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Preliminary Investigations of Juvenile Scallops (Placopecten Magellanicus) in Nova Scotia Inshore Habitats

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PRELIMINARY INVESTIGATIONS OF JUVENILE SCALLOPS (*PLACOPECTEN MAGELLANICUS*) IN NOVA SCOTIA INSHORE HABITATS

by

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ABSTRACT

Kenchington, E., C. Têtu and R. Mohn. 1991. Preliminary investigations of juvenile scallops (*Placopecten magellanicus*) in Nova Scotia inshore habitats. Can. Manuscr. Rep. Fish. Aquat. Sci. 2123: 38p.

An inshore scallop population survey was carried out from 1984-1988. Observations made during this survey are summarized. Tagging and caging experiments as well as documentation of juvenile population structure and a fall spat survey were performed in 1989 at a site on the Eastern Shore of Nova Scotia. The results of these investigations are presented.

RÉSUMÉ

Kenchington, E., C. Têtu and R. Mohn. 1991. Preliminary investigations of juvenile scallops (*Placopecten magellanicus*) in Nova Scotia inshore habitats. Can. Manuscr. Rep. Fish. Aquat. Sci. 2123: 38p.

On a procédé à une campagne d'évaluation de la population de pétoncles côtiers de 1984 à 1988. Les observations effectuées lors de cette campagne sont résumées ici, ainsi que les résultats des expériences de marquage et d'encagement, de l'étude de la structure de la population de juvéniles et d'un relevé automnal du naissain réalisés en 1989 à un site de la côte est de la Nouvelle-Écosse.

INTRODUCTION

During the summer and fall of 1989, a number of research initiatives were begun with the purpose of identifying viable research directions in the study of the ecology of juvenile scallops (*Placopecten magellanicus* Gmelin 1791). Much of the data collected is of interest, as so little is known of the early life stages of this species in the wild.

Previously, a survey of inshore scallop populations had been carried out under the direction of Dr. R. K. Mohn (1984-1988, Dept. of Fisheries & Oceans, Halifax). The purpose of this survey was to identify potential aquaculture sites for this species by locating areas of recurrent natural spat settlement. The first stage of this project was to synthesize this survey information. Once collated, this data provided information on scallop population size, structure and habitat preference along the Eastern shore, South shore and Atlantic coast of Nova Scotia. Only a few sites showed that juvenile animals appeared over successive years. From these locales, field excursions established a suitable site at which preliminary ecological studies were initiated. These included tagging and caging experiments as well as documentation of juvenile population structure and a fall spat survey. The results of these investigations, and the collated inshore scallop survey results are detailed below.

METHODS AND RESULTS

INSHORE SCALLOP POPULATION SURVEY

During the period of 1984 to 1988 inshore scallop populations were surveyed. In August and September of each summer, SCUBA divers visited the 34 locations listed in Table 1. Not all sites were visited every year. At each site, scallops were collected by a pair of divers swimming side by side in a search pattern. Particular attention was paid to find small scallops less than 60mm in shell height (the distance from the centre of the hinge to the maximum projection point on the rim perpendicular to the hinge). The swims were timed, and the abundances were recorded as the number of scallops collected per dive duration. Observations on depth and substratum at which the scallops occurred were noted. Shell height was measured on all captured animals.

Table 2 gives a summary of the observations taken at each site in the survey. Maps of each area can be found in Appendix A.

The descriptions of the bottom type are often inconsistent from year to year. This may be due to a failure to hit the same location within a general area on repeat visits.

Frequency distributions of the shell height data of most of the survey collections are presented in Appendix B. Collections were grouped by general area (see Table 1) when samples from successive years could not be combined by site. The Mushaboom Harbour sites were only sampled in 1984 (Appendix B, Figs.1B, 2B, 10B). Figure 1B shows that three of the sites show different modal values which may indicate a different settlement date, or different growth rates within the Harbour. Yearly returns to the same site (Appendix B) show that there are fluctuations in the abundance of juvenile scallops from year to year, but that in almost all cases settlement was recurrent. This is particularly striking in the comparison of shell height data from scallops caught at Sheet Harbour, SALIS 2, in figure 4B. Many more juveniles were found in 1985, as compared to 1984 and 1986.

Of the various bottom types sampled in the survey, the juveniles were found most abundantly on gravel bottoms. The mean number of juveniles per sample on this type of bottom was 69. Gravel and cobble bottoms were the next most prevalent habitat, with a mean

number of 35 animals found per sample. Juveniles were also found on gravel-silt, gravel-sand, gravel-rock and on gravel boulder substrata with mean numbers ranging from 5-12. Silt bottoms also supported small numbers of juveniles (mean 6/sample), particularly if interspersed with rock (mean 10/sample) but also with sand (5/sample). A few juvenile animals were found on cobble-rock and bedrock ledge areas (4/sample in both cases).

From this inventory, seven sites from five areas (where juvenile scallops were found repetitively) were selected as potential study sites.

The largest number of juvenile scallops in the survey were found at Second Peninsula, Lunenburg (S1), (particularly at site 31) on a mostly gravel bottom.

The greatest numbers of juvenile animals on the Eastern Shore were found at Sheet Harbour (E2) at the SALIS 2 (#9) site. Other locations selected as potential study sites are listed below. Bay of Islands (E3), sites 15 and 16, around Calf Island, had large numbers of small animals. These sites are characterized by a silty bottom with eelgrass beds. In Necum Teuch Harbour (E4) the best site for juvenile scallops is site 19, the only site on the east side of the bay. The bottom type there is a cobble and gravel matrix. In Liscomb Harbour (E5) the best sites for juvenile and adult scallops are close to Wilson Pt. (sites #23 and #25). These sites are relatively sheltered compared to the outside area (E6) which was sampled only in 1984 and yielded mostly large scallops from a gravel and cobble bottom.

The second location visited was Sheet Harbour (E2: SALIS 2), and it proved to have suitable habitat diversity and juvenile abundance to be used for preliminary experimental studies. Furthermore the scallops were concentrated around an island and along a narrow band of gravel on the adjacent shores. This was considered to be a good limiting factor for controlling movement of marked animals if bottom type proved to be a factor in juvenile distribution. A mussel aquaculture farm is located near the SALIS 4 site reinforcing the potential for spat collection.

JUVENILE SCALLOP DISTRIBUTION AT SALMON ISLAND, SHEET HARBOUR, NOVA SCOTIA

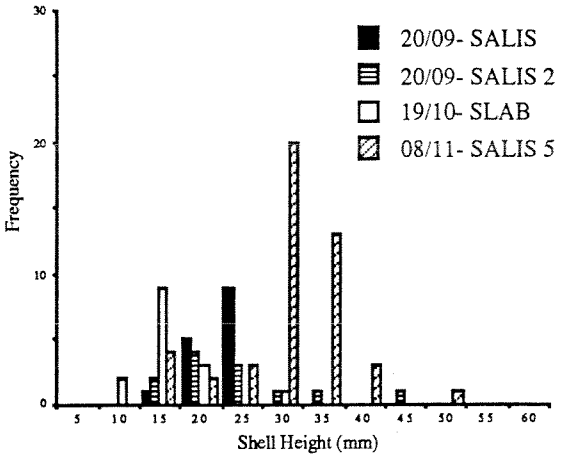


Fig. 1. Frequency distribution of shell height of juvenile scallops collected at different sites surrounding Salmon Is. in the fall of 1989.

The study area chosen was around Salmon Island in the middle section of Sheet Harbour (Table 1, area E2), on the Eastern Shore of Nova Scotia. Nine dives were made from the 17th of July to the 8th of November 1989 (Table 3). Table 3 lists the collection date, search (dive)

time and number of juvenile scallops found at each site. Mean shell height of the juvenile scallops collected on each of these trips is given in Table 4. Only animals with shell height < 50 mm are included. Figure 1 shows the frequency distributions of these shell height data.

Small scallops were found on the muddy substratum location (SALIS 2). In July the mean height was 10.5 mm with a skewed frequency distribution (Fig. 2). By mid-October the animals had increased shell height by approximately 10 mm.

A second site, on the north-west side of the island (SALIS 5) was visited twice: late in the summer and in the fall. This area is characterized by boulders and gravel with sand and silt patches. The first collection was done during a short dive when adults (Fig. 3) were collected as well as juveniles. The average size of the juveniles was 13.2 mm on Aug.4. A greater number of juveniles was found during a longer dive in the fall, when average size reached 27.2 mm. The number of scallops found per minute was equivalent at both times.

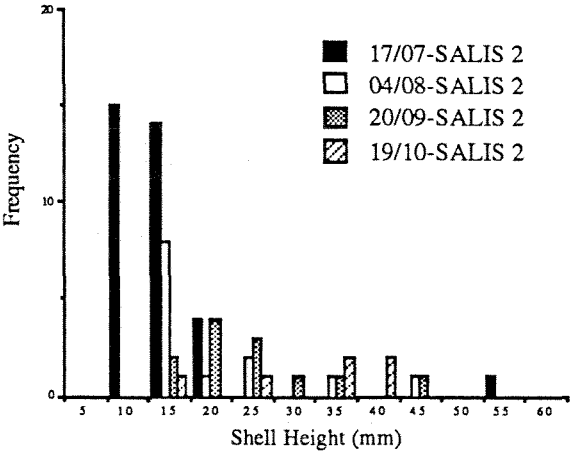


Fig. 2. Frequency distribution of shell height of juvenile scallops collected on muddy bottom, N.E. Salmon Is.

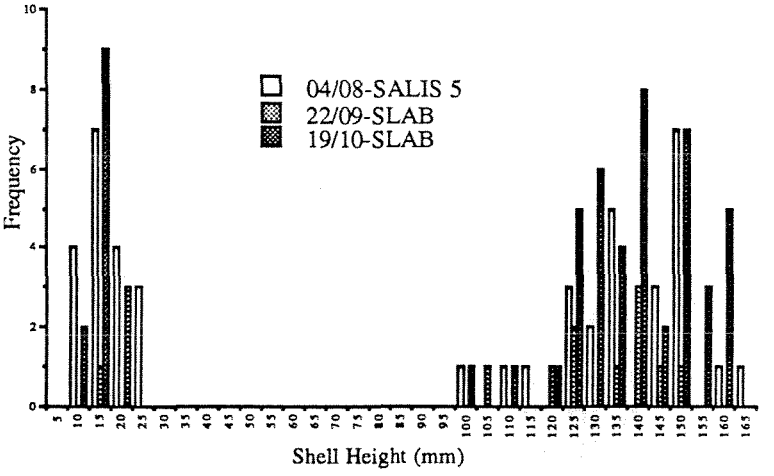


Fig. 3. Frequency distribution of shell height of scallops collected at two sites in Sheet Harbour, N.S.

During a short dive at the deeper gravel location across the harbour (SLAB) on Sept. 22, a single juvenile was observed and a small number of adults were found (Table 3) and figure 3.

The second sampling effort at this site was longer and 15 juveniles were found sporadically during the 50 min. dive. This area was characterized by occasional patches of rocks and seaweed along a gravel strip at 15 m depth. The average size of the juveniles was 17.9 mm. The frequency distribution is shown in figure 3. It would appear that a failure in recruitment occurred to produce the gap between small animals and adults.

The only 1989 collection made on the gravel bed south of Salmon Island (SALIS) was done on Sept. 20. The average size of the 15 juveniles found was 19.9 mm . The scallops showed very little range in size (Table 4).

The frequency distribution of the total scallop population collected at SALIS 5 and SLAB are shown in figure 3.

Table 4 gives the average shell height of juvenile scallops collected during the 1989 field season.

PRELIMINARY STUDIES OF JUVENILE GROWTH

Placopecten magellanicus is known to spawn in the fall on the Atlantic offshore banks. There is a hypothesis that an additional spawning season in the spring may occur in inshore populations. Recent work by Dadswell *et al.* (unpublished, 1990) supports this hypothesis and suggests that differential growth rates among summer and fall spat will result in a blend of cohorts in the size frequency distribution of a sample. Monitoring the size of scallops collected from the wild at different times of the year and the growth of juveniles maintained in the aquarium simultaneously, provides some background information on the conditions of early growth at Sheet Harbour and whether size range can be due to different growth rates within a given cohort.

All juvenile animals observed during most dives in 1989 were captured and returned to the laboratory in coolers containing ice packs. Animals were maintained in aquaria at ambient sea temperature of the Halifax Harbour water until returned to the site. During the summer, the juveniles were fed only food available through the seawater system. For longer periods of maintenance, during the winter months, they were fed approximately 40 L of phytoplankton culture (*Chaetoceros gracilis, Isochrysis sp.*) 3 times a week.

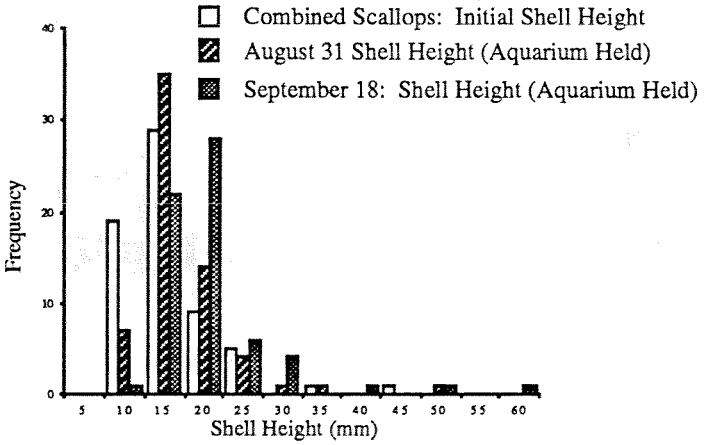


Fig. 4. Frequency distribution of shell height of juvenile scallops from SALIS 2 and SALIS 5 and during growth in aquarium.

The first group of juveniles to be monitored in the aquaria were collected (at sites SALIS 2 and SALIS 5) during the first two outings and measured twice subsequently (Table 5). From August to September, average size increased from 12.7 to 17.8 mm under aquarium conditions. Therefore growth was approximately 5 mm over a 50 day period. Figure 4 shows the frequency distribution of the initial size measurements and of the two successive height measurement data sets.

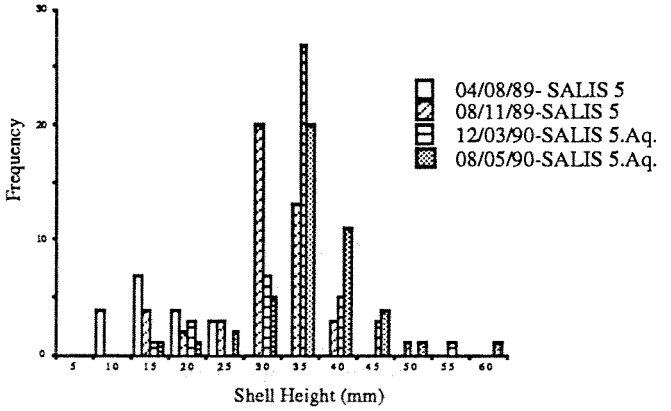


Fig. 5. Frequency distribution of shell height of juvenile scallops collected on gravel bottom, N.W. of Salmon Is. and maintained in aquarium over winter.

A second group of 46 juvenile scallops was collected at SALIS 5 on Nov. 8 and maintained in aquaria over winter. The average height of this group of juveniles went from 27.2 mm to 32.7 mm or 5.5 mm in 6 months. Figure 5 shows the shell height frequency distribution of the two collections from SALIS 5 in late summer and the successive remeasurements the following spring.

