

An Assessment of the Georges Bank  
Surf Clam Resource - Summer 1984

by

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## SUMMARY

Fishing for surf clams, Spisula solidissima, on Georges Bank was initiated during the spring of 1984. Landings from the fishery were derived primarily from the Cultivator Shoals area on the western portion of the Bank. Initial catch rates of clams from the fishery were nearly 300 bushels per hour fishing, but declined significantly through summer 1984, to about 100 bushels per hour. The average clam size in landings samples was 153 mm (6.02 inches) shell length. Total Georges Bank surf clam landings through November 1984 were 401 thousand bushels or about 6.8 million pounds of clam meats. Approximately 17 different vessels participated in the Georges Bank fishery during 1984. The vast majority (82%) of participating vessels were size class 3 (greater than 100 GRT), the remaining vessels (18%) were size class 2 (50-100 GRT).

The productivity potential of the Georges Bank surf clam resource was assessed utilizing information from a series of research surveys conducted by the Northeast Fisheries Center (NEFC) on Georges Bank during 1980-1984. Additional information on the status of the resource was obtained from commercial vessel logbook reports, the results of exploratory fishing mandated as a condition of participation in the fishery, and from monitoring studies conducted by NMFS observers aboard commercial vessels and through routine sampling of landings by port agents.

The surf clam resource appears primarily concentrated in the northern and western section of Georges Bank. Very little of the resource was found to exist in the Canadian portion of the Bank. Although densities of clams are great in some locations, these areas are generally more localized and sporadic than in traditional clam fishing areas of the Middle Atlantic Bight. Extremely irregular bottom topography and diverse sediment types on the Bank are severe impediments to standard surveying practices and exploratory fishing operations. Average clam size for the entire resource was 122 mm (4.8 inches shell length) from NMFS clam surveys during 1984. Growth rates of surf clams in the shallow portions of the Bank (e.g.  $\leq 30$  fathoms) appear similar to clam growth patterns observed in the Middle Atlantic region. Surf clams obtained from deeper waters along the north-western portion apparently grow substantially slower than clams in shallower waters.

Potential harvest quotas for the Bank were computed assuming the same management strategy (i.e., exploitation ratio) as for Middle Atlantic and Southern New England surf clam resources. If the ratio of clam landings to survey biomass index is similar in all three areas (and thus the exploitation rate is approximately equivalent), then the appropriate Georges Bank catch quota would be approximately 250-300 thousand bushels (4.3-5.1 million pounds of meats) per year. This strategy should result in stable catch levels for several years as the exploitation rate would likely be relatively low.

## Introduction

The modern fishery for surf clams, Spisula solidissima, has been primarily prosecuted in the Middle Atlantic region and more recently off Southern New England, although the fishery had its beginnings on Cape Cod during the last century (Serchuk et al. 1979, Murawski and Serchuk 1981, 1983a, 1984). Recent renewed interest in New England surf clam resources has been generated due to the restrictive management regime employed in the Middle Atlantic to rebuild the stocks. During 1983 a significant quantity of surf clams was landed from Nantucket Shoals, off the Southern New England coast. Additional exploratory fishing by the fleet during spring 1984 revealed a dense concentration of clams in the Cultivator Shoals area on the western side of Georges Bank. Although the presence of surf clams on Georges Bank has been documented in the past (Merrill and Ropes 1969), only recently have quantitative sampling efforts been conducted to assess resident stocks of surf clam and ocean quahog, Arctiça islandica in the area (Murawski and Serchuk 1983b). Dredging surveys performed by the Northeast Fisheries Center (NEFC) during 1980-1983 were localized in the southern half of Georges Bank to evaluate ocean quahog abundance. Low-level sampling in the central and northern portions of the Bank confirmed the distribution of surf clams in these regions, although the survey data were not sufficient to perform a reliable stock assessment of the surf clam resource.

The rapid development of the Georges Bank surf clam fishery during 1984 necessitated a directed research program to provide managers with adequate information about the extent of the stocks to facilitate rational management of the fishery. During most of 1984, the Georges Bank surf clam fishery was conducted under authority of a research exemption which allowed

the fishery to proceed without quota, effort, or clam size regulation but which required that participants collect biological data and conduct exploratory fishing. This report describes the results of the NEFC research program established to: (1) monitor the quantity, rate, and biological characteristics of clam landings from the Bank, (2) explore and assess the quantity, distribution, and size composition of clam resources throughout the region, and (3) evaluate landings limitations for the area, given a management strategy for Georges Bank surf clam resources identical to that for regulated populations in the Middle Atlantic and Southern New England areas.

#### Research Program

Prior to 1984 a separate Georges Bank area was not recognized in the management scheme for FCZ surf clam resources. Rather, all of New England (east of Montauk Point, New York) was treated as a single management area. A single catch quota (200 thousand bushels during most of 1984) was applied to the New England management area, based on an assessment of the Southern New England surf clam resource (Murawski and Serchuk 1983b). Substantial surf clam landings and very high initial catch rates from the fishery on Georges Bank during spring 1984 led managers to exempt Georges Bank landings from the New England quota rather than risk quota overharvest and potential fishery closures throughout New England. A condition of the Georges Bank quota exemption was that vessels in the fishery were obliged to provide specific data on their fishing practices and to spend a portion of their time conducting exploratory fishing operations so as to define the distribution and density of surf clams on the Bank. Initially, an

informal cooperative NMFS-Industry research program for Georges Bank surf clam resources was established during early July, but was later made a mandatory requirement for surf clam fishing on Georges Bank. The program ran until early October, from which data were gathered for this assessment. Catch quota evaluations for the Georges Bank surf clam resource were based on the explicit management objective that the harvest rate for the Georges Bank resource should be consistent with those for other areas (i.e., Middle Atlantic, Southern New England). These evaluations were based primarily on comparisons of research vessel survey catch data among areas. A similar procedure was employed in assessing harvest quotas for the Southern New England region (Murawski and Serchuk 1983a). To accomplish this exercise, preliminary information about the distribution of clam resources on the Bank was needed before conducting the research vessel survey, so as to efficiently and effectively survey the entire resource. Hence, it was essential that commercial vessels cooperate in fishing areas on the Bank likely to have surf clams and to scout these areas for later intensive research vessel survey sampling. A section of the Bank likely to contain most of the clam resource was identified and subdivided into surveying blocks of 10' latitude by 10' longitude (Figure 1). By assigning a different 10' square to each vessel during a specific time period, it was anticipated that some information from about 40 of the 10' squares would be available before the research survey was conducted. Monitoring of the fishery and the cooperative research program was accomplished utilizing logbook forms similar to those required in other FCZ surf clam fisheries. Additionally, the Northeast Regional Office, NMFS, committed personnel from the International Observer Program to accompany as many vessel trips as

possible to document production and exploratory fishing and to monitor the biological characteristics (clam sizes, by-catch, etc.) of the fishery. These observers were supplemented by NEFC staff who participated on several commercial vessel trips.

