4VWX and 5Zc White Hake
1996 Stock Assessment

by

M. Fowler, J. Black, B. Mohn, and M. Sinclair

Marine Fish Division
Maritimes Region, Science Branch
Bedford Institute of Oceanography
P.O. Box 1006, Dartmouth
Nova Scotia, B2Y 4A2

ABSTRACT

The single management unit (4VWX/5Zc) for Scotian Shelf/Bay of Fundy white hake may encompass up to four stock components. These are tentatively identified as a Scotian Shelf component, a possibly discrete slope component, a Gulf of Maine contiguous with the U.S.A. 5ZY/6 white hake management area, and a Laurentian Channel component contiguous with the 4T Channel component as well as (perhaps) the slope component. Overall trends in landings suggest that most of the stock(s) in the 4VWX are in decline, while the western 4X/5Zc portion may be doing relatively well. Preliminary estimates of total annual mortality infer that fishing mortality in recent years has been above the $F_{0.1}$ target. Length frequencies are skewed toward younger ages, and there are fewer large fish in the eastern part of the management unit compared to earlier time periods. Before 1996 there were no restrictions on fishing effort for white hake in 4VWX and 5Zc.

RÉSUMÉ

La seule unité de gestion (4VWX/5Zc) de la merluche blanche du plateau néo-cossais/baie de Fundy peut compter jusqu'à quatre composantes du stock, que l'on a identifiées provisoirement comme la composante du plateau néo-écossais, la composante potentiellement distincte du talus, la composante du Golfe du Maine adjacente à l'unité de gestion américaine 5ZY/6 de la merluche blanche, et la composante du chenal Laurentien adjacente à la composante 4T du chenal et (peut-être) la composante du talus. D'après les tendances générales des débarquements, presque tous les stocks de 4VWX seraient à la baisse, tandis que dans la partie ouest de 4X/5Zc, les stocks se porteraient relativement bien. Selon les estimations préliminaires de la mortalité totale annuelle, la mortalité par pêche au cours des dernières années a été supérieure à l'objectif de $F_{0.1}$. Les fréquences de longueur montrent un déplacement vers des poissons plus jeunes, et il y a moins de poissons de grande taille dans la partie est de l'unité de gestion comparativement aux années antérieures. Jusqu'en 1996, il n'y avait aucune restriction en ce qui concerne l'effort de pêche pour la merluche blanche de 4VWX et 5Zc.

Introduction

White hake (*Uropycis tenuis*) on the Scotian Shelf and in the Bay of Fundy was added to the stock assessment agenda of the Department of Fisheries and Oceans (DFO) in 1995. Previously this species was managed only in the Gulf of St. Lawrence, the fishery for which was closed in 1995. Quota reductions for fisheries on more traditionally sought species (e.g. cod, haddock, pollock) have resulted in the re-direction of fishing effort on species such as white hake that were historically of insufficient commercial value to deliberately target.

Stock Structure and Management Units

The present management units for white hake (*Urophycis tenuis*) are North Atlantic Fisheries Organization (NAFO) Divisions 4T, 4VWX+5Zc, and the United States part of 5Z plus 5Y and 6. The stock structure of white hake is not well understood. Fahay and Able (1989) have reviewed the literature with particular reference to the Gulf of Maine area. Based on egg, larval, 0-group and age 1 distributions, as well as physical oceanographic information, they concluded that white hake in the Gulf of Maine and Bay of Fundy are sustained by early spring spawning along the continental slope off southern New England, Georges Bank, and the Scotian Shelf. The conclusion is based on the following observations;

- no eggs or larvae have been observed within the Gulf of Maine during January to June surveys of the Marine Resources, Monitoring, Assessment and Prediction Program,
- pelagic juveniles (0-group) were abundant in May-June with an on-shore gradient of increasing length,
- demersal 0-group juveniles have been sampled in several near-shore sites beginning in June-July,
- age 1 juveniles are observed in the same areas as demersal 0-group juveniles, but at slightly deeper depths,
- spawning on the Scotian Shelf, from larval distributions, occurs in August-September, and
- the circulation during mid-summer should limit the drift of larvae from the Scotian Shelf to the Gulf of Maine area due to relatively longer residence time on the Shelf.

It was concluded (Fahay and Able 1989 based on Markle et al., 1982), based primarily on the 1978 Scotian Shelf Ichthyoplankton Program surveys, that white hake on the Scotian Shelf are recruited from two spawning periods, the above mentioned slope spawning in

early spring and Shelf spawning in August. Markle et al. (1982) speculated that Gulf of St. Lawrence early summer spawning may also contribute to Scotian Shelf May-June larval distributions.

Based on discontinuous autumn adult distributions in the southern Gulf of St. Lawrence, tagging results of Kohler (1971) and morphometric/meristic studies Hurlbut et al. (1996) concluded that there are two stock components within the NAFO 4T statistical areas. The "channel" component is predominantly in deeper waters of the Laurentian Channel (>200m). The "strait" component is distributed in the shallower waters of the Magdalen Shelf, predominantly at either end of the Northumberland Strait. A study on allozymes showed low levels of variability and no differences between the two components (Clay et al., 1992).

The large-scale distribution of white hake is shown in Figure 1a. The 1975 to 1994 groundfish research vessel surveys are the source of the data. The surveys that have been combined are the following:

Newfoundland/Labrador	-	all months
Northern Gulf of St. Lawrence	-	July to September, January
Southern Gulf of St. Lawrence	-	August to October
Scotian Shelf/Bay of Fundy	-	July to September
USA	-	September to December

Potential differences in catchability between surveys/regions are not considered, and we suspect some misidentification of red hake as white hake, especially with smaller fish (approximately 40cm or less).

The Scotian Shelf survey does not sample the near-shore area. The distributions of white and red hake (identification to species suspect) from the 1995 and 1996 "ITQ" (Individual Transferable Quota) small dragger surveys, and the 1994 and 1995 longline sentinel surveys in 4Vn and 4VsW are shown in Figures 2a-b, 3, and 4a-b. From these surveys it is clear that the aggregate Research Vessel (RV) surveys are capturing the distributional limits of the species for white hake larger than about 30cm in length. Also the 1990 to 1994 distributions (Figure 1b) are very similar to the 1975 to 1994 results, suggesting persistent geographic structure under a range of environmental conditions.

The distributional pattern shows some discontinuities. The Gulf of Maine/Bay of Fundy distributional area is separate from the inshore Scotian Shelf. The latter area is also separated from the southern Gulf of St. Lawrence and Sydney Bight. The slope water distribution from off Banquereau Bank to Georges Bank appears to be continuous, and possibly discrete from the inshore Shelf and Gulf of Maine components.

For the Scotian Shelf/Bay of Fundy area the 1970 to 1996 distribution of mostly mature (greater than or equal to 35cm) and immature (less than 35cm) white hake are

compared (Figures 5a-b). The only area of difference between juvenile and adult white hake is in the Gulf of Maine/Bay of Fundy area. Juvenile white hake are not as abundant in the deeper waters in the Gulf of Maine area of the survey, but are observed at higher abundance levels in the shallow waters within the Bay of Fundy and approaches. In general, the larger juvenile white hake (age 2 predominantly) that are sampled by the survey co-exist with adults. This supports an interpretation that the several components are self-sustaining. The depth and temperature distributions of the two size-classes are also summarized for the overall time series (Figures 5a-b). Few fish are observed in water temperatures below 3°C or over 10°C. Catch per tow for adults peaks at intermediate depths (approximately 150 meters), whereas there is little relationship between depth and abundance for juveniles.

The length frequencies from the Scotian Shelf/Bay of Fundy RV survey have been grouped within 5 year blocks for four areas that reflect the discontinuities in the distribution of the species (Figures 6a-e). A gap in sampling for length frequencies exists for the years 1990 and 1991. The strata that have been grouped are the following:

Scotian Shelf basins	-	470, 471, 460, 461, 462
Gulf of Maine/Bay of Fundy	-	478, 466, 454, 453, 452, 451, 449
Laurentian Channel	-	446, 440
Scotian Shelf Slope	-	484, 485, 490, 491, 492, 493, 494, 495

The strata areas are shown in Figure 7. Visual inspection of the length frequency distributions suggests persistent differences between areas. The slope areas tend to have more small fish than inshore areas, and the Gulf of Maine/Bay of Fundy length frequencies often diverge markedly from the other areas in general pattern.

Based on the limited literature dealing with stock structure, and the above geographic patterns in distributions of white hake, it does not appear that the present management units in Scotia/Fundy waters are properly associated with the existing stock complexes.

Taking a precautionary approach we should assume, until proven otherwise, that the separate distributional concentrations reflect self-sustaining stock units. The mismatch between white hake distributional features, statistical reporting areas for catch and effort, and the regional responsibilities for management (USA and several DFO regions) complicates the implementation of management units for this species. White hake in the western part of 4X and 5Zc would appear to be part of a Gulf of Maine area stock complex. The 4Vn and 4Vs white hake along the Laurentian Channel are probably a continuation of the Channel component of the 4T management unit. The white hake in the basins of the Scotian Shelf (western 4W and eastern 4X) may be a self-sustaining unit. The relationship between the slope white hake along the Scotian Shelf and the aggregations on the Shelf itself are not evident. In the analysis of biomass trends an attempt is made to describe differences between areas within the management units.

1996 Fisheries Management Activities

Before 1996 there were no restrictions on fishing effort for white hake in 4VWX and 5Zc. Based on the 1995 Stock Status Report for white hake , which stated that "given this lower level of biomass, "[from the 1994 RV survey] "catches should be restricted to the average landings of 2,500t observed during the 1970s", a Total Allowable Catch (TAC) for 4VWX was implemented for the first time. Two thousand five hundred tonnes was allocated to fixed gear under 65' (2,000t for 4X and 500t for 4VW). Other fleet sectors have been restricted with by-catch regulations:

ITQ fleet (less than 65') - 20% (March 1 - May 31)
Trawlers greater than 65') - 10%

The 4X fixed gear (less than 45') quota has been broken down by season, but not by gear sectors:

	Quota	Landings
April 1 - June 30	552	927.7
July 1 - September 30	928	955.0
October 1 - December 30	360	

Quota over-runs were not deducted from subsequent seasons, being permitted on the basis that it was the first year of quota management for this fishery, and the industry was allowed some flexibility to devise an appropriate harvesting strategy. However, the fishery was closed from August 8 to September 15, and closed again on Oct 10. The industry also introduced its own trip limits, which are not enforced by DFO, as follows:

- initially 20,000 lb/trip (2 trips/month); but if 3 trips, a cap of 40,000 lb.
- August 1 moved to 10,000 lb/trip
- mid-August moved to 5,000 lb/trip

For 5Zc, the fixed gear quota in 1996 was set at double the 1994/95 landings. The rationale for the increase is that the cod and haddock TACs on Georges Bank are higher in 1996 relative to 1995. The fixed gear (less than 65') quota has been allocated equally to each association based on number of vessels per group. Quota trades between groups are permitted.

The Fishery

The trends in overall landings from 1966 to 1995 are shown by NAFO Divisions in Table 1 and Figure 8. In 4Vn, 4Vs and 4W there has been a gradual decline since the mid-1980s. The 4X landings have been increasing over the long term (since 1977) but

are also down from the mid-1980s. The Canadian landings on Georges Bank have been about 550 tonnes annually except for the jump in 1992 to 1994. Most of the landings during the past three decades have come from 4X.

Speculation that the declines in 4Vn and 4W may in part be due to colder water temperatures causing either expiration or relocation of white hake needs to be addressed. Summer temperature profiles for 1970-92 on the Scotian Shelf (Simon and Comeau, 1994) demonstrate a long-term cold-water phase throughout the 1980s and into the 1990s. In 4Vn and 4Vs bottom temperatures fell below 2.5^{0}C, less than the 3^{0}C loosely regarded as the lower temperature threshold for white hake. This would not, however, explain the decline in 4W landings, where the temperature doesn't fall below 5^{0}C. We'll need to examine the distribution and abundance of white hake with respect to temperature, probably in conjunction with depth, in some detail before we can draw any conclusions.

The 1992 to 1996 Canadian landings by unit area (Figure 9) and gear type are shown in Tables 2a through f. An increasing proportion of the landings from the central Scotian Shelf area (i.e. the western part of 4W and the eastern part of 4X) is being taken further away from shore:

	4Wk, 4Xm, 4Xo	4Wj, 4Wl, 4Xn
1992	1413	236
1993	1071	579
1994	1053	161
1995	279	954
1996 (to July)	124	309

Landings from 5Zj have also declined sharply during this time period.

The breakdown of landings by gear sector for the Canadian fishery between 1989 and 1996 is summarized in Table 3. The longliner fleet has consistently taken more than half of the overall landings (disregarding the incomplete landings for 1996). Most of the remaining landings are from trawling and gillnets. The gillnet proportion has increased compared to that landed by draggers in recent years. Tonnage classes 2 and 3 (i.e. less than 65') are responsible for between 76 and 93% of the annual trawler landings between 1989 and 1996 (to date).

The seasonal characteristics of the Canadian fishery by NAFO Statistical area are illustrated for the 1989 to 1996 period in Table 4 and Figure 10. For most of the shelf the fishery peaks in the July to August period. The fisheries in 4Vs, 4Vn, and 5Zc, however, tend to peak somewhat earlier (April to June). This could indicate some on-shelf movement of slope components of white hake in the spring. Since 1993, the fishery in 4X/5Y appears to have been extended to a larger part of the year (April to December), suggesting that fishing effort has been increasing.

The proportion of the Canadian landings for which the logs indicate that white hake was directed for, is shown from 1966 to 1996 in Table 5. Until 1987 a large proportion of the landings were unspecified with respect to the species being targeted, nor has the processing of commercial landings since then been able to distinguish between white and red hake. Given the small size of red hake, which average 30-35cm (Scott and Scott, 1988), it appears unlikely that they could represent any appreciable component of the catch in Scotian Shelf or Bay of Fundy waters, as the fishery rarely catches hake under 40cm. If the landings have been reported in a consistent manner from 1988 to 1996, there has been a gradual increase in the directed fishery. Consideration of the possible impacts of successive improvements in catch monitoring protocols on reported white hake landings since 1991 will be necessary to confirm the details of these trends.

The landed values and rough estimates of the price per kg during the past several years are shown in Table 6. The calculations suggest that the unit price for white hake has increased during the 1990s. The landed value has been between 2 and 4 million dollars annually.