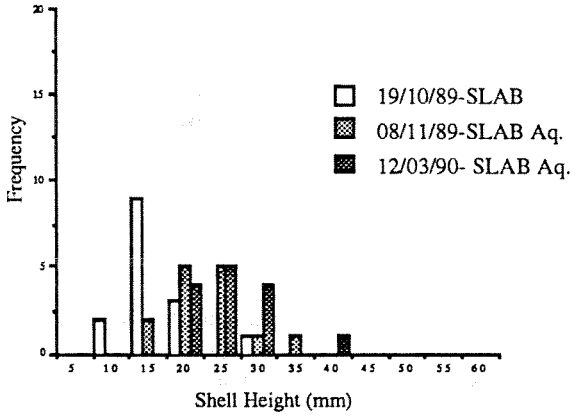


Fig. 6. Frequency distribution of shell height of juvenile scallops from Slab Pt. and during growth in aquarium.

A group of 20 juveniles collected at Slab Pt. on Oct. 19 were maintained *in situ* in lantern net type enclosures at two sites (SALIS and SALIS 2) in order to compare growth rates of known animals in the field to those in aquaria. The size and number of scallops at the beginning and the end of the period of outplant is given in Table 6. Mortality was low at the SALIS 2 site. Only one of the ten died. At SALIS on the outside of the island, predation was assumed to be the cause of death of four of the five scallops placed in the enclosure resting on the bottom. The shells were finely cracked and the animals apparently consumed.

The observed difference in the average height of these animals was 2 mm over a 20 day period. The animals were then returned to Halifax and monitored in the aquarium over the winter. Growth was from an initial average of 19.9 mm to 23.1 mm at the end of 6 months. This represents an average growth of 3.2 mm over winter which is much reduced from the observed summer growth, but comparable to that recorded on the SALIS 5 over-wintered scallops. A frequency distribution of the shell height measurements over time is shown in figure 6.

RELEASE-RECAPTURE EXPERIMENT

Tagging

Various methods of tagging were tested on animals maintained in captivity. These included a latex underbody paint with a plastic fixative, acrylic paint (Tamiya color- X6), a marine enamel paint, and plastic flagging tape pieces glued on with Krazy ® glue.

The method of marking with a plastic tape fixed with Krazy glue was used for trial in the field. Release of tagged juveniles and subsequent searches were carried out during successive dives according to the schedule described in Table 7. Dive time is an estimate of the time period of the searches to attempt to recapture tagged juveniles. Of the 64 tagged animals released at the mud substratum location (SALIS 2) on Sept. 20, three were found dead near the site of release and one was found alive approximately 100 m north during the 40 min survey on Sept. 26. Another survey at this site (Oct. 2) yielded two tagged juveniles within a 10 m perimeter of the release site.

A dive on Sept. 26 at the adjacent site, on the south side of the island (SALIS) did not yield any recaptures. On Oct. 2, another group of 30 tagged juveniles were released at the gravel (SALIS) site near the mussel collector's anchor. There were no tagged juveniles found at this location during a 20 min. dive, on Oct.19. Swimming a transect in the S.W. direction down to a depth of 15 m indicated that this gravel bed is restricted to a limited area at 8-10 m depth and surrounded by mud, except for the approach to the island where some large rocks are found. A sharp change of bottom type was observed between this area and the adjacent muddy site (SALIS 2). None were recaptured during later collections at SALIS 2, SALIS 5 and SLAB.

SPAT COLLECTION

After successfully locating juvenile scallops at these Sheet Harbour locations, an attempt was made to see if spat could be located in the same vicinity as the juveniles. Two locations were sampled near Salmon Island in Sheet Harbour. Spat collection was done in late September using Japanese spat bag collectors with a mesh size of 3 mm, measuring 42 x 75 cm, and containing 9/13 monofilament gillnet . Bag weight was standardized to 600g per collector. Collectors were attached at three depths (1 bag per depth) to a rope tied to the main line which was anchored at 10m depth. Collectors were set out at 3 dates over a 10 day period and retrieved 38 days after the last set was positioned.

Samples are identified according to three parameters:

1) Location-SALIS 2-Inside (I) the island is a more sheltered site where the bottom is mostly silt with a few rock outcrops. -SALIS-Outside (O) the island is more exposed and a gravel bed ultimately offers a different substratum for settlement. Collectors were attached to a single line anchored at each site.

2) Position-Collectors were placed at 3 positions relative to the bottom: (B) was approximately 1 m from the bottom. (M) was approximately 3 m from the bottom and (T) was approximately 5 m from the bottom (and breaking surface).

3) Time: A series of 3 bags were put out over a period of 2 weeks starting on Sept. 22 and retrieved on Nov. 8. The first set was left in place for 47 days. The second set was in on Sept. 26 and left for 43 days. The third set was in on October 1 and left for 38 days.

Therefore, a given collector put in at SALIS (O), 3 m off the bottom (M) on Sept 22 is identified as OM1.

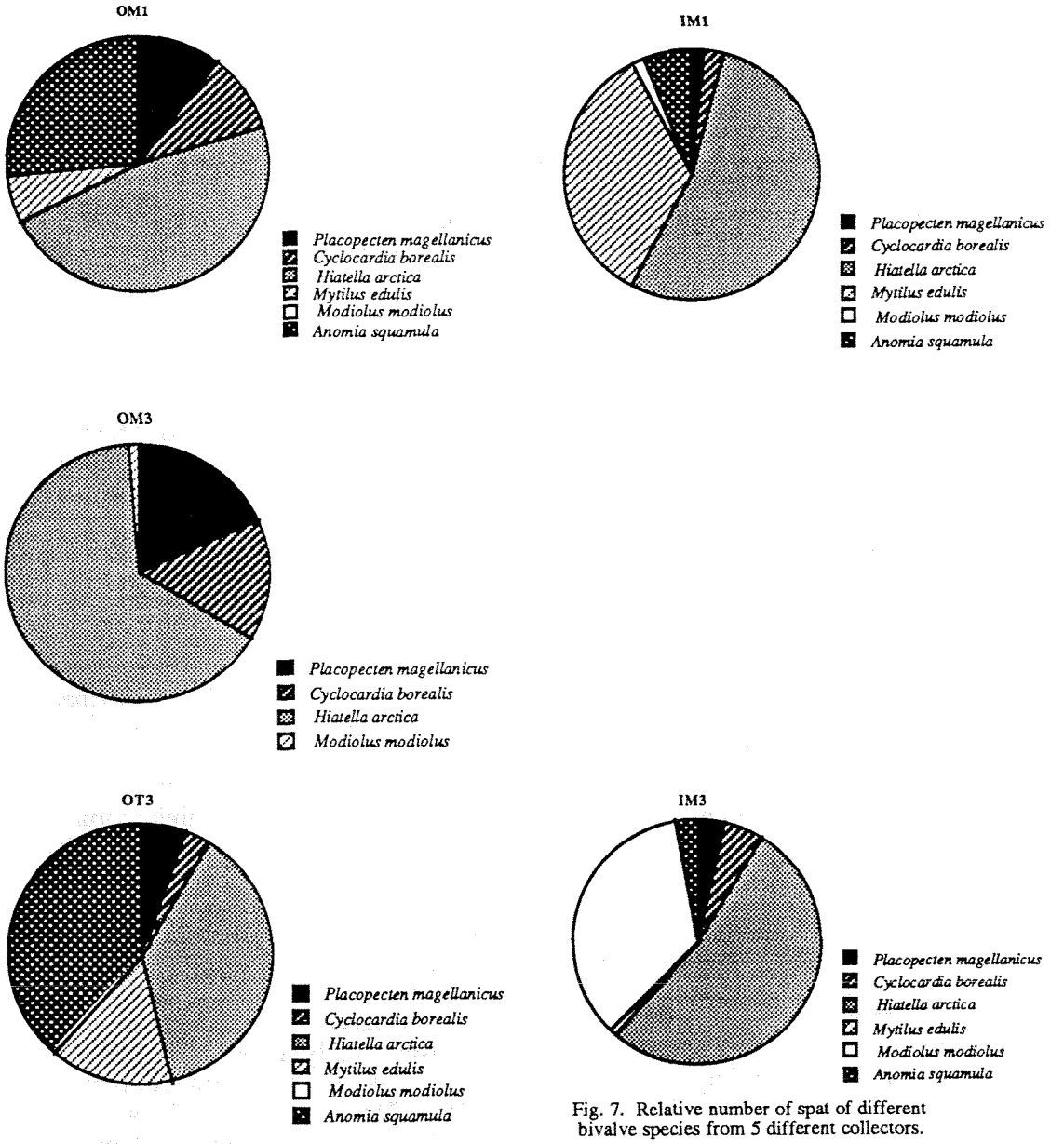


Fig. 7. Relative number of spat of different bivalve species from 5 different collectors.

Spat bags were cleaned and the content sorted on 500 and 330 micron sieves. Material was preserved in 70% ethanol until counts could be done using a dissecting microscope. One bag (IT3) was kept in running seawater in an aquarium in order to observe growth and obtain larger bivalve specimens for taxonomic verification. This bag was cleaned on Feb. 22, 1990.

Partial results from the spat collection are presented in Table 8 as the number of scallops found in 5 samples with reference to the location and position in the water column. Due to the length of time required to sort and identify the collections, only 5 of the bags were fully processed (Tables 8, 9). Counts of all bivalve spat collected were done on these samples. Pie charts (Fig. 7) illustrate the proportion of each species in each sample. Other taxonomic groups observed in the collectors were bryozoans, hydrozoans, foraminifera, gastropods, spirorbid worms and polychaetes. *Hiatella arctica* was the most abundant species collected.

At the time of setting up the collectors, temperature observations showed that the thermocline was breaking up. Surface temperature went from 18°C on Sept. 22 to 16.5°C on Sept. 26 and to 11°C on Nov. 1.

The counts of scallop spat are higher on the SALIS (Inside) than on the SALIS 2 (Outside) location in 4 out of 5 collectors (Table 8). However, the proportion of scallops as opposed to other organisms is lower on the inside collectors. The third (time) sets have more scallops than the first sets in the collector hanging in the top and middle position at this inside location. The collector OB3 was lost at sea. It appears that the collectors hanging at 5 m off the bottom caught more spat than the 3 collectors at the lower position at the outside location.

SUMMARY

There are variations in the size structure of groups of juvenile scallops collected at different sites around Salmon Island in Sheet Harbour as was found in the 1984 survey of Mushaboom Harbour. However, the number of animals found, and the number of sites visited within a comparable time frame were minimal. The inside silty location (SALIS 2) appears to have more animals early in the summer while the outside gravel areas (SALIS 5, SLAB) appear to have greater numbers in the fall. This may indicate a movement of the scallops to a different substratum and/or depth, however this would require further investigation to confirm. A preference for gravel substrata was indicated from the survey, and somewhat supported from the Sheet Harbour data.

Because scallops are actively swimming as juveniles and the various habitats described above are at close proximity, repetitive observations and collection at different sites provides a preliminary view of the habitat preference of young scallops. Tagging experiments should map the movement patterns and dispersion of juvenile scallops from one area to another. The release-recapture experiments indicate wide movement of the small scallops, high mortality or both. Future experiment should use greater numbers of tagged animals and more intensive searches shortly after release.

The spat collection was successful at both sites. Slightly greater numbers were found at the SALIS 2 location than on SALIS. The abundance of other species of bivalves varies from one collector to the other, and it appears that the proportion of scallops is larger on the SALIS collectors than on those from SALIS 2. The number of post- larvae on these sites after settlement may be large enough that density could be measured early in the spring and survivorship monitored. The ability to collect spat from an area which showed recurrent juvenile abundances enhances the value of the survey data. This suggests that the juveniles may not be moving far from the areas in which they settle at least in these inshore bays, and that their presence indicates at least the potential for spat collection at the same locale. Such sites may be important in locating sources of spat for scientific and commercial purposes, while the survey of the juveniles marks out potential bottom culture sites for this species.

Table 1. List of sites and their general locations from the inshore scallop populations survey (1984-1988).

Area Code*	Site Number	Site Name	Location
E1	1	BOUT	South end Boutilier Is.
	2	GULL	North Gull.Is
	3	LAW	North of Lawrence Is.
	4	MUSH1	NW Mushaboom Hbr. channel side of Is.
	5	MUSH2	NW Mushaboom Hrb. other side of Is.
	6	GATES	N side of the Gates
E2	7	CHPT	Ward Pt.
	8	SALIS	South end of Salmon Is.
	9	SALIS2	Between mainland and SE Salmon Is.
	10	SALIS3	Between mainland and NE Salmon Is.
	11	SALIS4	N end of Salmon Is.
	12	SALIS5	NW end of Salmon Is.
	13	SLAB	Slab Pt.
E3	14	BAPT	W Baptiste Is.
	15	CALF	NE Calf Is.
	16	CALF2	S Calf Is.
	17	LOBIS	S Lobster IS.
	18	SNOCA	N ledge between Snow Is. and Calf Is.
E4	19	CALF3	Between Calf Is. and Lang Is.
	20	CHMAC	Between MacDonald Is. and mainland
	21	MAC	Between MacDonald Is. and Torpey Is.
	22	WHIT	Off gravel beach off White Is. Bay
E5	23	LISCO	N Liscomb Hrb. off Wilson Pt.
	24	LISCO4	N Liscomb Hrb. off Fox Pt.
	25	LISCO3	N Liscomb Hrb.-East of Wilson Pt.
	26	LISCO2	N Liscomb Hrb.-channel off Fox Pt.
E6	27	HEM3	W Hemloe Is.(green Buoy to rock ledge)
	28	HEMIS	S Hemloe Is. by Gravel Pt.
	29	SHAGL	Shag Ledge
S1	30	SECPEN 1	E Fifty Acres Is.
	31	SECPEN 2	NE Mason Is.
	32	SECPEN 3	W Mason Is. (Graveyard Bay)
	33	SECPEN 3A	SW Fifty Acres Is.
	34	SECPEN 4	E Mason Is.- off Hebb Pt.

*Area codes: Eastern shore- E1= Mushaboom Harbour,E2= Sheet Harbour, E3= Bay of Islands,E4= Necum Teuch Harbour,E5= Liscomb Harbour,E6= Hemloe Island; South shore- S1= Second Peninsula.

Table 2. Description of sites and the number of scallops found (by size groups) in the inshore population survey (1984-1988).

