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CAFSAC RESEARCH DOCUMENT 80/19.

An analysis of white hake (*Urophycis tenuis*) groundfish, ichthyoplankton,
and commercial sampling data in the southern Gulf of St. Lawrence

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ABSTRACT

Trends in the fishery and biology of white hake in Division 4T were analyzed with respect to the commercial fishery and annual Canadian groundfish surveys. These surveys indicate that white hake abundance in Division 4T is centered off the eastern end of Prince Edward Island. Peak catches in the commercial fishery are in July and August, and about 85% of the catches are made by vessels under 25 gross registered tons. Ichthyoplankton surveys indicated large numbers of white hake larvae in 1970 and 1975. The 1979 nominal catch was larger than those of the past five years, which may be due in part to good recruitment of the 1975 year-class. Greater effort directed towards sampling and ageing white hake is necessary for an analytical assessment of this stock.

INTRODUCTION

White hake (*Urophycis tenuis* Mitchell) is caught in NAFO Subareas 3 and 4 with the majority of the catch in Subarea 4 taken in the southern Gulf of St. Lawrence (Div. 4T). Canadian groundfish surveys indicate that white hake abundance in the southern Gulf of St. Lawrence is centered off the eastern end of Prince Edward Island. Due to ice coverage, the fishery is seasonal in nature, being virtually absent from December through April and peaking in July through September. Confusion has existed as to the species caught in the southern Gulf. Cox (1921) and Vladykov and McKenzie (1935) determined that only red hake (*Urophycis chuss* Walbaum) were present, but Leim and Scott (1966) mentioned that both red hake and white hake were present, but difficult to differentiate. However, based on morphological criteria, Musick (1967) suggested that all hake caught in the southern Gulf are white hake (*U. tenuis*). This report is based on the premise that all *Urophycis* landed in NAFO Div. 4T are *U. tenuis*.

Tagging studies by Kohler (1971) indicated that southern Gulf of St. Lawrence white hake tend to remain in the Gulf, with little inter-mixing with other populations. For management purposes, it may be treated as a single stock. The fishery on this stock is currently unregulated, but before adequate regulations can be established, an analysis of data previously collected is necessary. This report summarizes data collected through NAFO statistics, by cruises of the research vessel *E. E. Prince* in the southern Gulf in the fall of 1970-1979, and by sampling commercial catches.

RESULTS AND DISCUSSION

Nominal Catch

Nominal catches from the southern Gulf of St. Lawrence white hake stock were obtained from NAFO Statistical Bulletins and from unpublished data available from NAFO. Annual nominal catch from 1960 through 1978 averaged 5100 metric tons, with peak catch in the mid-1960's, and with catches from 1974-1978 below the long-term average (Table 1). Catches increased to about 7200 tonnes in 1979. The southern Gulf white hake fishery is entirely Canadian, and over 99% of the landings are by Quebec and Maritimes-based fishermen.

Nominal catch by trawlers from 1972 to 1979 comprised from 20 to 43% of the annual total, and gillnetters caught between 21 and 37% of the annual total (Table 2). Long-line and hand-line catch declined from a high of 27% of the total nominal catch in 1972 to under 10% from 1975 to 1979.

Nominal catch by vessels with a weight of under 25 tons comprised 84% of the total landings from 1972 to 1979 (Table 3). Virtually all of the catch of gillnetters, long- and hand-liners, and by miscellaneous or unknown gears were by vessels under 25 tons. Nominal catch by trawlers and Danish and Scottish seiners under 25 tons varied from 3 to 86% of the total for each gear, but were generally above 50%.

The seasonal nature of the fishery is indicated by Table 4. Since the fishery is conducted by small boats, winter weather conditions including seasonal ice coverage preclude fishing from December until April, but it starts in May, peaks in the July to September period, and declines through October and November. Kohler (1971) found the same pattern for the fishery in 1967 and 1968.

E. E. Prince Research Cruises

Starting in 1971, stratified surveys covering the entire southern Gulf of St. Lawrence have been conducted in September with the research vessel E. E. Prince. The southern Gulf has been divided into 25 strata (Fig. 1). However, in the fall, white hake were seasonally abundant in about only six strata. White hake have been most abundant in strata 32 and 33, and from 1973 onwards, these two strata usually accounted for over 50% of the catch in the entire southern Gulf (Table 5). The catch of white hake in stratum 39 comprised 33% in 1971 and 18% in 1979 of the estimated population size, but in other years in the 1970's, the catches were negligible.

The mean length of the catch varies considerably among strata. From 1973 onwards, the mean length of the catch in stratum 32 was under 36 cm, whereas the mean length of the catch in stratum 20 was over 60 cm (Fig. 2). Smaller white hake (<46 cm) were caught in strata 15 and 25. However, the mean length of the catch in stratum 25 has been increasing since 1975. There was some tendency in 1976 for decreasing mean length of catch.

Length frequency distributions show no consistent trends from 1970 to 1979. In 1975 and 1976, white hake in the 34 cm size class were the most abundant class, but from 1970 to 1974, no one length frequency predominated (Fig. 3). The variability in the length frequency may be explained by examining for each stratum the annual mean length (Fig. 2) and its proportion of the total catch (Table 5). In 1971, over 50% of the catch was from strata 25 and 39, with the mean lengths being 36 cm and 42 cm respectively. The length frequency distribution is thus skewed to favour the smaller size classes. In 1972, 50% of the catch was from strata 20 and 21, where the mean length of white hake caught was over 66 cm, thus skewing the length frequency distribution to favour larger

hake. In 1973, 72% of the total catch was from stratum 33 (mean length of white hake caught was 54 cm), and thus white hake 50 to 60 cm in length were indicated as most abundant. Similar arguments are applicable to the annual variation in length frequency distributions from 1974 to 1979. This variability occurs because white hake are caught in any abundance in only 6 of the 25 strata in the southern Gulf.

The estimated population numbers of the southern Gulf white hake population is shown in Figure 4a, and that of population biomass is shown in Figure 4b. The size of the population was estimated by multiplying the average catch per set by the stratum weighting factor (number of possible sets in stratum) and summing over all strata. However, it is difficult to ascertain if the trends in Figure 3 are real because 95% confidence limits may be over 600% larger than the mean.

Ichthyoplankton Surveys

Annual larval abundance surveys began in the southern Gulf of St. Lawrence in 1965 and continued through to 1975. However, white hake larvae were identified in only the 1970 to 1975 samples. An index of abundance for white hake larvae is shown in Table 6. The larval abundance index indicated strong year classes in 1970 and 1975. Larvae were distributed over the entire southern Gulf (Figs. 5 - 10), with concentrations along the western coast of Cape Breton Island and southwest of the Magdalen Islands (Fig. 11).

Commercial Samples

Sampling of the commercial catch in the southern Gulf of St. Lawrence white hake fishery has been inconsistent, with sampling occurring only in 1966-67 and 1975-77. Ageing of 56 white hake caught in 1967 and 172 white hake in 1976 has been done.

An examination of the length frequencies of the catch by the different gears indicated that gillnets always caught more hake ≥ 58 cm than did any other gear. Long-lines always caught more of these larger hake than did either otter trawls (Fig. 12) or Danish seines, and otter trawls always caught more larger hake than did Danish seines. The size composition of the total catch is dependent upon the selectivities of the gears and their relative proportions of the total catch.

All of the ageing data for the commercially-caught southern Gulf white hake are listed in Table 7. It should be noted that an ageing validation study has not been performed for white hake and the ageing criteria used were those for a "typical" gadoid. The ring structure in otoliths of white hake is complex, which also makes interpretation difficult. The mean lengths of ages 4 through 8 in the 1967 sample may be inflated due to underestimation of age of hake in the 70 cm to 90 cm size class, and we suggest that the 1967 age data are unreliable. The 1976 data indicate that white hake of the same age caught by gillnets were larger than white hake caught by otter trawls or Danish and Scottish seines.

