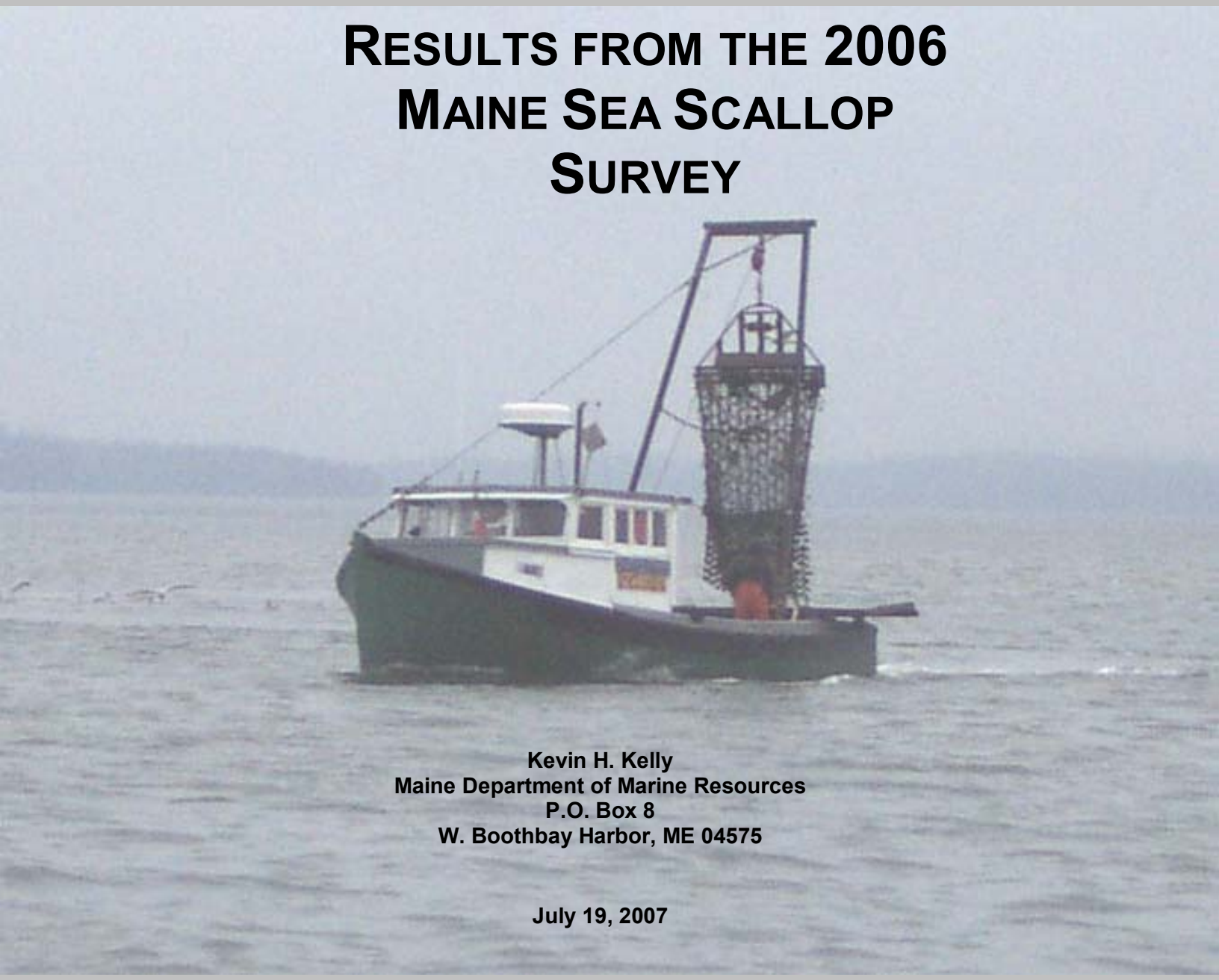
RESULTS FROM THE 2006 MAINE SEA SCALLOP SURVEY



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

July 19, 2007

Executive Summary

The Maine sea scallop survey was carried out in fall 2006 prior to the December 1st opening of the fishery in Zones 1-6 (Eastern Penobscot Bay to St. Croix River). The survey last took place in this portion of the coast in 2003. A total of 276 tows were made with two commercial vessels each using a standardized survey drag. A systematic survey of Cobscook Bay indicated a large increase in abundance of sublegal (<4 in. shell height) scallops and a very slight decrease in abundance of harvestable (≥4 in.) scallops in Cobscook Bay in 2006. Highest abundance of sublegals in Cobscook Bay was in the Pennamaquan River and in South Bay and most were in the 3½-3¾ in. range. Because of the change in minimum legal shell height from to 3¾ in. to 4 in. between survey periods a significant increase in harvestable biomass due to increased meat yield was realized in Cobscook Bay. The estimate of harvestable biomass increased 20.9% from 2003 despite the very slight decrease in harvestable abundance. In most other survey strata, abundance remained at low levels or decreased from 2003. Zone 3 (Great Wass Is. to Little R.) had a significant decrease in abundance while Zone 6 (Eastern Penobscot Bay to Western Blue Hill Bay) had a slight improvement. In Gouldsboro Bay, a historically productive area, abundance of sublegal and harvestable scallops remained relatively low but was higher than average for the stratum (Schoodic Point to Great Wass Is.). Duck Is. and Libby Is. had very low abundance of all size classes. Harvestable scallops were abundant in a small area around Mt. Desert Rock, an area not previously surveyed.

The scallop survey along with dealer and harvester catch reporting and increased port sampling will improve the information available for understanding and managing the resource. The recent creation of the Northern Gulf of Maine Management Area by the New England Fisheries Management Council increases the importance of Maine having an ongoing survey to provide information on abundance and distribution of the scallop resource.

Introduction

Sea scallops (*Placopecten magellanicus*) have been harvested along the Maine coast since the late 1800's (Wallace 1997; Schick and Feindel 2005). 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 primary gear type is the dredge, although Maine also permits commercial and non-commercial harvest of scallops by diving. Although Maine scallop landings are currently low (Fig. 1), at times the value of the Maine scallop fishery has been second only to lobster.

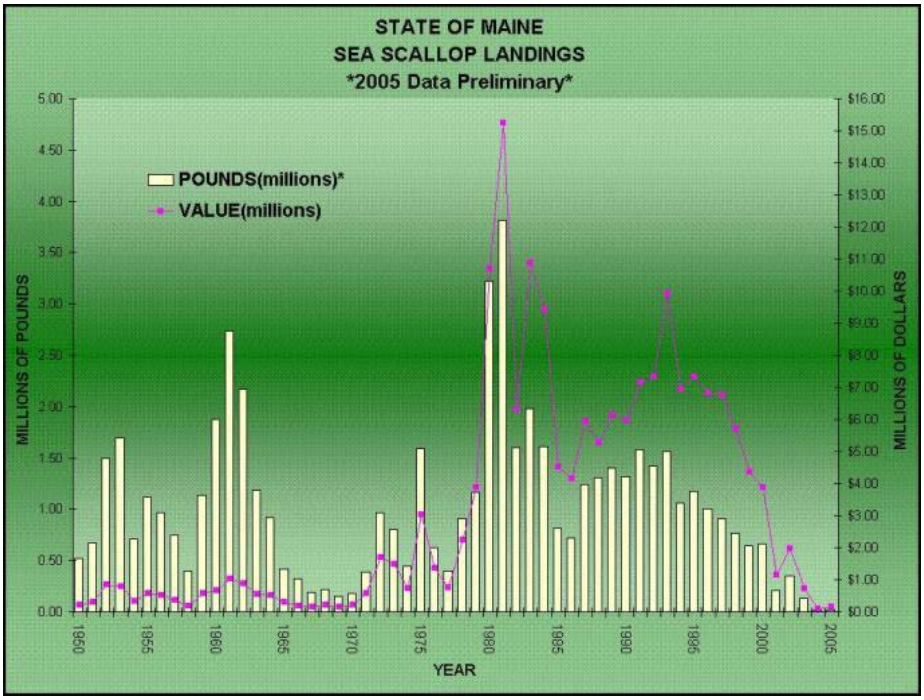


Figure 1. Maine scallop landings, 1950-2005.

A variety of fishermen harvest scallops in Maine: lobstermen who rig for scalloping during the off-season, draggers who also fish for ocean quahogs, sea urchins and sea cucumbers, and groundfish draggers who may fish for scallops during periods of high abundance. Many divers who fish for scallops also harvest sea urchins. The number of scallop dragger licenses issued by the Maine Department of Marine Resources (DMR) has fluctuated somewhat since 1990. There was a general increase between 1990 (608 licenses) and 2000 (905 licenses) but then there was a decline reaching to only 495 licenses in 2006. In comparison, the number of scallop diver licenses also increased between 1990 (267) and 1998 (470) but then declined to only 115 in 2006.

There are also vessels home-ported in Maine which hold federal general category permits which allow the landing of up to 400 lbs. per day of scallop meats from scallop exemption or open access areas in federal waters. In 2004, there were 561 of these permits held by Maine vessels but only 70 of these had landed at least 1,000 lbs. of scallops in any one year during 2000-2004 (NEFMC 2007). There are also three federal limited access permit vessels from Maine (K. Wilhelm, NMFS/NERO, pers. comm.) that fish under a Days-At-Sea program with much higher possession limits and a higher allocation of landings. However, most of the scalloping by federally-permitted vessels currently takes place south of the Gulf of Maine (NEFMC 2007).

Maine scallop season runs from December 1 until April 15, a period which minimizes conflict with the lobster fishery. A vessel is limited to a maximum 10.5 ft. dredge width, a minimum 5.5 in. twine top and a minimum 3.5″ ring

size. Scallops which are shucked must have a 4.0 in. minimum shell height. There are other area-specific restrictions along portions of the coast such as Cobscook Bay, Gouldsboro Bay, Blue Hill Bay, the Swans Island Lobster Conservation Area and the Damariscotta River.

In 2000, DMR held a series of meetings along the coast with members of the fishing industry, academic and government scientists, and fishery managers to develop research priorities for five major marine resources including sea scallops. Research priorities for scallops included monitoring and assessment with a focus on Cobscook Bay (Alden and Perkins 2001). Subsequent to that an industry/science collaborative project was initiated with a suite of monitoring programs, including a fishery independent survey (Schick and Feindel 2005). Funding for the project, including the 2002 and 2003 surveys, was provided by the Northeast Consortium. The current survey, including the work presented in this report, is funded by the Scallop Research Fund established by DMR in 2003.

Purpose and extent of survey

The purpose of the survey is to characterize and monitor scallop distribution and relative abundance along the coast of Maine. Survey data can contribute to our understanding of geographic variability in population size, population structure and seed occurrence. The objectives of the survey are to a.) determine the relative abundance of the scallop resource along nearshore coastal Maine, and, b.) compare results to surveys done in previous years, in light of regulatory and environmental changes.

The survey provides information on size distribution, abundance/stock size and spatial distribution of scallops. It is necessary to monitor changes in abundance and stock size from year to year to evaluate effects of the fishery and know what is available for harvest. The survey provides information needed to evaluate potential management strategies such as rotational harvest strategies, harvest limits, closed areas to protect spawning and enhance recruitment, and area-specific strategies such as for Cobscook Bay.

In 2006, survey strata 1-6 (Eastern Penobscot Bay to the St. Croix River) were surveyed. These strata had not been surveyed since 2003, and include Cobscook Bay and the Great Wass Is. to Little River stratum which the 2002-03 surveys demonstrated as the most productive scallop areas of coastal Maine.

Methods

Vessels and timing

The survey was conducted aboard two commercial vessels each using a standardized survey drag. Vessels were selected for the survey by a Request for Proposals (RFP) process in summer 2006. Two vessels were used in order to broaden industry participation, to take advantage of local knowledge and to

maximize survey efficiency (whereas the survey was to be conducted over a broad geographic area with increased sampling intensity and within a fairly narrow time frame). Vessels were the 45 ft. *F/V Foxy Lady II* from Stonington and the 42 ft. *F/V Alyson J 4* from Cutler. The 2006 survey was conducted during Oct. 31-Nov. 27. It was optimal for the survey to be conducted once most lobster traps had been hauled out for the season to minimize gear conflict and to enable completion of all planned survey tows but also to complete the survey prior to the opening of commercial scallop season (Dec. 1).

Gear

The survey dredge (Fig. 2) was a 7.0 ft. wide chain sweep with 2.5 in. rings in the ring bag to retain small scallops. The dredge was unlined and the twine top was double hung with 3.5 in. mesh. Drag specifications were decided in consultation with several industry members prior to the 2002 survey. The drag size and weight represented a compromise between being wide enough to cover a significant area per tow, heavy enough to sample deeper waters but also of a size that could be transported by a large pickup truck (Schick and Feindel 2005).

Figure 2. Survey drag.

Survey design

A subset of the coastal zones (or "strata") defined for the 2002-03 surveys were followed in 2006 (Fig. 3). Strata 1-6 were surveyed in 2006 with the following modifications:

1. Stratum 1 for 2006 was Cobscook Bay only. St. Croix River was added as a new stratum labled"1A".

2. Another new stratum was also added: Mt. Desert Rock, Stratum 5A.

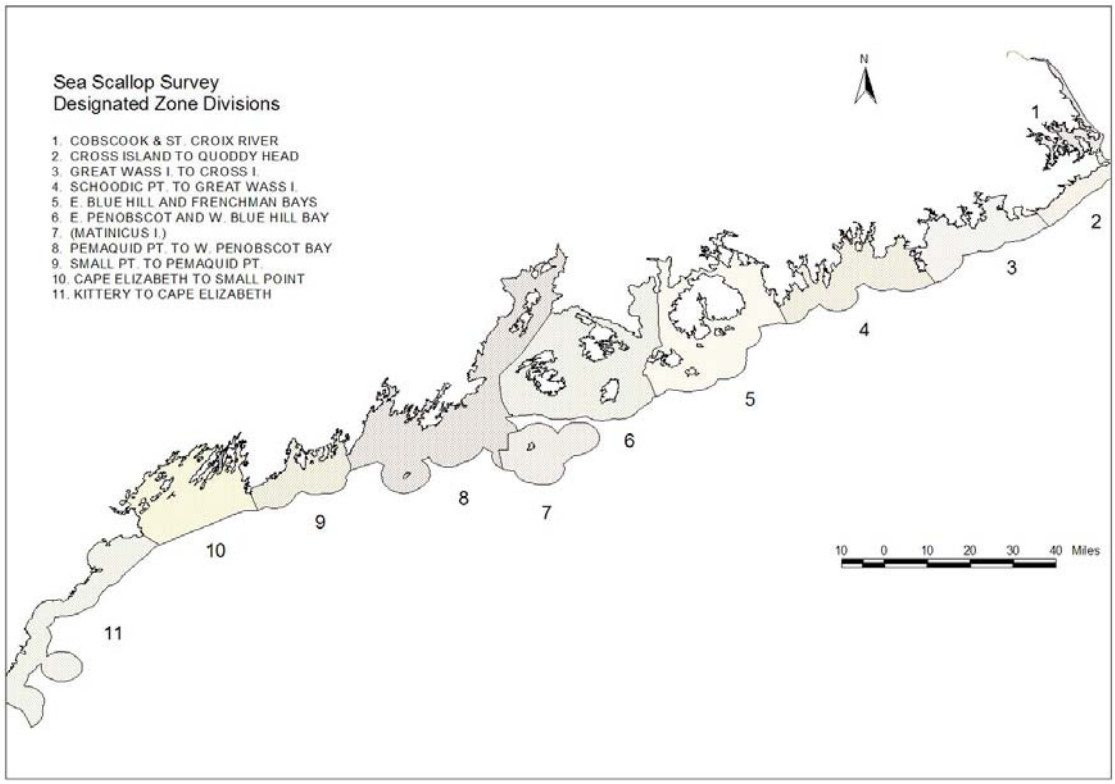


Figure 3. Survey strata - Maine DMR scallop survey.

