Abundance and Distribution of Finfish and Squid from *E. E. Prince* Trawl Surveys in the Southern Gulf of St. Lawrence, 1970 - 79

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August 1981

Canadian Technical Report of Fisheries and Aquatic Sciences No. 1028

Government of Canada Fisheries and Oceans
Gouvernement du Canada Pêches et Océans

Canadian Technical Report of Fisheries and Aquatic Sciences

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Canadian Technical Report of
Fisheries and Aquatic Sciences 1028

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ABUNDANCE AND DISTRIBUTION OF FINFISH AND SQUID FROM *E.E. PRINCE* TRAWL SURVEYS IN THE SOUTHERN GULF OF ST. LAWRENCE, 1970-79

by

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This is the one hundred and forty-first Technical Report from
the Biological Station, St. Andrews, N.B.

Cat. No. Fs 97-6/1028 ISSN 0706-6457

Correct citation for this publication:

Koeller, P. A., and M. A. LeGresley. 1981. Abundance and distribution of finfish and squid from *E.E. PRINCE* trawl surveys in the southern Gulf of St. Lawrence, 1970-79. Can. Tech. Rep. Fish. Aquat. Sci. 1028, iv + 56 p.

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ABSTRACT

Koeller, P. A., and M. LeGresley. 1981. Abundance and distribution of finfish and squid from *E.E. PRINCE* trawl surveys in the southern Gulf of St. Lawrence, 1970-79. Can. Tech. Rep. Fish. Aquat. Sci. 1028, iv + 56 p.

The abundance and distribution of finfish and squid as determined by 10 yr of random, stratified, groundtrawl surveys in the southern Gulf of St. Lawrence are presented. A large increase in the abundance of cod and American plaice was the most important observed trend during the decade. These species dominate the groundfish community of the Gulf and accounted for 68% of the biomass estimates on the average. Three groups of fish were identified which occupy geographically different and hydrologically distinct areas. A small group of species is widely distributed, probably because they tolerate the extremely cold water that covers much of the area in September. A second group is found in the warm inshore areas. Most species in this group have a separate, apparently isolated population around the Magdalen Islands. The third group occupies the deeper, moderately warm water along the edge of the Laurentian Channel and is probably found in the unsampled areas of the channel's plain. Many species in this group concentrate at the northwestern and southeastern end of the channel area. Those to the southeast may be extensions of populations found along the northeastern edge of the Scotian Shelf.

Key words: Abundance, distribution, groundfish, trawling, surveys, Gulf of St. Lawrence

RÉSUMÉ

Koeller, P. A., and M. LeGresley. 1981. Abundance and distribution of finfish and squid from *E.E. PRINCE* trawl surveys in the southern Gulf of St. Lawrence, 1970-79. Can. Tech. Rep. Fish. Aquat. Sci. 1028, iv + 56 p.

Nous présentons les données sur l'abondance et la distribution des poissons et des calmars que les levés par chalutage de fond aléatoires et stratifiés dans le golfe Saint-Laurent ont fourni sur une période de 10 ans. Cette décennie a été surtout marquée par une augmentation importante du nombre de morues et de plies canadiennes. Ces espèces dominent la communauté dans poissons de fond du golfe et représentaient en moyenne 68% de la valeur calculée de la biomasse. On a identifié trois groupes d'espèces de poisson occupant des secteurs dont les caractères gographiques et hydrologiques sont différents. Un petit groupe d'espèces, probablement parce qu'elles tolèrent les eaux extrêmement froides qui recouvrent en septembre la plus grande partie de cette région, sont dispersées sur une vaste étendue. Un deuxième groupe vit dans les eaux côtières chaudes. Pour la majorité des espèces de ce groupe, il y a, autour des Îles-de-la-Madeleine, une population distincte, apparemment isolé. Les espèces du troisième groupe habitent les eaux plus profondes et modérément chaudes du bord du chenal Laurentien et on les retrouve probablement dans les endroits non échantillonnés de la plaine du chenal. Plusieurs espèces de ce groupe se concentrent à l'extrémité nord-ouest et sud-est du chenal. Celles au sud-est peuvent être des extensions de populations trouvées en bordure au nord-est du plateau continental Scotian.

INTRODUCTION

Groundfish trawl surveys in the southern Gulf of St. Lawrence began in 1957 and were conducted by the Groundfish Investigation of the Biological Station, St. Andrews, N.B., later the Marine Fish Division, Maritimes Region. Originally, these were intended as abundance surveys for cod and concentrated on a number of fixed stations near shore between the Gaspé and Prince Edward Island. In 1970, a stratified random sampling design (Cochran 1953) was adopted and the following year stratification and sampling were extended to the entire southern Gulf (Northwest Atlantic Fisheries Organization (NAFO), formerly International Commission for the Northwest Atlantic Fisheries (ICNAF) Division 4T). Data from this survey series have been used extensively for assessment of important commercial groundfish. However, the broad geographical coverage and extensive data collected have produced valuable information on other species, including many whose distribution is known only from scattered records of occurrence. This report presents the main features of distribution and changes in abundance of finfish and squid for the first 10 yr of standardized random stratified surveys in the area.

METHODS

Sampling methods used on Marine Fish Division groundfish cruises have been outlined by Halliday and Kohler (1971). The stratification scheme is given in Fig. 1, and a bathymetric map with place names used in the text is shown in Fig. 2. The survey area was divided into three depth strata (<50, 51-100, and 101-200 fath, i.e. <92, 93-183, 184-366 m) which are roughly related to fish distribution patterns. Since most of the southern Gulf is less than 50 fath deep, the shallowest stratum was subdivided, using various criteria, to create additional strata. Thus, strata 20 and 22 are separated by the 20-fath contour, and strata 28 and 35 are separated from adjoining strata by the same contour. The eastern edge of stratum 22 was determined from previous information on the distribution of cod, which appeared to concentrate west of this line. Other strata delineate broad geographical entities. The inshore limit of sampling varies, being about 20-50 fath off the Gaspé and Cape Breton coast, 15-20 fath along the north shore of Prince Edward Island, and 10 fath elsewhere. The offshore limit is the 200-fath contour of the Laurentian Channel. Station allocation within strata has remained essentially unchanged, with minor differences from year to year due to contingencies, and was approximately proportional to stratum area. Fifty-seven random stations are occupied yearly in an area of 20,399 naut mi^2, giving an overall sampling density of one station every 358 naut mi^2. All strata were sampled every year except in 1970, when strata 15, 25, 29, and 31-39 inclusive were omitted.

All surveys were conducted during September of each year by the stern trawler *E.E. PRINCE* fishing a "Yankee 36" survey trawl with a small mesh liner in the codend. A standard set of 30 min at 3.5 knots was used throughout. The vessel is limited as to the number of crew it can carry so that trawling operations are restricted to daylight hours. Survey dates and number of stations completed are given in Table 1.

Sampling requirements for all surveys included total weight and numbers of all fish species and squid. Weights were recorded to the nearest kilogram, and weights less than 0.5 kg were recorded as zero. Environmental parameters measured included bottom temperature and bottom salinity. Numerous other observations, both biological and environmental, were made but are not included in this report.

In order to maintain continuity of the fixed station time series begun in 1957, *E.E. PRINCE* has continued to occupy 13 of the original fixed stations during each of the random stratified surveys. Sampling methods at these stations are identical to methods at random stations. Catches of fixed stations were plotted on the distribution maps to include all available information, but were excluded from biomass and population estimates.

Wherever possible, the catches at individual stations on the distribution maps have been given in kilograms per standard tow. Those species consistently caught in weights less than 0.5 kg are plotted as numbers per standard tow. Many species

Table 1. General statistics for *E.E. PRINCE* trawl surveys in the Gulf of St. Lawrence, 1970-79.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Dates	15-24/9	7-30/9	6-25/9	5-24/9	4-26/9	3-21/9	8-26/9	7-28/9	9/9-6/10	5/9-2/10
Cruise no.	P079	P091	P106	P122	P143	P157	P172	P188	P204	P229
No. of random stations completed	24	53	56	59	53	57	54	54	52	63
No. of fixed stations completed	13	13	14	12	17	10	12	12	11	11
Total	37	66	70	71	70	67	66	66	63	74

exhibited a recognizable distribution pattern from year to year (Fig. 6-14), while others were caught in such small quantities that the accumulated catches of 5 yr (Fig. 15-41) had to be plotted before a pattern emerged. A number of species were caught only on rare occasions and were not plotted. Table 4 gives a complete record of all fish species occurrences.

The biomass and population estimates in this report were calculated, using the formula:

$$T = \sum_{n=1}^{k} (A_h \cdot Y_h)$$

where T = total biomass or population estimate in a group of strata;
A_h = area of the h^{th} stratum in standard units;
Y_h = mean catch per standard unit in the h^{th} stratum in numbers or kilograms;
k = number of strata in the group.

A standard unit is the area swept by the survey trawl during a standard 30-min tow at 3.5 knots, i.e., 1.75 naut mi x W, where W is the nominal wing spread of the trawl.

The bottom temperatures and salinities obtained during each cruise were contoured and plotted by computer at the Marine Environmental Data Service (MEDS), Ottawa, using the CONMAP program.

The location of all fishing stations is given in Fig. 42.

RESULTS AND DISCUSSION

DISTRIBUTION OF BOTTOM TEMPERATURE AND SALINITY DURING SEPTEMBER

Individual observations and contour maps of bottom temperature and salinity are shown in Fig. 43-46 in an attempt to associate the distribution of fish species and hydrographic conditions. This approach can broadly outline the obvious and general relationships. The sampling intensity is such that small differences in the contour plots cannot be taken at face value. Any possible association between yearly changes in hydrographic conditions and fish distribution, although they may be mentioned in the text, requires a more rigorous analysis beyond the scope of this report.

A number of observations can be made which are common to many or all of the contour maps and thus typify hydrographic conditions at the time of the study (September). A large cold water area at or below 0°C covers much of the central portion of the southern Gulf on and around Bradelle Bank. This water is now thought to originate locally and represents the remnant of the upper mixed layer from the previous winter (Forrester 1964). A feature common to most years is the extension of the cold water layer toward the Gaspé Peninsula and along the north shore of Chaleur Bay. In general, water temperatures increase and salinities decrease shoreward and into shallower water, with the warmest water and lowest salinities occurring at either end of P.E.I., in Chaleur Bay, and around the Miscou and Magdalen Islands. Water temperatures and salinities increase with bottom depth along the edge of the Laurentian Channel. This saline warm water is thought to originate from outside the Gulf (Lauzier and Bailey 1957). The warm surface, cold intermediate, and moderately warm, deep water commonly seen in summer and fall depth profiles of the Gulf are thus represented on the horizontal plane by the warm Magdalen Island region, the cold Bradelle Bank, and the warmer Laurentian Channel, respectively.

CHANGES IN FINFISH AND SQUID ABUNDANCE FROM 1970-79

Biomass estimates are summarized in Table 2 and Fig. 3. Biomass and population estimates for all species are given in Tables 3 and 4. Note that omission of some strata in 1970 will have caused the underestimation of many species. This is particularly evident for redfish, which are common in the omitted strata. Underestimates for some species like cod and plaice were probably small because they are not common in these strata.

Cod decreased in abundance during the first half of the decade (Fig. 3), then increased greatly during the second half, possibly accentuated by

Table 2. Summary of biomass estimates from *E.E. PRINCE* groundfish surveys in the southern Gulf of St. Lawrence (metric tons (MT) x 10^{-3}), 1970-79.

Species	1970[a]	1971	1972	1973	1974	1975	1976	1977	1978	1979	Mean (1970-79)
Cod	104.0	79.8	77.3	85.6	72.1	54.8	70.5	88.6	146.3	217.5	99.7
Plaice	36.1	58.8	61.8	75.7	116.7	120.5	192.4	173.2	118.6	187.6	114.1
Other flatfish	5.4	10.7	13.2	12.1	31.5	15.2	42.4	17.4	23.9	19.9	19.2
Redfish	-	34.0	43.2	44.1	43.9	19.5	14.0	30.0	32.4	16.1	27.7
White hake	1.7	4.3	6.0	15.8	26.3	10.8	8.6	6.6	20.9	19.4	12.0
Skates	2.3	8.5	5.8	9.8	8.3	5.7	3.8	6.6	4.1	7.0	6.2
Pelagics	21.5	56.3	22.1	20.8	19.7	29.5	9.0	8.9	35.6	5.0	22.8
Other finfish	4.3	7.2	5.8	2.8	8.5	5.8	10.4	7.8	6.7	8.3	6.8
Squid	-	0.4	0.02	0.04	-	1.0	16.9	15.3	30.8	15.1	8.0
Total	175.3	260.0	235.2	266.7	327.0	262.8	368.0	354.3	419.3	495.9	316.5

[a]Strata 15, 25, 29, and 31-39, inclusive, were not surveyed in 1970.

Table 3. Estimates of population numbers ($x10^{-3}$) from research vessel surveys in the southern Gulf, 1970-79. (- indicates no catch; + indicates present, number unknown).

Species	Year									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Cod	82,085	64,984	69,015	77,212	60,820	53,529	120,455	101,237	146,953	275,743
Haddock	25	82	304	201	143	195	235	35	157	842
White hake	623	5,430	3,073	11,998	21,156	16,984	14,294	7,082	18,917	15,102
Silver hake	-	-	-	-	141	44	22	9	12	-
Longfin hake	-	246	178	99	-	304	-	205	84	346
Pollock	-	-	97	-	52	36	39	9	108	24
Greenland cod	540	266	125	110	691	631	1,095	1,042	-	404
Arctic cod	-	-	-	-	-	-	43	-	-	-
Redfish	77	119,837	94,361	85,682	110,995	53,793	32,764	55,546	45,725	32,458
Greenland halibut	-	122	62	187	575	402	598	965	731	487
Plaice	202,646	306,848	259,148	266,882	634,462	597,336	1,059,834	1,218,835	610,164	996,581
Witch	1,340	3,928	2,124	3,250	3,787	3,393	2,929	4,518	1,481	3,428
Yellowtail	2,317	7,809	9,971	12,252	17,513	11,361	10,687	44,020	25,574	35,093
Winter flounder	8,359	17,256	21,999	18,209	66,836	29,128	130,483	20,530	48,596	31,892
Brill	37	-	-	-	81	-	198	808	238	784
Striped wolffish	-	-	36	51	9	106	-	141	-	33
Northern wolffish	-	-	-	-	21	7	-	-	-	-
Herring	93,152	199,946	79,111	97,934	9,813	82,613	31,315	33,442	158,985	38,263
Shad	-	-	43	29	79	22	-	21	12	-
Gaspereau	1,716	22,118	16,203	28,323	43,920	3,154	3,447	1,574	5,844	1,640
Smelt	6,597	144	79,281	89,942	384,744	6,788	8,510	17,979	14,737	4,257
Capelin	-	1,146	1,363	463	314	34,445	1,710	142	-	1,077
Mackerel	437	535	3,738	563	1,898	1,428	45	124	899	713
Sand launce	-	-	-	-	-	-	-	80	-	-
Fourbeard rockling	48	-	-	66	69	+	-	-	-	-
Rockling (unid.)	-	-	-	30	-	-	-	-	-	-
Cunner	37	-	29	128	121	31	-	-	-	17
Barndoor skate	-	-	-	-	18	-	-	-	-	29
Thorny skate	1,009	5,415	3,496	6,460	6,311	3,531	1,667	5,792	1,451	3,370
Smooth skate	-	76	400	1,028	846	144	56	314	-	233
Little skate	-	-	-	-	-	880	-	-	-	662
Winter skate	290	944	462	883	516	31	1,003	212	1,500	219

Table 3. (cont'd)

Species	Year									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Northern hagfish	-	48	27	66	70	-	-	-	-	141
Longhorn sculpin	3,043	4,275	2,426	2,261	28,265	17,259	10,281	5,017	14,978	3,202
Shorthorn sculpin	-	19	-	-	159	-	96	-	38	35
Mailed sculpin	214	897	99	126	4,966	681	104	414	-	-
Hookear sculpin	-	18	-	18	-	12	-	-	-	-
Sea raven	17	1,084	2,928	503	930	1,408	620	521	1,272	1,026
Black dogfish	-	-	-	-	-	-	121	96	159	1,868
Arctic alligator fish	51	-	38	111	-	-	-	180	-	-
Alligator fish (unid.)	-	-	20	-	202	-	23	-	-	268
Angler	-	-	-	-	39	70	39	59	17	24
Common grenadier	-	365	352	275	133	277	121	266	47	2,257
Longnose grenadier	-	-	-	-	-	-	-	-	188	-
Rock grenadier	-	-	-	-	-	-	-	57	-	-
Lumpfish	356	265	42	-	223	68	29	174	8	20
Atl. spiny lumpsucker	-	-	-	-	47	-	-	-	-	-
Greenland seasnail	-	-	-	-	+	-	-	-	-	-
Longfin seasnail	-	-	-	-	-	-	-	90	-	-
Seasnail (unid.)	46	-	-	20	+	-	-	-	-	-
Snake blenny	-	667	688	36	+	61	38	601	-	112
Radiated shanny	25	-	-	25	-	-	-	-	-	-
Daubed shanny	2,677	-	-	-	-	-	-	-	-	-
Fourline snake blenny	-	-	-	-	+	-	-	-	-	-
Common shanny	-	-	-	-	6,096	58	-	-	-	-
Shanny (unid.)	-	-	-	2,320	-	-	-	32	-	-
Wrymouth	-	-	-	38	-	-	-	-	-	-
Ocean pout	1,546	69	565	1,209	253	397	-	-	249	100
Arctic eelpout	-	-	-	-	2,919	826	1,741	8,122	1,369	5,821
Eelpout (unid.)	512	5,604	1,160	818	56	-	5,265	-	323	-
Vahl's eelpout	-	-	-	-	2,181	113	-	2,453	70	202
Esmark's eelpout	-	-	-	-	-	-	-	16	-	-
Threespine stickleback	-	-	-	-	963	-	-	-	-	-
Barracudina (unid.)	-	-	-	-	-	-	-	-	-	75
Squid	290	1,628	131	160	124	5,010	64,373	51,471	106,681	53,840

Table 4. Biomass estimates from research vessel catches (metric tons) in the southern Gulf, 1970-79. (- indicates no catch; + indicates species present but less than 0.5 kg).

Species	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Cod	104,006	79,799	77,331	85,553	72,110	54,818	70,519	88,570	146,333	217,474
Haddock	+	47	187	421	285	146	234	17	94	1,260
White hake	1,749	4,307	6,039	15,836	26,302	10,827	8,575	6,578	20,876	19,357
Silver hake	-	-	-	-	18	22	22	9	12	-
Longfin hake	-	35	+	16	-	58	-	19	+	65
Pollock	-	-	155	-	52	73	39	17	216	48
Greenland cod	360	216	125	206	289	311	1,054	1,217	-	379
Redfish	+	33,952	43,237	44,113	43,909	19,539	14,041	30,029	32,396	16,056
Greenland halibut	-	182	78	323	35	258	232	1,347	1,351	689
Plaice	36,121	58,789	61,817	75,721	116,673	120,454	192,364	173,192	118,579	187,611
Witch	1,285	1,983	1,593	2,307	2,268	2,105	2,477	3,885	1,086	2,331
Yellowtail	641	1,930	2,400	3,383	3,922	1,813	2,106	7,667	5,864	8,132
Winter founder	3,470	6,565	9,089	6,054	25,268	10,986	37,615	4,409	15,546	8,674
Brill	+	-	-	-	+	-	16	76	12	77
Striped wolffish	-	-	61	141	+	68	-	266	-	89
Northern wolffish	-	-	-	-	63	76	-	-	-	-
Herring	20,507	51,478	15,138	11,117	2,184	27,874	8,223	7,873	33,564	4,049
Shad	-	-	43	43	158	44	-	21	12	-
Gaspereau	370	4,675	2,673	5,863	6,787	592	409	261	1,136	418
Smelt	460	+	3,196	3,563	10,514	162	302	752	461	140
Capelin	-	24	+	+	+	180	+	+	-	+
Mackerel	133	94	1,007	182	81	635	15	41	386	390
Cunner	+	-	14	15	40	+	-	-	-	+
Barndoor skate	-	-	-	-	55	-	-	-	-	259
Thorny skate	1,870	7,270	4,997	8,438	7,257	4,778	2,521	6,016	2,016	5,444
Smooth skate	-	56	193	271	417	122	19	225	-	160
Little skate	-	-	-	-	-	749	-	-	-	864
Winter skate	382	1,203	588	1,114	541	62	1,314	384	2,075	282
Longhorn sculpin	657	826	328	386	4,365	2,367	1,755	716	2,884	495
Shorthorn sculpin	-	19	-	-	+	-	34	-	38	+
Mailed sculpin	46	+	+	+	+	+	+	+	-	-
Sea raven	17	1,071	2,535	318	799	1,157	653	438	1,370	997
Black dogfish	-	-	-	-	-	-	121	96	112	1,233
Angler	-	-	-	-	78	273	235	59	+	48
Common grenadier	-	17	+	16	+	22	+	+	+	152
Lumpfish	1,319	589	42	-	223	250	+	174	8	20
Snake blenny	-	+	+	+	+	+	+	105	-	+
Ocean pout	1,647	84	541	1,204	93	218	-	-	124	65
Arctic eel pout	-	-	-	-	1,860	670	1,065	4,037	1,584	3,434
Eelpout (unid.)	220	4,275	1,780	139	+	-	5,230	-	180	-
Vahl's eelpout	-	-	-	-	363	61	-	605	35	25
Squid	+	355	18	45	+	1,028	16,934	15,266	30,834	15,111

reductions in total allowable catch beginning in 1976. Redfish were somewhat less abundant, on the average, during the second half of the decade than during the first. White hake varied considerably in abundance with a maximum in 1974, followed by a decline to a minimum in 1977. It appeared to be on the increase again toward the end of the decade. Skate and "other finfish" biomass changed little throughout the survey period, with no apparent trends. Squid catches were negligible until 1975 when they began to increase greatly. Flatfish generally showed a net increase during most of the decade, which appeared to level off during the last 3 yr. American plaice is by far the most important of these, accounting for 86% of total flatfish biomass on the average, followed by winter flounder, yellowtail flounder, witch flounder, and Greenland halibut, in descending order of importance. Pelagic species appear to have decreased in abundance during the second half of the survey period.

The relative importance of the main species and species groups in terms of biomass is shown in Fig. 4. Total estimated biomass increased considerably during the period due mainly to increases in plaice from 1970-74 and to both plaice and cod from 1975-79. These two species accounted for 68% of the finfish biomass on the average and as much as 84% in 1 yr.

While these estimates are almost always associated with large sampling variance, the trends shown here can be accepted with some confidence, at least for the more abundant, commercially important species. For example, correlations of survey abundance estimates with an independent method for cod and plaice were shown to be highly significant (Beacham 1980; Metuzals 1980). Some species, such as white hake and squid, exhibit similar survey trends in other areas, implying large-scale environmental influences whose effects are detectable by trawl survey methods (Koeller 1980). Estimates of the less abundant species have not, however, been validated and should be approached with caution. They are presented here as a general indication of their relative importance in the Gulf finfish community. The variability of survey data in the Gulf is discussed in Koeller (1981).

FISH DISTRIBUTION PATTERNS IN THE SOUTHERN GULF OF ST. LAWRENCE DURING SEPTEMBER

The distribution of most fish species in the southern Gulf appears to fall into three main categories. All species which are caught in large enough quantities to show clearly defined patterns are so categorized in Table 5. Several species, such as cod and plaice, and particularly white hake, show characteristics of more than one type of pattern. The three categories are:

1. Widely distributed over the entire Gulf with no discernible concentrations recurring from year to year. Relatively few species fall into this category and, except for plaice, they contribute little to the total biomass. The large central area of very cold water around Bradelle Bank is apparently avoided by many species.

2. A relatively large number of species and proportion of the total biomass concentrating nearshore (a) around the Magdalen Islands, (b) at the southeastern end of Prince Edward Island, and (c) along the New Brunswick shore from the northwestern end of Prince Edward Island into Chaleur Bay. Most species in this group occur in all three areas. The Magdalen Shallows concentrations are always distinct from the other two and may represent separate stocks or populations. Although the New Brunswick shore and southeastern Prince Edward Island concentrations also appear separate, in many cases they may represent ends of a continuous distribution through Northumberland Strait, or along the northern coast of Prince Edward Island in water shallower than 15 fath, areas which are not sampled. Incidental catches of pelagic species also fall into this category.

3. Species occurring along the slope of the Laurentian Channel in water deeper than 50 fath. Sampling extends only to the 200-fath contour, thus excluding most of the surface area termed the Laurentian Channel. It is likely that these species represent the southwestern edge of a more widely distributed channel community. Many of these species may also be extensions of groups distributed along the continental slope from Banquereau Bank to Cape Breton, described by Scott (1976).

Table 5. Groundfish distribution patterns with associated species in the southern Gulf of St. Lawrence.

Widely distributed	Deep	Shallow inshore
Plaice	White hake	Cod
Thorny skate	Redfish	White hake
Arctic eelpout	Greenland halibut	Winter flounder
Greenland cod	Witch flounder	Yellowtail
Lumpfish	Longfin hake	Brill
Mailed sculpin	Angler	Capelin
	Black dogfish	Herring
	Grenadier	Gaspereau
	Haddock	Shad
	Pollock	Smelt
	Smooth skate	Mackerel
	Wolffish	Longhorn sculpin
	Illex	Shorthorn sculpin
		Sea raven
		Winter skate
		Ocean pout
		Vahl's eelpout

DISTRIBUTION OF INDIVIDUAL SPECIES

American plaice (*Hippoglossoides platessoides*) (Fig. 5)

This species was widely distributed within the southern Gulf and was most abundant in water less than 50 fath deep with temperatures less than 2°C. It was present in small numbers in the deeper water of the Laurentian Channel slope. This is the only commercially important species found in relatively large quantities in the central area of cold water on and around Bradelle Bank. Powles (1965) also found plaice to be widely distributed in the southern Gulf. Meristic studies indicated the presence of one discrete stock. Research vessel catch distributions (May-October) and tagging experiments also suggested the presence of two "groups" within this stock, one concentrating west

of the Magdalens and the other along the Cape Breton coast from Cape North to St. George's Bay. Although the present distribution shows a slight tendency to concentrate in the western part of the area, no similar concentration was evident near Cape Breton. Distribution appeared to be continuous between the two areas during most years. In the fall, plaice migrate from the cold inshore areas of the Gulf to overwinter in the warmer water of the channel slope (Powles 1965). It is apparent that in September not many have reached deeper water. However, the migration may have begun at this time and any summer concentrations may have lost their coherence.

Atlantic cod (*Gadus morhua*) (Fig. 6)

Cod were widely distributed in the area but had a strong tendency to concentrate in the western part (strata 16-21). A distinct concentration was also evident in the deeper water of the Laurentian Channel just north of Cape Breton in 1978 and 1979. Distribution appeared to be more widespread than usual in 1979. Cod were caught along the channel slope during all years, but larger catches were usually made to the southwest in shallower water. They occurred in a wide range of temperatures but were less abundant below 0°C and above 10°C.

Except for a poorly defined concentration around the Magdalen Islands during some years, the five "regional" stocks (Gaspé, Chaleur Bay, northern Prince Edward Island, Magdalen Islands, and west Cape Breton) described by McKenzie and Smith (1955) and Templeman (1962), were not apparent from the present data. The west Cape Breton concentration, previously seen from summer research vessel and commercial catch distributions (Jean 1964; Kohler 1968) was noticeably absent. Southern Gulf cod are now considered to belong to a single unit stock for management purposes (Hare 1977). It is a migratory stock showing similar (but more extensive) movements to plaice, i.e. shallow inshore in summer, deeper and offshore in winter. During September the distributions of both species overlap and they often occur together in trawl catches. Commercial size cod leave the Gulf entirely in the fall to overwinter along the channel slope off eastern Cape Breton (Martin and Jean 1964). It is apparent that for most of the population this migration has not begun in September. The absence of the west Cape Breton concentration may be due to its early migration from the area and this group may be represented by the large catches north of Cape Breton during 1978 and 1979. However, these catches could also be an extension of the usual summer range of a separate stock originating outside the area. The widespread distribution of 1979 could be due to an earlier than usual migration of the western concentration. Average bottom temperatures in 1978 and 1979 were the two highest of the decade and may be related to the unusual distribution patterns in those years. It is noteworthy that significant concentrations of cod and plaice previously seen along the Cape Breton shore were absent or poorly defined in the present data.

Herring (*Clupea harengus*) (Fig. 7)

Although the survey was designed to obtain groundfish abundance estimates, the data have had some limited use in herring assessments (Winters and Moores 1980). The daylight-only operation of this survey may have contributed to the usefulness of herring data for this purpose. Surveys designed specifically for herring (e.g. Georges Bank and North Sea young herring surveys) are often modified groundfish surveys whose most significant difference is daylight-only trawling to minimize variations in catches due to vertical migrations.