A von Bertalanffy growth curve fitted to the combined 1976 data gave the following estimates of growth parameters: $L_{\infty} = 105$ cm, $K = 0.11$, $t_0 = -1.52$ years (Table 7). A von Bertalanffy growth curve fitted to commercial ageing data from other NAFO Divisions indicated that white hake in Div. 4X may reach greater maximum lengths than do hake in other areas (Table 8). The parameters K and L_{∞} are inversely related as indicated by Knight (1969).

An assessment of total allowable catches for this white hake fishery is impossible at this time owing to:

1. About 85% of the landings are made by the inshore fleet (vessels under 25 tons) and effort data are not available for this size class of vessel, thus prohibiting the application of a Schaefer model to determine sustainable yields.
2. Virtually no ageing has been done on white hake in either the commercial or the research samples, as a reliable ageing technique has not yet been established, thus precluding Pope's (1972) cohort analysis.

Commercial sampling for NAFO Division 4T white hake has been generally poor, and regular annual sampling from hake caught by all gear types is recommended if an analytical assessment is to be done. Therefore, greater effort directed toward validating an ageing technique for white hake is recommended, as this will allow routine ageing of samples.

ACKNOWLEDGEMENTS

Gordon Moulton provided NAFO statistics on white hake landings from 1972-78. The ichthyoplankton data are presented with the permission of Dr. A. C. Kohler, the scientist responsible for the conduct of the Gulf of St. Lawrence ichthyoplankton programme.

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Table 1. Nominal catch (metric tons round) of white hake in Div. 4T, 1960-1979

YEAR	CANADA (MQ)	CANADA (N)	TOTAL
1960	2008	7	2015
1961	5333	0	5333
1962	7244	0	7244
1963	6546	4	6550
1964	6205	0	6205
1965	4706	0	4706
1966	7024	0	7024
1967	6550	0	6550
1968	4260	0	4260
1969	4207	1	4208
1970	5668	0	5668
1971	5646	61	5707
1972	5731	26	5757
1973	5681	21	5702
1974	3603	13	3616
1975	4108	17	4125
1976	3745	13	3758
1977	3979	5	3984
1978	4553	8	4561
1979	7204 *	-	7204

*Maritimes data only

Table 2. Nominal catch (metric tons round) of Div. 4T white hake by gear, 1972-78 (% of annual landings in parenthesis).

YEAR	OTTER AND PAIR TRAWLS	DANISH AND SCOTTISH SEINES	LONG- AND HAND-LINES	GILLNETS	MISCELLANEOUS OR UNKNOWN
1972	1140 (20)	863 (15)	1604 (27)	1190 (21)	960 (17)
1973	2468 (43)	211 (4)	1045 (18)	1265 (22)	713 (13)
1974	1454 (40)	305 (8)	345 (10)	1100 (31)	412 (11)
1975	1576 (39)	306 (7)	324 (8)	1285 (31)	634 (15)
1976	1429 (37)	398 (11)	183 (5)	1147 (31)	601 (16)
1977	1227 (31)	408 (10)	231 (6)	1300 (33)	818 (20)
1978	1265 (28)	606 (13)	419 (9)	1689 (37)	582 (13)
1979 *	2798 (39)	902 (13)	469 (6)	2325 (32)	724 (10)
TOTAL	13357 (34)	3999 (10)	4620 (12)	11301 (29)	5444 (15)

* Maritimes data only

Table 3. Nominal catch (metric tons round) of Div. 4T white hake by vessels under 25 tons, 1972-1978 (% of total landings for that gear in parentheses).

YEAR	OTTER AND PAIR TRAWLS	DANISH & SCOTTISH SEINES	LONG- AND HAND-LINES	GILLNETS	MISC. OR UNKNOWN	TOTAL (<25 TONS)	% OF TOTAL LANDINGS
1972	503(44)	739(86)	1592(99)	1185(100)	960(100)	4979	86
1973	1801(73)	7(3)	1039(99)	1252(99)	713(100)	4812	84
1974	1045(72)	129(42)	342(99)	1084(99)	412(100)	3012	83
1975	995(63)	114(37)	316(98)	1191(93)	634(100)	3250	79
1976	1067(75)	269(68)	183(100)	1103(96)	601(100)	3223	86
1977	1056(86)	69(17)	230(100)	1182(91)	818(100)	3355	84
1978	1163(92)	54(9)	412(98)	1474(87)	582(100)	3685	81
1979*	2702(97)	239(27)	465(99)	2325(100)	722(100)	6453	90
TOTAL	10305(77)	1620(41)	4583(99)	10796(96)	5442(100)	32769	(84)

* Maritimes data only

Table 4. Nominal catch by month of white hake in Div. 4T, 1972- 1979

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1972	1	2	0	11	52	391	1275	1693	1164	873	278	16	5757
1973	0	0	0	9	53	567	1477	1363	1420	696	114	3	5702
1974	0	0	0	4	38	228	1376	923	434	426	181	6	3616
1975	1	0	0	0	54	352	1270	1040	866	384	151	7	4125
1976	10	3	0	15	70	249	1097	855	949	469	41	0	3758
1977	0	0	0	1	68	550	1211	905	654	363	231	1	3984
1978	0	0	0	0	32	543	1178	1116	874	456	362	0	4561
1979	0	0	0	0	53	681	2045	1622	1158	824	807	14	7204
TOTAL	12	5	0	40	420	3561	10929	9517	7519	4491	2165	47	38707
% of Total Landings	0	0	0	0	1	9	28	25	19	12	6	0	100

Table 5. % of total catch in different strata of white hake during the
fall cruises in Div. 4T of the research vessel E. E. Prince

STRATUM	1971	1972	1973	1974	1975	1976	1977	1978	1979
15	1	6	1	5	12	11	32	5	10
20	4	15	13	4	1	5	7	26	10
21	2	35	1	1	1	20	2	2	5
25	20	16	2	8	8	10	16	6	3
32	10	11	5	8	55	1	14	10	10
33	18	2	72	66	2	45	9	40	37
37	10	3	0	3	4	6	6	6	1
TOTAL	65	88	94	95	84	98	86	95	76

Table 6. Relative abundance (number/100,000 m³ of water strained) of white hake larvae determined by neuston nets in the southern Gulf of St. Lawrence.

YEAR	ABUNDANCE
1970	276.95
1971	39.17
1972	2.39
1973	17.07
1974	3.09
1975	258.53

Table 7. Average length (cms) of aged white hake from commercial samples in Div. 4T. Sample size is in parenthesis.

Age	1967	1976		
	Otter Trawl	Otter Trawl	Gillnet	Seine
3		43(1)		36(6)
4	57(17)	46(1)		46(9)
5	61(10)	50(5)	58(8)	53(16)
6	66(6)	61(2)	63(6)	55(16)
7	60(10)	58(8)	68(3)	62(27)
8	68(2)	63(5)	68(4)	66(17)
9	68(1)	69(8)		67(9)
10	62(1)	66(2)		77(10)
11	82(1)	80(3)		85(1)
12	73(1)	81(2)		73(1)
13		81(2)		
TOTAL	(56)	(39)	(21)	(112)

Table 8. Parameters of the von Bertalanffy growth equation for white hake that have been aged in the commercial samples.