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).

Within each stratum, survey stations were selected randomly by fishing area (stratified random design) using SYSTAT™ and ArcView™ software. The number of stations assigned within each region was roughly proportional to the size of the strata although fewer stations were assigned in areas considered to be only of minor importance. There were a number of permanent stations located in some of the more commercially important beds and exploratory tows were also conducted in areas that had either not been surveyed or only lightly surveyed previously, such as Cutler shore. Tows were also added further offshore (but within state waters) around Libby Island and Mt. Desert Rock - two historically productive scallop grounds. Individual stations were plotted using Capn Voyager™ software which was used onboard by the survey captains to navigate.

For Cobscook Bay, a systematic sampling approach was taken in order to conduct a direct assessment of abundance. Six survey strata (South Bay, Pennamaquan River, East Bay, Whiting Bay, Johnson Bay and “other”) based on

spatially contiguous fished areas were determined in consultation with fishing industry members prior to the 2003 survey and repeated in 2006. Sampling stations were based on a 500 m grid to accommodate a mean tow length of approximately 300 m. There were 85 total stations in the 2006 Cobscook Bay survey with 50 stations in South Bay where most of the scallop resource is located. The total number of stations was 31% higher in '06 than in '03.

Five 100 m X 2 m diver transects were also performed at three stations to determine dredge efficiency. All scallops in each dive transect were measured and enumerated. These stations (SM1S39, SM1S46, SM1S51) were located in areas of higher scallop density in South Bay. At each station two replicate tows from each vessel (n=4) were used to determine size-specific scallop density by dredge for comparison.

Sampling procedure

Tow times were generally 2-3 minutes in Cobscook Bay and 2.5-5 minutes in other areas, depending on bottom type, scallop abundance and presence of lobster gear. Stations were sampled by a straight line tow. Boat speed averaged about 3.5-4 knots. Location (dredge in, tow start and haulback) was recorded on board using a handheld GPS unit with external antenna interfaced with a field computer.

The following protocol was employed (based on Schick and Feindel 2005):

1.) Station information was entered from the wheelhouse (tow duration, depth, and bearing).

2.) Bottom type was recorded as combinations of mud, sand, rock, and gravel based on sounder information, charts, 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, and ocean quahogs were culled from the pile for subsequent measurement. Catch of the later species was quantified because of their importance in other drag fisheries. While the chainsweep is not a suitable sampling device for ocean quahogs – their presence in the catch suggests the existence of a bed below the sediment.

5.) A representative sample of bycatch was set aside and enumerated using a 0-5 qualitative abundance scale (corresponding to "absent", "present", "rare", "common", "abundant", and "very abundant").

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

7.) The shell height (distance from the umbo to the outer edge, perpendicular to the hinge line) of individual scallops was measured. Most often the entire catch was measured, but for very large catches the pile was sometimes halved or quartered carefully with a shovel and then a smaller portion measured.

8.) On selected tows, a subsample of 24 scallops, chosen to represent a wide size range of the catch, were measured (shell length, width, and height), shucked, and the meats placed in a compartmentalized box, in the order that the animals were measured so that weights could be matched to the corresponding shell measurements when weighed on shore.

Figure 4. Scientist and crew working a 2006 survey tow.

The following table summarizes data collected for each tow:

Data items collected – ME DMR Sea Scallop survey

COLLECTED DATA - FIELD SUMMARY

TRIP	STATION INFORMATION IDENTIFIERS	TOW LOCATION	TOW INFO	ENVIRON. DATA
Trip identifier	Tow identifier	Dredge in (Lat, Lo, Time stamp)	Tow time elapsed	Bottom type
Trip date	Zone	Tow start (Lat, Lo, Time stamp)	Depth	Bottom temperature
Port sailed from	Strata	Haulback (Lat, Lo, Time stamp)	Bearing	
Weather	Location (description)	Drag off-bottom (Lat, Lo, Time stamp)	Wire out	
Precipitation	Tow number	Distance towed	Tow speed	
Wind/ sea stata	Sample type			
Return time	(random, exploratory, "fixed", other)			
Comments				

SCALLOP DATA CATCH	SIZE STRUCTURE	BIOMETRICS	BYCATCH
Number scallops caught	Shell height	Shell height	Tow photo ID
Volume of catch (shellstock)		Shell length	Species
Weight of catch (shellstock)		Shell depth	Abundance (1-5 scale)
Proportion of tow sampled (100, 50, 25%)		Meat weight	Trash type
Number of clappers			Trash amount (1-5 scale)
Coments			Comments

AUXILLARY DATA QUAHOG CATCH	SEA CUCUMBER CATCH	CTD DATA
Number of quahogs	Number of cucumbers	Location (lat/ long)
Shell height	Catch weight	File identifier
Shell length	Catch volume	
Shell depth	Coments	
Shell (dead) abundance (1-5 scale)	Size index (SL x diam 1 x diam 2)	

from Schick and Feindel (2005)

Juniper Allegro™ ruggedized handheld computers with RS232 serial port inputs for digital calipers, Ohaus Navigator balances and Garmin Map76 handheld GPS units were used in data collection. This setup facilitated rapid entry of shell measurements and location 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).

Data analysis

Catch of each tow was standardized to scallops per square meter. Area swept per tow was calculated using tow distance and drag width (7 ft. = 2.1 m). Tow distance was determined using either ArcView™ or Capn Voyager™

software. Total catch was further broken down into "seed" (<2 ½ in. = 63.5 mm), "sublegal" (2 ½ in. to <4 in. = 63.5 – 101.5 mm), and "harvestable" (4 in. or greater = ≥101.6 mm) size classes. In 2003, the legal standard for harvestable size was 3 ¾ in. or greater (≥ 95.25 mm) and "sublegal" was 2 ½ in. to < 3 ¾ in. (63.5 – 95.24 mm).

Estimates of total abundance for each of the three size classes were calculated for Cobscook Bay using the classic Cochran approach (Cochran 1977). The finite population correction factor was ignored since the proportion of area sampled was small compared to the total area of each stratum. Harvestable biomass was calculated by applying the shell height-meat weight relation for Cobscook Bay (Schick and Feindel 2005) to the numbers of harvestable scallops at shell height per stratum. Biomass was summed across strata to determine total harvestable biomass for Cobscook Bay.

Data from all survey strata were examined at three different spatial scales (large scale, regionally, and patch scale or tow by tow) to look at relative abundance, size structure and recruitment trends. Abundance data for three other historically important areas (Libby Is., Gouldsboro Bay, Duck Is.) were also examined individually.

Results

There were 276 survey tows completed between eastern Penobscot Bay and the St. Croix River during Oct. 31 - Nov. 27, 2006. Cobscook Bay was surveyed during Nov. 6-9. There were 9,382 scallops measured during the survey and 1,074 meats were weighed. The largest individual scallop was 179.6 mm and the largest number of scallops in a single tow was 1,720 in Cobscook Bay (Pennamaquan River).

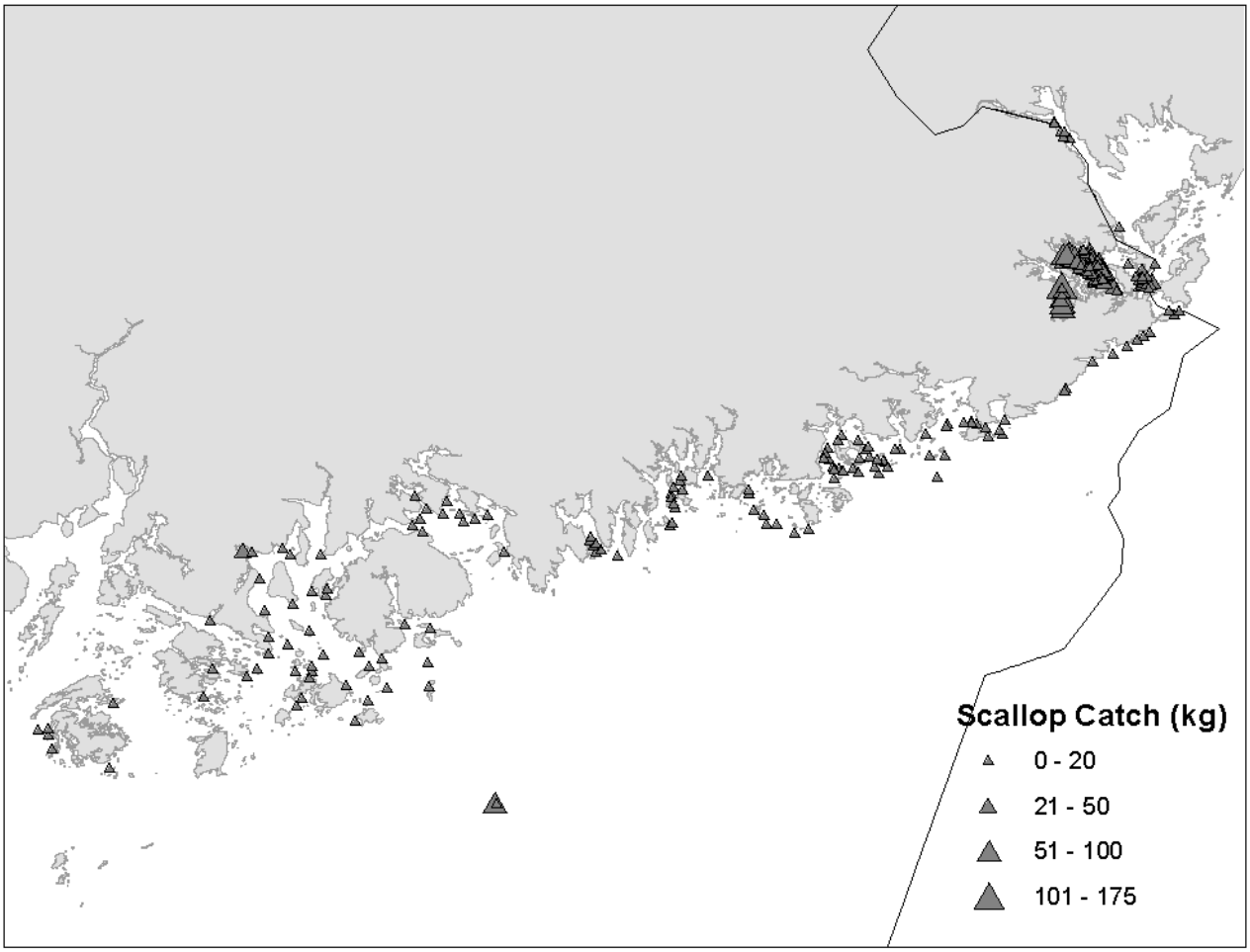


Figure 5. Scallop catch weight (shellstock) by tow, 2006 survey.

Zone 1 (Cobscook Bay)

Cobscook Bay has particular importance as a scalloping area in Maine and is subject to a special set of regulations on drag width (5.5 ft. max.), meat count (35/lb. max.) and possession (15 gal. meats/day max.). Survey intensity was quite high (85 tows in '06) in this area so that a direct assessment of abundance could be made. Station locations are indicated in Figs. 6-8.

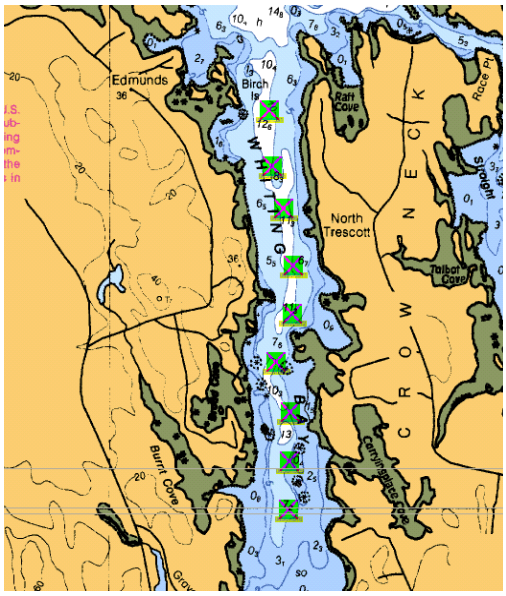


Figure 6. 2006 survey stations (Whiting Bay).

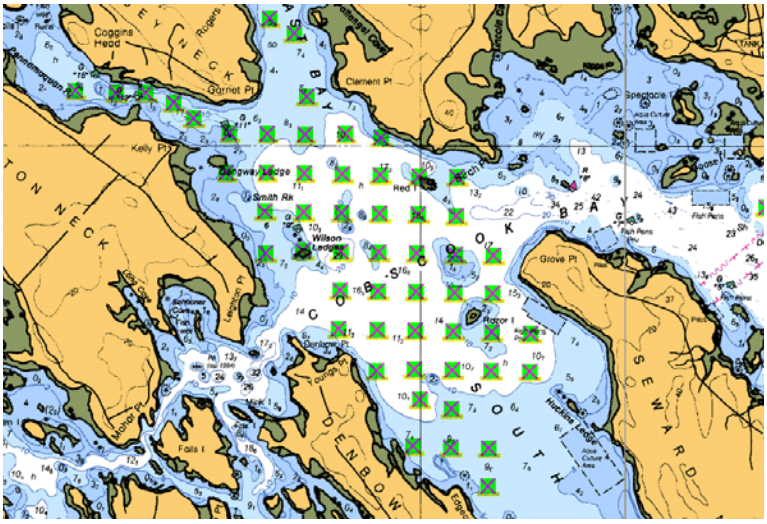


Figure 7. 2006 survey stations (Penn R., South Bay, East Bay).

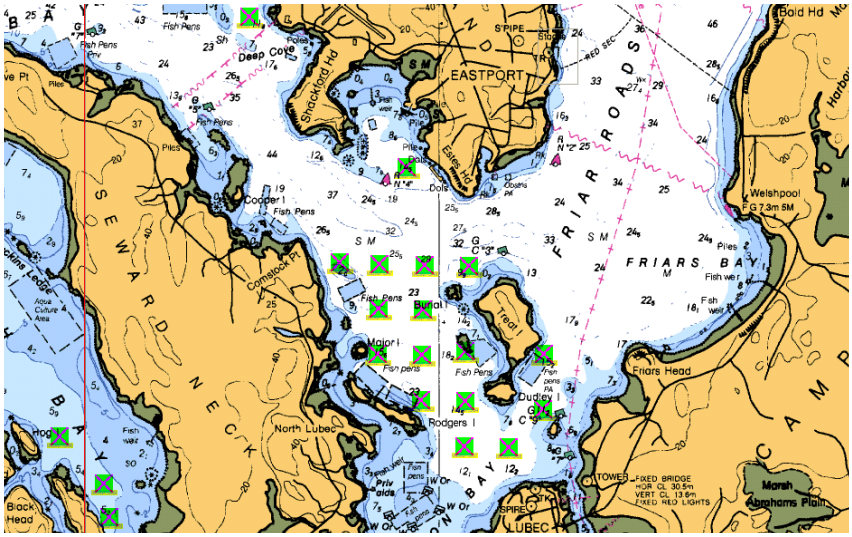


Figure 8. 2006 survey stations (Johnson Bay and "other").