Further monitoring of the fishery was accomplished by NMFS port agents who verified commercial catch and effort and area fished data, and obtained size frequency distributions of landings not sampled by at-sea observers. Port agents also collected landings samples for ageing purposes to provide data on the growth rate and age composition of the Georges Bank catch.

A research vessel survey of the Georges Bank area was conducted during 25 July - 1 August 1984, with the NOAA R/V DELAWARE II, using standard clam surveying procedures (see Murawski and Serchuk 1981, 1983b for standard protocol). A stratified random survey was initially designed for the Georges Bank area, with the number of stations allocated to individual survey strata (Figure 2) based on stratum area and on the expected spatial distribution of clams within each stratum. Data from the exploratory fishery conducted prior to the survey were to be used in assigning the number of random stations to every survey stratum. However, due to the few numbers of 10' squares actually explored by the fleet prior to the survey, previous survey and fishery logbook data had to be used to augment the limited exploratory fishing data to derive sampling intensities for the various survey strata.

The Georges Bank surf clam resource proved particularly difficult to survey using standard procedures developed for the Middle Atlantic region. Shallow areas of the Bank (<30 fathoms) are extremely irregular in bottom topography, and the diversity of substrate types is much greater than in the southern region (Figures 3 and 4). Because of the ubiquitous distribution

of rocks, cobbles, pebbles, boulders, etc., much of the survey gear was damaged when attempting to maintain the random station scheme. Observations by NMFS personnel aboard commercial vessels and written comments in logbooks indicated that exploratory fishing operations also resulted in extensive gear loss in many of these areas. Accordingly, survey procedures were modified during the cruise to allow continuation of sampling without jeopardizing the dredge and major components of the survey gear. Time of tow was reduced from the standard five minutes to one-minute duration. Additionally, before the dredge was set at a particular location, an echosounding trace of the bottom was taken to assess the "hardness" of the substrate. Where bottom type was judged to be rocks, etc., the station location was abandoned and the vicinity searched for "towable" bottom.

Catch quota evaluations for the Georges Bank surf clam resource were conducted in the following manner. A stratified mean weight-per-tow index was computed for Georges Bank, in similar fashion to those for Mid-Atlantic assessment regions (Murawski and Serchuk 1984). This index was then multiplied by the area of the Georges Bank survey strata sampled; a similar procedure was performed for the Middle Atlantic region. A Georges Bank landings quota was then computed by relating the ratio of the 1984 Middle Atlantic quota (40,000,000 lbs in meat weight) to the Middle Atlantic stock weight index expanded by area:

$$\frac{40,000,000}{\text{MWPT} \cdot \text{MA}} = \frac{x}{\text{GBWPT} \cdot \text{GBA}}$$

where:

- 40,000,000 = Middle Atlantic surf clam quota in pounds of meats  
( assuming 17 pounds of meat per bushel),
- MWPT = Middle Atlantic weight-per-tow index from NEFC  
research vessel survey,
- MA = the area (in square nautical miles) of the Middle  
Atlantic Region surveyed to derive MWPT,
- GBWPT = Georges Bank weight-per-tow index from the 1984  
NEFC research vessel survey,
- GBA = the area (in square nautical miles) of the Georges  
Bank region surveyed to derive GBWPT,
- x = potential Georges Bank surf clam quota in meat  
weight (pounds).

This formulation assumes a constant ratio between the biomass index and catch quota. As this ratio is a rough approximation of the exploitation rate, it implies that exploitation rates of clams will be similar in both regions, and thus management strategies will be equivalent.

Given the various problems encountered during the 1984 Georges Bank research vessel survey (see above), we assessed the sensitivity of the quota calculation to various methods for standardizing the time of survey tow, and to account for the large proportion of the Bank that is not fishable due to rough bottom. Also, we assessed the sensitivity of the quota calculations by utilizing all available research survey data (1980-1984) in comparison to 1984 data alone, and evaluated the consequences of the survey sampling "missing" a large hypothetical concentration of clams.

## Results and Implications

Data obtained from logbook submissions by vessels participating in the Georges Bank fishery (research program) during 1984 are summarized in Table 1 and Figure 1. A total of at least 17 different vessels participated in the fishery through October 1984. Most of the vessels (82%) were Class 3 (greater than 100 gross registered tons), the remainder were Class 2 (50-100 GRT). The vast majority of participating vessels listed Middle Atlantic locations as home port.

Average catch rate (bushels per hour fished) declined sharply after June, possibly indicating decreased clam abundance in the Cultivator Shoals area (where virtually all landings through mid-August were derived). However, these data should be interpreted cautiously since various vessels participated in the fishery at different times during the year. Several of the largest vessels that fished heavily during June and early July did not fish during the second half of July and early August. Thus, the data are likely confounded by vessel fishing power differences. Nevertheless, the apparent drop in CPUE is striking, particularly since most of the catch and effort was by Class 3 vessels.

Average CPUE for the Georges Bank fishery during 1984 was 121 bushels per hour. This rate is more than double the average CPUE value for the Class 3 fleet in the Middle Atlantic region during 1983 (56 bushels/hour). However, the Middle Atlantic landings were subject to a minimum clam size for landings, which generally required extensive culling of the catch. CPUE for Class 3 vessels in the Mid-Atlantic increased substantially during 1984 as increasing proportions of small clams were landed. Average CPUE for

Class 3 vessels in the Middle Atlantic region during the third quarter of 1984 was 91 bushels/hour, only 25% less than the 1984 Georges Bank average.

