Scallop Fishing Grounds on the Scotian Shelf - 1985

by

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ABSTRACT

On the Scotian Shelf, scallop beds occur on Middle Ground, Sable Island/Western Bank, Browns Bank/Tusket, German Bank/ Lurcher Shoals, and the outer Bay of Fundy. Historically, these grounds had never sustained production (measured by catch) for more than a few years until the 1980's when significant effort was diverted to these beds by both the Bay of Fundy fleet (vessels under 19.8m) and the deep-sea fleet (vessels over 19.8m). These grounds have traditionally been considered as second choice to the more proximate Digby grounds (Bay of Fundy fleet) or to the more lucrative Georges Bank (deep-sea fleet). However, in 1985 there has been an important decrease in the number of vessels fishing the Scotian Shelf, stock abundance becoming depleted.

Middle Ground research survey indices show limited quantities of older animals (age 5+) with no sign of prerecruits. In the Sable Island/Western Bank area, all year-classes were represented. On Browns Bank/Tusket, scallops are absent except for a high contingent of age 2 animals. Previous dense concentrations of juveniles have been reduced drastically due, in all likelihood, to significant flatfish predation. German/Lurcher and the outer Bay of Fundy are characterised by decreasing numbers of much older animals (age 10+). Recruitment to these areas is generally sporadic.

With promising outlook for Georges Bank stocks, it is doubtful that the Scotian Shelf will attract a substantial fishing activity in the near future, except maybe for the Sable Island area.

RESUME

Sur le plateau néo-écossais on trouve des bancs de pétoncles sur Middle Ground, la région de l'Ile de Sable et le banc Western, le banc Browns et Tusket, le banc German et les haut-fonds de Lurcher, et les approches de la baie de Fundy. Du point de vue historique, ces bancs n'ont jamais produit d'une façon soutenue d'après les captures, pour plus de quelques années jusqu'en 1980 et subséquemment lorsque la flottille de la baie de Fundy (bâteaux de moins de 19.8m) et la flotte hauturière (bâteaux de plus de 19.8m) y ont appliqué un effort de pêche important. Ces régions avaient traditionellement été considérées comme second choix aux bancs de pétoncles de Digby plus proches (flottille de la baie de Fundy) ou au banc Georges plus lucratif (flotte hauturière). Cependant, 1985 a été témoin d'une baisse appréciable du nombre de bâteaux opérant sur le plateau néo-écossais, l'abondance des stocks ayant subi des réductions importantes.

Les indices d'inventaires de recherche révèlent des quantités limitées d'animaux plus vieux (âge 5+) et aucune évidence de prérecrues sur Middle Ground. Toutes les classes d'âge sont représentées dans la région de l'Ile de Sable et du banc Western. Le banc Browns/Tusket n'a pas de pétoncles sauf pour un contingent élevé d'animaux de deux ans. Antérieurement, d'importantes concentrations de juvéniles ont subi des réductions drastiques dû, en toutes probabilités, à une prédation intensive par des poissons plats. German/Lurcher et les approches de la baie de Fundy sont characterisés par un nombre décroissant de pétoncles beaucoup plus vieux (âge 10+). Dans ces régions, le recrutement est généralement sporadique.

Vu l'état prometteur des stocks du banc Georges, il est douteux que le plateau néo-écossais attire un niveau substantiel d'activité de pêche dans le proche avenir, sauf peut-être pour la région de l'Ile de Sable.

INTRODUCTION

This document updates the recent (1979 onward) profile of the scallop stocks and their exploration on the Scotian Shelf from Robert et al (1985). Scallop grounds on the Scotian Shelf include from east to west (Fig. 1) Banquereau Bank, Middle Ground, the Sable Island area and Western Bank, Browns Bank (south side, north side: Tusket area), German Bank, Lurcher Shoals, the outer reaches of the Bay of Fundy (i.e. downstream from a line drawn across the Bay from Brier Island, N.S. to Grand Manan Island, N.B.), and Southwest Bank. The importance of the scallop fishery on the Scotian Shelf has been inversely related to the stock status of the more productive Georges Bank. The relative contribution of Scotian Shelf grounds and Saint Pierre Bank also exploited during 'lean' years on Georges Bank is given on Figure 2. Since the biological information presented in Robert et al (1985), knowledge on growth has improved markedly and has been incorporated in the present report. Yield per recruit analyses have not been upgraded since Robert et al (1985).

A segment of the annual stock survey on Browns Bank (southeast edge) was devoted to look specifically at the area where an important year-class (1981 year-class) had been discovered in 1983.

METHODS

Fishery Information

There are two sources of information to estimate the respective contributions of scallop fishing grounds on the Scotian Shelf. The Statistics Division, Department of Fisheries and Oceans, Halifax, compiles, on a yearly basis, landings by vessel size and by NAFO sub-subareas. Log information as to the origin of the catch provided by vessels is the other source. There are at times discrepancies between statistical and logged catches as NAFO sub-subareas are not tailored to the physical location of particular scallop beds and may cut a major scallop bed in two. This inadequacy of the statistical system was previously presented in Robert et al (1984).

All vessels (over 25.5 G.T. or 14m L.O.A.) fishing the Scotian Shelf are required to keep logbooks in which daily fishing activities are recorded. Daily log records supply information on the catch and its location and fishing effort such as hours spent fishing, width of gear, and number of crew. Catch-rate estimates may be computed when complete effort data are provided with respect to the catch (Class 1 data). Total effort may be estimated according to the effort that generated the catch for which all information (location, hours fished, gear, etc.) is available. The productivity of a specific ground may also be established assuming that the catch with known location is representative of the total catch from that ground.

Scallop Fleets

Two components of the Canadian offshore fleet may drag for scallops on the Scotian Shelf. The deep-sea fleet, L.O.A. over 19.8m is excluded from a 12 nautical miles zone near-shore and the Bay of Fundy. The Bay of Fundy fleet, L.O.A. between 14 and 19.8m mostly (Bay of Fundy-licensed vessels), may fish scallop beds in the Bay of Fundy and other areas of the Scotian Shelf.

Despite the different size of vessels, both fleets used an offshore-type scallop drag which width may vary from 2.4 to 4.9m (8-16 feet). The Bay of Fundy fleet fishes only one drag at a time while the deep-sea fleet fishes two drags simultaneously, one on each side; these are slightly wider than the ones used by the Bay of Fundy fleet. On occasion, a Bay of Fundy vessel may use a gang of Digby-type drags.

Catch Sampling

Catch sampling information is available for the deep-sea fleet only. Port coverage varies greatly so that fishing areas like German/Lurcher off southwest Nova Scotia have not been given good coverage. Yarmouth and Saulnierville-based vessels are the main users of those grounds. Since the exploitation of scallop grounds on the Scotian Shelf is somewhat irregular and does not necessarily take place year after year, sampling of the catch is sporadic. The port sampling data was checked against the log data base from 1979 onward to verify the origin (as per NAFO sub-subareas) of catches that were sampled. This led to a few changes in the catch sampling data; they are given in this report.

Survey Procedures on the Scotian Shelf

The catch distribution derived from log records for each particular fishing ground is used to randomly stratify survey stations. Catches from the deep-sea fleet over the year prior to the survey are considered. Annual surveys are carried out during May on a Goverment research vessel. In 1985, an additional stratum, 'exploratory' was tagged on the Browns Bank stock survey in an area that had revealed high numbers of age 2 scallops previously.

A 2.44m wide New Bedford offshore dredge (75-mm ring size) lined with 38-mm stretch mesh polypropylene netting was the survey gear on Middle Ground, Sable Island and Western Banks, and Browns Bank. Due to extremely rough bottoms, the lining was removed for fishing German/Lurcher.

Tows were of ten minutes duration; distance towed was determined either from Loran C bearings, start-end of tow, or from continuous recording via a desk-top computer. Catches were later standardised to a tow length of 800m. For each tow, the following data were recorded: 1) shell heights in 5-mm intervals for all live scallops and cluckers (shells with both valves still attached at the hinge); 2) tow location with Loran C bearings; 3) depth (m);

4) compass bearing for direction of tow; 5) duration of tow in minutes; 6) substrate type; 7) count of the number of vertical rings covered by the catch; and 8) total scallop catch as a round weight.

Biological Information Supporting the Fishery Analysis

Only essential information such as growth-rate and meat yield for a given shell height are discussed here. For most fishing areas, the number of samples examined is limited. Data presented here are an integral part of a study in progress. Table 1a) presents variables of von Bertalanffy growth curves and the number of scallop shells that have been ring-read for each area. It also gives the parameters for estimating meat yield as a function of shell height and the number of animals examined. In an attempt to reduce seasonal effects in yield conditions, samples collected at all times of the year have been included in the analysis to approximate a 'year round' value. This set of data was used in the analysis of the stock survey data for the different areas. Since then, more biological information has been processed (including material collected during 1985). Given a larger number of samples the majority of the biological variables change little except for meat yield from the Lurcher Shoals (Table 1b).

Figure 3 shows shell height at age for different areas derived from von Bertalanffy growth curves (values from Table 1a). Of the areas looked at, Middle Ground has the fastest growth-rate while Browns Bank has the slowest. Even though German Bank and Lurcher Shoals are geographically adjacent to each other, the growth-rate of scallop beds above latitude 43°50'N, i.e. Lurcher Shoals and the outer reaches of the Bay of Fundy is significantly ($P<0.01$ level) better than on German Bank, below latitude 43°50'N.

RESULTS

Scallop Fleets

Previous to 1984, over 100 vessels from the deep-sea fleet and the Bay of Fundy fleet were exploiting scallop grounds on the Scotian Shelf (Table 2). This activity has steadily declined in 1984 and 1985.

For both fleets, the Scotian Shelf fishery is not a feature as permanent as the Georges Bank fishery for the deep-sea fleet and the traditional scallop grounds within the Bay of Fundy for the Bay of Fundy fleet. These grounds are exploited on an opportunistic basis or when the principal (Georges Bank, Digby) stocks are in a depleted condition.

To give methodical coverage to all fishing areas (Fig. 2) (from east to west), each area will be looked at with respect to: a fishery profile, an estimate of its productivity in terms of distribution of scallop beds and abundance, catch sampling, and survey results.

Middle Ground

Middle Ground(s) is the shallowest scallop fishing area of the Scotian Shelf with an average depth of 45m. It is located in NAFO SA 4W north of latitude 44°N and west of longitude 60°W. According to logged fishing locations, commercial densities of scallops would occur in an area of 500 nautical miles^2. Its fishery characteristics are found in Table 3. With a sporadic production, maximum of 105 t in 1983, it does not appear that good catch-rates may be maintained. Figures 4 to 7 illustrate the gradual intensification of exploited grounds from 1980 to 1984, catches coming from a greater number of ten-minute squares (TMS); up to 1983 catches increased from a particular TMS. As Table 4 indicates, the catch was sampled somewhat adequately in 1983-1984; the average scallop meat weight represented fairly large (105-120 mm) mature scallops.