Only a small proportion of the logs indicate effort information, or perhaps the information has not been key punched (Table 7). The information on effort for 1995, however, has improved considerably for some gear sectors. The data is not adequate to estimate trends in days fished, but does indicate the area fished in recent years. The gillnet and trawl fisheries, for which there is effort data between 1992 and 1995, have predominantly been within the Gulf of Maine part of 4X off southwest Nova Scotia (Figures 11 a through d). In contrast the longline fishery, for which there is effort data, has been more broadly distributed with a greater component of the effort along the slope of the Scotian Shelf from Georges Bank to Banquereau (Figures 11e and 11f). The seine fishery appears to be confined to a small area off the tip of Cape Breton, close to the 4T line (Figures 11g and 11h). The patterns of effort, limited as they are, suggest that the catch rate information comes from comparable areas over time.

The short time series (1989 to 1995) on catch per unit effort (CPUE) trends are shown in Table 7 and Figure 12. Although based on a small sampling of the respective fisheries, the longline CPUE data suggest a decline in 4Vs and 4W, an increase in 4X/5Y, and no clear trend in 5Zc. Catch rates in the trawl fishery were highest in 1989, declined through 1991, stabilized for the 1992-94 period, then dropped in 1995. It is difficult to interpret the gillnet catch rate trends, perhaps due to the generally low monitoring for effort (including none for 1994, which seems unreasonable).

In summary the recent (1989 to 1996) description of the Canadian white hake fishery in 4VWX and 5Zc indicates:

- increase in directed fishery,
- longer season of fishery,
- increase in price,
- expansion of area of the fishery,

- declines in landings and CPUE within 4VW,
- increased landings in 4X/5Zc but mixed signals from CPUE

This combination of observations infers that effort has been increasing overall, but the rate cannot be quantified. This conclusion is consistent with comments by representatives of the fishing industry.

Length Composition of Landings

Sampling of the Canadian commercial landings for white hake length composition has been inconsistent over time, area and gear sector (Table 8a). The 1993 to 1995 samples allow some comparison between gear types and areas. In order to characterize landings from the separate distributional areas identified from the RV survey (Figures 1 and 6) only the samples for which the unit area has been identified were selected for analysis (Table 8b). In the following comparisons samples have been combined without weighting by associated landings. The 1995 longline length composition for western 4W/eastern 4X "basins" is compared with that for the Gulf of Maine area in Figure 13. There are fewer large fish greater than 70cm being landed from the Scotian Shelf "basins". This reflects comments by fishers about the lack of large white hake in western 4W/eastern 4X, as well as the RV survey length frequencies from the two areas in recent years (Figure 6e). Differences between gear sectors can only be evaluated for the Gulf of Maine area due to the poor sampling coverage in other areas. The trawl and gillnet fisheries are landing a similar size range, predominantly fish between 60 to 80cm, whereas the longliners are landing a large proportion of fish between 45 and 75cm.

The trends in length frequencies over time for the "handline/longline" (we suspect these are mostly, if not entirely, longliners) fisheries in the Gulf of Maine area and the Scotian Shelf "basins" are shown in Figures 14a and 14b. For the Gulf of Maine area the size composition shows virtually no trend at all, whereas fish sampled in the vicinity of the Shelf "basins" are markedly smaller in the 1990's relative to any of the earlier years.

Research Vessel Survey Abundance Trends

Using the same strata that were grouped to describe length frequencies between the four areas in Figures 6a-e, the trends in catch per tow are shown in Figures 15a-c (note the differences in scale between the boxes). An intercalibration study (Fanning, 1985) to compare catchability of the three different vessels used over the time series suggests that no adjustment is required to standardize white hake catches across survey periods. Adult abundance levels (Figure 15a) in recent years have been at moderate levels relative to the long-term average along the slope of the Laurentian Channel and in the Gulf of Maine area. On the central Scotian Shelf (both in the basins and along the Slope) recent abundance estimates are below average, reflecting the recent trends in landings.

There are no obvious trends in recruitment (Figure 15b), except perhaps a slight increase over time within the Scotian Shelf "basins".

The number and weight per standard tow, as well as abundance and biomass estimates, for 4VW and 4X are shown in Figure 16 and Table 9a-b. The biomass estimates for 4VW have been at low levels since 1992. In contrast, 4X biomass has been increasing in 1995/96. A comparison of Figures 15 and 16 infers that the increase in 4X is in the Gulf of Maine area, not in eastern 4X. The trawlable biomass estimate for 4VW in 1996 is 6,312t and for 4X is 31,368t, assuming a catchability coefficient of 1.0.

The annual 1970 to 1996 survey length frequencies for 4VW and 4X are shown in Figures 17a-f. During recent years there are less large fish (i.e. greater than 60cm) in 4VW compared to the long-term average (bottom of Figure 17c). This is not the case for 4X, as we might expect given the smaller sizes evidenced by Commercial Sampling. The 1996 length span is similar to the long-term average (bottom of Figure 17f) There is some evidence that abundant year-classes are followed over time. The comparison between 4X and 4VW survey length frequencies for 5 year blocks during 1970 to 1974 and 1992 to 1996, are shown in Figures 18a and 18b. The 4X distributions are similar between time periods, whereas there is a steeper decline in larger fish and a shorter overall length span in 4VW during recent years compared to 1970/74. The annual survey length frequencies are also grouped (Figures 19a-d) by the separate areas identified in Figure 6. The lack of large fish in the central Shelf (Figure 19b) and Shelf edge (Figure 19c) is clearly illustrated. A similar change has not occurred with the Gulf of Maine area (Figure 19a) or along the Laurentian Channel (Figure 19d).

Estimates of Fishing Mortality

Total mortality (Z) has been estimated using the linearized catch curve based on length composition data. This method is described in detail in section 4.4.5 of Sparre et al (1989). Length data are converted into age data using the inverse von Bertalanffy growth equation. Given a set of length frequency data and the growth parameters k and $L\infty$ it is possible to derive an estimate of Z.

For the Gulf of Maine area the 1994 USA assessment (Sosebee, 1995) includes an estimate of growth rate of white hake by fitting the von Bertalanffy growth equation to the age data from the 1987-1989 spring and the 1987 autumn surveys, sexes combined. $L\infty$ was 125.8cm and k was 0.153. For the southern Gulf of St. Lawrence, Clay and Clay (1991) estimate the growth parameters as follows:

	$L\infty$	k
Research Vessel		
male	120.8	0.0842
female	454.4	0.0200
Commercial		
male	84.0	0.218
female	136.6	0.106

The parameters for the Gulf of Maine area are used in the Z calculations. The method is illustrated in Figure 20. Four situations are considered (Figures 21a-d).

RV Survey Gulf of Maine - 1970-1974
RV Survey Gulf of Maine - 1992-1996

RV Survey Scotian Shelf Basins - 1970-1974
RV Survey Scotian Shelf Basins - 1992-1996

Using the empirical relationship of Hoenig (1983) natural mortality for white hake is estimated at 0.19.

$$\ln Z = 1.46 - 1.01 \ln T_{max}$$

Age span (Tmax) is about 23 years.

The estimates of fishing mortality (F) are:

Gulf of Maine 1970-74 - 0.69
Gulf of Maine 1992-96 - 0.67
Scotian Shelf 1970-74 - 0.59
Scotian Shelf 1992-96 - 0.76

The comparable estimates for the Gulf of Maine from the most recent USA assessment (using the DeLury analysis) are 0.45 (1992) and 0.42 (1993).

In Figure 22 the yield, biomass and fecundity at different F levels are estimated. $F_{0.1}$ is 0.19. Both the DeLury and length based estimates of F suggest that present fishing effort is generating fishing mortality above F_{max}. Given the length/fecundity relationship for white hake at high F levels, a small fraction of the reproductive potential is maintained (less than 10% at the estimated levels). However, there is no evidence from the RV survey time series of a downward trend in recruitment.

References

Clay, D., and H. Clay. 1991. Determination of age and growth of white hake (*Urophycis tennuis* Mitchell) from the southern Gulf of St. Lawrence, Canada (including techniques for commercial sampling). Can. Tech. Rep. Fish. Aquat. Sci. 1828: 29p.

Clay, D., M.M. Ferguson, T. Hurlbut, and W. Stott. 1992. An allozyme survey of white hake (*Urophycis tenuis*) from the southern Gulf of St. Lawrence. Can. Tech. Rep. Fish. Aquat. Sci. 1907: 12p.

Fahay, M.P., and K.W. Able. 1989. White hake, *Urophycis tenuis*, in the Gulf of Maines: Spawning seasonality, habitat use, and growth in young of the year, and relationships to the Scotian Shelf population. Can. J. Zool. 67: 1715-1724.

Fanning, L.P. 1985. Intercalibration of research survey results obtained by different vessels. CAFSAC Res. Doc. 85/3:43p.

Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fish. Bull. 82(1):898-903.

Hurlbut,T., G. Nielsen, R. Morin, G. Chouinard, and R. Hebert. 1996 - The status of white hake (*Urophycis tenuis,* Mitchell) in the southern Gulf of St. Lawrence (NAFO division 4T) in 1995. DFO Atl. Fish. Res. Doc. 96/41:70p

Kohler, A.C. 1971. Tagging of white hake, *Urophycis tenuis* Mitchell, in the southern Gulf of St. Lawrence. ICNAF Res. Bull. 8: 21-25.

Markle, D.F., D.A. Methven, and L.J. Coates-Markle. 1982. Aspects of spatial and temporal co-occurrence on the life history stages of the sibling hakes, *Urophycis chuss* (Walbaum 1792) and *Urophycis tenuis* (Mitchell 1815) (Pisces: Gadidae). can. J. Zool. 60: 2057-2078.

Scott, W. B., and M. G. Scott. 1988. Atlantic fishes of Canada. Can. Bull. Fish. Aquat. Sci. 219:731p.

Simon, J. E., and P. A. Comeau. 1994. Summer distribution and abundance trends of species caught on the Scotian Shelf from 1970-92, by the Research Vessel Groundfish Survey. Can. Tech. Rep. Fish. Aquat. Sci. 1953:145p.

Sosebee, K. 1995. White hake, pp. 90-91. In: Status of the Fishery Resources off the Northeastern United States for 1994. NOAA Tech. Memo. NMFS-NE-108.

Sparre, P., E. Ursin, and S.C. Venema. 1989. Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fish. Tech. Paper no. 306.1:337p.

Table 1. White Hake Landings (metric tons) as reported to NAFO. Includes foreign landings through 1992. Landings for 1993-95 are Canadian only. NAFO area 5Zc (c=Canada) has only existed since 1986.

AREA YEAR	4VN	4VS	4W	4X	5Zc
66	348	22	433	827	
67	127	254	241	507	
68	138	50	325	965	
69	137	65	544	1710	
70	189	83	741	2063	
71	433	124	1458	3003	
72	199	271	1298	4084	
73	273	146	1450	3843	
74	223	142	1331	4013	
75	181	138	1338	2910	
76	261	116	757	2214	
77	288	152	848	2052	
78	202	257	773	2534	
79	338	182	367	2160	
80	585	369	342	2603	
81	564	222	413	2364	
82	414	204	609	3575	
83	401	315	630	2595	
84	239	301	690	3419	
85	346	542	1109	3109	
86	397	538	1412	4833	648
87	587	751	1609	5278	555
88	333	379	789	4008	534
89	293	476	946	3425	583
90	191	311	1239	3735	547
91	172	301	1044	2860	563
92	158	304	810	3455	1138
93	136	281	768	3633	1681
94	224	213	598	3235	955
95	32	286	570	4199	481

Table 2a. Canadian landings (metric tons) of white hake by unit area for 1992 through the first half of 1996.

	92	93	94	95	96	Table Total
4VB	11	1	3	2	0	17
4VC	271	261	143	182	59	915
4VE	0	4	.	7	0	11
4VN	158	136	224	32	5	556
4VU	15	15	67	96	5	198
4WD	8	9	4	2	1	24
4WE	18	31	22	5	0	75
4WF	13	28	2	10	0	53
4WG	15	8	11	52	4	90
4WH	3	37	20	25	1	86
4WJ	73	48	38	38	7	204
4WK	570	410	380	66	3	1429
4WL	61	127	46	202	54	489
4WM	0	4	0	13	0	18
4WU	70	66	75	158	17	387
4XL	.	3	.	.	.	3
4XM	359	243	189	71	29	892
4XN	102	404	77	714	248	1544
4XO	484	418	484	142	92	1619
4XP	344	973	520	1719	577	4133
4XQ	669	882	426	965	204	3147
4XR	309	212	251	147	79	999
4XS	127	63	96	35	7	328
4XU	922	363	1094	358	127	2864
5YB	125	73	98	47	4	348
5YC	0	.	.	.	0	0
5YF	1	.	.	.	1	2
5YU	.	.	0	.	.	0
5ZH	.	.	0	0	2	2
5ZJ	1003	1448	455	388	18	3312
5ZM	57	125	13	85	0	280
5ZU	76	109	487	8	32	712
Total	5863	6500	5224	5569	1578	24734

Table 2b. Canadian landings (metric tons) of white hake in 1992 by unit area and gear sector.

	TRAWL	SEINE	LONGLINE	HANDLINE	GILLNET ET AL	Table Total
4VB	10	0	1	.	0	11
4VC	7	0	263	0	0	271
4VE	0	.	0	.	.	0
4VN	27	86	42	3	0	158
4VU	0	.	15	0	0	15
4WD	0	0	8	0	0	8
4WE	0	0	17	.	0	18
4WF	0	0	12	.	0	13
4WG	1	0	14	.	0	15
4WH	1	0	2	0	0	3
4WJ	0	0	72	0	1	73
4WK	2	0	498	4	65	570
4WL	2	0	54	0	5	61
4WM	0	.	0	.	0	0
4WU	21	0	46	0	2	70
4XL	.	.	0	.	.	0
4XM	2	2	133	8	215	359
4XN	15	0	62	0	25	102
4XO	16	0	384	18	66	484
4XP	126	0	192	0	26	344
4XQ	404	0	225	4	36	669
4XR	158	0	113	38	0	309
4XS	74	0	0	0	52	127
4XU	6	0	749	0	167	922
5YB	53	.	4	0	68	125
5YC	0	.	.	.	.	0
5YD	.	.	.	.	.	.
5YF	1	.	.	.	.	1
5YU	0	.	.	.	0	0
5ZH	.	.	.	.	.	.
5ZJ	26	.	917	2	58	1003
5ZM	1	.	56	.	1	57
5ZN	.	.	.	.	.	.
5ZU	0	.	76	0	0	76
Total	955	89	3955	77	787	5863

Table 2c. Canadian landings (metric tons) of white hake in 1993 by unit area and gear sector.

