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An Assessment of the Surf Clam Resource in FCZ waters off Southern New England-Spring 1983

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Summary

The relative abundance of surf clams, Spisula solidissima, in FCZ waters off Southern New England was assessed using data from a series of research vessel survey cruises during 1980-1982. These data were compared to similar information for surf clam assessment areas further to the South (New Jersey to North Carolina). Based on these analyses about 5% of the total resource in numbers, and 10% in weight is found in the Southern New England area.

The majority of the Southern New England Resource is concentrated at the periphery of Nantucket Shoals, which is an area difficult to survey and fish due to irregular bottom topography, shallow depths, and swift tidal currents. Distribution of the surf clam resource in Southern New England appears more sporadic than in other Middle Atlantic assessment areas.

Size and age data for the Southern New England stock indicate the population is dominated by clams 7-10 years old, and that recruitment has been relatively poor during the last 5-6 years. Southern New England clams appear slightly faster growing than their Middle Atlantic counterparts, and meat yields are greater for similar sized clams in the Southern New England Area.

Introduction

Harvest of surf clams, Spisula solidissima, from offshore waters of the United States East Coast has been managed since November 1977, under provisions of the Surf Clam and Ocean Quahog Fishery Management Plan (Mid-Atlantic Fishery Management Council 1977). Initial management measures implemented during 1977-1979 considered as a single management unit, all surf clam resources off the U.S. Coast 3-200 n miles from land. Effective 1 January 1980 two separate management units were established; the New England area was defined as the region east of a line running SSE from Montauk Point, New York (Mid-Atlantic Fishery Management Council 1979). Management measures implemented to regulate the harvest from New England waters were different than those for the Middle Atlantic region, particularly regarding the vessel moratorium, fishing effort restrictions, and minimum clam sizes (Murawski and Serhuk 1982). A variable harvest quota (25-100 thousand bushels per year) was established in October 1981 for New England.

Surf clams occur throughout the New England area, however, north of Cape Cod their distribution is almost exclusively within state territorial waters (Merrill and Ropes 1969). Harvest of New England surf clams from the FCZ have been derived exclusively from the Southern New England Shelf (primarily in the area south of Martha's Vineyard and Nantucket Island, Massachusetts). This report summarizes available information on the distribution, relative abundance, and population dynamics of surf clams inhabiting FCZ waters off Southern New England (SNE) and updates a previous analysis of the resource (Murawski 1979).

Primary information sources include results of research vessel survey cruises conducted in the area, and biological sampling data from commercial fishing vessel operating in Southern New England waters during spring 1983.

Distribution

Distribution of the Southern New England (SNE) surf clam resource can be inferred from published catch records of various sampling programs (Merrill and Ropes 1969), as well as more recent research vessel sampling data obtained from Northeast Fisheries Center (NEFC) cruises. Data presented by Merrill and Ropes indicated that the majority of the SNE surf clam resource is concentrated in inshore waters on the south side of Cape Cod, as well as near Martha's Vineyard, and in Rhode Island waters. Several offshore catch records imply the FCZ resource is located primarily south and east of Nantucket Island, in relatively shallow waters of the Nantucket Shoals. No distribution records were reported for a large portion of the SNE shelf from east of Montauk Point, New York, to southwest of Nantucket Island. They also reported that the maximum depth of occurrence of live surf clams throughout the Northeast was 66 meters (36 fathoms), and that few occurrences were noted in waters deeper than 40 meters (22 fathoms).

Surf clam catch records are available from a series of nine research vessel survey cruises during 1969-1982 (Table 1). A total of 219 individual survey stations was occupied during the cruises. At each station a 4 or 5 minute dredge tow was made; dredge dimensions varied somewhat among the cruises (Table 1). Prior to 1980,stations

were occupied along grid transects, more recent cruises employed a stratified random survey design. Catch data from pre-1980 cruises have been post-stratified to conform to the latter design. Survey strata in the Long Island and Southern New England areas are illustrated in Figure 1. Corresponding depth ranges, areas, and cumulative catch data (for all surveys combined) are presented for each Southern New England survey stratum individually (Table 2).