The distribution pattern appears to be consistent in its general features throughout the sampling period. Catches concentrated in the west along the Gaspé coast, in Chaleur Bay, and near the mouth of the Miramichi River, with occasional large catches at the southern end of Prince Edward Island and around the Magdalen Islands. A decrease in the size of catches in the Chaleur Bay area was evident in 1978 and 1979. Herring, like most other commercially important species in the Gulf, are migratory and spend only the summer months in the area. In the fall (November) they move out of the area by way of the Magdalen Islands and Prince Edward Island to overwinter along the southwestern coast of Newfoundland (Winters and Beckett 1978). It is possible that the concentrations observed around the Magdalens (1970, 1971), along the Laurentian Channel (1971), and the southern end or north shore of Prince Edward Island (1973, 1976-79) represent early migrants from the spawning and feeding grounds to the west.

Redfish (*Sebastes* spp.) (Fig. 8)

Except for two small catches in shallower water, redfish were restricted to depths greater than 50 fath along the slope of the Laurentian Channel. All sampling fell within the 200-fath contour but commercial and research vessel catch distributions (Kohler 1968; Templeman 1959) show that the southern Gulf concentration does not extend much beyond this. On the basis of limited information from commercial catches, Kohler (1968) identified this group as a stock separated from a northern stock by the deep water of the channel. The present data show a strong tendency for catches to concentrate at the northwestern and southeastern end of the channel area. Steele (1957) noted a difference in the length frequencies of catches obtained in these areas and attributed this to differential distribution of sizes of the same group. It is also possible that catches from these two areas represent separate populations. The southeastern group may belong to a group distributed along the edge of the channel from Banquereau to Cape Breton (Scott 1976), while the northwestern group may belong to a northern stock.

Squid (*Illex illecebrosus*) (Fig. 9)

Squid were common in survey catches only from 1975-79. The increase in abundance during the last half of the decade in the Gulf corresponds to similar increases on the Scotian Shelf, where the fishery is concentrated. Squid were not caught commercially in the Gulf from 1970-74 and only in negligible amounts from 1975 on. Survey abundance indices on the Scotian Shelf have been positively correlated with average bottom temperatures (Dufour 1979; Koeller 1980). In the Gulf, squid tended to remain in the warmer water of the Laurentian Channel but they have strayed farther into the shallower regions at times. Such intrusions were most apparent in 1978 and 1979 when average bottom temperatures in the area were the highest of the decade. The simultaneous abundance increase on the Shelf and in the Gulf, together with the distribution of the main concentration along the southeastern channel area, suggest that Gulf squid are

immigrants from the Scotian Shelf that have moved through Cabot Strait.

Thorny skate (*Raja radiata*) (Fig. 10)

This was the most abundant and widespread of the skate species caught, occurring in deep water along the channel slope as well as inshore. It was found on the central area of cold water during some years (1971, 1972, and 1974) but never in large amounts, and appeared to avoid this area in other years. The largest catches were generally restricted to inshore areas along the Quebec, New Brunswick, and Cape Breton coast, and near the Magdalen Islands. McEachran and Musick (1975) concluded that thorny skate and smooth skate (Fig. 38) were sympatric species, although the former had a wider temperature range and distribution. In the southern Gulf the thorny skate is considerably more widespread and overlap in the distribution of the two species is small.

White hake (*Urophycis tenuis*) (Fig. 11)

White hake exhibited characteristics of both shallow inshore and deep offshore distribution patterns. It was consistently found along the New Brunswick shore from northern Prince Edward Island into Chaleur Bay, at the southern end of Prince Edward Island, and less frequently around the Magdalens. It also occurred along the channel slope at all times. It was thus found in a wide range of depths (10-200 fath) and temperatures (2-13°C), but seldom occurred in the cold water of the central Gulf. As with redfish, there was some tendency for white hake to concentrate at the northwestern and southeastern ends of the channel area.

The majority of white hake caught commercially in the Maritime provinces and Quebec come from the Gulf, and most of these are caught off southern Prince Edward Island and along its north shore (Kohler 1968; Beacham and Schweigert 1980). Research vessel catches do not reflect the apparent importance of these concentrations. To some degree, this may be due to the relatively low sampling intensity off southern Prince Edward Island and the absence of sampling inside the 15-fath contour along the north shore. The distribution of catches from other research cruises (Nepszy 1968), however, confirms the presence of relatively large concentrations in other areas. Tagging experiments indicate movement from southern Prince Edward Island along the north shore toward the northwestern end of the Island and beyond (Kohler 1971), but there is no evidence of movement into the Laurentian Channel or out of the Gulf. It is possible that catches in the Channel area within the Gulf, particularly those to the southeast, represent an extension of the well-defined group between Banquereau Bank and Cape Breton (Scott 1976), but it seems unlikely that two separate stocks would occupy two areas so different in their physical characteristics. The relationship of the fish caught in the shallow inshore area and those caught in the Laurentian Channel requires further investigation.

Winter flounder (*Pseudopleuronectes americanus*) (Fig. 12)

This is the second most important flatfish species after American plaice in research vessel biomass estimates and commercial landings in NAFO Division 4T. It shows the typical distribution pattern of the inshore group, being common in warm water off southeastern and northwestern Prince Edward Island, around Miscou, in Chaleur Bay and near the Magdalens. There appears to be a paucity of large catches directly off the mouth of the Miramichi River. This species frequents warm (12-15°C) inshore areas and undergoes localized seasonal migrations (McCracken 1963a; Van Guelpen and Davis 1979). It also moves into the intertidal zone at high tide to feed (Tyler 1972). Since the inshore limit of the survey is usually 10, and sometimes 20 fath, it is likely that a considerable portion of the population was not sampled. Distribution along the coast may be more extensive and continuous than is suggested by Fig. 12. Dunbar et al. (1980), for example, record occurrences along the north shore of Prince Edward Island, in Northumberland Strait, and in the Miramichi estuary.

Witch flounder (*Glyptocephalus cynoglossus*) (Fig. 13)

Catches were generally small; witch are found in deeper water along the slope of the Laurentian Channel as well as in shallow water along the Gaspé, New Brunswick and Cape Breton coasts, and occasionally within Chaleur Bay. They are relatively scarce or absent in the central and southern part of the area as well as around the Magdalen Islands, possibly because they avoid the extreme temperatures here. The present results agree with the summer distribution of research vessel catches given by Powles and Kohler (1970). Witch are basically a deep-living species but adults occur in shallow water during summer. In September many of these fish are apparently still found inshore.

Yellowtail (*Limanda ferruginea*) (Fig. 14)

There is no information available on the distribution of this species in the Gulf other than records of occurrence (e.g. Leim and Scott 1966; Dunbar et al. 1980). Commercial catches averaged only 15 tons, compared to 900 tons for witch flounder from 1970-78, although research vessel catches suggest that a relatively large population is present. Concentrations occur around the Magdalen Islands and along the New Brunswick shore, but it was seldom caught within Chaleur Bay and at the southeastern end of Prince Edward Island. There are no records from Northumberland Strait and it may be absent there. Although yellowtail prefers shoal water, it is found deeper than the winter flounder (Bigelow and Schroeder 1953). Thus, distribution as outlined by the trawl survey may reflect its actual range quite well.

Angler (*Lophius americanus*) (Fig. 15)

This species was rarely caught in the Gulf and is restricted to the slope of the Laurentian Channel. Jean (1965) obtained larger catches during winter when it concentrates in deeper water along the slopes and channels at the edge of the continental shelf. In summer it apparently moves into shallower water and disperses over a wider area, resulting in smaller catches. Its absence from the shallow central areas of the Gulf in September suggests an avoidance of the cold water there. It was caught only once between 1970-74 and six times between 1975-79, most catches occurring at the southeastern end of the channel area. Scott (1976) shows angler distributed along the channel slope from Banquereau to Cape Breton and the Gulf fish could be an extension of this population.

Arctic eelpout (*Lycodes reticulatus*) (Fig. 16)

This eelpout is widespread in most of the southern Gulf but concentrates in the extension of cold central water which runs along the Gaspé coast into Chaleur Bay. According to Dunbar et al. (1980), it has not been reported previously in the southern Gulf. It favors colder water as would be expected for a northern species whose range extends into the Arctic. Both distribution maps and abundance estimates indicate a considerable increase in numbers during the second half of the decade. However, only positively identified catches of this species were plotted and used to calculate abundance estimates. It is probable that it was also recorded under the general category eelpout (*Lycodes* spp.) at times.

Black dogfish (*Centroscyllium fabricii*) (Fig. 17)

Black dogfish were not caught at all from 1970-74 and only in small numbers from 1975-79. It was restricted to water below 100 fath and concentrated at the northwestern end of the Laurentian Channel edge. Pinhorn (1976) showed a concentration in the same area but centered on the bottom (plain) of the channel. The species is seldom caught above 200 m (Templeman 1963) and catches by *E.E. PRINCE* must represent the southwestern edge of this population. The absence of spiny dogfish (*Squalus acanthias*) is noteworthy. When present, it apparently concentrates at the channel edge, especially near the Magdalen Islands (Pinhorn 1976). This is a migratory species which arrives in the Gulf during July (Leim and Scott 1966). Its absence in September suggests that it has already moved on, probably toward Labrador where it is known to arrive in August and September.

Brill (*Scophthalmus aquosus*) (Fig. 18)

Only three catches were recorded during the first half of the decade in the shallow areas at the mouth of the Miramichi River and at both ends of Prince Edward Island. Catches were larger and more frequent from 1975-79, but occurred only at the southeastern end of the Island. It has been recorded previously at the northeastern end, in the Miramichi estuary, and around the Magdalens (Leim and Scott 1966; Dunbar et al. 1980). Brill live in shallow, warm water with their upper limit of distribution to the intertidal zone (Bigelow and Schroeder 1953). Its total range may not be represented by groundfish survey results.

Capelin (*Mallotus villosus*) (Fig. 19)

This is a pelagic fish but it was caught in large enough numbers to indicate a definite distribution pattern. The capelin is subarctic and appears to favor the colder water of the Gulf, particularly along the Gaspé peninsula. Isolated catches were also made off Cape Breton. Concentrations in these areas are common but penetration farther south into the shallows is rare and limited to particularly cold years (Jangaard 1974). It is migratory and spawns on the beaches within the Gulf mainly before the September survey. Since most spent fish die, those caught during the survey may represent survivors of the main spawning.

Common grenadier (*Nezumia bairdi*) (Fig. 20)

This is the only grenadier commonly found in the Gulf (Parsons 1976) and the only one caught during the *E.E. PRINCE* surveys. It is a deep-living species seldom taken in less than 200 fath (Parsons 1976). It was caught only along the channel slope, mainly below 100 fath. Like black dogfish and redfish, it appears to concentrate at the northwestern and southeastern ends of the channel area and probably has its main population somewhat deeper than the lower depth limit of the trawling survey. Again, the southeastern concentration may be an extension of the population found along the channel edge from Banquereau to Cape Breton shown by Scott (1976).

Eelpout (*Lycodes* spp.) (Fig. 21)

The distribution of unidentified *Lycodes* species is similar to both Vahl's and Arctic eelpout. Most catches recorded only as eelpout probably were one of these species. However, some catches may have been ocean pout (*Macrozoarces americanus*), especially those made farther to the south.

Gaspereau (*Alosa pseudoharengus*) (Fig. 22)

Gaspereau concentrated in the shallow, warm water along the New Brunswick shore and at the southeastern end of Prince Edward Island. Except for its absence from the Magdalen Islands, it exhibits the distribution pattern of the inshore group of groundfish species. Gaspereau are anadromous, entering the rivers of the Gulf from the mouth of Chaleur Bay southward in the spring to spawn (Leim and Scott 1966). Groundtrawl catches concentrated near the two major fisheries on the Miramichi and West Rivers. At present, there is no fishery on the Restigouche River and fish caught around the Miscou Islands may originate from smaller rivers entering near the mouth of Chaleur Bay. Spawning fish have usually left the rivers by July (Leim and Scott 1966), but virtually nothing is known about their distribution and movements in the sea. The present data indicate that they have not ventured far from the river mouths in September, and their overwintering grounds may be close by.

Greenland cod (*Gadus ogac*) (Fig. 23)

Catches of Greenland cod were always small but relatively frequent. It is widespread in shallow water (<50 fath) mainly southeast of the Magdalen Islands. It appears to tolerate a wide range of temperatures and is found in the cold central area as well as in the warmer inshore regions. Its tolerance for lower salinities (Leim and Scott 1966) is shown by its presence at the head of Chaleur Bay. In the southern Gulf, it has previously been reported only from the Miramichi estuary (Dunbar et al. 1980) and is not important commercially.

Greenland halibut (*Reinhardtius hippoglossoides*) (Fig. 24)

Catches were restricted to the Cape Breton and Gaspé coasts, and to the channel slope, with a definite tendency to concentrate in the northwestern part of the region. It appears to be common in the depression southwest of American Bank. This species prefers colder (-0.5 to 3.0°C) and deeper (>100 fath) water. Templeman (1973) attributes its occurrence in the Gulf to the cold intermediate layer which also restricts its abundance because of its shallowness. Greenland halibut also require an adjacent deeper and warmer area for spawning and development of young, apparently provided by the Laurentian Channel.

The Atlantic halibut (*Hippoglossus hippoglossus*), reported to occur off the Gaspé and as far south as the Miramichi River (Dunbar et al. 1980), is notably absent from survey catches. Kohler (1968) shows its distribution along the channel slope from Gaspé to Cape Breton. This species is found mainly in the northern part of the Gulf and undergoes extensive migrations (McCracken 1958). Its absence in September does not exclude its presence at other times of year.

Haddock (*Melanogrammus aeglefinus*) (Fig. 25)

Haddock were seldom taken, and only in small numbers. Distribution was similar to Greenland halibut in that they occur along the Gaspé and Cape Breton coasts, and along the channel edge. Two catches were made in the vicinity of the Magdalen Islands, one of these being the largest of the decade. The main concentration appears to be off northern Cape Breton, agreeing with previous summer distribution of research and commercial catches (McCracken 1965). Needler (1930) also recorded commercial catches from the Gaspé and the Magdalen Islands. Much like cod, haddock leave the Gulf in November-December to overwinter on the Scotian Shelf (McCracken 1963b). Although abundance in the Gulf may always have been considerably lower than on the Shelf (McCracken 1965), Gulf haddock appear to have declined beginning in the early 1950's until the fishery virtually disappeared in the mid 1960's. Research vessel catches in the 1970's show no sign of recovery.

Longfin hake (*Phycis chesteri*) (Fig. 26)

This species was found exclusively along the edge of the Laurentian Channel, mainly below 100 fath. It is known to occur to 500 fath (Leim and Scott 1966) and *E.E. PRINCE* trawl catches probably define only the edge of its distribution. Scott (1976) found it relatively common along the edge of the Scotian Shelf from south of Browns Bank to Cape Breton. Distribution through Cabot Strait is probably continuous.

Longhorn sculpin (*Myoxocephalus octodecemspinosus*) (Fig. 27)

This is the most common sculpin caught by research vessels in the Maritimes. In the Gulf it appears to be restricted to warm inshore areas and shows the typical distribution of the inshore group. It is particularly abundant off the southeastern tip of Prince Edward Island. A well established and apparently isolated population occurs around the Magdalens. This species is tolerant of lower salinities (Bigelow and Schroeder 1953) and is found well into Chaleur Bay, with relatively large catches at its head. It is common on Western, Sable Island, and Banquereau Banks at depths between 20 and 50 fath in relatively warm (>3°C) water (Scott 1976). Its absence from similar depths in the central area around Bradelle Bank is probably due to the cold water there.

Lumpfish (*Cyclopterus lumpus*) (Fig. 28)

Catches were always small but relatively widespread, occurring within Chaleur Bay as well as offshore around Bradelle Bank and along the Laurentian Channel. It appears to be more abundant in the western part of the survey area and avoids the warm shallow areas to the south around Prince Edward Island. It was caught more frequently during the first half of the decade.

Mackerel (*Scomber scombrus*) (Fig. 29)

Mackerel distribution appeared to be well defined, particularly from 1970-74. Concentrations occurred at either end of Prince Edward Island and around the Magdalen Islands, with continuous but smaller catches along the New Brunswick shore into Chaleur Bay. Catches were less frequent from 1975-79. The concentration around the Magdalens was still apparent but those around Prince Edward Island were much less conspicuous. Three catches were made offshore in the vicinity of Orphan Bank during this period.

Like herring, mackerel are pelagic and present only during the summer months. Data from egg and larval surveys indicate that spawning occurs during early July, slightly offshore between Orphan Bank and the northern tip of Prince Edward Island (Lett and Marshall 1978). By September, these fish have apparently moved out of the main spawning ground into shallower and warmer water, perhaps to feed until their migration from the Gulf in October and November.

Mailed sculpin (*Triglops murrayi*) (Fig. 30)

This is another species previously known only from isolated records of occurrence, which appears to be relatively widespread and common in the southern Gulf. It was found both along the channel in moderately deep (51-100 fath) and warm water as well as in the central area of cold water. It appears to avoid the warm shallow areas to the south. Its abundance appears to have decreased noticeably during the last 5 yr of the decade.

Ocean pout (*Macrozoarces americanus*) (Fig. 31)

The distribution of ocean pout is noticeably different from the two common *Lycodes* species. It favors the warmer inshore areas at the southern end and north shore of Prince Edward Island and along the New Brunswick shore. Its range extends into Chaleur Bay and into deeper water along the Gaspé coast, with isolated catches near the Magdalen Islands and Bird Rocks. It avoids the central cold water. This species also appears to have declined in numbers during the last 5 yr of the survey period.

Pollock (*Pollachius virens*) (Fig. 32)

Pollock are seldom caught east of Sable Island during research vessel surveys, and Scott (1976) shows only two small catches east of the Gully from 1970-74. It was rarely caught during the Gulf surveys and was restricted to the slope of the Laurentian Channel. Commercial catches in the Gulf have always been negligible. Reports of occurrence in the southern Gulf are relatively common but are confined to inshore areas (Dunbar et al. 1980). Juveniles are seldom caught offshore by research vessels since they move inshore early in their life history, where they remain at least during their first year. It is possible that some of the Gulf reports were of these "harbour" pollock. Larvae do not occur in the southern Gulf, however, and the presence of a breeding population seems unlikely.

Sea raven (*Hemitripterus americanus*) (Fig. 33)

This species was frequently caught but usually in small numbers. With one exception, catches of more than 10 fish were confined to a small concentration off southern Prince Edward Island. This is similar to the distribution of longhorn sculpin, whose territory appears to overlap the sea raven's everywhere except in Chaleur Bay. The sea raven is seldom found in estuaries (Bigelow and Schroeder 1953) and its avoidance of Chaleur Bay may be due to an intolerance of the lower salinities here.

Shad (*Alosa sapidissima*) (Fig. 34)

This anadromous species was caught only six times during the decade. Shad are known to undergo extensive migrations along the east coast of North America and fish caught in the southern Gulf do not necessarily spawn in the local rivers.

Shorthorn sculpin (*Myoxocephalus scorpius*) (Fig. 35)

Although one catch was made along the channel edge, this species prefers the shallow inshore areas. It is most abundant in water shallower than 10 fath (Bigelow and Schroeder 1953) and its full range may not be represented by *E.E. PRINCE* trawl catches. It has previously been reported as larvae around the Magdalen Islands (Leim and Scott 1966) and may occur there in very shallow, unsampled areas.

Silver hake (*Merluccius bilinearis*) (Fig. 36)

Silver hake were seldom caught east of the Gully during *A.T. CAMERON* summer surveys (Scott 1976) on the Scotian Shelf, and never north of Banquereau Bank. They have been frequently reported in the southern Gulf but always in small numbers (Beaulieu and Corbeil 1914). McKenzie and Scott (1956) consider them "strays" in the area. Like pollock, most reports are from inshore areas while research vessel catches show them distributed mainly along the channel slope. Larvae are rarely caught in the Gulf (Kohler et al. 1977).

Smelt (*Osmerus mordax*) (Fig. 37)

Smelt are anadromous, entering estuaries in the fall where they remain during the winter (Leim and Scott 1966). The large, distinct concentrations off southeastern and northwestern Prince Edward Island and at the head of Chaleur Bay probably consist mainly of fish which enter the West, Miramichi, and Restigouche Rivers in the spring to spawn.

Smooth skate (*Raja senta*) (Fig. 38)

This skate frequently occurs in research vessel catches along the eastern edge of the Scotian Shelf (Scott 1976). Those caught along the southeastern part of the channel slope within the Gulf are probably an extension of this population. Like several other species occurring along the slope, there is a paucity of catches northeast of the Magdalens, suggesting a separate population off the Gaspé. Smooth skate were found mainly below 50 fath with occasional catches in shallower water. Isolated catches occurred off the Magdalen Islands.

Vahl's eelpout (*Lycodes vahlii*) (Fig. 39)

Like the arctic eelpout, this species has not been reported previously in the southern Gulf (Dunbar et al. 1980), yet it occurs there in relatively large numbers. Its main concentration is also in the cold water along the Gaspé coast. A secondary concentration may be present along the Cape Breton coast. It is occasionally found further offshore along the channel slope and around Bradelle Bank.

Winter skate (*Raja ocellata*) (Fig. 40)

This skate prefers the warm shallow water of the southern Gulf and occurs in all three areas frequented by the inshore group of species. It appears to be tolerant of the lower salinities found near the head of Chaleur Bay. Its distribution is in marked contrast to that of the smooth skate, which is found in deeper water along the channel edge, and the thorny skate which is widespread in the area.

Wolffish (*Anarhichas lupus*) (Fig. 41)

The wolffish was found mainly along the channel edge in depths greater than 50 fath. One isolated catch was made in the shallows to the south. On the Scotian Shelf it is found in relatively shallow (<50 fath) moderately warm (24°C) water on the banks. Like the angler, longhorn sculpin, and other species, its absence from the shallow water around Bradelle Bank is probably due to the extremely cold water found there.

ACKNOWLEDGMENTS

Contour plots of temperature and salinity were provided by MEDS, Ottawa, through the special efforts of J. Gagnon and M. Bayly. Computer programs for plotting catch data were developed by D.N. Fitzgerald. F. Cunningham and W. McMullon prepared figures and photographs, Ms. B. McCullough and Mrs. J. Hurley typed the report, and Ms. R. Garnett did the editing. Drs. J. S. Scott and D. Markle reviewed the manuscript and provided useful comments. Special thanks to the Captains and crew of the *E.E. PRINCE* and the technical staff of the Marine Fish Division for their cooperation throughout the survey period.

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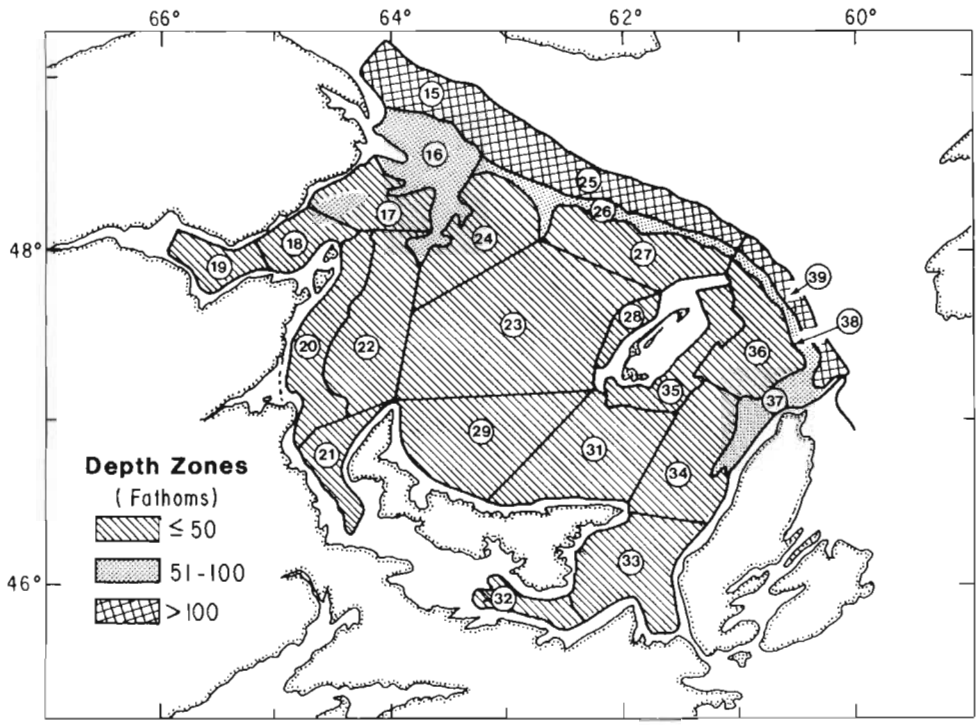

Fig. 1. Stratification scheme used for the Gulf of St. Lawrence groundfish surveys.

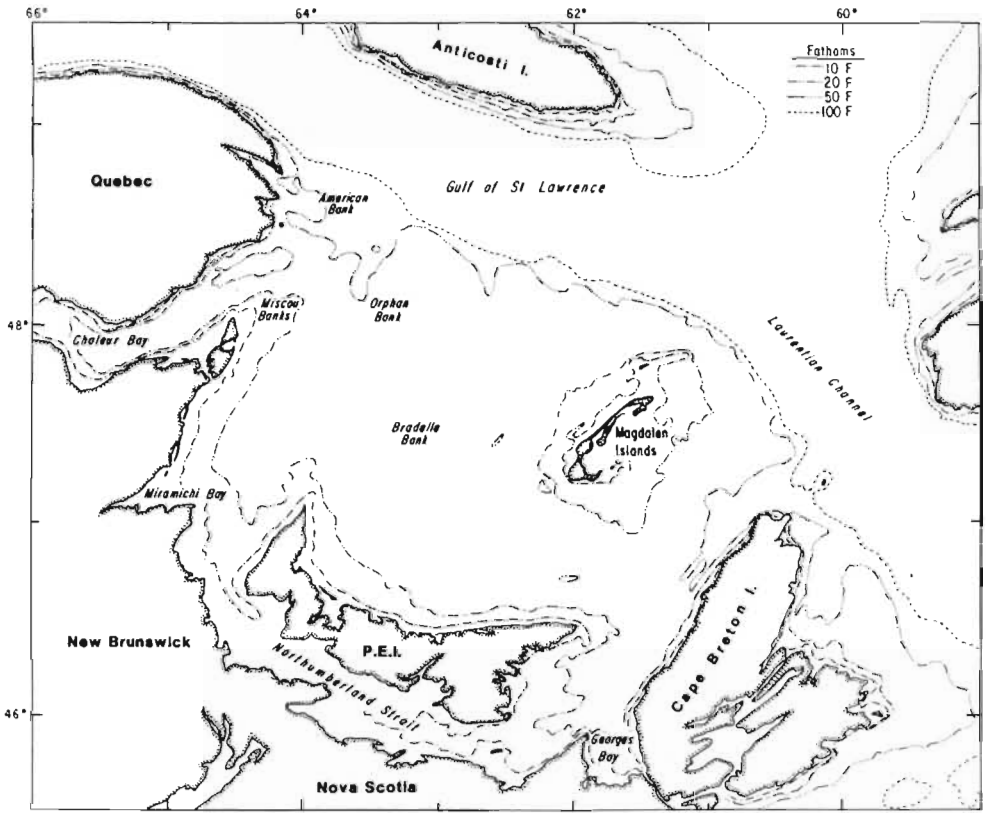

Fig. 2. Bathymetric map of the southern Gulf of St. Lawrence with place names used in the text.