	TRAWL	SEINE	LONGLINE	HANDLINE	GILLNET ET AL	Table Total
4VB	0	0	0	0	.	1
4VC	6	0	255	0	0	261
4VE	0	.	4	.	.	4
4VN	72	23	41	0	0	136
4VU	0	.	15	0	0	15
4WD	0	0	9	0	0	9
4WE	0	0	26	.	5	31
4WF	0	0	28	.	0	28
4WG	0	.	8	.	0	8
4WH	0	0	37	0	0	37
4WJ	0	0	48	.	0	48
4WK	0	0	362	0	47	410
4WL	0	.	119	.	7	127
4WM	.	0	4	.	.	4
4WU	4	0	62	0	0	66
4XL	0	.	0	.	3	3
4XM	1	1	157	1	84	243
4XN	7	0	346	1	49	404
4XO	15	0	242	14	147	418
4XP	189	0	486	1	298	973
4XQ	309	0	219	17	337	882
4XR	86	.	101	10	15	212
4XS	40	0	0	0	23	63
4XU	3	0	292	0	68	363
5YB	49	.	0	0	24	73
5YC	.	.	.	.	.	.
5YD	.	.	.	.	.	.
5YF	.	.	.	.	.	.
5YU	.	.	.	.	.	.
5ZH	.	.	.	.	.	.
5ZJ	25	.	1379	0	44	1448
5ZM	1	.	117	.	7	125
5ZN	.	.	.	.	.	.
5ZU	0	.	107	0	1	109
Total	807	24	4465	45	1158	6500

Table 2d. Canadian landings (metric tons) of white hake in 1994 by unit area and gear sector.

	TRAWL	SEINE	LONGLINE	HANDLINE	GILLNET ET AL	Table Total
4VB	3	0	1	.	0	3
4VC	26	0	115	.	2	143
4VE	.	.	0	.	.	0
4VN	150	6	61	7	0	224
4VU	0	0	67	0	.	67
4WD	0	0	4	0	0	4
4WE	0	0	5	0	17	22
4WF	0	0	2	.	0	2
4WG	1	0	10	.	0	11
4WH	0	0	20	.	0	20
4WJ	1	.	36	.	0	38
4WK	0	0	353	0	27	380
4WL	0	.	45	.	0	46
4WM	0	.	0	.	0	0
4WU	0	0	75	0	0	75
4XL	.	.	0	.	.	0
4XM	0	0	110	3	76	189
4XN	9	0	57	0	11	77
4XO	10	0	321	3	150	484
4XP	295	0	108	8	110	520
4XQ	303	0	29	4	90	426
4XR	70	0	28	7	148	251
4XS	47	0	0	0	48	96
4XU	2	0	679	0	412	1094
5YB	33	.	0	0	64	98
5YC	.	.	.	.	.	.
5YD	.	.	.	.	.	.
5YF	.	.	.	.	.	.
5YU	.	.	.	.	0	0
5ZH	0	.	.	.	.	0
5ZJ	26	.	405	2	22	455
5ZM	1	.	11	0	1	13
5ZN	0	.	.	.	0	0
5ZU	0	0	458	0	29	487
Total	978	6	3001	34	1206	5224

Table 2e. Canadian landings (metric tons) of white hake in 1995 by unit area and gear sector.

	TRAWL	SEINE	LONGLINE	HANDLINE	GILLNET ET AL	Table Total
4VB	2	0	0	.	0	2
4VC	37	0	144	0	0	182
4VE	.	.	7	.	0	7
4VN	13	5	15	0	0	32
4VU	0	.	74	0	22	96
4WD	0	0	2	0	0	2
4WE	0	.	5	0	0	5
4WF	0	.	10	.	0	10
4WG	1	.	51	.	0	52
4WH	11	.	13	0	0	25
4WJ	4	.	33	.	0	38
4WK	0	0	62	0	4	66
4WL	15	.	183	1	3	202
4WM	0	0	13	0	0	13
4WU	.	0	114	1	43	158
4XL	.	.	0	.	0	0
4XM	4	0	52	1	14	71
4XN	5	0	691	0	18	714
4XO	8	0	97	0	37	142
4XP	119	0	1255	2	344	1719
4XQ	100	0	440	0	425	965
4XR	53	0	4	0	90	147
4XS	12	0	5	0	18	35
4XU	0	0	127	1	231	358
5YB	7	0	0	0	41	47
5YC	.	.	.	.	.	.
5YD	.	.	.	.	.	.
5YF	.	.	.	.	.	.
5YU	.	.	.	0	.	0
5ZH	.	.	0	.	0	0
5ZJ	19	.	338	0	31	388
5ZM	0	.	81	.	4	85
5ZN	.	.	.	.	.	.
5ZU	0	.	7	0	1	8
Total	410	5	3824	5	1325	5569

Table 2f. Canadian landings (metric tons) of white hake in first half of 1996 by unit area and gear sector.

	TRAWL	SEINE	LONGLINE	HANDLINE	GILLNET ET AL	Table Total
4VB	0	0	0	.	0	0
4VC	13	0	45	0	0	59
4VE	.	.	0	.	.	0
4VN	3	1	1	.	0	5
4VU	0	0	3	.	2	5
4WD	0	0	0	0	1	1
4WE	0	0	0	.	0	0
4WF	0	.	0	0	0	0
4WG	1	0	3	.	0	4
4WH	0	0	1	0	1	1
4WJ	0	.	7	.	0	7
4WK	1	0	2	0	1	3
4WL	1	0	50	0	3	54
4WM	0	0	0	.	0	0
4WU	0	0	16	0	2	17
4XL	.	.	0	.	.	0
4XM	1	0	16	0	12	29
4XN	6	0	232	0	11	248
4XO	6	0	53	0	32	92
4XP	64	0	205	0	308	577
4XQ	70	0	12	0	122	204
4XR	7	0	0	0	72	79
4XS	2	0	3	0	2	7
4XU	0	0	60	0	67	127
5YB	1	.	0	0	3	4
5YC	0	.	.	.	.	0
5YD	0	.	.	.	.	0
5YF	1	.	.	.	0	1
5YU	.	.	.	.	.	.
5ZH	.	.	2	.	.	2
5ZJ	3	0	7	0	8	18
5ZM	0	.	0	.	0	0
5ZN	.	.	.	.	.	.
5ZU	8	.	22	0	2	32
Total	187	1	740	1	648	1578

Table 3. Canadian landings (metric tons) of white hake by NAFO divisions and gear sectors for 1989 through first half of 1996.

AREA	4VN	4VS (+4VU)	4W	4X/5Y	5Zc	TOTAL	
1989							
TRAWL	31	16	25	321	12	405	7.1 %
SEINE	165	1	2	2	.	170	3.0 %
LONGLINE	90	405	791	2069	524	3878	68.4 %
HANDLINE	4	8	10	83	0	105	1.9 %
GILLNET ET AL	1	45	110	907	47	1110	19.6 %
TOTAL	291	475	937	3383	582	5669	100.0 %
1990							
TRAWL	23	19	26	781	45	893	15.2 %
SEINE	86	0	3	2	.	91	1.6 %
LONGLINE	76	290	1039	2059	487	3951	67.3 %
HANDLINE	3	2	21	152	.	177	3.0 %
GILLNET ET AL	2	0	148	598	14	762	13.0 %
TOTAL	190	310	1236	3592	546	5874	100.0 %
1991							
TRAWL	41	18	52	482	29	622	12.6 %
SEINE	68	0	0	3	0	71	1.4 %
LONGLINE	57	275	944	1703	508	3487	70.7 %
HANDLINE	1	0	2	49	.	52	1.1 %
GILLNET ET AL	2	.	78	604	13	698	14.2 %
TOTAL	170	293	1076	2841	550	4931	100.0 %
1992							
TRAWL	27	18	29	856	26	956	16.3 %
SEINE	86	0	0	2	.	89	1.5 %
LONGLINE	42	283	723	1861	1049	3959	67.5 %
HANDLINE	3	.	4	68	2	77	1.3 %
GILLNET ET AL	0	.	73	655	59	787	13.4 %
TOTAL	158	301	829	3442	1137	5868	100.0 %
1993							
TRAWL	72	7	5	698	26	807	12.4 %
SEINE	23	0	0	1	.	24	0.4 %
LONGLINE	41	274	704	1842	1603	4465	68.7 %
HANDLINE	0	.	0	45	.	45	0.7 %
GILLNET ET AL	.	.	59	1048	52	1158	17.8 %
TOTAL	136	281	768	3633	1681	6500	100.0 %
1994							
TRAWL	150	29	3	770	27	978	18.7 %
SEINE	6	0	.	0	.	6	0.1 %
LONGLINE	61	183	551	1331	874	3001	57.4 %
HANDLINE	7	.	.	25	3	34	0.7 %
GILLNET ET AL	.	2	44	1109	52	1206	23.1 %
TOTAL	224	213	598	3235	955	5224	100.0 %
1995							
TRAWL	13	39	32	307	19	410	7.4 %
SEINE	5	.	0	0	.	5	0.1 %
LONGLINE	15	225	486	2672	426	3824	68.7 %
HANDLINE	0	0	2	4	.	5	0.1 %
GILLNET ET AL	.	22	51	1216	36	1325	23.8 %
TOTAL	32	286	570	4199	481	5569	100.0 %
1996							
TRAWL	3	14	2	158	11	187	11.9 %
SEINE	1	.	0	0	.	1	0.1 %
LONGLINE	1	48	79	583	31	740	46.9 %
HANDLINE	.	0	1	0	0	1	0.1 %
GILLNET ET AL	.	2	6	628	11	648	41.0 %
TOTAL	5	64	88	1369	52	1578	100.0 %

Table 4. Canadian landings (metric tons) of white hake by NAFO division and month for 1989 through first half of 1996.

MONTH \ AREA	4VN	4VS (+4VU)	4W	4X/5Y	5Zc	TOTAL
1989						
1	0	1	6	27	6	40
2	.	33	0	9	0	42
3	0	78	9	24	0	112
4	0	109	12	18	1	139
5	47	59	10	103	17	236
6	121	55	62	538	176	952
7	11	50	294	615	213	1184
8	23	22	328	900	100	1373
9	23	14	141	779	58	1015
10	39	12	48	231	12	342
11	26	37	11	126	0	200
12	1	5	15	13	.	33
TOTAL	291	475	937	3383	582	5669
1990						
1	0	52	4	45	1	102
2	0	40	2	25	0	66
3	0	5	6	42	0	53
4	12	63	44	21	.	139
5	33	48	26	116	4	226
6	39	30	63	432	171	735
7	21	35	366	735	127	1284
8	15	21	412	987	140	1575
9	22	3	259	844	74	1202
10	11	8	34	187	26	265
11	35	1	14	117	4	171
12	1	5	6	42	0	55
TOTAL	190	310	1236	3592	546	5874
1991						
1	15	6	18	10	0	49
2	0	4	2	35	0	41
3	13	9	1	28	0	51
4	7	25	7	38	1	77
5	19	86	84	92	9	291
6	57	63	68	367	162	717
7	10	77	339	527	162	1116
8	7	9	291	720	79	1105
9	20	5	120	653	77	874
10	12	3	117	252	43	427
11	9	4	27	85	18	144
12	1	1	1	34	0	39
TOTAL	170	293	1076	2841	550	4931
1992						
1	1	9	17	31	0	58
2	0	4	3	25	0	32
3	0	12	13	79	1	105
4	1	31	11	78	1	123
5	35	129	71	245	9	490
6	51	49	38	426	336	900
7	26	40	219	570	321	1175
8	9	1	259	730	262	1260
9	10	4	150	666	80	909
10	9	2	36	326	83	456
11	15	5	6	201	44	272
12	0	15	7	65	1	88
TOTAL	158	301	829	3442	1137	5868

[CONTINUED

Table 4 (continued).

MONTH / AREA	4VN	4VS (+4VU)	4W	4X/5Y	5Zc	TOTAL
1993						
1	0	11	7	13	1	31
2	0	12	2	21	0	35
3	0	7	15	90	0	112
4	2	67	38	150	1	259
5	42	80	109	658	145	1032
6	56	39	79	767	638	1579
7	20	34	131	442	303	930
8	5	19	206	645	129	1004
9	5	8	129	501	44	686
10	3	3	47	250	99	402
11	2	.	5	84	256	347
12	0	3	0	13	66	82
TOTAL	136	281	768	3633	1681	6500
1994						
1	.	2	0	22	0	25
2	0	21	18	43	0	82
3	34	6	23	16	0	79
4	79	7	32	260	0	379
5	15	30	31	464	3	543
6	48	45	21	380	468	962
7	26	54	105	560	273	1018
8	8	23	170	452	143	796
9	11	12	135	419	48	626
10	1	8	54	375	6	444
11	1	0	9	141	9	161
12	.	5	1	102	3	111
TOTAL	224	213	598	3235	955	5224
1995						
1	.	25	13	19	0	57
2	.	16	1	23	0	40
3	.	7	29	34	.	70
4	.	28	59	465	.	552
5	6	20	28	287	.	341
6	2	19	62	651	171	905
7	13	57	94	524	155	843
8	6	67	91	336	62	562
9	3	29	103	863	35	1033
10	3	10	62	587	15	676
11	1	6	28	272	35	342
12	.	1	1	137	9	148
TOTAL	32	286	570	4199	481	5569
1996						
1	.	8	0	18	0	26
2	.	7	1	29	.	38
3	.	2	9	24	.	35
4	.	5	3	42	.	50
5	1	21	23	913	2	961
6	1	14	37	72	8	132
7	3	7	14	270	42	337
TOTAL	5	64	88	1369	52	1578

Table 5. Canadian landings (metric tons) of white hake by fishery as reported to NAFO (1966-92) and Statistics Branch (1993 through first half of 1996).

YEAR	DIRECTED	BYCATCH	UNSPECIF	Table Total	Percent Directed
66	.	124	1493	1617	
67	.	143	773	916	
68	.	1111	435	1546	
69	.	1711	701	2412	
70	.	887	2084	2971	
71	618	1296	3090	5004	
72	.	1146	4276	5422	
73	.	852	4927	5779	
74	652	1112	4127	5891	
75	.	848	3829	4677	
76	.	1130	2404	3534	
77	100	874	2437	3411	
78	521	810	2540	3871	
79	368	880	2036	3284	
80	611	897	2646	4154	
81	527	2484	821	3832	
82	866	1873	2616	5355	
83	737	1957	1806	4500	
84	1395	2500	1484	5379	
85	1536	2112	2329	5977	
86	3078	2194	2650	7922	
87	2585	2109	3986	8680	
88	2891	2884	240	6015	48.1%
89	2824	2624	226	5674	49.8%
90	3314	2419	148	5881	56.4%
91	2483	2140	293	4916	50.5%
92	3273	2098	487	5858	55.9%
93	4500	1751	249	6500	69.2%
94	2980	2020	225	5224	57.0%
95	3836	1539	194	5569	68.9%
96	1195	349	33	1578	75.7%

Note that for the 1993-96 landings, we use UNSPECIF to contain any landings not declared as directed but for which white hake was the predominant species caught. Much of this will be reported as directed fishing to NAFO.