Tables 5, 6, and 7 report stock survey findings. A relatively slight pulse of age 5 scallops observed in 1983 (Table 6) was rapidly depleted as later results indicate. Even though the gear was lined, there has not been a sign of prerecruits.

Sable Island/Western Bank

Since 1980 commercial quantities of scallops have been fished in a small area (60 nautical miles^2) of Western Bank, at the edge of the Continental Shelf, southwest of Sable Island itself within the 50-m isobath (Figs. 4-7). Catches appear to have stabilized (Table 3); catch-rates, although at a low level, have also been consistent (average 0.220 kg/crhm). Fishing areas (on a TMS basis) have been extending continuously over the years. However, it appears that the productivity per TMS is somewhat declining after 1983 (Figs 4-7). The sampling of the catch (Table 4), somewhat sporadic, show a diversity of annual mean weights, from 9.46 in 1980 to 27.41 g in 1985 as exploration led to more intensive exploitation of some beds and included some grounds geographically dispersed. In 1984-1985, areas in the immediate vicinity of Sable Island provided the fleet with extra large scallops. Survey results (Tables 5-7) show a good stock profile, all year-classes being represented with a large number of prerecruits (especially observed during the 1985 survey).

Browns Bank/Tusket area

When commercially important, scallop aggregations are found along the southern edge of Browns Bank (NAFO sub-subarea 4Xp) around the 100-m isobath, and on the northern side of Browns Bank (Tusket, NAFO sub-subarea 4Xo) but in much deeper waters.

These scallop beds are exploited by both fleets, the deep-sea fleet landing more than the Bay of Fundy fleet (Table 8). Despite discrepancies between statistical landings and logged catches, the scallop production from the Browns Bank area has

decreased erratically; the same may be said for catch-rates. Figures 8-13 map the productivity on a TMS basis; it has declined markedly in 1984. The meat weight distribution in the catch (Table 9) varies greatly on an annual basis but the percentage examined is too small to draw any conclusion; no catch from Browns Bank was looked at in 1985. Browns Bank represents the lowest yield per recruit values encountered from Scotian Shelf scallop fishing grounds.

Survey characteristics are given in Tables 10-12. Although age 2 scallops are not caught effectively by the survey gear, this is the only age-class caught in any quantities during the last three annual surveys. According to the 1983 results i.e. high abundance of age 2 scallops, 1981 year-class, one would have expected some indications of this year-class in the 1984 results although station locations are not exactly replicated year after year. Abundance of the 1981 year-class from 1984 results is difficult to reconcile with results from the previous year. In 1985, an exploratory stratum targeting the specific area of high juvenile abundance in 1983 showed high numbers of juveniles (age 2) again but in addition, a large number of cluckers for that particular year-class. For 244 age 2 live scallops per standard tow in 1985, 180 cluckers were counted giving a ratio cluckers/live scallops of 0.74 which is extremely high.

German Bank/Lurcher Shoals and Outer Reaches of the Bay of Fundy

NAFO sub-subarea 4Xq includes German Bank and the lower half of the Lurcher Shoals (up to latitude 44°N); the upper half of Lurcher Shoals is part of sub-subarea 4Xr. Statistical landings and logged catches for both fleets (Tables 13 and 14) diverge for these respective areas illustrating the misrepresentation resulting from the statistical areas boundaries as presently set. Biological differences exist between German Bank and Lurcher Shoals; growth-rate being slower on German Bank relative to Lurcher Shoals and the outer reaches of the Bay of Fundy.

Despite their inadequacies, general trends of declined fishable stocks show in Tables 13 and 14 especially the 1985 figures. Catch-rates have also decreased to low levels. All potential grounds have been given extended coverage (Figs 8-13). The production of some TMS from Lurcher was comparable to some TMS on Georges Bank for a few years. However, the 1984 map shows a decrease in TMS outputs. Sampling of the catch (Table 15) has been less than 0.01 % of the catch landed four years out of six; it did not take place in 1985. Mean size of meats shucked vary from 11 to 23 g on a per annum basis.

The research gear was not lined during surveys on these grounds which are extremely rough; it therefore, does not provide any indication of prerecruits. Tables 16-18 have survey results for the past three years. This area is characterised by old (age 7+) scallops but their abundance is declining.

Southwest Bank

A few vessels have fished the deeper waters of NAFO subsubarea 5Yb; level of catches have not been significant though. An inshore fleet from Grand Manan Island expends the most effort in this statistical area (see Grand Manan stock evaluation for 1985 in Robert and Lundy 1986).

DISCUSSION

Status on Productivity

According to historical catches, Scotian Shelf scallop fishing grounds had never produced catch levels such as the ones encountered recently. Moreover, production as determined from catch, had never been sustained for a time period of 5 years or more before. But then, these grounds have traditionally been considered as second choice to the more lucrative Georges Bank by the deep-sea fleet. It is only recently that the lowest Canadian catches on record have been registered for Georges Bank (1,945 t in 1984). The Scotian Shelf may have been an unrealised potential for some time.

Although actual catch-rates on the Scotian Shelf are comparable to the ones on Georges Bank if they are not slightly higher, the stock abundance is getting depleted nowadays. With promising outlook for Georges Bank stocks, it is doubtful that the Scotian Shelf will generate a substantial fishing activity in the near future, except maybe for the Sable Island area.

As of 1985, landings in NAFO subarea 4X i.e. Browns, German, and Lurcher have been very low. Research surveys have not revealed any quantities of recruits nor prerecruits. In NAFO subarea 4W landings are still relatively important but declining. However, significant numbers of all age-groups have been observed during the latest stock survey in the Sable Island area.

Recruitment on Browns Bank

Large number of age 2 scallops have been observed during Browns Bank stock surveys on several occasions to disappear prior to their presence as age 3 animals being noted during the course of the next annual survey. Because of the randomly catch stratified survey design, the surveyed locations are not necessarily duplicated from year to year, hence dense but highly localised patches of juveniles could be missed easily during normal survey procedures. Juveniles might have moved away 'somewhere' although there is no evidence yet of strong directed movements in post-metamorphose scallops. Mass mortalities may have taken place on the 1981 year-class and gone unnoticed. The annual survey

took place in May 1983; in August 1983, an interim mini-survey revealed that juveniles were still there and alive. Mortalities had to occur between August 1983 and the next May survey (1984). According to Dickie (1955) and Merril and Posgay (1964), a 9-month period would be more than sufficient for small cluckers (25-mm shell height approximately) to desarticulate and a massive death phenomenon to go unnoticed. The valves of the shell would have yet to disintegrate though.

The high ratios of clucker/live scallops of yet another seemingly abundant year-class from the exploratory stratum of the May 1985 survey show that mass mortalities are likely although the cause(s) remains unknown. One may discard the possibility of a non-natural cause like incidental fishing mortality; very low fishing activity levels in 1984 and 1985 may not have contributed to the collapse of a year-class.

One possible cause may be heavy predation by flatfish. In late 1983 fishermen observed, in the Browns Bank area, flounders with stomachs heavily laden with small size scallops. Naidu (pers. comm.) has investigated flatfish predation on scallops on Saint Pierre Bank. According to his data, flatfishes were feeding on both the Iceland scallop (*Chlamys islandicus*) and the deep-sea scallop (*Placopecten magellanicus*) at discrete time periods during the year. They seem to predate more heavily on the former. The mean size (per fish length intervals 30-73 cm) of deep-sea scallops ingested ranged from 15 to 45 mm. Such values match shell heigths reached by age 2 deep-sea scallops from Browns Bank. There is no known concentrations of Iceland scallops on Browns Bank. Flatfish could be held responsible for the large disappearance of juvenile scallops. Depending on the distance traveled by the fish during the digestion of their scallop meal(s), shells would not necessarily be dropped in the vicinity of the live scallop concentrations. As such, a juvenile year-class may disappear with few traces left behind.

If such recruitment failures are repeating themselves, it does not offer Browns Bank scallop stocks great opportunities for recovery.

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Table 1a.-Biological data on growth-rate and meat yield for scallop fishing grounds on the Scotian Shelf. N = number of scallops examined.

	Growth	Yield
Middle Grounds	N = 357 H_{inf} = 162.765mm t_0 = 1.3248 k = 0.1803	N = 169 intercept = -10.450 slope = 2.840
Sable, Western Bank	N = 963 H_{inf} = 139.159mm t_0 = 1.4209 k = 0.2096	N = 507 intercept = -10.632 slope = 2.800
Browns Bank	N = 368 H_{inf} = 113.074mm t_0 = 1.3708 k = 0.2664	N = 360 intercept = -16.655 slope = 4.093
German Bank	N = 600 H_{inf} = 130.945mm t_0 = 1.3870 k = 0.2300	N = 420 intercept = -13.395 slope = 3.404
Lurcher Shoals	N = 566 H_{inf} = 155.775mm t_0 = 1.2231 k = 0.1755	N = 327 intercept = -8.688 slope = 2.416

Table 1b.- Improved biological data on growth-rate and meat yield (year round values) for scallop fishing grounds on the Scotian Shelf. N= number of scallops examined.

	Growth	Yield
Middle Grounds	N = 387 H_∞ = 161.532mm t_0 = 1.3363 k = 0.1846	N = 289 intercept = -10.752 slope = 2.890
Sable, Western Bank	N = 1087 H_∞ = 139.082 t_0 = 1.3786 k = 0.2103	N = 1112 intercept = -10.751 slope = 2.818
Browns Bank	no change	N = 420 intercept = -16.265 slope = 3.997
German Bank	no change	N = 598 intercept = -13.750 slope = 3.463
Lurcher Shoals	no change	N = 565 intercept = -11.791 slope = 3.052

Table 2.- Number of vessels by fleet involved in fishing scallop grounds on the Scotian Shelf as per log information.

Fleet	1979	1980	1981	1982	1983	1984	1985
Bay of Fundy	38	37	44	45	27	29	14
Deep-sea	75	75	76	75	73	50	34
Total	113	112	120	120	100	79	48

Table 3.- Fishery characteristics for the Middle Grounds area (NAFO 4WE) for the deep-sea fleet. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries & Oceans, Halifax. Effort pertaining to Class 1 catch only.

Year	Landings	Logged catches	Class 1 catch	Effort(crhm)	CPUE(kg/crhm)
1979	-	-	-	-	-
1980	3.65	1.42	1.42	5,434	0.262
1981	-	-	-	-	-
1982	72.39	60.20	59.24	115,613	0.512
1983	105.16	104.92	100.59	309,055	0.325
1984	11.90	9.94	8.34	47,585	0.175
1985	26.89	21.59	21.59	99,345	0.217

Fishery characteristics for Sable Island and Western Bank (NAFO 4WJ)

1979	-	-	-	-	-
1980	60.99	50.48	50.48	217,362	0.232
1981	0.56	0.00	0.00	0	-
1982	64.10	59.69	59.69	237,538	0.251
1983	185.15	165.88	163.86	882,760	0.186
1984	71.30	63.11	62.04	362,924	0.171
1985	64.93	76.00	76.00	294,217	0.258

Table 4.- Nature of the catch from NAFO SA 4W determined by the analysis of scallop meat weights.