Scallop abundance was higher in Cobscook Bay in 2006 than in 2003. This was primarily due to a significant increase in abundance of sublegal

scallops. The largest increase in sublegals was in the Pennamaquan River. South Bay, Whiting Bay and the area designated as “other” also had significantly higher numbers of sublegals (Table 1, Figs. 9-14).

Abundance of harvestable scallops in South Bay, the primary scalloping ground, was similar between 2003 (0.077 scallops per $m^{2)}$ and 2006 (0.070 scallops per m^2). South Bay had the highest density of harvestable scallops of all strata in both years. Whiting Bay and “other” had slight increases in abundance of harvestable scallops in 2006. Johnson Bay had very similar abundance and distribution by size class between the two surveys.

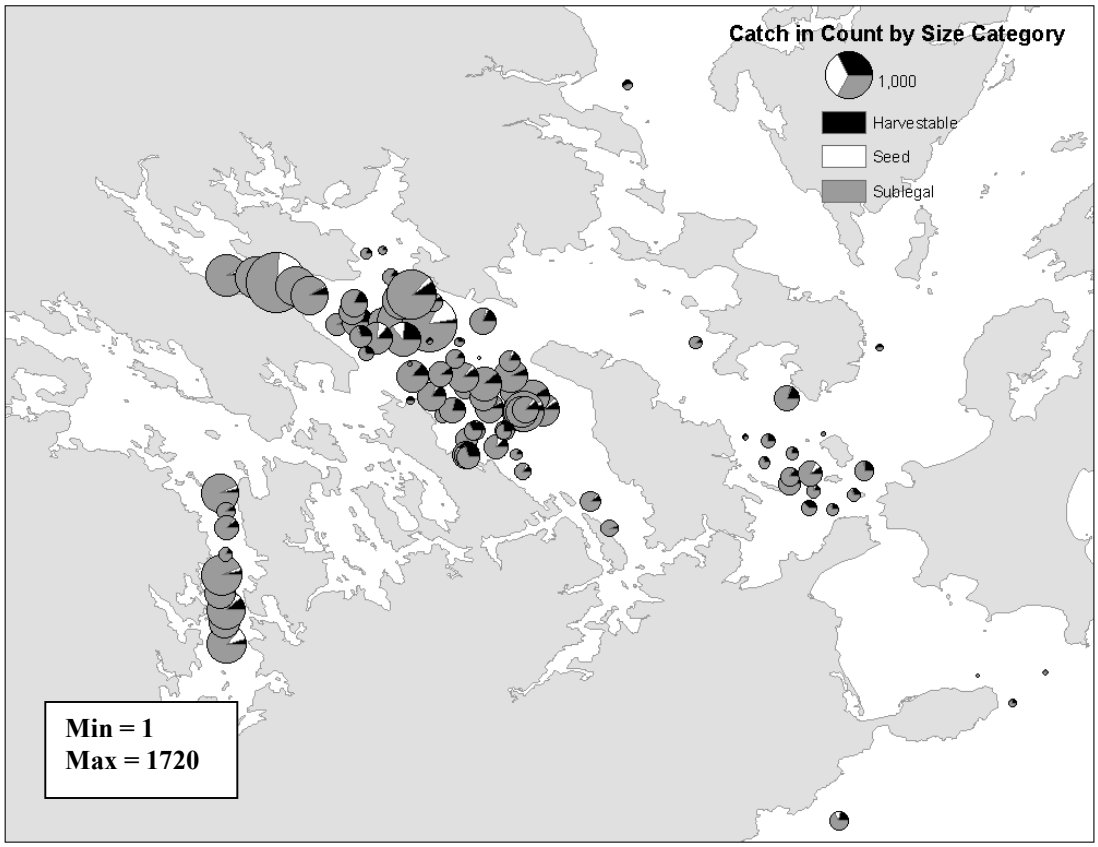


Figure 9. Scallop size class composition and abundance (Cobscook Bay), 2006 survey.

Table 1. Survey summary statistics for Cobscook Bay (2006) by stratum and overall (mean +/- standard error).

strata	total		South Bay		East Bay		Penn. River		Whiting Bay		Johnson Bay		other	
area (hec)	2,158		1,182		92		64		135		401		284	
no. sites	84		49		3		5		9		15		3	
			Density (scallops per sq m)											
			density	S.E	density	S.E	density	S.E	density	S.E	density	S.E	density	S.E
seed			0.025	0.007	0.000	0.000	0.137	0.090	0.030	0.013	0.007	0.002	0.003	0.002
sublegal			0.492	0.069	0.092	0.037	1.274	0.187	0.738	0.128	0.126	0.027	0.284	0.129
harvestable			0.070	0.007	0.022	0.006	0.048	0.016	0.057	0.010	0.042	0.008	0.063	0.020
all sizes			0.587	0.078	0.114	0.043	1.459	0.282	0.825	0.139	0.174	0.035	0.351	0.144
			Abundance (no. scallops)											
	abundance		abundance	S.E	abundance	S.E	abundance	S.E	abundance	S.E	abundance	S.E	abundance	S.E
seed	461,005		297,145	82,855	0	0	87,763	57,615	40,130	17,079	26,094	8,535	9,873	6,041
sublegal	9,020,084		5,813,292	814,123	85,080	33,862	815,506	119,626	996,706	172,936	503,437	109,897	806,063	365,177
harvestable	1,303,199		828,724	85,443	19,854	5,391	30,580	10,481	76,652	12,918	167,293	31,010	180,097	56,899
all sizes	10,784,288		6,939,162	927,432	104,934	39,246	933,848	180,453	1,113,489	188,172	696,823	139,772	996,032	410,060
	Harvestable biomass (kg) (unadjusted)													
	biomass	S.E	biomass	S.E	biomass	S.E	biomass	S.E	biomass	S.E	biomass	S.E	biomass	S.E
	34,132	5,544	21,166	2,108	653	198	695	234	1,881	335	4,446	818	5,292	1,851

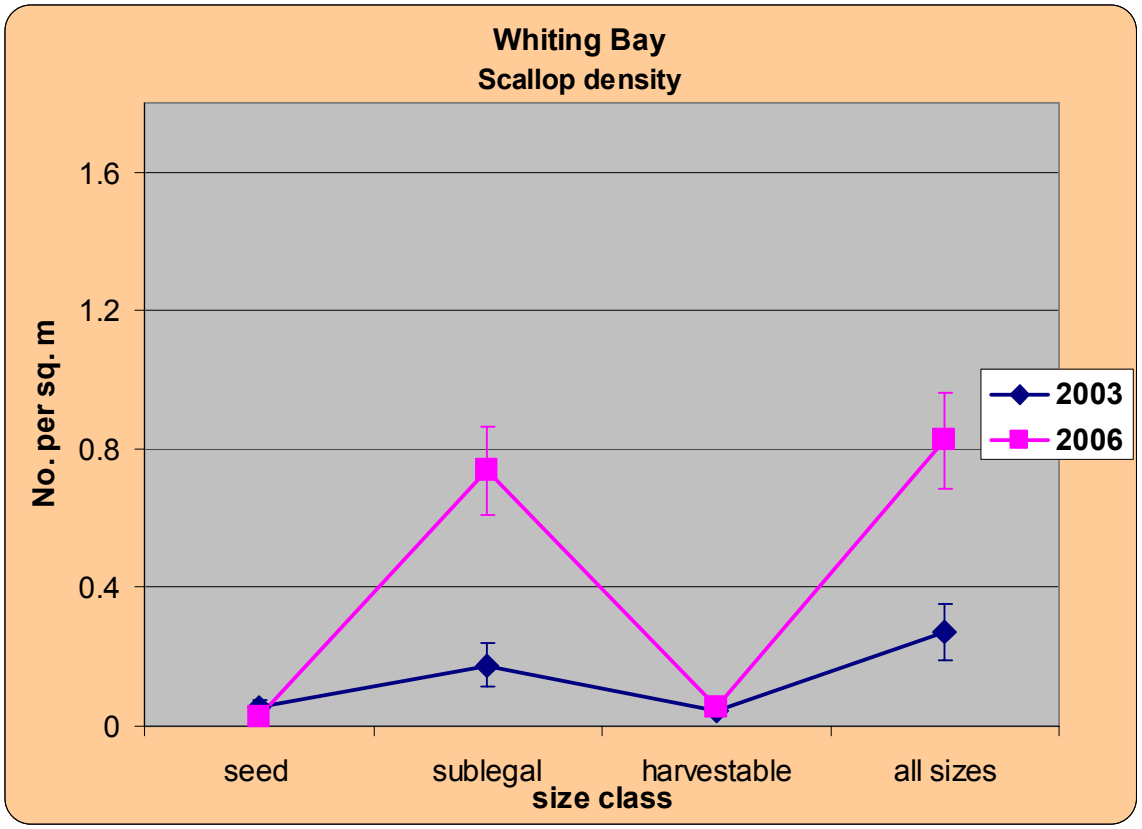


Figure 9. Mean scallop density by size group, Whiting Bay.

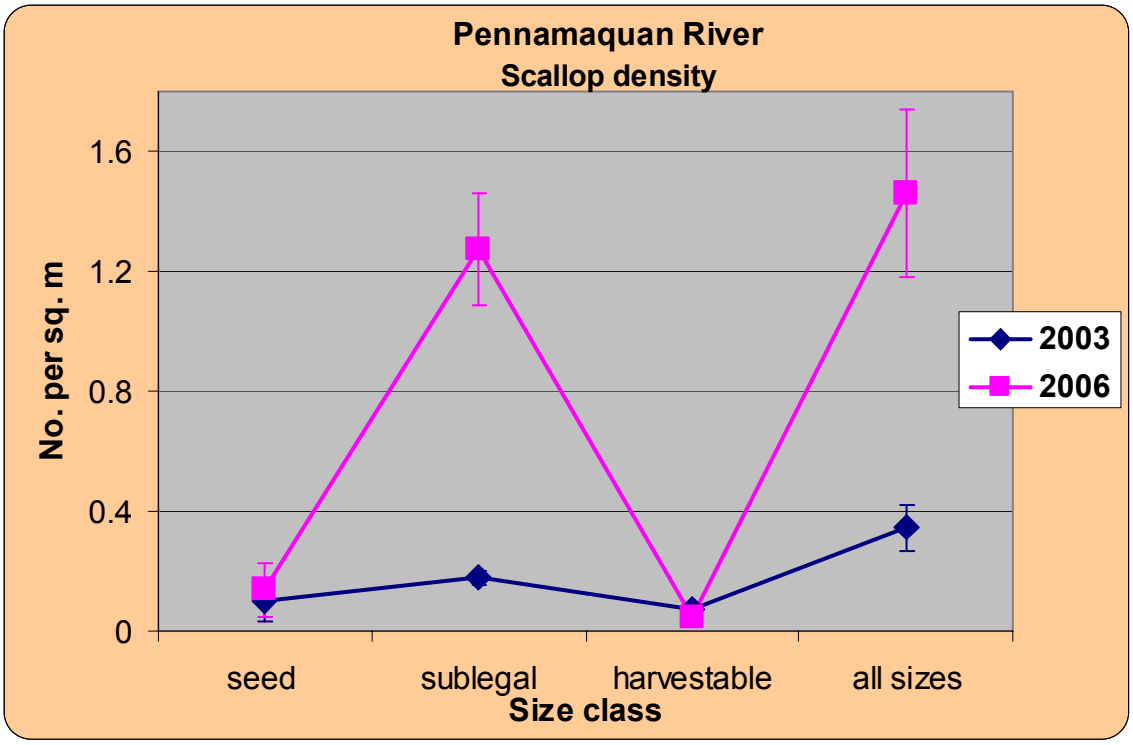


Figure 10. Mean scallop density by size group, Pennamaquan River.

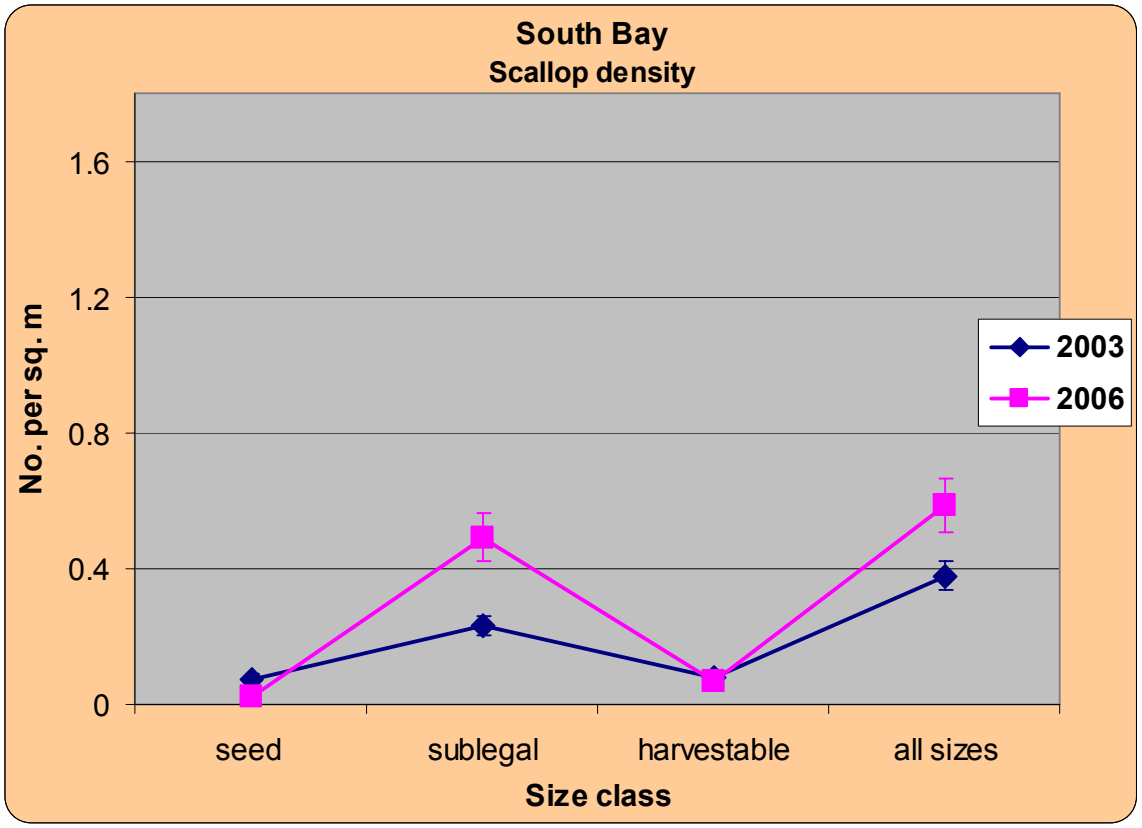


Figure 11. Mean scallop density by size group, South Bay.