Table 6. Commercial value of white hake in the directed fishery.

	METRIC TONS	$ VALUE	PRICE/KG
1989	3335	1893380	$0.568
1990	3434	2125649	$0.619
1991	2715	1950295	$0.718
1992	3449	2885636	$0.837
1993	4749	3575519	$0.753
1994	3205	2570356	$0.802
1995	4030	3931103	$0.976

Table 7. Catch per unit effort and monitoring statistics for longline, trawl, and gillnet components of the fishery by year and NAFO division.

		LONGLINE					TRAWL					GILLNET				
		Total Catch	Catch with effort	% Catch with effort	Effort	CPUE	Total Catch	Catch with effort	% Catch with effort	Effort	CPUE	Total Catch	Catch with effort	% Catch with effort	Effort	CPUE
4VS																
	1989	405	173	43	90	1.922										
	1990	290	123	42	66	1.864										
	1991	275	169	61	114	1.483										
	1992	283	179	63	109	1.642										
	1993	274	160	58	141	1.135										
	1994	183	15	8	28	.536										
	1995	225	123	55	131	.939										
4W																
	1989	791	53	7	42	1.262										
	1990	1039	93	9	68	1.368										
	1991	944	130	14	106	1.226										
	1992	723	107	15	114	.939										
	1993	704	160	23	148	1.081										
	1994	551	32	6	62	.516										
	1995	486	316	65	334	.946										
4X/5Y																
	1989	2069	63	3	54	1.167	321	76	24	34	2.235	907	149	16	53	2.811
	1990	2059	138	7	583	.237	781	284	36	189	1.503	585	51	9	29	1.759
	1991	1703	67	4	65	1.031	482	106	22	111	.955	599	24	4	57	.421
	1992	1861	114	6	88	1.296	855	471	55	369	1.276	654	59	9	71	.831
	1993	1842	531	29	328	1.619	699	337	48	259	1.301	1046	434	41	245	1.771
	1994	1331	0	0			769	291	38	231	1.260	1105	0	0		
	1995	2672	2228	83	1316	1.693	159	38	24	54	.704	1215	559	46	501	1.116
5Zc																
	1989	524	93	18	52	1.789										
	1990	487	96	20	50	1.920										
	1991	508	73	14	56	1.304										
	1992	1049	280	27	113	2.478										
	1993	1603	730	46	372	1.962										
	1994	874	22	3	7	3.143										
	1995	426	268	63	199	1.347										

Catch = Weight of white hake landed, in metric tons, for which effort data has been processed.
Effort = Number of days fished, directing for white hake (white hake the main species caught).
CPUE = Catch per unit effort.

Table 8a. National Sampling Program inventory of numbers of white hake measured in 4VWX/5Z by NAFO division, year, and gear sector.

	4VN	4VS	4W	4X	5ZJ	MIX	Group Total
SIDE TRAWL							
65	.	.	.	561	.	.	561
66	.	.	.	.	.	729	729
67	.	.	.	.	.	476	476
75	.	.	.	.	.	200	200
Group Total	.	.	.	561	.	1405	1966
SEINE							
77	564	.	.	.	.	.	564
95	44	.	.	.	.	.	44
Group Total	608	.	.	.	.	.	608
LONGLINE							
88	.	.	.	265	.	.	265
89	.	.	.	173	.	.	173
93	.	268	.	833	367	.	1468
94	.	353	268	1307	288	.	2216
95	.	.	1418	3433	240	215	5306
96	.	.	9	1061	.	.	1070
Group Total	.	621	1695	7072	895	215	10498
GILLNET							
85	.	.	.	55	.	.	55
86	.	.	218	.	.	.	218
87	.	.	.	44	.	.	44
88	.	.	.	68	.	.	68
95	.	.	.	927	188	.	1115
96	.	.	.	722	.	.	722
Group Total	.	.	218	1816	188	.	2222
TRAWL							
77	.	.	.	.	.	204	204
87	.	.	141	.	.	.	141
93	.	.	.	369	.	.	369
94	.	.	.	250	.	.	250
95	353	566	.	247	.	.	1166
96	666	.	.	266	.	.	932
Group Total	1019	566	141	1132	.	204	3062
H/L LINE							
49	.	.	.	200	.	.	200
50	.	.	.	200	.	.	200
72	.	.	.	166	.	.	166
73	.	.	107	.	.	.	107
74	.	.	.	275	.	.	275
76	.	.	.	233	.	.	233
77	.	.	.	169	.	.	169
78	.	.	.	317	.	.	317
82	.	.	122	.	.	.	122
83	.	.	.	.	.	255	255
85	.	.	.	377	135	.	512
87	.	.	.	16	.	.	16
88	.	.	.	265	.	.	265
89	.	.	.	173	.	.	173
Group Total	.	.	229	2391	135	255	3010

Table 8b. National Sampling Program inventory of white hake for 4WX & 5Z. The number of samples are recorded on the left of each column, the number of white hake measured on the right.

	FUNDY-GEORGES				SHELF BASINS					Table Total
	4XP	4XQ	4XR	5ZJ	4WK	4WL	4XM	4XN	4XO	
SIDE TRAWL										
65	.	.	.	.	.	.	.	1 561	.	1 561
LONGLINE										
88	1 265	.	.	.	.	.	.	.	.	1 265
89	.	.	.	.	.	.	.	1 173	.	1 173
93	1 287	.	.	1 367	.	.	.	2 546	.	4 1200
94	.	2 565	.	1 288	.	1 268	.	2 551	1 191	7 1863
95	5 1469	2 518	.	1 240	.	2 471	2 462	4 984	.	16 4144
96	.	.	.	.	1 9	.	1 219	3 614	.	5 842
GILLNET										
85	.	.	.	.	.	.	1 55	.	.	1 55
87	.	.	.	.	.	.	2 44	.	.	2 44
88	.	.	.	.	.	.	1 68	.	.	1 68
95	3 715	.	1 212	1 188	.	.	.	.	.	5 1115
96	3 722	.	.	.	.	.	.	.	.	3 722
TRAWL										
93	2 369	.	.	.	.	.	.	.	.	2 369
94	.	1 250	.	.	.	.	.	.	.	1 250
95	.	.	.	.	.	.	.	1 16	.	1 16
96	.	1 266	.	.	.	.	.	.	.	1 266
H/L LINE										
49	.	.	1 200	.	.	.	.	.	.	1 200
50	.	.	1 200	.	.	.	.	.	.	1 200
72	.	.	1 166	.	.	.	.	.	.	1 166
73	.	.	.	.	.	1 107	.	.	.	1 107
74	.	.	.	.	.	.	.	1 275	.	1 275
76	.	.	.	.	.	.	.	1 233	.	1 233
77	.	.	.	.	.	.	.	.	1 169	1 169
78	.	.	.	.	.	.	.	1 317	.	1 317
82	.	.	.	.	1 122	.	.	.	.	1 122
85	.	.	.	1 135	.	.	.	.	1 203	2 338
87	.	.	.	.	.	.	1 16	.	.	1 16
88	1 265	.	.	.	.	.	.	.	.	1 265
89	.	.	.	.	.	.	.	1 173	.	1 173
Number Samples	16	6	4	5	2	4	8	18	3	66
Number Fish	4092	1599	778	1218	131	846	864	4443	563	14534

Table 9a. Abundance and biomass estimates for white hake as derived from the summer Research Vessel surveys in NAFO divisions 4V & 4W from 1970 to 19 assuming a constant catchability of 1.0

YEAR	NUMBER PER TOW	WEIGHT PER TOW (KG)	ABUNDANCE ESTIMATE	BIOMASS ESTIMATE (MT)
1970	3.03	4.61	8075826	12289
1971	1.88	1.61	5010510	4281
1972	2.15	2.73	5744619	7285
1973	2.95	3.41	7870192	9099
1974	6.22	5.65	16587743	15061
1975	2.14	2.20	5718201	5856
1976	4.06	3.39	10824643	9043
1977	4.12	5.04	10996882	13441
1978	3.47	3.65	9257628	9727
1979	1.61	2.11	4294965	5638
1980	2.35	2.52	6277425	6708
1981	8.30	7.22	22147946	19258
1982	8.75	6.22	23328004	16602
1983	13.10	6.69	34939280	17848
1984	10.24	10.63	27299962	28355
1985	16.56	13.76	44169040	36690
1986	12.52	12.14	33399188	32375
1987	4.64	4.69	12381201	12511
1988	7.68	5.49	20482414	14655
1989	8.87	4.94	23666340	13176
1990	4.16	3.54	11089183	9441
1991	3.86	3.33	10301716	8881
1992	4.89	2.47	13036943	6594
1993	4.70	2.75	12546390	7332
1994	3.68	1.95	9803189	5210
1995	5.82	2.46	15514824	6549
1996	5.31	2.37	14169892	6312

Table 9b. Abundance and biomass estimates for white hake as derived from the summer Research Vessel surveys in NAFO division 4X from 1970 to 1996, assuming a constant catchability of 1.0

YEAR	NUMBER PER TOW	WEIGHT PER TOW (KG)	ABUNDANCE ESTIMATE	BIOMASS ESTIMATE (MT)
1970	22.60	28.87	35572420	45400
1971	3.70	4.03	5817671	6339
1972	4.70	6.73	7395671	10583
1973	14.41	16.37	22662956	25733
1974	8.27	8.16	13003354	12835
1975	22.99	22.17	36157096	34865
1976	5.61	7.26	8819116	11414
1977	6.59	10.51	10368477	16529
1978	6.37	10.83	10011212	17032
1979	4.90	7.58	7711134	11920
1980	2.11	5.30	3312784	8338
1981	5.26	9.23	8277487	14514
1982	6.88	9.31	10825259	14636
1983	25.51	32.50	40109124	51107
1984	10.89	15.93	16981754	24826
1985	9.40	14.10	14787661	22167
1986	23.90	23.21	37578840	36500
1987	13.05	18.98	20526232	29847
1988	7.94	12.01	12491008	18887
1989	8.35	10.48	13122897	16483
1990	14.13	19.38	22216746	30472
1991	19.43	21.92	30546510	34473
1992	31.35	27.90	49298580	43866
1993	10.10	10.28	15886217	16161
1994	8.89	6.90	13978029	10861
1995	12.37	13.48	19454566	21192
1996	16.21	19.95	25495046	31368

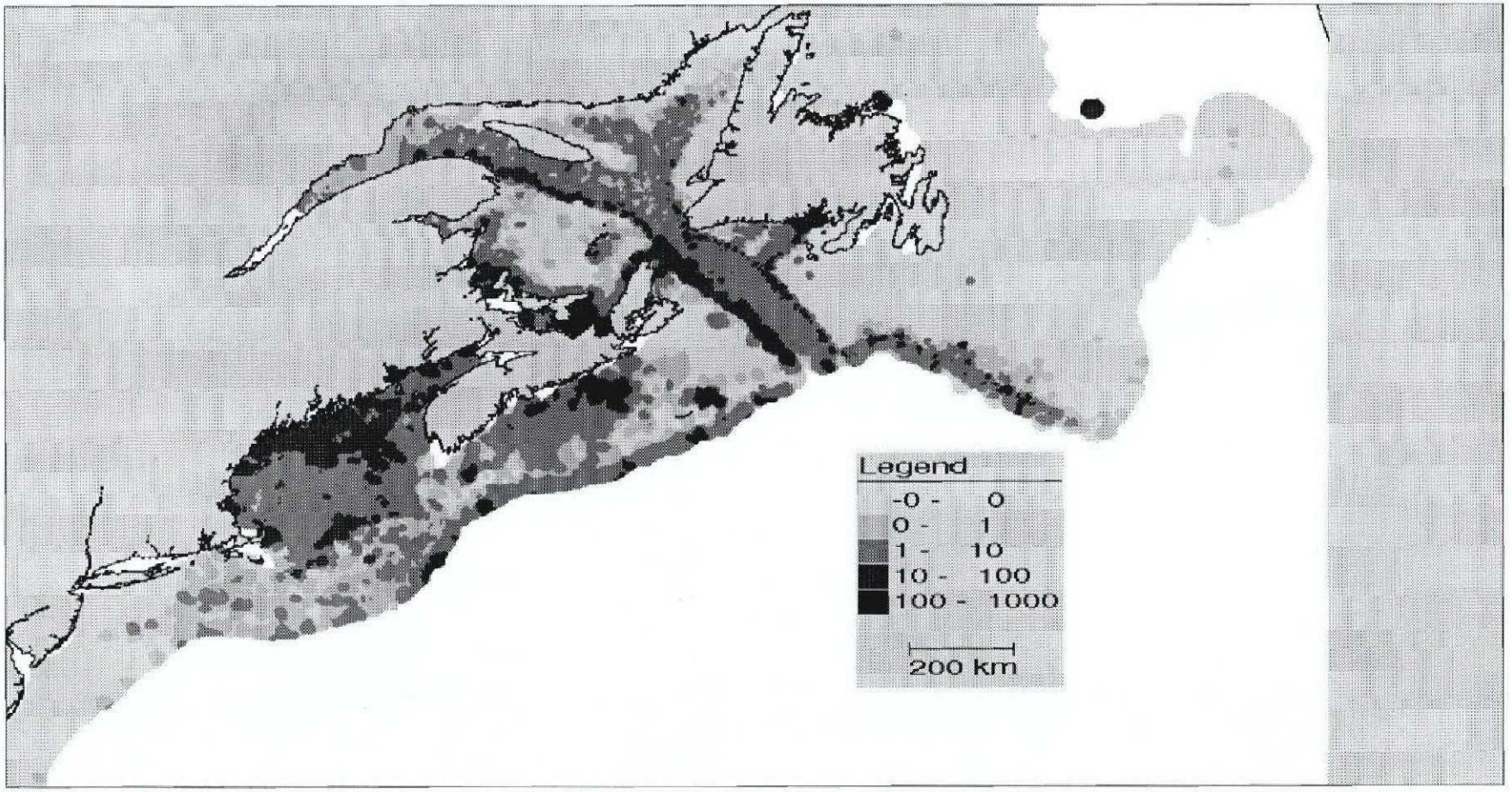


Figure 1a. Composite distribution of white hake as determined by Research Vessel surveys from 1975 to 1994. Some of the fish may be misidentified red hake, especially in earlier years.