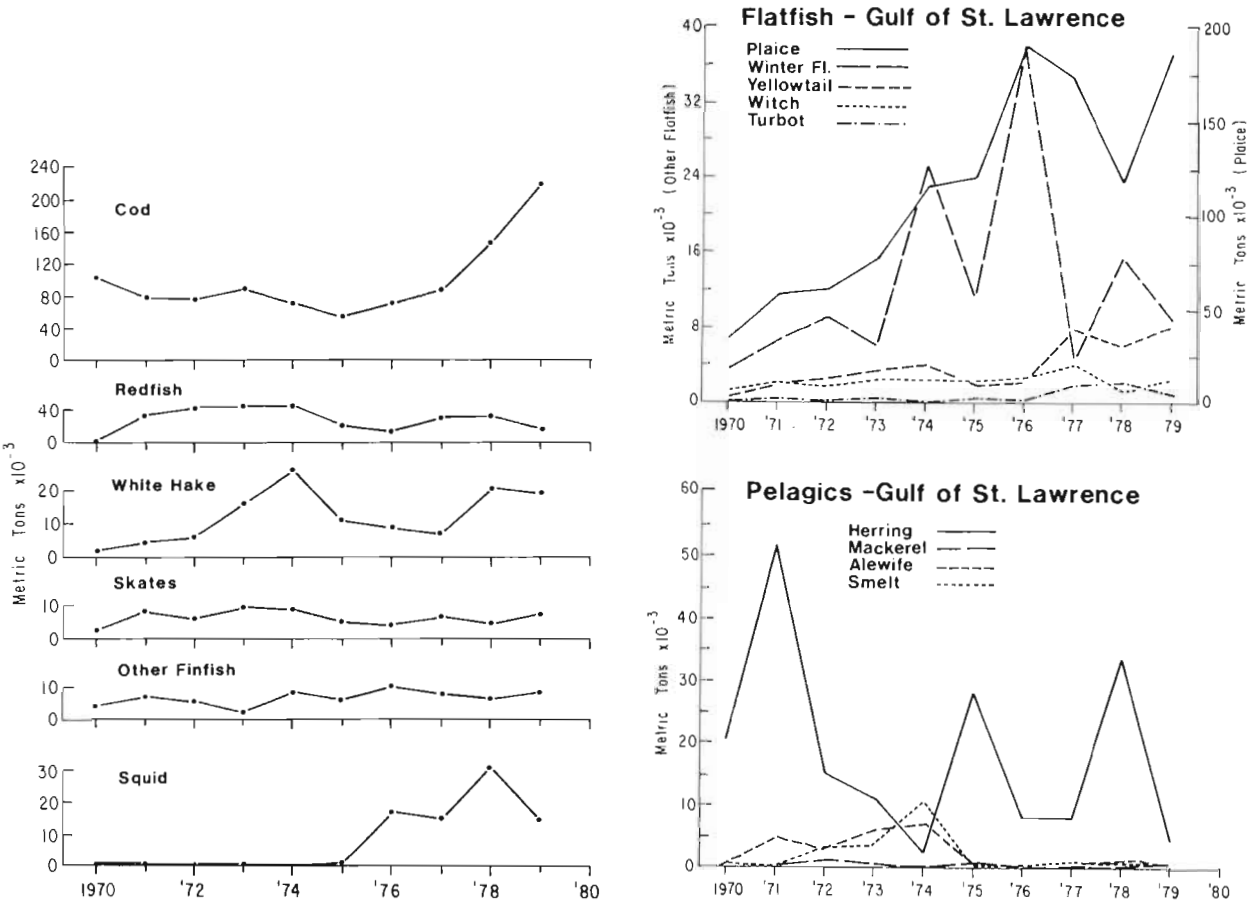

Fig. 3. Biomass changes for major species and species groups in the southern Gulf of St. Lawrence.

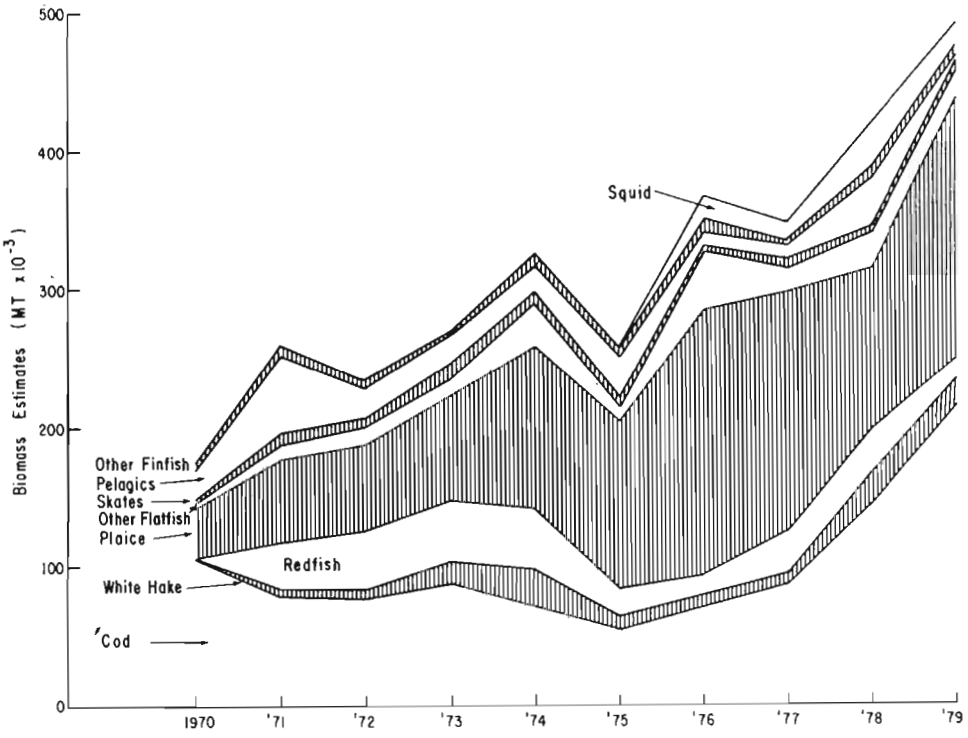

Fig. 4. Biomass changes for major species and species groups in the southern Gulf of St. Lawrence.

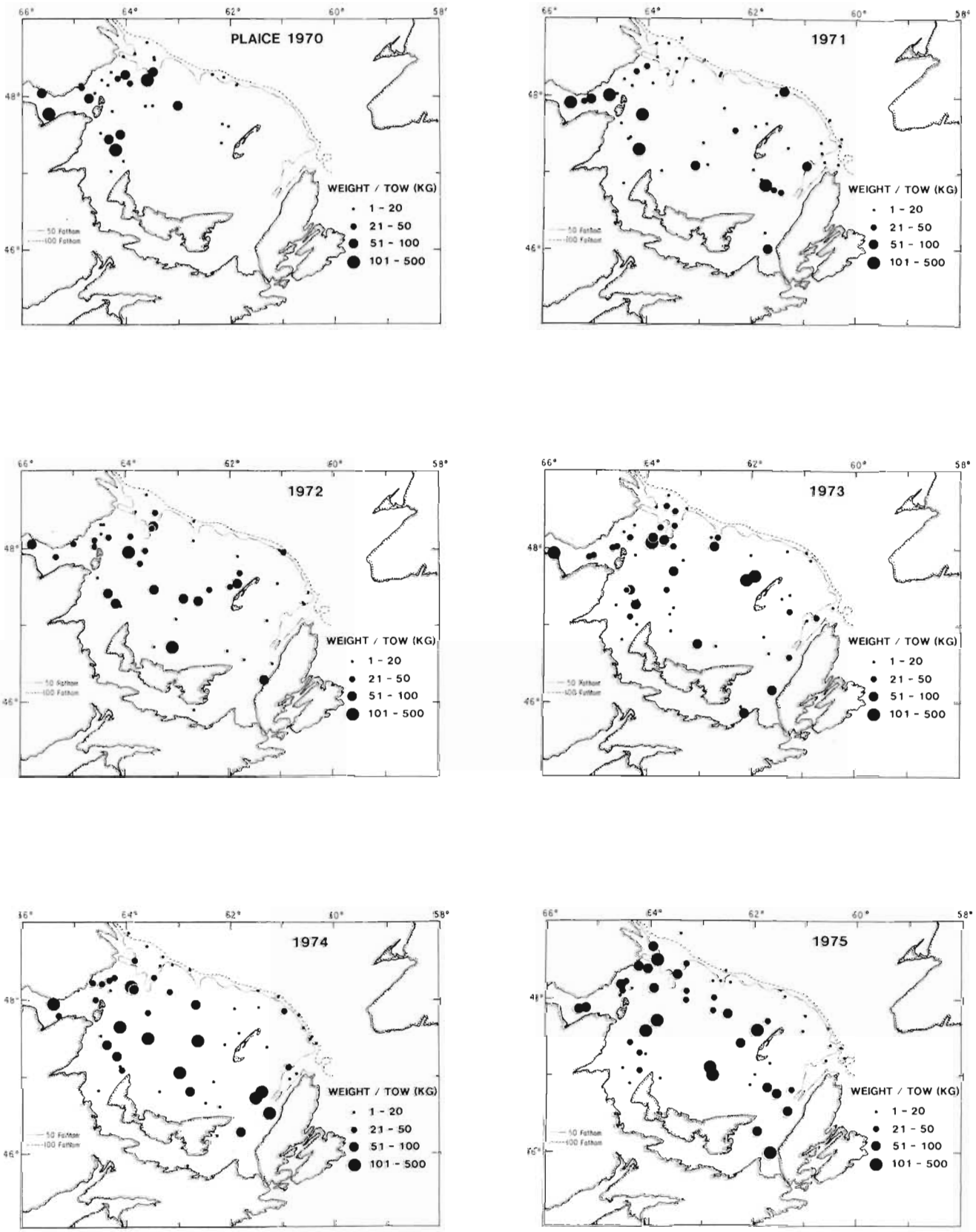

Fig. 5. American plaice (*Hippoglossoides platessoides*) 1970-75.

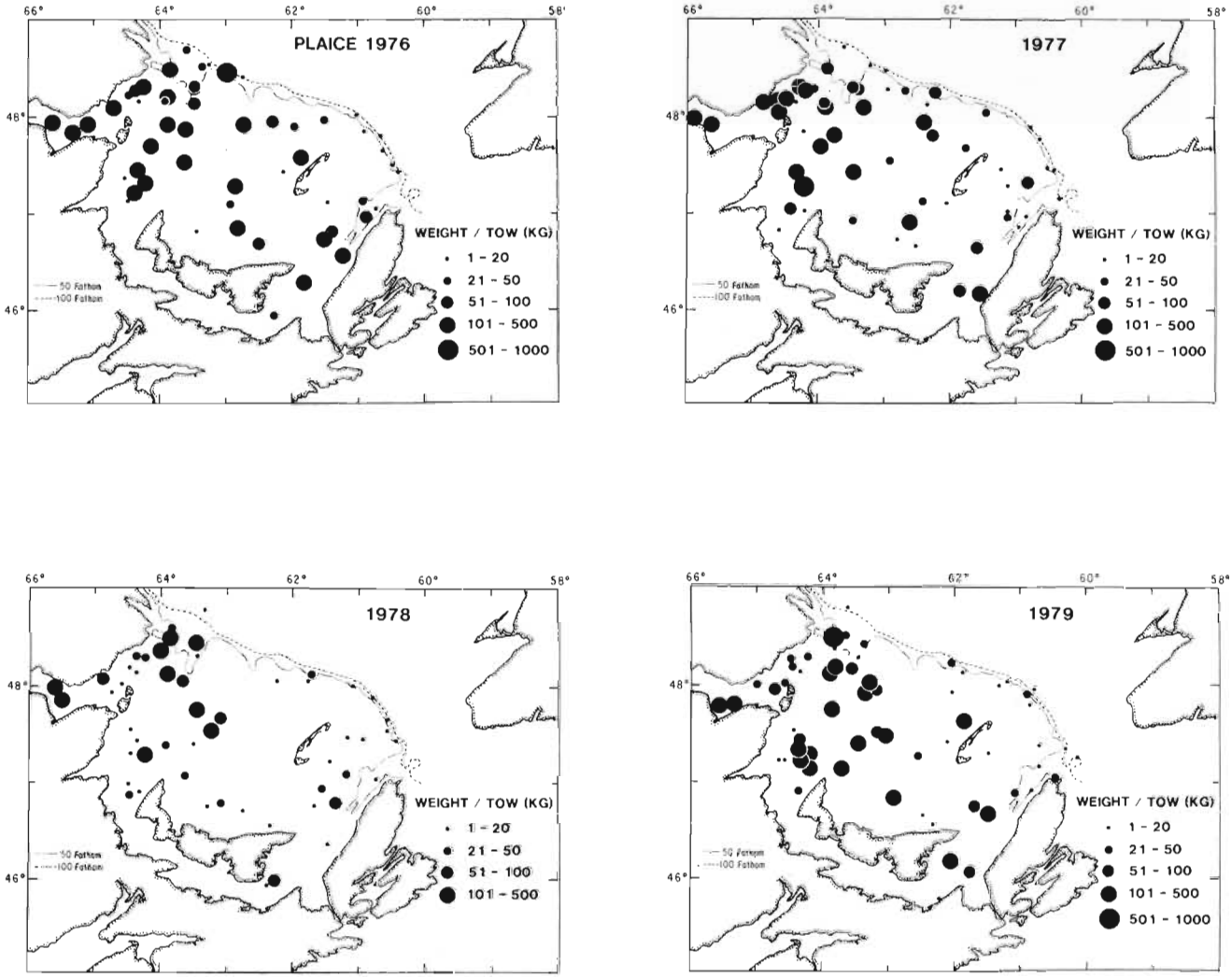

Fig. 5 (cont'd.) American plaice *(Hippoglossoides platessoides)* 1976-79.

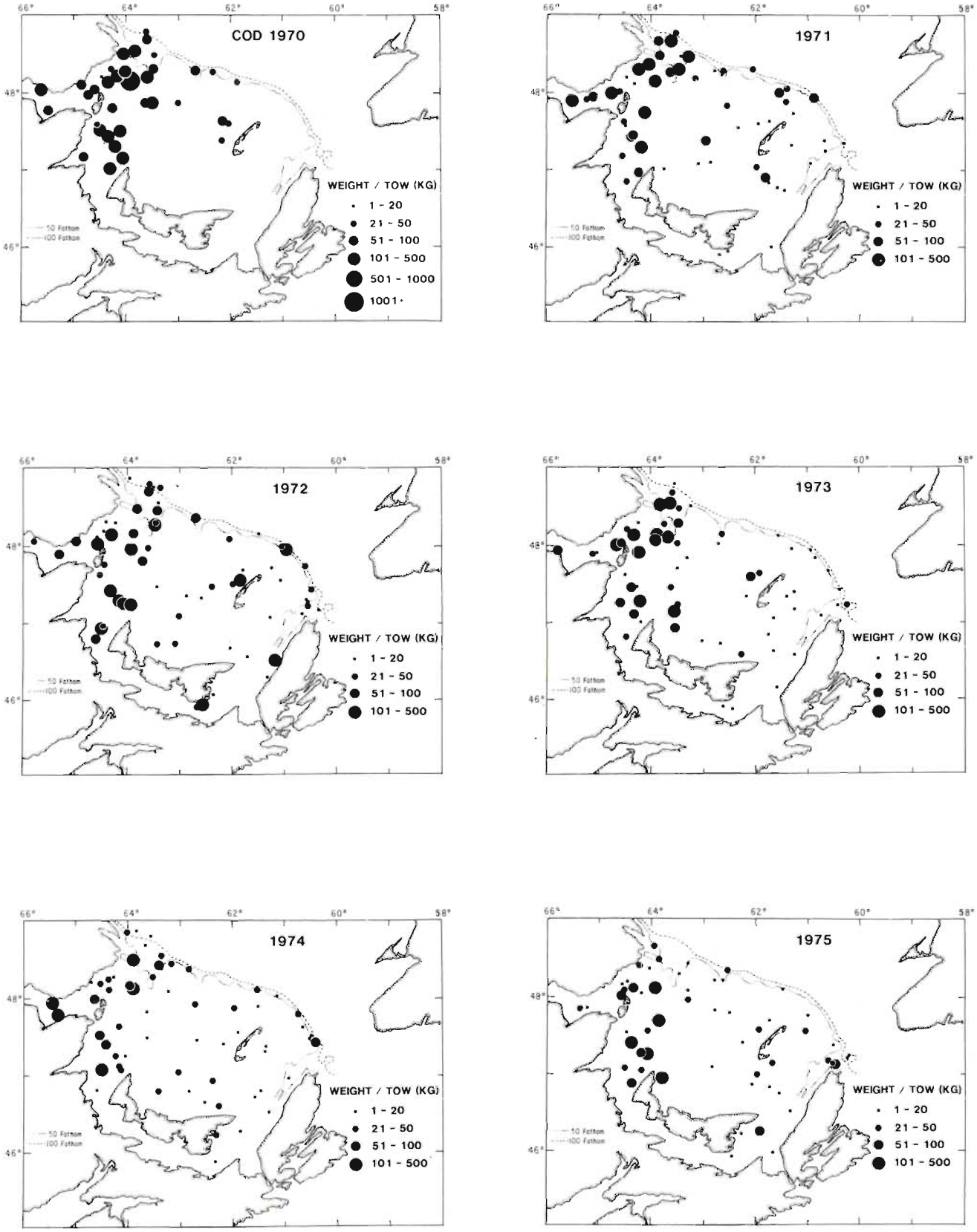

Fig. 6. Atlantic cod *(Gadus morhua)* 1970-75.

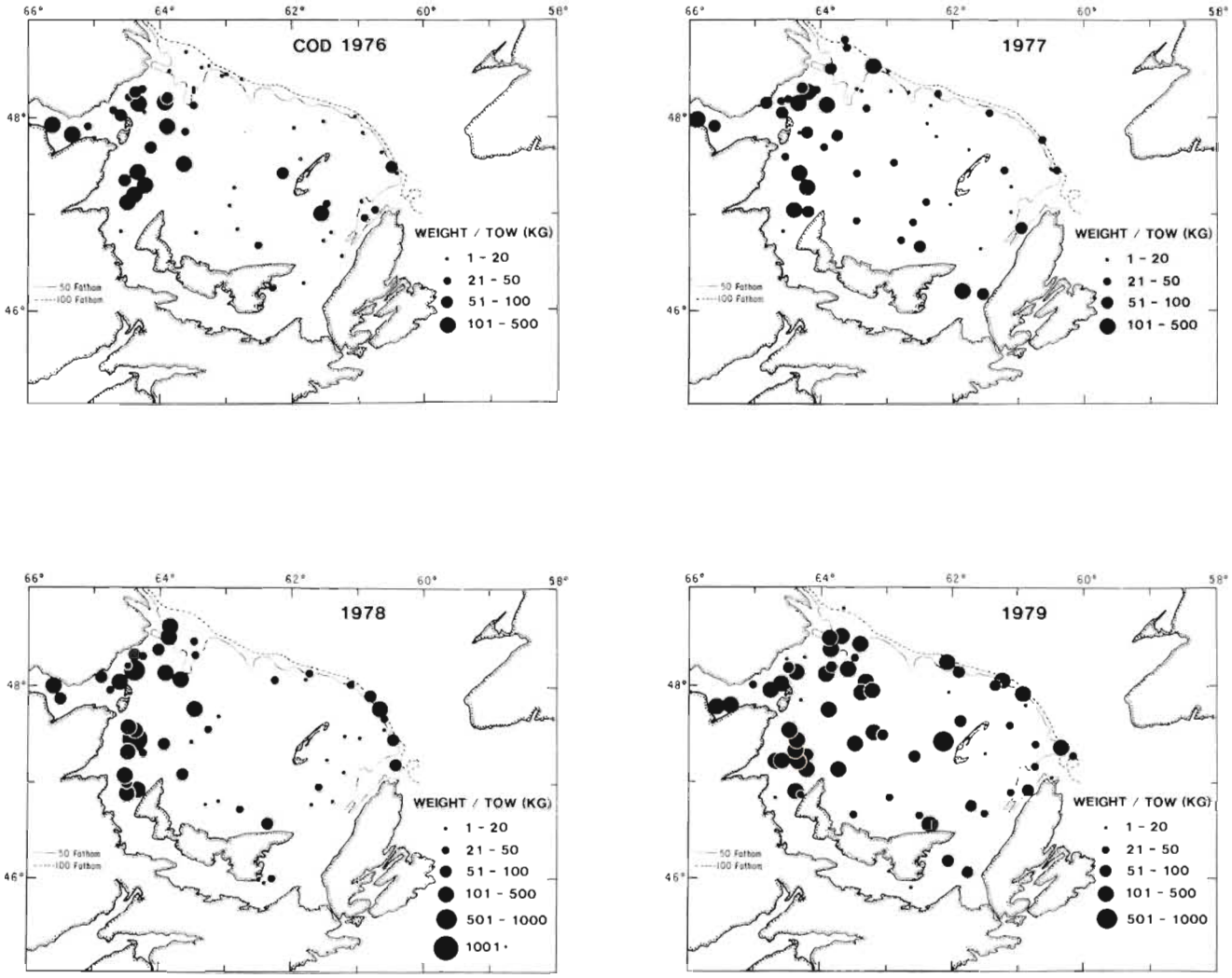

Fig. 6 (cont'd.) Atlantic cod *(Gadus morhua)* 1976-79.

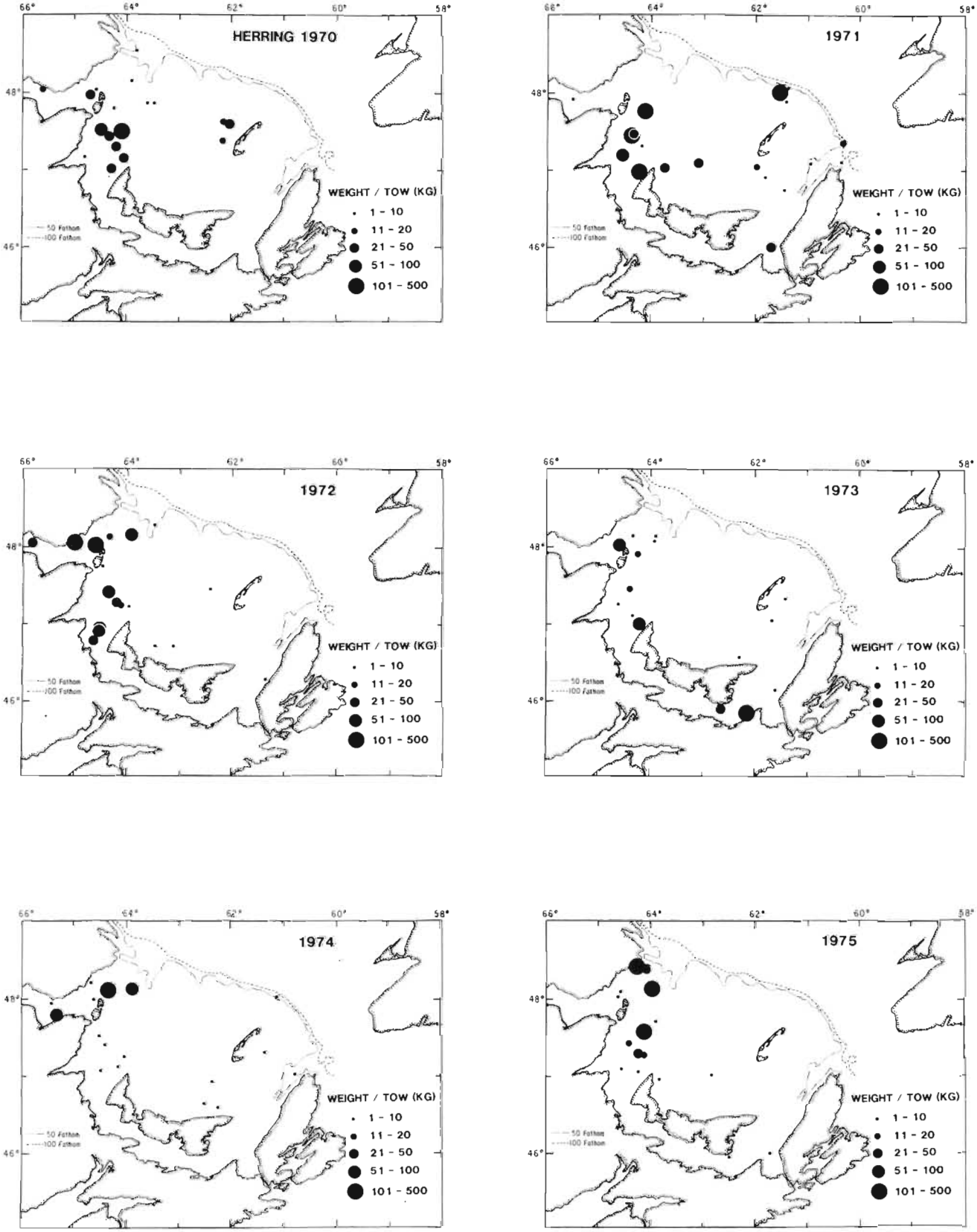

Fig. 7. Herring *(Clupea harengus)* 1970-75.

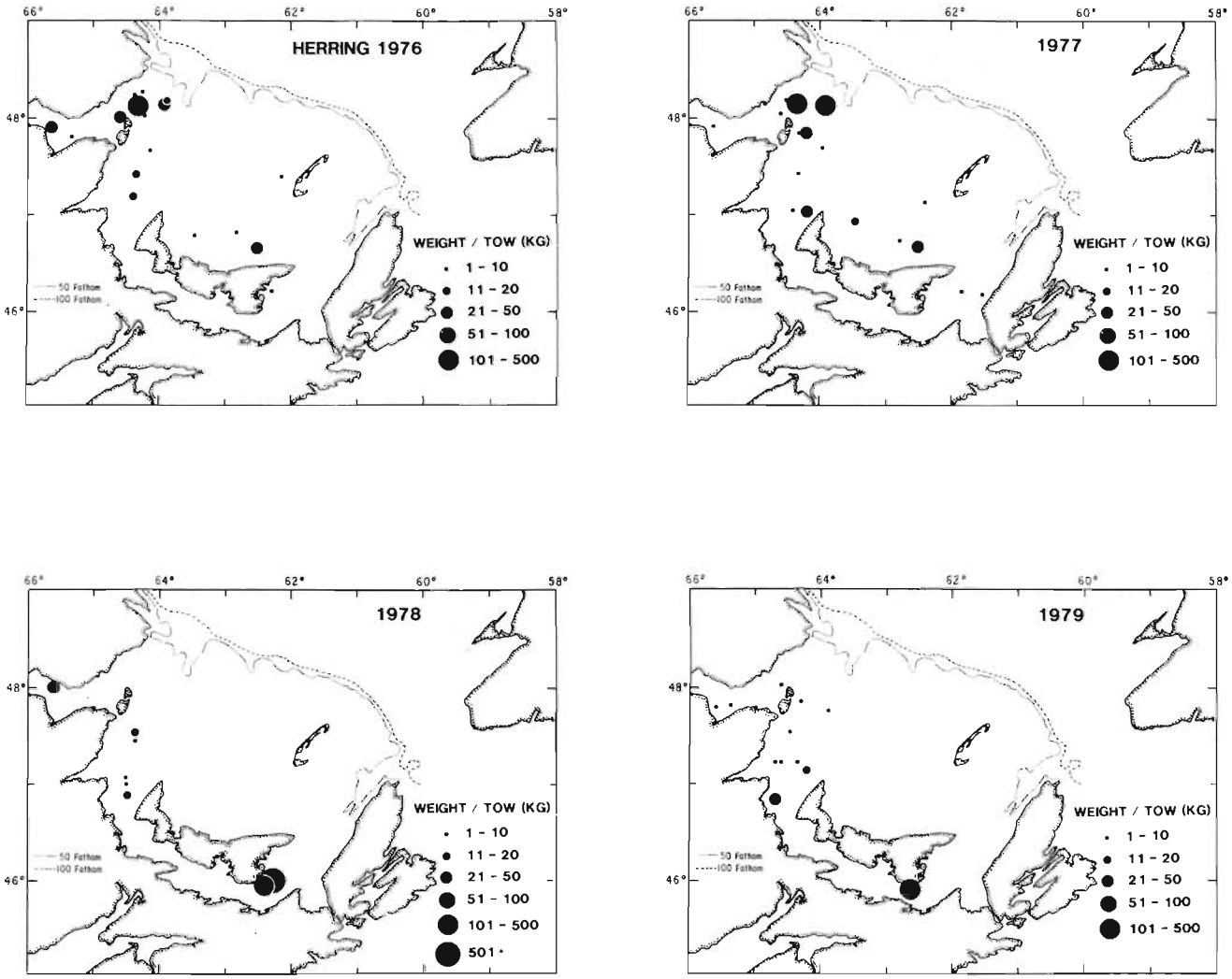

Fig. 7 (cont'd.) Herring *(Clupea harengus)* 1976-79.