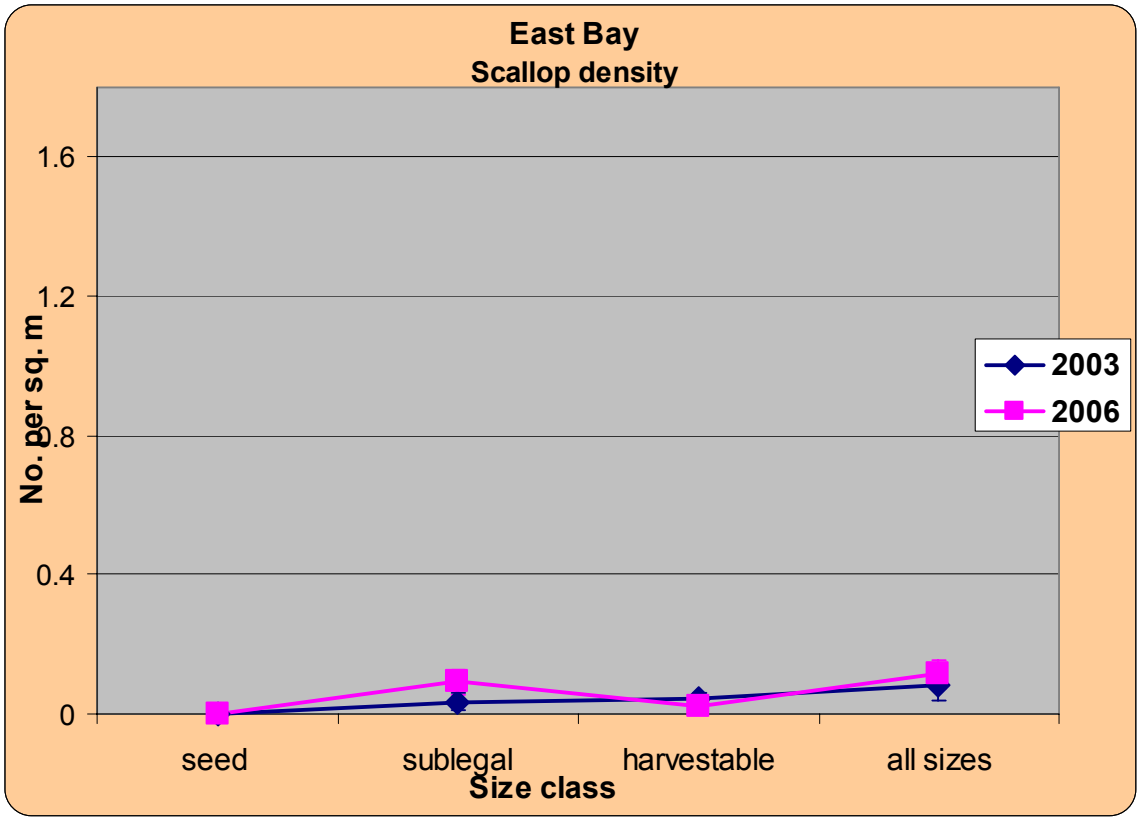


Figure 12. Mean scallop density by size group, East Bay.

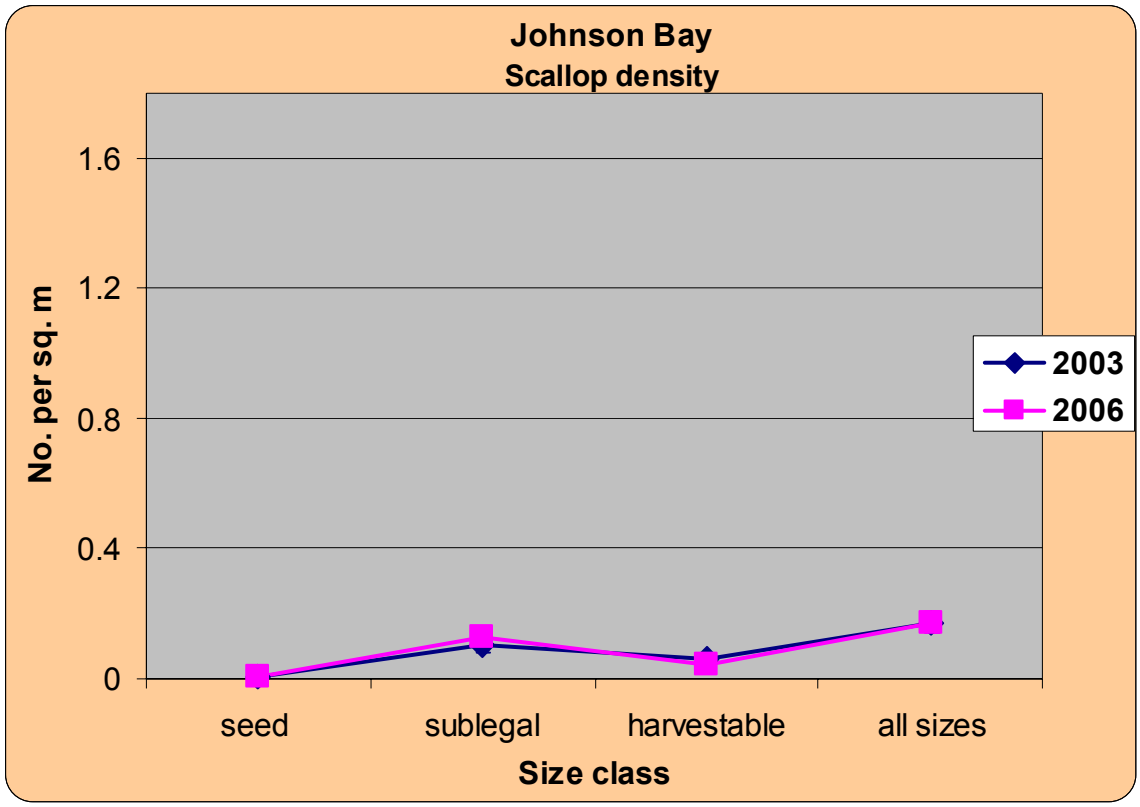


Figure 13. Mean scallop density by size group, Johnson Bay.

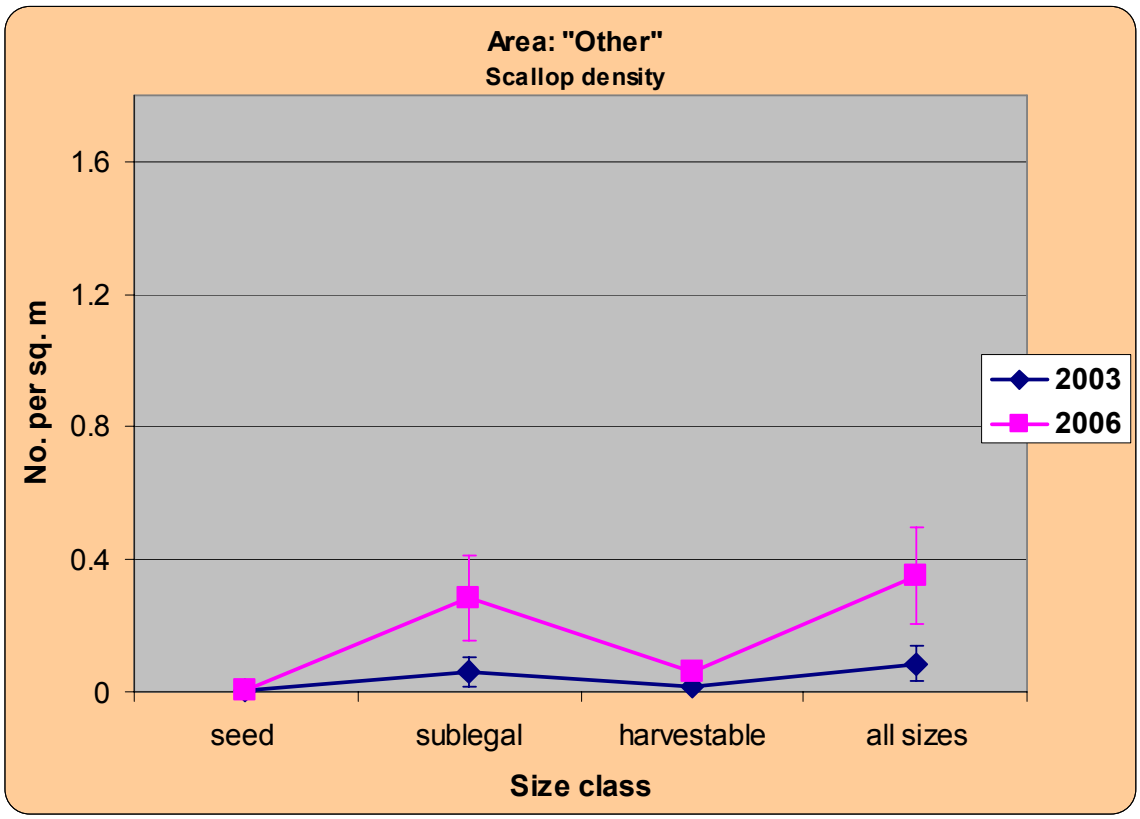


Figure 14. Mean scallop density by size group, area: "other".

Relative size structure within South Bay did not change appreciably between years, although there was some increase in the proportion of 3.5-3.74 in. scallops (Fig. 15). In the Pennamaquan River, where there was a large increase in abundance of sublegal scallops in 2006, a significant increase occurred in the proportion of 3.5-3.74 in. scallops. Johnson Bay had little change in size structure between sampling periods and Whiting Bay had a slight increase in the proportion of 3.75-3.9 in. scallops in 2006.

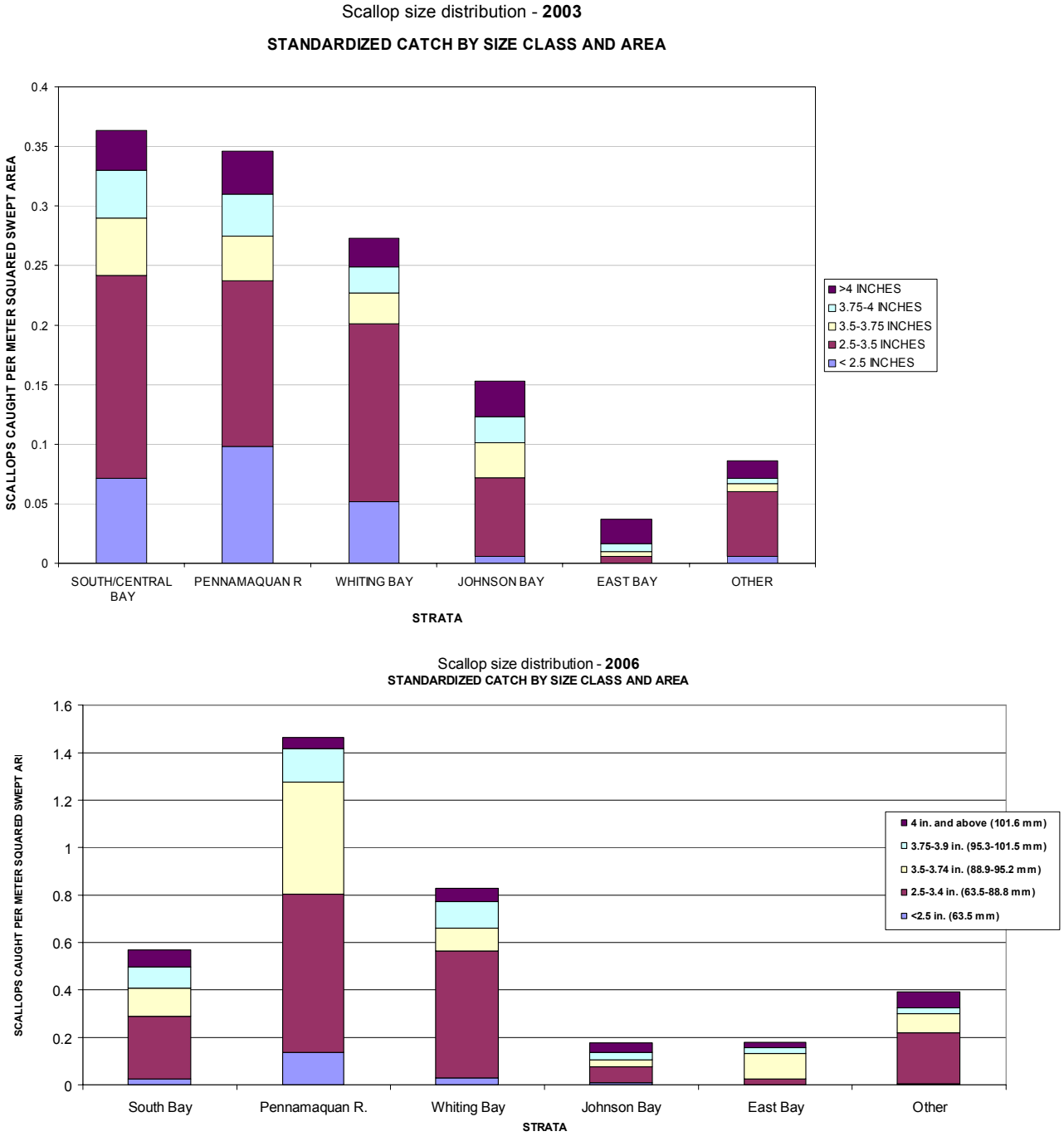


Figure 15. Size distribution of scallops in Cobscook Bay, 2003 (*top*) and 2006 (*bottom*).

Total harvestable biomass (meat weight) increased 20.9% from 28,246 kg (62,272 lbs.) in 2003 to 34,142 kg (75,270 lbs.) in 2006 (Fig. 16). As noted earlier the overall abundance of harvestable scallops decreased very slightly between 2003 and 2006 but because of the change in minimum legal shell height from 3.75 to 4.0 in., a significant increase in harvestable biomass was realized between survey periods.

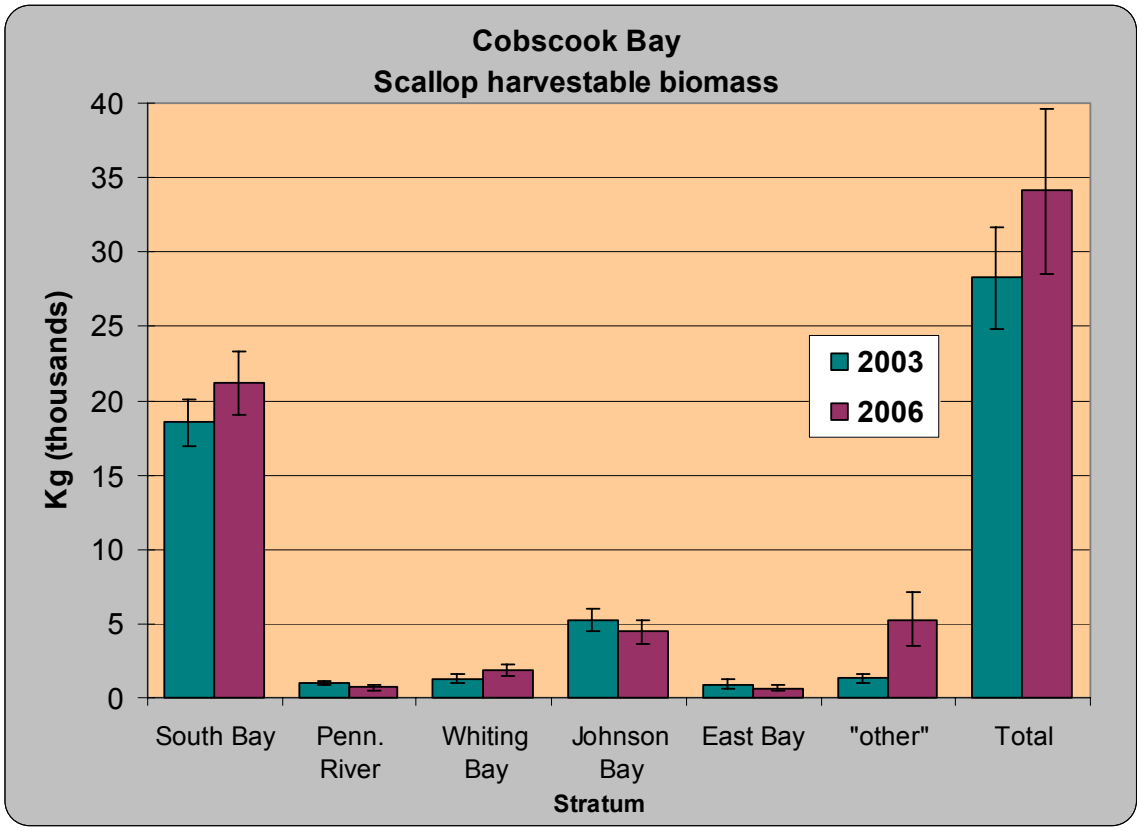


Figure 16. Harvestable biomass (meat weight) of scallops in Cobscook Bay, 2003 and 2006.