Division	Year	Gear	Number	L_{∞} (cms)	K	t_0 (yrs)
30	1976	long-line	52	144	.10	.30
4V-4W	1967	otter trawl	34	71	.45	.23
4T	1976	otter trawl, gillnet, seine	172	105	.11	-1.52
4X	1974	long-line	60	194	.06	-0.87
4X	1976	long-line	68	140	.10	.05

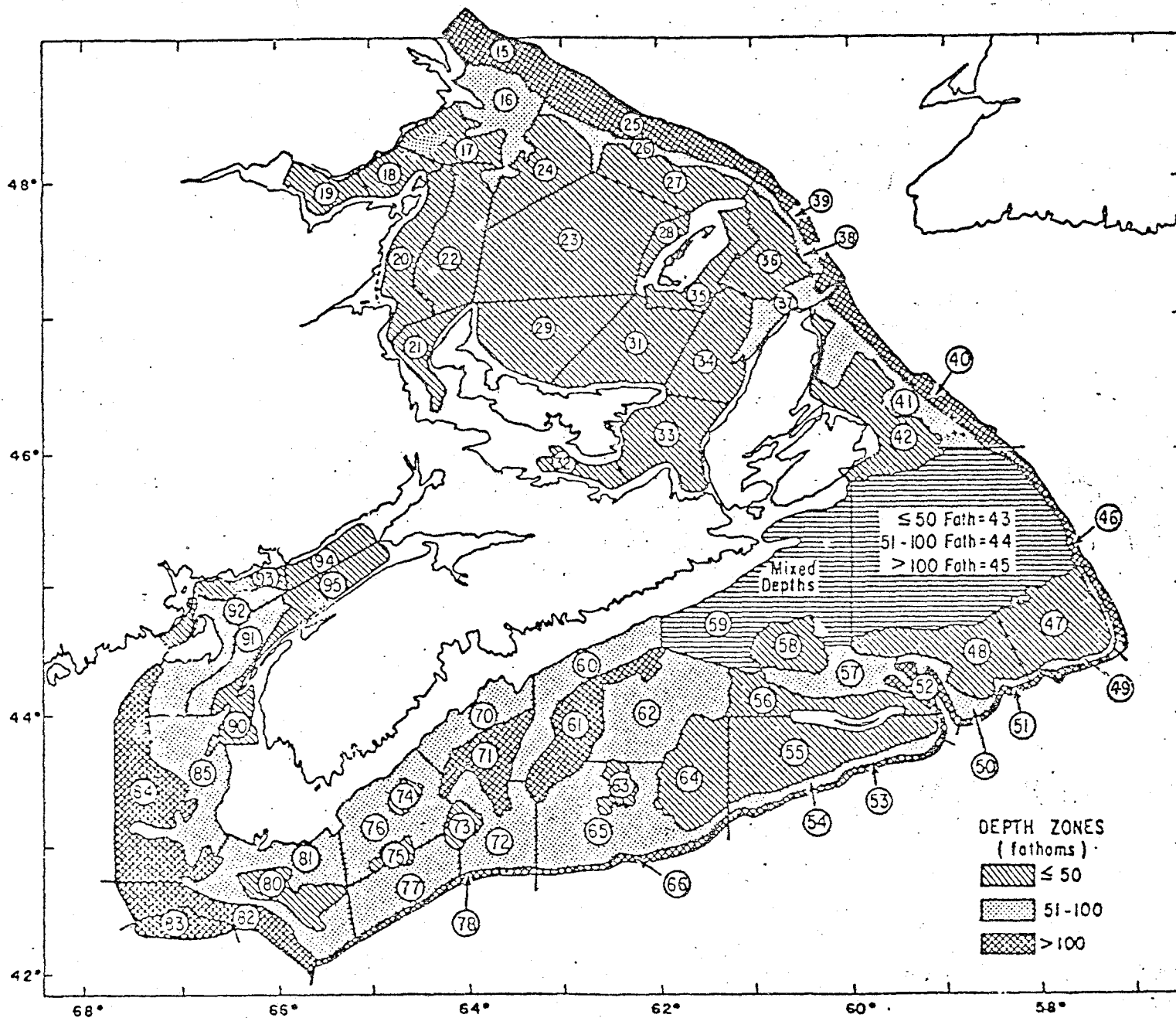


Fig. 1. Diagram of stratification schemes for Div. 4T and Div. 4VWX.

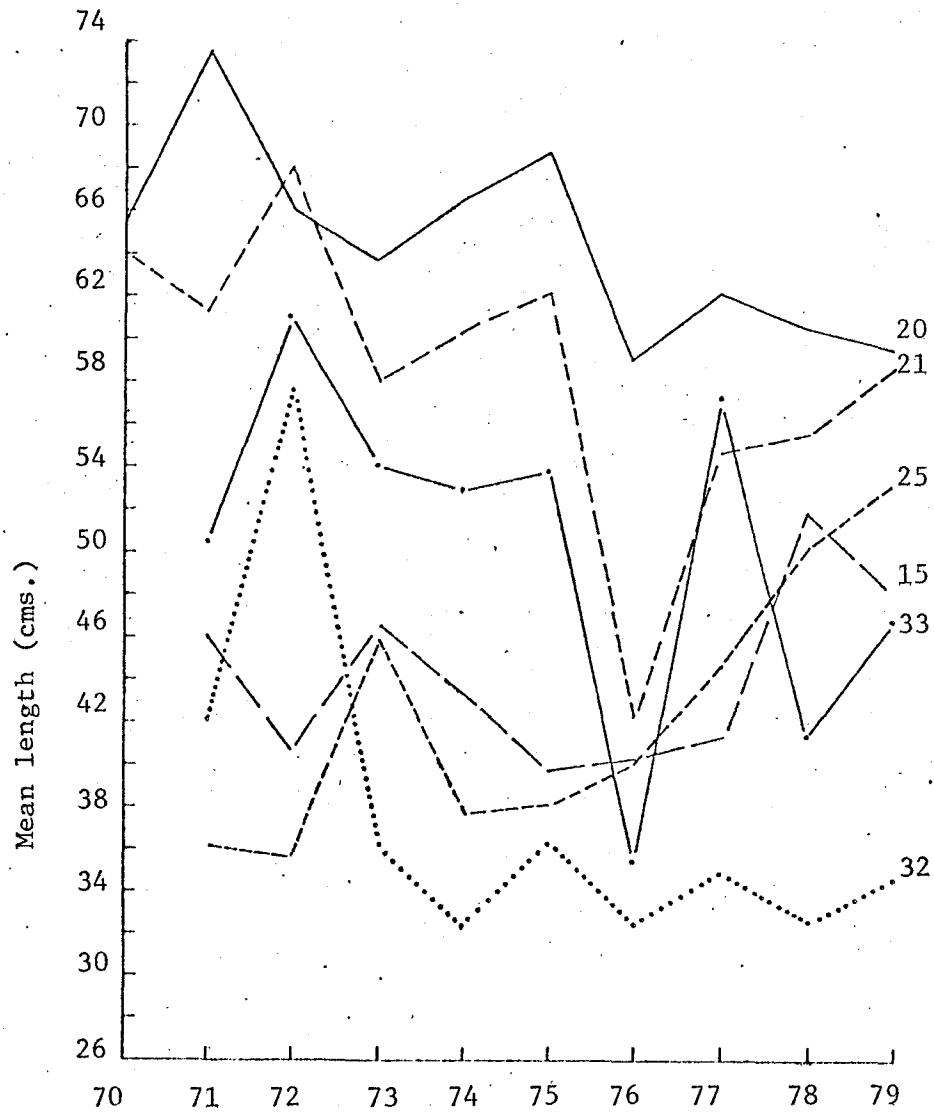


Figure 2. Mean length (cm) of white hake caught in various strata in Div. 4T by the research vessel E. E. Prince.