Site	Bottom Type	Depth (ft)	Number/size class <60	60-100mm	>100	Date
1	silt	2-30	1	20	58	21/08/84
2	boulder, silt	10-40	0	0	52	21/08/84
3	rock, silt	30-40	1	5	81	21/08/84
4	silt	30-40	0	4	82	20/08/84
5	silt	30-40	1	0	23	20/08/84
6	gravel, silt	15-20	0	1	75	21/08/84
7	gravel, silt	20-30	2	0	1	23/08/84
8	gravel, silt	20-30	0	6	58	23/08/84
8	gravel, silt	20-30	2	3	14	10/09/86
8	rock, silt	30	1	0	0	28/08/87
9	rock, silt	20-30	5	2	3	23/08/84
9	rock, silt	25-30	70	6	15	10/09/85
9	rock, silt	15-30	12	1	0	04/09/86
10	rock, silt	10-20	1	4	1	23/08/84
10	silt	25-35	29	5	24	10/09/85
11	rock, silt	20	3	0	27	23/08/84
11	cobble,silt	25-30	10	2	35	10/09/85
11	silt	20-30	1	3	30	04/09/86
11	gravel, sand	25-30	10	1	4	28/08/87
12	cobble, sand	20-40	1	19	89	21/08/84
12	gravel, silt	20-30	0	33	50	11/10/84
13	cobble, sand	25-30	0	3	47	21/08/84
13	gravel,rock	25	0	9	85	24/09/85
13	cobble	25	0	0	9	04/09/86
13	gravel,rock	20	0	2	7	28/08/87
14	silt	20	2	9	89	27/08/84
15	silt,sand	10	6	38	62	28/08/84
15	silt,sand	5-15	8	23	39	12/09/85
15	silt,sand	20	6	34	60	09/09/86
15	silt,sand	10	4	7	18	01/09/87
16	silt,sand		7	99	108	27/08/84
16	silt	5-15	8	38	45	12/09/85
16	gravel, silt	5-18	8	23	43	09/09/86
16	silt,sand	10	1	10	19	01/09/87
17	rock,ledge	10-15	4	26	70	28/08/84
17	gravel	20	5	41	33	09/09/86
17	gravel,rock	15	3	5	1	01/09/87
18	gravel,cobble	10-20	0	10	39	28/08/84

Table 2 cont'd. Description of sites and the number of scallops found (by size groups) in the inshore population survey (1984-1988).

Site	Bottom Type	Depth (ft)	Number/size class <60	60-100mm	>100	Date
19	gravel,cobble	15	1	32	69	30/08/84
19	gravel,cobble	25	15	21	22	10/09/86
19	gravel,cobble	20-25	12	43	23	03/09/87
20	gravel,boulder	15	7	17	41	30/08/84
20	gravel,cobble	15	2	14	2	10/09/86
20	cobble,silt	12	8	15	5	03/09/87
21	gravel,cobble	15-30	2	6	21	30/08/84
21	rock, silt	30	1	14	36	10/09/86
21	gravel,boulder	25	10	32	19	03/09/87
22	cobble,rock	20-30	4	2	36	12/08/85
23	boulder,silt	15-20	8	16	35	04/09/84
23	rock, silt	15-25	1	23	21	17/09/85
23	rock, silt	20-30	14	46	48	16/09/86
23	gravel	20	9	37	48	29/09/87
23	gravel,rock	20	12	29	59	29/09/87
24	silt,sand	10-35	3	4	7	04/09/84
24	silt	20	1	6	2	17/09/85
24	silt	30	0	8	2	16/09/86
24	silt	20	5	6	7	29/09/87
25	gravel, silt	15-20	14	56	61	17/09/85
26	gravel, silt	40	5	7	15	16/09/86
27	gravel,cobble	15	1	3	19	04/09/84
28	cobble	10	0	6	86	04/09/84
29	gravel,cobble	40	0	2	6	04/09/84
30	gravel, silt	20	2	25	49	10/09/84
30	gravel, sand		0	3	8	19/09/85
30	gravel, rock	25	10	19	19	18/09/86
30	gravel, silt	25-20	7	27	29	08/09/87
30	gravel, silt	25	26	72	38	02/10/87
30	gravel, sand	25-30	11	78	48	31/08/88
31	cobble,silt	40-45	26	223	18	10/09/84
31	gravel,cobble	40-50	23	138	4	19/09/85
31	gravel, silt	45	51	34	10	18/09/86
31	gravel,cobble	35-40	354	207	16	02/10/87
31	gravel	20-45	76	243	24	31/10/88
32	gravel	60-70	113	0	0	18/09/86
32	gravel	40-60	77	43	58	25/09/86
32	gravel	40-50	79	72	26	08/09/87
32	silt	30-50	20	55	22	31/08/88
33	gravel, silt	40	62	66	21	02/10/87
34	gravel	20-30	54	125	25	08/09/87

Table 3. Abundances of juvenile scallops collected at Sheet Harbour, N.S.

Date	Dive time (min.)	No. juvenile scallops	No/min dive	Location: Substrate
17/07/89	45	33	.73	SALIS 2: Inside- Mud
04/08/89	45	13	.29	SALIS 2: Inside- Mud
04/08/89	25	18	.72	SALIS 5: Outside- Boulder
20/09/89	30	15	.50	SALIS: Outside- Gravel
20/09/89	20	12	.60	SALIS 2: Inside- Mud
22/09/89	15	1	.07	SLAB: near buoy- Gravel and rock
19/10/89	30	6	.20	SALIS 2: Inside- Mud
19/10/89	50	15	.30	SLAB: west of buoy- Gravel and rocks
08/11/89	60	46	.77	SALIS 5: Outside- Boulders and gravel

Table 4. Average height (mm) of scallops collected at different sites at Sheet Harbour during the summer of 1989.

Date	Mean	s.d.	n	Site
17/07/89	10.5	3.0	33	SALIS 2*
04/08/89	17.3	10.3	13	SALIS 2
04/08/89	13.2	4.3	18	SALIS 5*
20/09/89	19.9	2.4	15	SALIS
20/09/89	22.2	8.1	12	SALIS 2
19/10/89	24.3	8.2	6	SALIS 2
19/10/89	17.9	4.9	15	SLAB *
08/11/89	27.2	7.0	46	SALIS 5

* when scallops of less than 50 mm were selected out of a larger sample

Table 5. Average height of groups of scallops maintained in the aquarium for various periods of time.

Date	Mean	s.d.	n	Site
Initial size	12.7	6.1	64	SALIS 2 & SALIS 5
31/08/89	15.0	7.9	64	Aquarium-SALIS 2&5
18/09/89	17.8	8.0	64	Aquarium-SALIS 2&5
8/11/89	19.9	4.9	14	Outplant -SLAB
12/03/90	23.1	6.0	14	Aquarium- SLAB
08/05/90	24.1	6.7	15	Aquarium- SLAB
12/03/90	30.9	7.5	46	Aquarium-SALIS 5
08/05/90	32.7	7.9	46	Aquarium- SALIS 5

Table 6. Size of scallops in outplant experiment, position of net relative to the bottom and location of anchor line relative to the island.

Location		Inside (SALIS 2)		Outside (SALIS)	
Date		19/10	08/11	19/10	08/11
Position	Scallop#	B		A	
Suspended 1 m off the bottom	1	16	-	21	22
	2	20	23	32	32
	3	17	20	17	19
	4	19	22	15	16
	5	22	25	15	17
Position	Scallop #	C		D	
On bottom	1	19	21	27	-
	2	16	18	26	-
	3	12	14	31	-
	4	16	17	20	20
	5	12	13	32	-

Table 7. Schedule for release-recapture experiment of tagged animals.

Location	Date	Activities
SALIS 2	20/09/89	released 64 tagged juveniles (combining 3 collections from July 17 and Aug 8)
SALIS 2	26/09/89	surveyed for 40 min
SALIS	26/09/89	survey for 25 min
SALIS	02/10/89	released 27 tagged juveniles (combining 2 collections from Sept 20)
SALIS 2	02/10/89	surveyed for 30 min using circular search pattern around anchor with 10m line
SALIS 2	19/10/89	surveyed for 30 min
SALIS	19/10/89	surveyed for 20 min (straight line in S.W. direction to 15 m depth)
SALIS 5	08/11/89	surveyed for 60 min

Table 8. Number of bivalve spat on different collectors placed at Sheet Harbour.

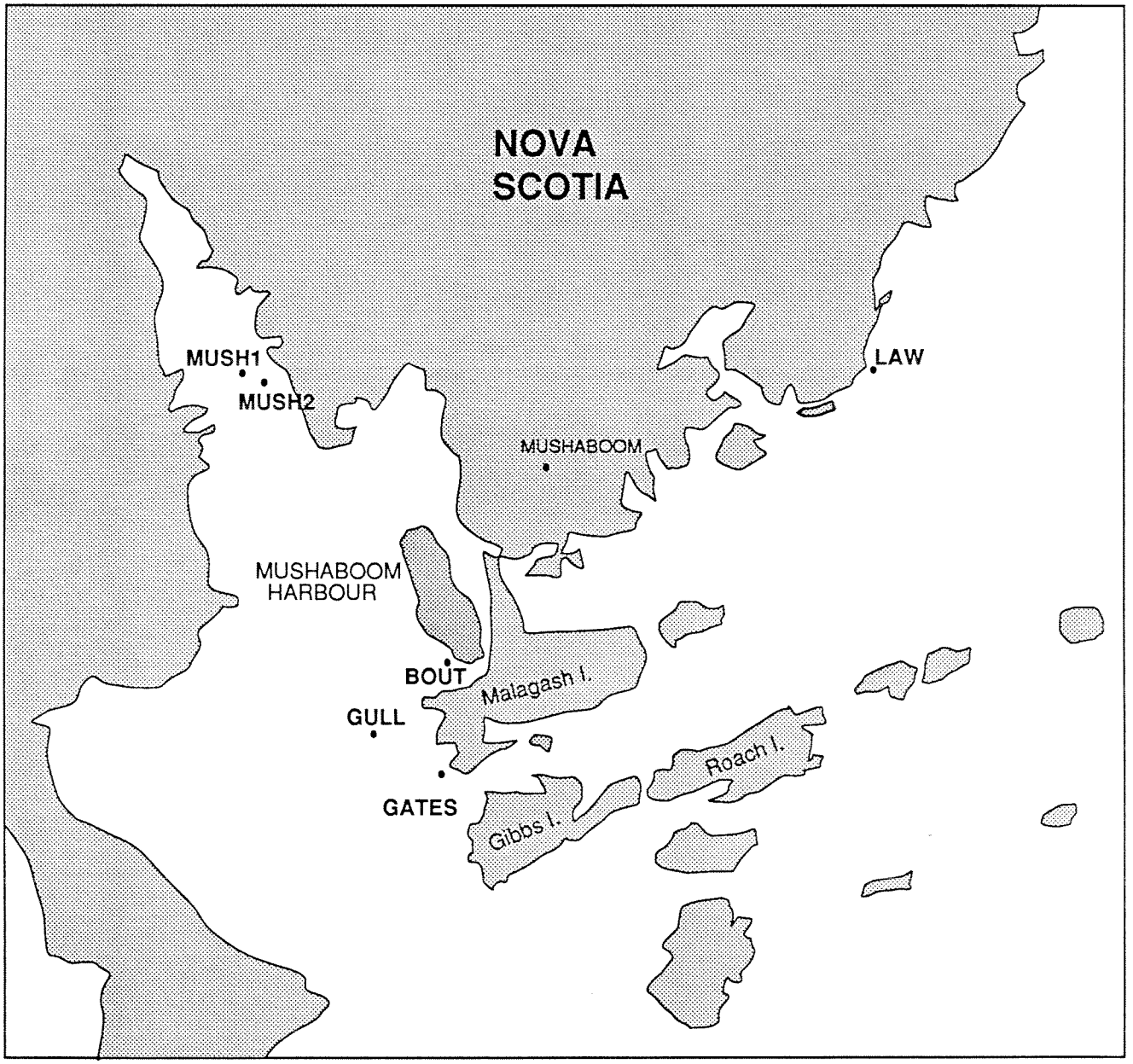
	Collector Identification Code				
Species	OM1	IM1	OT3	IM3	OM3
Placopecten magellanicus	56	115	116	171	20
Cyclocardia borealis	52	187	64	258	16
Hiatella arctica	218	3954	771	2540	70
Mya sp.	40	85	18	35	0
Mytilus edulis	34	2552	320	1678	1
Modiolus modiolus	0	137	0	132	0
Anomia squamula	144	444	803	185	12
Total	544	7474	2092	3999	119

Table 9. Relative percent of bivalve species found on each of the collectors at Sheet Harbour.

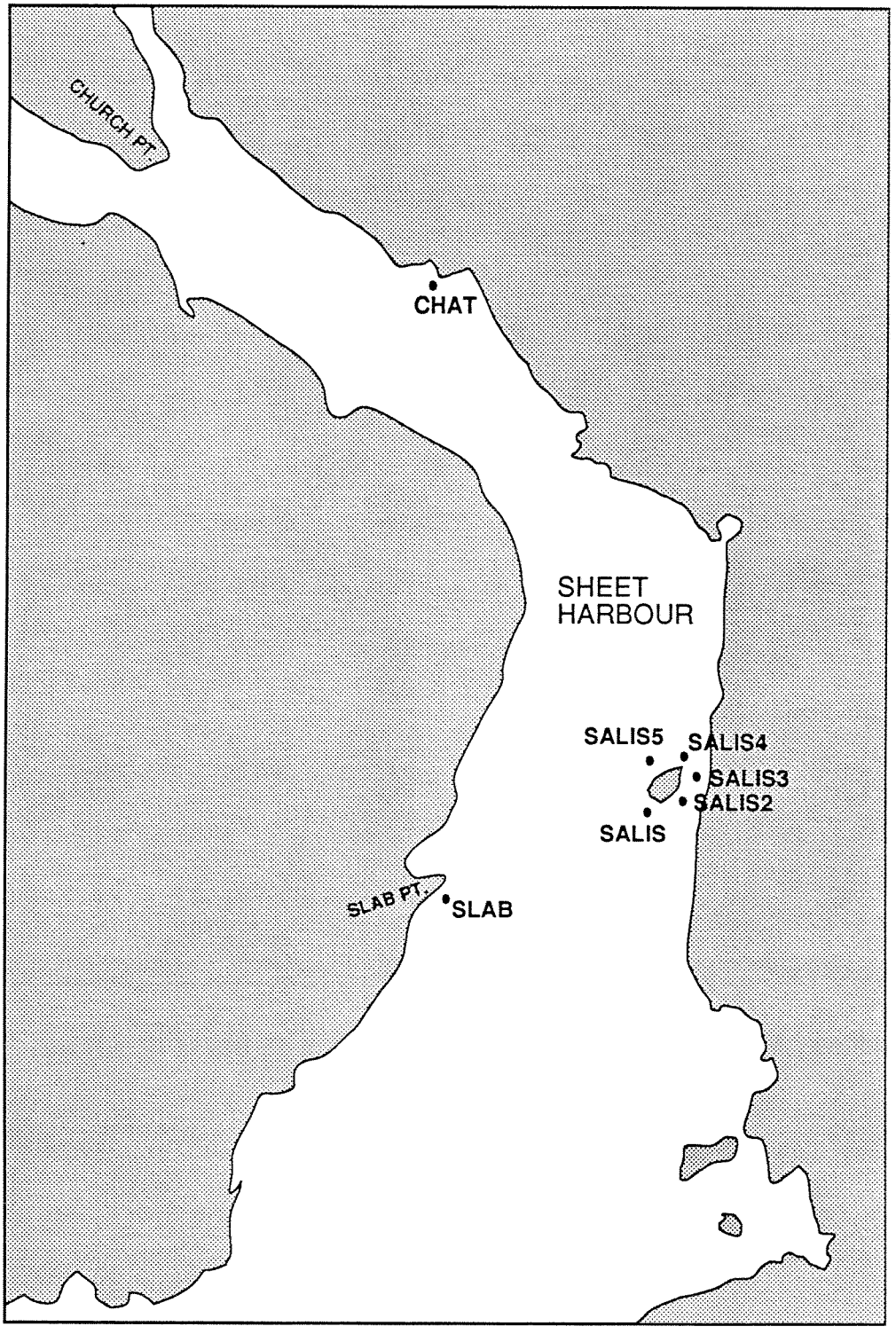
Species	OM1	IM1	OT3	IM3	OM3
Placopecten magellanicus	10.3	1.5	5.5	4.3	16.8
Cyclocardia borealis	10.1	2.5	3.1	6.4	13.4
Hiatella arctica	47.5	54.0	37.7	63.5	58.8
Mytilus edulis	6.2	34.1	15.3	42.0	1.0
Modiolus modiolus	0.1	1.8	0.1	3.3	0
Anomia squamula	26.5	5.9	38.4	4.6	10.1