Dredge efficiency for Cobscook Bay

The diver transects performed during the 2006 survey indicated that the survey drag was 43.6% efficient at capturing scallops ≥3.75 in. This estimate is less than the previous estimate for the DMR survey dredge (68.0%; Schick and Feindel 2005) but compares favorably with the efficiency estimate for the NMFS survey dredge (45% in Closed Areas I and II on Georges Bank; NMFS/NEFSC 2004). Our estimate also compares well with efficiency of New England-style commercial dredges (42.7%; Gedamke et al. 2004). For the cooperative survey of scallop abundance in Closed Area II using commercial-type gear (SMAST, VIMS, Fisheries Survival Fund, NMFS), the dredge efficiency was estimated to be 53.1 – 54.4% (Gedamke et al. 2005). We are using an unlined dredge – unlined dredges have higher efficiency than lined dredges so that our estimate of

43.6% is well within the range of what would be expected (D. Hart, NMFS/NEFSC, pers. comm.).

The particular bottom type of our dredge efficiency study site was largely sandy gravel, typical of much of Cobscook Bay, which also likely increases gear efficiency over the more rocky areas along much of the rest of coastal Maine. If the dredge efficiency factor is applied to the estimates of harvestable biomass for Cobscook Bay, the adjusted biomass estimate for is 64,784 kg (142,820 lbs.) in 2003 and 78,284 kg (172,590 lbs.) in 2006.

Zone 1A (St. Croix River)

There were seven stations sampled in 2006 (Fig. 17). All tows were fixed stations last surveyed in '02. This stratum was characterized by weak scallop abundance (0.005 per m^2) although harvestables (0.003 per m^2) were slightly more abundant than sublegals (0.002 per m^2; Fig. 18). Catch rates were also low in 2002 (Schick and Feindel 2005). Highest catch rate in 2006 was around Frost Is. near Passamaquoddy Bay.

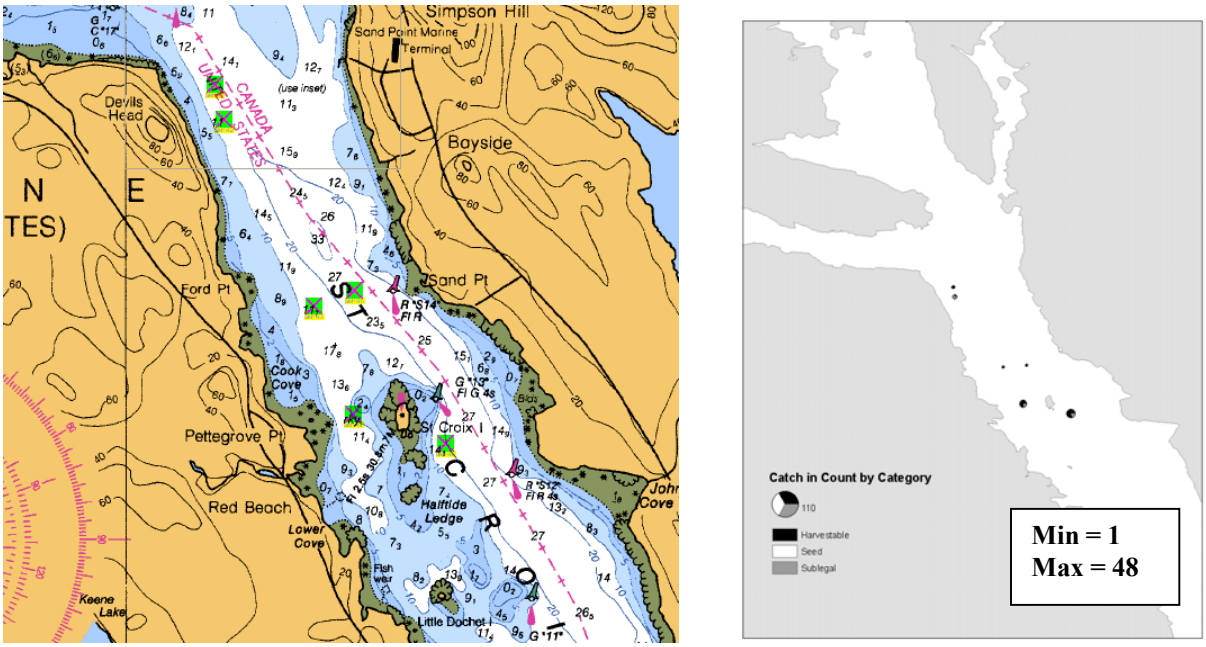


Figure 17. Location of 2006 survey stations (*left*) and scallop size class composition and abundance (*right*) (St. Croix River).

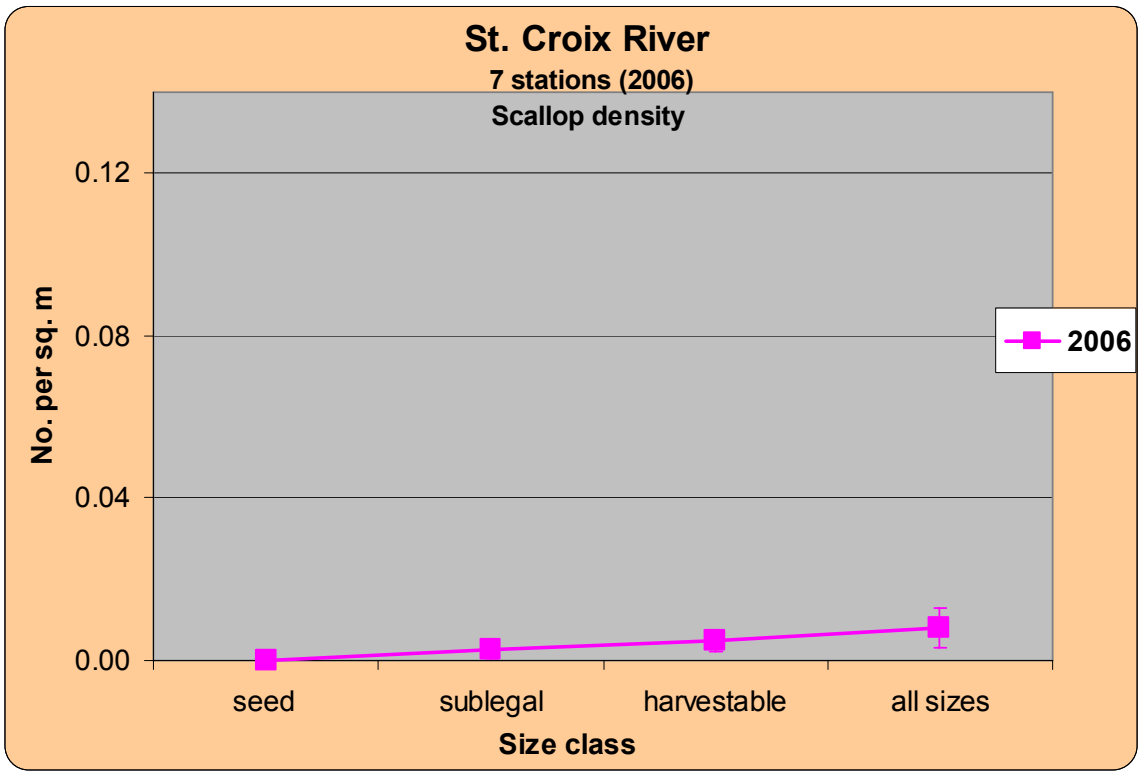


Figure 18. Mean scallop density by size group, Stratum 1A.

Zone 2 (Cross Is. to Quoddy Head)

The previous survey ('02) of this stratum was quite limited (five tows) and in '03 the survey did not cover this area due to presence of lobster gear. In 2006, there were 15 exploratory tows made in this Cutler shore stratum (Fig. 19). Abundance of scallops did not change appreciably between '02 and '06 (Fig. 20). Overall abundance (0.040 per m^2) was slightly (not significantly) lower than '02 (0.051 per m^2). Harvestables had a very slight decrease from 0.024 per m^2 ('02) to 0.014 per m^2 ('06). Highest catch rates in '06 were around Morton Ledge and Holmes Cove.

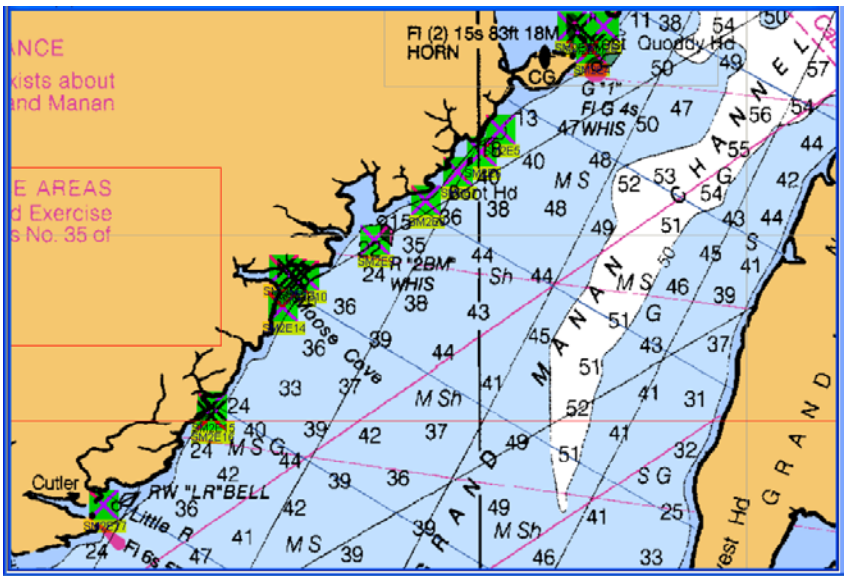
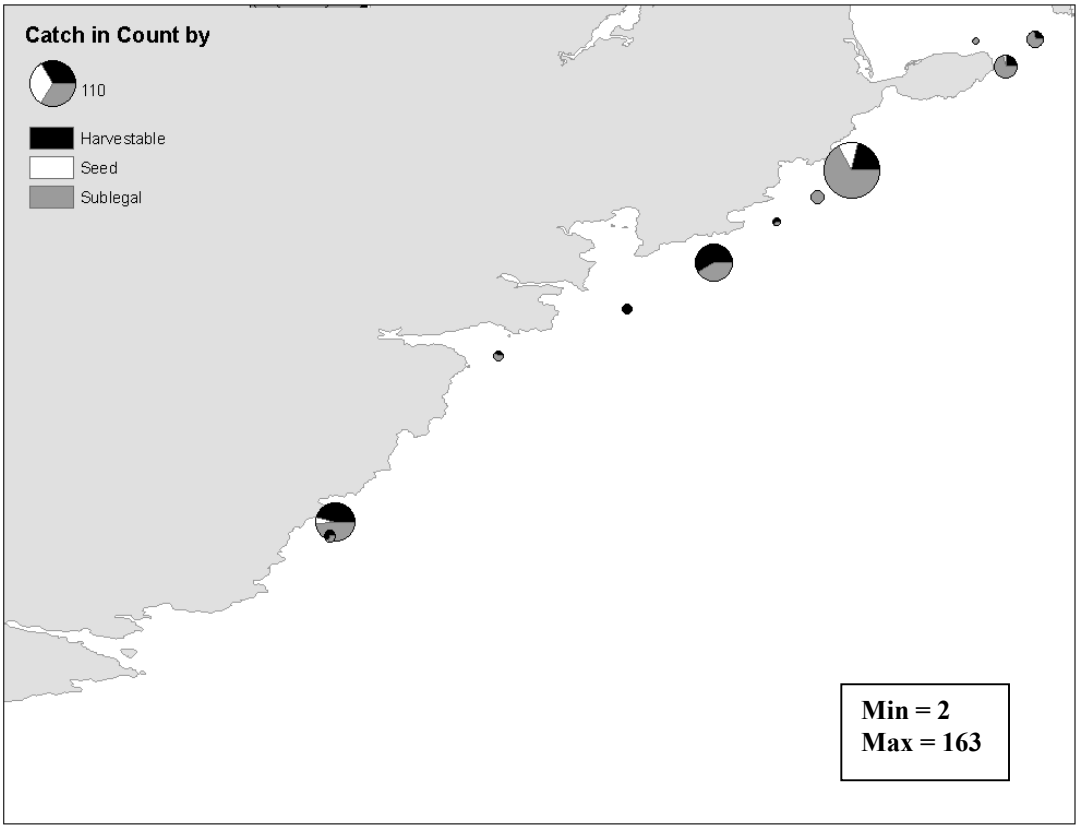


Figure 19. Location of 2006 survey stations (*above*) and scallop size class composition and abundance (*below*) (Cross Is. to Quoddy Head).



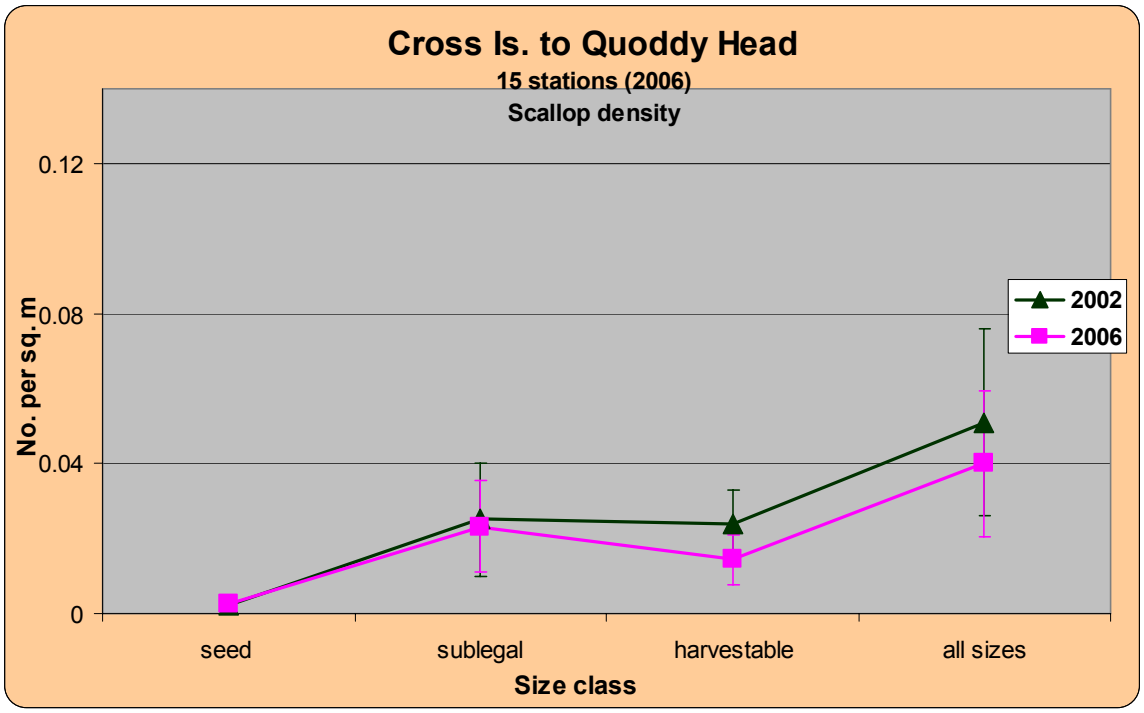


Figure 20. Mean scallop density by size group, Stratum 2.