Total landings from the Georges Bank surf clam fishery were about 401 thousand bushels through November 1984. Most landings were derived from one 10' square (Figure 1) on the western portion of the Bank. However, during late August-September an additional high density area was exploited by several vessels.

As previously mentioned, little of the expected exploratory fishing effort was conducted prior to the research vessel survey. Only 18 of the 10' squares on the Bank were visited at least once by commercial vessels during 1984 (Figure 1). Only two of the squares contained significant catches of clams; four other areas showed some indication of clam resources.

A total of 19 commercial vessel trips had NMFS observers onboard and an additional 15 vessel trips were interviewed by NMFS port agents. Thus, a relatively large proportion (in excess of 25%) of vessel trips for which logbooks were submitted were accompanied by observer or port agent sampling. Size frequency distributions of clams sampled by the observers at sea and from landings are given in Table 2 and Figure 5. A pronounced mode at 150-159 mm (5.9-6.3 inches shell length), is evident in both data sets, although the observer data showed smaller clams in the population. Average shell sizes in both sets of samples were nearly equal. Ageing analyses performed on three commercial samples of Cultivator Shoals clams revealed that most individuals were nine years old (1975 year class). Mean shell length at age for this cohort (154 mm for age nine during July 1984) was nearly equal to that expected in Middle Atlantic populations (Murawski and Serchuk 1981).

Research vessel survey data are summarized in Tables 2-4 and in Figures 5 and 6. Average catch per tow values varied considerably among survey strata (Table 3). Stratum 67 (the Cultivator Shoals region) exhibited the highest catch rate, and contained the largest clams of the strata sampled. Moderate densities of clams were apparent in Strata 65 and 72. However, clams in these strata were smaller than those in Stratum 67. Catches in most other strata were relatively low. When all survey data are combined into an overall size frequency distribution (Table 2, Figure 5) the large numbers of small clams in survey strata east of Cultivator Shoals become apparent. Average size of clams caught in the research vessel survey was considerably smaller than in either interview or observer samples. This difference is partly reflective of the fact that commercial vessels concentrated on large clams on Cultivator Shoals, and the use of smaller dredge openings in the research vessel gear to retain prerecruit sized clams.

Average catch rates for all research vessel survey data combined (1980-1984) are given in Table 4. These data are not substantially different from the 1984 data taken separately (Table 3).

A distribution plot of all research vessel survey data is presented in Figure 6. These data indicate the high density area on Cultivator Shoals as well as intermittent large clam catches to the northeast. Another concentration of clams is indicated just east of Georges Shoals. These data are consistent with results of exploratory fishing operations conducted by commercial vessels (Figure 1). Although some surf clams are apparently distributed over a wide area on the Bank (Figure 5), fishable concentrations appear to be mostly confined to the northern portion of the Bank. The recently determined U.S.-Canada boundary in the Georges Bank region is plotted along with the distribution of survey catches from the

area. Although relatively little sampling was accomplished on the Canadian side it is likely that little surf clam resource exists there due to the deeper water depths (generally >30 fm) and coarse bottom topography (Figures 3 and 4).

A total of 610 clams obtained from the research vessel survey of the Bank during 1984 were utilized in age/growth studies. Age analyses revealed 20 different age classes on the Bank, with the majority of clams in the 4 to 5 and 8 to 9-year-old groups. Growth rates for shallow areas (less than about 30 fathoms) were similar to long-term growth rates exhibited by Middle Atlantic surf clam populations. Several areas along the northern portion of the Bank (mean depth 30 fm) exhibited distinctly slower growth rates than shallower areas. However, these areas exhibiting slower growth did not represent a large proportion of total clam biomass on the Bank.

Results of nine different quota computations for the Georges Bank surf clam resource, based on the assumption of a similar exploitation rate as in the Mid-Atlantic, are given in Table 5. The various calculations were made to assess the sensitivity of quota calculations to assumptions on the treatment of the Georges Bank survey data. These assumptions relate to: (1) the inclusion/exclusion of survey data from 1980-1983; (2) the treatment of reduced tow time at some stations occupied during 1984; (3) the treatment of nonfishable bottom topography in various survey strata; and (4) the sensitivity of the analyses to an additional hypothetical "hot spot" not sampled by the research vessel.

Average 1984 survey catch per tow in weight for the Middle Atlantic area was 4.24 kg; the area of the Middle Atlantic region is 12,565 square nautical miles. Although the various weight-per-tow and areal values used in

the Georges Bank analyses presented in Table 5 differ, the Georges Bank resource is apparently only a small fraction of the size of the Middle Atlantic resource. Based on these calculations, the Georges Bank resource is about 7-13% as large as the Mid-Atlantic surf clam population. Potential Georges Bank quotas, based on the nine different options for treating the survey data, varied from 161,509 to 340,011 bushels per year. However, the most plausible options (Runs 1, 2, 4, 6, and 9) indicate a quota range of about 250-300 thousand bushels per year for the Georges Bank area. Assuming a conversion factor of 17 lbs/bushel, this represents an annual catch of between 4.25-5.1 million pounds of meats. Annual harvests from Georges Bank in this range could likely be sustained for several years due to the assumed low annual exploitation rate.

### Acknowledgements

We wish to thank all those whose efforts were critical in conducting this assessment of the Georges Bank surf clam resource. Special recognition is due those vessel owners, captains, and crews that participated in the research program and provided data on a timely basis. The International Observer Program Office (NMFS, NER), directed by Ms. Pat Gerrior, provided necessary support to effectively monitor the fishery, particularly at the outset. NMFS port agents Paul Swain, Dea Fried, Dennis Main, and Bill Sprague contributed substantially in assessing the day-to-day shifts in the conduct of the fishery and research program. Scientific personnel and crew aboard the NOAA R/V DELAWARE II conducted their assigned mission often under very difficult logistical conditions. Mr. Chris Gledhill provided an assessment of the length-weight relationship of Georges Bank surf clams necessary to compute the weight-per-tow indices. Mr. Gary Shepherd performed the ageing used to assess the growth rate and age composition of clams based on commercial and research vessel sample data. Finally, we thank Dr. Vaughn Anthony for providing technical review of this assessment.