APPENDIX A

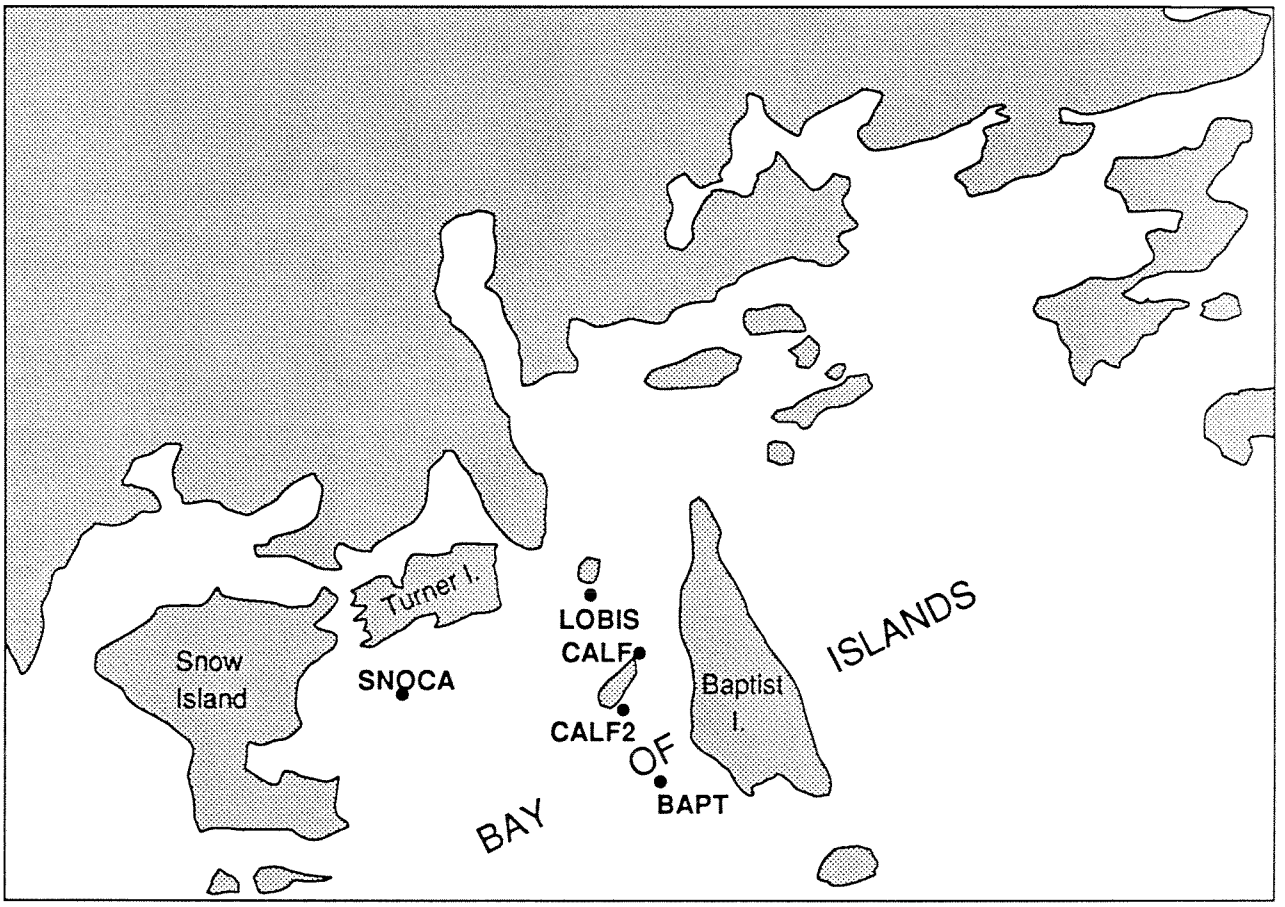
Reference guide to inshore survey sampling stations.



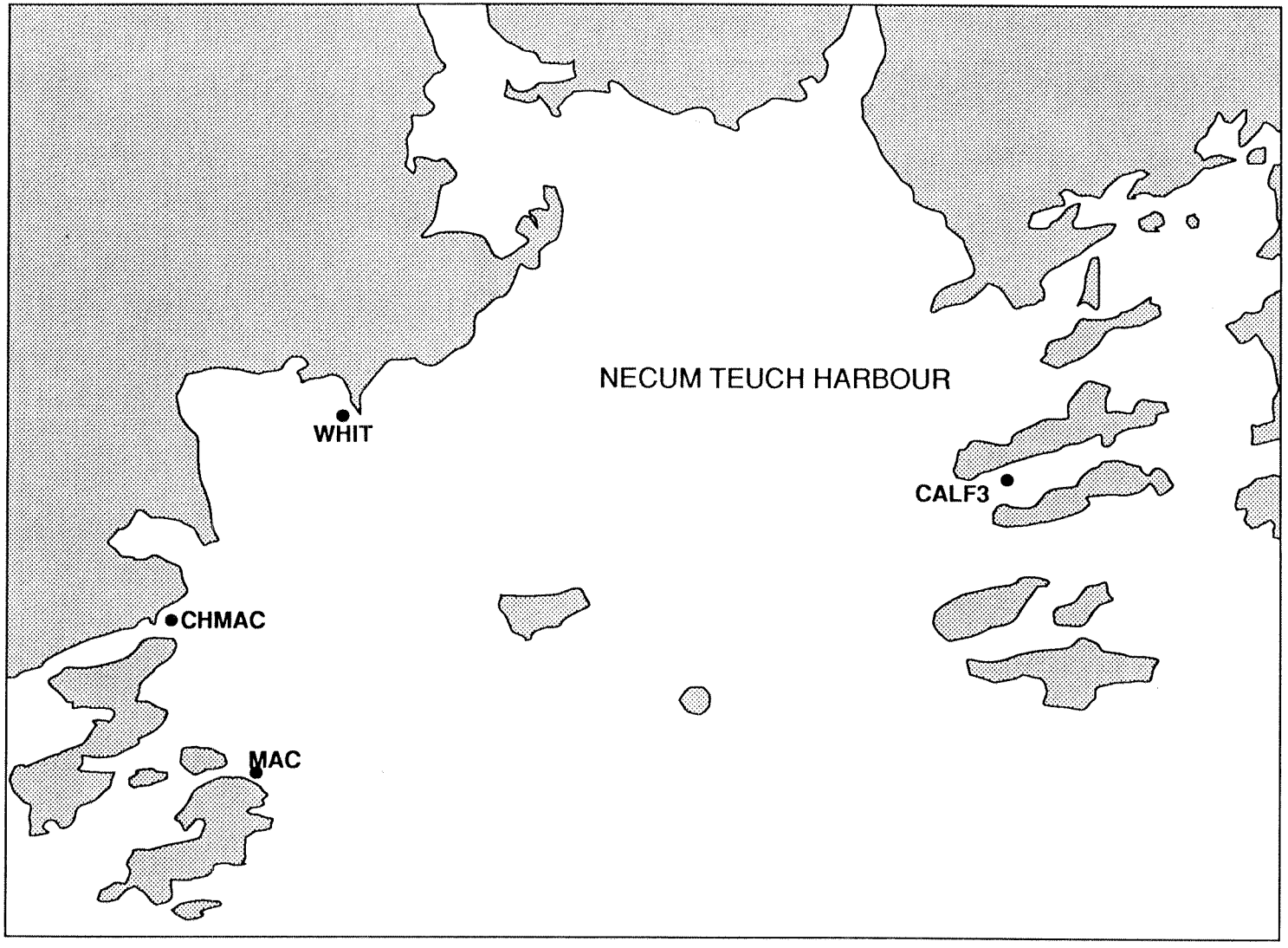
Appendix A. Figure 1A. Reference guide to location of sampling stations for the Mushaboom area (E1).



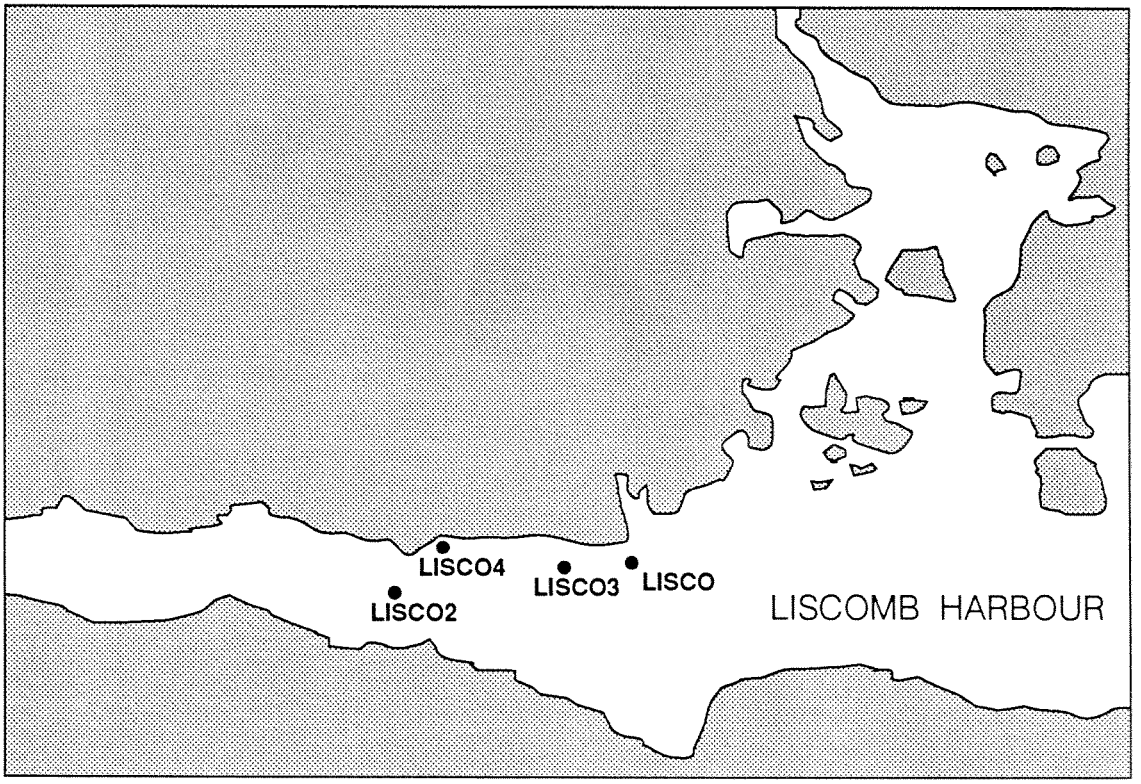
Appendix A. Figure 2A. Reference guide to the survey sampling sites in Sheet Harbour (E2).



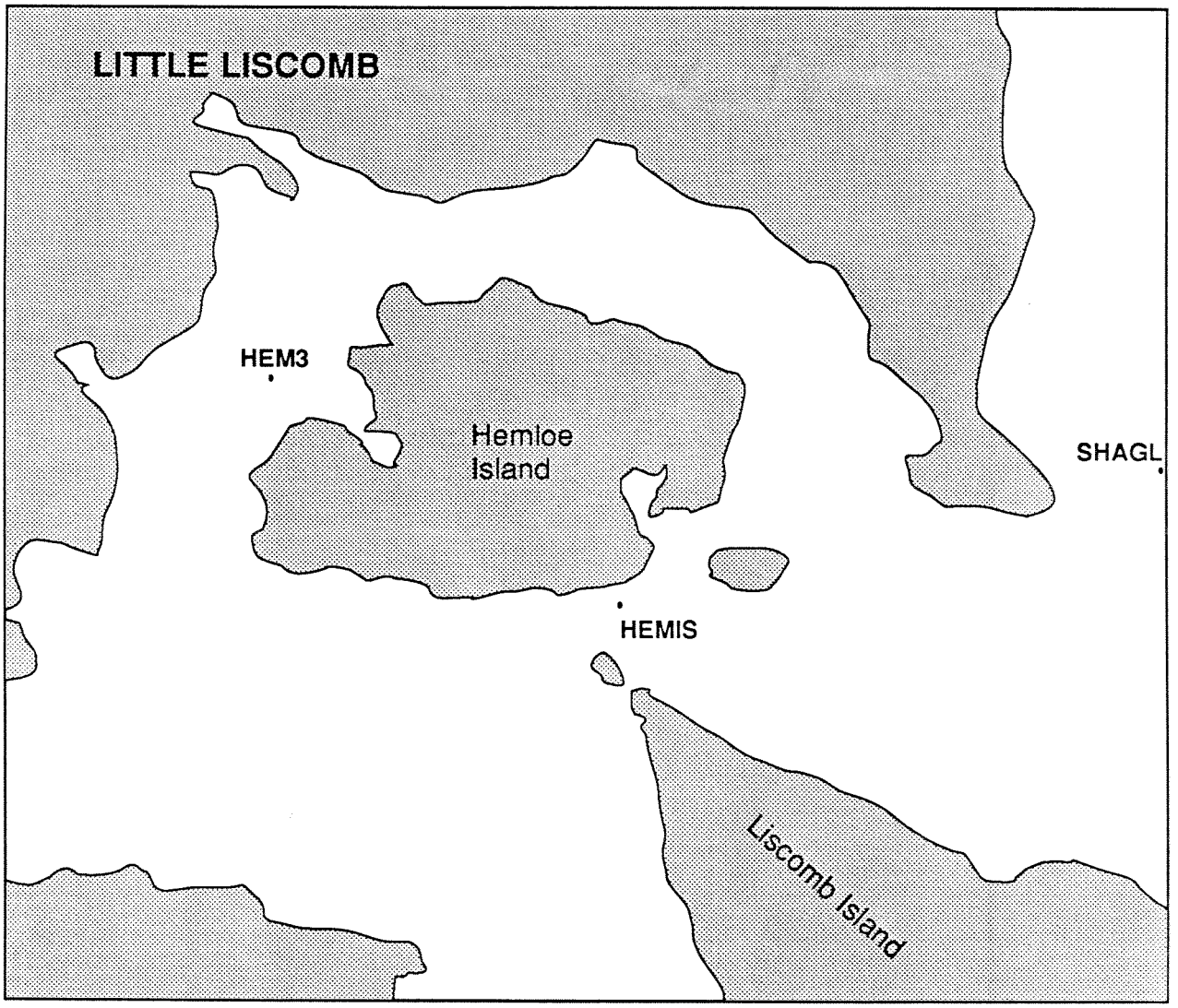
Appendix A. Figure 3A. Reference guide to the survey sites in the Bay of Islands area (E3).