Zone 3 (Great Wass Is. to Little River)

Sampling intensity was greater in 2006 (44 stations; Fig. 21) than in 2002 (29 stations) and 2003 (25 stations). There were 41 random and three fixed stations in 2006. Overall abundance (0.031 per m^2) declined significantly since the 2002 survey (0.070 per m^2) and particularly since the 2003 survey (0.111 per m^2) although catches were more variable in the previous surveys (Fig. 22). The density of harvestable scallops was significantly lower in 2006 (0.016 per m^2) than in 2003 (0.051 per m^2). Seed abundance, which was noted to be fairly strong in 2003, declined in 2006. Highest catch rates in 2006 were around Codhead Ledge near Englishman Bay and near Little Machias Bay.

Libby Islands

Tows were added to the 2006 survey in the Libby Islands area because of its proximity to historically-productive scallop grounds in federal waters. Catch rates were quite low, with very small numbers of seed and sublegals and mean density of harvestables (0.013 per m^2) below average for the stratum (Table 2).

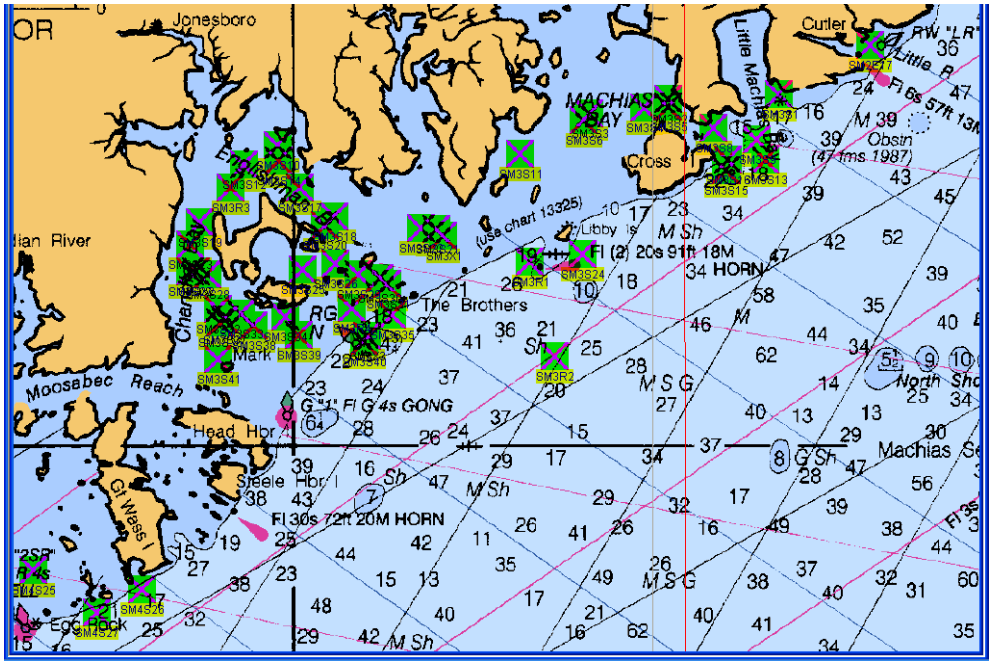


Figure 21. Location of 2006 survey stations (*above*) and scallop size class composition and abundance (*below*) (Great Wass Is. to Little River).

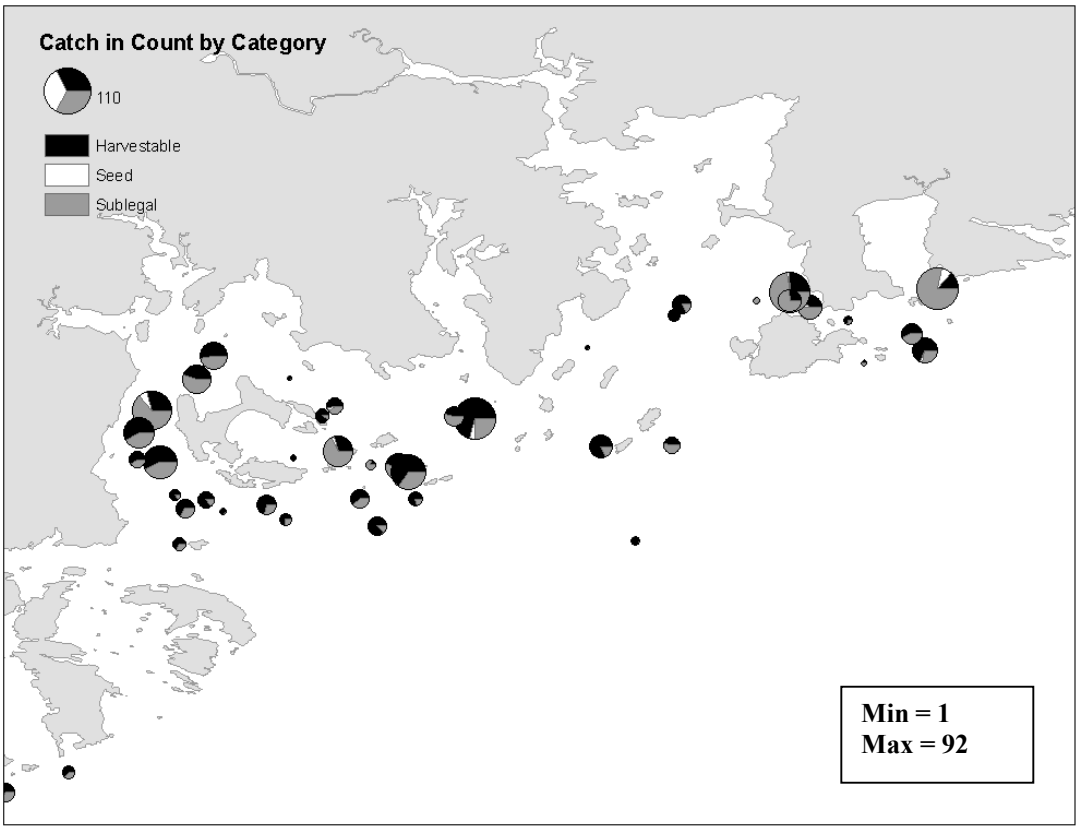


Figure 22. Mean scallop density by size group, Stratum 3.

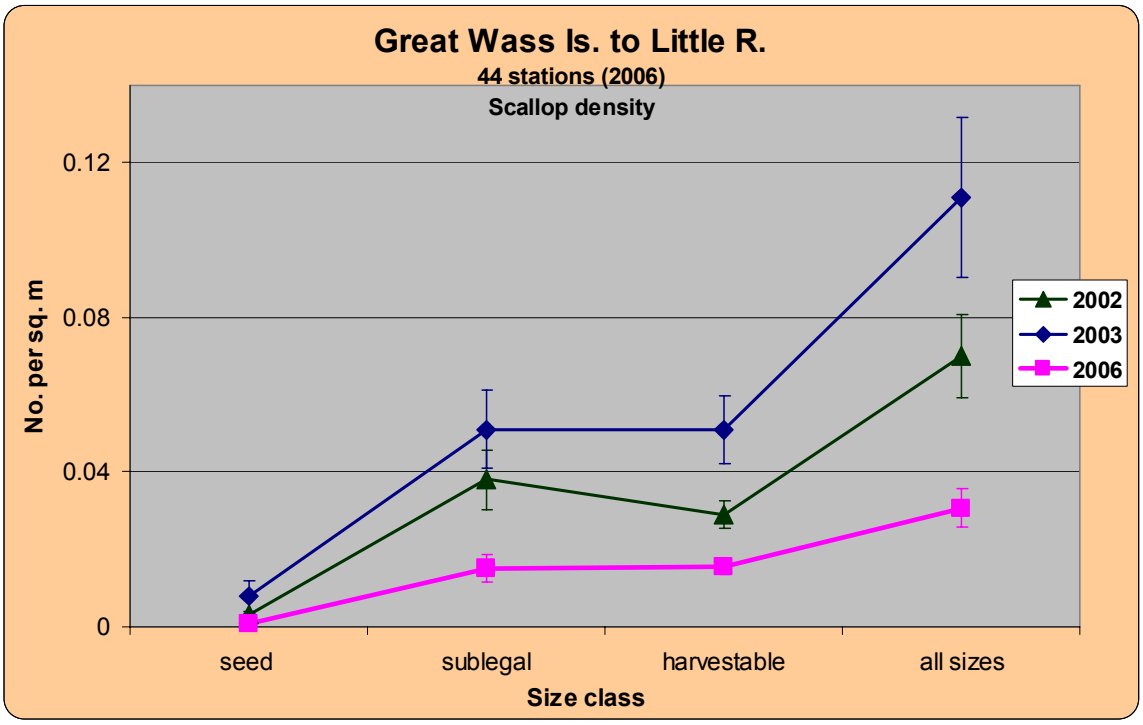


Table 2. Scallop density per tow by size group from areas of special interest.

		Density			
Gouldsboro Bay	**station**	**seed**	**sublegal**	**harvestable**	**overall**
	SM4R1	0.0076	0.0319	0.0411	0.0806
	SM4R2	0	0.0348	0.0206	0.0555
	SM4R3	0	0.0210	0.0184	0.0395
	SM4R4	0	0.0195	0.0195	0.0389
	SM4S28	0	0.0070	0.0117	0.0187
	SM4S32	0	0.0038	0.0265	0.0302
	mean	0.0013	0.0197	0.0230	0.0439
Duck Is.	SM5S35	0	0	0.0052	0.0052
	SM5S36	0	0	0	0
	mean	0	0	0.0026	0.0026
Libby Is.	SM3R2	0	0	0.0055	0.0055
	SM3R1	0	0.0058	0.0266	0.0324
	SM3S24	0	0.0072	0.0062	0.0134
	mean	0	0.00433	0.01277	0.01710

Zone 4 (Schoodic Pt. to Great Wass Is.)

There were 38 stations sampled in this stratum in ’06 (39 in ’02 and 40 in ’03) (Fig. 23). Of the ’06 stations, 32 were randomly-selected within the grounds, four were fixed and two were exploratory. Abundance (0.017 per m^2) was slightly less than in ’02 (0.026 per m^2) and ’03 (0.024 per m^2) (Fig. 24). Harvestable abundance (0.008 per m^2) was down in ’06 from ’02 (0.014 per m^2) and ’03 (0.013 per m^2). Sublegal abundance was very similar in ’06 to ’02 and ’03. Highest catches of harvestables were in Gouldsboro Bay and overall highest catch was in Strout Narrows.

Gouldsboro Bay

In Gouldsboro Bay, overall density was relatively low (0.044 per m^2) for this historically productive area but higher than average for the stratum (Table 2). Both sublegals and harvestables were higher than average for the stratum but virtually no seed was observed.

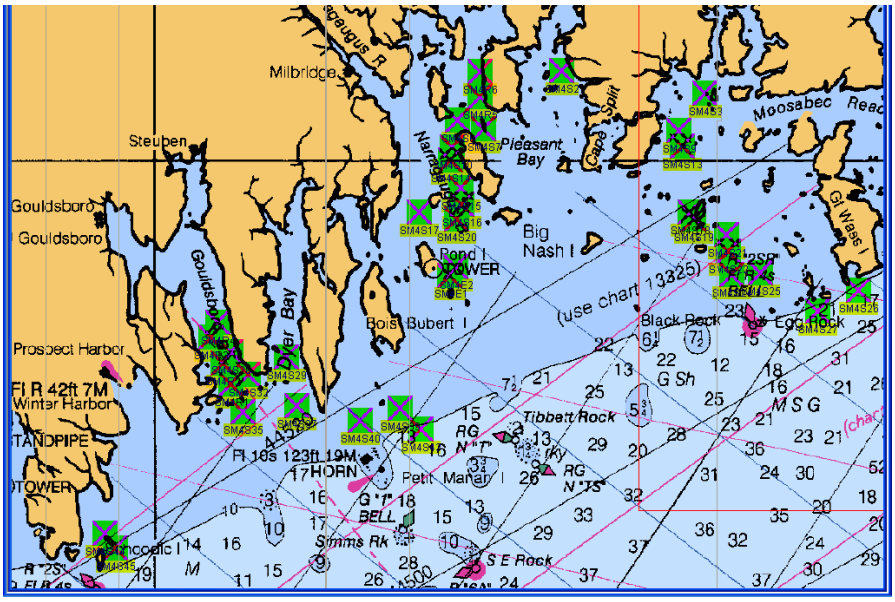
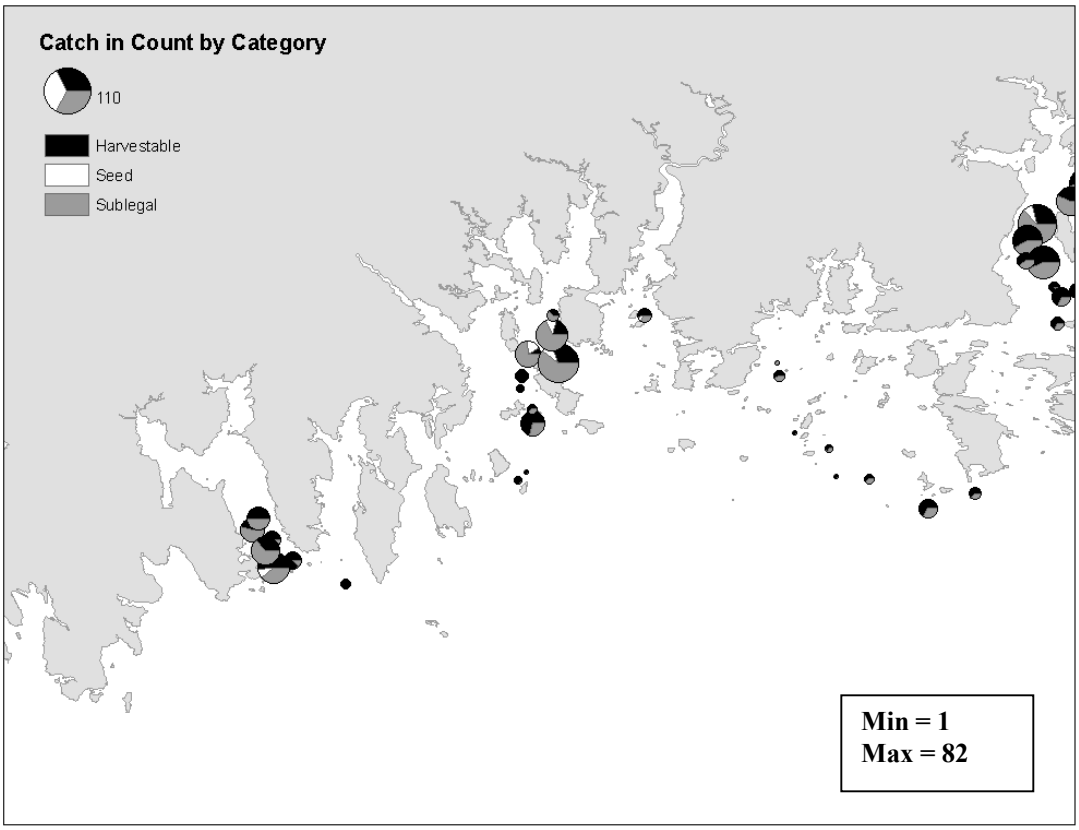


Figure 23. Location of 2006 survey stations (*above*) and scallop size class composition and abundance (*below*) (Schoodic Pt. to Great Wass Is.).