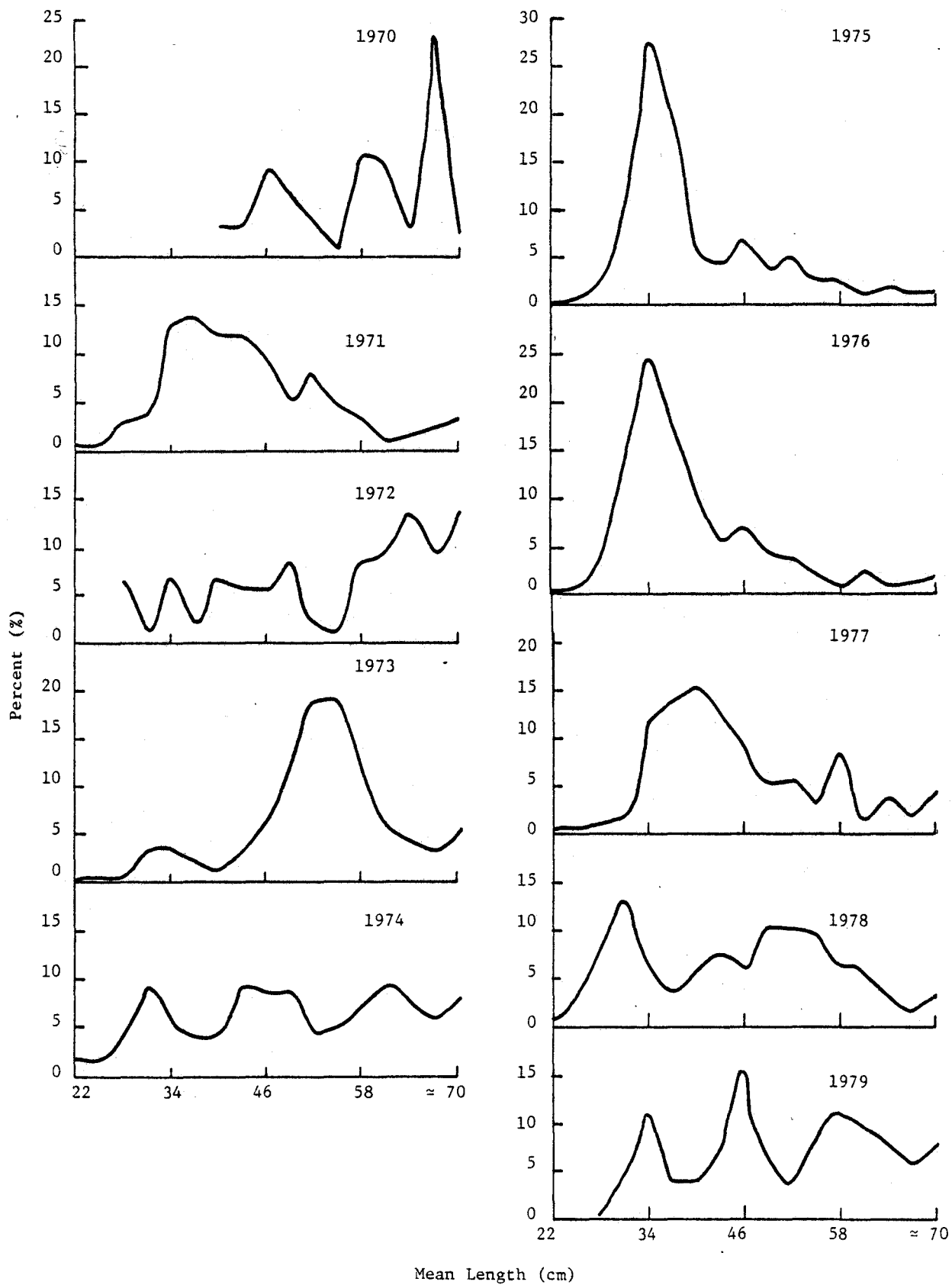


Figure 3. Length frequency distribution of white hake caught during research cruises.

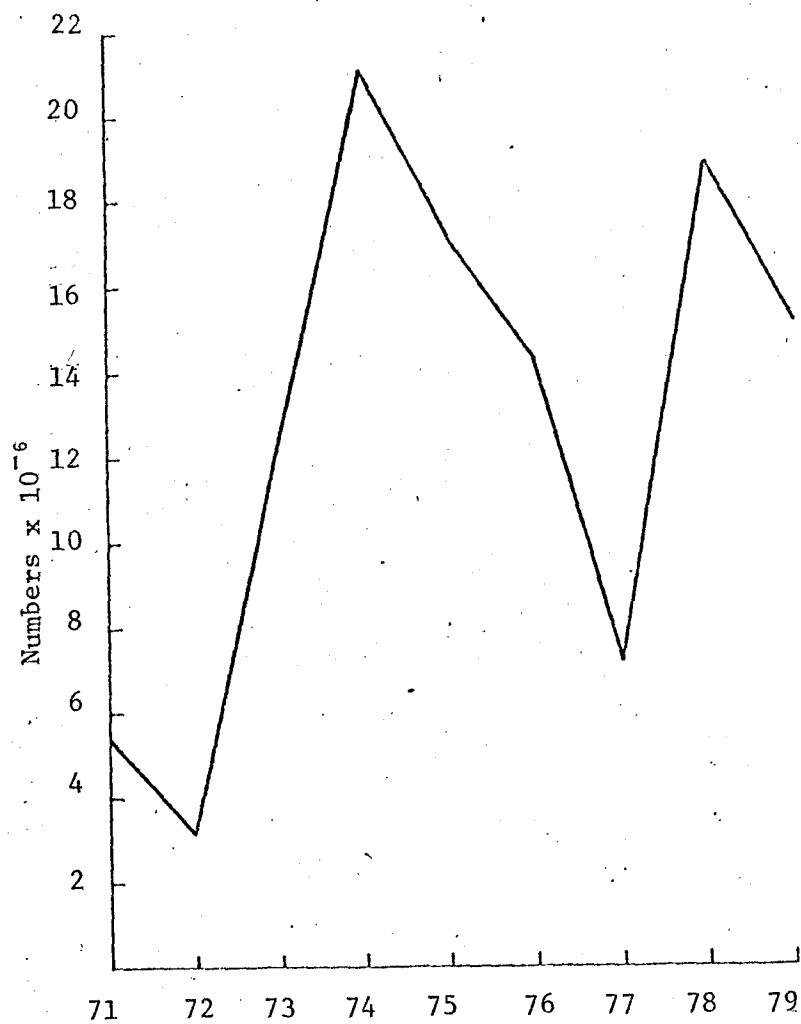


Figure 4a. Estimated population size of white hake in Div. 4T
as derived from groundfish cruises

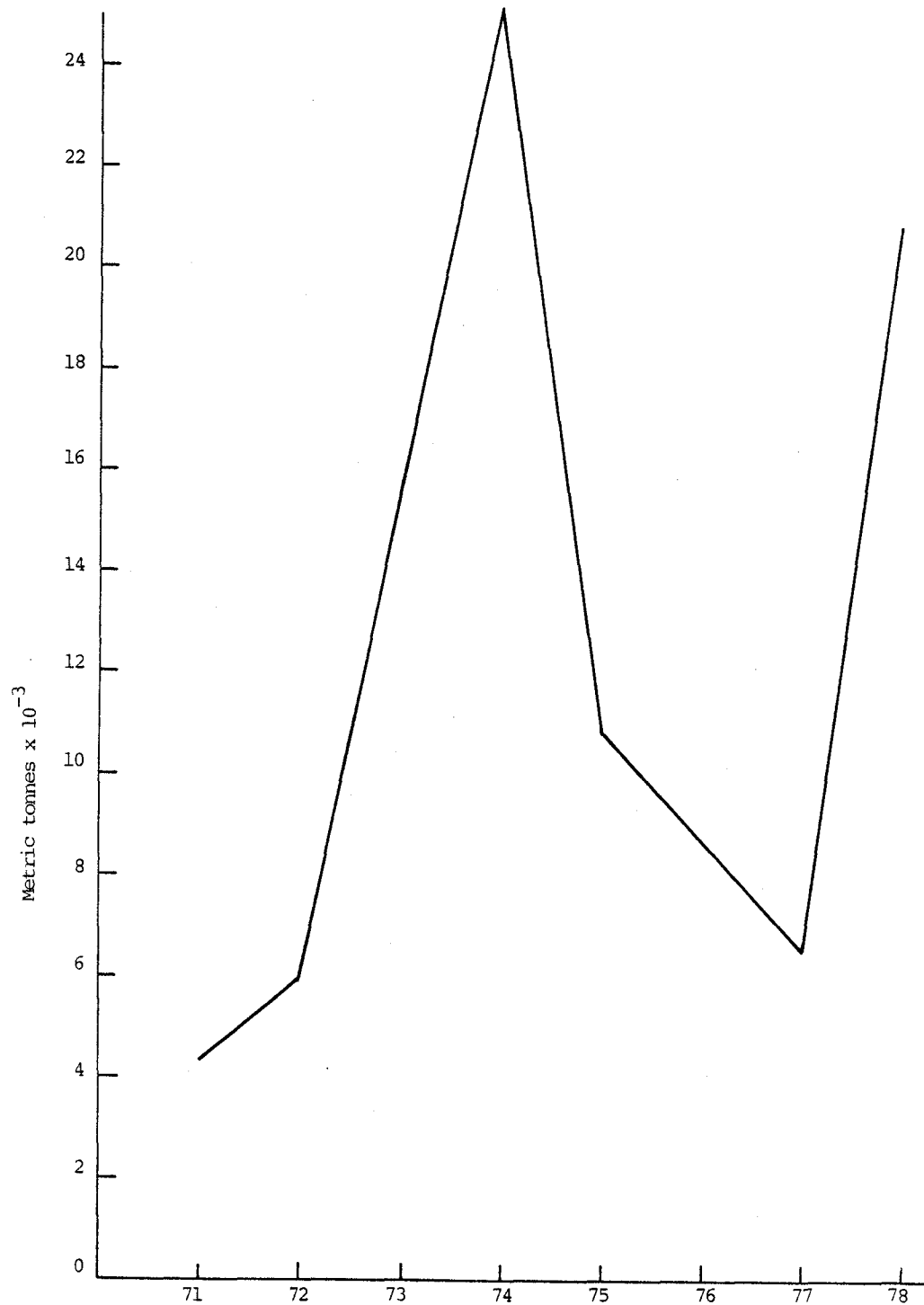


Figure 4b. Estimated biomass of white hake in Div. 4T as derived from groundfish cruises.