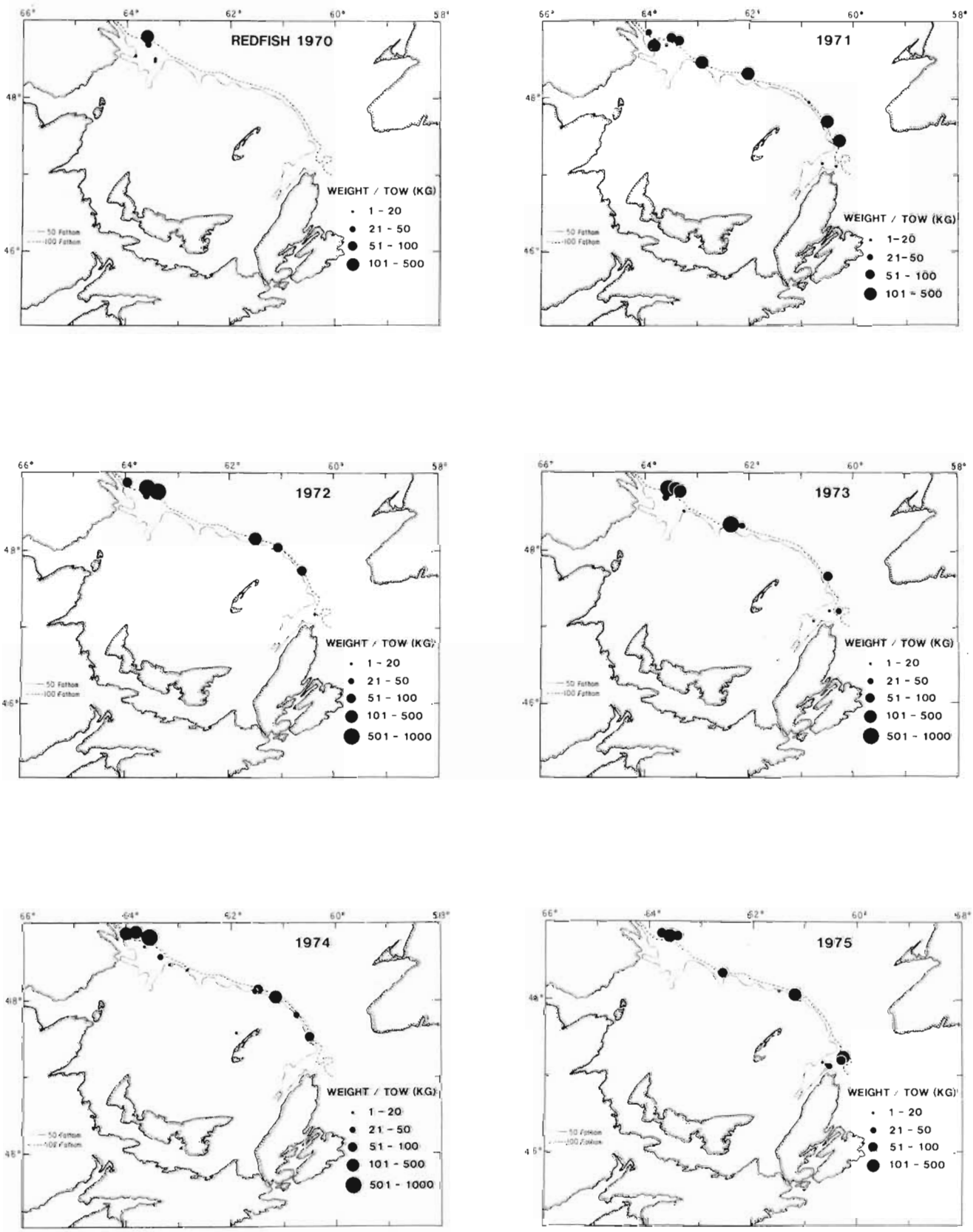

Fig. 8. Redfish *(Sebastes* spp.) 1970-75.

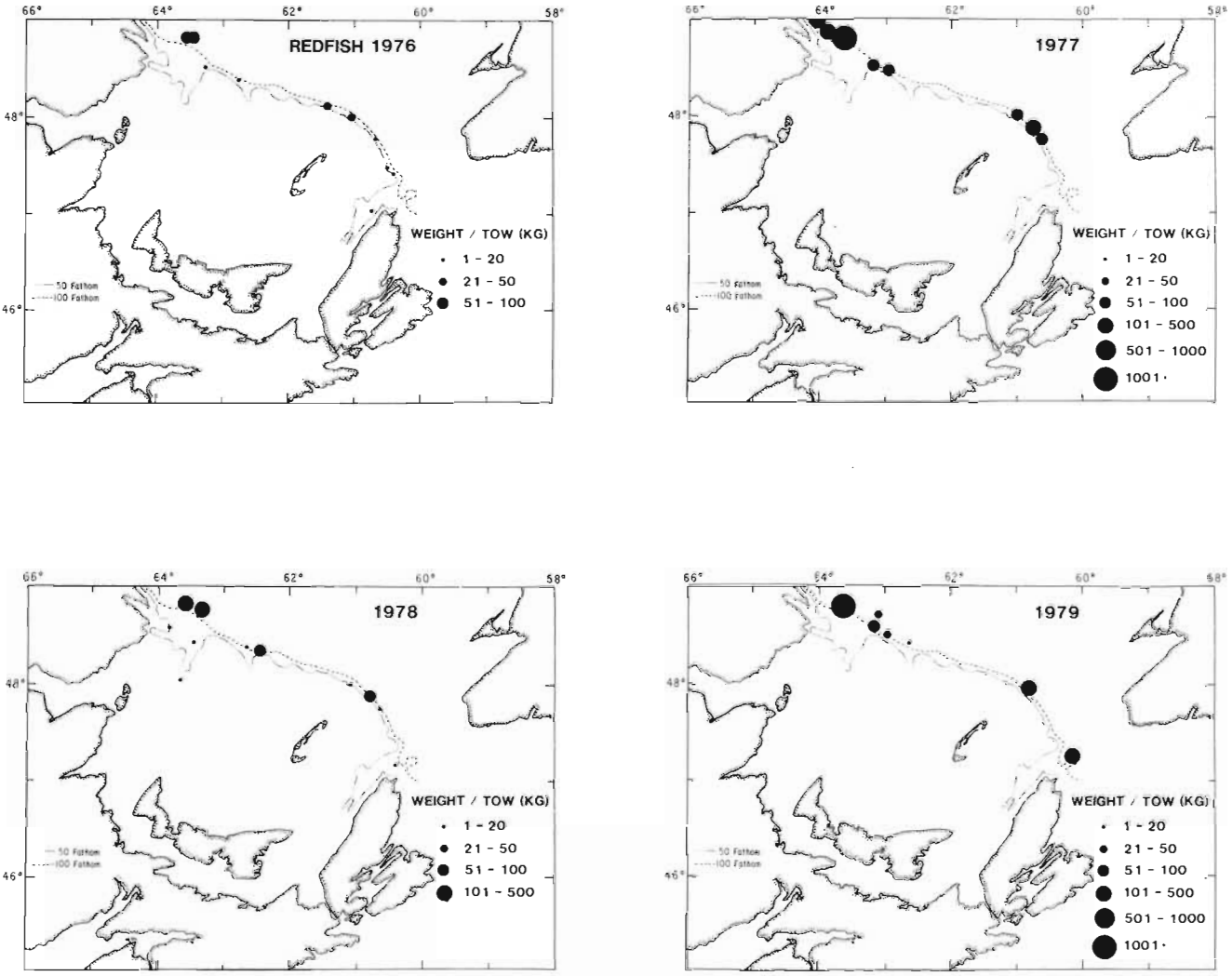

Fig. 8 (cont'd.) Redfish *(Sebastes* spp.*)* 1976-79.

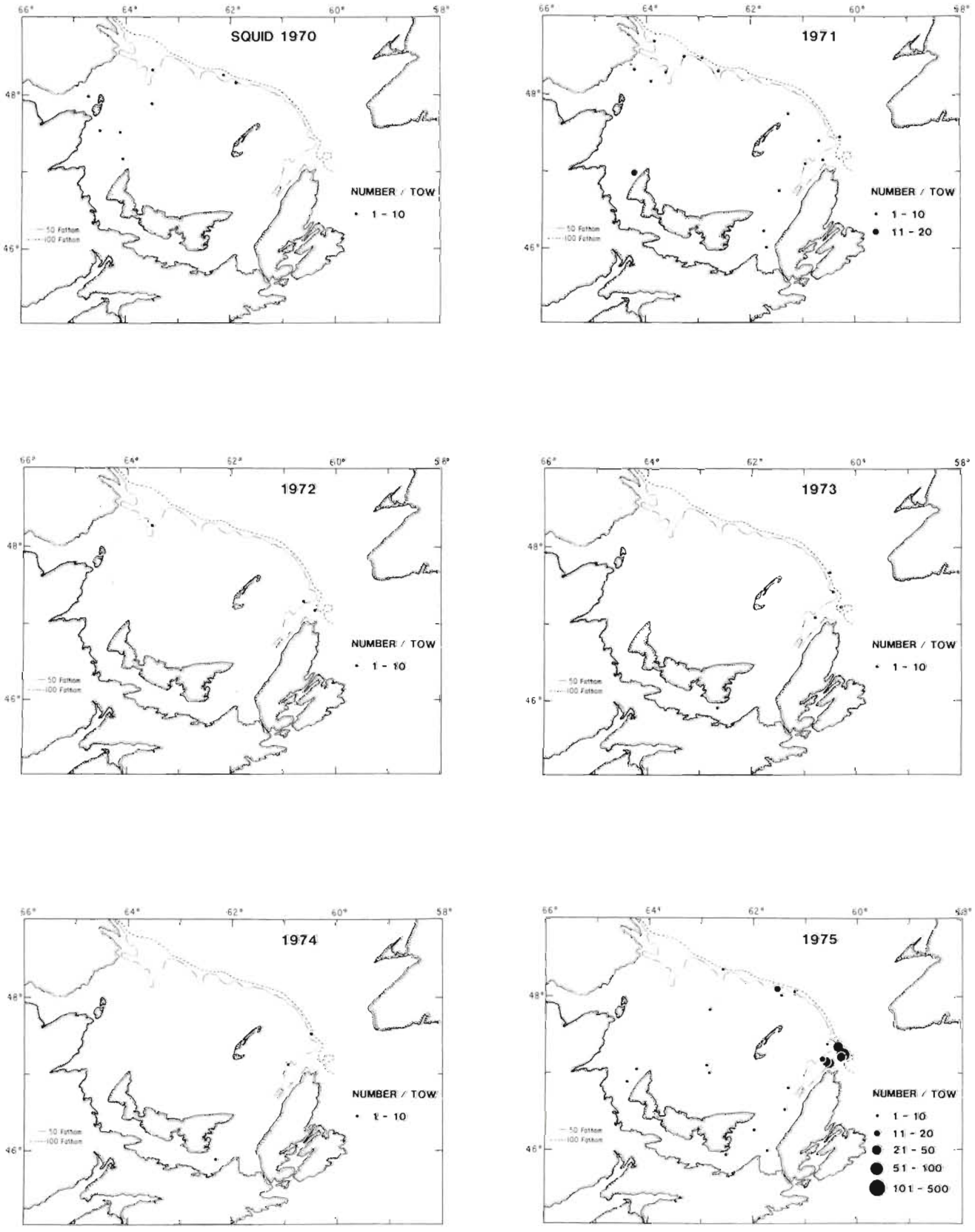

Fig. 9. Squid (*Illex illecebrosus*) 1970-75.

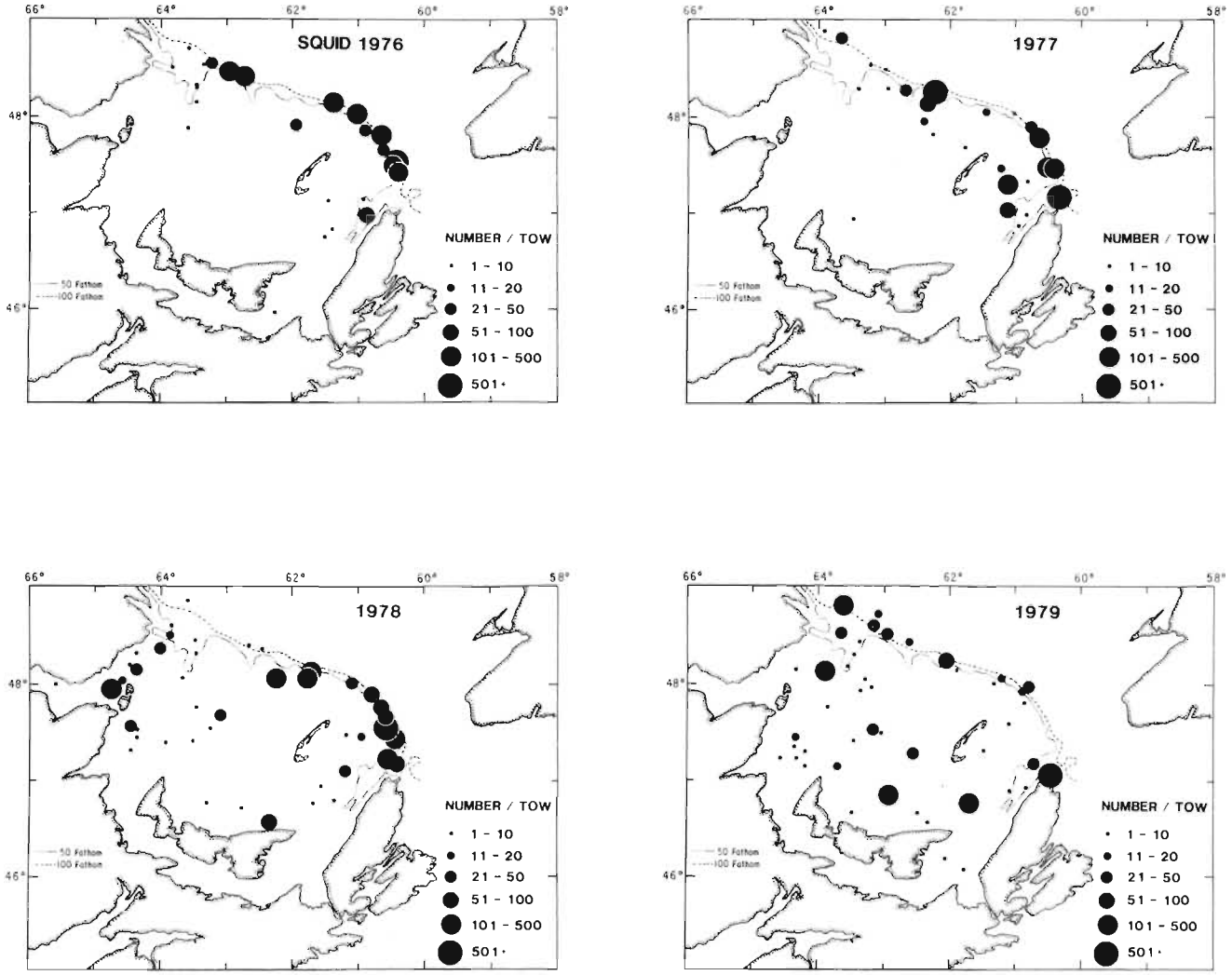

Fig. 9 (cont'd.) Squid *(Illex illecebrosus)* 1976-79.

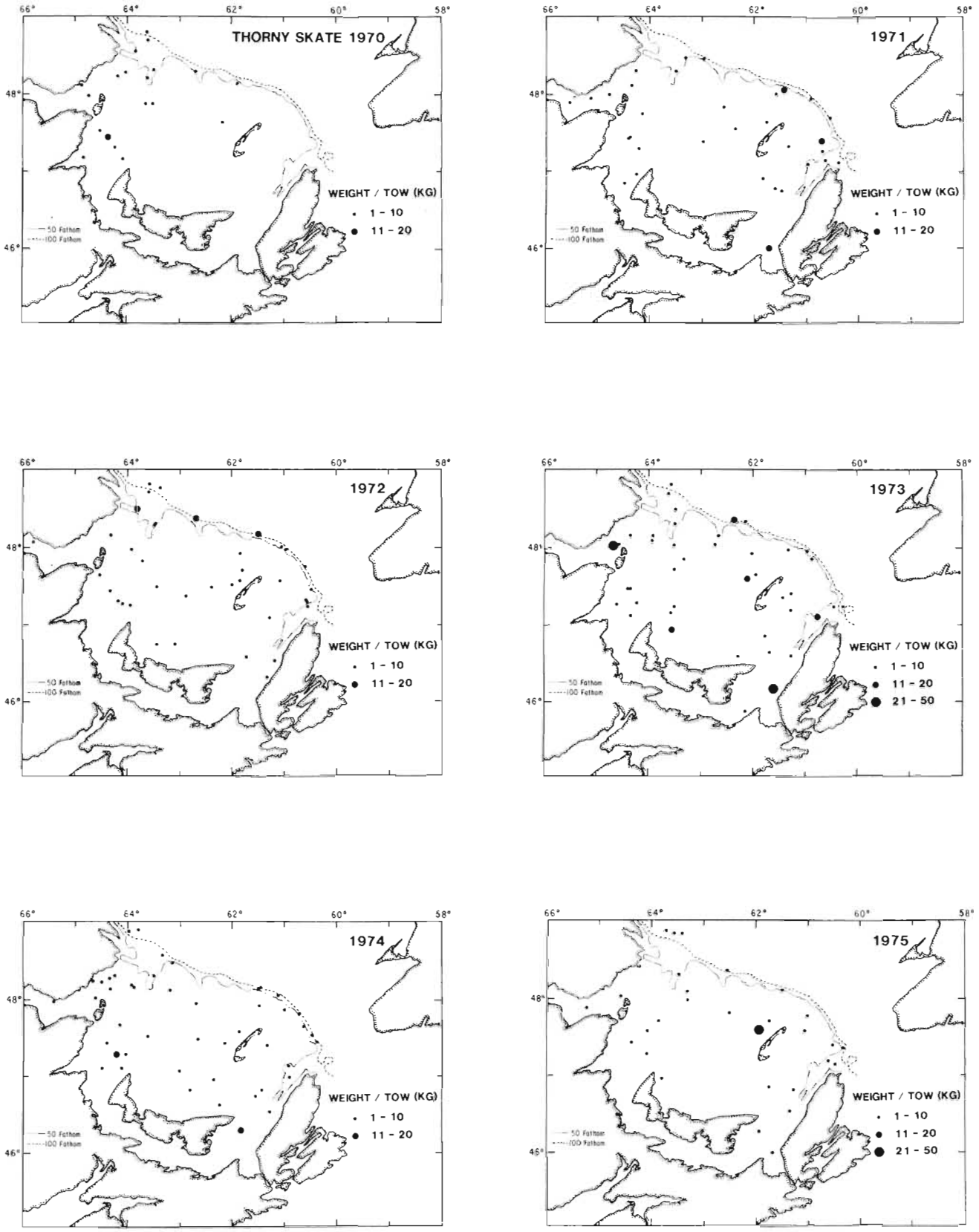

Fig. 10. Thorny skate *(Raja radiata)* 1970-75.

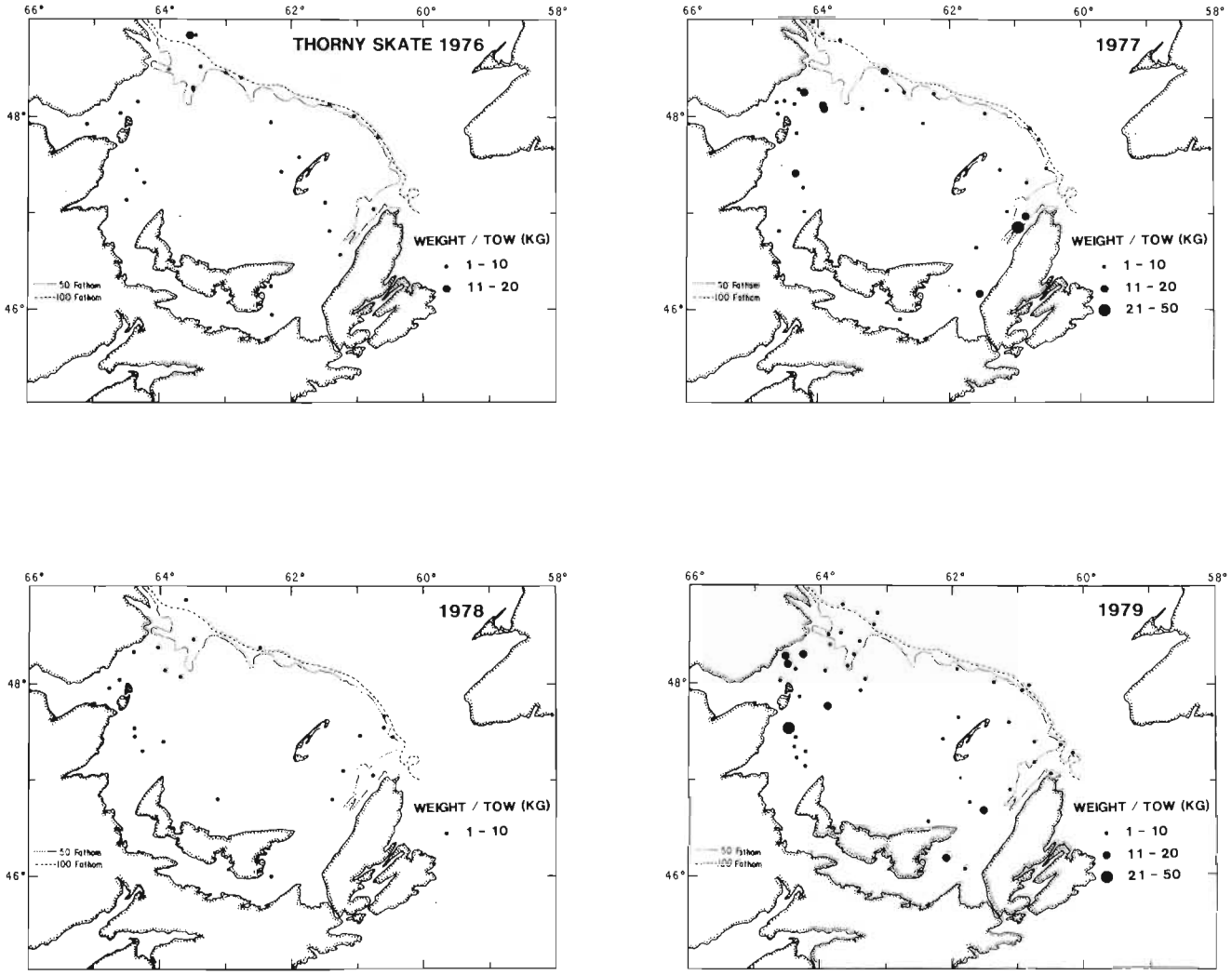

Fig. 10 (cont'd.) Thorny skate *(Raja radiata)* 1976-79.

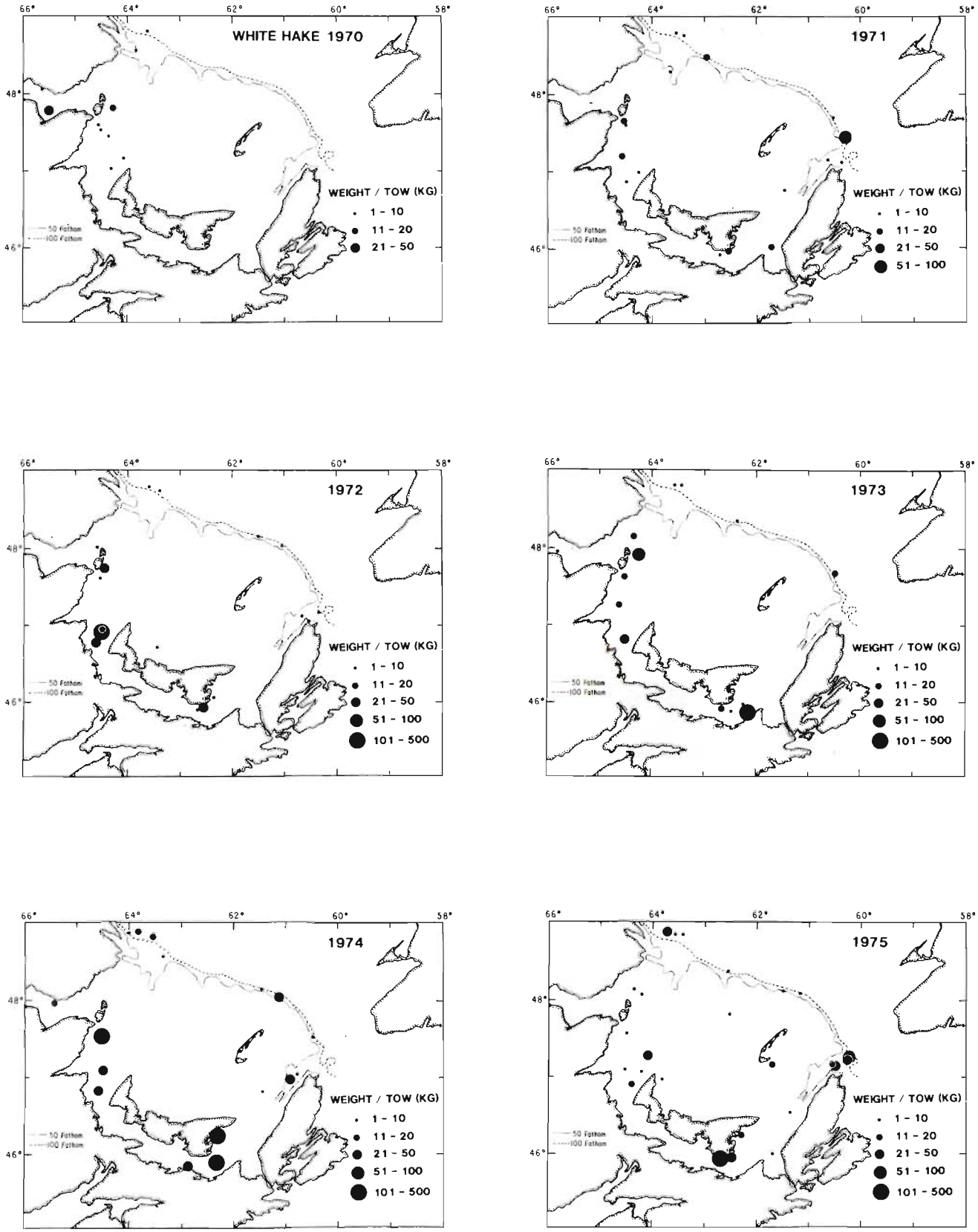

Fig. 11. White hake *(Urophycis tenuis)* 1970-75.

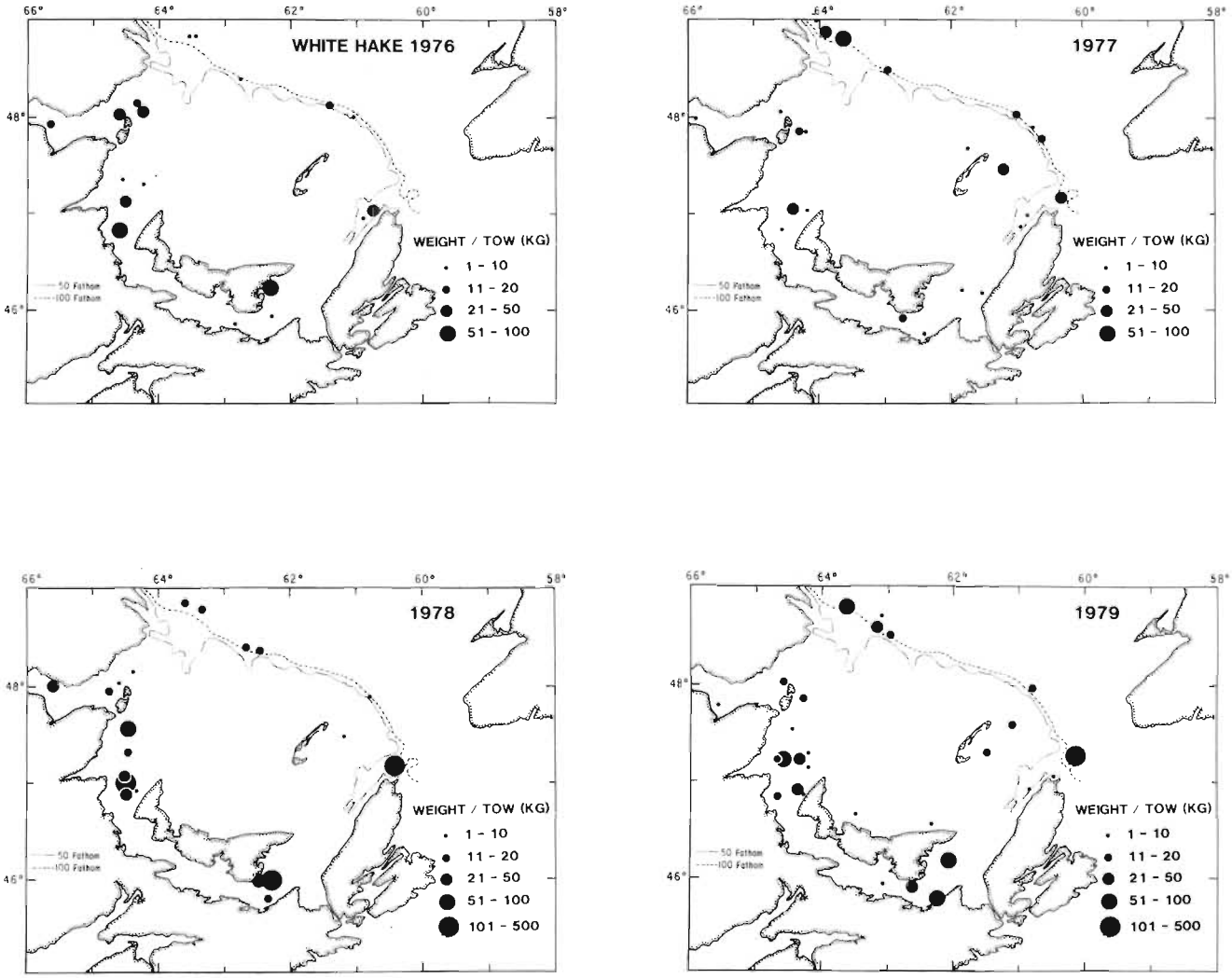

Fig. 11 (cont'd.) White hake *(Urophycis tenuis)* 1976-79.