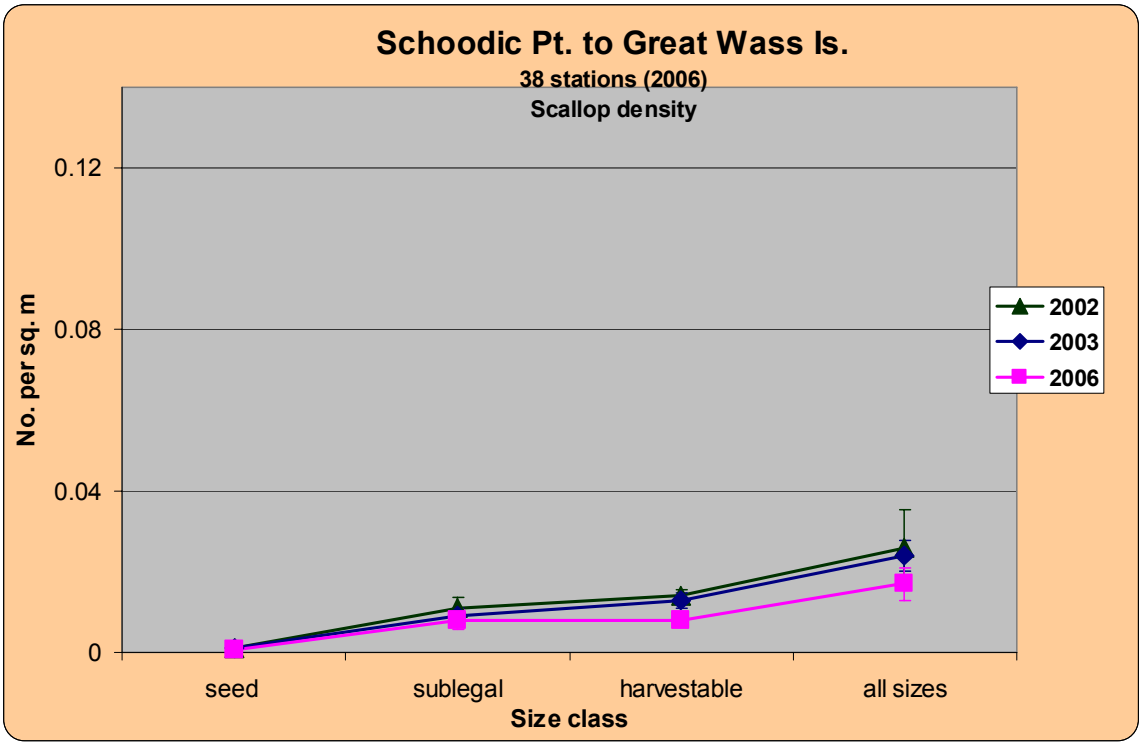


Figure 24. Mean scallop density by size group, Stratum 4.

Zone 5 (Eastern Blue Hill Bay and Frenchman Bay)

There were 41 stations sampled in 2006 (Fig. 25) that included 32 random, eight fixed and one exploratory station. Overall density (0.007 per m^2) remained very low and decreased slightly (Fig. 26). There were virtually no seed scallops and very few sublegals were observed. Older larger scallops comprised much of the catch of harvestables. The highest catch rate was around Jordan Harbor.

Duck Islands

This area is in proximity to historically-productive scallop grounds in federal waters. Catch rates were very low with no seed or sublegal scallops and a mean density of harvestables (0.003 per m^2) below average when compared to the overall stratum (Table 2).

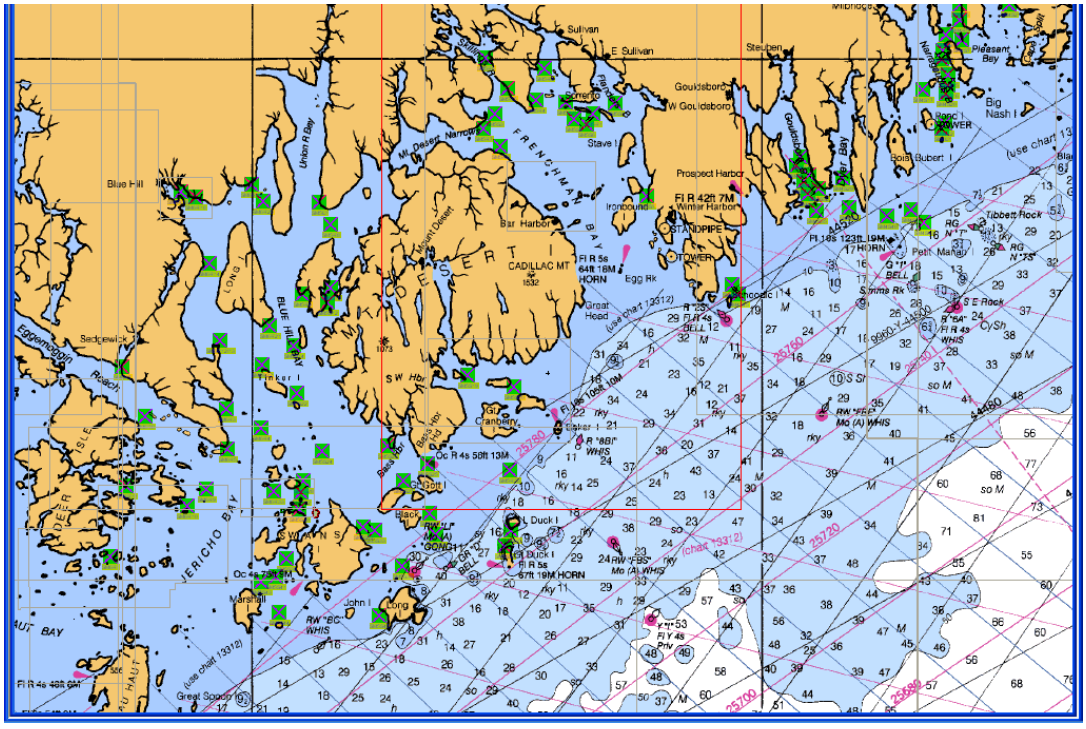
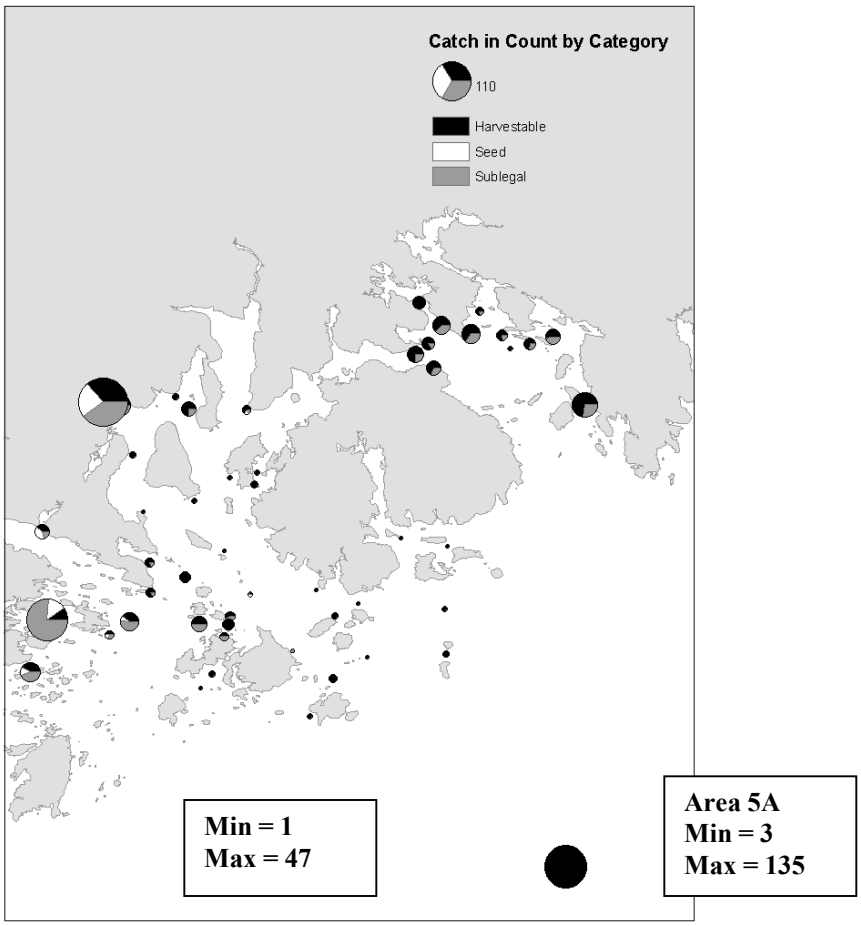


Figure 25. Location of 2006 survey stations (*above*) and scallop size class composition and abundance (*below*) (Eastern Blue Hill Bay and Frenchman Bay).



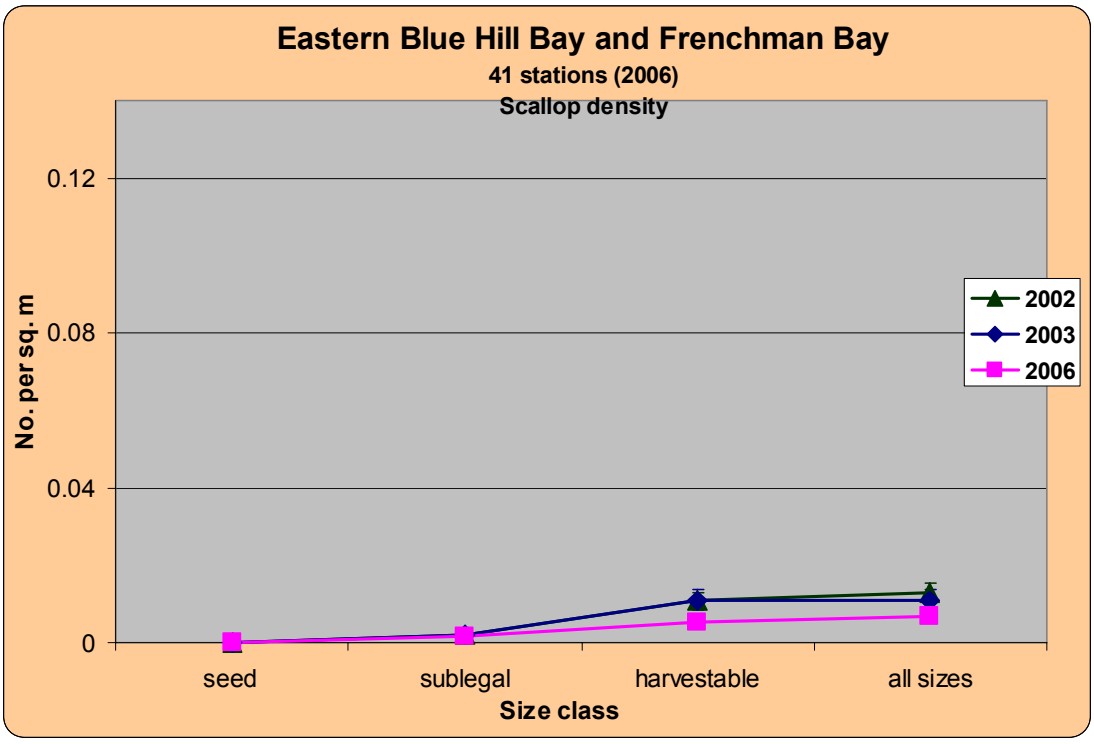


Figure 26. Mean scallop density by size group, Stratum 5.

Zone 5A (Mt. Desert Rock)

This stratum was added to the survey because of its historical scallop production and due to its significance as an offshore area that is actually within state waters. Four exploratory tows were made (Fig. 27). No seed or sublegal scallops were caught and the overall density was 0.030 per m^2 (Fig. 28). Two tows yielded no scallops but one tow yielded 136 large (130-161 mm) scallops.

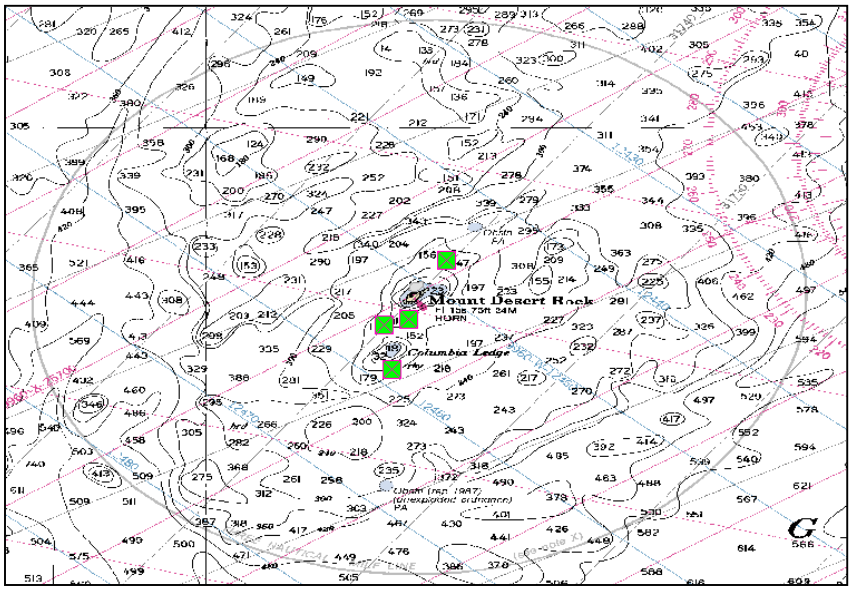


Figure 27. 2006 survey stations (Mt. Desert Rock).