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Table 1. Monthly catch and effort summary for the Georges Bank surf clam fishery, 1984. Analyses are based on vessel logbook data submitted to NMFS. Total landings through November 1984 were 400,688 bu.

Month	Total Catch (Bushels)	Total Hours Fished	Data for CPUE calculations*		CPUE Bushels/Hour
			Total Catch	Hours Fished	
May	22,929	77	22,929	77	298
June	56,718	238	54,909	238	231
July	89,420	683	83,177	683	122
August	89,344	886.5	74,178	886.5	84
September	87,774	701.5	76,768	701.5	109
October	5,737	44	5,737	44	130
TOTAL	351,922	2630	317,698	2630	121

\*Data used when catch and hours fished were greater than 0 for individual trip records.

Table 2. Length frequencies (%) of Georges Bank surf clams from the 1984 NMFS survey, from port sampling of vessels, and from NMFS observer measurements made aboard commercial vessels, summer 1984.

Shell Length (mm)	Percent Distribution by Size Interval		
	Research Vessel Survey	Interview Samples	Observer Samples
20-29	0.10		
30-39	1.00		0.02
40-49	0.90		0.06
50-59	2.30		0.11
60-69	2.79		0.13
70-79	5.09		0.28
80-89	5.79		0.41
90-99	6.99		0.78
100-109	8.08		1.24
110-119	8.48		2.05
120-129	9.28		4.76
130-139	11.88	5.59	11.33
140-149	16.07	28.07	26.02
150-159	14.77	47.78	34.89
160-169	5.69	18.24	15.83
170-179	0.80	0.32	2.07
180-189	0.00		0.02
190-199	0.01		
Mean Shell Length (mm)	122	153	148
Mean Shell Length (inches)	4.80	6.02	5.83
Number of samples	138*	15	19**

\* - Stratified mean catch per tow (numbers) at length based on 138 survey stations occupied during July-August 1984.

\*\* - Number of vessel trips sampled by NMFS observers; a total of 25,413 clams were measured.

Table 3. Stratified mean numbers of surf clams per tow by size interval in various sampling strata on Georges Bank during July-August 1984\*. Strata boundaries are illustrated in Figure 1.

Shell Length (mm)	Stratum														
	54	57	59	61	63	65	67	68	69	70	71	72	73	74	
20-29						0.14	0.06		0.06						
30-39				0.50		0.85	0.23		0.06				0.13		
40-49	0.33					0.85	0.48	0.14	0.06			0.21			
50-59				0.50		1.40	0.68	0.09	0.28	0.11		0.42	0.13	0.29	
60-69				1.00		1.84	1.44	0.18	0.22		1.14	0.32	0.13		
70-79	0.33			1.00		2.99	2.33	0.27	0.44		0.86	1.26	0.25		
80-89	0.67			0.50		6.09	2.43	0.23	0.22	0.11	1.29	1.58	0.50		
90-99	0.33					10.66	2.06	0.45	0.06		1.00	2.74	0.25	0.14	
100-109	0.33					9.57	2.52	0.23	0.11	0.11	1.86	4.21	0.13	0.29	
110-119	0.33					11.43	3.15	0.18			2.43	4.32			
120-129	0.67					11.33	7.39		0.06		4.29	3.26			
130-139						6.34	17.71				2.43	3.58			
140-149						1.65	36.11	0.09	0.39		1.14	2.21			
150-159							34.99		0.89		0.14	1.21			
160-169							14.83		0.28			0.11			
170-179							1.50		0.17						
180-189															
190-199									0.06						
Total Numbers Per Tow	3.00	0.00	0.00	3.50	0.00	65.14	127.90	1.86	3.33	0.33	16.57	25.42	1.50	0.71	
Number of Tows	3	1	2	2	2	7	31	22	18	9	7	19	8	7	

\*Survey included some 5-minute and some 1-minute tow durations.

Table 4. Stratified mean number of surf clams per tow during NMFS surveys of Georges Bank, 1980-1984. Surveys were conducted aboard the NOAA R/V DELAWARE II utilizing a 1.5-meter (60-inch) wide hydraulic clam dredge.

Stratum	Mean Number Per Tow	Number of Tows	Proportion of Georges Bank Area**
54	2.2000	5	0.0302
55	0.5000	2	0.0396
57	2.0000	4	0.0200
59	0.2500	12	0.0585
60	0.0000	2	0.0881
61	0.5714	14	0.0627
62	0.0000	3	0.0763
63	0.5000	8	0.0755
64	0.0000	2	0.1075
65	56.0000	12	0.0178
66	0.0000	1	0.0289
67	121.4848	33	0.0228
68	2.0000	27	0.0403
69	2.5455	33	0.1021
70	1.2778	18	0.0566
71	14.6250	8	0.0159
72	27.3077	26	0.0548
73	1.3529	17	0.0545
74	0.8462	13	0.0471

\*Survey tows during 1980-1983 were 5 minutes duration, tows during 1984 were 1 and 5 minutes duration.

\*\*See Figure 1 for Stratum Areas.

Table 5. Calculated Georges Bank surf clam quotas (bushels and meat weight in pounds) for nine different sets of assumptions about NMFS survey data. Quotas were computed assuming the same ratio of biomass index to landings as in the Middle Atlantic management area.