	% catch examined / catch landed	meat weight (g) mean	min	max	s.d.
Middle Grounds					
1983	0.0240	20.00	3.04	69.99	0.13
1984	0.0392	14.84	4.23	46.97	0.14
1985	0.0175	22.88	6.31	66.40	0.22
Sable Island/Western Bank					
1980	0.0133	9.46	3.87	22.11	0.04
1981	-	-	-	-	-
1982	0.0015	9.15	4.65	15.38	0.11
1983	0.0339	13.49	2.25	72.43	0.04
1984	0.0161	11.10	2.65	42.48	0.07
1985	0.0025	27.41	11.27	54.30	0.52

Table 5.- Number of survey stations in NAFO SA 4W by year and by stratum types.

Middle Grounds	1983	1984	1985
low catch	4	8	5
medium	4	-	-
high	12	12	5
total	20	20	10

Sable, Western Bank	1983	1984	1985
low catch	N/A	14	7
medium	N/A	13	25
high	N/A	13	8
total		40	40

Table 6.- Average number of scallop at age caught in a lined 2.44 m. New Bedford offshore dredge, Middle Grounds, Sable Island-Western Bank area.

Middle Grounds	Age(years)										Mean	s.d.
	1	2	3	4	5	6	7	8	9	10+		
1983 stock survey												
low	0	0	0	0	1	0	0	0	0	0	2	2
medium	0	0	0	2	13	8	1	0	0	2	26	15
high	0	0	0	3	31	9	0	0	0	1	55	67
1984 stock survey												
low	0	0	0	0	2	1	2	1	0	0	8	10
high	0	0	0	0	2	6	4	2	1	2	17	16
1985 stock survey												
low	0	0	0	3	6	2	4	1	0	0	20	23
high	0	0	0	0	0	0	3	3	0	1	10	13

Sable Island area												
1984 stock survey												
low	0	4	2	4	5	3	3	1	1	5	28	39
medium	1	22	6	3	8	6	4	1	1	4	60	63
high	0	5	5	6	10	9	3	3	2	3	46	39
1985 stock survey												
low	0	71	55	27	15	12	7	6	2	9	205	222
medium	0	9	15	16	7	6	6	5	2	7	74	59
high	1	59	112	40	33	24	6	4	2	0	281	181

Table 7.- Summary of average number of scallops at age caught for prerecruits, shell height under 75mm or age less than 5 years, and recruits, shell height over 75mm by catch stratum.

	Age(years)		
	1-4	5-10	11+
Middle Grounds 1983			
low	0	1	0
medium	2	23	1
high	3	40	1
Middle Grounds 1984			
low	0	6	0
high	0	16	1
Middle Grounds 1985			
low	3	13	0
high	0	6	1
Sable Island/Western Bank 1984			
low	10	14	4
medium	32	21	3
high	16	28	2
Sable Island/Western Bank 1985			
low	153	43	8
medium	40	27	6
high	212	69	0

Table 8.- Fishery characteristics for the Browns Bank-Tusket area (NAFO 4XP and 4XO) for the two fleets. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries & Oceans, Halifax. Effort pertaining to Class 1 catch only.

Bay of Fundy Fleet Year	Landings	Logged catches	Class 1 catch	Effort(hm)	CPUE(kg/hm)
1979	213.50	228.19	168.39	5,375	31.33
1980	48.39	38.83	5.79	3,181	1.82
1981	19.05	19.18	3.84	639	6.01
1982	1.25	6.98	3.92	1,294	3.03
1983	-	-	-	-	-
1984	0.47	-	-	-	-
1985	8.30	3.52	0.03	202	0.17

Deep-sea Fleet Year	Landings	Logged catches	Class 1 catch	Effort(crhm)	CPUE(kg/crhm)
4XP					
1979	73.05	68.95	67.86	132,931	0.510
1980	258.23	195.54	189.07	443,346	0.426
1981	24.98	12.76	12.65	19,910	0.636
1982	114.07	83.40	82.84	217,580	0.381
1983	63.32	34.83	33.46	135,526	0.247
1984	16.60	4.95	4.95	26,565	0.186
1985	6.93	15.54	15.54	36,413	0.427
4XO					
1979	0.00	12.44	12.44	18,671	0.666
1980	13.17	40.79	33.41	60,841	0.549
1981	0.36	1.40	1.40	2,219	0.632
1982	47.55	70.87	65.76	86,204	0.763
1983	42.70	53.11	44.96	78,613	0.572
1984	10.57	13.24	13.24	45,619	0.290
1985	-	0.84	0.84	2,155	0.389

Table 9.- Nature of the catch from Browns Bank/Tusket area determined by the analysis of scallop meat weights.

	% catch examined / catch landed	meat weight (g)			
		mean	min	max	s.d.
1979	0.0022	16.29	4.01	58.66	0.18
1980	0.0195	10.54	1.37	87.46	0.04
1981	0.0080	35.75	13.71	55.37	0.35
1982	0.0020	16.39	2.90	47.13	0.18
1983	0.0000	-	-	-	-
1984	0.0062	21.98	6.46	68.63	0.51
1985	0.0000	-	-	-	-

Table 10.- Number of survey stations on both sides of Browns Bank NAFO Sa 4Xp to the south, NAFO Sa 4Xo to the north by year and by stratum types.

	1983	1984	1985
low catch	16	2	2
medium	-	7	14*
high	18	10	8
total	34	19	24

*exploratory

Table 11.- Average number of scallops at age caught in a lined 2.44m New Bedford offshore dredge, Browns Bank-Tusket area.

	Age (years)										Mean	s.d.
	1	2	3	4	5	6	7	8	9	10+		
1983 stock survey												
low	46	368	2	0	1	1	1	1	1	2	676	1068
high	59	248	1	0	0	0	1	2	3	10	416	969
1984 stock survey												
low	0	0	0	0	0	0	0	0	0	0	0	-
medium	3	94	53	6	3	0	0	2	3	14	209	280
high	3	58	0	0	0	6	12	9	4	4	118	184
1985 stock survey												
exploratory	3	244	0	0	0	0	0	1	2	14	286	328
low	0	0	0	0	0	0	0	0	0	0	1	0
high	0	1	0	0	0	0	0	0	0	2	6	6

Table 12.- Summary of average number of scallops at age caught for prerecruits, shell height under 75mm or age less than 5 years, and recruits, shell height over 75mm by catch stratum.

	Age(years)		
	1-4	5-10	11+
Browns Bank/Tusket 1983			
low	416	6	1
high	308	9	7
Browns Bank/Tusket 1984			
low	0	0	0
medium	156	11	11
high	61	34	1
Browns Bank/Tusket 1985			
exploratory	247	6	11
low	0	0	0
high	1	0	2

Table 13.- Fishery characteristics for the German/Lurcher area (NAFO 4XQ) for both fleets. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries & Oceans, Halifax. Effort pertaining to Class 1 catch only. (In parenthesis, catches supported by sales slips only.)

Bay of Fundy Fleet

Year	Landings	Logged catches	Class 1 catch	Effort(hm)	CPUE(kg/hm)
1979	293.82	258.25	182.37	7,112	25.64
1980	113.72	89.91	65.96	6,485	10.17
1981	194.73	185.51 (46)	125.57	14,352	8.75
1982	99.06	119.11 (16)	78.11	12,348	6.33
1983	43.68	32.30 (6)	16.76	5,949	2.82
1984	11.07	32.90	25.29	7,660	3.30
1985	2.80	1.45	0.30	416	0.71

Deep-sea Fleet

Year	Landings	Logged Catches	Class 1 catch	Effort(crhm)	CPUE(kg/crhm)
1979	102.32	141.22	138.80	152.574	0.910
1980	1269.71	1120.89	1009.64	1,588,506	0.636
1981	379.69	190.74	172.61	282,922	0.610
1982	659.74	535.84	403.51	954,628	0.423
1983	587.76	465.88	420.45	1,092,569	0.385
1984	207.13	175.83	156.45	581,969	0.269
1985	33.76	16.60	15.91	46,295	0.344

Table 14.- Fishery characteristics for the outer reaches of the Bay of Fundy (NAFO 4XR) for both fleets. It is not possible to estimate landings from the Bay of Fundy fleet from this area; 4XR statistical landings also include the traditional fishing grounds off Digby. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries & Oceans, Halifax. Effort pertaining to Class 1 catch only.

Bay of Fundy Fleet

Year	Logged catches	Class 1 catch	Effort(hm)	CPUE(kg/hm)
1979	0.05	0.05	11	4.72
1980	135.31	119.05	9,881	12.05
1981	179.23	174.71	16,416	10.64
1982	161.25	155.06	20,626	7.52
1983	35.24	30.86	6,011	5.13
1984	24.90	23.96	7,674	3.12
1985	9.71	9.61	2,814	3.42

Deep-sea Fleet

Year	Landings	Logged catches	Class 1 catch	Effort(crhm)	CPUE(kg/crhm)
1979	-	-	-	-	-
1980	16.86	67.13	60.91	124,890	0.488
1981	2.53	45.92	42.70	109,294	0.391
1982	0.03	86.68	57.90	152,872	0.379
1983	13.02	83.76	70.27	205,023	0.343
1984	4.55	24.35	20.11	98,465	0.204
1985	1.48	5.73	4.08	16,702	0.244

Table 15.- Nature of the catch from German Bank/Lurcher Shoals area determined by the analysis of scallop meat weights.

	% catch examined / catch landed	meat weight (g)			
		mean	min	max	s.d.
1979	0.0019	11.39	4.74	34.15	0.06
1980	0.0135	11.66	2.20	85.82	0.02
1981	0.0084	12.74	2.34	75.27	0.04
1982	0.0171	16.04	3.69	76.92	0.03
1983	0.0010	11.99	3.35	44.13	0.11
1984	0.0008	22.69	3.88	53.52	0.42
1985	0.0000	-	-	-	-

Table 16.- Number of survey stations in NAFO Sa 4Xq, German Bank/Lurcher Shoals by year and by stratum types.

	1983	1984	1985
low catch	15	8	5
medium	19	35	44
high	37	36	22
total	71	79	71

Table 17.- Average number of scallops at age caught in an unlined 2.44 m New Bedford offshore dredge, German/Lurcher.