Surf clams were virtually absent at stations occupied in Southern New England survey strata deeper than 30 fathoms (55 meters). In general, the highest proportion of clam catches, and the highest catch rates (mean catch per station) occurred in the relatively shallow survey strata around the periphery of Nantucket Shoals (i.e., strata 95, 96, 41, 45, 46). A distribution plot of all 219 stations occupied during the surveys reveals that most relatively large surf clam catches were derived from the area south and east of Nantucket Island, along the 5-15 fathom depth contours (Figure 2). Largest relative catch rates were from survey strata 46 and 96 (on the east side of Nantucket Shoals), however, these calculations were based on very few survey stations (3 and 1 respectively). Stratum 95 (west side of Nantucket Shoals, 5-15 fathoms deep) was where surf clams were consistently caught in quantity (during 1983 the predominance of FCZ surf clam landings from New England waters were derived from the shoalward edge of stratum 95).

The shallowest areas of Nantucket Shoals (less than 5 fathoms) were generally not regularly surveyed due to the water depth, irregular topography, and swift tidal currents in the area. Nevertheless, it is clear that at least some surf clam resources exists within the area not

surveyed (about 495 square nautical miles). This has been verified by commercial catches, and by survey work at the shallowest extent of stratum 95. Since some of the largest survey catches were made at the shallowest stations occupied in the Nantucket Shoals, it is reasonable to speculate that the resource extends to areas that cannot be surveyed (assumptions about the contribution of this area to the total Southern New England Resource are treated in the next section).

Relative Abundance

Relative abundance indices for the Southern New England Region were computed for two reasons: to assess the relative abundance and size composition among various depth zones, and to compare with similar indices from other assessment areas in the Middle Atlantic. By weighting abundance indices for each assessment area by the total area of each, it is then possible to estimate the relative proportion of the total resource (both Southern New England and Middle Atlantic) inhabiting each assessment area.

Surf clam catch data for 1980-1982 are given for those survey strata historically yielding significant surf clam catches (Table 3). Because none of the Southern New England surveys during 1980-1982 was completely synoptic, data for the three years were aggregated to compute a single abundance index. Aggregation of the three most recent years' data is probably valid since changes in clam abundance during the period were most likely small (the resource was composed of relatively large clams implying that recruitment during the period was minimal (Table 3), additionally, significant harvesting of the Southern New England FCZ resource did not begin until Mid-1982). Survey catches from the

three years were combined by depth zones (Table 4). This procedure was employed to include survey strata that were not sampled during 1980-1982, but where clam resources probably exist (e.g., stratum 96), and to discount the effects of single large catches from strata that were minimally sampled (e.g., stratum 46). Abundance indices for the three depth zones were computed individually and weighted by the area of each to calculate an abundance index for the Southern New England region.

Stratified abundance indices (in numbers) were also computed by one cm shell length class to assess the overall size composition of the Southern New England surf clam resource (Figure 3), and size variation by depth (Figure 4).

Length frequency statistics from the surveys (1980-1982) indicate that the surf clam resource in Southern New England waters is dominated by large (relatively old) clams (Figures 3 and 4). Very few clams less than 12 cm (shell length) were captured in any of the depth strata, indicating that recruitment in the past 5-6 years has been relatively poor. Clams in the 13-17 cm size range dominated the resource. The largest clams were found in the shallower depth strata, the predominance of small individuals was in the deepest depth (Figure 4). Length data from commercial vessel sampling confirm the relatively large size of clams from the Southern New England Region. Sampled catches were from the 5-15 fathom depth range near Nantucket Shoals. Length frequencies from commercial catches and survey samples from those depths are nearly identical (Figures 3 and 4).

The relative abundance of surf clams during 1980-1982 was greatest in the 5-15 fathom depth zone (mean number per tow = 28.7). Clams were

less dense in the two deeper survey strata (Table 4). Of the entire Southern New England survey area, 30% was in the 5-15 f. depth zone, 43% in the 15-25 f. range, and 27% at 25-30 f. The total abundance index (in numbers), weighted by these areas, is 13.6 clams/survey tow.

A total weight per tow index for the Southern New England area was computed by multiplying mean drained meat weights at length, by the number per tow index at each 1 cm length interval, and summing over all lengths (the appropriate shell length-drained meat weight equation for the Southern New England area is described in the next section). The relative abundance index in weight for the Southern New England area (1980-1982), calculated by the above method, is 2.00 kg/tow (Table 5).