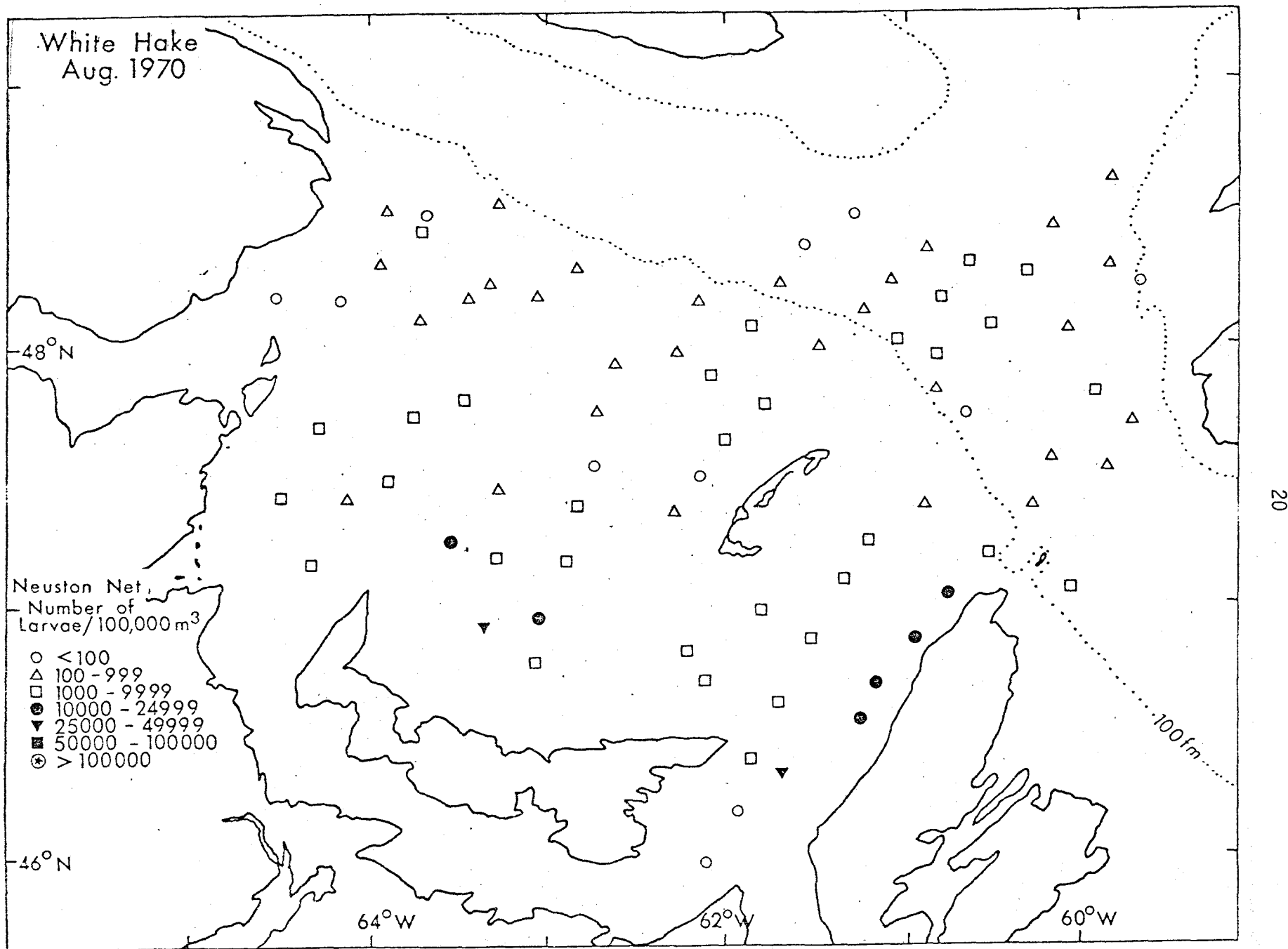


Figure 5. Distribution of larval white hake on ichthyoplankton surveys 1970-75.

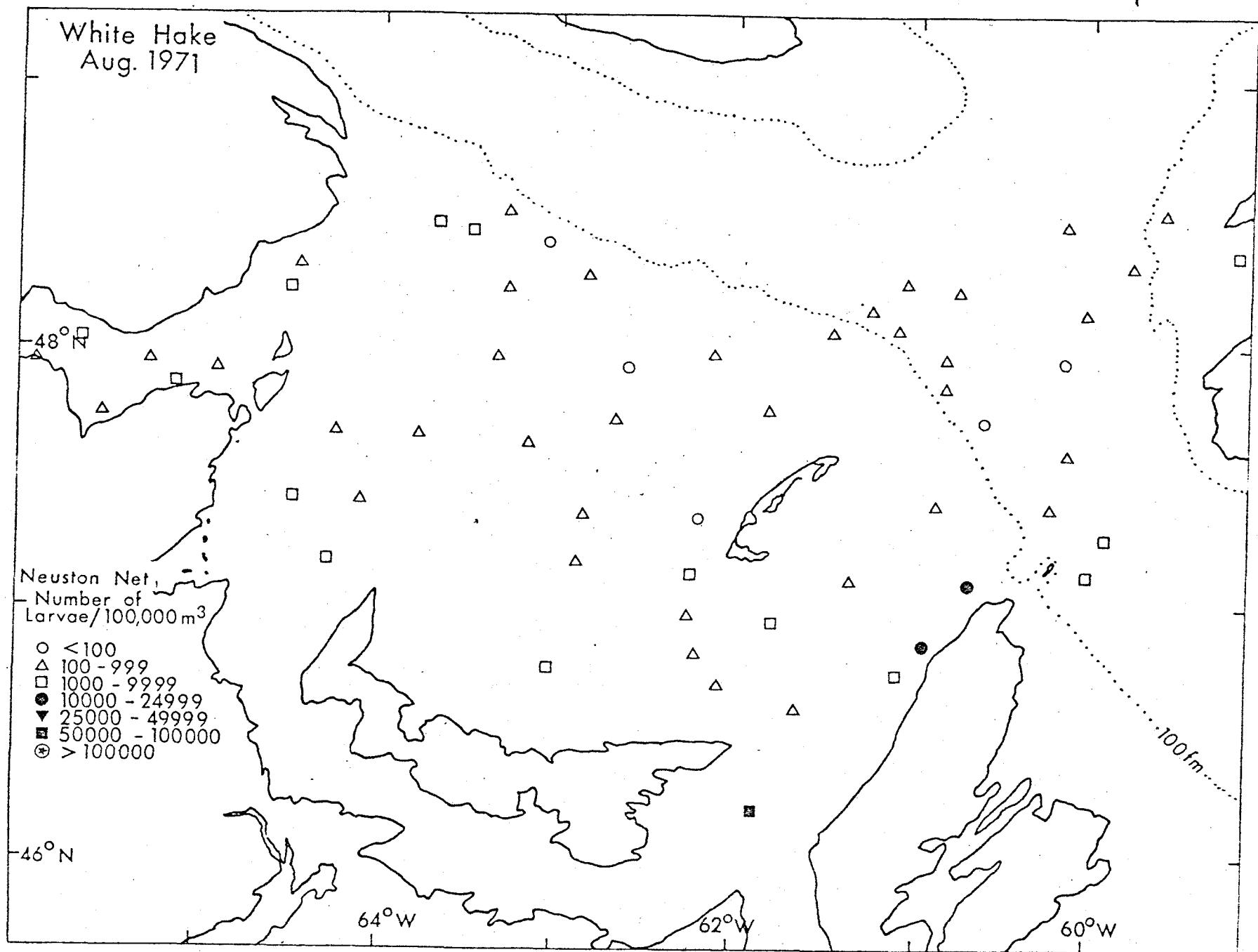


Figure 6. Distribution of larval white hake on ichthyoplankton surveys 1970-75.