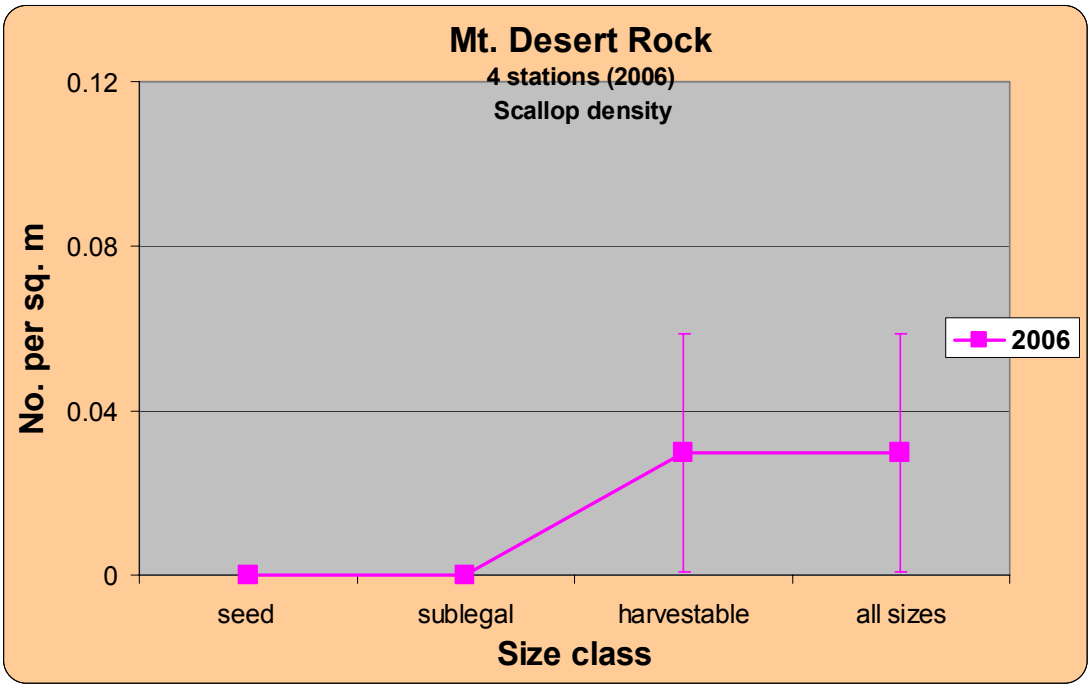


Figure 28. Mean scallop density by size group, Stratum 5A.

Zone 6 (Eastern Penobscot Bay and Western Blue Hill Bay)

A total of 27 stations were sampled in 2006 (Fig. 29) compared to 33 in 2003. All stations were fixed locations. Overall scallop density (0.027 per m^2) was higher, but not significantly higher than in 2003 (0.013 per m^2) and catches were more variable (Fig. 30). Density of harvestable scallops was very similar and a slight increase was seen in sublegals. The highest catch rate was observed in Blue Hill Harbor.

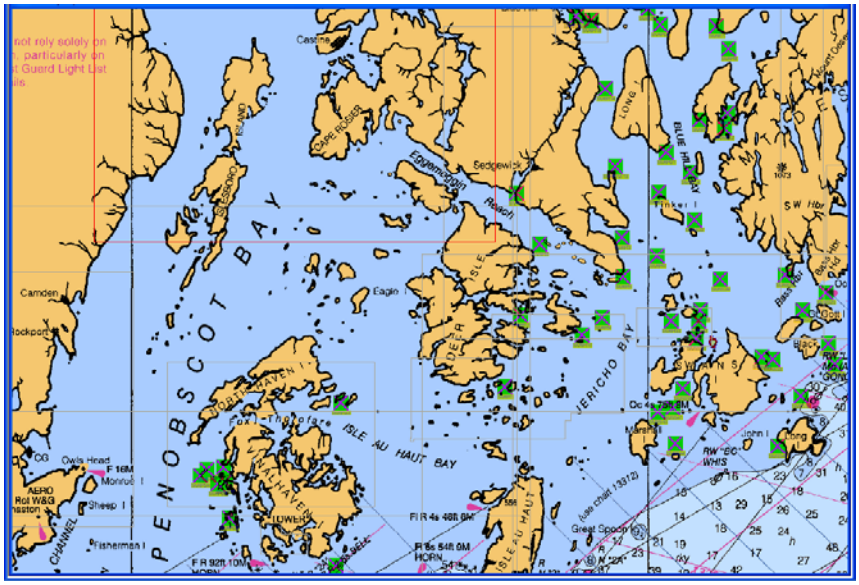
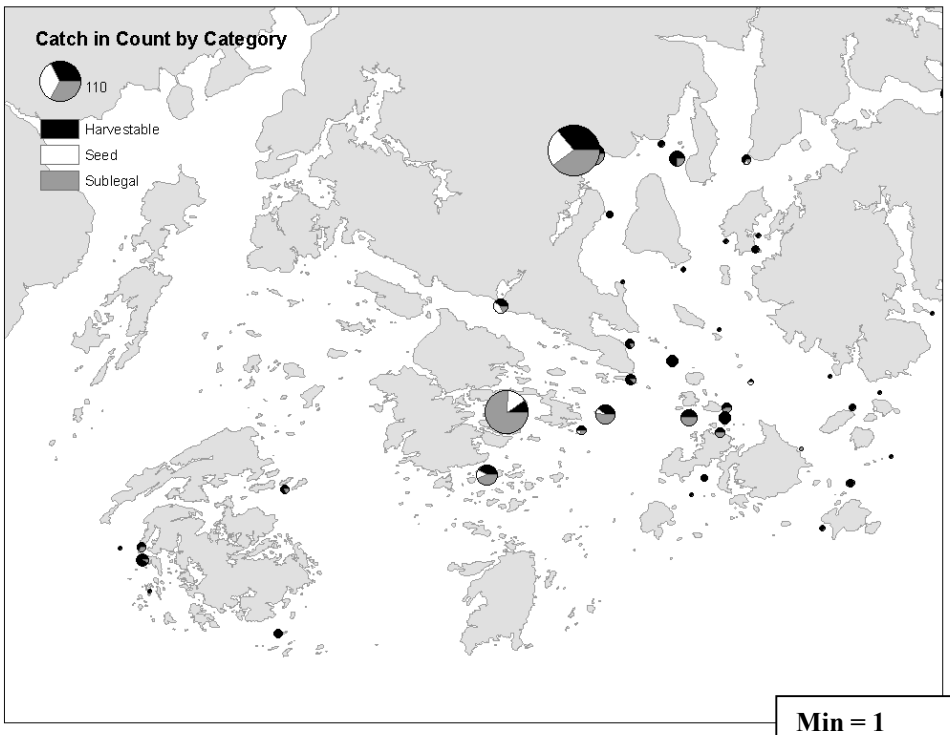


Figure 29. Location of 2006 survey stations (*above*) and scallop size class composition and abundance (*below*) (Eastern Penobscot Bay and Western Blue Hill Bay).



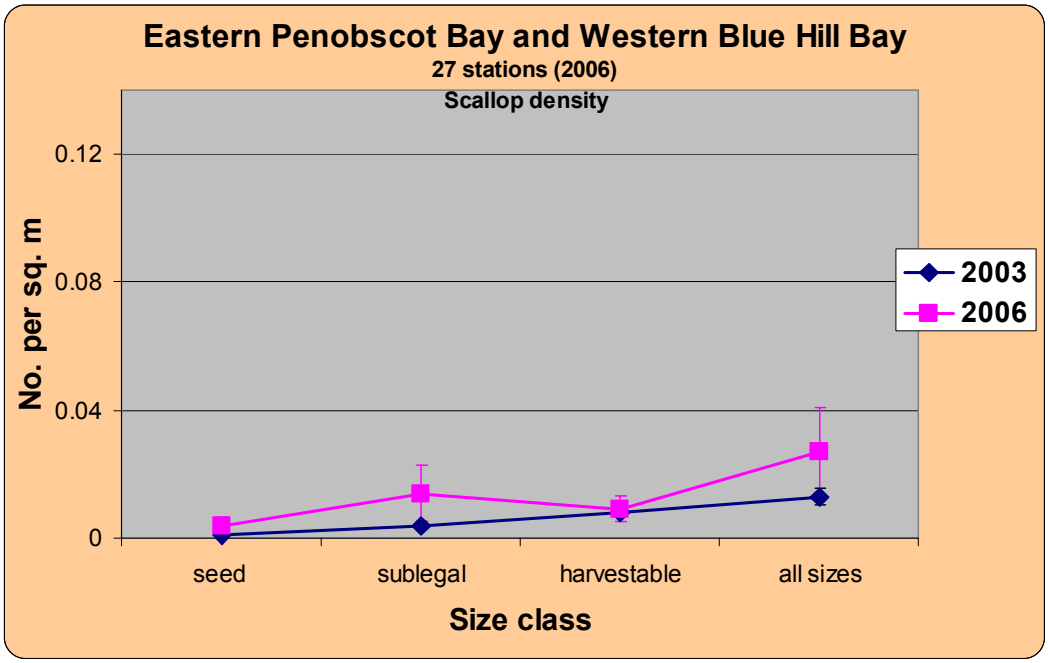


Figure 29. Mean scallop density by size group, Stratum 6.

Conclusions

Results from the survey indicate that scallop abundance has continued to be low and has shown some decline since 2003 for several eastern Maine strata. In Cobscook Bay however, there was a significant increase in scallop abundance. The only other area showing some improvement was eastern Penobscot Bay to western Blue Hill Bay. An area that showed relatively healthy scallop abundance in 2002-03 (Great Wass Is. to Little R.) had lower abundance of scallops in 2006 and there was little indication of incoming recruitment. This is somewhat similar to results of the recent assessment of the Grand Manan, N.B. area which indicated a decline of as high as 44-46% in harvestable abundance between 2003-06 (DFO 2007).

Increased fishing effort may have had an effect on lowered abundance of scallops in the Great Wass Is. to Little River area between ’03 and ’06. The center of fishing activity apparently shifted easterly from Hancock County to Washington County between 1986-87 and 2001-04 (Schick and Feindel 2005). Fishing effort was thought to be contributing to a recent decline in harvestable abundance in the southwest New Brunswick/outer Bay of Fundy/Grand Manan area (DFO 2005) and Zone 4 may have had a similar situation. However, an episodic die-off which may explain a decline and is evidenced by the abundance of clappers, was not observed in the DMR survey (only two clappers observed in 44 tows).

Cobscook Bay was characterized by a large increase in sublegal (particularly 3 ½ - 3 ¾ in.) scallops. The significant increase in abundance of

sublegal scallops in South Bay and the Pennamaquan River may be an effect of the minimum legal shell height increase from 3 ½ to 3 ¾ in. in 2003. The Harvestable biomass also increased almost 21% in Cobscook Bay despite a very slight decline in abundance of harvestable scallops. The phased increase in minimum legal shell height from 3 ½ in. (2002) to 3 ¾ in. (2003) to 4 in. (2004) appeared to have a significant positive effect on potential yield for the 2006-2007 season. The higher meat yield of ≥ 4 in. scallops resulted in an increase in harvestable biomass.

The survey as well as available landings and anecdotal information indicate that the scallop resource along much of the coast is currently well below its potential. Better information is becoming available however to help guide future management.

Future Research Needs

Data on distribution and abundance of scallops from the Maine/New Hampshire fall and spring inshore trawl surveys will be examined for resource trends in areas outside the current survey strata. These data will also be examined to determine if survey stations needed to be added in some of these other areas. Data from DMR surveys on sea urchins, ocean quahogs and sea cucumbers will similarly be utilized for information on distribution and occurrence of scallops.

There will also be refinement and expansion of DMR's scallop port sampling program in '07. This will provide more information on catch, effort, meat size and price as well as characterization of vessels, gear types and locations fished. Mandatory reporting by dealers of scallop landings becomes effective this year. The DMR Scallop Advisory Council also recently forwarded a motion to require mandatory reporting of scallop catch information by fishermen. This should greatly improve our base of information for understanding and managing the Maine scallop fishery.

The recent creation of the Northern Gulf of Maine (NGOM) Management Area under Amendment 11 to the Atlantic Sea Scallop Fishery Fishery Management Plan will have implications for how the Maine inshore fishery is managed and assessed. The NGOM area will be managed under a hard TAC but currently the scallop resource in federal waters of the GOM does not have an assessment. State landings will have an impact on the NGOM area and all (state and federal) landings in the NGOM from federally-permitted vessels will count toward the TAC. State and federal components of the resource, the fishery and this survey will all interact within the NGOM structure.

State scallop surveys will be used in assessment for the NGOM area so it remains critical to continue this work. We propose surveying Cobscook Bay in 2007 to track the status of the highly abundant 3 ½ - 4 in. scallops observed in 2006, to observe whether these scallops will recruit to the fishery and to monitor

the overall status of the scallop resource in this most productive area. Zones 2-6 (Eastern Penobscot Bay to Quoddy Head) would then be surveyed in 2008.

Survey data is essential for managers to gauge the status of Maine's most productive scallop area in relation to the current management structure. The survey provides information on size distribution, abundance/stock size and spatial distribution of scallops. It is necessary to monitor changes in abundance and stock size from year to year to evaluate effects of the fishery and know what is available for a sustainable harvest. The scallop survey provides information needed to evaluate potential management strategies such as rotational harvest strategies, harvest limits, closed areas to protect spawning and enhance recruitment, and area-specific strategies such as for Cobscook Bay.

Acknowledgements

Appreciation is extended to survey vessel captains Wallace Gray and Bruce Porter for their fine efforts and for the welcoming aboard their vessels. I would like to thank vessel crew Steve (*F/V Foxy Lady II*), Rich and Doug (*F/V Alyson J 4*), and Lawrence who provided great local knowledge out of S. Addison. David Sinclair and his crew provided diving services. Thanks to Glenn Nutting and Jim Berke for their work on the survey. Scott Feindel provided great technical advice and field assistance.

Thanks to the DMR Scallop Advisory Council for their approval of funding for the survey as well as their advice and input.

The Cobscook Bay portion of this study was presented at the 16th International Pectinid Workshop (Halifax, N.S., Canada) in May 2007 and thanks to DMR for providing financial support to attend the meeting.

Kohl Kanwit provided additional figures and Terry Stockwell, David Libby, Linda Mercer and Kohl Kanwit provided helpful reviews of this report.

References

Alden, R. and D. Perkins. 2001. Coastal fishery research priorities for the State of Maine. Prepared by the Gulf of Maine Aquarium.

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

Dept. of Fisheries and Oceans Canada (DFO). 2005. Stock assessment report on scallops (*Placopecten magellanicus*) in scallop production areas 1 to 6 in the Bay of Fundy. *DFO Can. Sci. Advis. Sec. Sci. Advis.* 2005/072.

Dept. of Fisheries and Oceans Canada (DFO). 2007. Stock assessment report on scallops (*Placopecten magellanicus*) in scallop production areas 1 to 6 in the Bay of Fundy. *DFO Can. Sci. Advis. Sec. Sci. Advis.* 2007/013.

Gedamke, T., W.D. DuPaul and J.M. Hoenig. 2004. A spatially explicit open-ocean DeLury analysis to estimate gear efficiency in the dredge fishery for sea scallop *Placopecten magellanicus*. *North American Journal of Fisheries Management* 24:335-351.

Gedamke, T., W.D. DuPaul and J.M. Hoenig. 2005. Index-removal estimates of dredge efficiency for sea scallops on Georges Bank. *North American Journal of Fisheries Management* 25: 1122-1129.

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.

National Marine Fisheries Service, Northeast Fisheries Science Center (NMFS/NEFSC). 2004. 39th Northeast Regional Stock Assessment Workshop (39th SAW) Assessment Summary Report & Assessment Report. *Northeast Fisheries Science Center Reference Doc.* 04-10.

New England Fishery Management Council (NEFMC). 2007. DRAFT Amendment 11 to the Atlantic Sea Scallop FMP. 223 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.

Wallace, D.E. 1997. The molluscan fisheries of Maine. *NOAA Tech. Rep. NMFS* 127:63-85

Walton, C.J. 1980. Status and characterization of the sea scallop fishery of Maine. *Maine Department of Marine Resources, Research Reference Document* 80/15, 32 p.