	Age(years)										Mean	s.d.
	1	2	3	4	5	6	7	8	9	10+		
1983 stock survey												
low	0	0	0	0	0	3	5	2	2	11	34	31
medium	0	0	0	0	0	3	11	12	7	12	58	53
high	0	0	0	0	0	5	9	8	8	13	50	45
1984 stock survey												
low	0	0	0	0	0	1	6	6	2	3	35	50
medium	0	0	0	0	0	5	10	6	5	8	41	83
high	0	0	0	0	0	2	11	13	8	10	48	64
1985 stock survey												
low	0	0	0	0	0	0	1	2	2	8	13	7
medium	0	0	0	0	0	2	6	4	3	7	28	30
high	0	0	0	0	3	5	6	5	3	5	27	37

Table 18.- Summary of average number of scallops at age caught for prerecruits, shell height under 75mm or age less than 5 years, and recruits, shell height over 75mm by catch stratum.

	Age(years)		
	1-4	5-10	11+
German Bank/Lurcher Shoals 1983			
low	0	15	8
medium	0	36	9
high	0	35	8
German Bank/Lurcher Shoals 1984			
low	0	15	3
medium	0	29	5
high	0	38	6
German Bank/Lurcher Shoals 1985			
low	0	6	7
medium	0	17	5
high	0	24	3

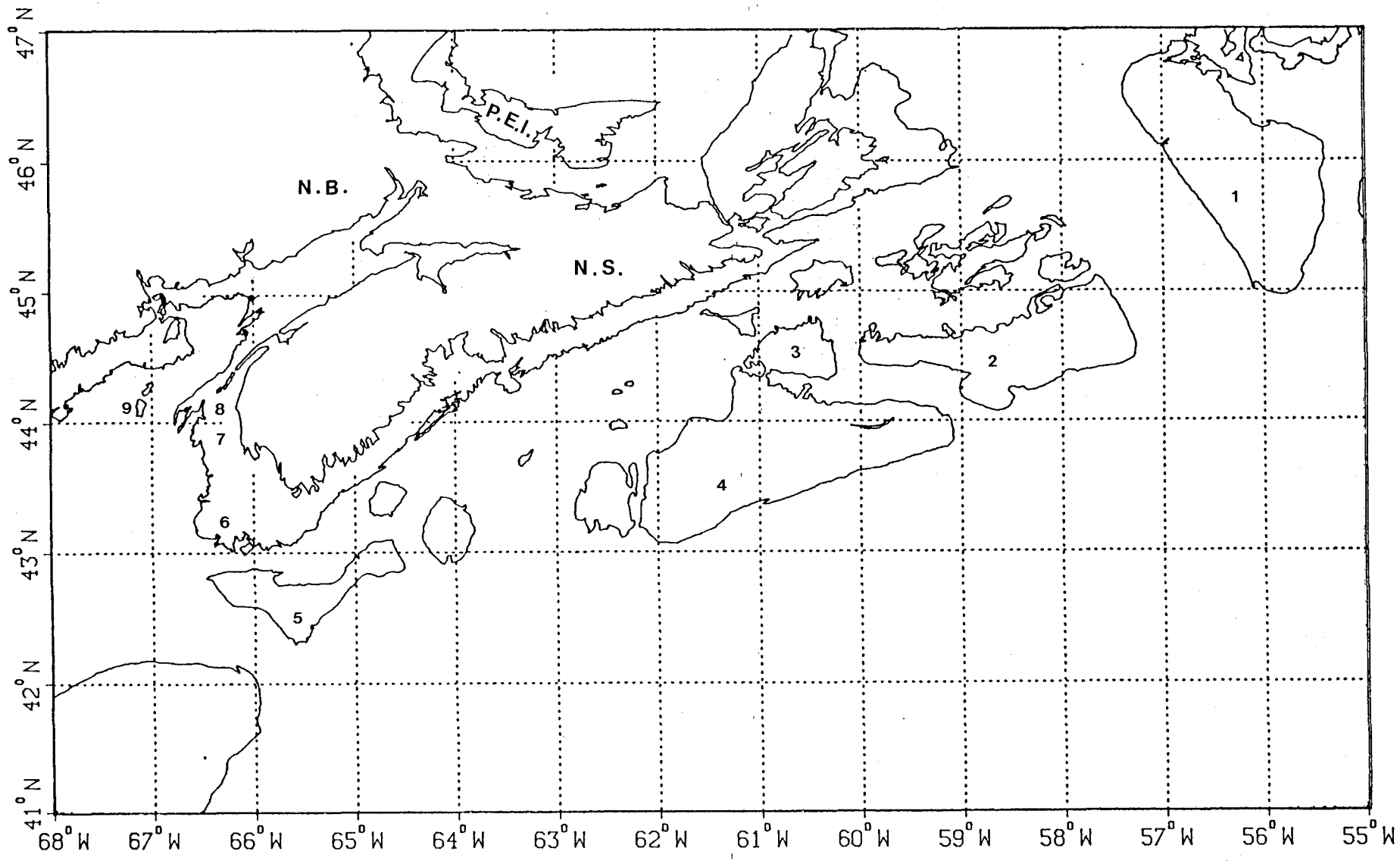


Figure 1.- Scallop fishing areas on the Scotian Shelf and St.Pierre Bank. The 100-m isobath is represented. Areas are in numerical order: (1) St.Pierre Bank; (2) Banquereau Bank; (3) Middle Ground ; (4) Sable Island area; (5) Browns Bank; (6) German Bank; (7) Lurcher Shoals; (8) Outer reaches of the Bay of Fundy and (9) Southwest Bank.

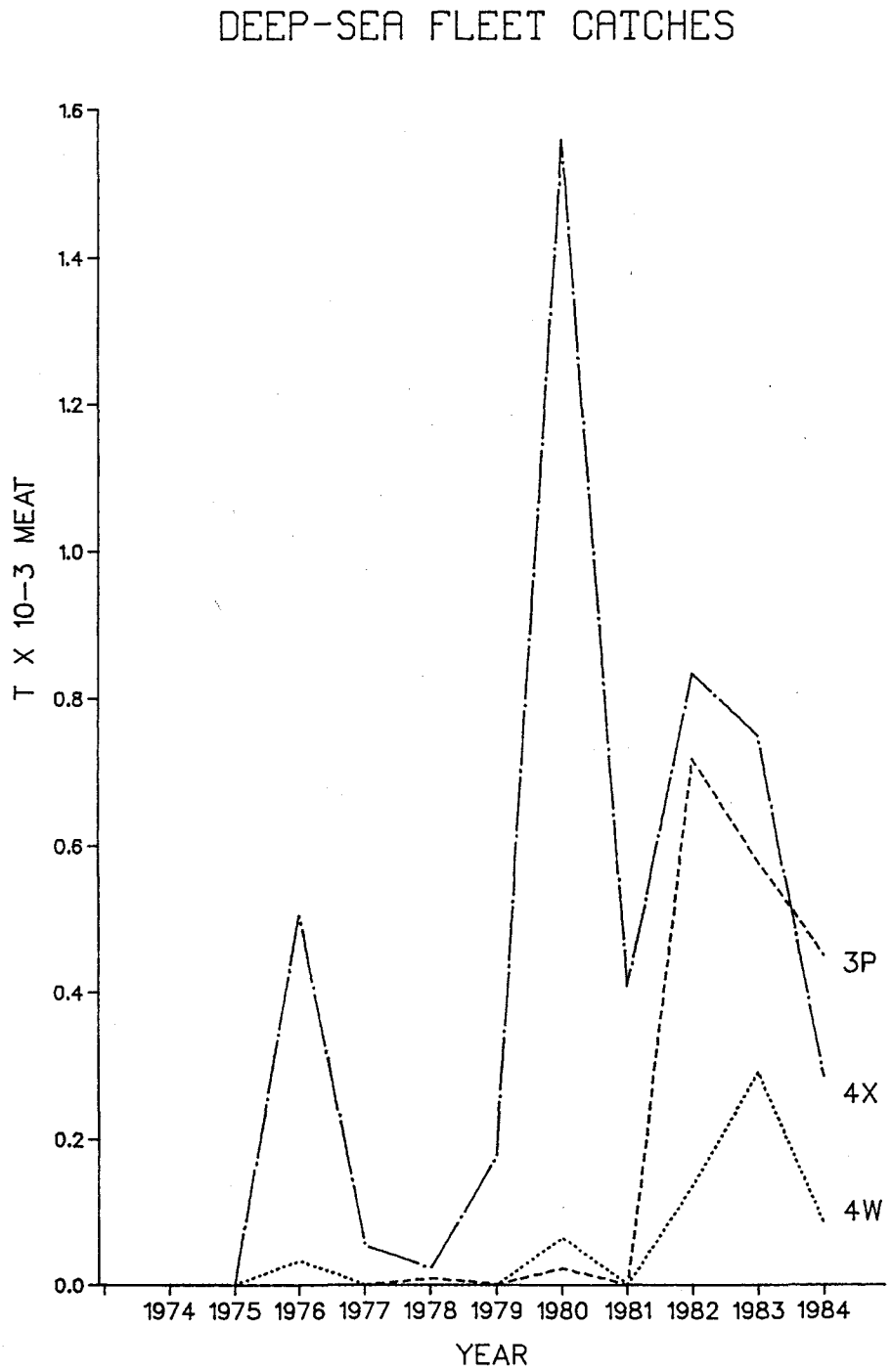


Figure 2.- Respective contributions (in t of scallop meats) of different NAFO sub-areas on the Scotian Shelf (4W and 4X) and Saint. Pierre Bank (3P) to the catches of the deep-sea scallop fleet.