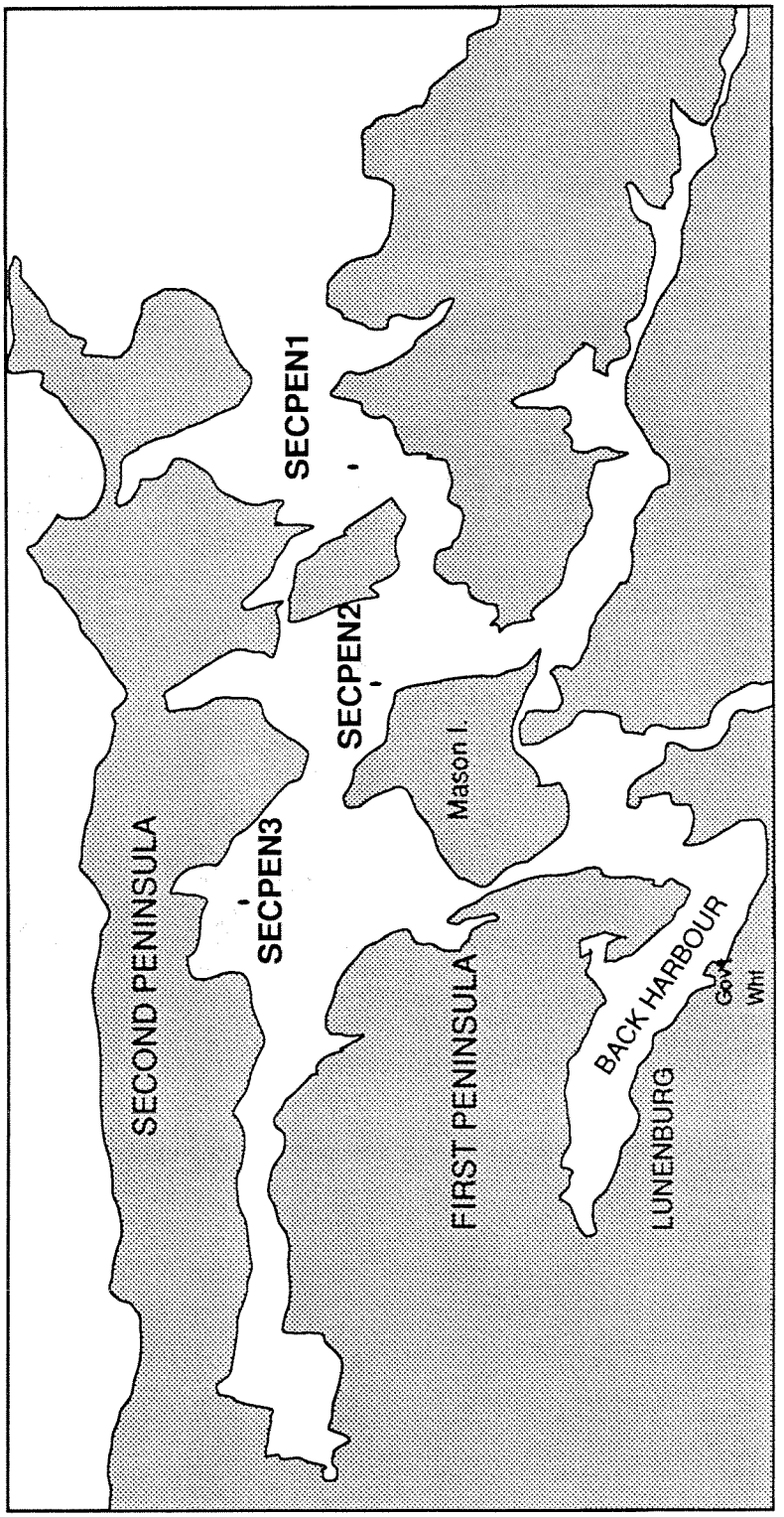
Appendix A. Figure 4A. Reference guide to the survey sites in Necum Teuch Harbour (E4).



Appendix A. Figure 5A. Reference guide to survey sampling sites in the Liscomb Harbour area (E5).



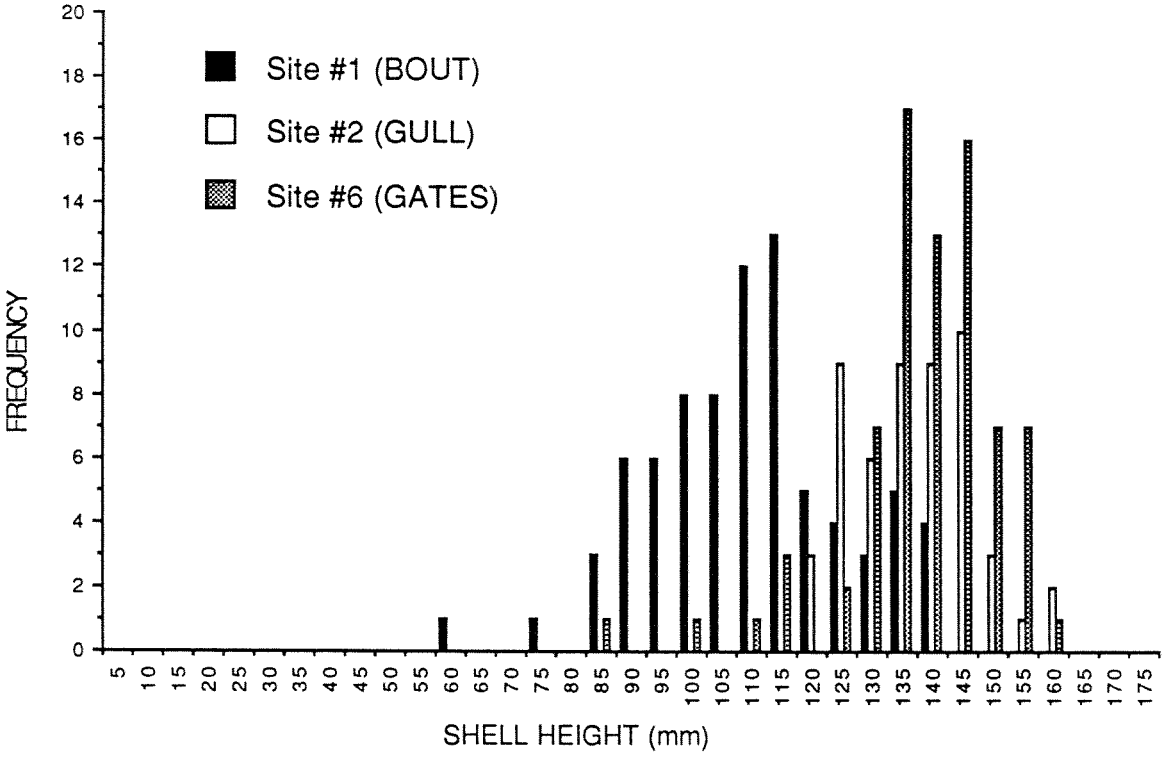
Appendix A. Figure 6A. Reference guide to survey sampling sites in the Hemloe Island, Little Liscomb area (E6).



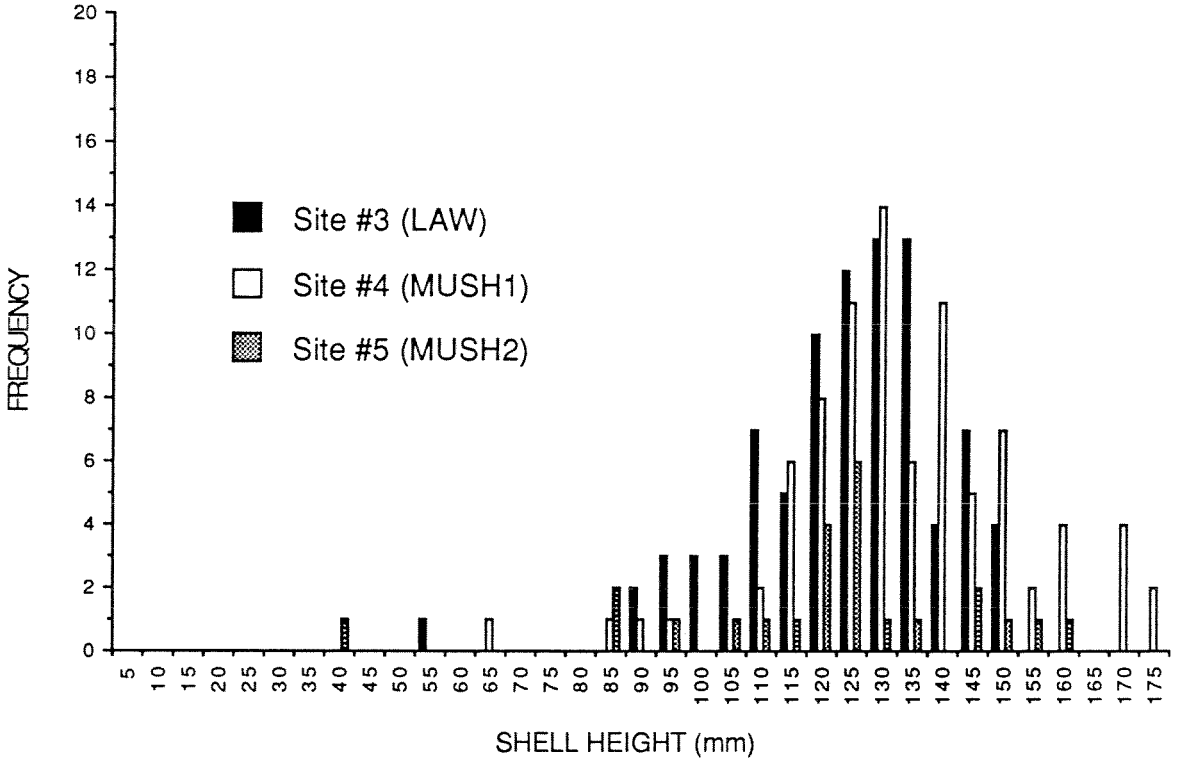
Appendix A. Figure 7A. Reference guide to survey sites in the Lunenburg area (S1).

APPENDIX B

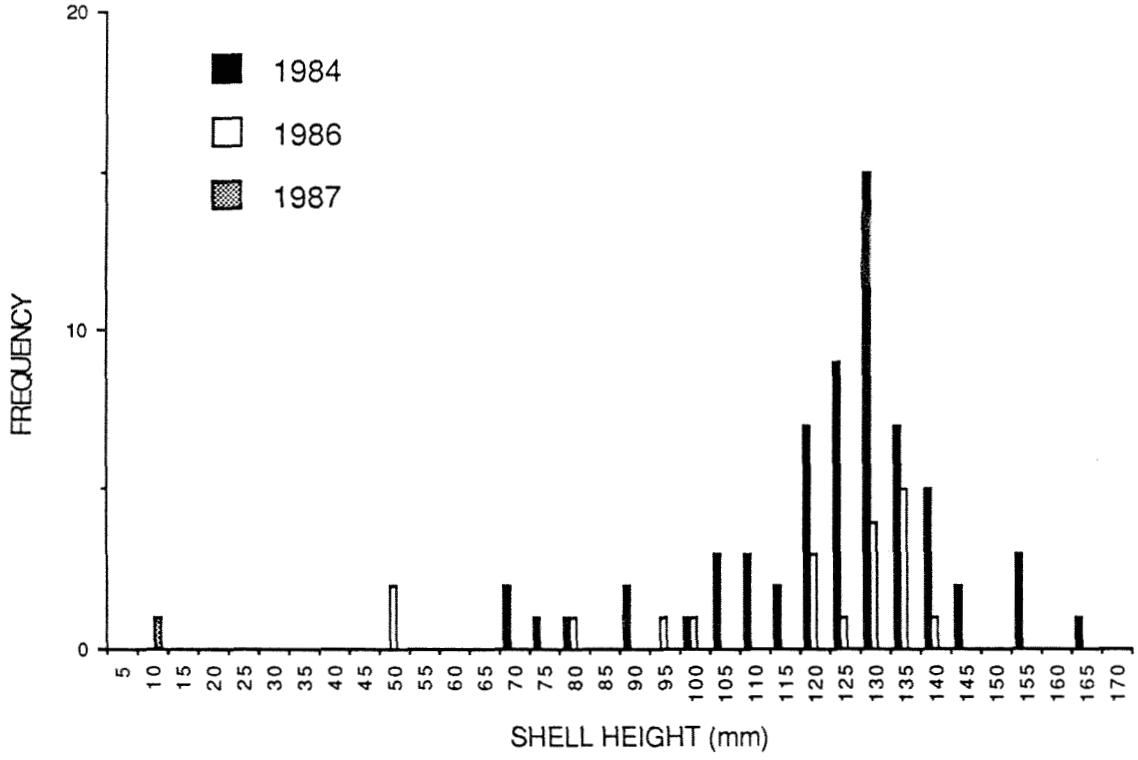
Frequency distributions of shell height of juvenile scallops collected in the inshore survey 1984-1988.



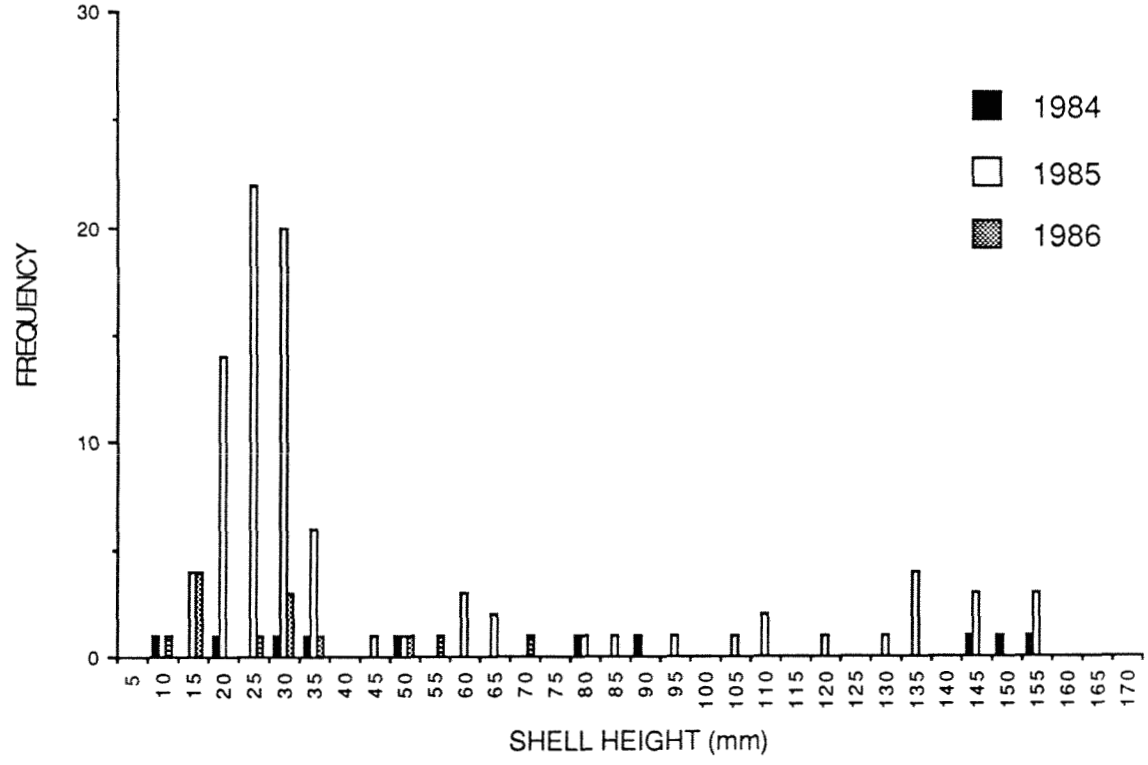
Appendix B. Figure 1B. Frequency distribution of scallop shell height collected in Mushaboom Harbour (E1), outer section in 1984.