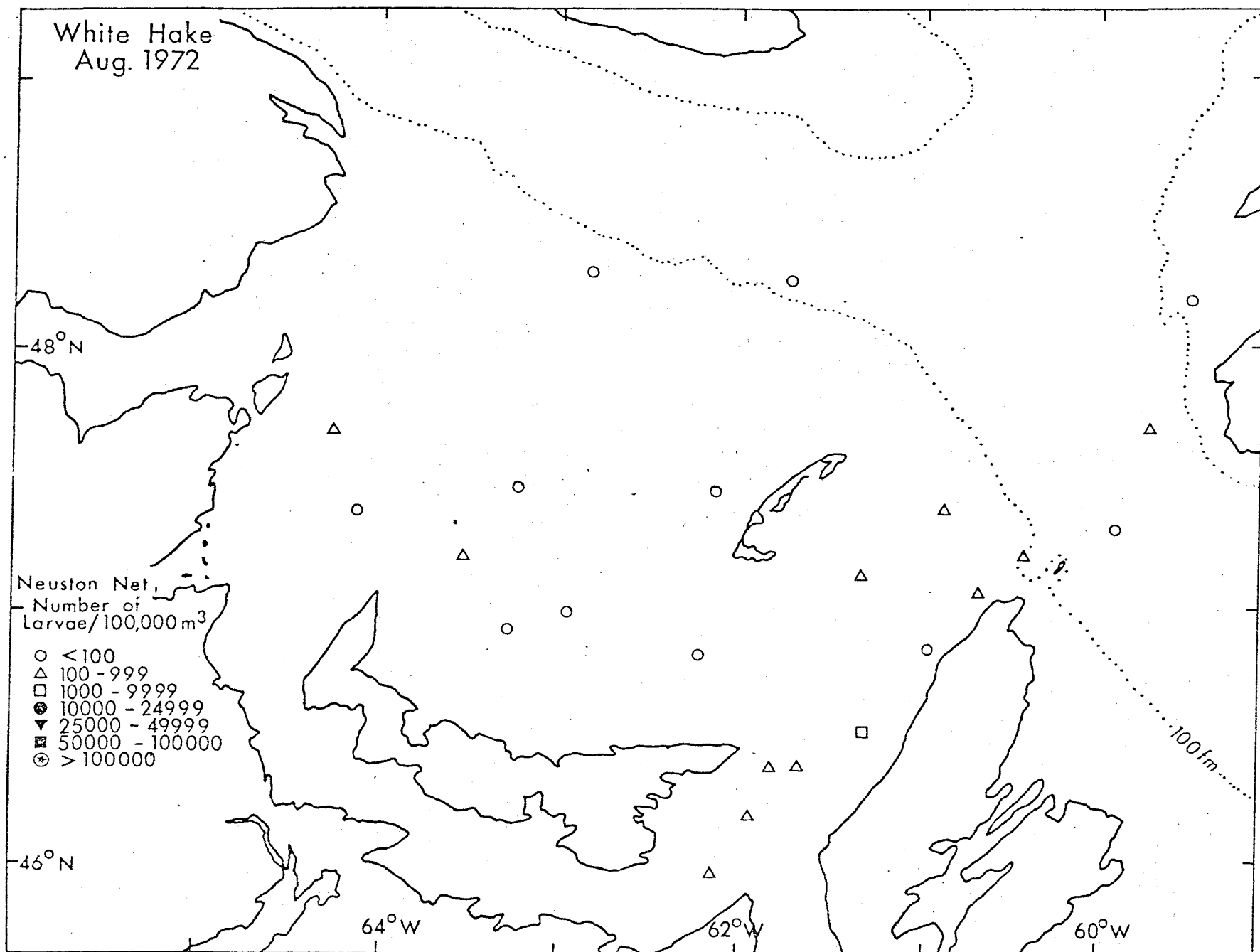


Figure 7. Distribution of larval white hake on ichthyoplankton surveys 1970-75.

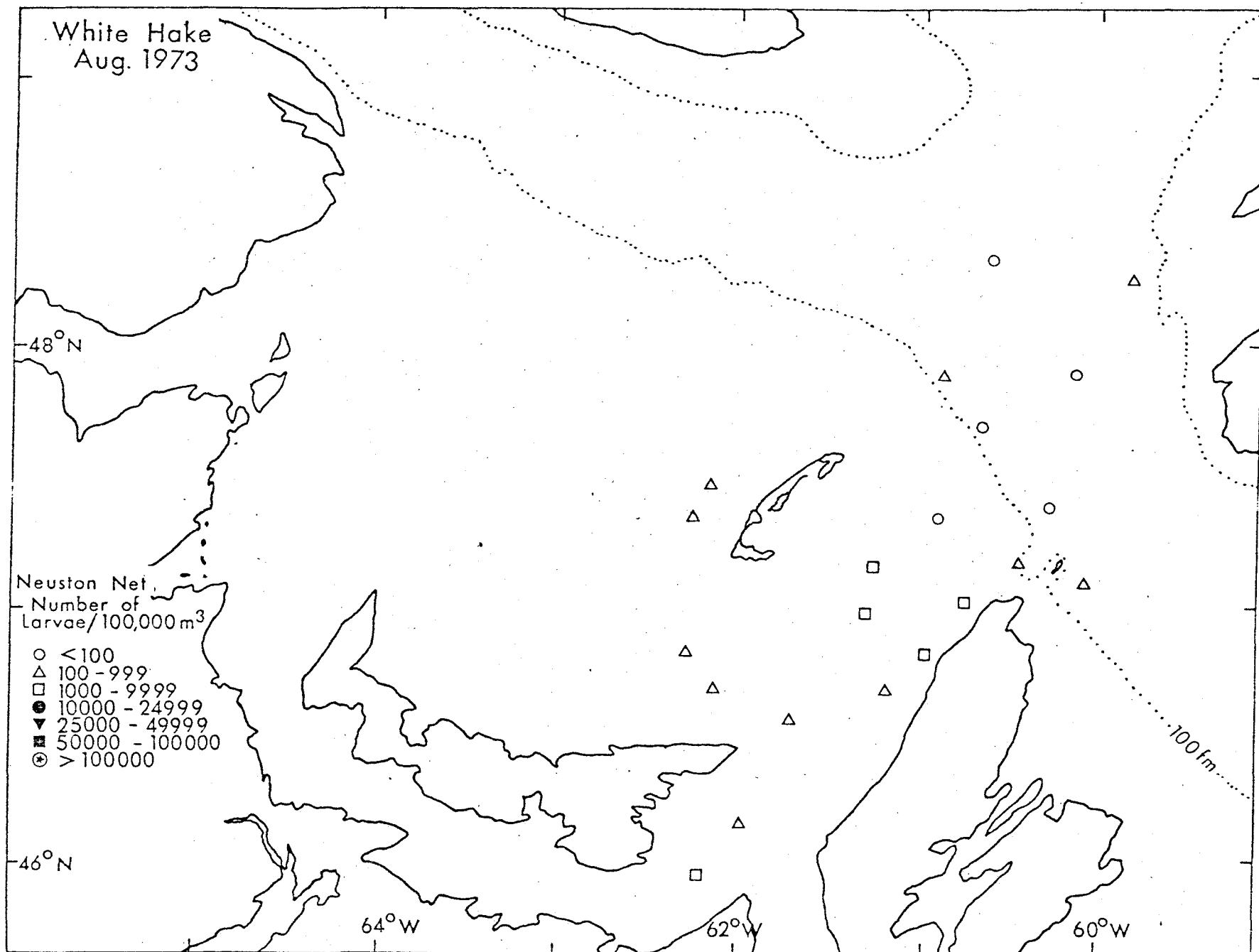


Figure 8. Distribution of larval white hake on ichthyoplankton surveys 1970-75.