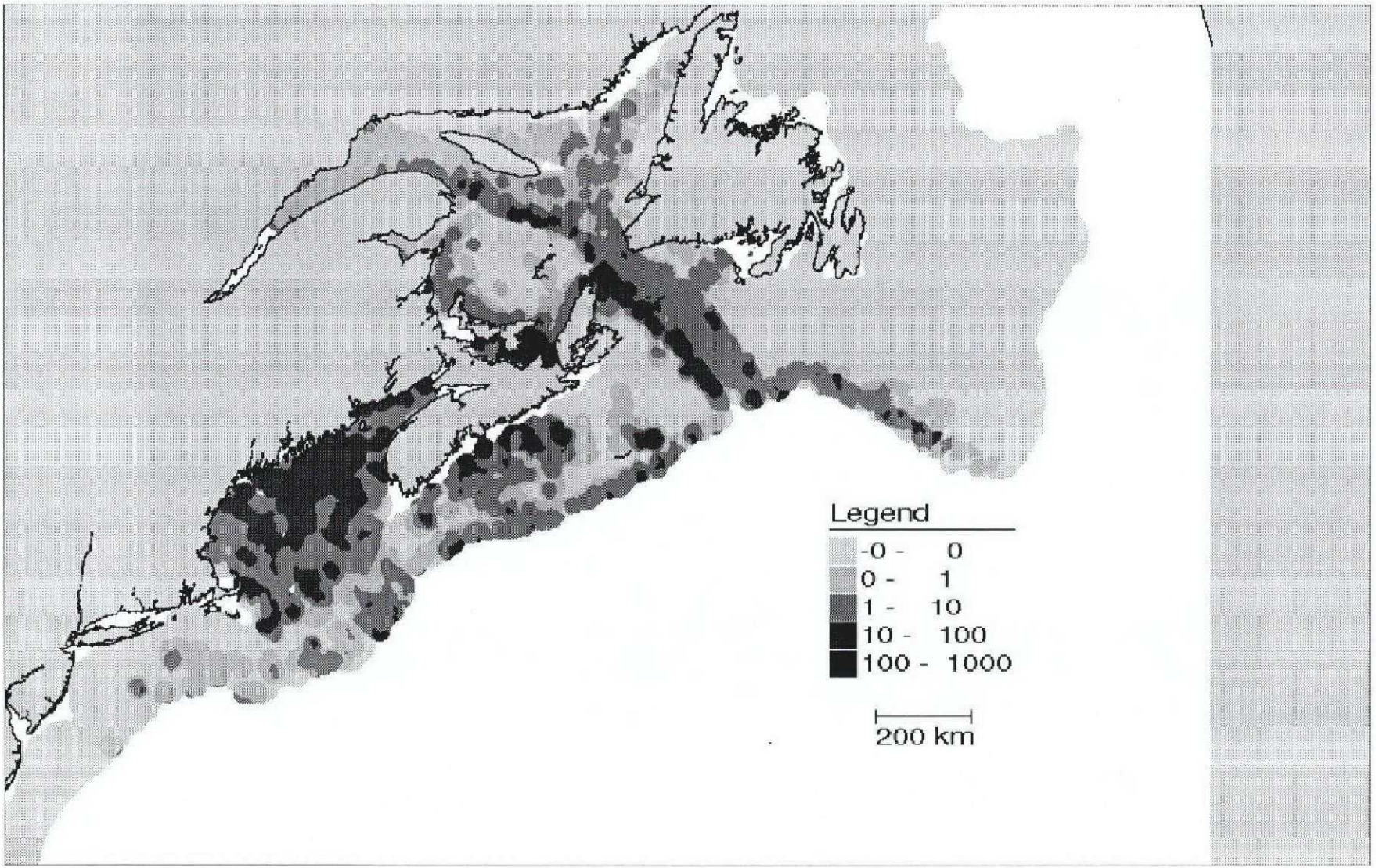


Figure 1b. Composite distribution of white hake as determined by Research Vessel surveys from 1990 to 1994. Some of the fish may be misidentified red hake, especially in earlier years.

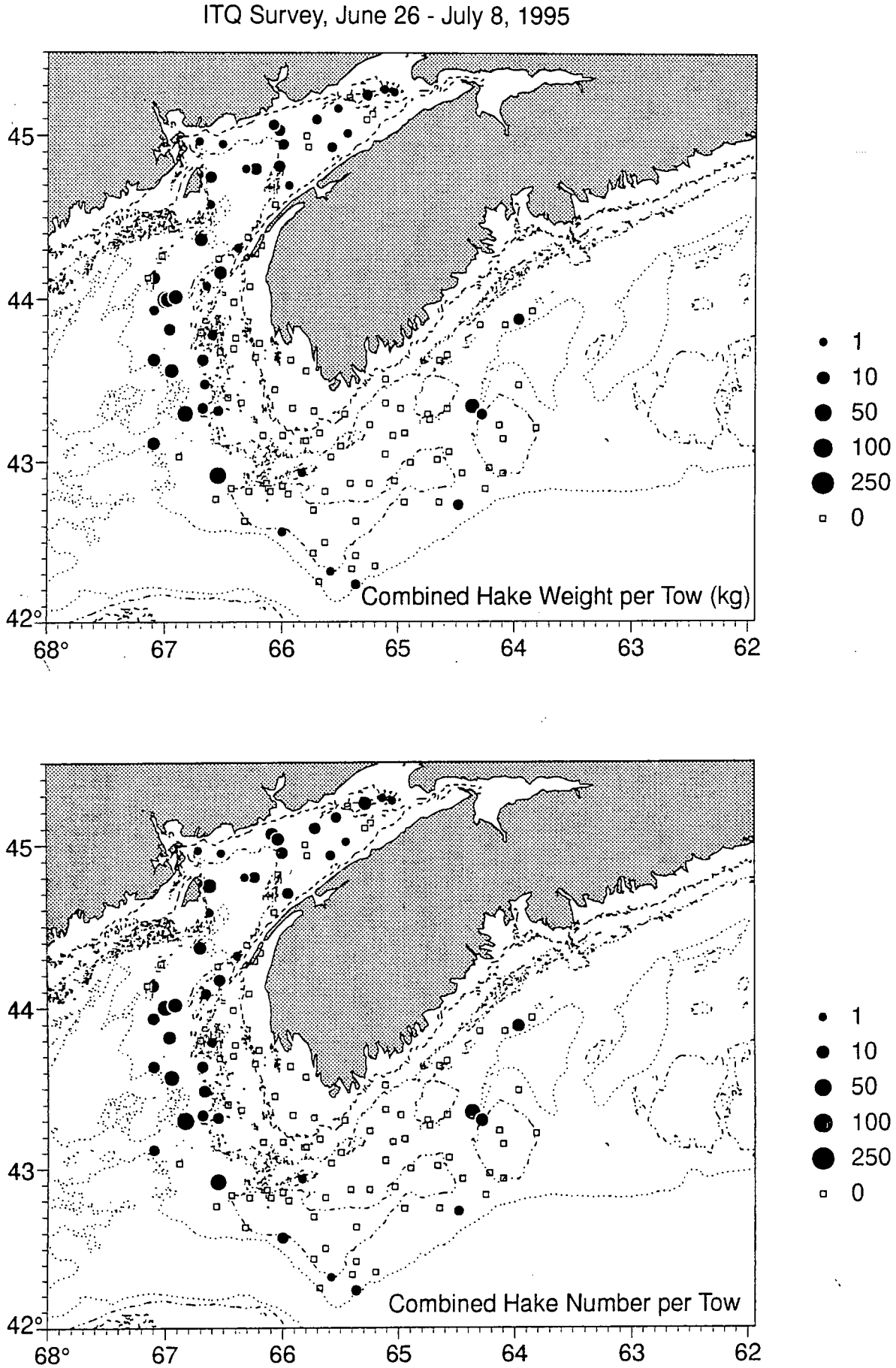


Figure 2a. Weights and numbers of white/red hake caught per tow during the 1995 ITQ survey.

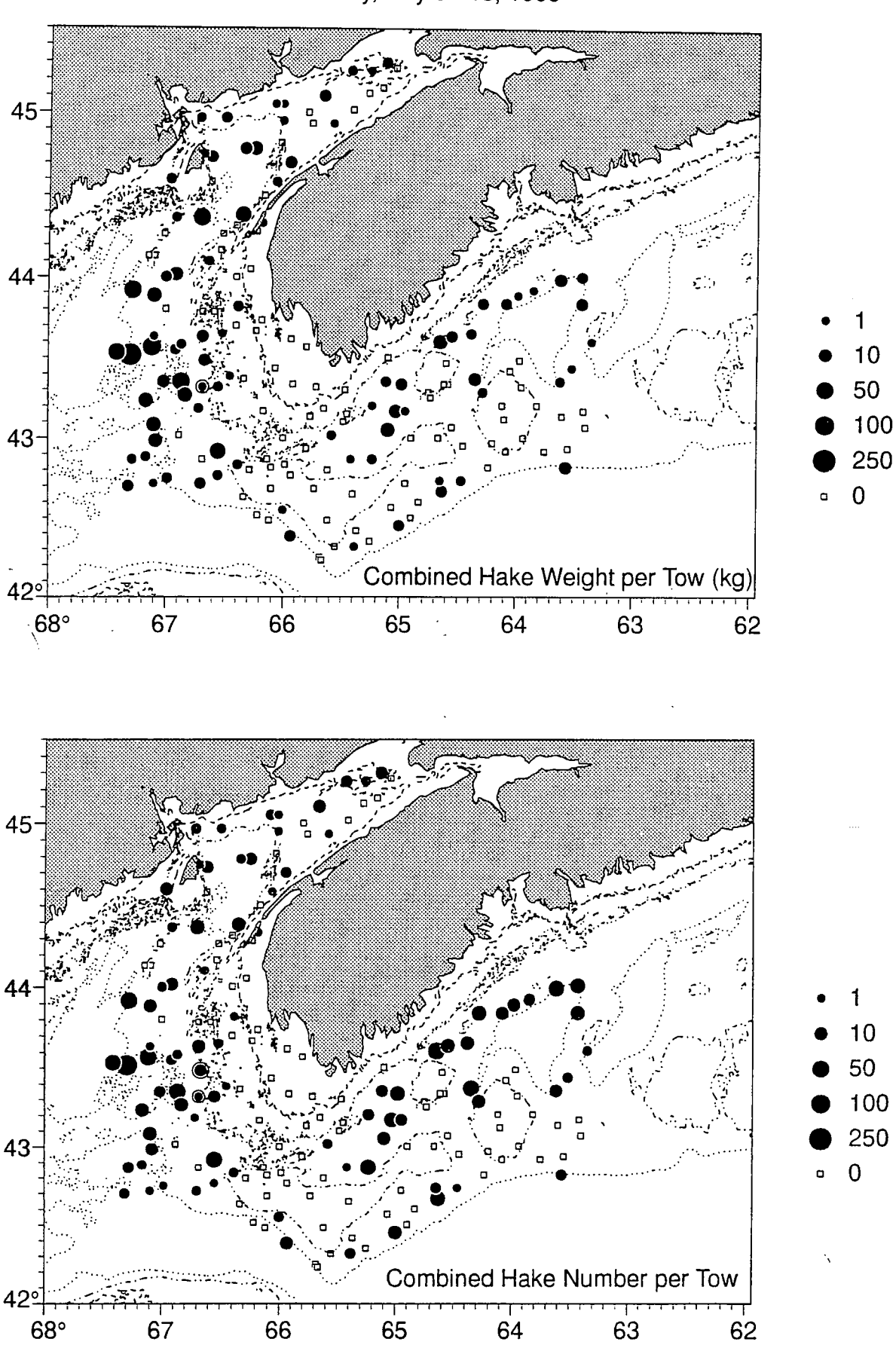


Figure 2b. Weights and numbers of white/red hake caught per tow during the 1996 ITQ survey.

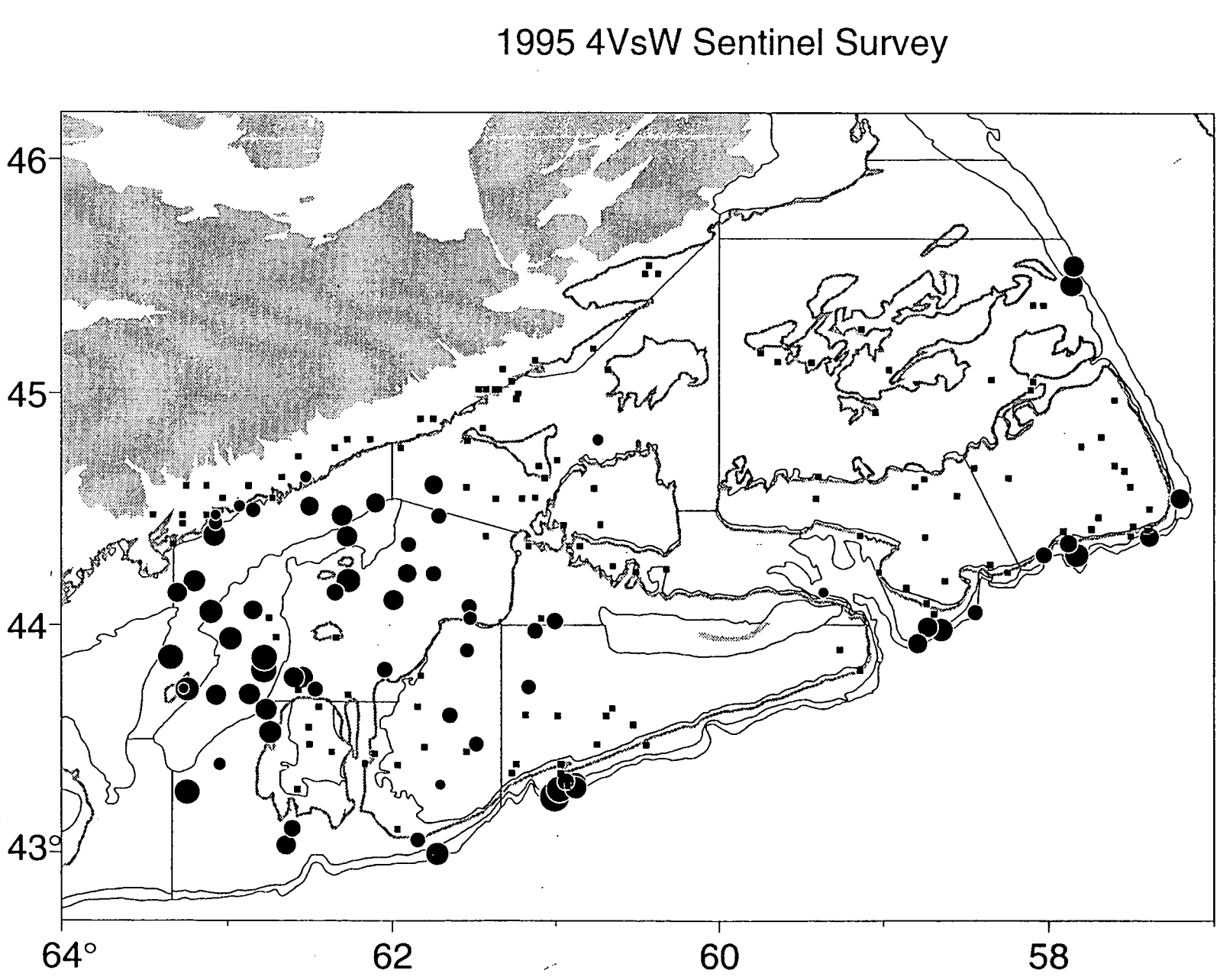


Figure 3. White/red hake distribution (relative abundance) caught during the 1995 Sentinel survey in 4VsW. The largest catch was 257 fish.