Run Number	Assumptions	Calculated Georges Bank Surf Clam Quota	
		Bushels	Pounds
1	All survey data used (1980-1984), No time of tow standardization, portions of stratum areas not discounted for nonfishable bottom	234,677	3,989,511*
2	Same as run 1 except only 1984 survey data used	243,816	4,144,872
3	Same as run 1 except all non-zero catches from 1980-1983 not used	224,887	3,823,080
4	All non-zero catches from 1980-1983 surveys deleted, one large tow added to Stratum 72	290,411	4,936,994
5	All non-zero catches from 1980-1983 surveys deleted, one minute survey tows during 1984 were standardized by doubling catches	340,011	5,780,199
6	Discount portions of stratum areas to account for nonfishable bottom areas, other conditions same as run 5-**	237,107	4,030,813
7	Same as run 6 except time of tow standardization not performed	161,509	2,745,649
8	Same as run 7 except all data for 1980-1984 are used	165,768	2,818,053
9	Same as run 5 except all data for 1980-1984 are used	302,757	5,146,864

\*- Assuming 17 pounds of meats per bushel

\*\*-Proportions of strata assumed fishable: 54-0.90, 55-0.90, 57-0.80, 59-1.00, 60-1.00, 61-1.00, 62-1.00, 63-0.60, 64-0.50, 65-0.50, 66-0.50, 67-0.80, 68-0.75, 69-0.70, 70-0.75, 71-0.70, 72-0.50, 73-0.50, 74-0.70 [based on data in Wigley (1961); Wigley et al. (1976), and observations during survey operations].

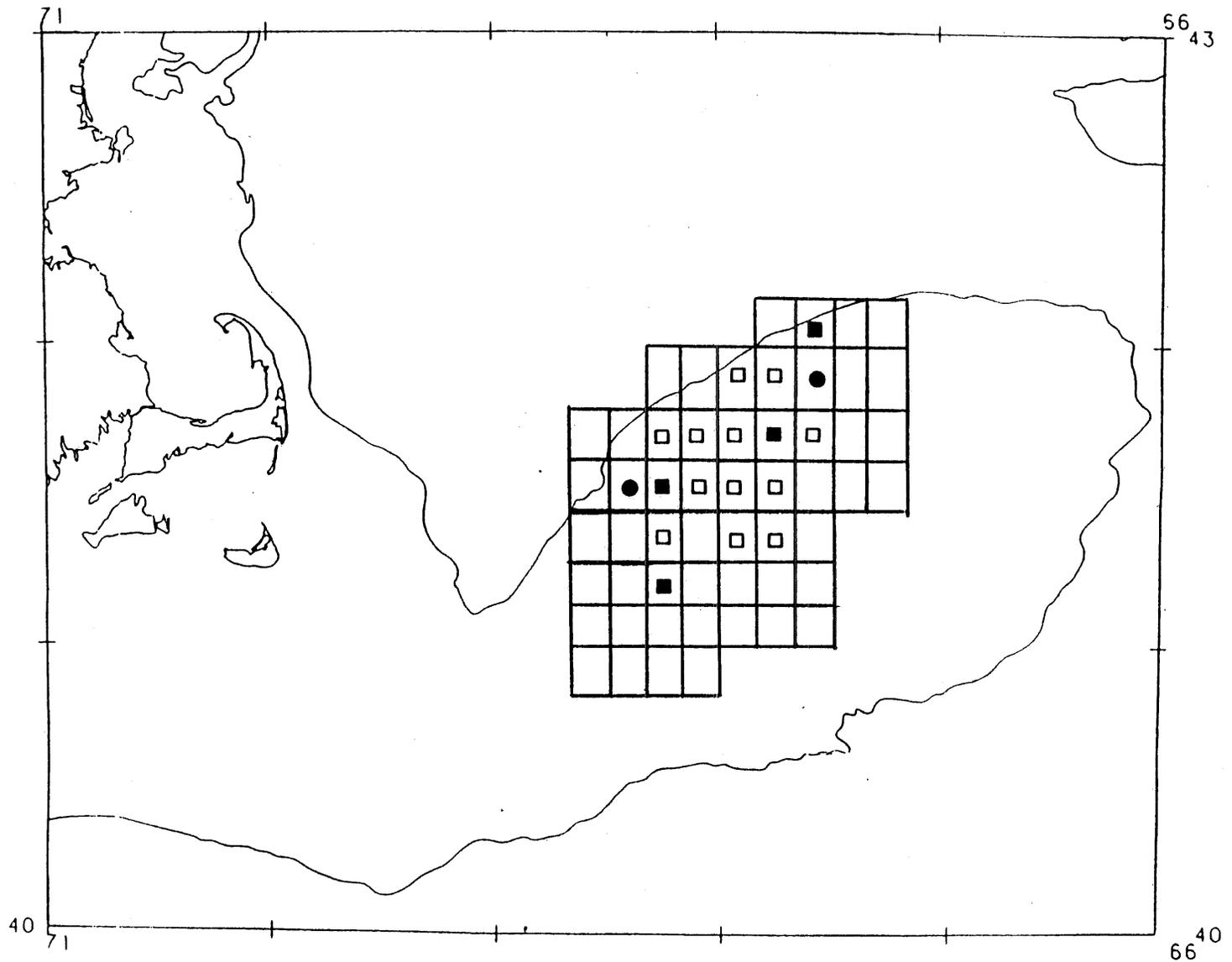
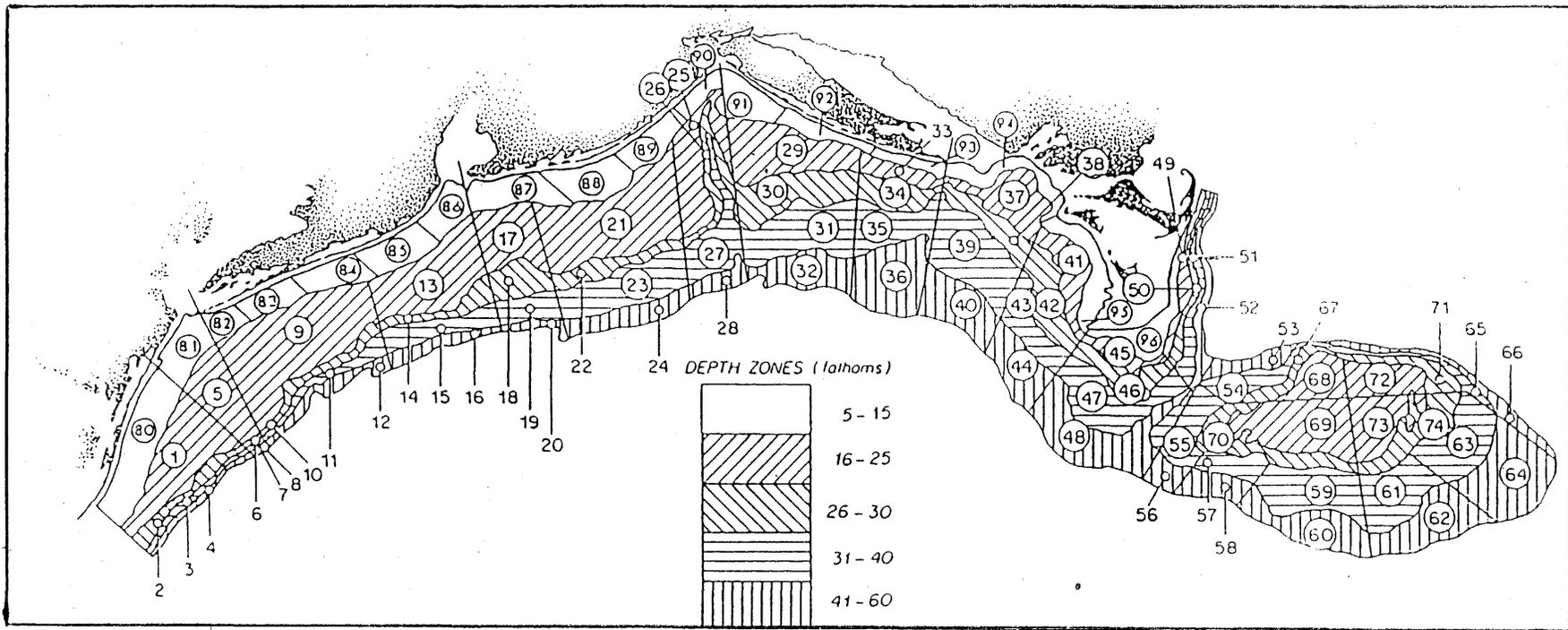