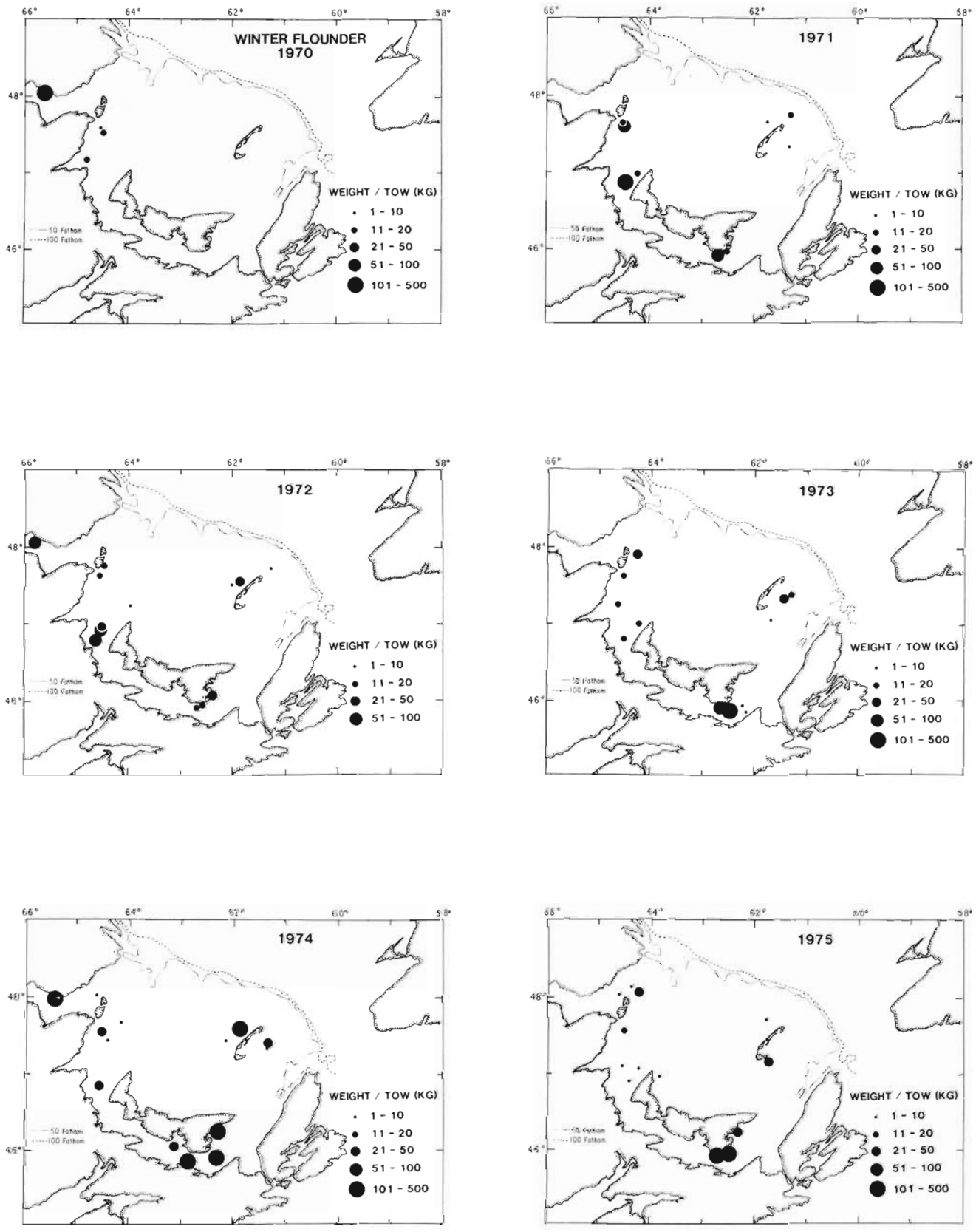

Fig. 12. Winter flounder *(Pseudopleuronectes americanus)* 1970-75.

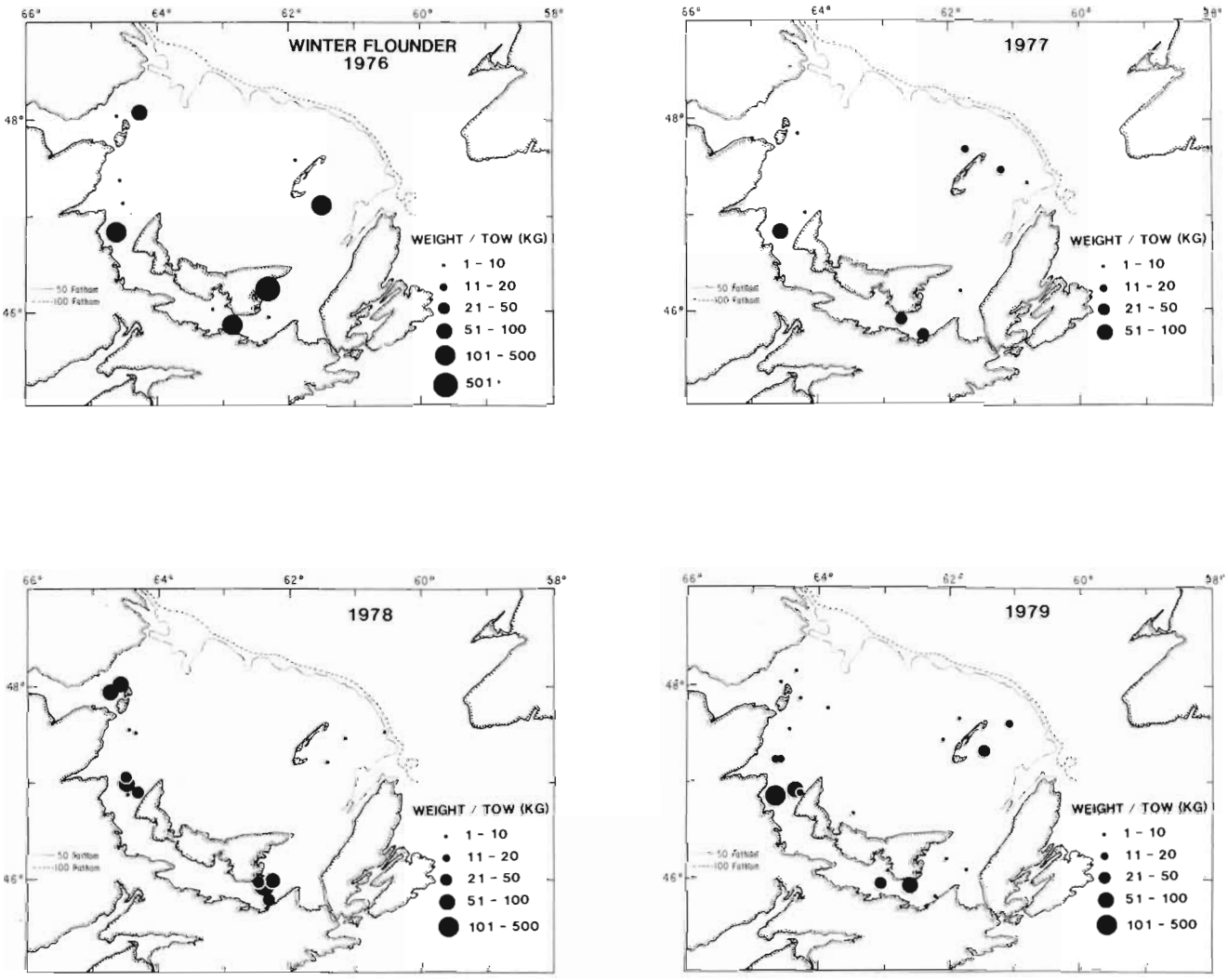

Fig. 12 (cont'd.) Winter flounder *(Pseudopleuronectes americanus)* 1976-79.

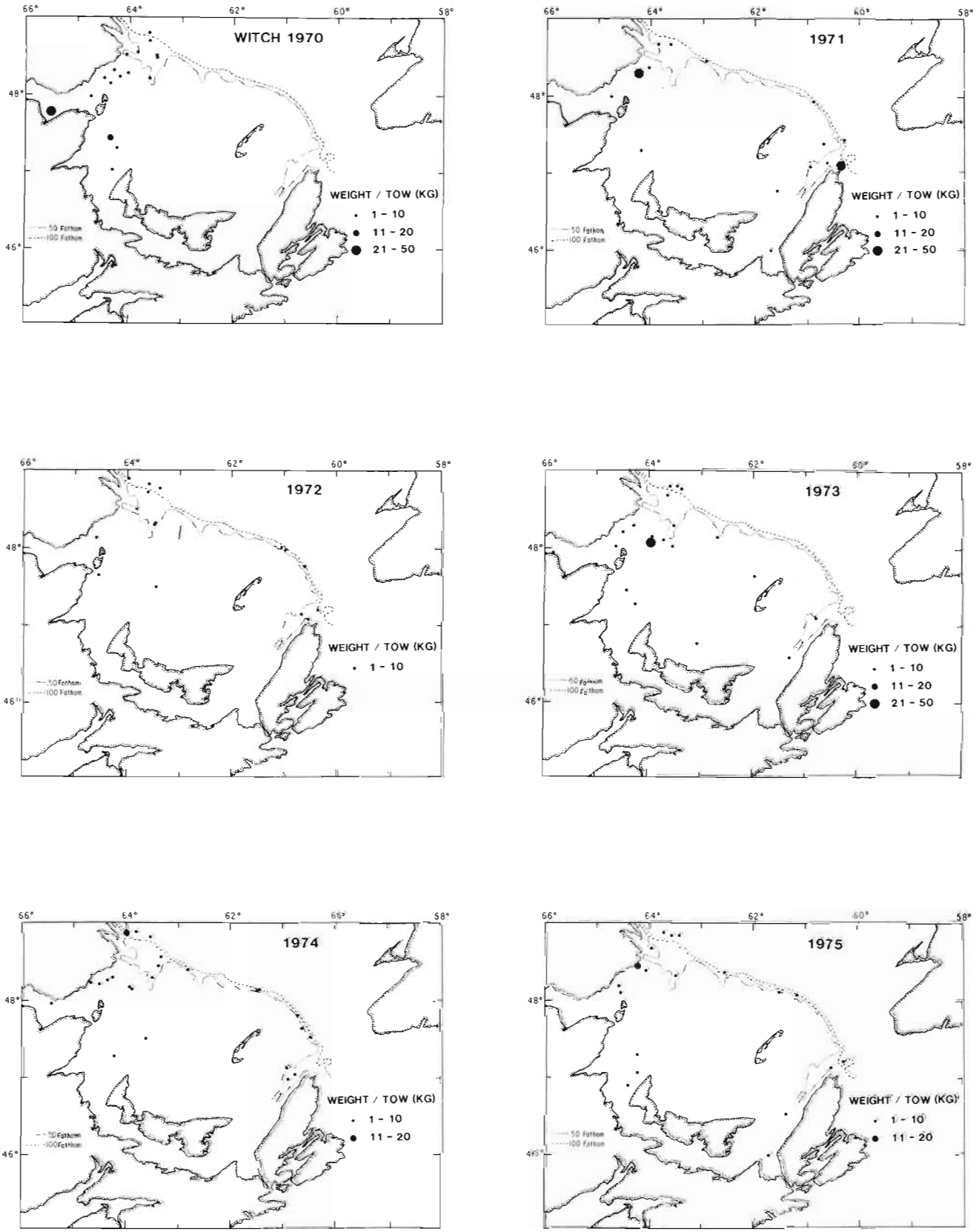

Fig. 13. Witch flounder *(Glyptocephalus cynoglossus)* 1970-75.

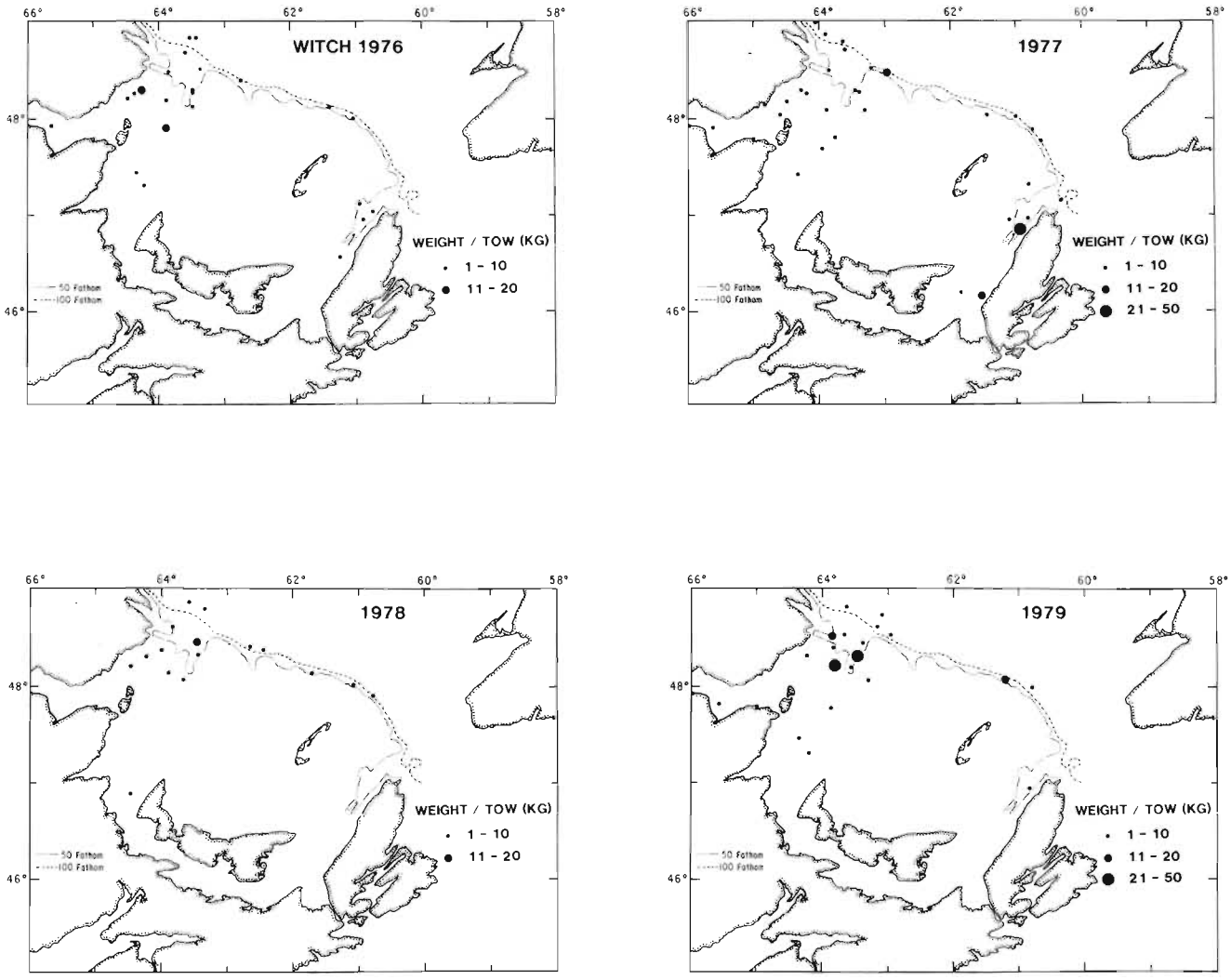

Fig. 13 (cont'd.) Witch flounder (*Glyptocephalus cynoglossus*) 1976-79.

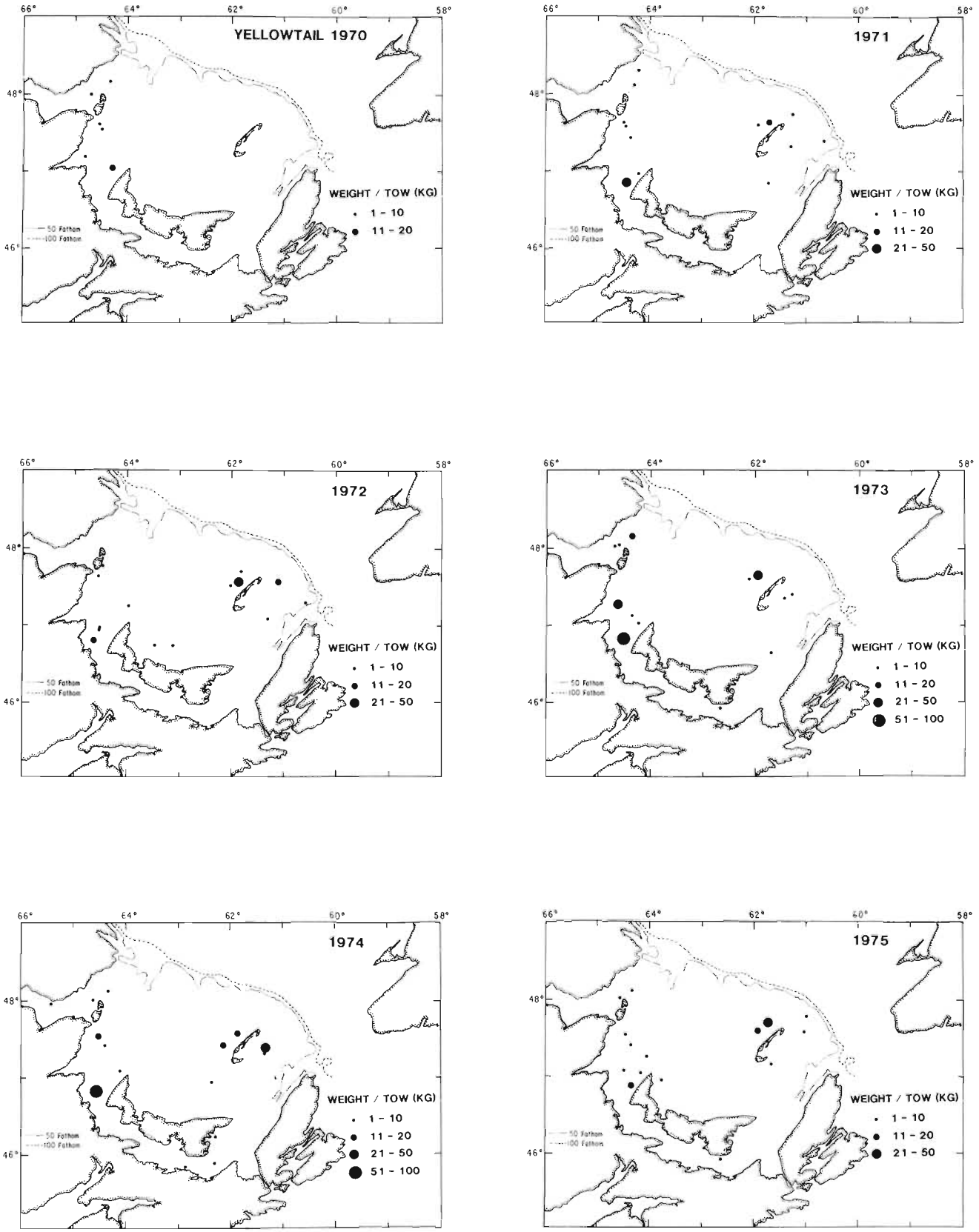

Fig. 14. Yellowtail flounder *(Limanda ferruginea)* 1970-75.

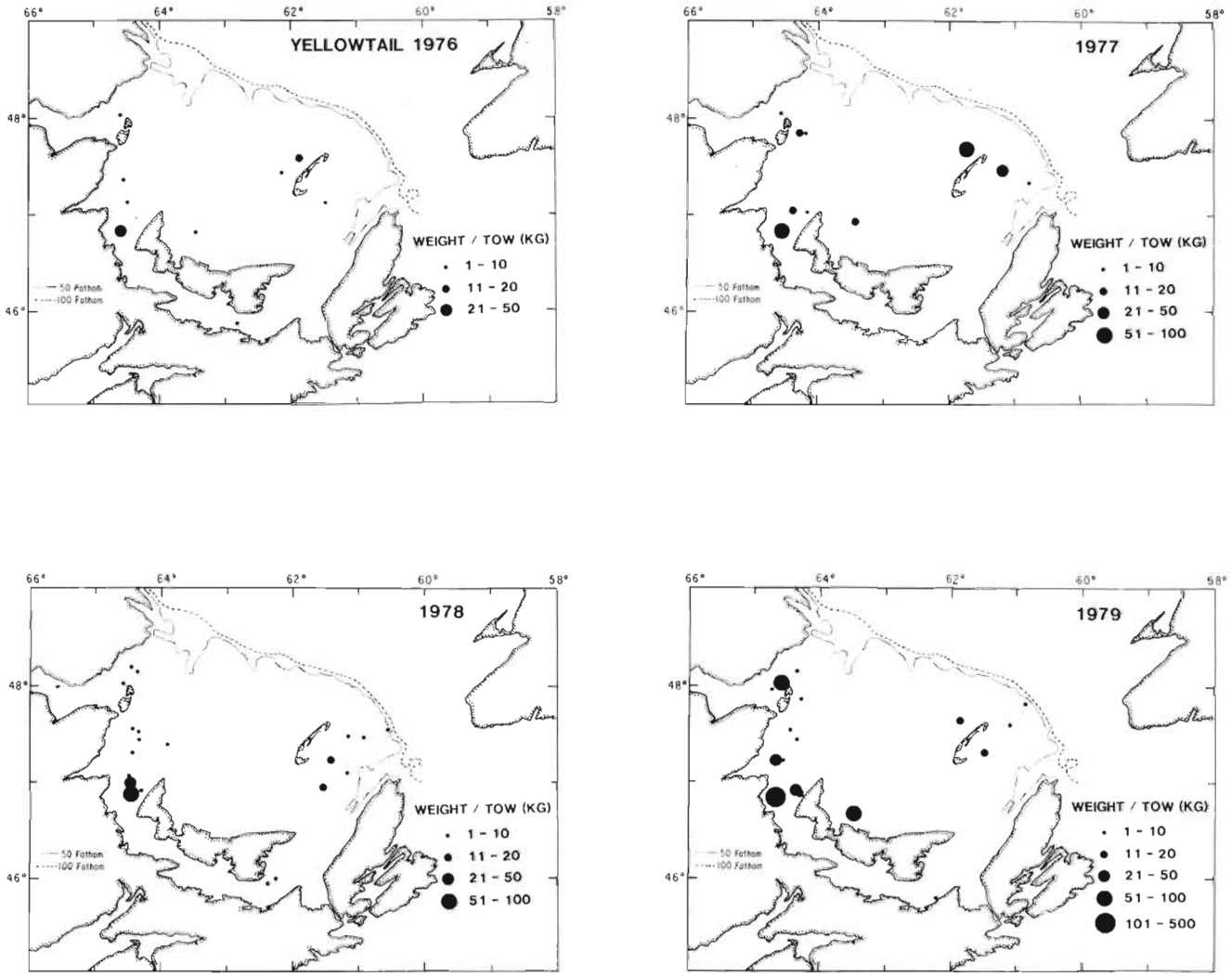

Fig. 14 (cont'd.) Yellowtail flounder *(Limanda ferruginea)* 1976-79.

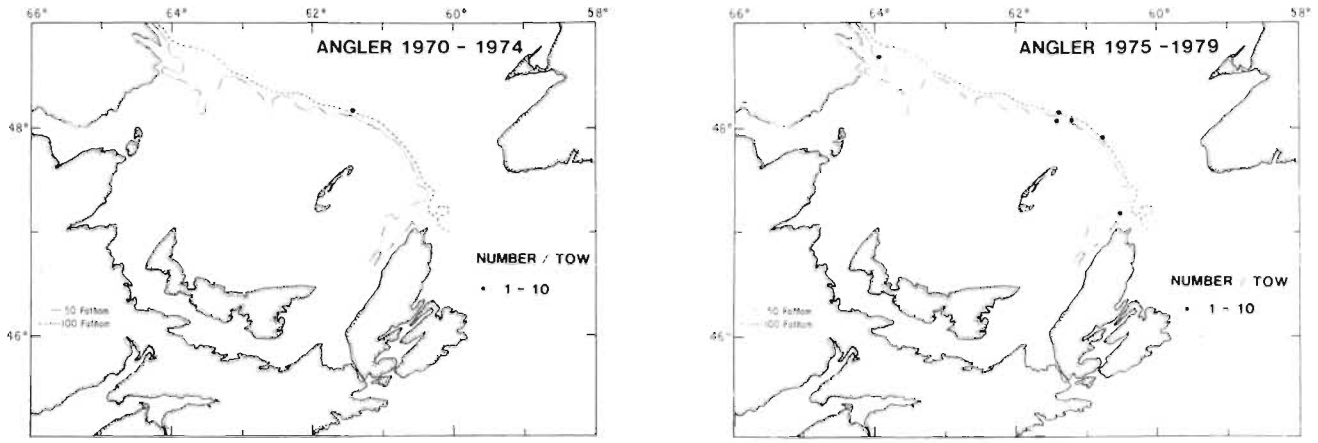

Fig. 15. Angler *(Lophius americanus)* 1970-74, 1975-79.

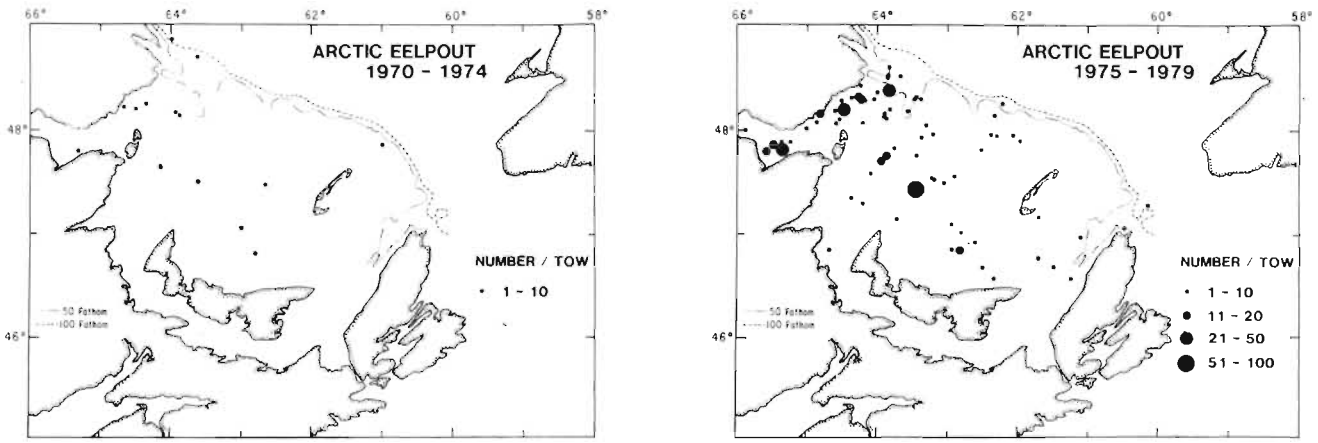

Fig. 16. Arctic eelpout *(Lycodes reticulatus)* 1970-74, 1975-79.

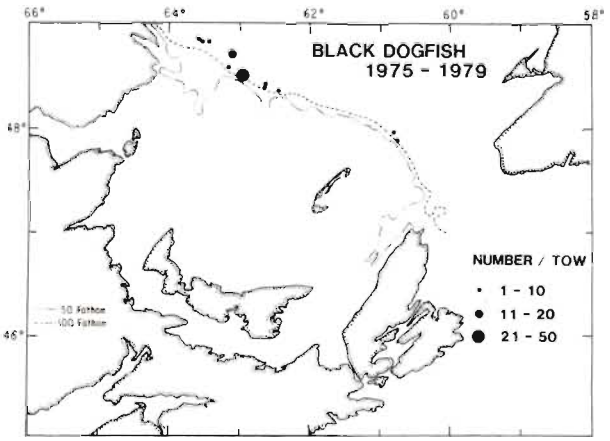

Fig. 17. Black dogfish *(Centroscyllium fabricii)* 1975-79.