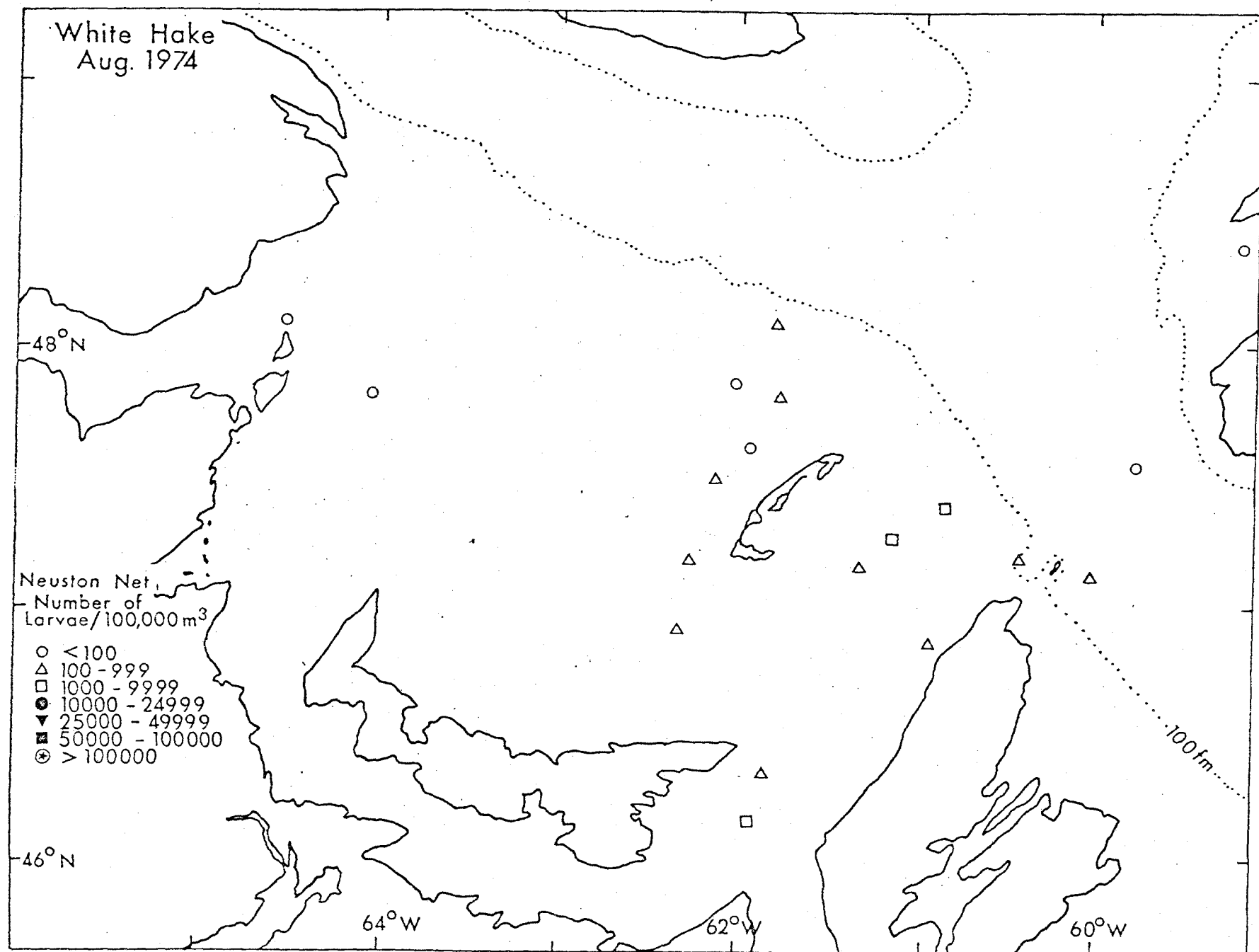


Figure 9. Distribution of larval white hake on ichthyoplankton surveys 1970-75.

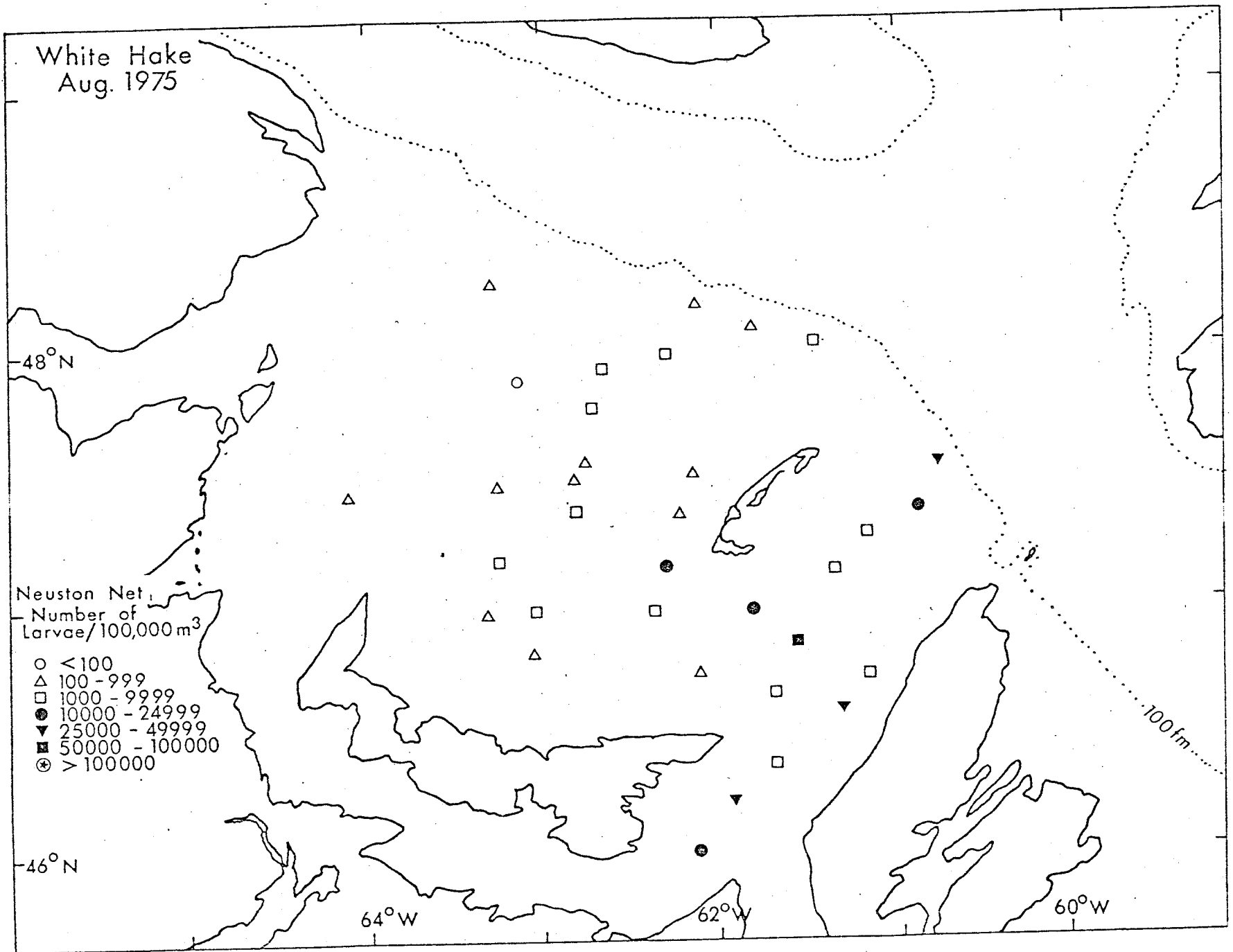


Figure 10. Distribution of larval white hake on ichthyoplankton surveys 1970-75.