Computations of the relative contribution of the Southern New England surf clam population to the resource enhabiting the region from Cape Cod to Cape Hatteras during 1982 are given in Table 5. Catch per tow indices for the Middle Atlantic assessment areas are from Murawski and Serchuk (1982). Based on these calculations, about 5% of the total resource in numbers, and approximately 10% of the total resource in weight was in the Southern New England area during 1982. Largest proportions of the total resource were found off Northern New Jersey, and the Delmarva Penninsula. The fact that only 5% of the numbers but 10% of the resource weight is found off Southern New England is indicative of the large size of clams in the New England area, relative to the Middle Atlantic.

These calculations are based on a Southern New England surf clam resource in waters 5-30 fathoms deep. However, as described earlier, at least some resource exists in shallower waters of Nantucket Shoals

that are generally not surveyed. In order to estimate the potential clam resource in the entire Southern New England Region, we assumed that the density of clams in the non-surveyed region was equivalent to that in the 5-15 fathom depth range. The relative abundance index for Southern New England waters was then re-computed by adding the weighted abundance for the shallow areas into calculation. If the shallow area is included, the overall weight index for Southern New England becomes 2.30 kg/tow. The total area of the Southern New England area increased to 4,370 square nautical miles. The contribution of the Southern New England region's surf clam biomass to the total increases only slightly, however, from 10.1% to 12.7%.

Age and Growth

Age and growth relationships of surf clam populations in the Southern New England region were assessed using length frequency sampling from both research and commercial catches, as well as data developed from biological samples collected in spring 1983.

Growth rates of the Southern New England population were compared to corresponding data collected from the two major Mid-Atlantic surf clam assessment areas (Tables 6 and 7). Age-length relations for the Southern New England resource are based on samples obtained from commercial vessel catches during April 1983. Length at age data (Table 6) suggest that clams of the same age are larger off Southern New England than their counterparts off New Jersey and the Delmarva Penninsula. This difference in length at age was about 2-9% for the ages where sampling was adequate for comparison (ages 7-10). Reasons

for the relatively rapid rate of growth off Southern New England are speculative but may relate to the greater productivity of the more northern waters, or density dependent factors.

The age range of clams from commercial samples off Southern New England was 5.5-12.5 years. Since the length distribution of these samples is generally consistent with survey length frequencies (for the 5-15 fathoms depth zone where clams are most abundant) it can be inferred that most of the Southern New England population during spring 1983 was composed of these age classes (particularly ages 7.5-10.5). Relatively few clams less than 6.5 years old were taken in Southern New England waters, although clams 4-7 years old were predominate in the 25-30 fathom depth range (Figure 4).

The relationship between shell length and drained meat weight for Southern New England clams was also compared to Mid-Atlantic populations (Table 7). For the same shell lengths, Southern New England clams contained 9-38% greater meat yields than similar sized clams in the more southern areas. This is consistent with observations reported by processors during 1982-1983, although part of the difference may be due to the season of capture, as New England data are based on samples obtained in April and Middle Atlantic data were obtained in February-March.

Conclusions

The relative abundance of surf clams in FCZ waters off Southern New England was assessed using data from a series of research vessel survey cruises during 1980-1982. Weighting the 1982 relative abundance

indices for the Southern New England and Middle Atlantic assessment regions by their respective areas resulted in estimates of the proportion of total surf clam resource in each of the five assessment areas. Based on these calculations about 10% of total surf clam biomass (stock weight) and about 5% of total numbers are currently found off Southern New England. Although part of the Southern New England resource is located in areas that cannot be surveyed (i.e., shallow areas of Nantucket Shoals), accounting for the potential resource in these areas did not appreciably increase the proportion of total stock weight located off Southern New England.

Distribution of surf clams in the Southern New England area appears to be relatively sporadic (more so than in the Middle Atlantic assessment regions). The majority of the Southern New England resource is concentrated at the periphery of Nantucket Shoals, an area difficult to survey and fish due to irregular bottom topography, shallow depths and swift currents.

Size and age data obtained for the Southern New England stock indicate that the population is dominated by clams 7-10 years old, and that recruitment has been relatively poor during the last 5-6 years. Rates of growth for Southern New England surf clams appear to be slightly greater than in the Middle Atlantic assessment area. The relatively large size and proportionally greater meat yields of Southern New England clams (Murawski and Serchuk 1982) are in part responsible for the dramatic increase in Southern New England FCZ landings during 1983 (114,000 bushels or 1.9 million pounds as of July 1983, landings in all of 1982 were about 76,000 bushels).