Figure 1. Ten minute latitude by ten minute longitude squares on Georges Bank where commercial vessels explored for surf clams, summer 1984. Open squares indicate little evidence of clam concentrations, closed squares indicate some fishable resource, closed circles indicate significant fishable concentrations of clams.



Southern Va.-  
North Carolina

Stratum	Miles
1	1,163
2	175
3	126
4	117
5	453
6	62
7	46
8	74
80	767
81	360

Delmarva

Stratum	Miles
9	2,171
10	152
11	229
12	204
13	1,127
14	219
15	394
16	211
82	180
83	241
84	417
85	382
86	203

New Jersey

Stratum	Miles
17	749
18	249
19	274
20	120
21	1,650
22	312
23	714
24	476
25	648
26	188
27	451
28	149
87	479
88	578
89	382
90	182

Long Island

Stratum	Miles
29	1,096
30	669
31	932
32	627
33	363
34	203
35	601
36	694
91	340
92	191
93	83

Southern  
New England

Stratum	Miles
37	672
38	280
39	967
40	573
41	602
42	343
43	432
44	383
45	392
46	416
47	871
48	1,109
49	244
50	150
51	139
52	307
94	229
95	446
96	495

Georges Bank

Stratum	Miles
53	268
54	278
55	364
56	209
57	184
58	300
59	538
60	810
61	576
62	701
63	694
64	988
65	164
66	266
67	210
68	370
69	938
70	520
71	146
72	504
73	501
74	433

Figure 2. Ocean quahog and surf clam survey strata off the northeast United States. Survey strata comprising each of six assessment areas are listed, along with the area (square nautical miles) of each.

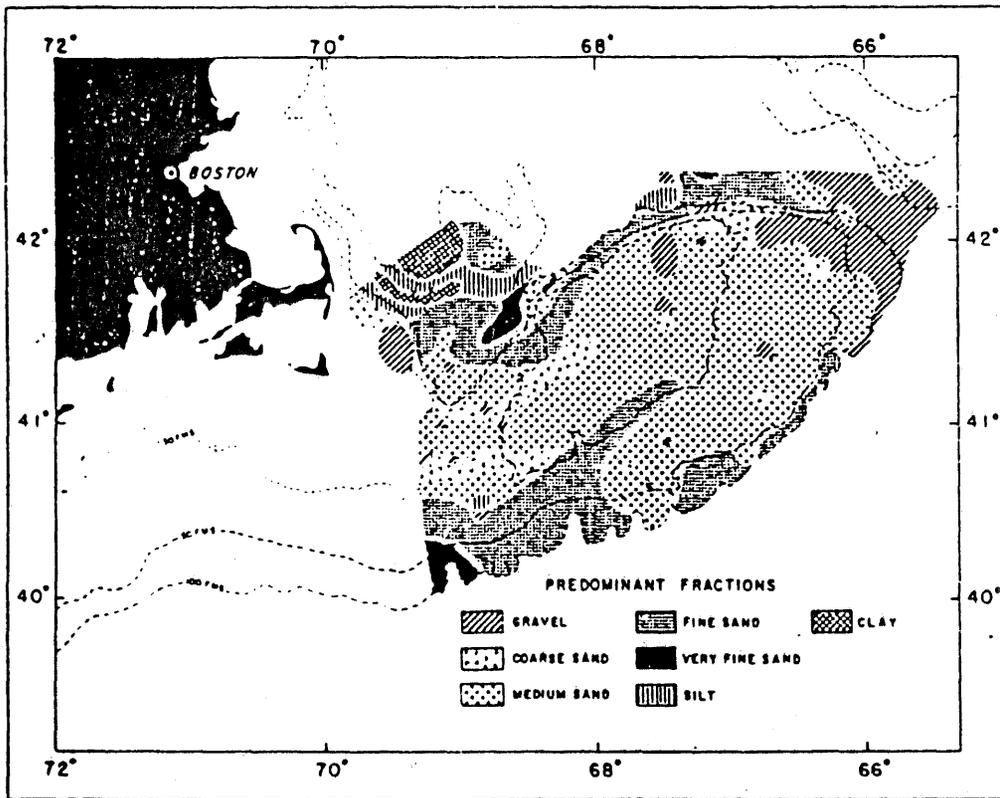


Figure 3. Geographic distributions of various sediment fractions (types) in the Georges Bank area. Figure is from Wigley (1961).