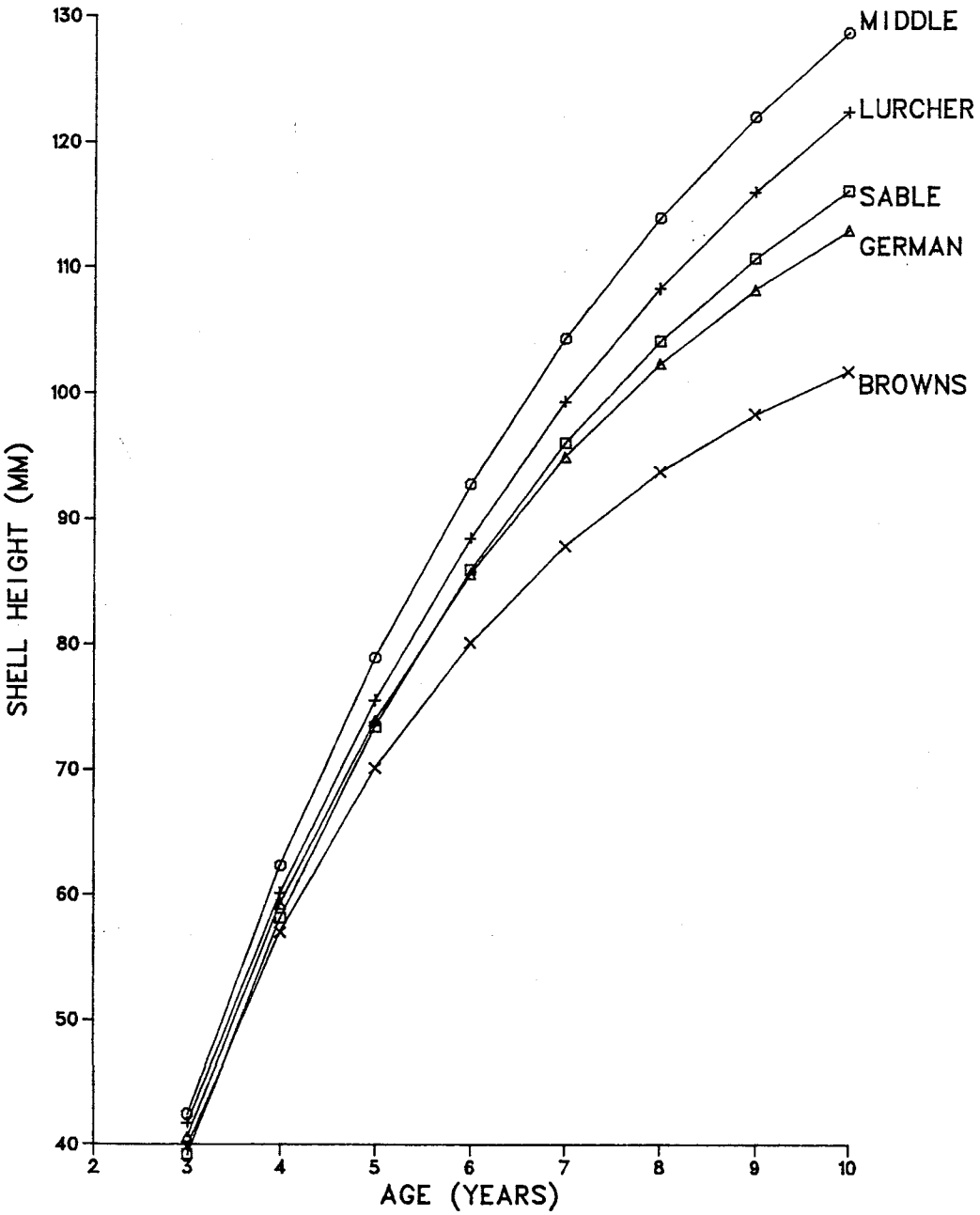
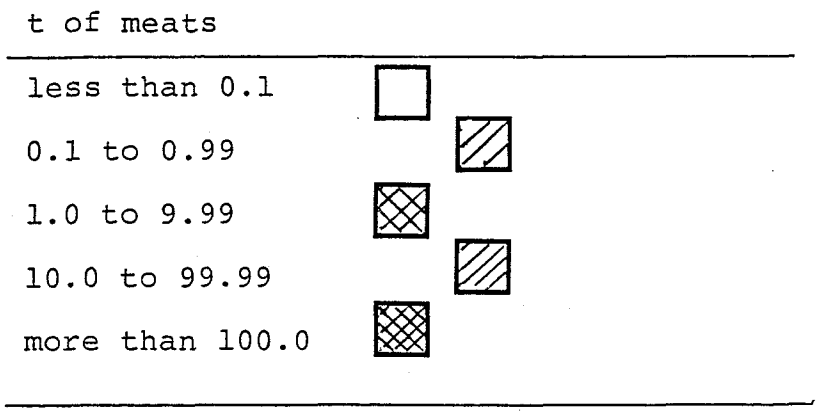


Figure 3.- Updated (1985 data) von Bertalanffy growth curves for Scotian Shelf scallop grounds, age expressed as a function of shell height.

Figures 4 to 7.- Productivity of scallop fishing grounds in NAFO SA 4W on a ten-minute square basis (TMS) according to the convention established below. The 100-m isobath is illustrated.

Figures 8 to 13.- Productivity of scallop fishing grounds in NAFO SA 4X on a TMS basis according to the following convention:



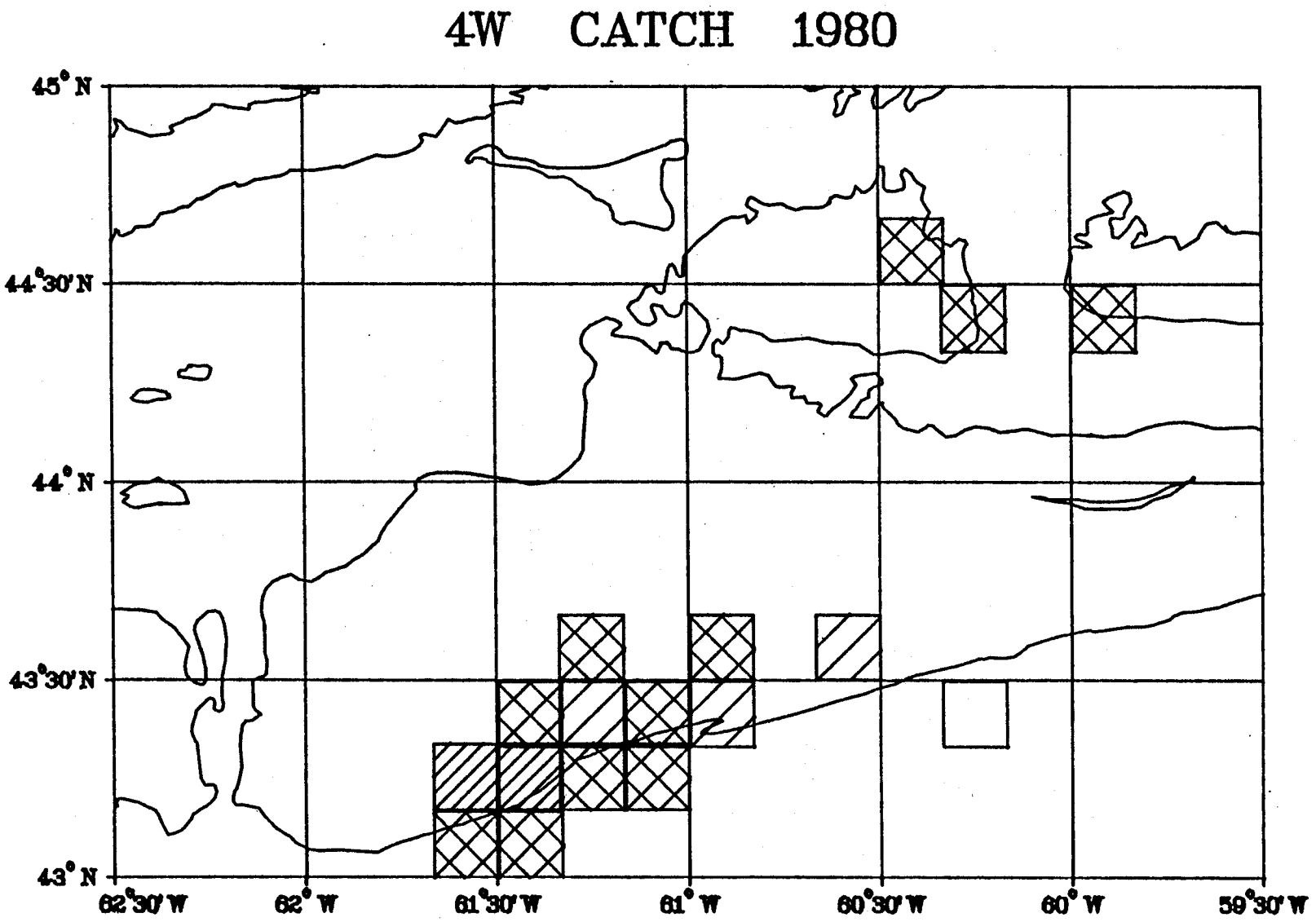

4W CATCH 1980
45° N
44°30'N
44° N
43°30'N
43° N
62°30'W
62° W
61°30'W
61° W
60°30'W
60° W
59°30'W

Figure 4.-

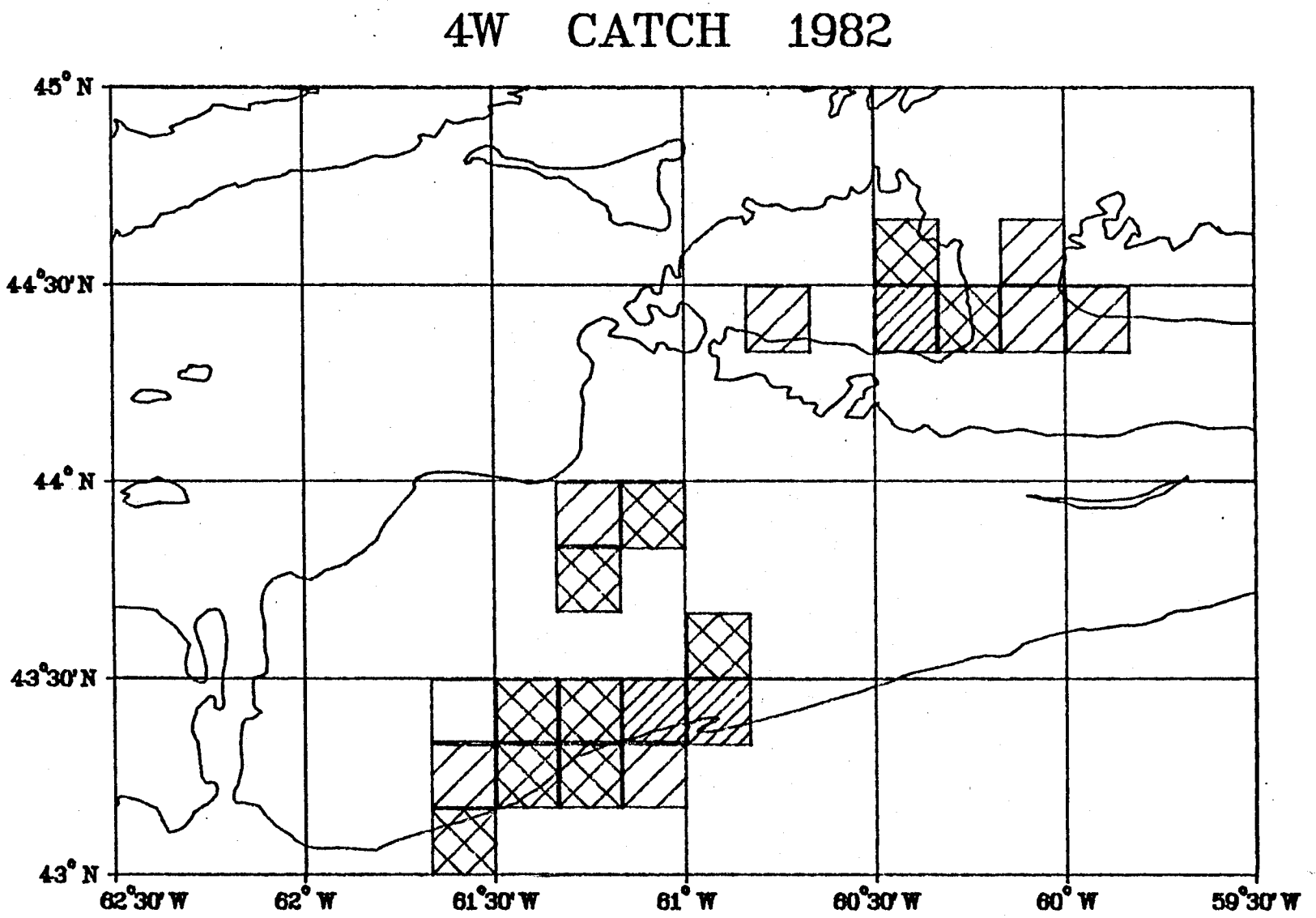

4W CATCH 1982
45° N
44°30'N
44° N
43°30'N
43° N
62°30'W
62° W
61°30'W
61° W
60°30'W
60° W
59°30'W

Figure 5.-

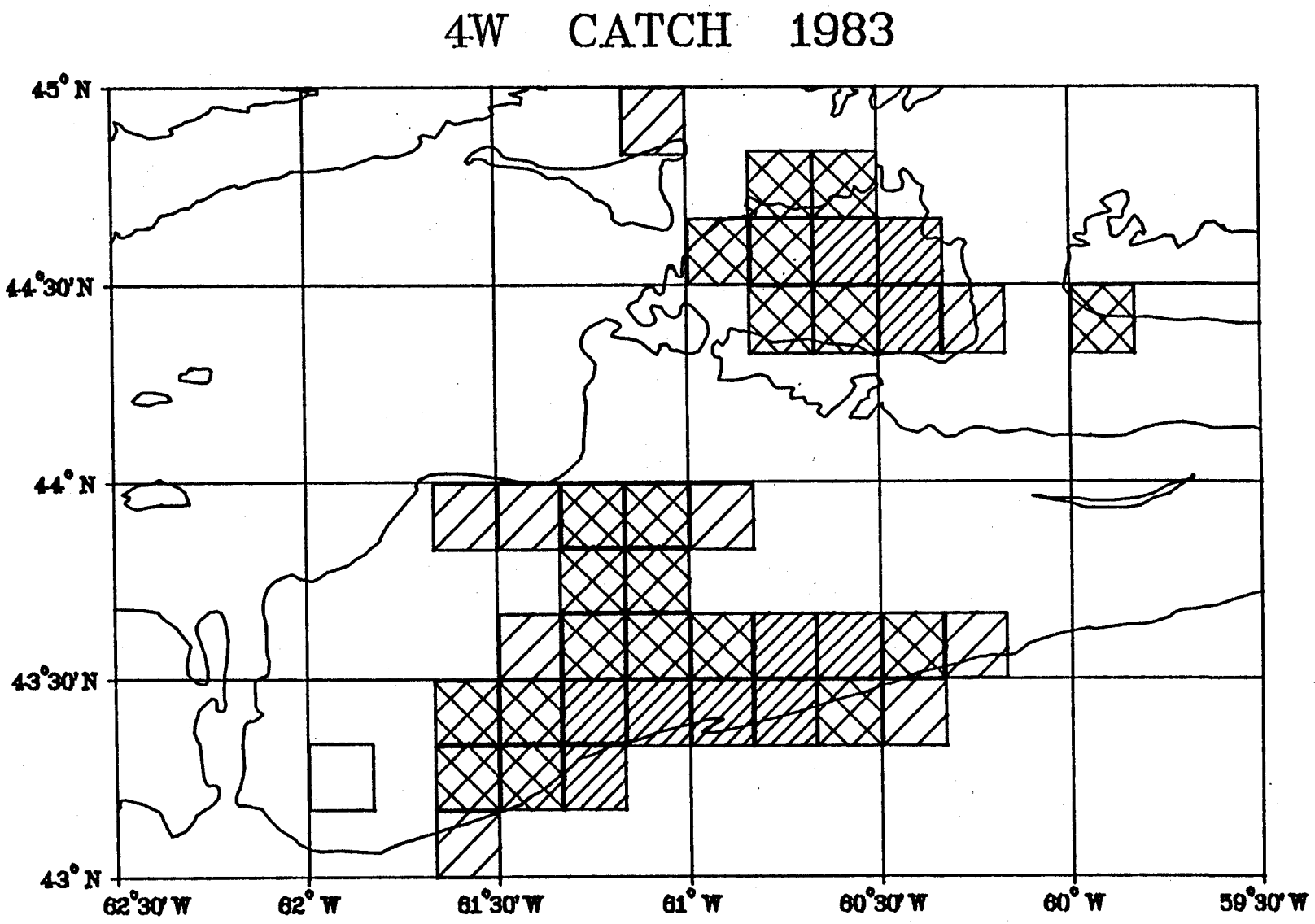

4W CATCH 1983
45° N
44°30'N
44° N
43°30'N
43° N
62°30' W