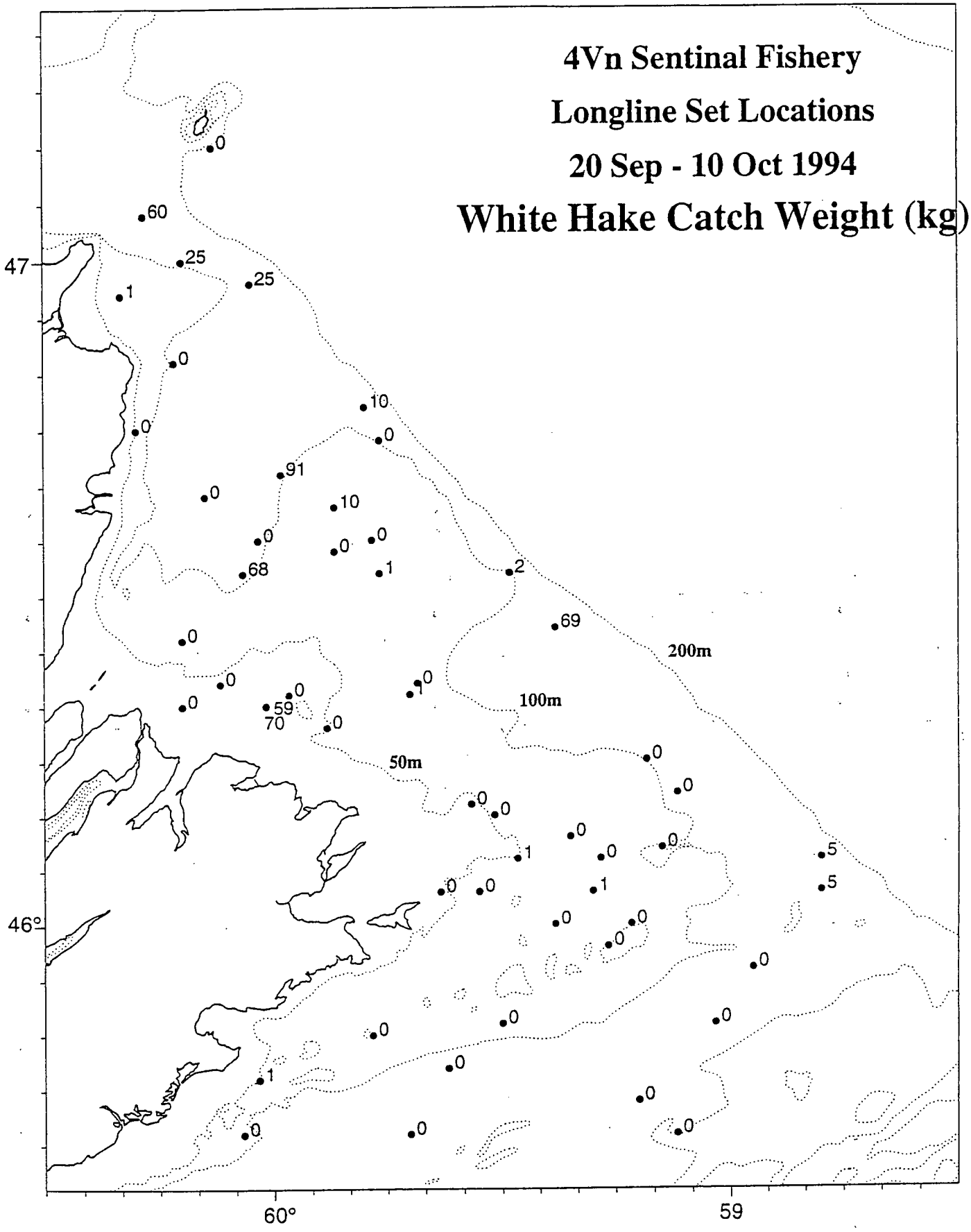


Figure 4a. White/red hake distribution in Sydney Bight during the fall 1994 Sentinel survey.

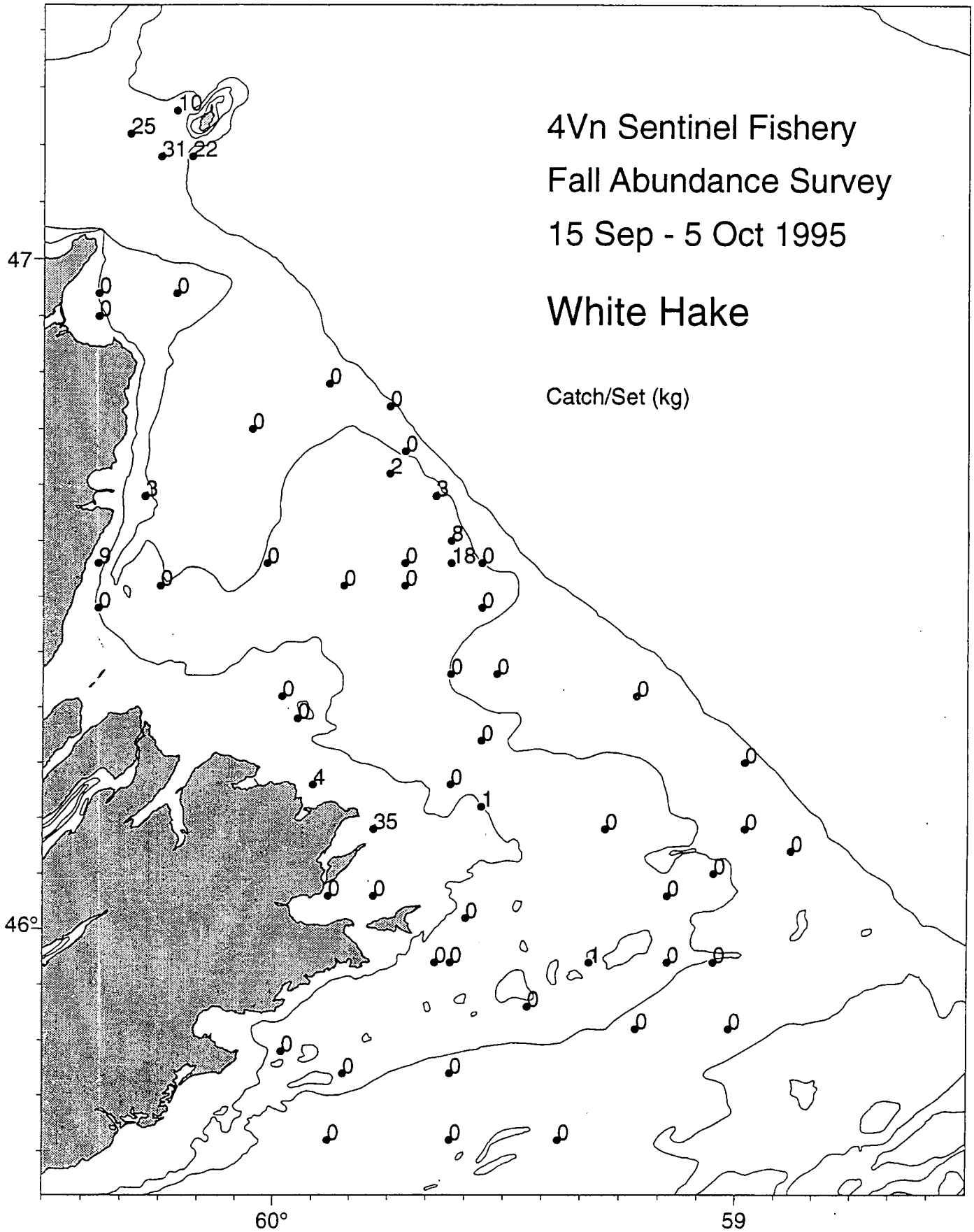


Figure 4b. White/red hake distribution in Sydney Bight during the fall 1995 Sentinel survey.

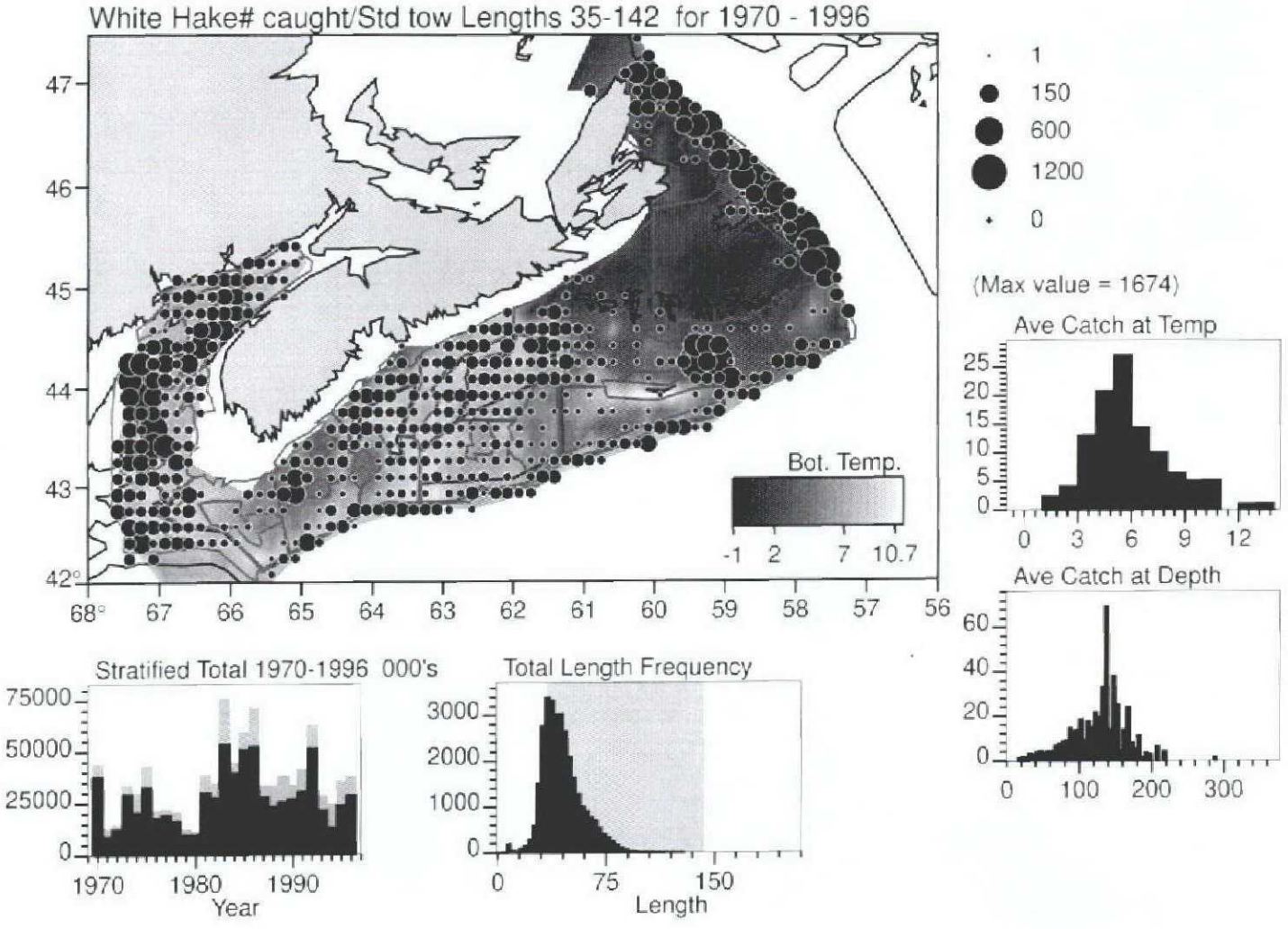


Figure 5a. Composite distribution of adult white hake as determined by Research Vessel surveys from 1970 to 1996. Grey background histogram for stratified total reflects all lengths. Shaded area of total length frequency histogram reflects plotted length range on map.

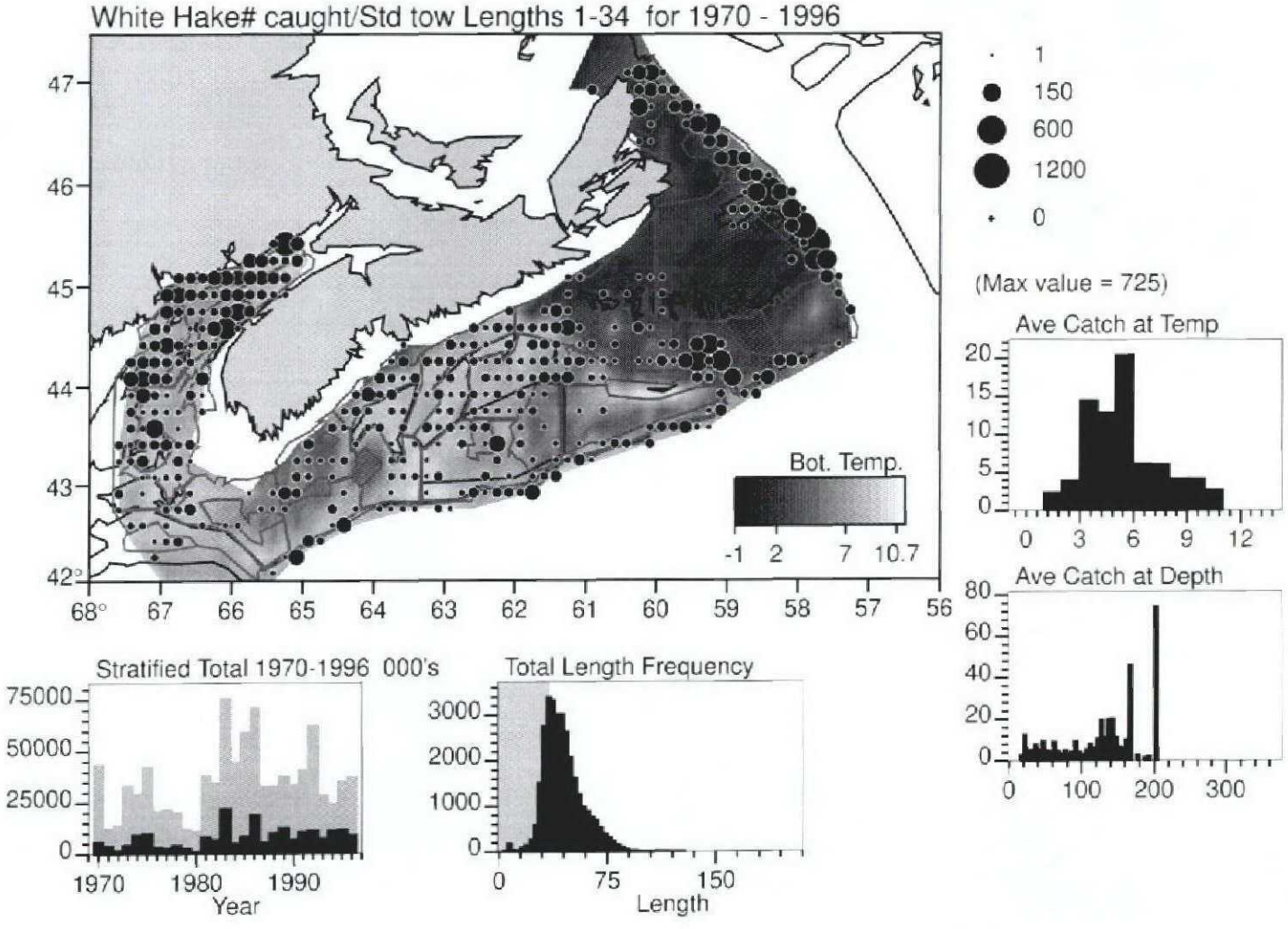


Figure 5b. Composite distribution of juvenile white hake as determined by Research Vessel surveys from 1970 to 1996. Grey background histogram for stratified total reflects all lengths. Shaded area of total length frequency histogram reflects plotted length range on map.