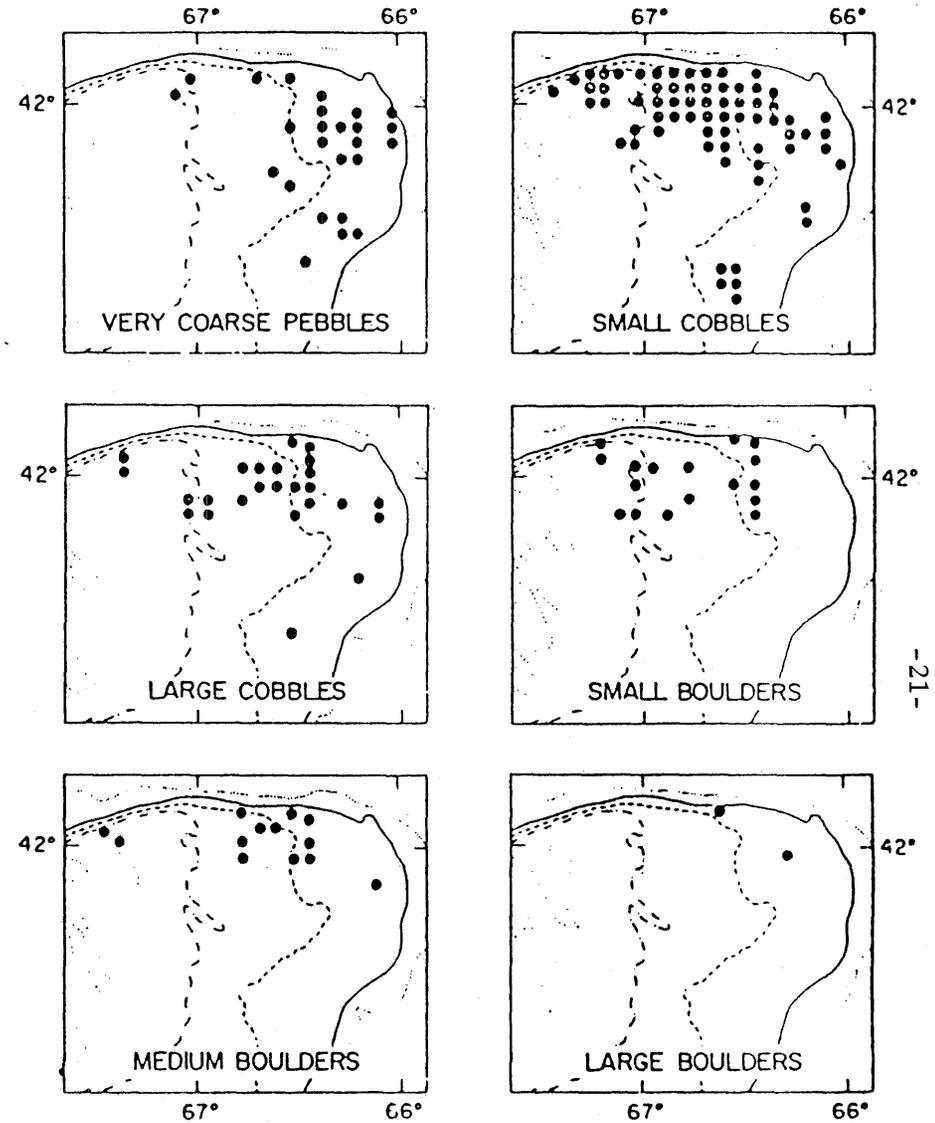


Figure 4. Geographic distribution of various classes of gravels on eastern Georges Bank. Figure is from Wigley et al. (1976).