62° W
61°30' W
61° W
60°30' W
60° W
59°30' W

Figure 6.-

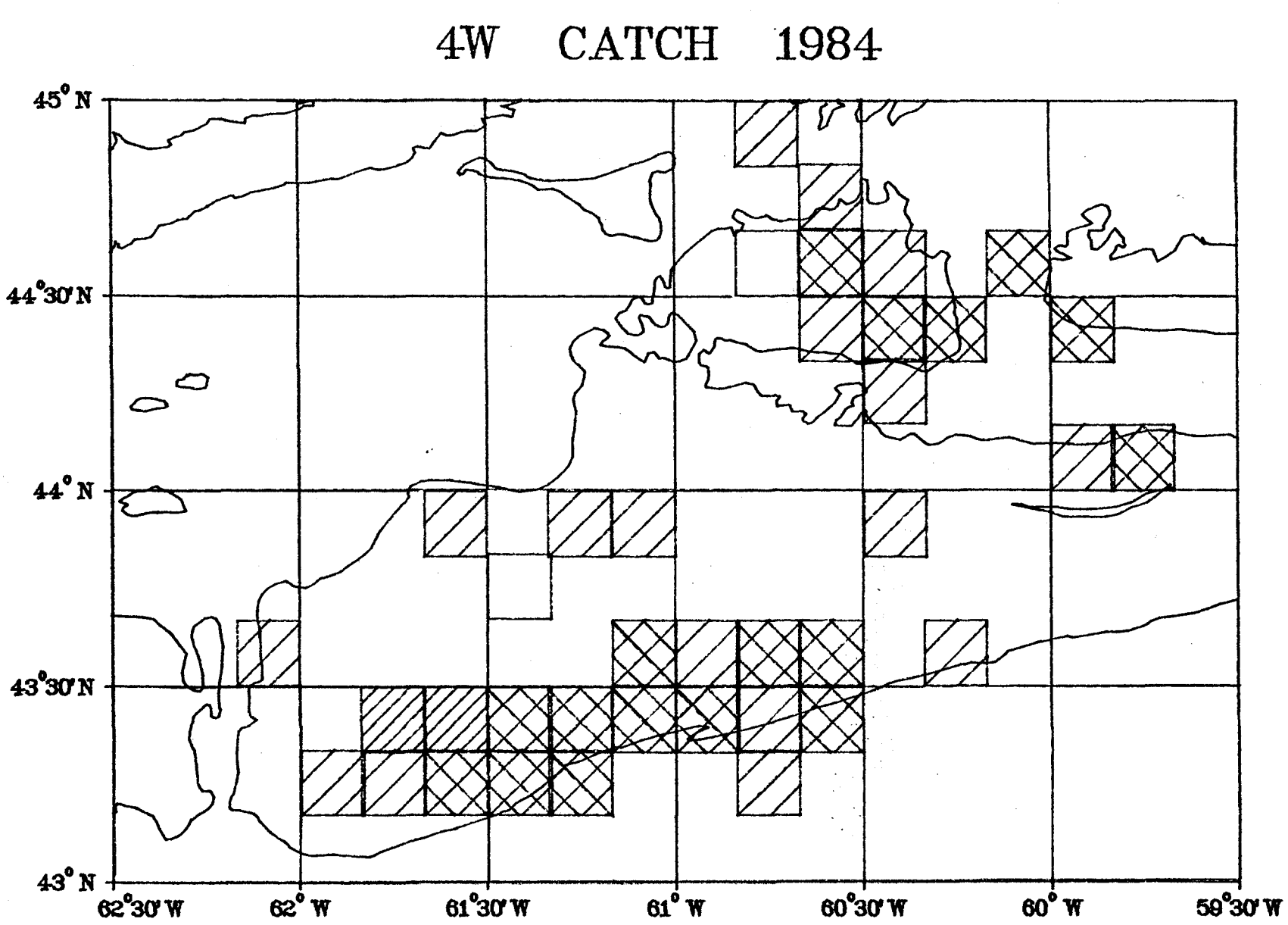

4W CATCH 1984
45° N
44°30'N
44° N
43°30'N
43° N
62°30'W
62° W
61°30'W
61° W
60°30'W
60° W
59°30'W

Figure 7.-

4X CATCH 1979

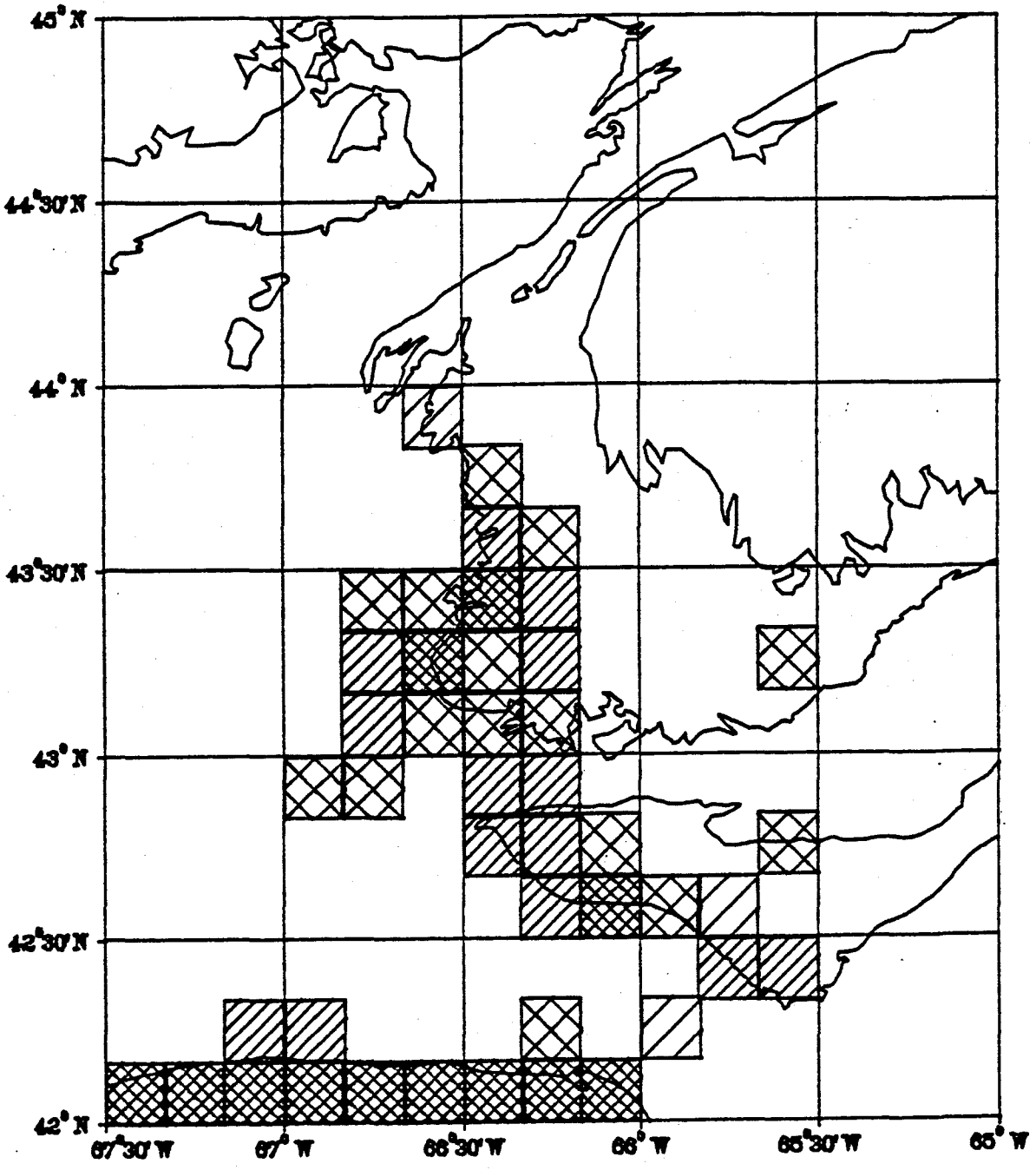


Figure 8.-

4X CATCH 1980

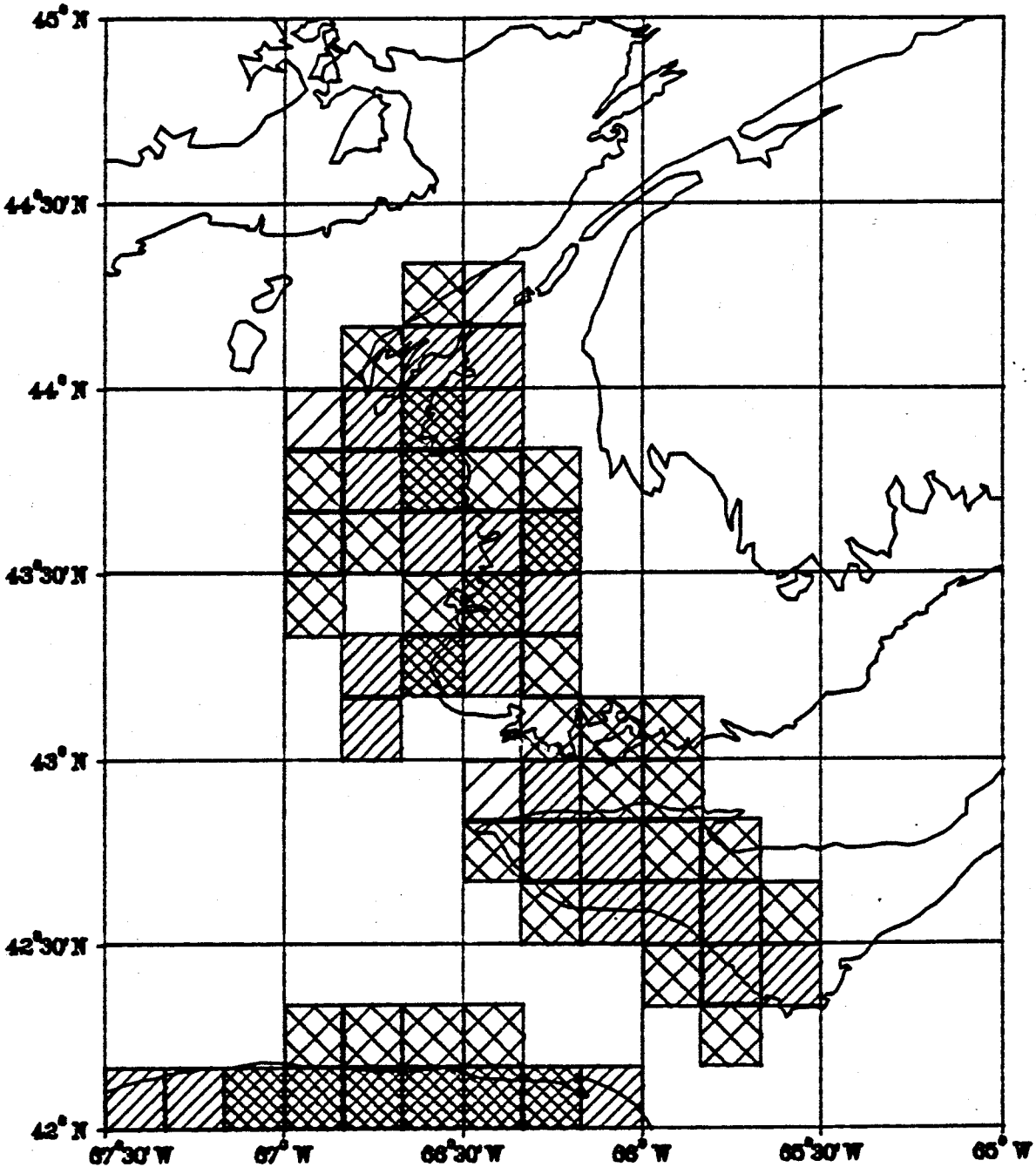


Figure 9.-

4X CATCH 1981

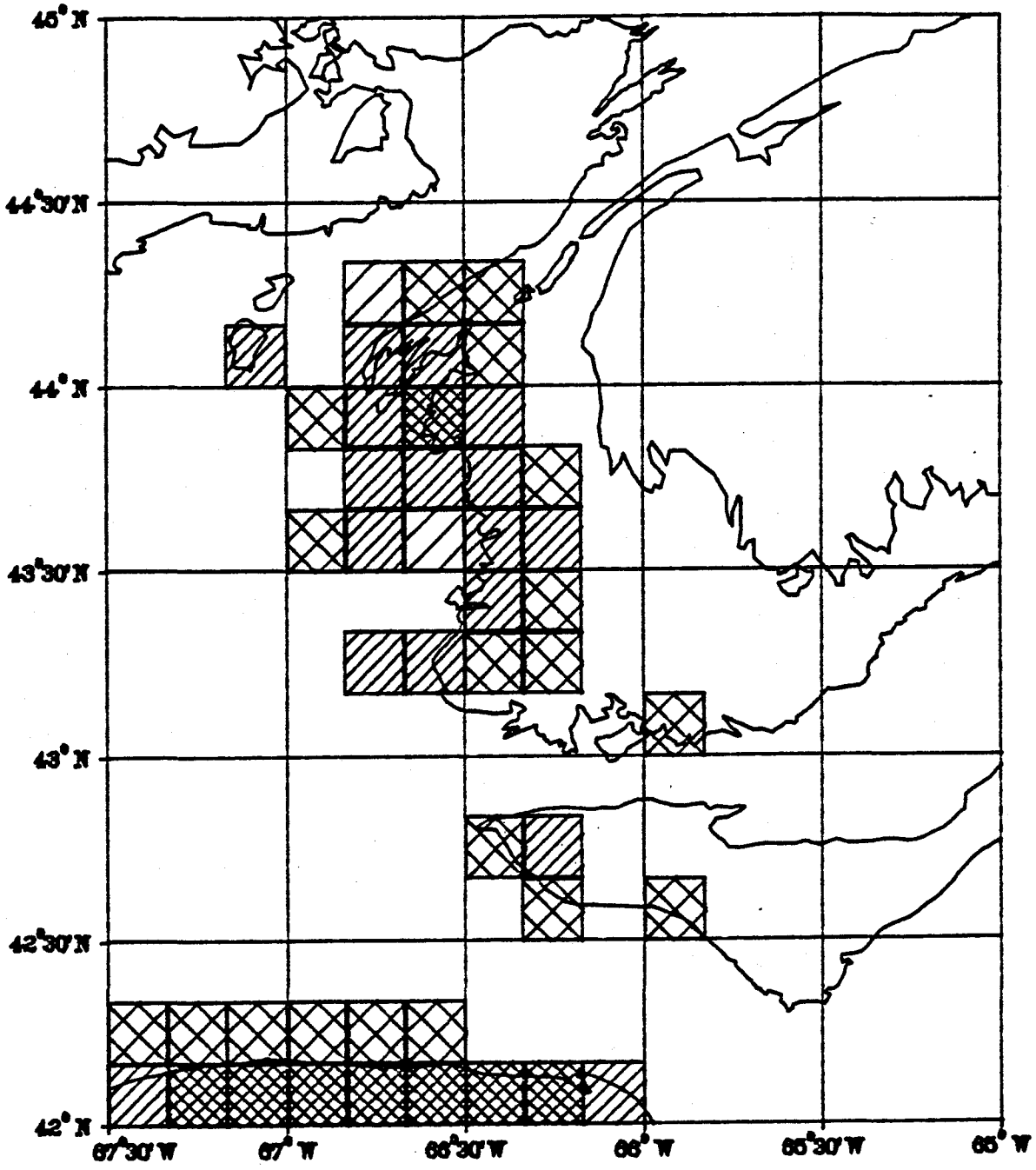