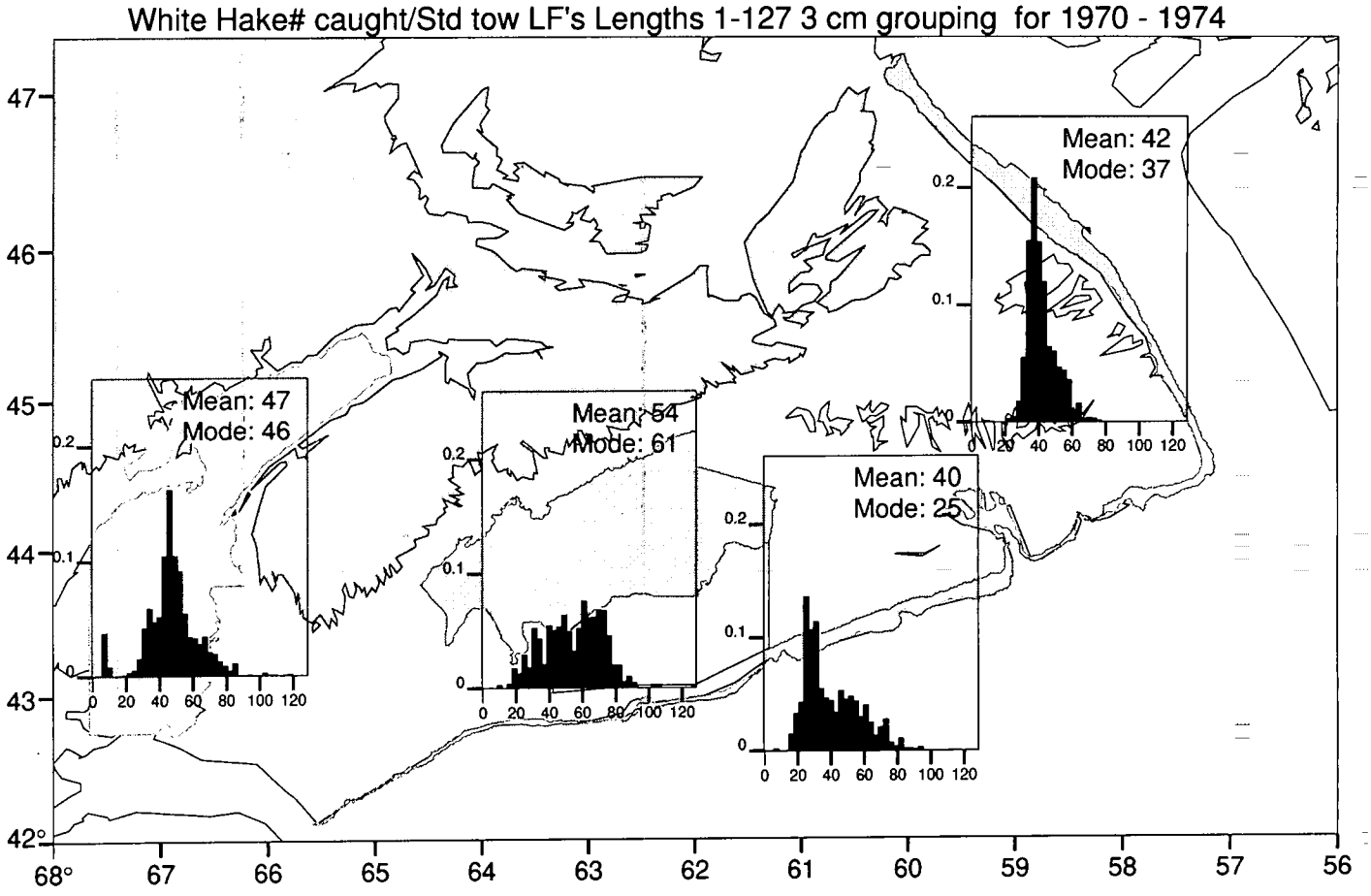


Figure 6a. Composite length frequencies (proportions at length) of white hake as determined by Research Vessel surveys from 1970 to 1974.

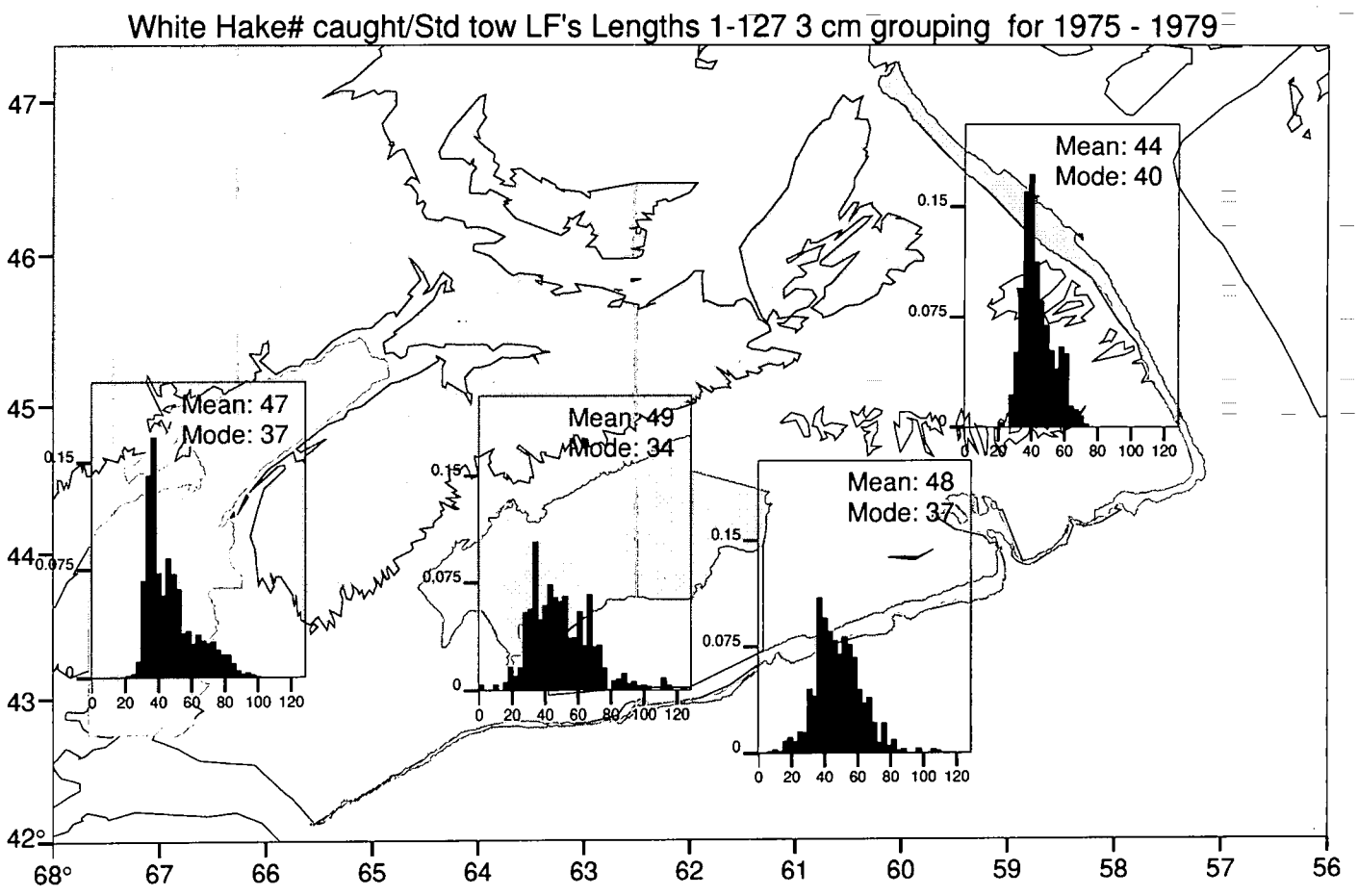


Figure 6b. Composite length frequencies (proportions at length) of white hake as determined by Research Vessel surveys from 1975 to 1979.

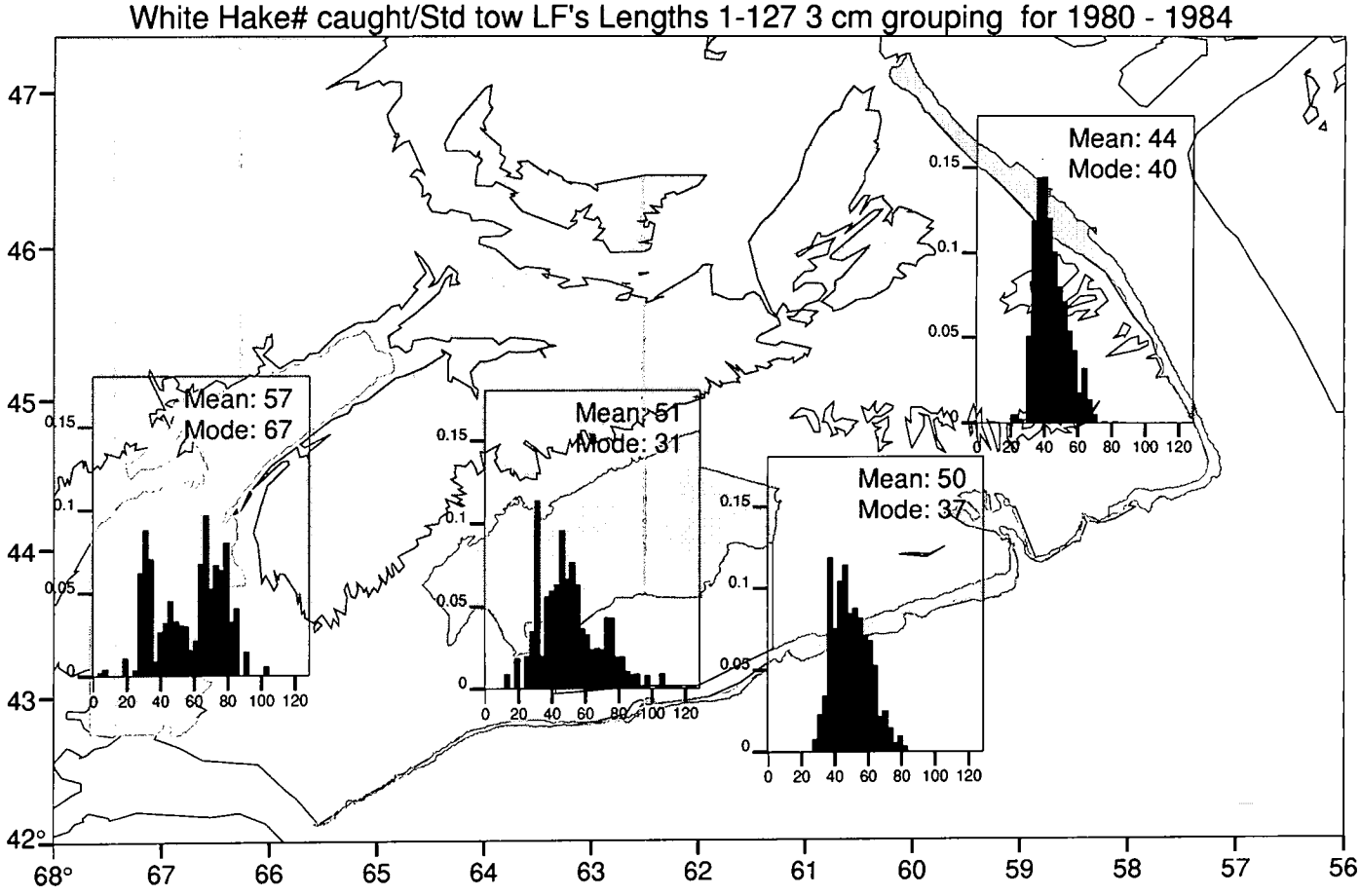


Figure 6c. Composite length frequencies (proportions at length) of white hake as determined by Research Vessel surveys from 1980 to 1984.

