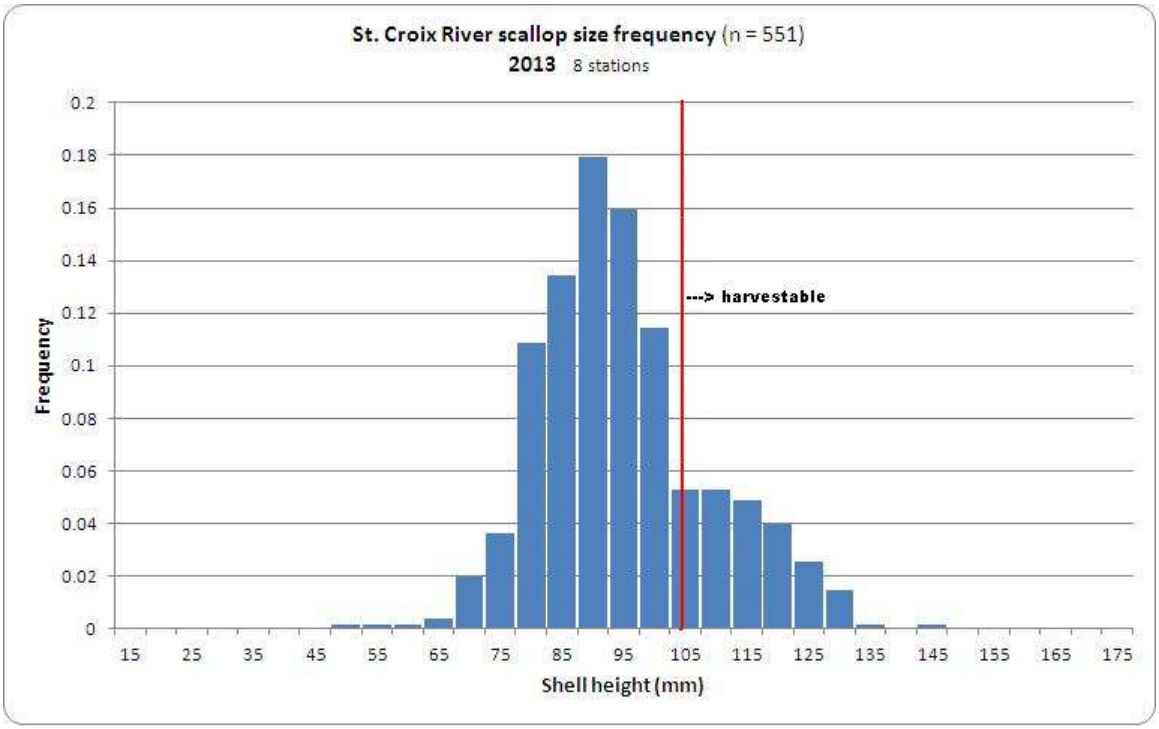


Figure 28. Size frequency (5 mm increments) of scallops in Stratum 1A, 2013.

Conclusions

Cobscook Bay continued to have time-series high levels of scallop production in 2013. High recruitment into the legal size range and higher than average meat weight were all observed in the 2013 survey. A record-high proportion (40%) of the scallop resource of Cobscook Bay was just below (within 16 mm SH) harvestable size and 22% was at or above (within 9 mm) legal size. Harvestable biomass was the second-highest ever observed on the survey.

Whiting/Dennys Bay continued to have significantly higher harvestable biomass than prior to the 2009 fishing closure (re-opened as a limited access area in 2012). This area had the highest density of harvestable scallops of the 2013 survey. Harvestable biomass was the second-highest of the time series and this area represented 16% of the overall legal-sized scallop resource of Cobscook Bay.

The St. Croix River had a relatively poor abundance of scallops, particularly seed and harvestables. A high amount of sublegals were observed at one location near St. Croix Is., following a high abundance of seed in 2012

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