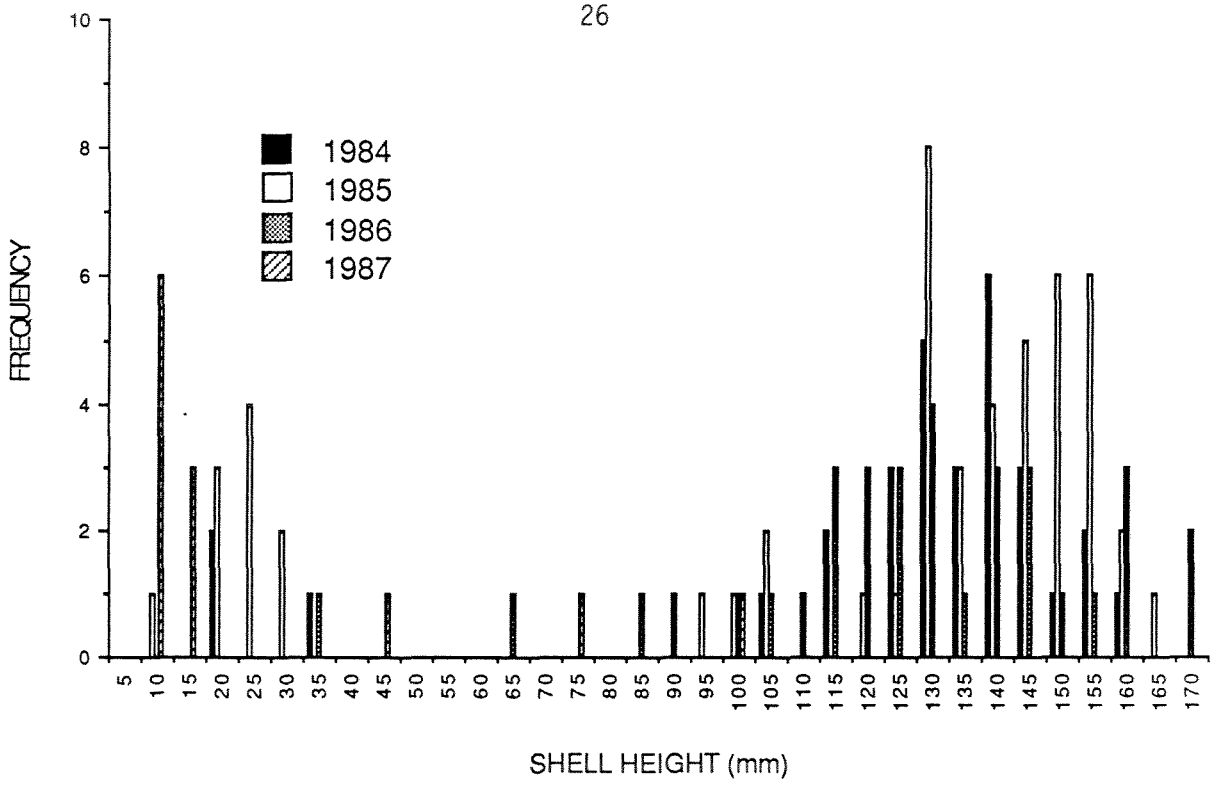
Appendix B. Figure 2B. Frequency distribution of scallop shell height collected in Mushaboom Harbour (E1), inner section in 1984.



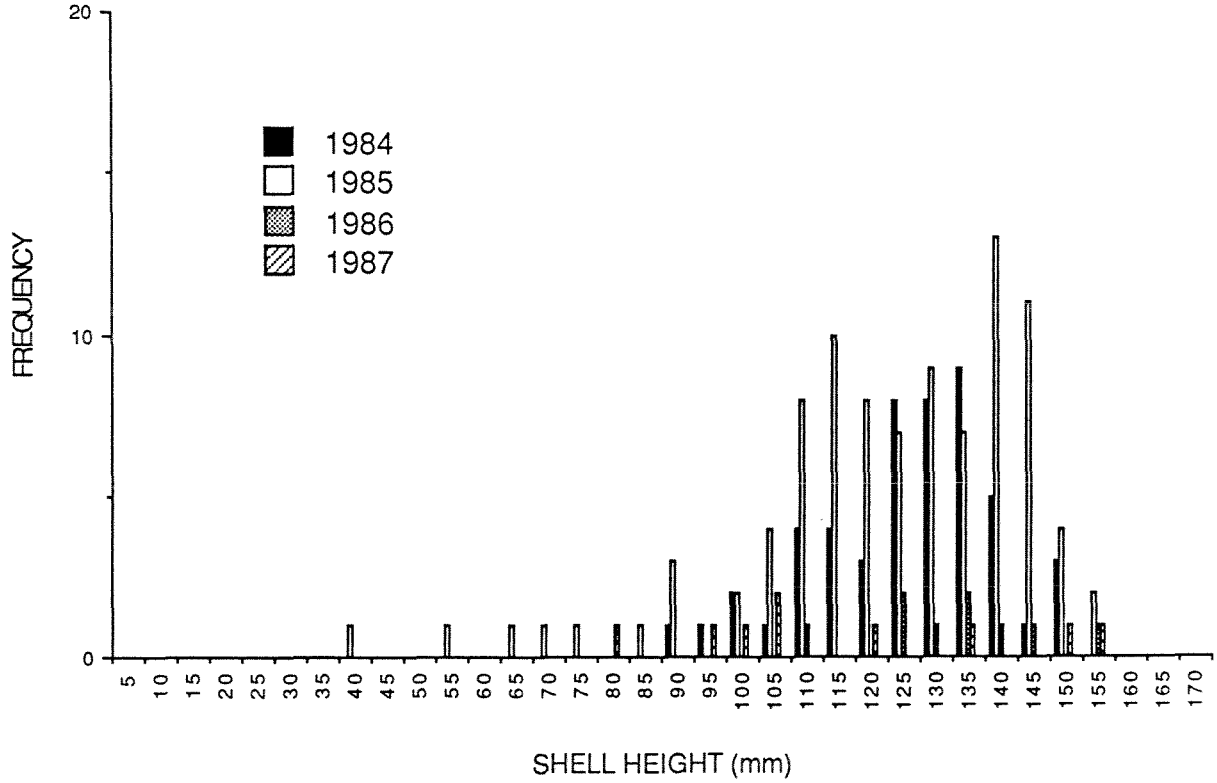
Appendix B. Figure 3B. Frequency distribution of scallop shell height collected in Sheet Harbour (SALIS) at Site #8 from 1984-1987.



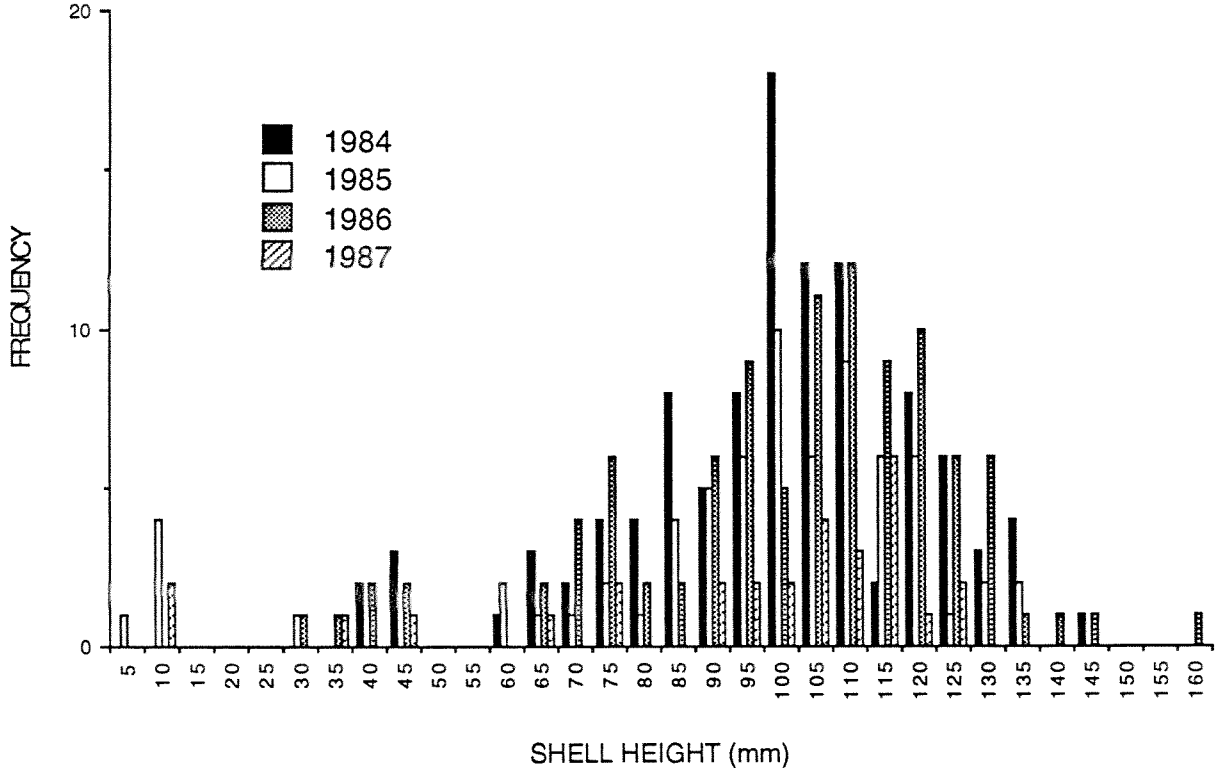
Appendix B. Figure 4B. Frequency distribution of scallop shell height collected in Sheet Harbour (SALIS 2) at Site #9 from 1984-1986.



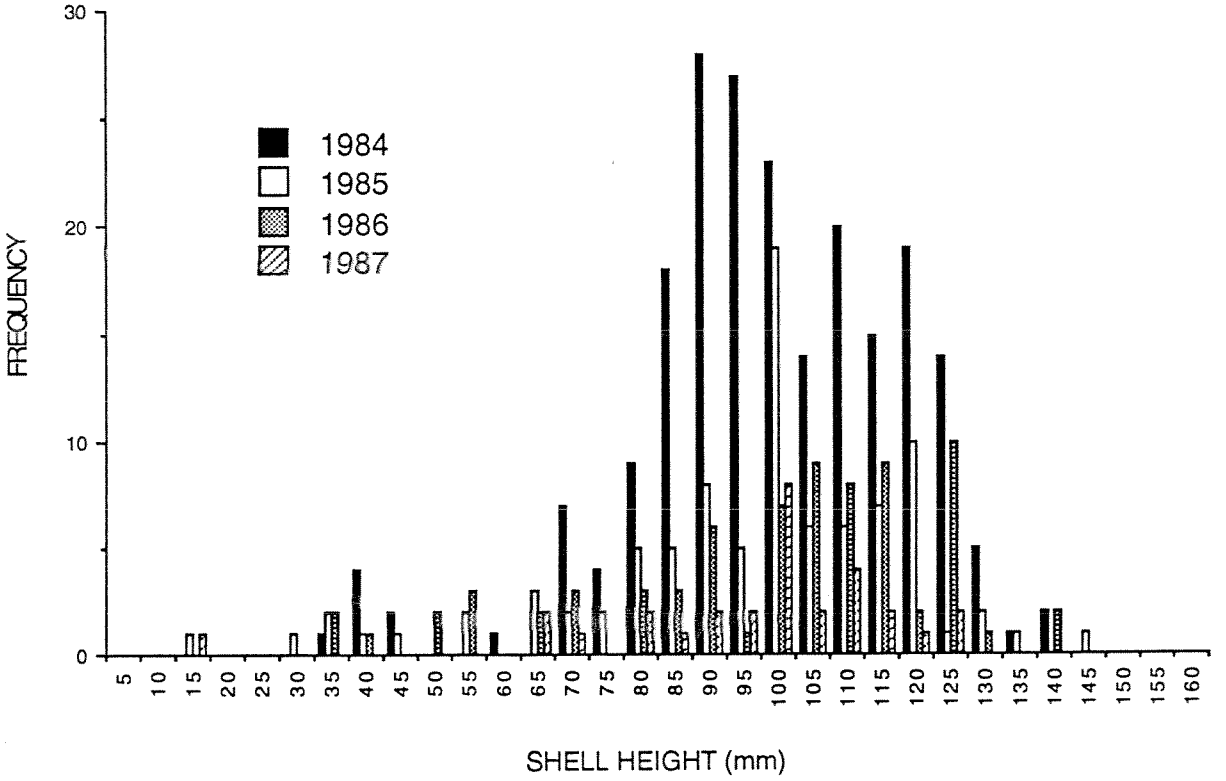
Appendix B. Figure 5B. Frequency distribution of scallop shell height collected in Sheet Harbour (SALIS 4) at Site #11 from 1984 to 1987.



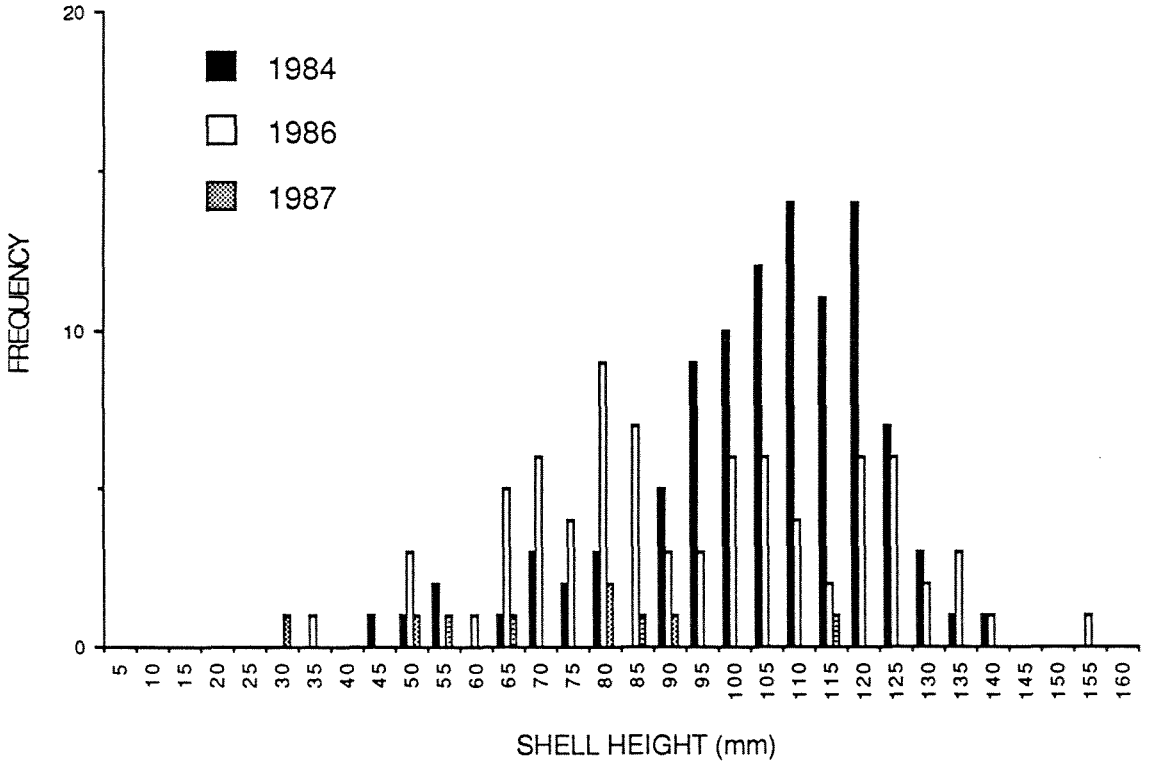
Appendix B. Figure 6B. Frequency distribution of scallop shell height collected in Sheet Harbour (SLAB) from Site #13 from 1984 to 1987.