Figure 10.-

4X CATCH 1982

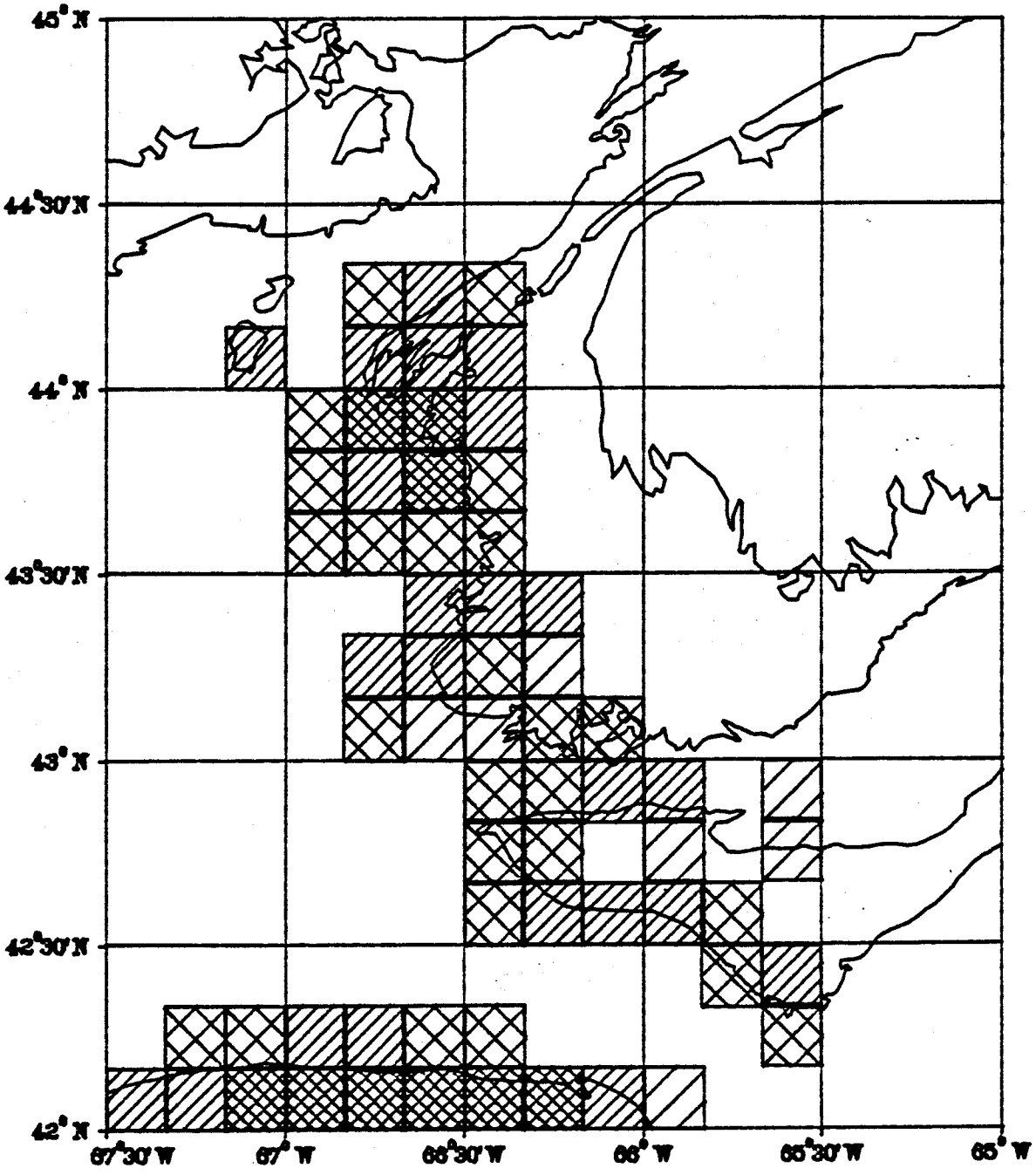


Figure I1 .-

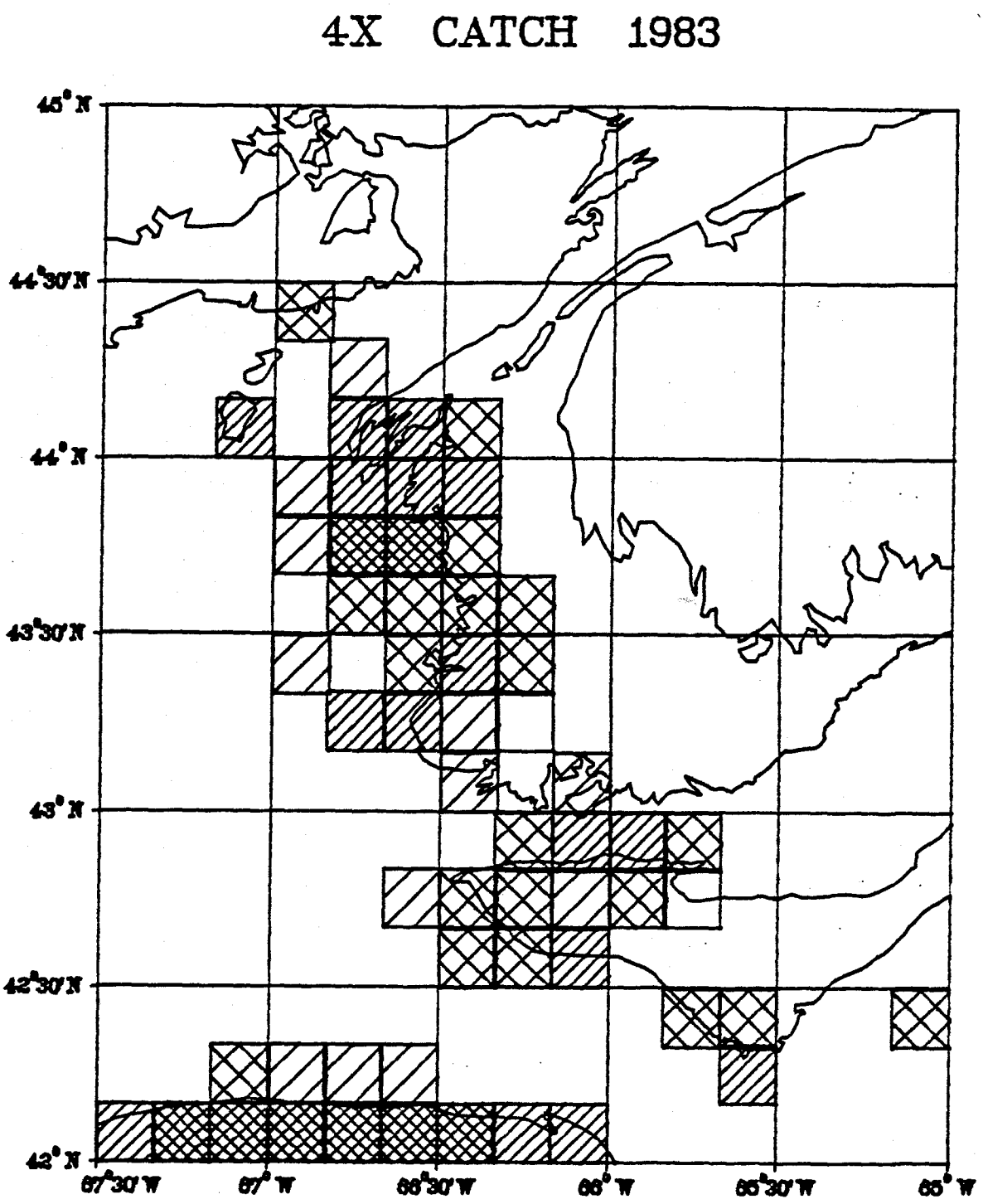

4X CATCH 1983
45° N
44°30'N
44° N
43°30'N
43° N
42°30'N
42° N
67°30'W
67° W
66°30'W
66° W
65°30'W
65° W

Figure 12.-

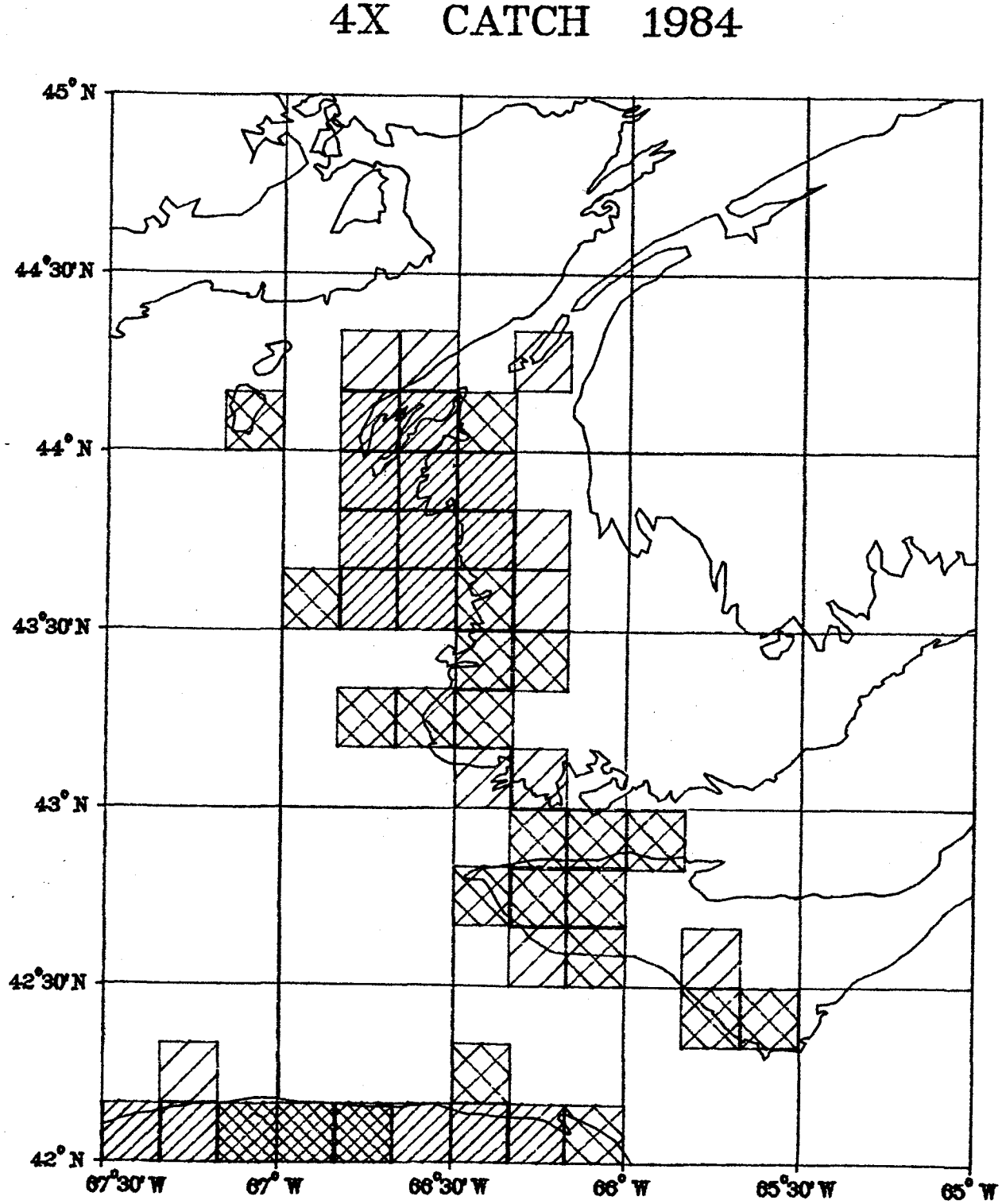

4X CATCH 1984
45° N
44°30'N
44° N
43°30'N
43° N
42°30'N
42° N
67°30' W
67° W
66°30' W
66° W
65°30' W
65° W

Figure 13.-