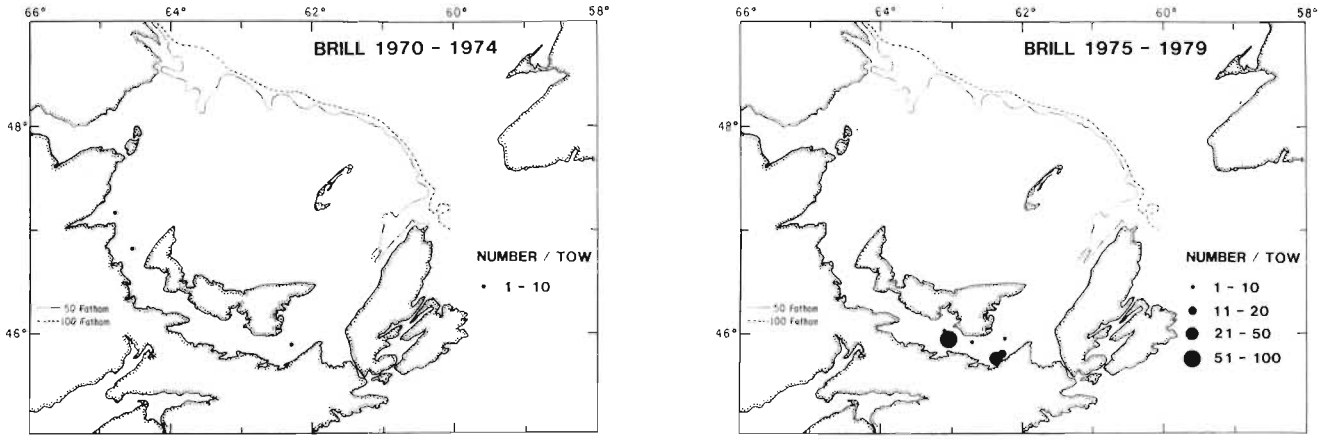

Fig. 18. Brill *(Scophthalmus aquosus)* 1970-74, 1975-79.

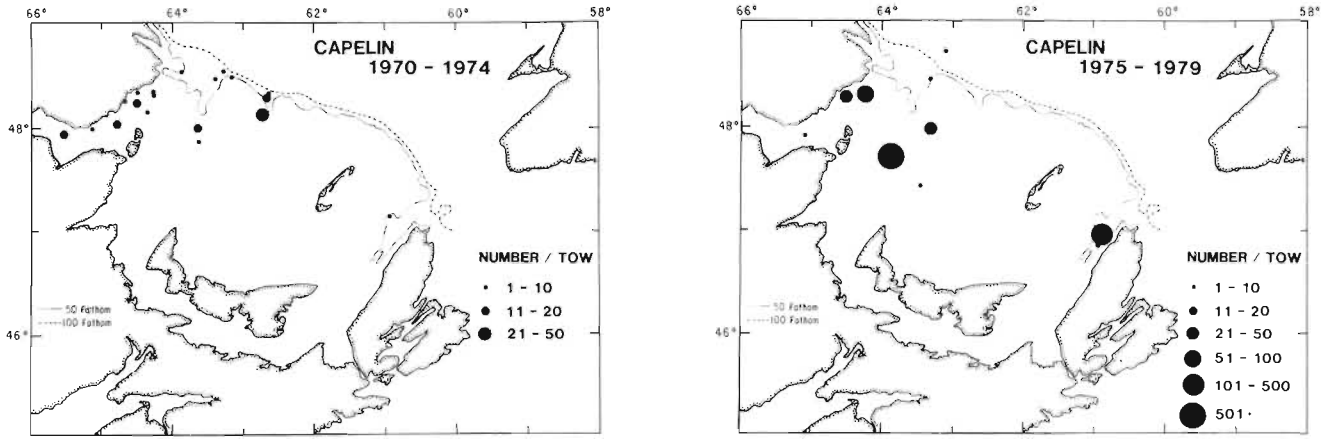

Fig. 19. Capelin *(Mallotus villosus)* 1970-74, 1975-79.

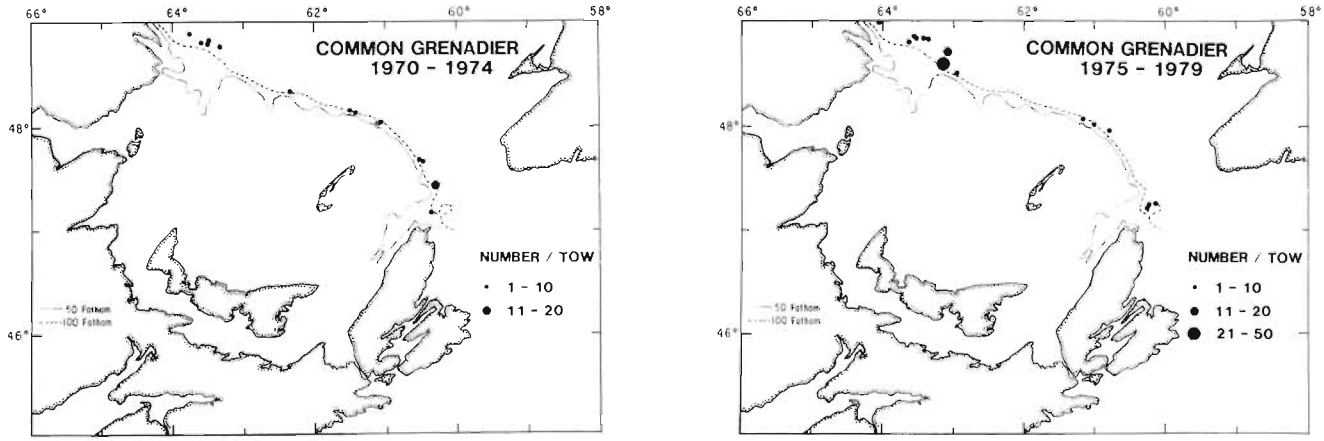

Fig. 20. Common grenadier *(Nezumia bairdi)* 1970-74, 1975-79.

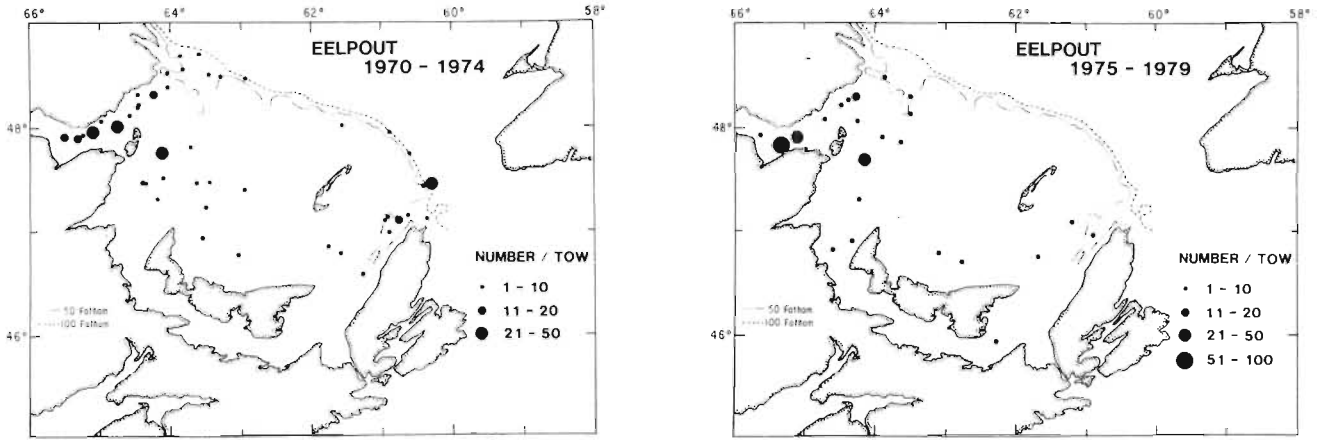

Fig. 21. Eelpout (*Lycodes* spp.) 1970-74, 1975-79.

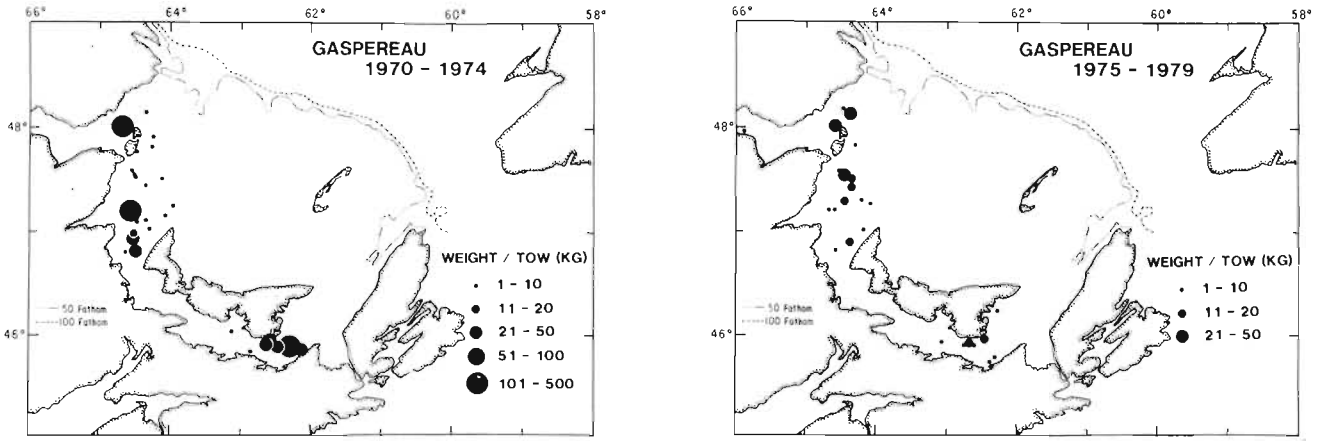

Fig. 22. Gaspereau (*Alosa pseudoharengus*) 1970-74, 1975-79.

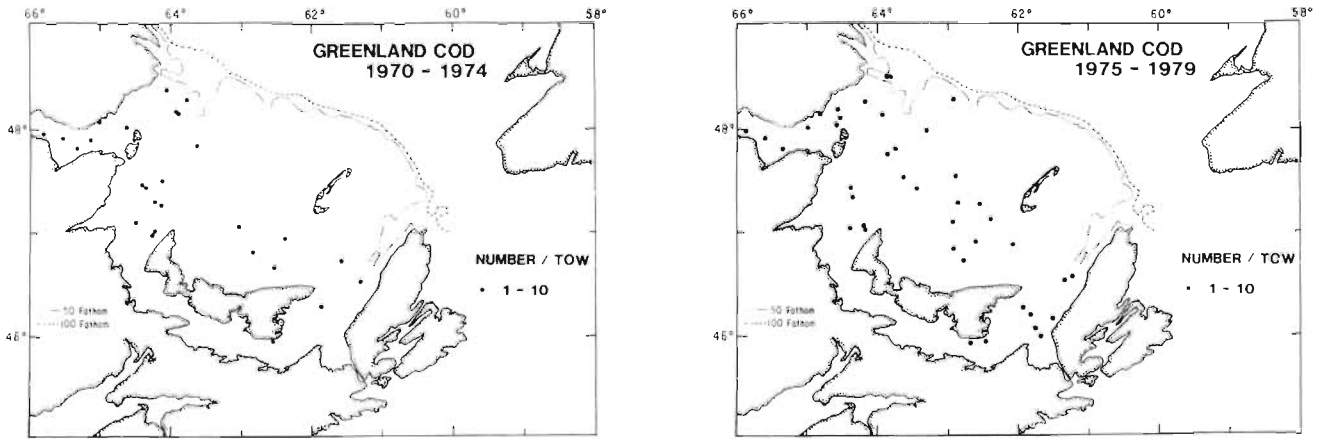

Fig. 23. Greenland cod (*Gadus ogac*) 1970-74, 1975-79.

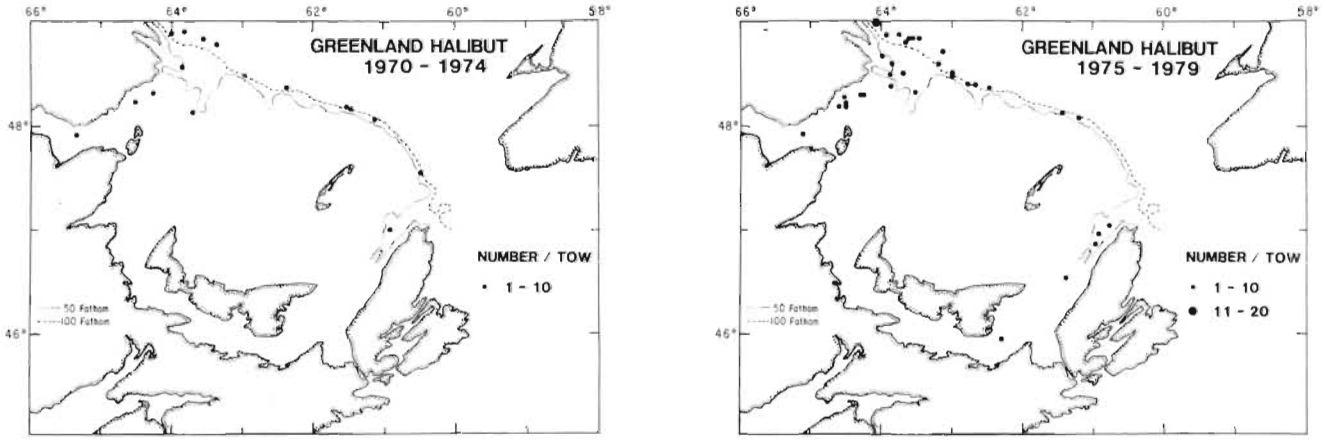

Fig. 24. Greenland halibut *(Reinhardtius hippoglossoides)* 1970-74, 1975-79.

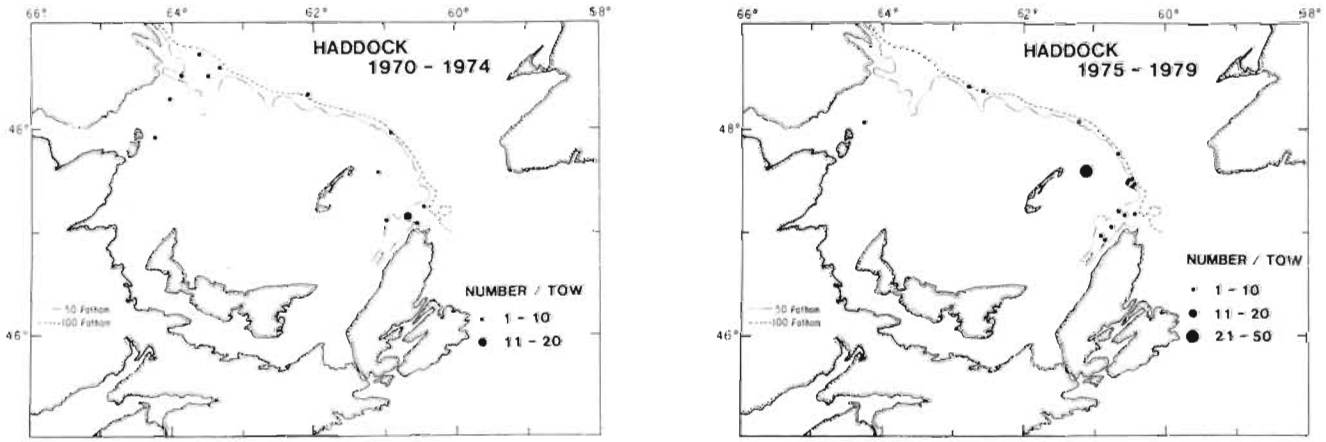

Fig. 25. Haddock *(Melanogrammus aeglefinus)* 1970-74, 1975-79.

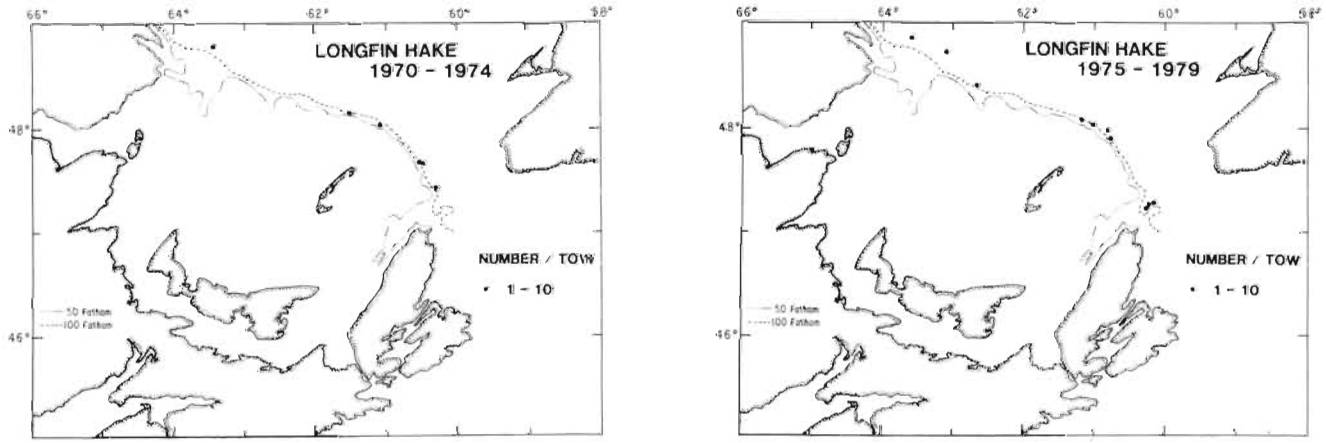

Fig. 26. Longfin hake *(Phycis chesteri)* 1970-74, 1975-79.

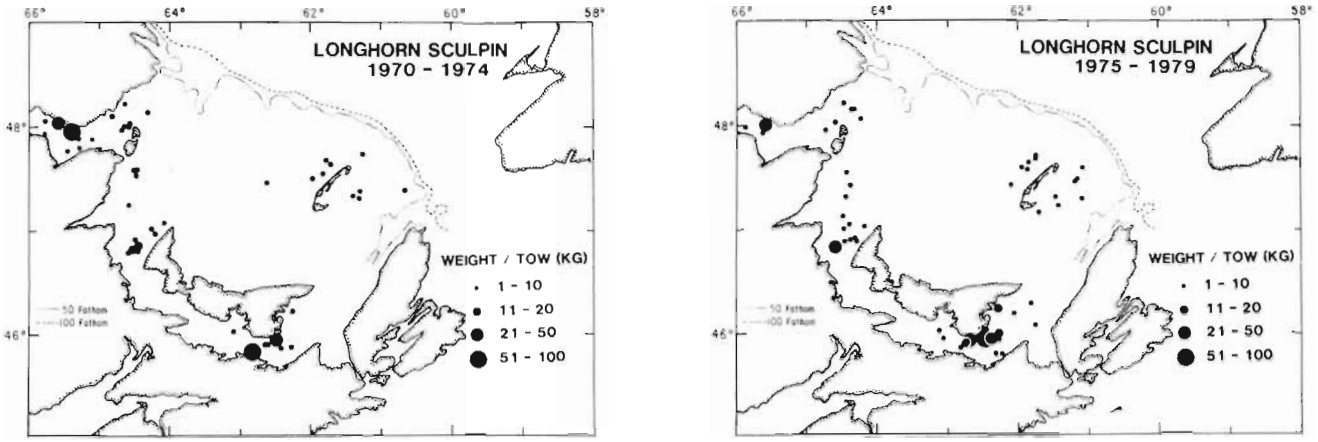

Fig. 27. Longhorn sculpin *(Myoxocephalus octodecemspinosus)* 1970-74, 1975-79.

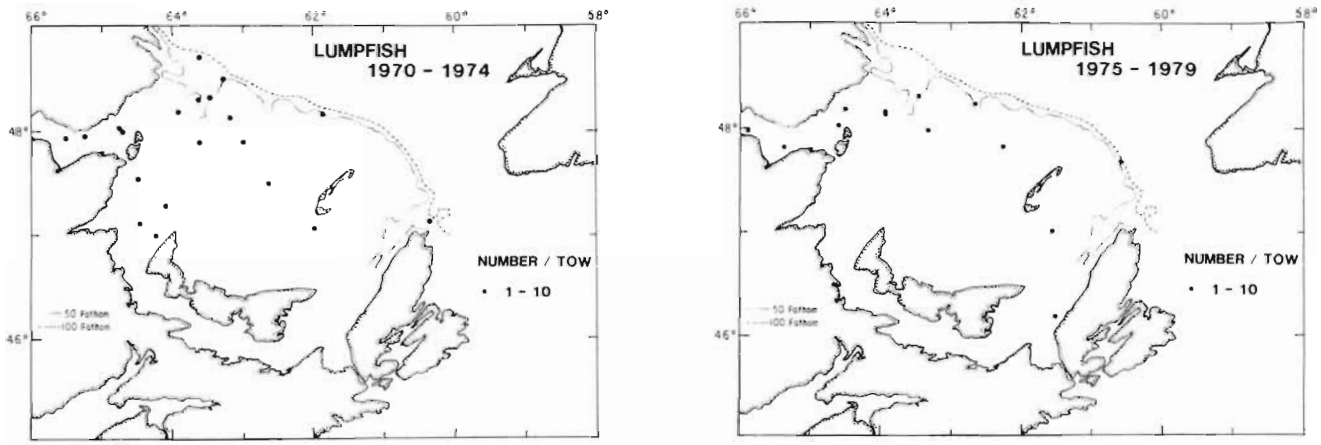

Fig. 28. Lumpfish *(Cyclopterus lumpus)* 1970-74, 1975-79.

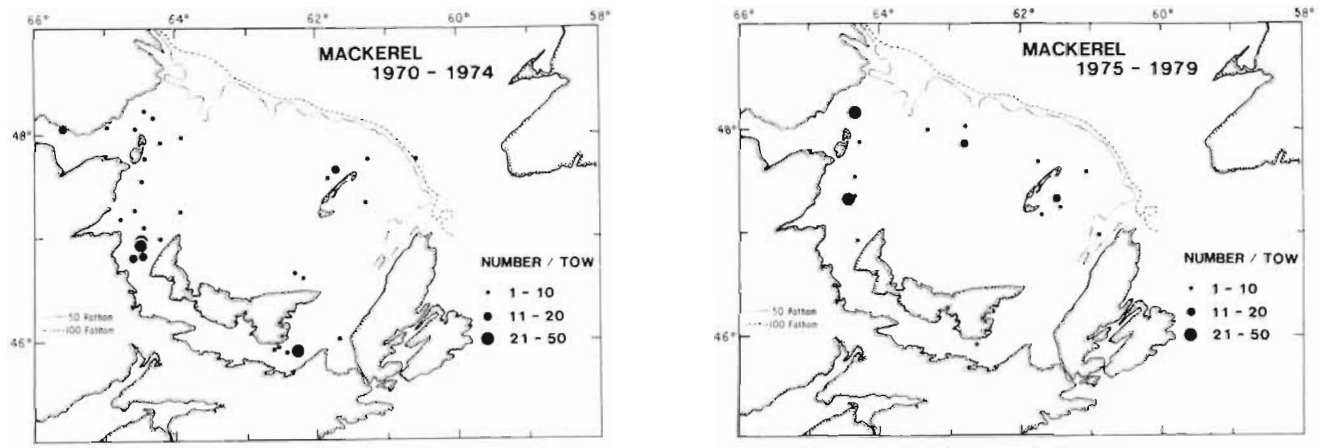

Fig. 29. Mackerel *(Scomber scombrus)* 1970-74, 1975-79.

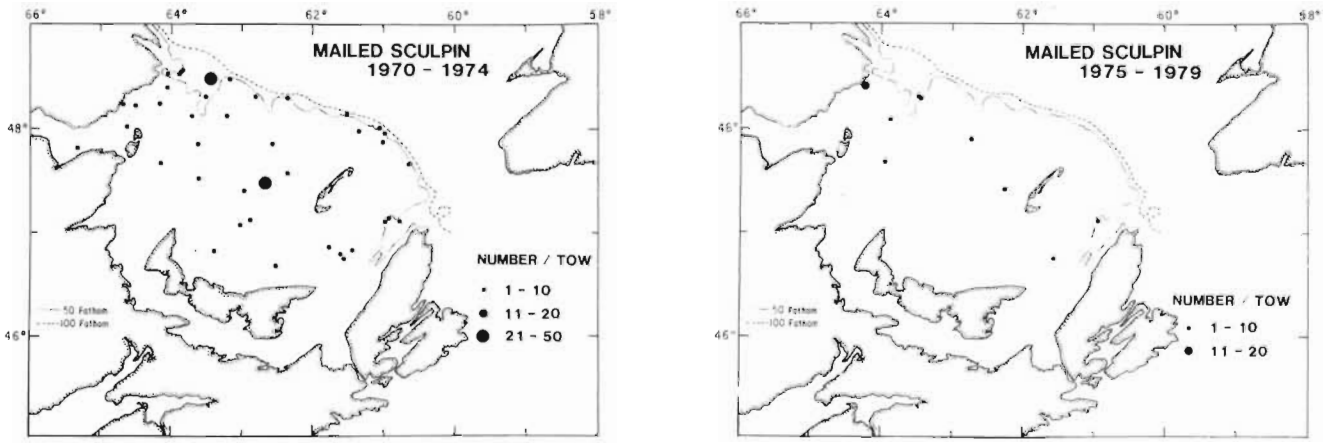

Fig. 30. Mailed sculpin *(Triglops murrayi)* 1970-74, 1975-79.

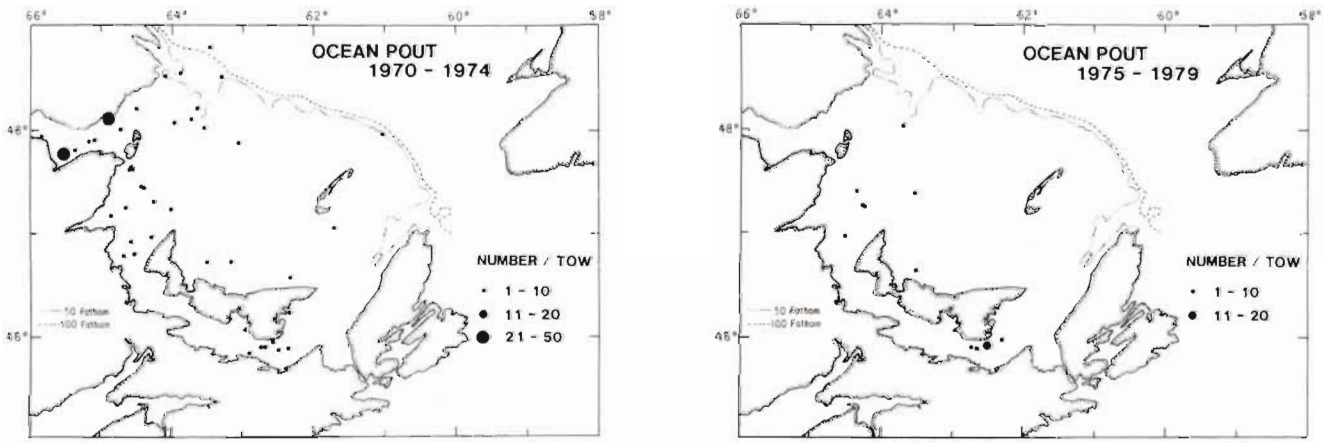

Fig. 31. Ocean pout *(Macrozoarces americanus)* 1970-74, 1975-79.