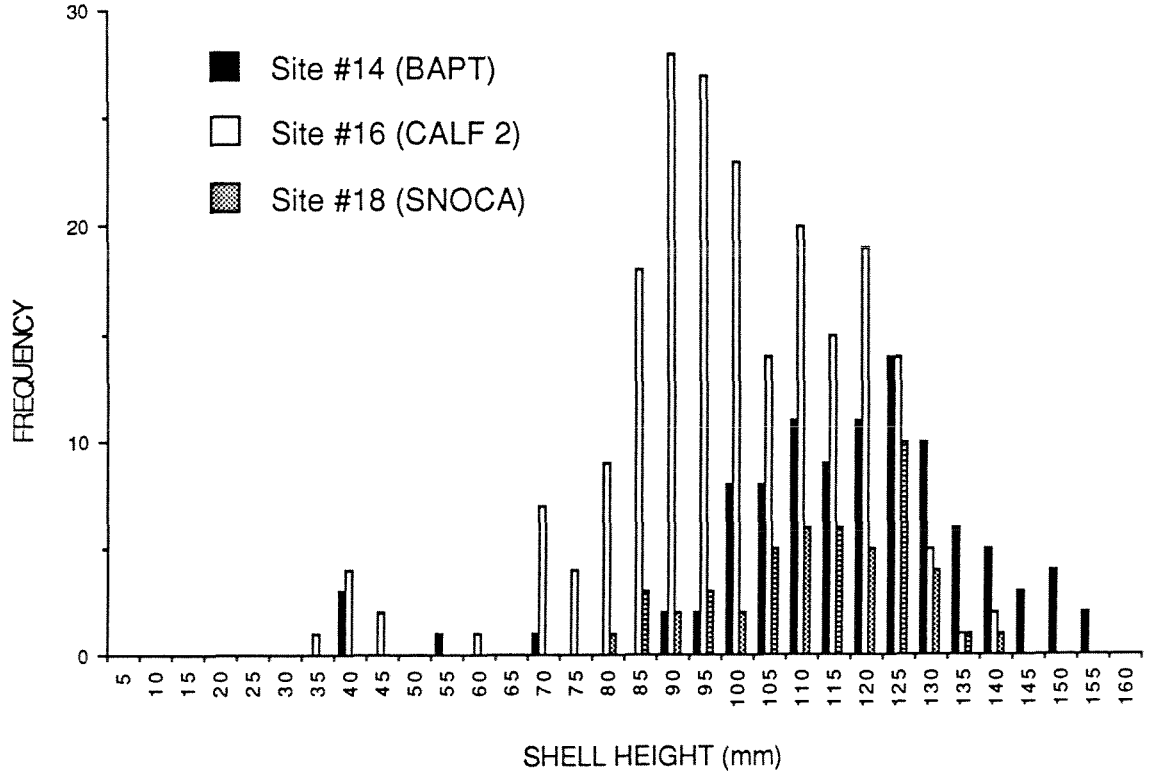
Appendix B. Figure 7B. Frequency distribution of scallop shell height collected at Site #15 (Area E3, CALF) from 1984-1987.



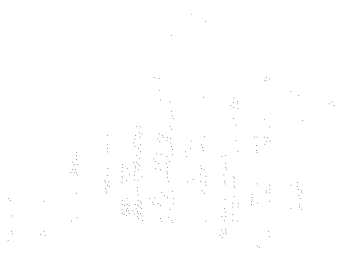
Appendix B. Figure 8B. Frequency distribution of scallop shell height collected at Site #16 (Area E3, CALF 2) from 1984 to 1987.

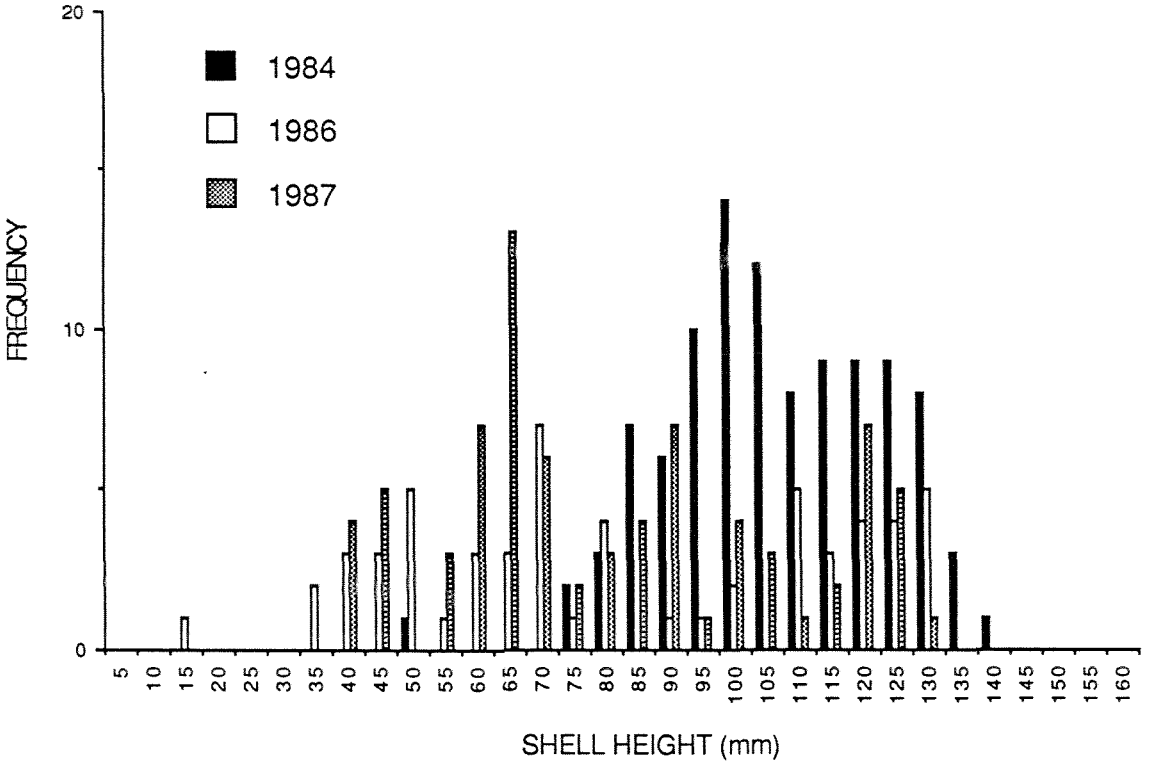


Appendix B. Figure 9B. Frequency distribution of scallop shell height collected at Site #17 (Area E3, LOBIS) from 1984 to 1987.

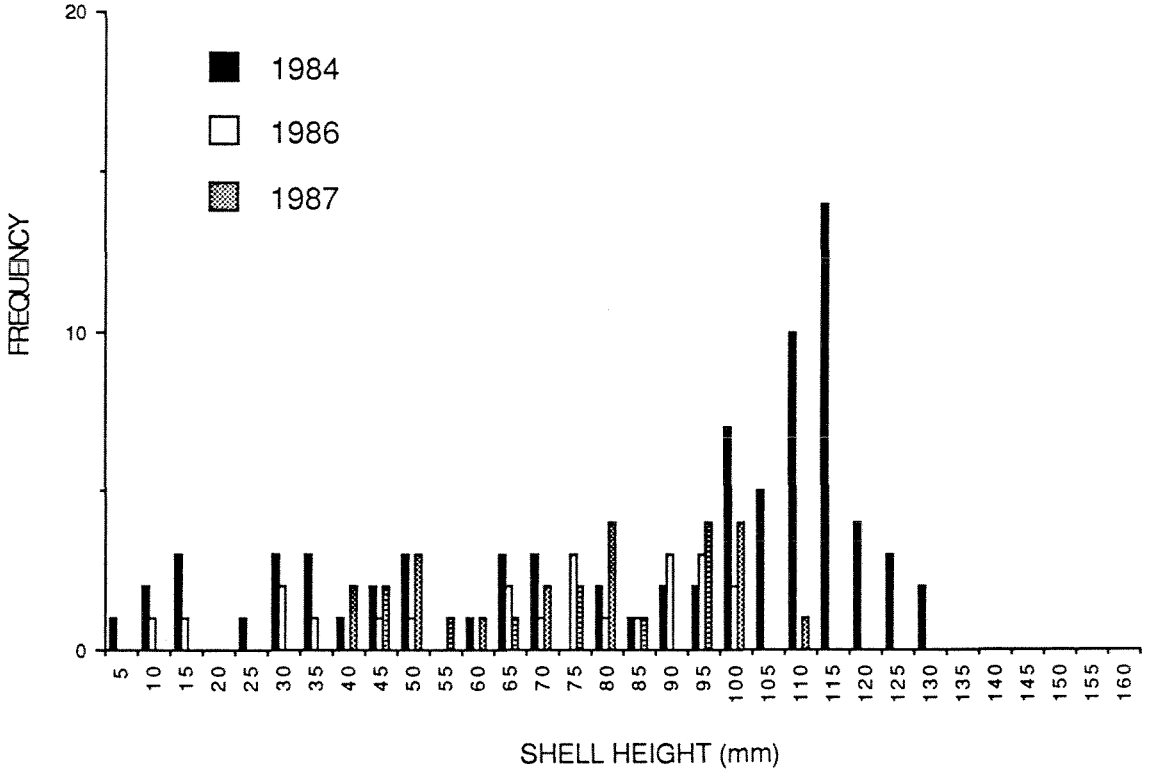


Appendix B. Figure 10B. Frequency distribution of scallop shell height collected at different sites in area E3 in 1984.

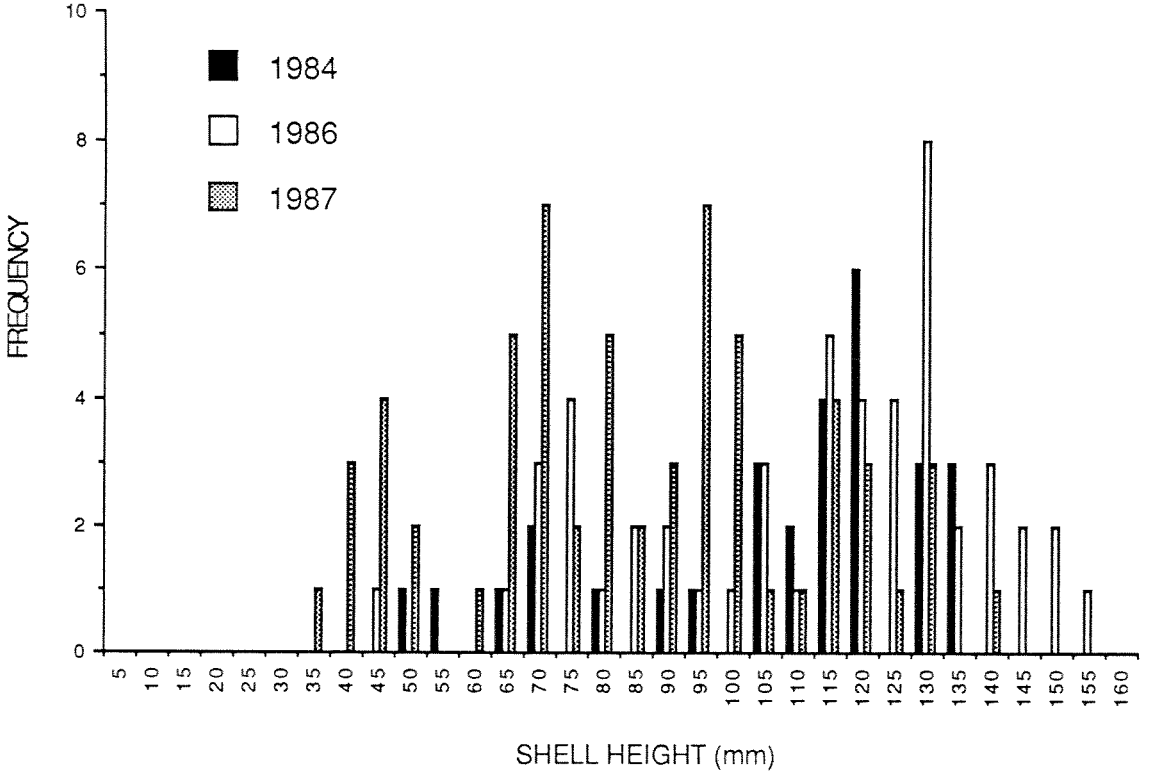




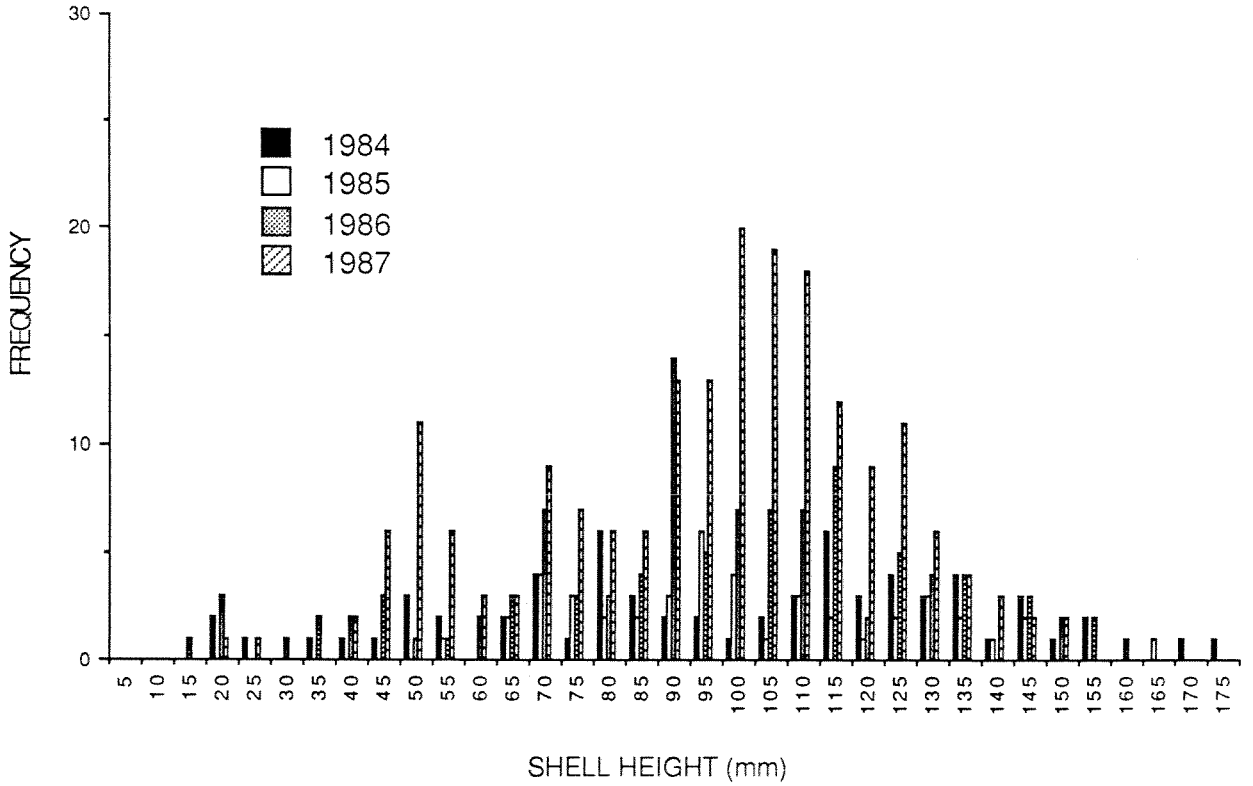
Appendix B. Figure 11B. Frequency distribution of scallop shell height collected at Site #19 (Area E4, CALF 3) from 1984 to 1987.