# GEORGES BANK SURF CLAM--1984

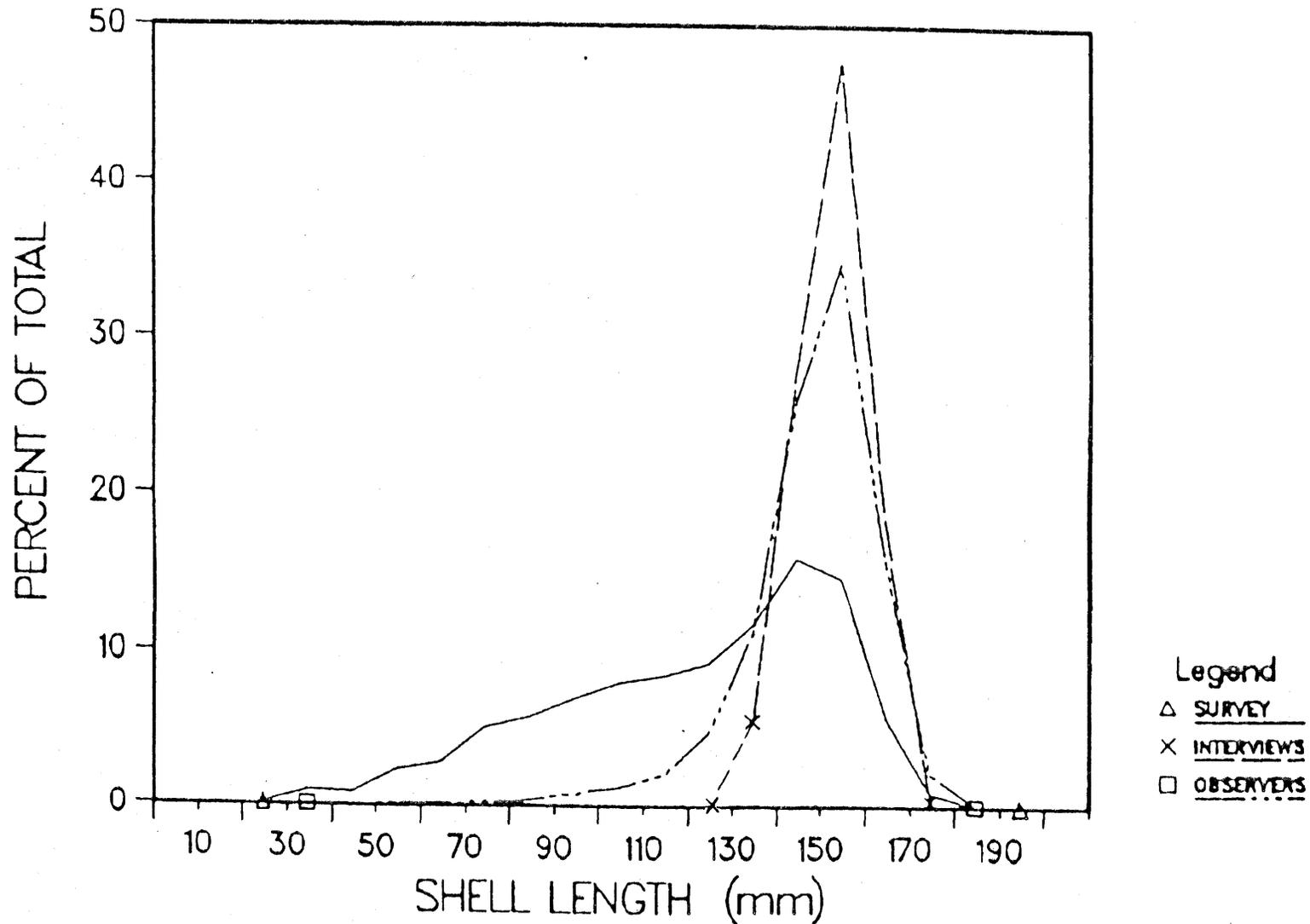


Figure 5. Size frequency distributions of surf clams on Georges Bank, 1984, as indicated from three different data sources. Solid line is the NEFC clam survey conducted during July-August 1984, dashed line represents data from port agent interview samples, dotted-dashed line is from NMFS observers aboard commercial vessels.

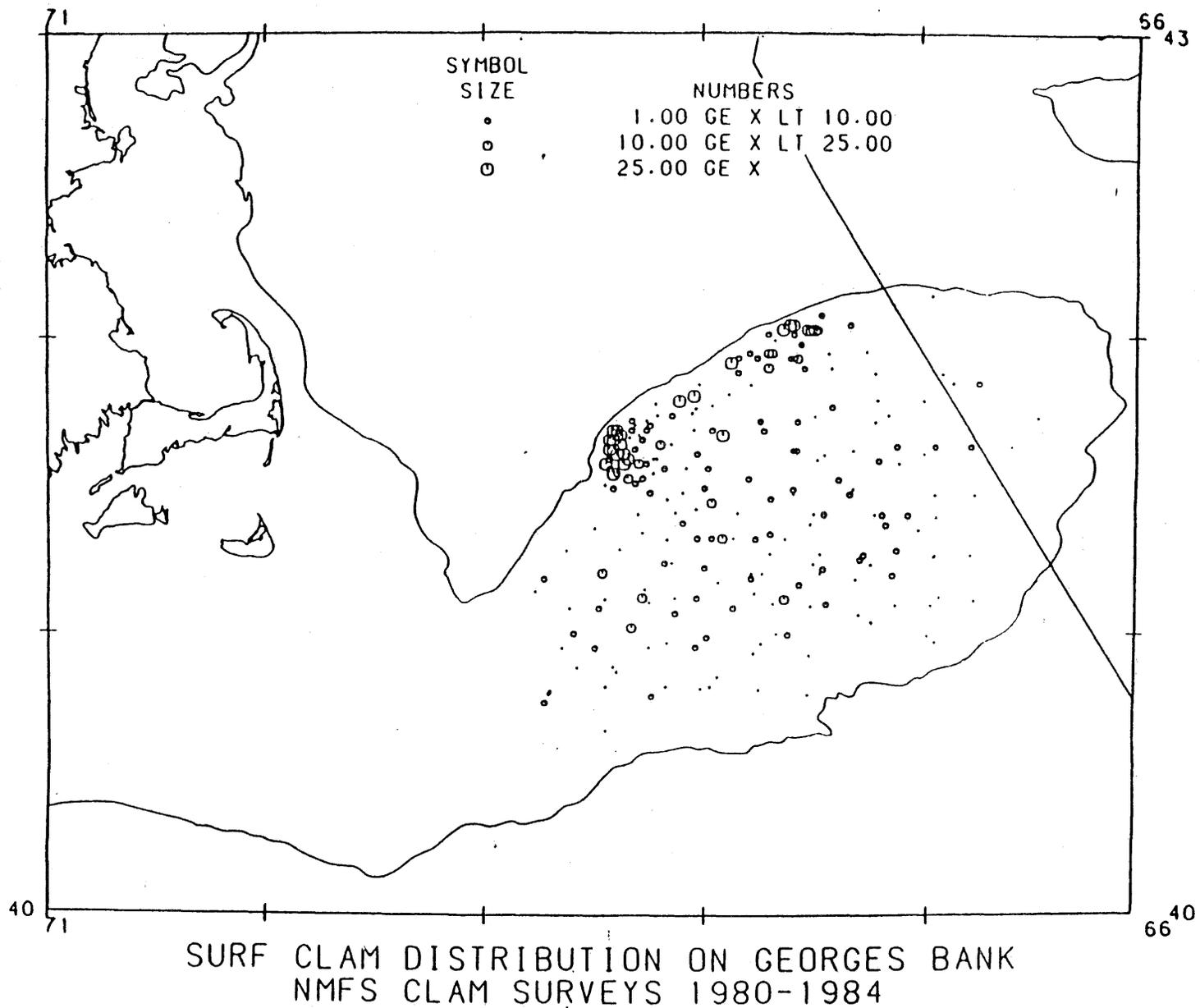


Figure 6. Distribution of surf clam catches during NEFC clam surveys of Georges Bank, 1980-1984. Small closed dots indicate survey locations where no clams were caught. Open circles indicate survey catches in numbers of clams. Diagonal line indicates approximate U.S.-Canadian boundary in the Georges Bank region.