References

Merrill, A. S., and J. W. Ropes. 1969. The general distribution of the surf clam and ocean quahog. Proc. Natl. Shellfish. Assoc. 59:40-45.

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Murawksi, S. A. 1979. On the question of offshore surf clam, Spisula solidissima, resources off New England. National Marine Fisheries Service, Woods Hole Lab. Ref. 79-22. 14pp.

Murawski, S. A., and F. M. Serchuk. 1982. Assessment and current status of offshore surf clam, Spisula solidissima, populations off the Middle Atlantic coast of the United States - Autumn 1982. National Marine Fisheries Service, Woods Hole Lab. Ref. 82-43. 61pp.

Table 1. Summary of research vessel cruises conducted by the Northeast Fisheries Center (NEFC) in the Southern New England Region. A total of 219 stations were occupied from 1969-1982. Survey gear was an hydraulic clam dredge.

Research Vessel	Dates of cruise (m-y)	Dredge Knife width (cm)	Time of tow (min)	Number of stations (a)	Ring Size (b) or bar space (cm)
Albatross IV	6-7 1969	76	5	22	5.1
Delaware II	8 1970	122	4	4	3.0
Delaware II	1-3 1977	122	4	45	3.0
Delaware II	1-2 1978	122	4	39	2.5
Delaware II	1 1979	152	5	13	5.1
Delaware II	1-2 1980	152	5	16	5.1
Delaware II	8-9 1980	152	5	11	5.1
Delaware II	8 1981	152	5	32	5.1
Delaware II	8 1982	152	5	37	5.1

(a) Number of stations occupied in the Southern England Area (see Figure 1).

(b) Portion of the dredges where the catch is accumulated.

Table 2. Summary of surf clam catch data for survey strata in the Southern New England Region, 1969-1982. Data are not adjusted for differences in dredge specifications among surveys. Referenced survey strata are illustrated in Figure 1.

Stratum	Depth Range (F)	Area N.M. ^{2}	Number of tows	Proportion of Non-Zero Catches	Catch Per Tow Mean	SD
37	15-25	672	21	0.14	0.48	1.57
38	25-30	280	21	0.05	0.05	0.22
39	30-40	967	54	0.00	0.00	0.00
40	40-60	513	5	0.00	0.00	0.00
41	15-25	602	39	0.28	0.72	2.28
42	25-30	343	13	0.00	0.00	0.00
43	30-40	432	16	0.06	0.06	0.25
44	40-60	383	1	0.00	0.00	0.00
45	15-25	392	6	0.50	10.00	23.04
46	25-30	416	3	1.00	76.67	80.75
47	30-40	871	11	0.27	0.27	0.47
48	40-60	1109	2	0.00	0.00	0.00
94	5-15	229	2	0.00	0.00	0.00
95	5-15	446	24	0.79	34.00	52.63
96	5-15	495	1	1.00	43.00	0.00

Table 3. Surf clam catch data for survey strata in the Southern New England region, 1980-1982. Surveys were conducted with a 1.5 m wide dredge towed for five minutes at each station. An overall abundance index for all years combined is presented.

Stratum	Years	Number of Tows	Number Per Tow		Clam Size (MM)	
			Mean	SD	Mean	SD
94	1980	0	--	--	--	--
	1981	0	--	--	--	--
	1982	2	0.00	0.00	--	--
	Σ	2	0.00	0.00	--	--
95	1980	9	39.00	42.45	150.73	17.74
	1981	4	27.25	48.56	143.17	20.24
	1982	4	21.50	28.31	148.26	19.43
	Σ	17	32.12	39.42	148.83	18.74
96	1980	0	--	--	--	--
	1981	0	--	--	--	--
	1982	0	--	--	--	--
	Σ	0	--	--	--	--
37	1980	0	--	--	--	--
	1981	2	1.00	1.41	65.00	4.66
	1982	7	0.14	0.38	95.00	0.00
	Σ	9	0.33	0.71	75.00	20.00
41	1980	11	1.36	4.20	124.33	32.83
	1981	5	1.00	1.00	159.00	11.40
	1982	6	0.50	0.84	148.33	5.77
	Σ	22	1.05	2.98	135.00	30.75
45	1980	0	--	--	--	--
	1981	0	--	--	--	--
	1982	3	20.00	32.05	158.17	20.13
	Σ	3	20.00	32.05	158.17	20.13
38	1980	3	0.00	0.00	--	--
	1981	2	0.00	0.00	--	--
	1982	3	0.00	0.00	--	--
	Σ	8	0.00	0.00	--	--