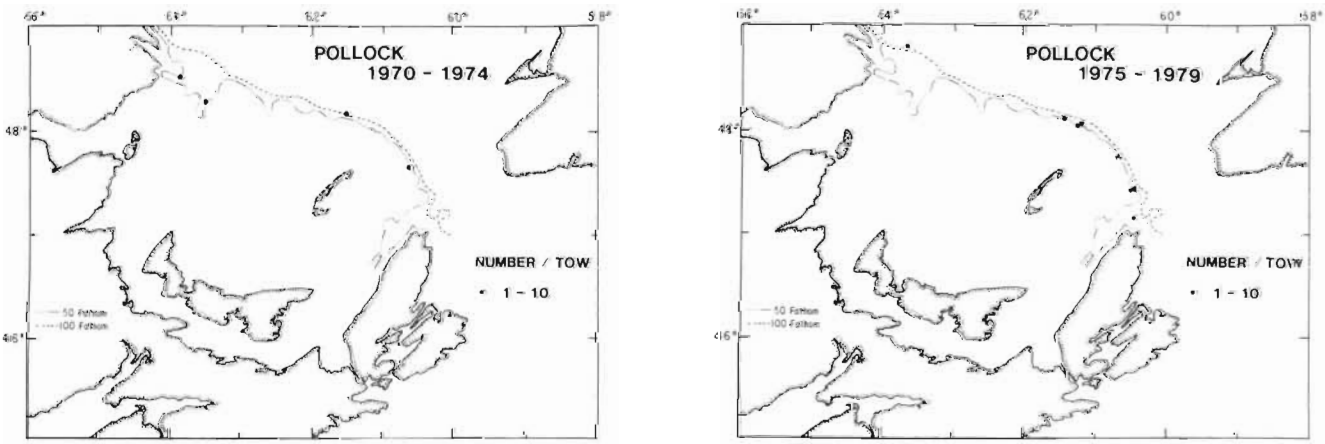

Fig. 32. Pollock *(Pollachius virens)* 1970-74, 1975-79.

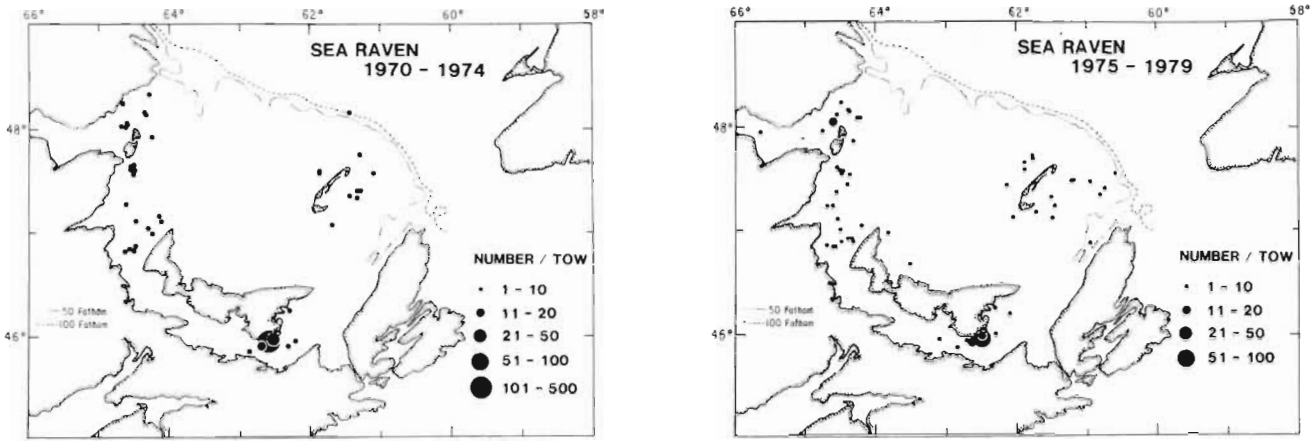

Fig. 33. Sea raven *(Hemitripterus americanus)* 1970-74, 1975-79.

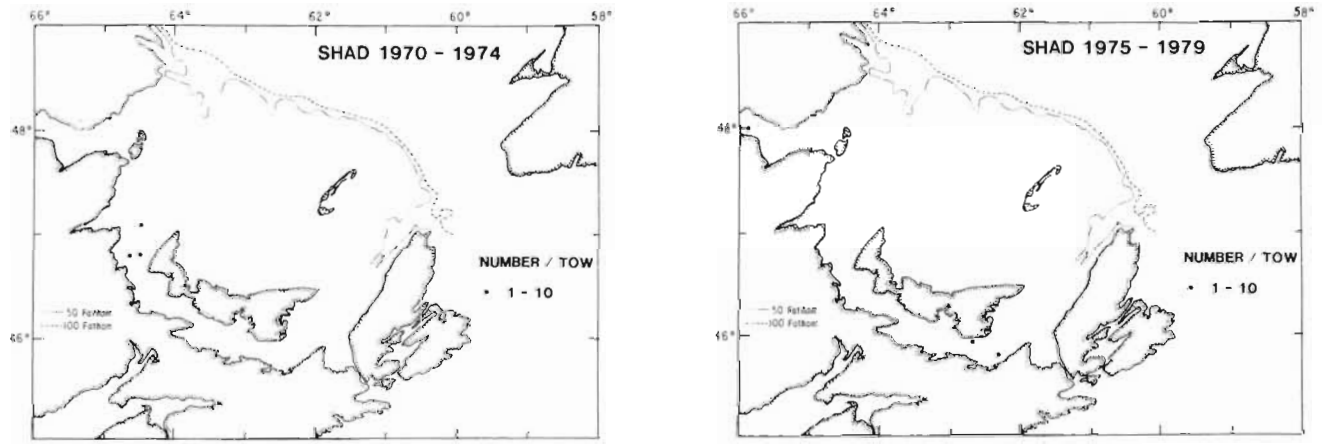

Fig. 34. Shad *(Alosa sapidissima)* 1970-74, 1975-79.

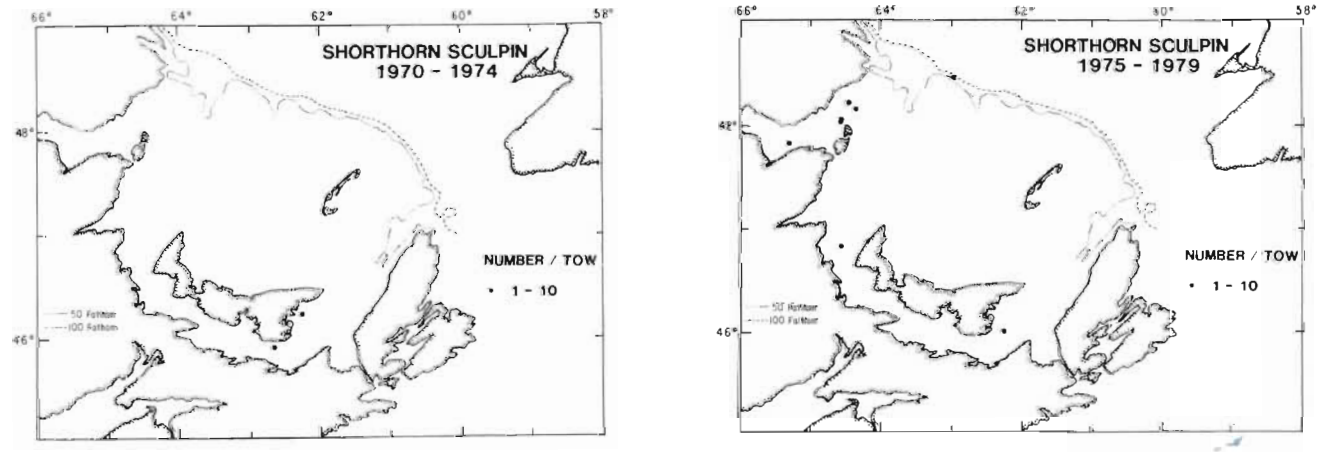

Fig. 35. Shorthorn sculpin *(Myoxocephalus scorpius)* 1970-74, 1975-79.

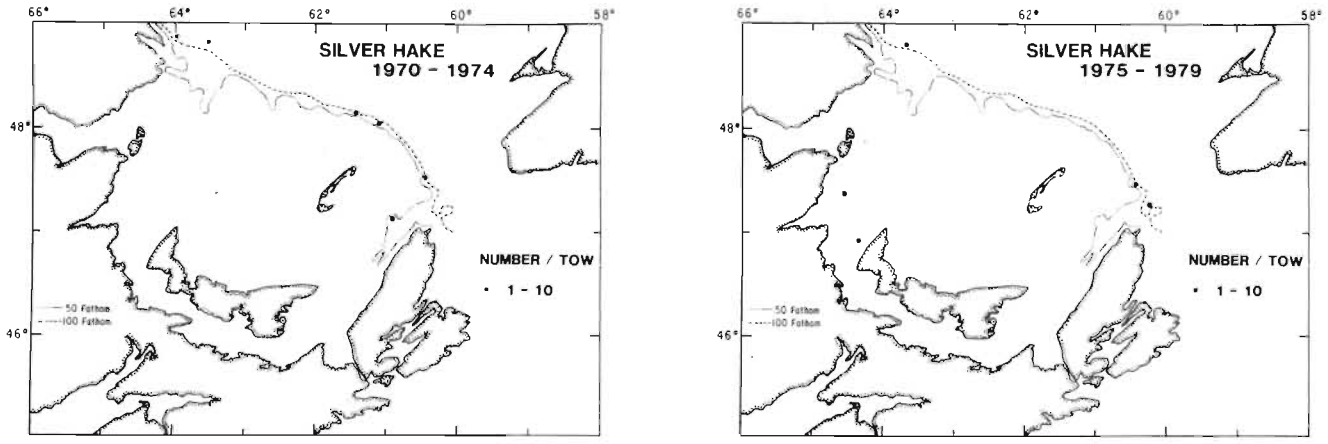

Fig. 36. Silver hake *(Merluccius bilinearis)* 1970-74, 1975-79.

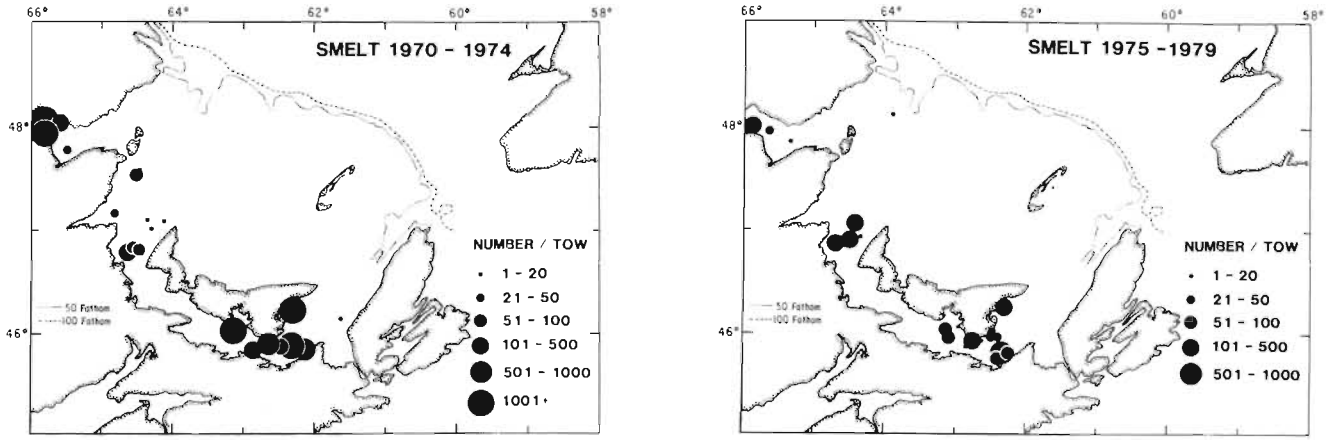

Fig. 37. Smelt *(Osmerus mordax)* 1970-74, 1975-79.

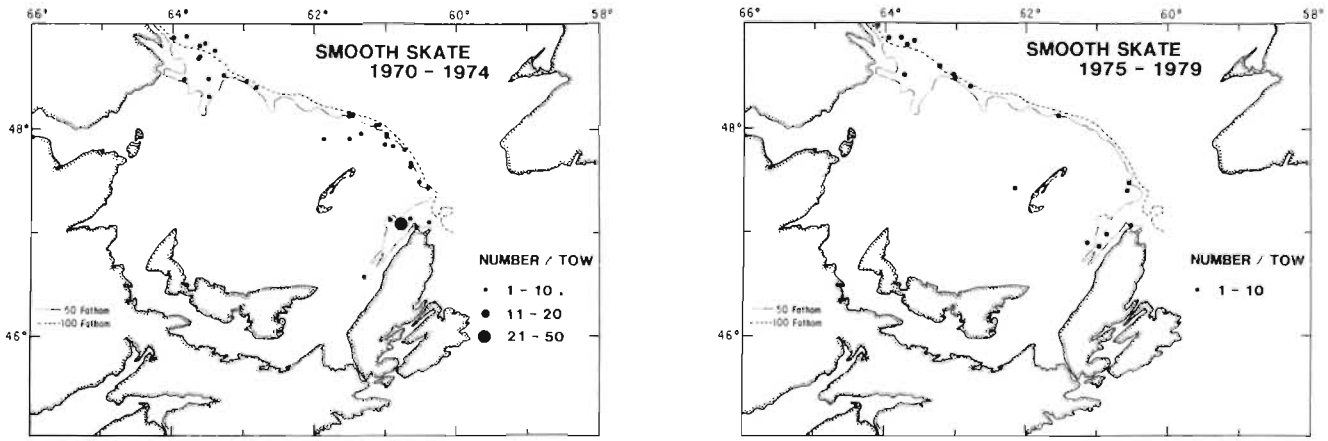

Fig. 38. Smooth skate *(Raja senta)* 1970-74, 1975-79.

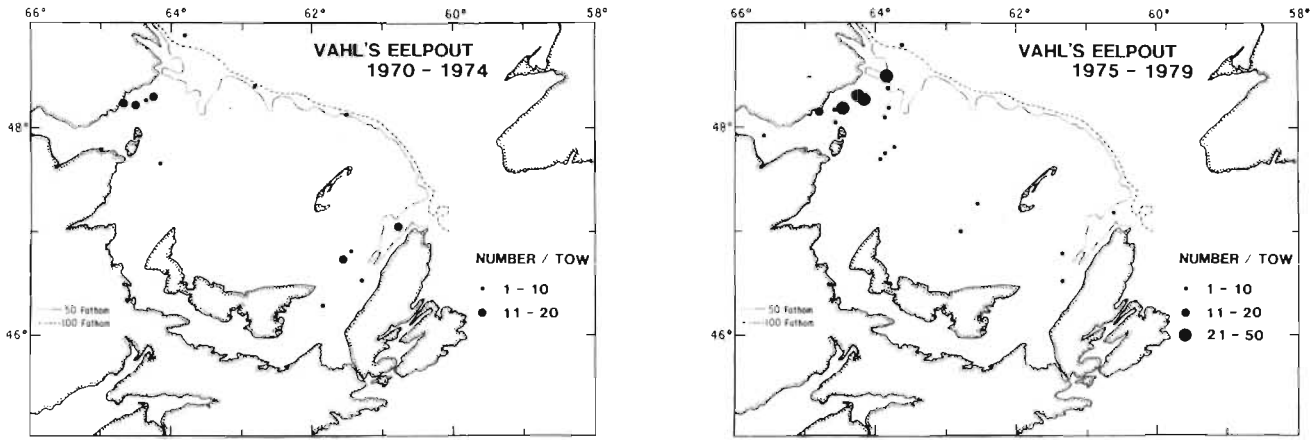

Fig. 39. Vahl's eelpout *(Lycodes vahlii)* 1970-74, 1975-79.

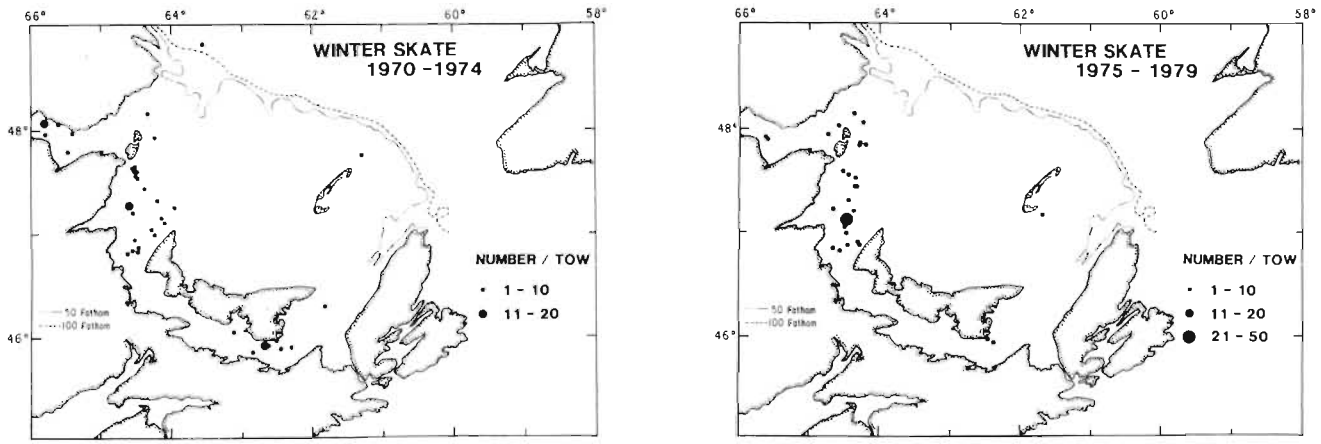

Fig. 40. Winter skate *(Raja ocellata)* 1970-74, 1975-79.

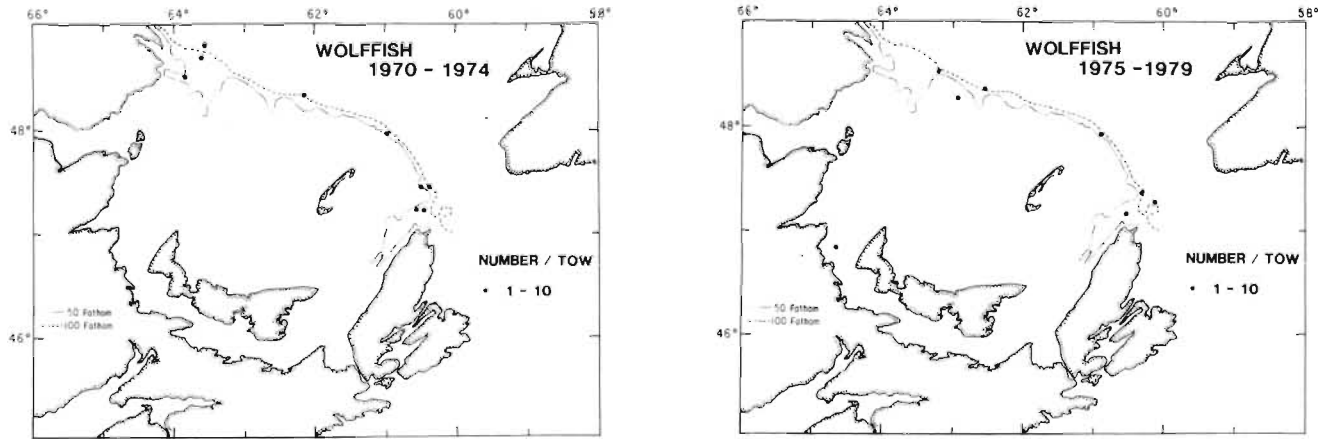

Fig. 41. Wolffish *(Anarhichas lupus)* 1970-74, 1975-79.

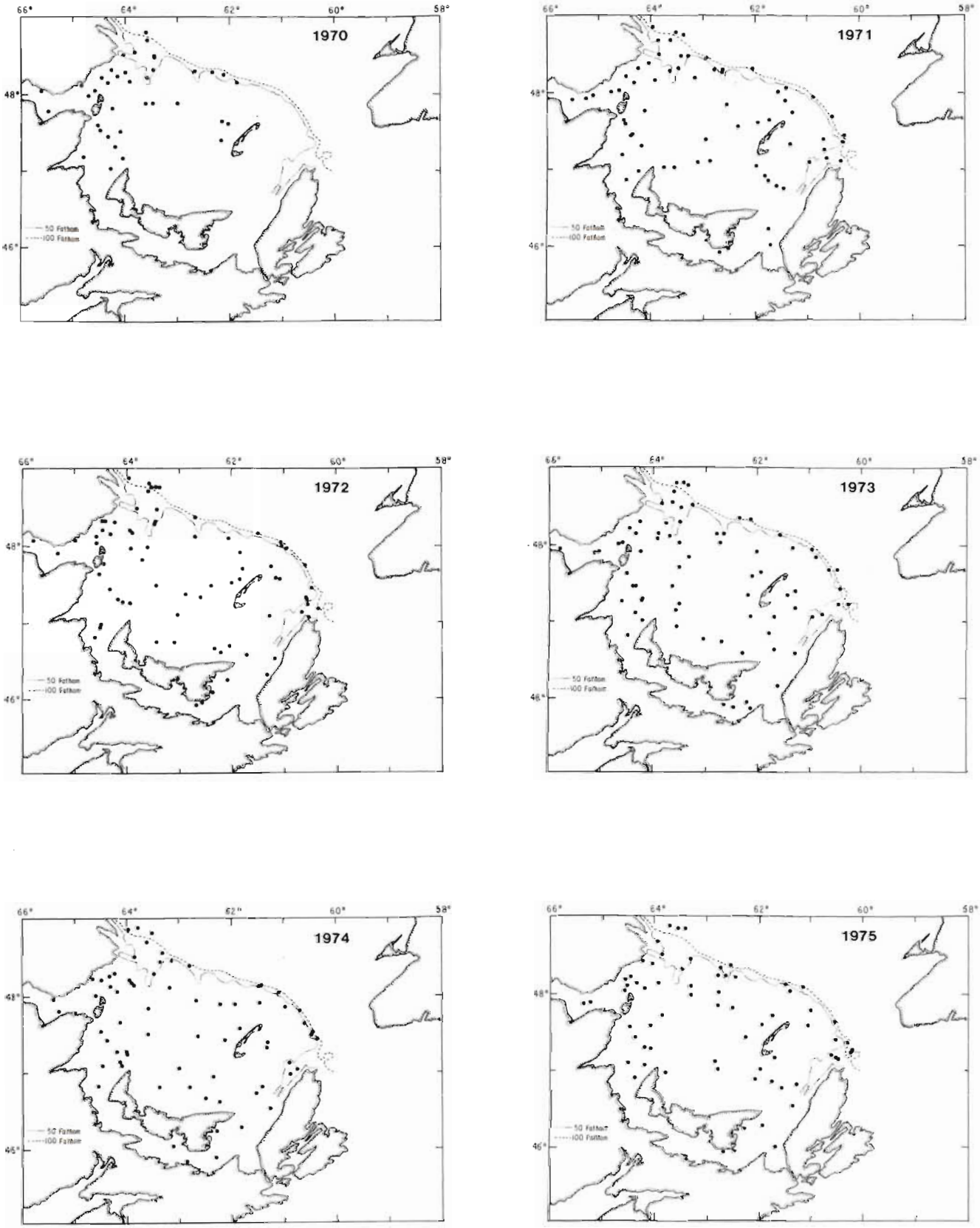

Fig. 42. Fishing station locations for *E.E. Prince* groundfish surveys, 1970-75.

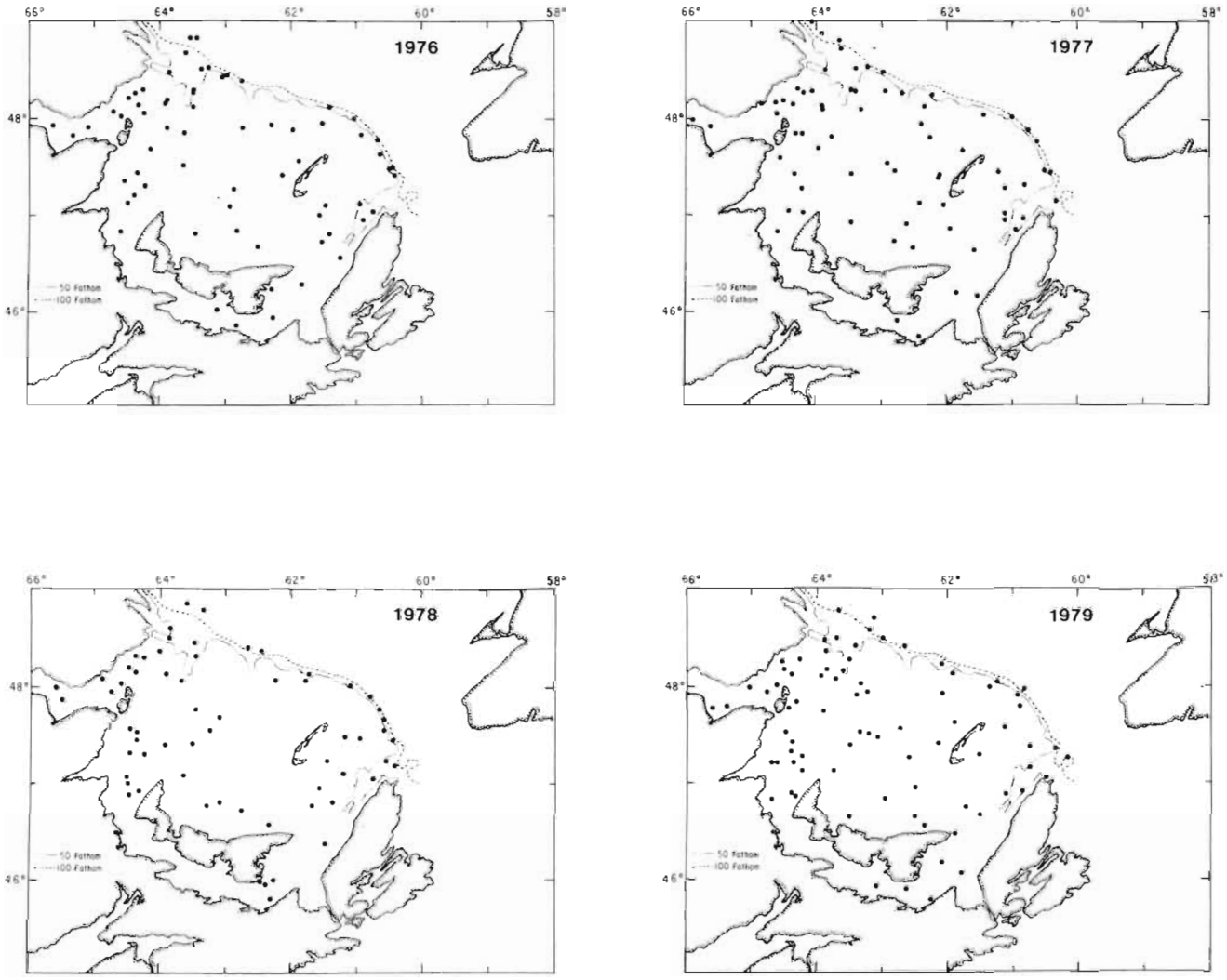

Fig. 42 (cont'd.) Fishing station locations for *E.E. Prince* groundfish surveys, 1976-79.

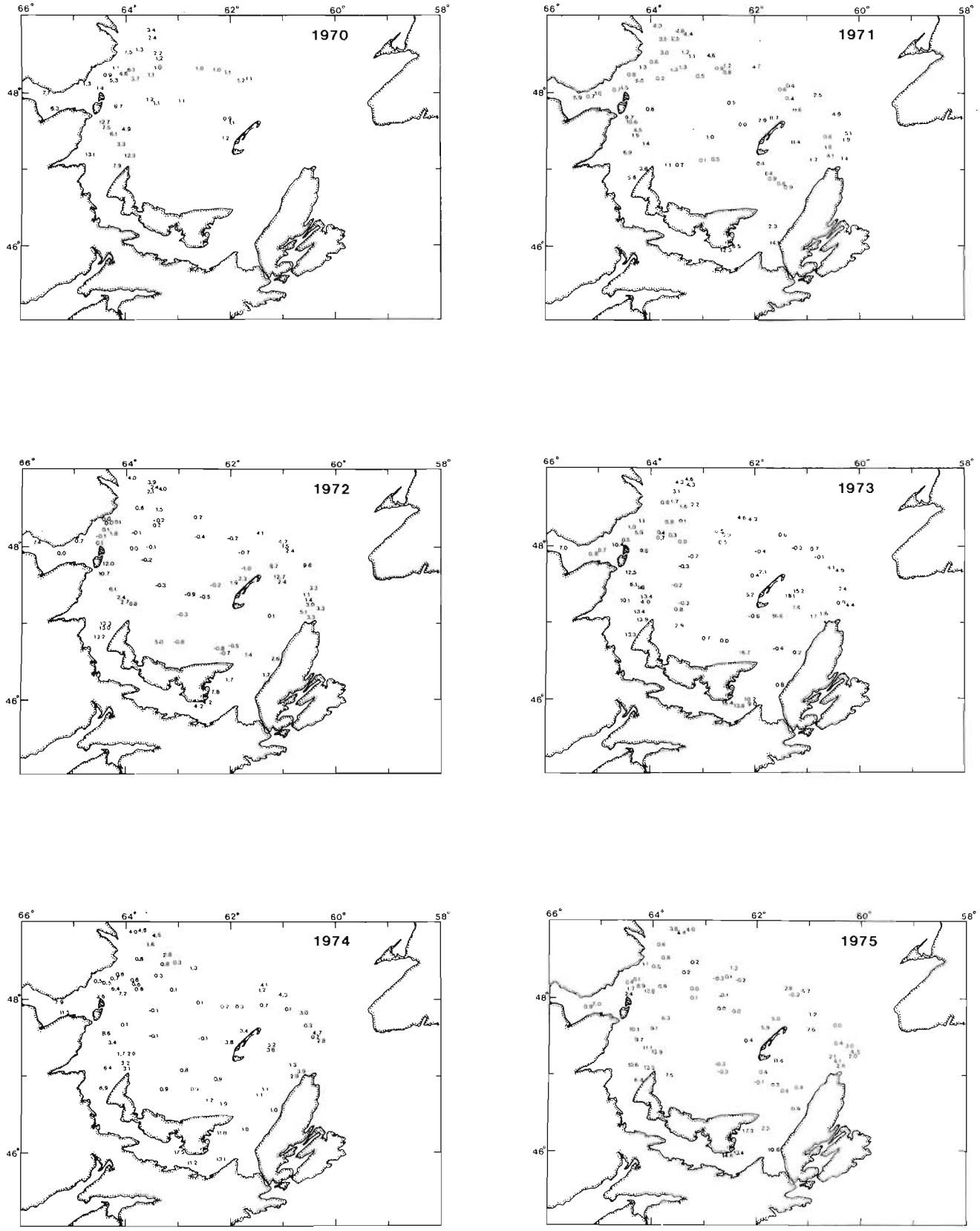

Fig. 43. Bottom temperatures at fishing stations occupied during *E.E. Prince* groundfish surveys, 1970-75.