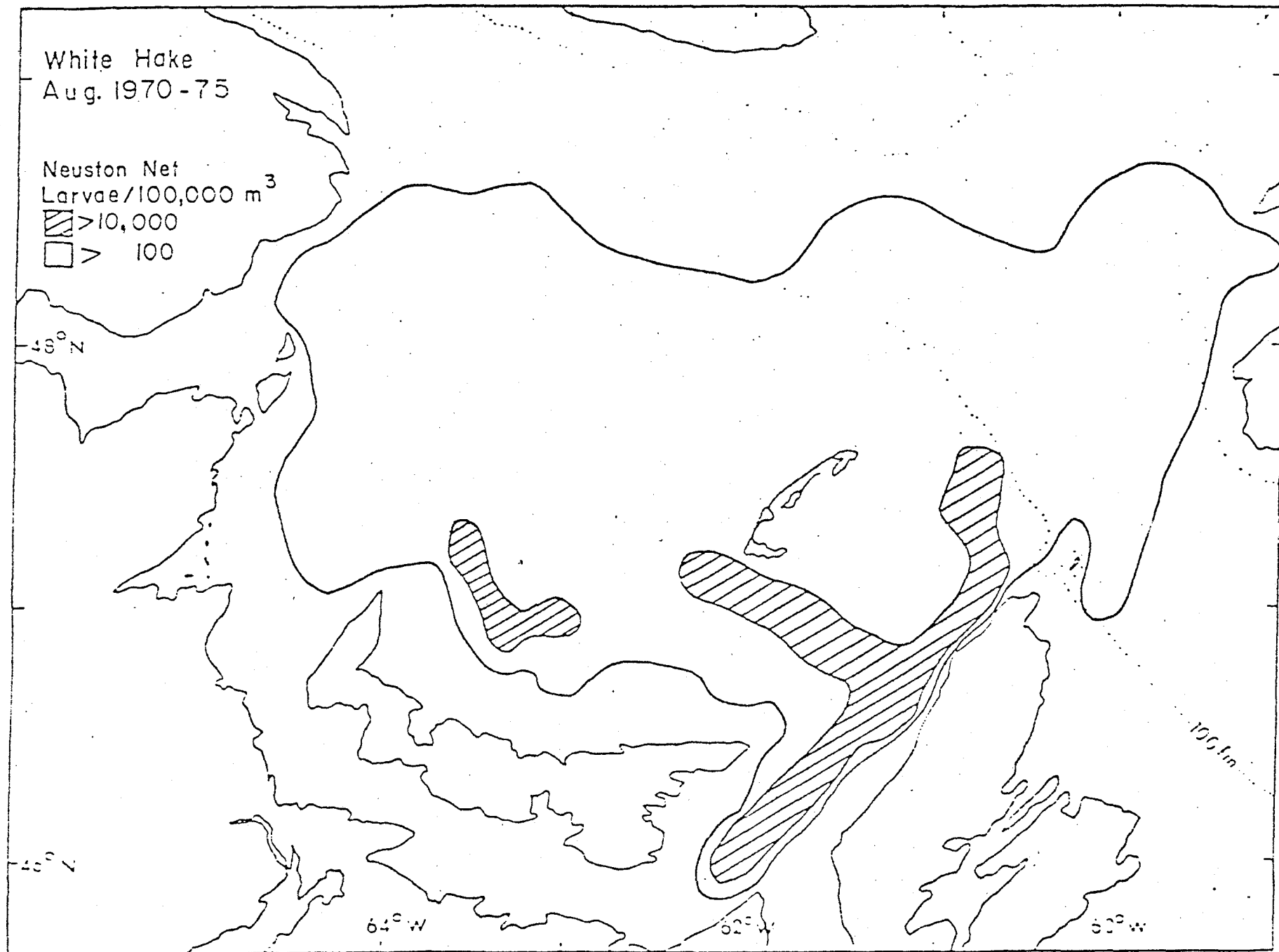


Fig. 11. Distribution of white hake larvae in the Gulf of St. Lawrence 1970-75.

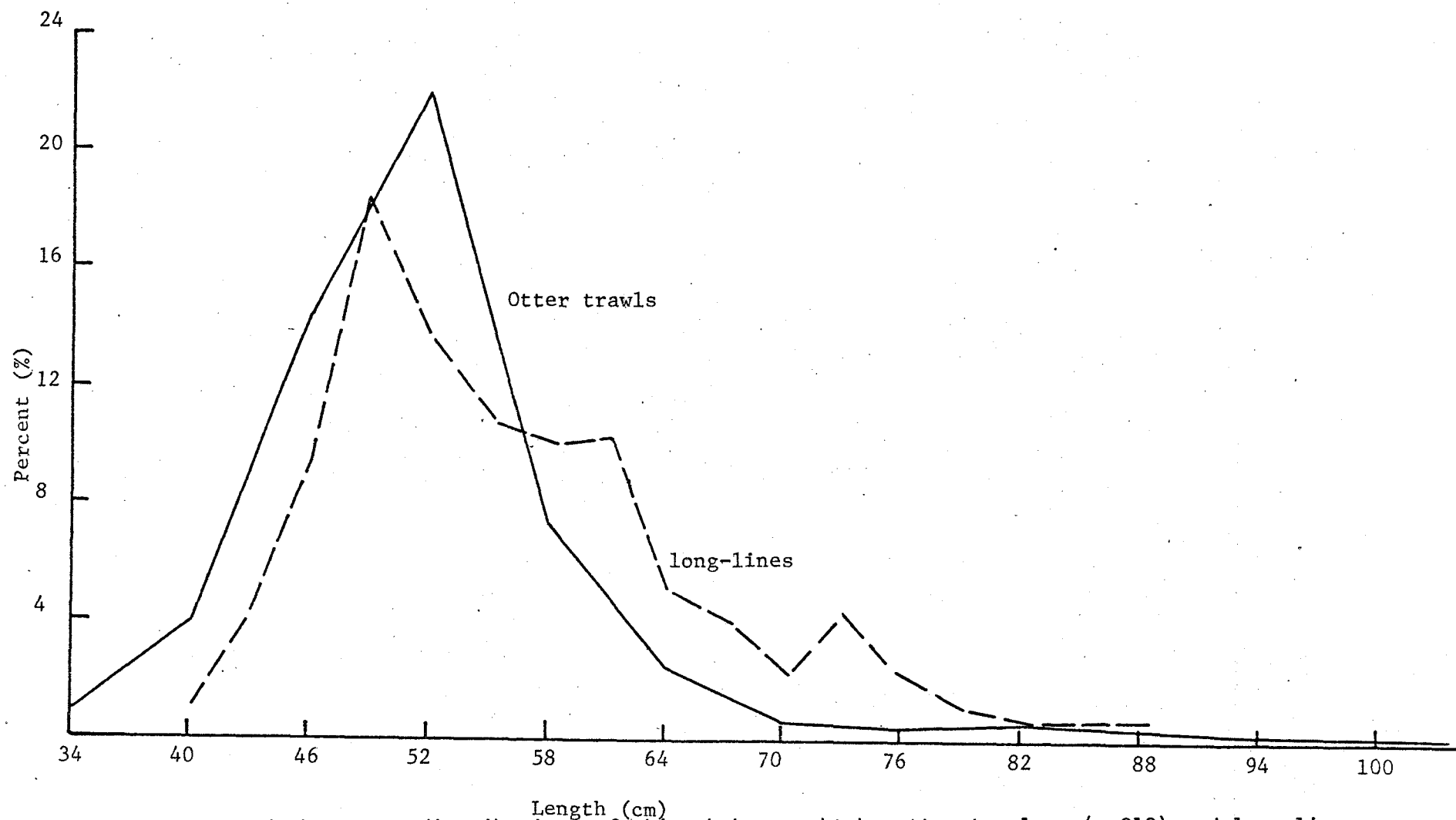


Figure 12. Length frequency distributions of white hake caught by otter trawlers (n=812) and long-liners (n=486) in 1966 in Div. 4T.