Table 3. Cont'd

Stratum	Years	Number of Tows	Number Per Tow Mean	Number Per Tow SD	Clam Size (MM) Mean	Clam Size (MM) SD
42	1980	3	0.00	0.00	--	--
	1981	3	0.00	0.00	--	--
	1982	0	--	--	--	--
	Σ	6	0.00	0.00	--	--
46	1980	0	--	--	--	--
	1981	0	--	--	--	--
	1982	2	113.50	70.00	128.13	21.32
	Σ	2	113.50	70.00	128.13	21.32
47	1980	1	0.00	--	--	--
	1981	0	--	--	--	--
	1982	4	0.75	0.50	75.00	17.32
	Σ	5	0.60	0.55	75.00	17.32

Table 4. Surf clam catch data aggregated for three separate depth zones (5-15, 15-25, and 25-30 fathoms) in the Southern New England region, 1980-1982. An overall abundance index for the three years combined is presented.

Depth Zone (f)	Survey Strata	Year	Number of Tows	Number Per Tow		Clam Size (MM)	
				Mean	SD	Mean	SD
5-15	94,95,96	1980	9	39.00	42.45	150.73	17.74
		1981	4	27.25	48.56	143.17	20.24
		1982	6	14.33	24.58	148.26	19.43
		Σ	19	28.74	38.52	148.83	18.74
15-25	37,41,45	1980	11	1.36	4.20	124.33	32.83
		1981	7	1.00	1.00	132.14	47.16
		1982	16	4.00	14.15	156.72	21.12
		Σ	34	2.53	9.93	149.07	29.00
25-30	38,42,46	1980	5	0.00	0.00	--	--
		1981	6	0.00	0.00	--	--
		1982	5	45.40	71.34	128.13	21.32
		Σ	16	14.19	42.37	128.13	21.32

Table 5. Calculation of the relative proportion of the total surf clam resource in each of five FCZ Assessment Areas. Data for New Jersey, Delmarva, and Southern Virginia-North Carolina are from Murawski and Serchuk (1982).

	Southern New England	Northern New Jersey	Southern New Jersey	Delmarva	Southern Virginia North Carolina
Area (n.Miles^2)	3,875	3,440	1,228	5,092	2,980
1982 Survey Abundance Index (Numbers)	13.57[a]	112.79	20.61	109.14	38.32
1982 Survey Abundance Index (weight,kg)	2.00[a]	8.78	3.51	5.68	1.99[b]
Percent of Total Stock (Numbers)	4.63	34.16	2.23	48.93	10.05
Percent of Total Stock (weight)	10.05	39.17	5.59	37.51	7.69

[a] Data for Southern New England are based on aggregated data for research vessel cruises during 1980-1982.

[b] Weight data for Southern Virginia-North Carolina are based on the number: weight ratio from Delmarva.

ble 6. Mean shell length (mm) at age for surf clams sampled from three FCZ Assessment Areas. New Jersey and Delmarva data are from Murawski and Serchuk (1982). Southern New England data are based on commercial samples obtained in April 1983.

AGE [a] (Years)	SHELL Length at Age (mm) Southern New England [b]	New Jersey [c]	Delmarva [d]
1.5		56.78	57.50
2.5		83.03	85.61
3.5		103.01	106.46
4.5		118.22	121.93
5.5	148.00 (1, 0.00)	129.79	133.41
6.5	152.67 (3,11.55)	138.59	141.93
7.5	158.30 (10, 8.72)	145.30	148.25
8.5	158.48 (44, 9.24)	150.40	152.94
9.5	163.83 (53, 9.48)	154.28	156.42
10.5	162.33 (9, 7.57)	157.23	159.00
11.5	162.57 (7, 5.88)	159.48	160.92
12.5	169.50 (2, 2.12)	161.19	162.34
13.5		162.49	163.40
14.5		163.49	164.18
15.5		164.24	164.76
16.5		164.81	165.19
17.5		165.25	165.51

[a] Surf clams are spawned in late summer-autumn. An October 1 birthday is thus assumed. For comparison with Southern New England samples, which were taken in April, growth of Middle Atlantic clams was computed for age plus 6 months (October-April).