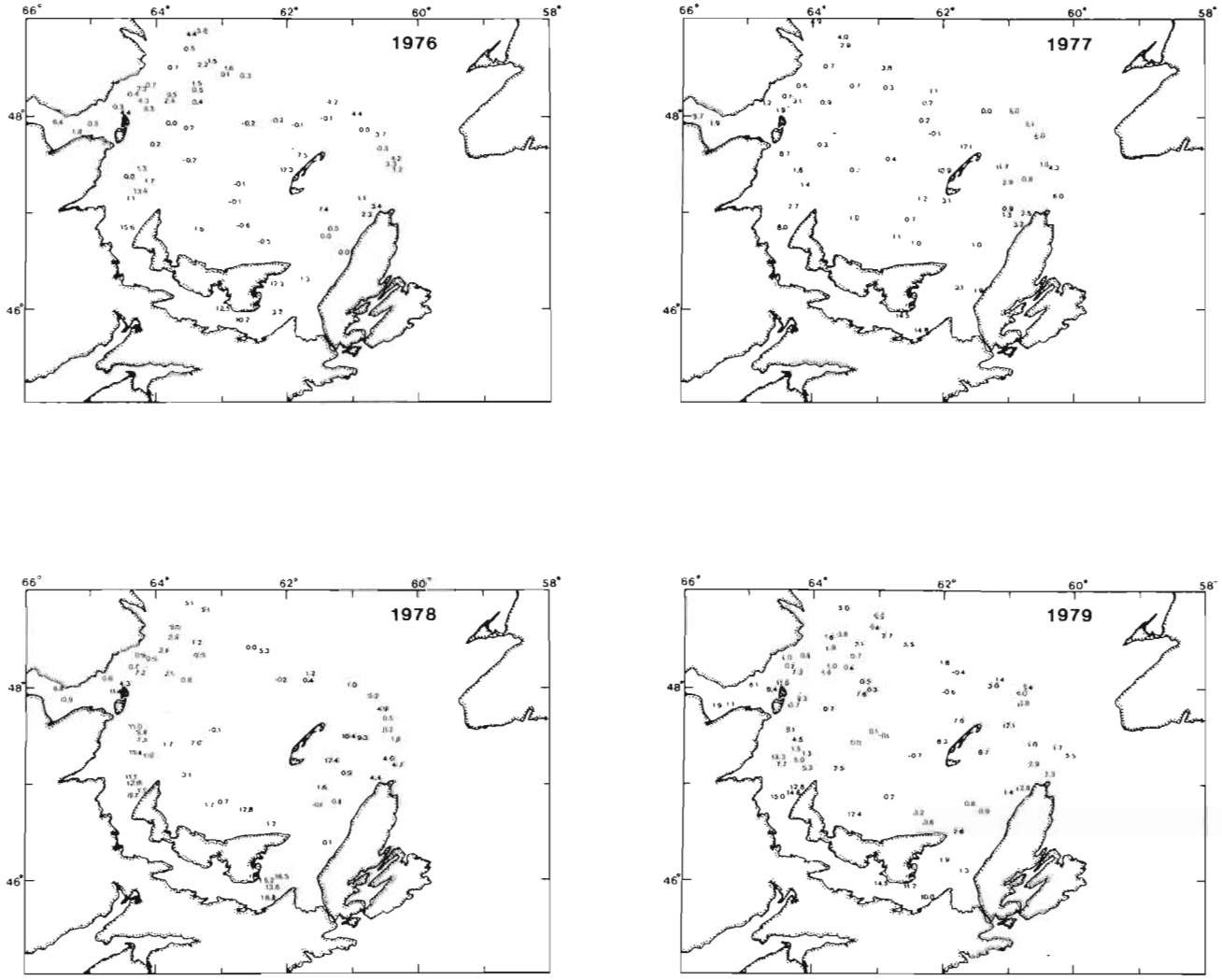

Fig. 43 (cont'd.) Bottom temperatures at fishing stations occupied during *E.E. Prince* groundfish surveys, 1976-79.

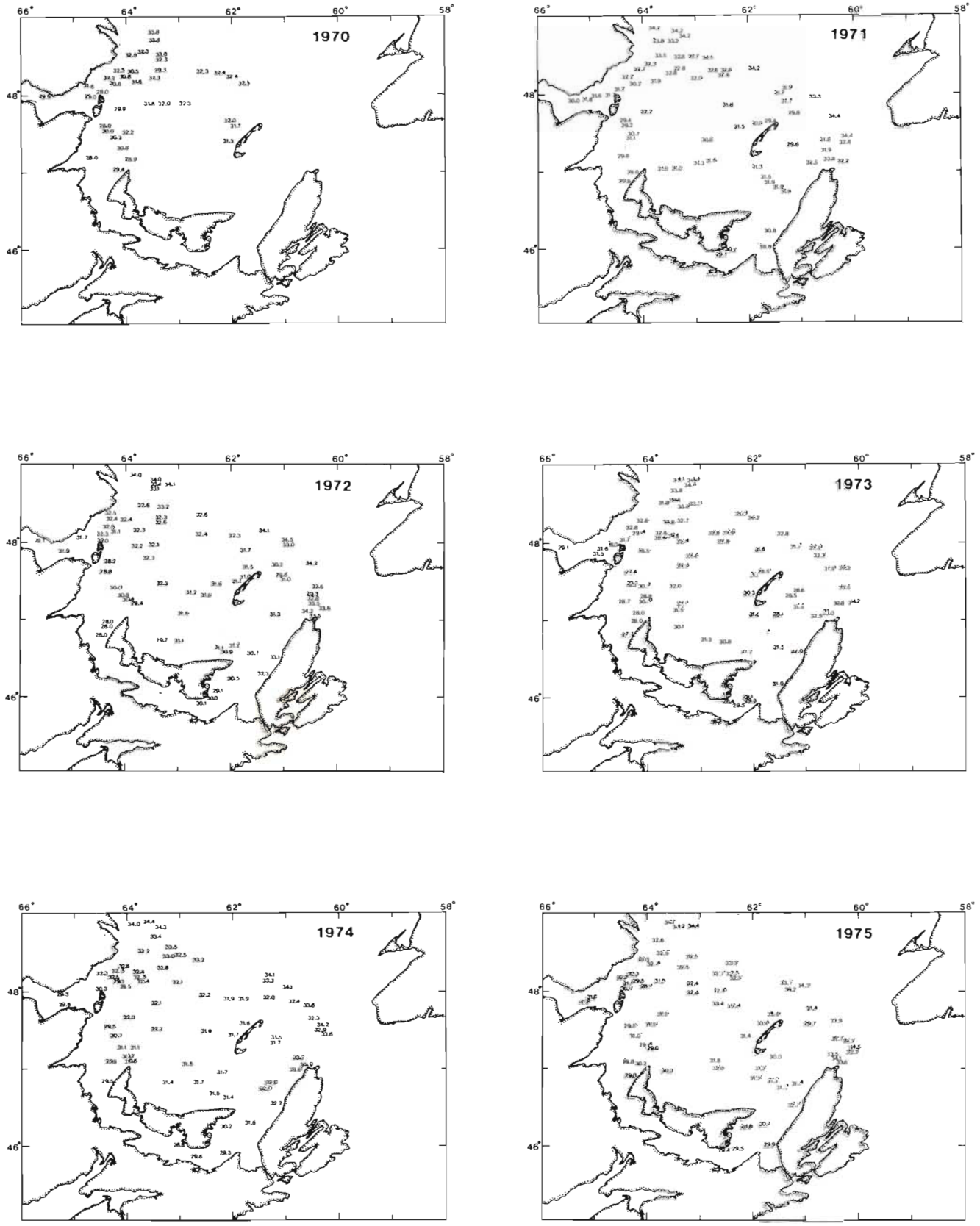

Fig. 44. Bottom salinities at fishing stations occupied during *E.E. Prince* groundfish surveys, 1970-75.

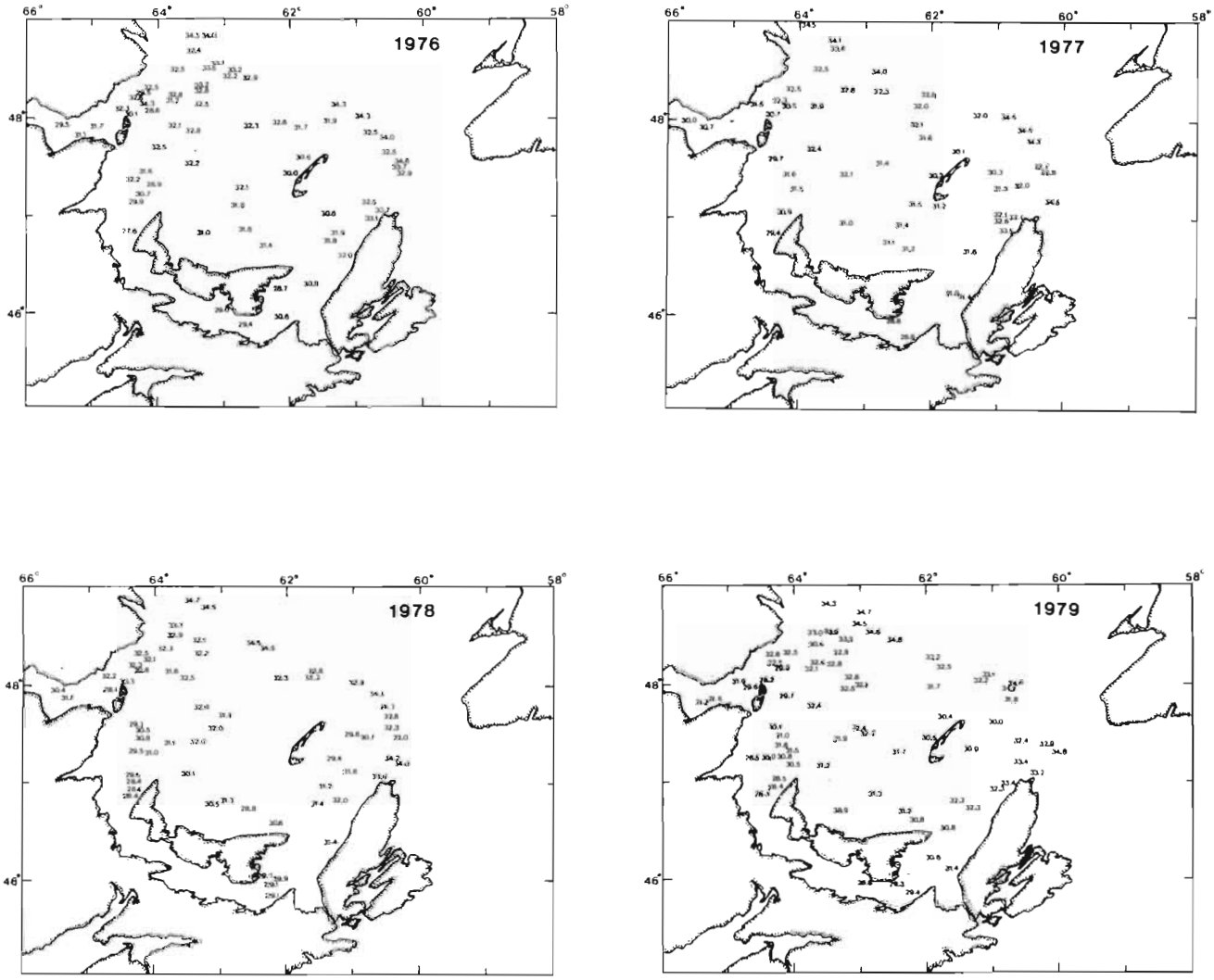

Fig. 44 (cont'd.) Bottom salinities at fishing stations occupied during *E.E. Prince* groundfish surveys, 1976-79.

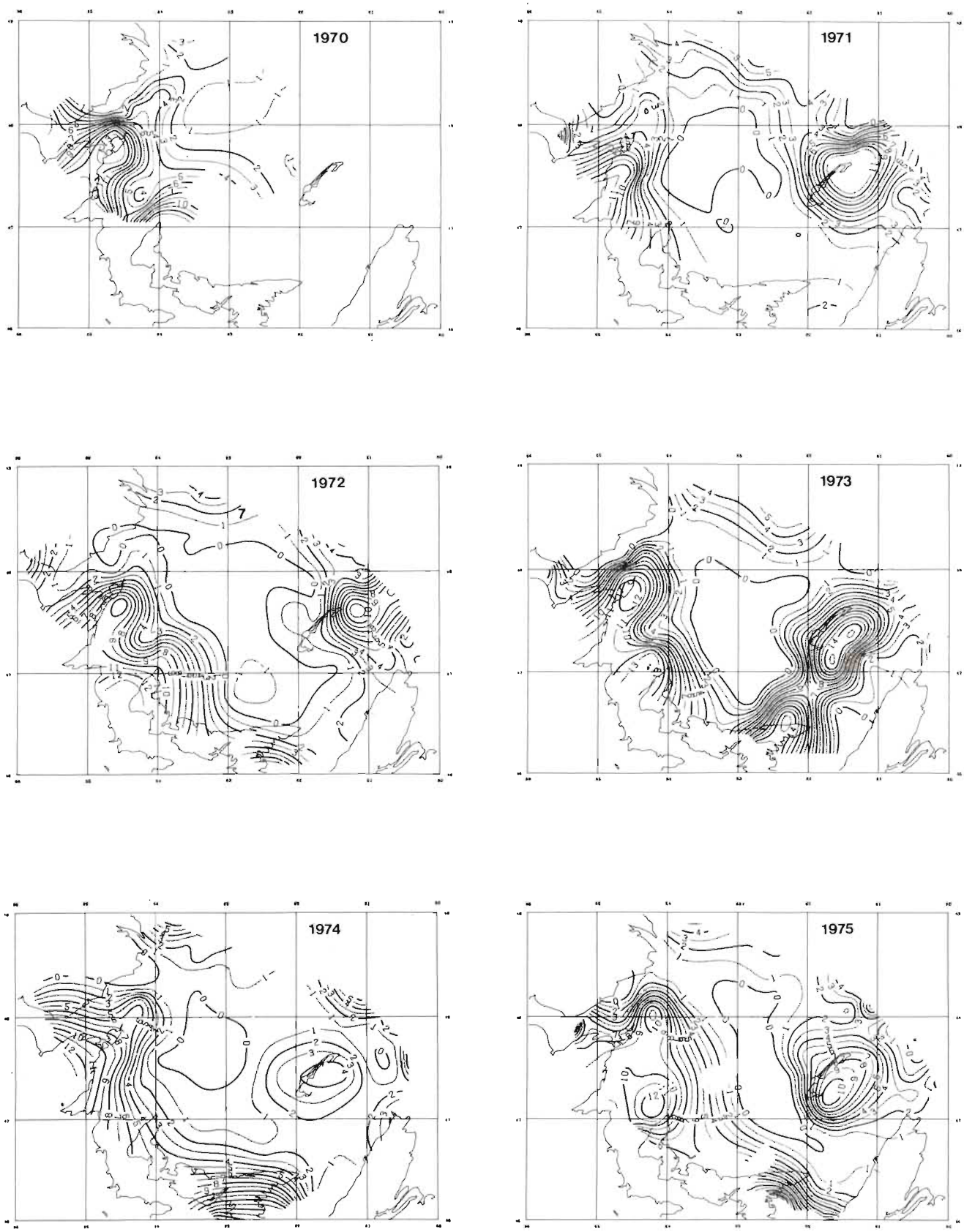

Fig. 45. Bottom temperature contours in the southern Gulf of St. Lawrence, 1970-75.

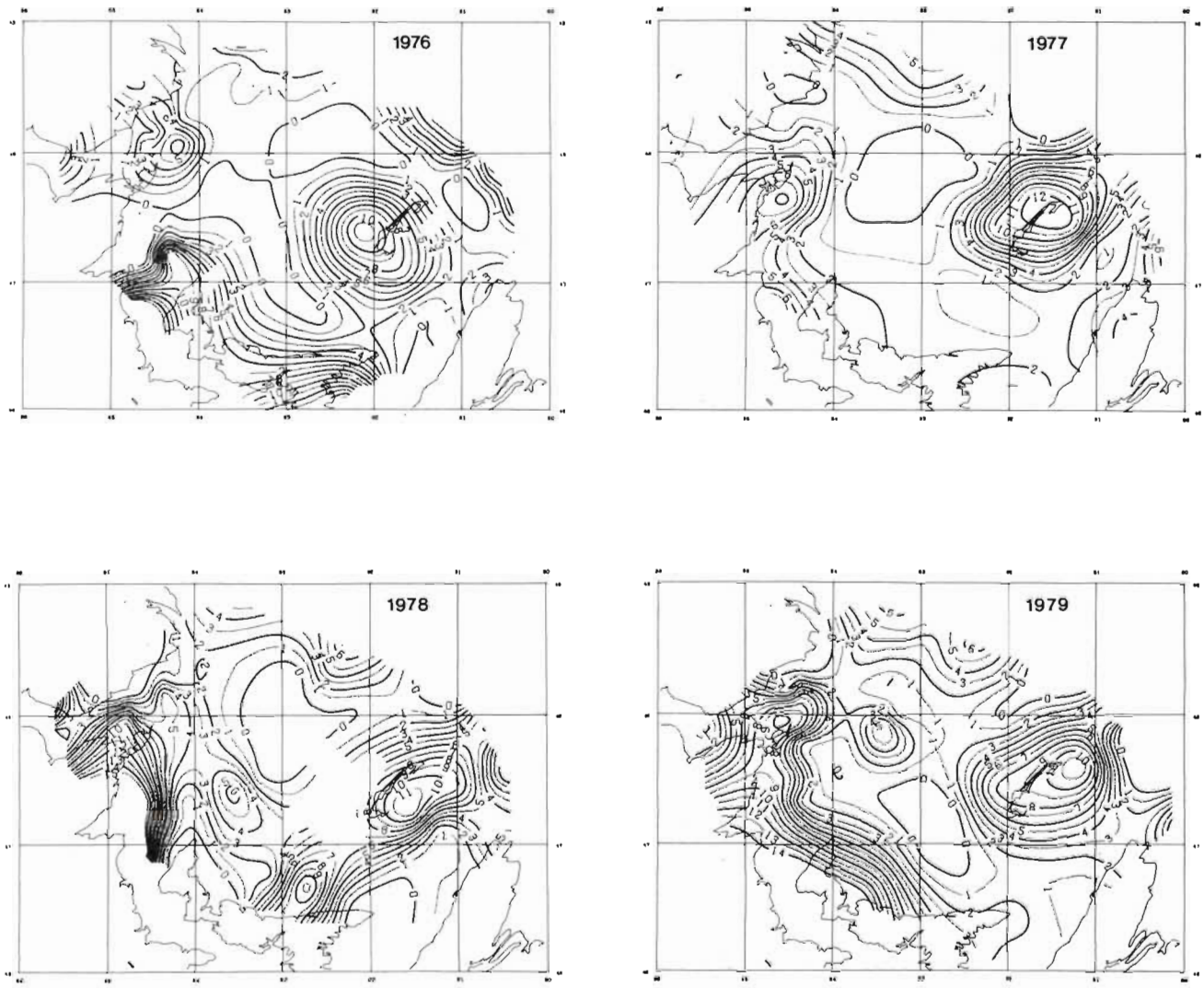

Fig. 45 (cont'd.) Bottom temperature contours in the southern Gulf of St. Lawrence, 1976-79.

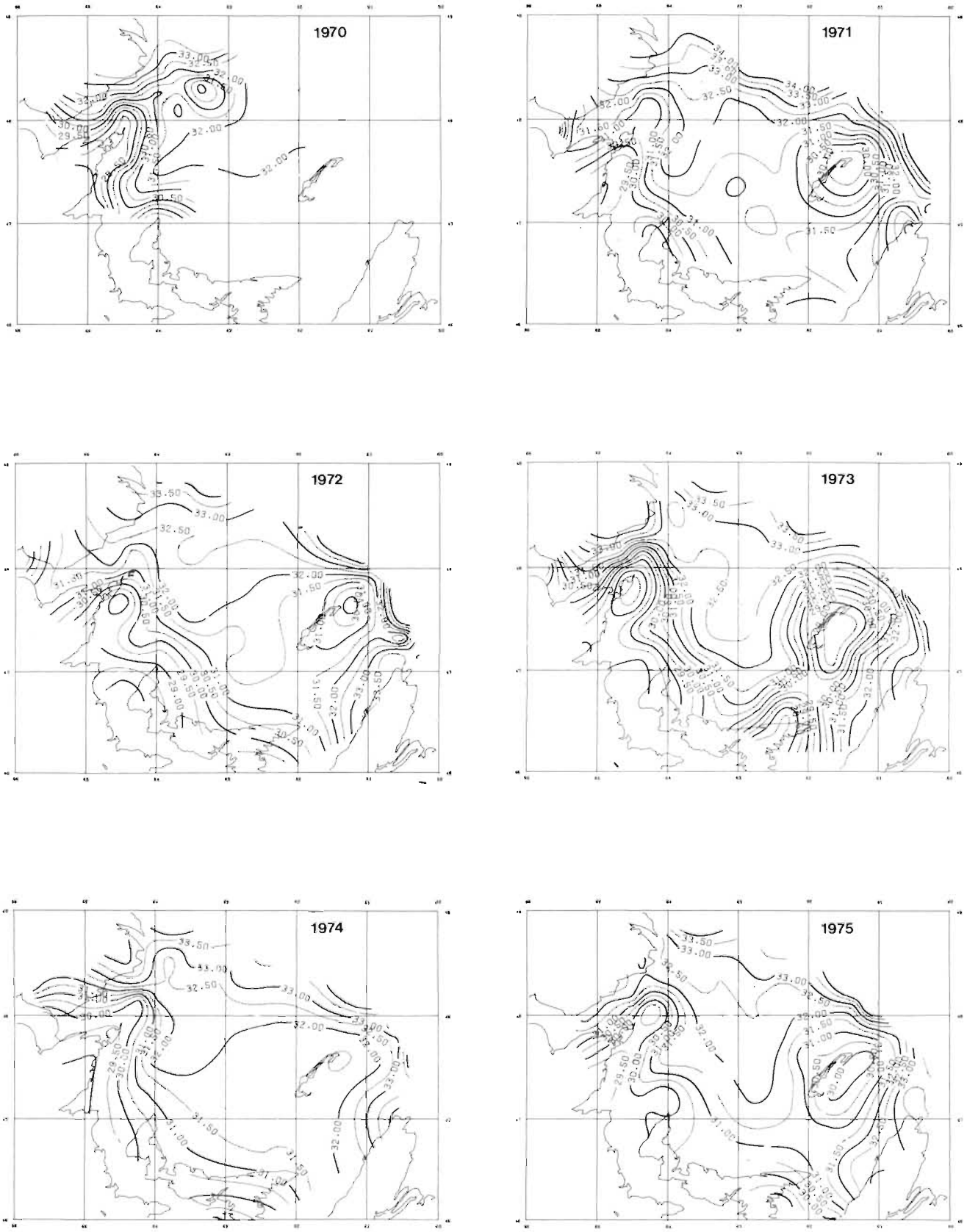

Fig. 46. Bottom salinity contours in the southern Gulf of St. Lawrence, 1970-75.

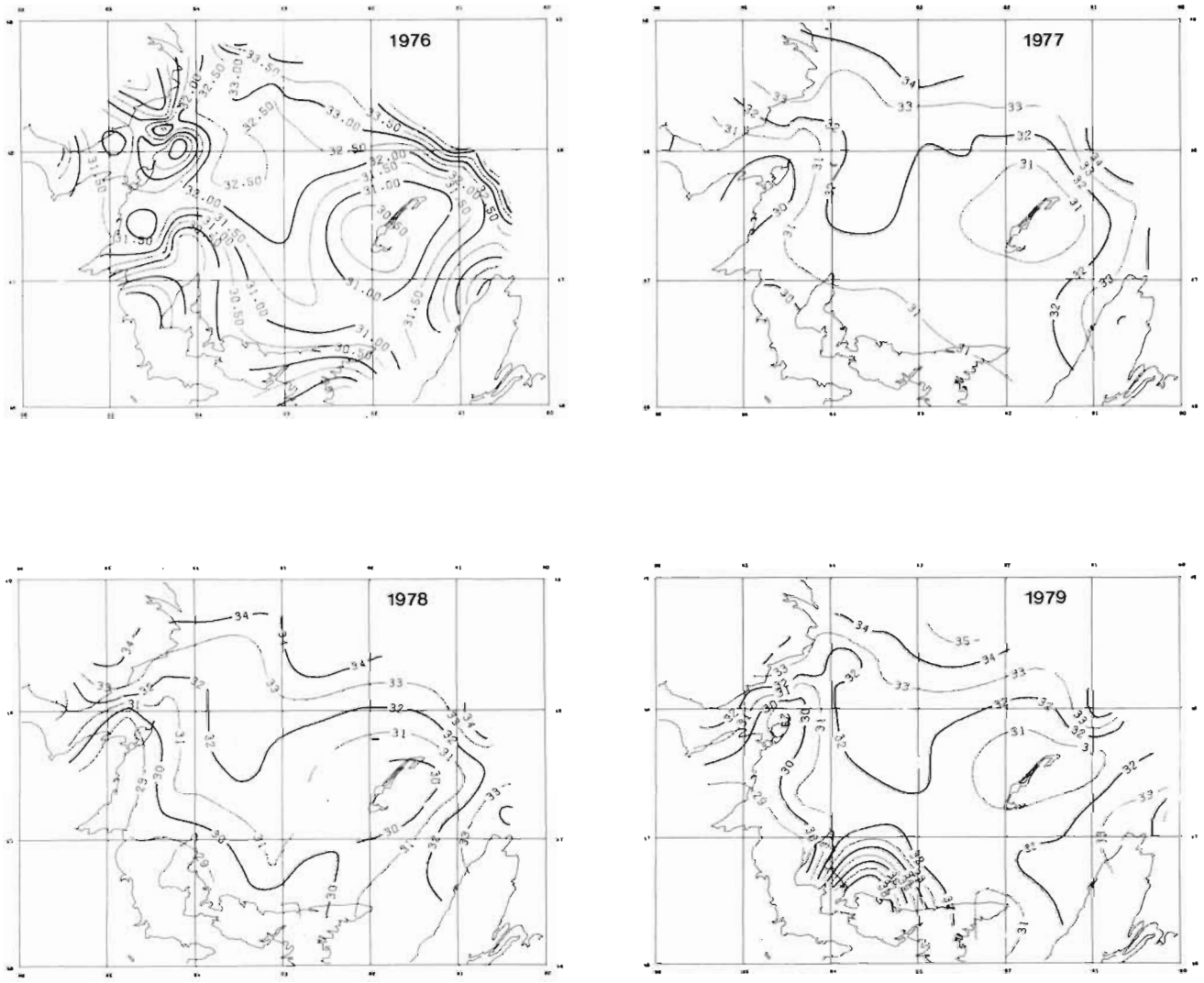

Fig. 46 (cont'd.) Bottom salinity contours in the southern Gulf of St. Lawrence, 1976-79.