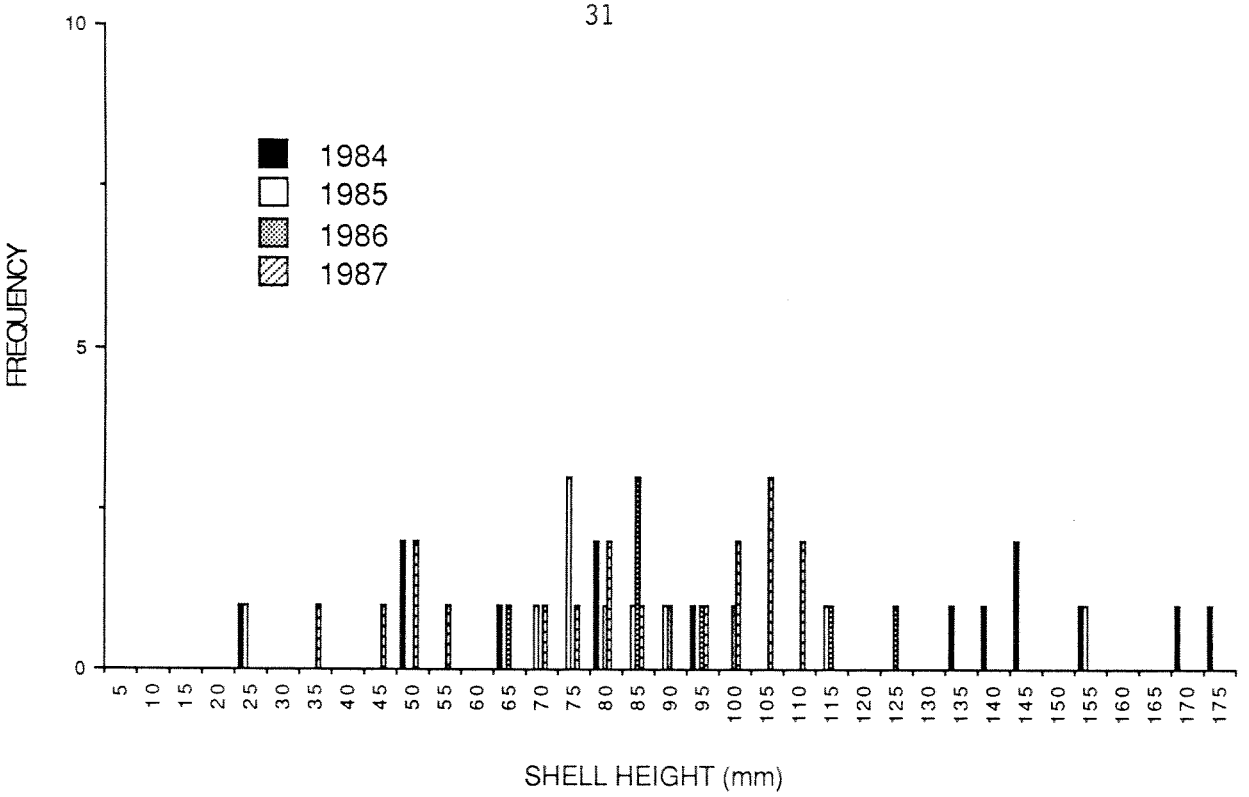
Appendix B. Figure 12B. Frequency distribution of scallop shell height collected at Site #20 (Area E4, CHMAC) from 1984 to 1987.



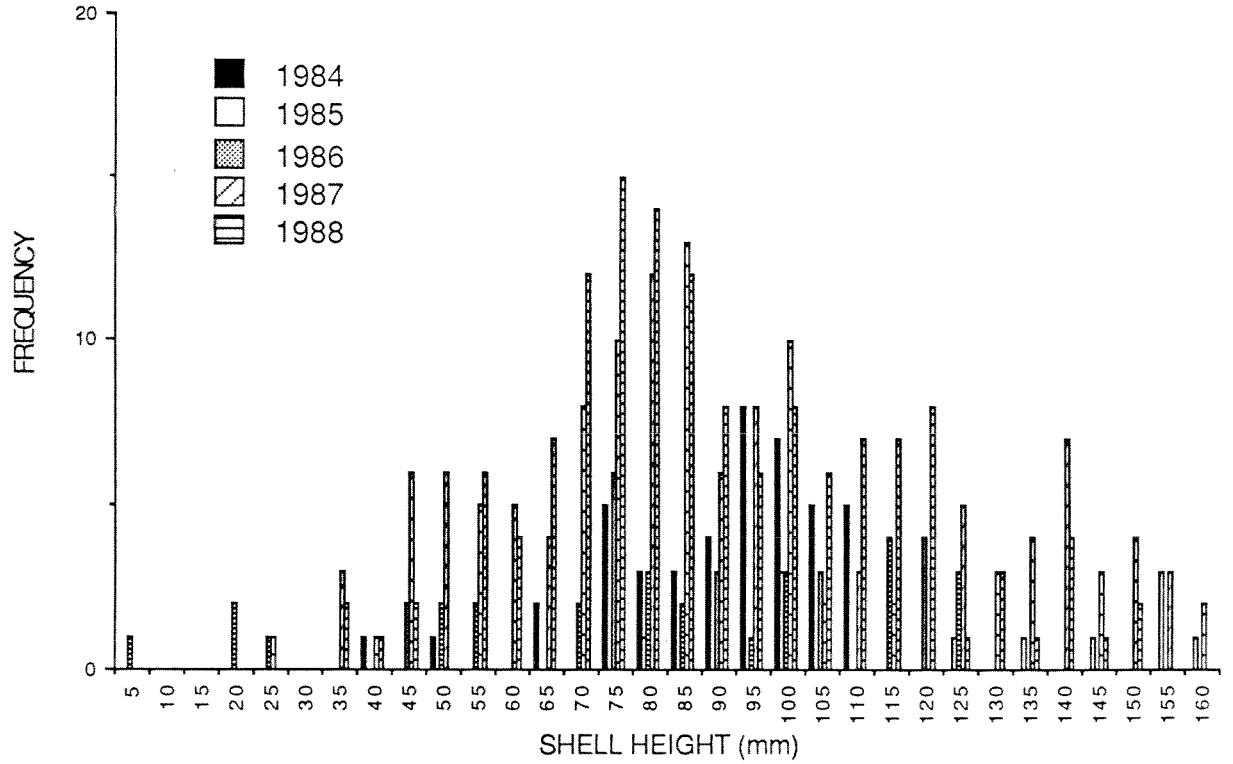
Appendix B. Figure13B. Frequency distribution of scallop shell height collected in Necum Teuch Harbour (Area E4, MAC) at Site # 21 from 1984 to 1987.



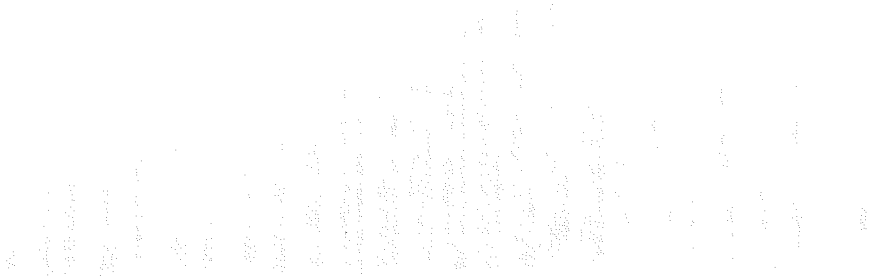
Appendix B. Figure 14B. Frequency distribution of scallop shell height collected in Liscomb Harbour (Area E5, LISCO) at Site #23 from 1984 to 1987.

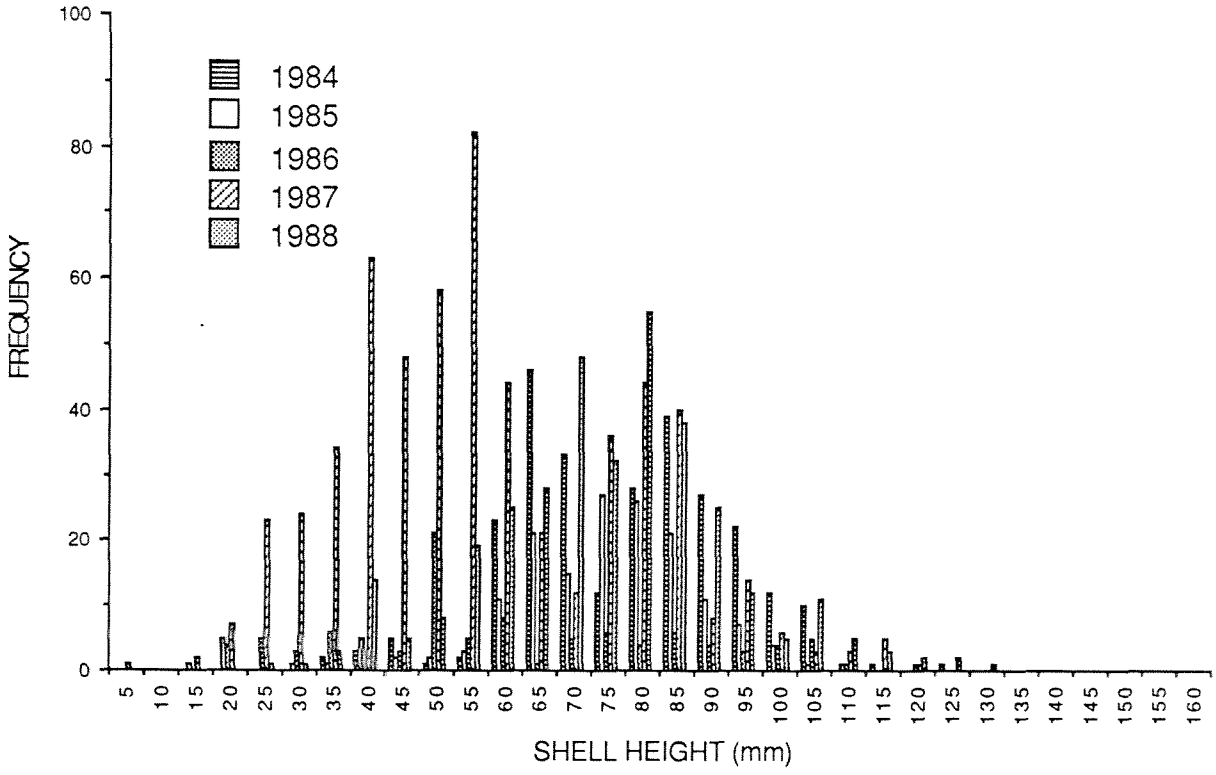


Appendix B. Figure 15B. Frequency distribution of scallop shell height collected from Liscomb Harbour (Area E5, LISCO 4) at Site #24 from 1984 to 1987.

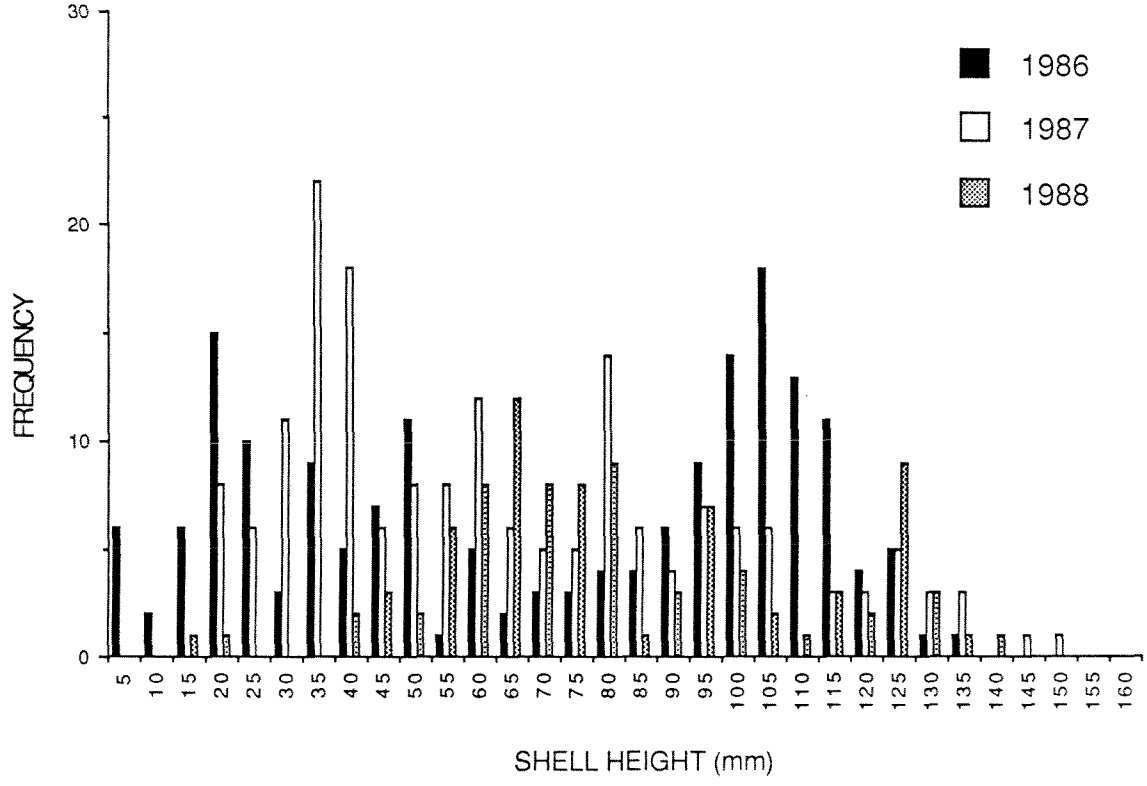


Appendix B. Figure 16B. Frequency distribution of scallop shell height collected at Site #30 (Area S1, SECPEN1) from 1984 to 1988.





Appendix B. Figure 17B. Frequency distribution of scallop shell height collected from Site #31 (Area S1, SECPEN2) from 1984 to 1988.



Appendix B. Figure 18B. Frequency distribution of scallop shell height collected at Site #32 (Area S1, SECPEN3) from 1986 to 1988.