[b] The three numbers are mean length at age, (sample size, SD).

[c] Computed from: $L_t = 166.64\ [1 - e^{-.2731\ (t + .0255)}]$

[d] Computed from: $L_t = 166.43\ [1 - e^{-.2984\ (t - .0794)}]$

Table 7. Calculated mean drained meat weight for various shell lengths for surf clams from three FCZ Assessment Areas. New Jersey and Delmarva data are from Murawski and Serchuk (1982). Southern New England data are from commercial samples obtained during April 1983.

Shell Length (mm)	Meat Weight (Grams) Southern New England [a]	New Jersey [b]	Delmarva [c]
30	2.35 [d]	1.49	1.36
40	5.00 [d]	3.36	3.01
50	8.96 [d]	6.31	5.59
60	14.45 [d]	10.55	9.25
70	21.64 [d]	16.31	14.18
80	30.71 [d]	23.79	20.52
90	41.80 [d]	33.18	28.42
100	55.09 [d]	44.69	38.05
110	70.72 [d]	58.50	49.53
120	88.83 [d]	74.80	63.02
130	109.55 [d]	93.78	78.64
140	133.02	115.62	96.55
150	159.38	140.50	116.86
160	188.73	168.60	139.71
170	221.22	200.10	165.23
180	256.96	235.16	193.55
190	296.06	273.97	224.79
200	338.64	316.69	259.07

[a] Predicted from: $\log_e W = -8.0556 + 2.6198 \log_e L$

[b] Predicted from: $\log_e W = -9.21034 + 2.8251 \log_e L$

[c] Predicted from: $\log_e W = -9.10598 + 2.7675 \log_e L$

[d] Out of range of data used to fit the regression equation

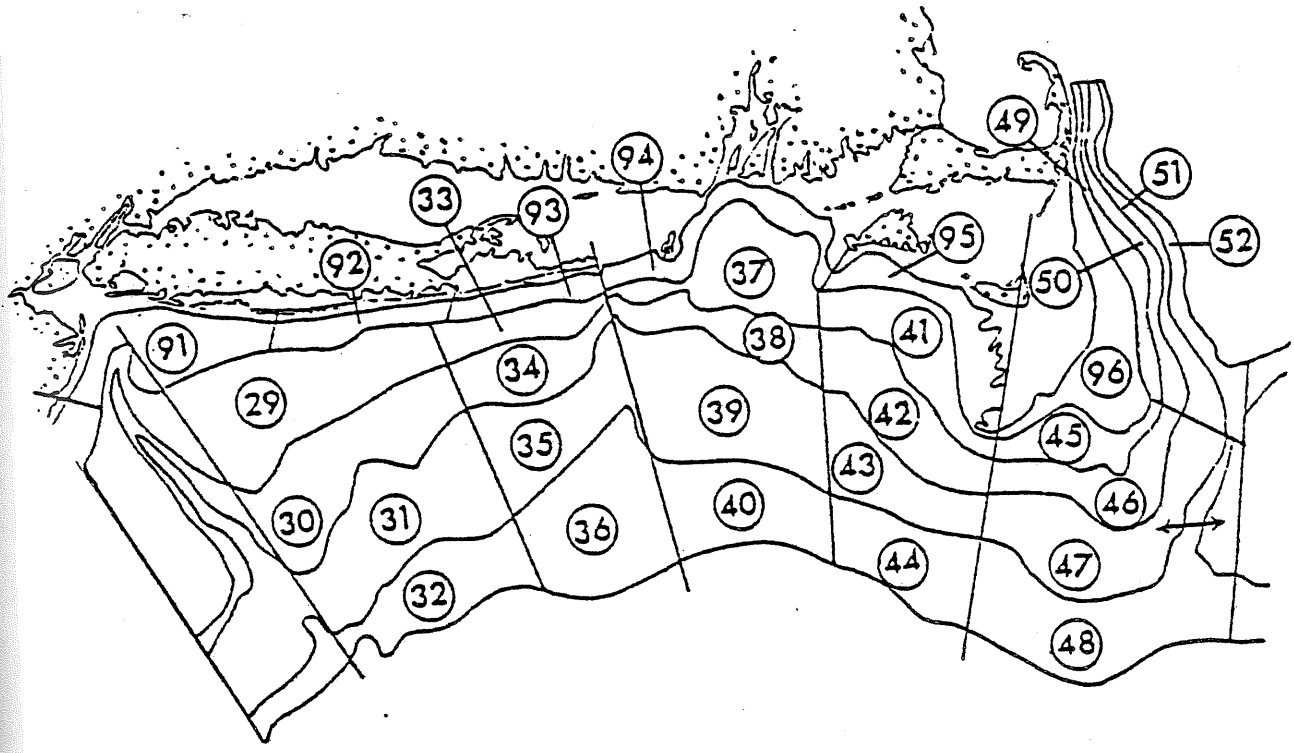

Figure 1. Surf clam and ocean quahog survey strata, Long Island-Southern New England. Areas (square nautical miles) associated with each survey stratum in the Southern New England Region (east of Montauk Point, New York) are given in Table 2.

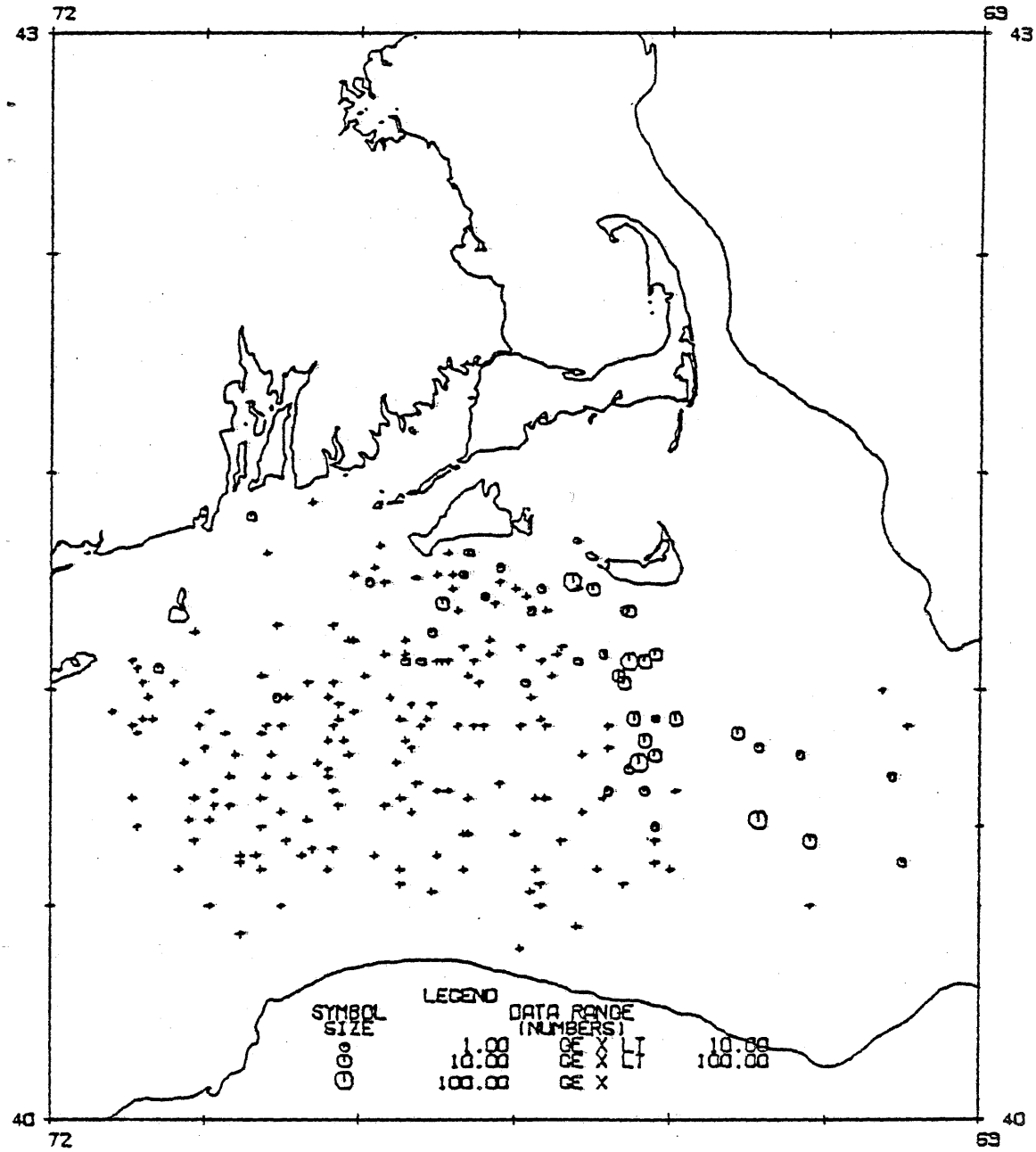

Figure 2. Surf clam catches (numbers) in the Southern New England Region, 1969-1982. Data are presented for 219 survey stations occupied during all cruises. Stations resulting in zero catch of surf clams are indicated by a cross; positive catches are indicated by a circle, the diameter if which is proportional to the number caught.

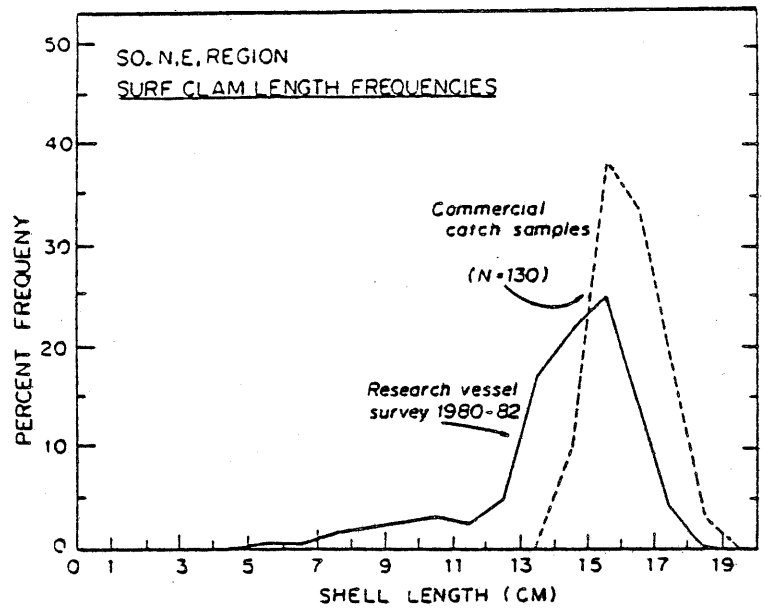

Figure 3. Shell length frequencies of surf clams sampled from the Southern New England Region, 1980-1982. Commercial samples were obtained in April 1983, research survey data are percent of stratified mean numbers per tow for cruises conducted during 1980-1982.

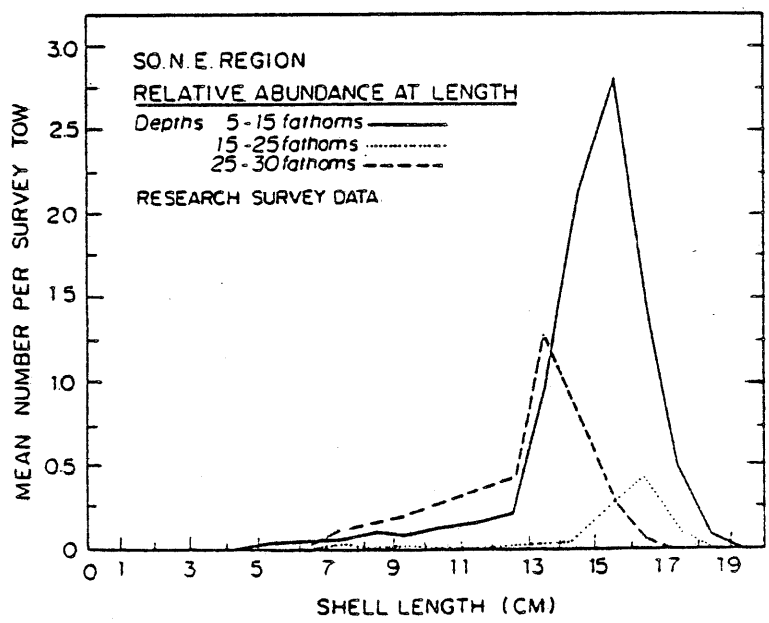

Figure 4. Relative abundance of surf clams in each 1 cm length group, for three depth zones in the Southern New England area, 1980-1982. Data are stratified mean numbers per tow for the three years combined, depth zones are 5-15, 15-25, and 25-30 fathoms.