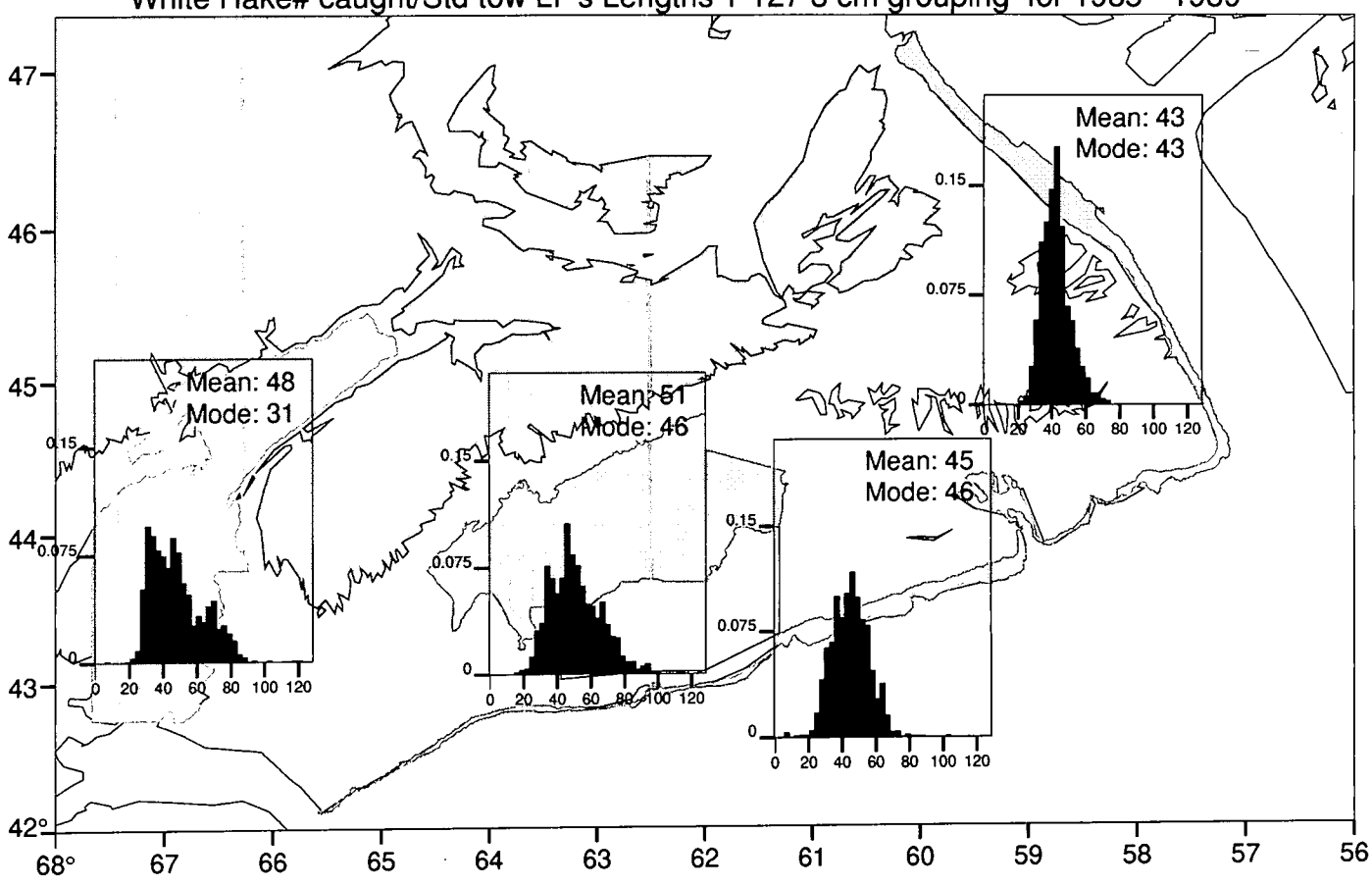


Figure 6d. Composite length frequencies (proportions at length) of white hake as determined by Research Vessel surveys from 1985 to 1989.

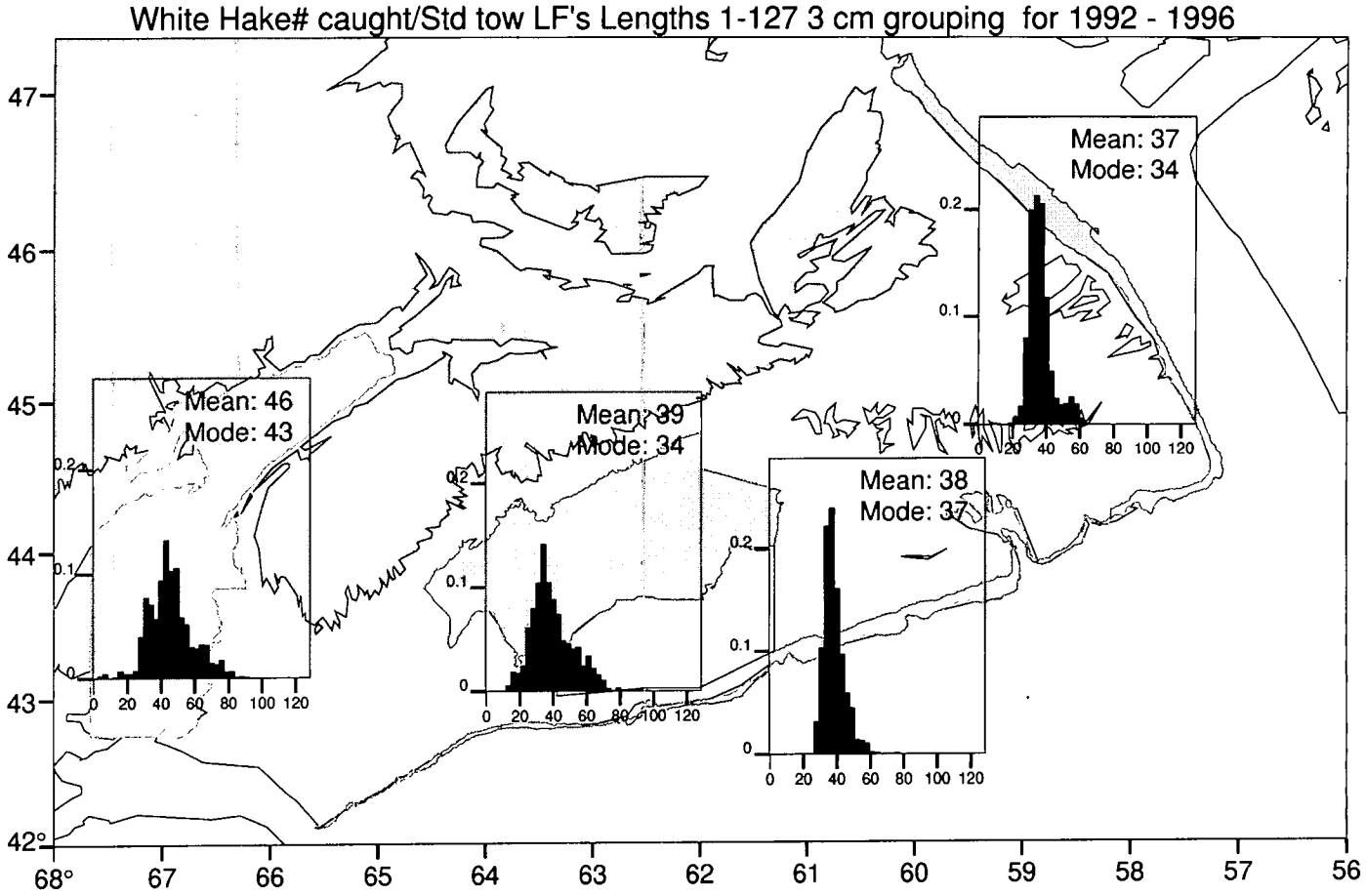


Figure 6e. Composite length frequencies (proportions at length) of white hake as determined by Research Vessel surveys from 1992 to 1996.

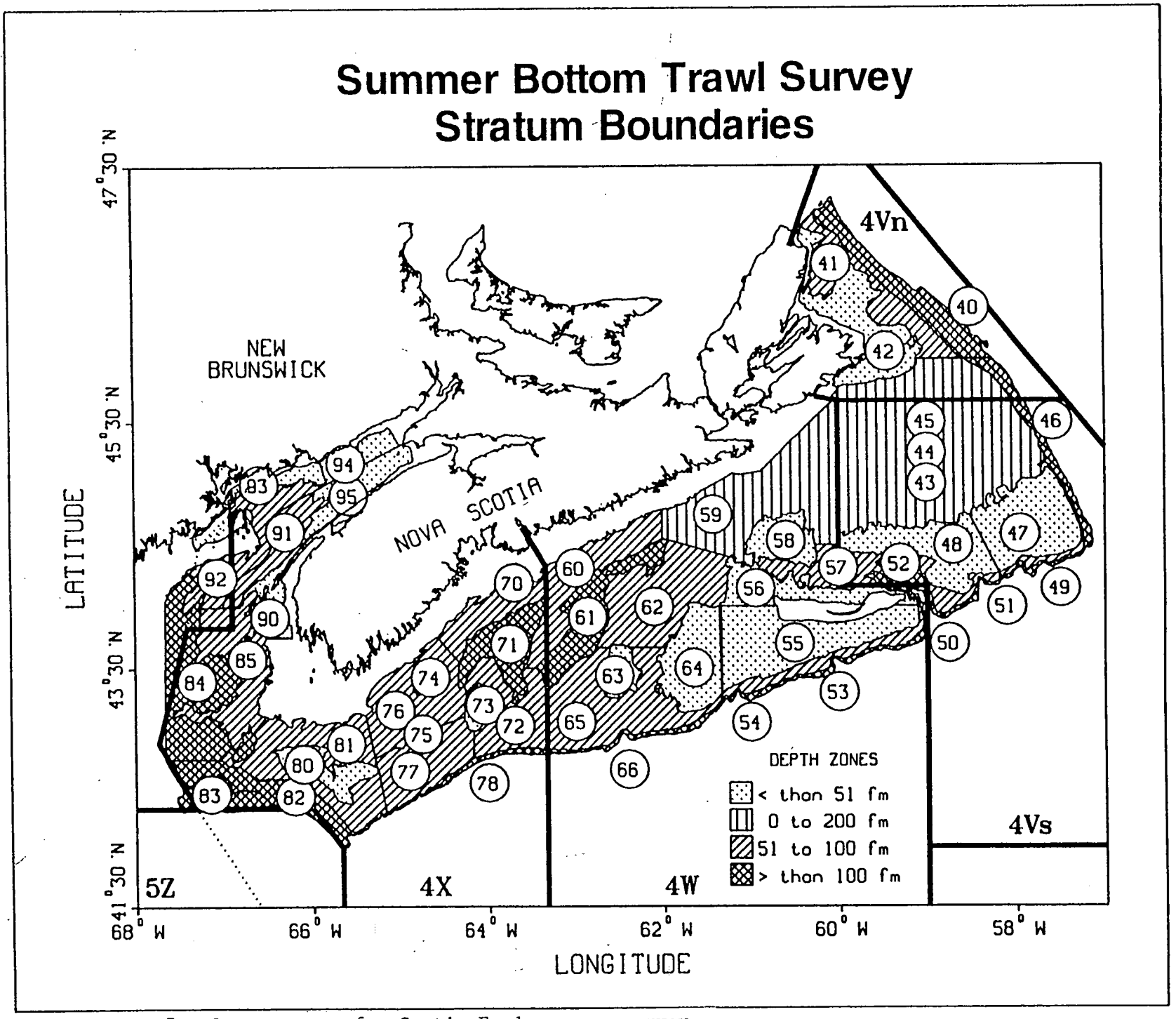


Figure 7. Strata areas for Scotia-Fundy summer survey.

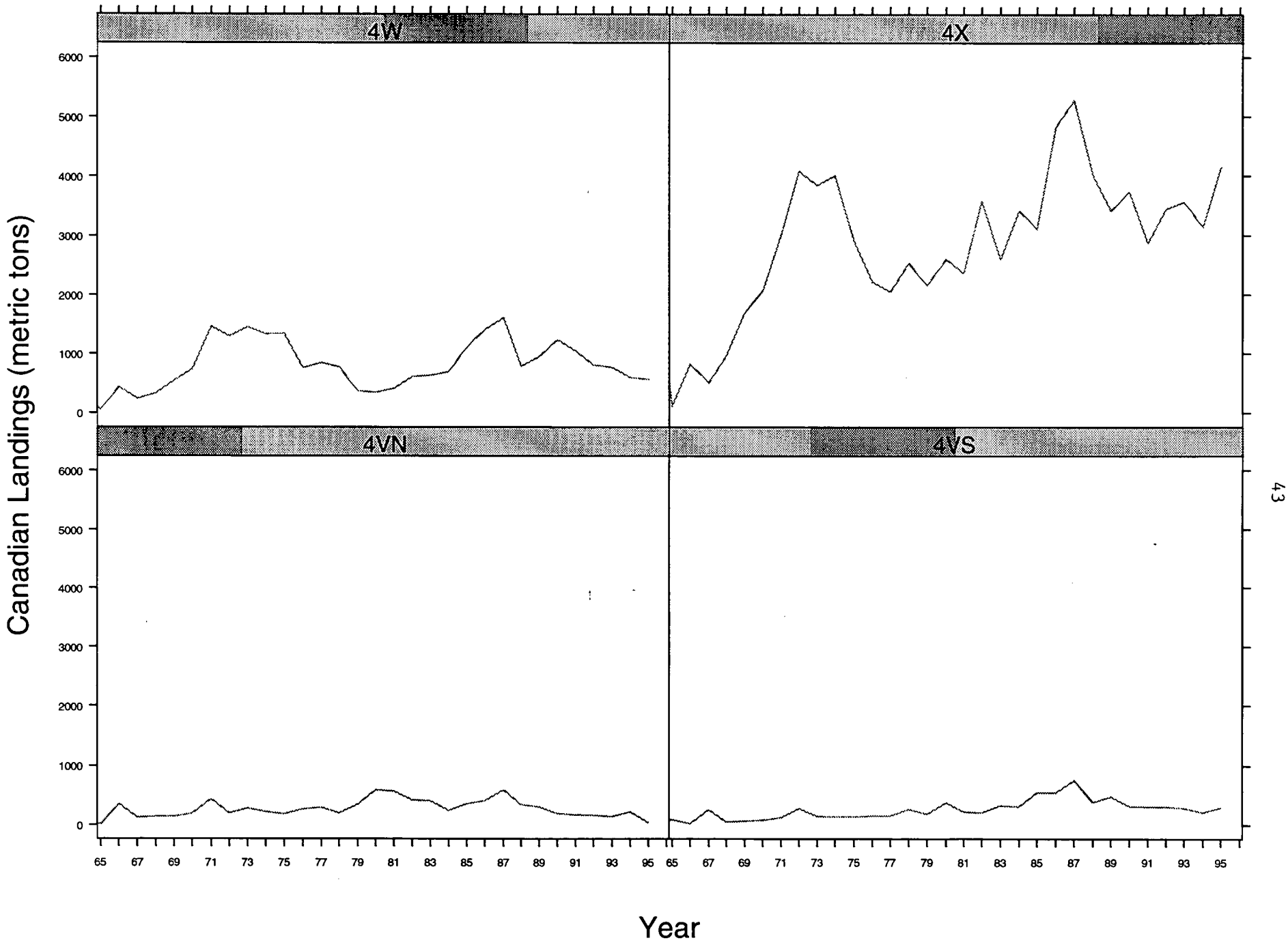


Figure 8. Canadian landings of white hake by NAFO division

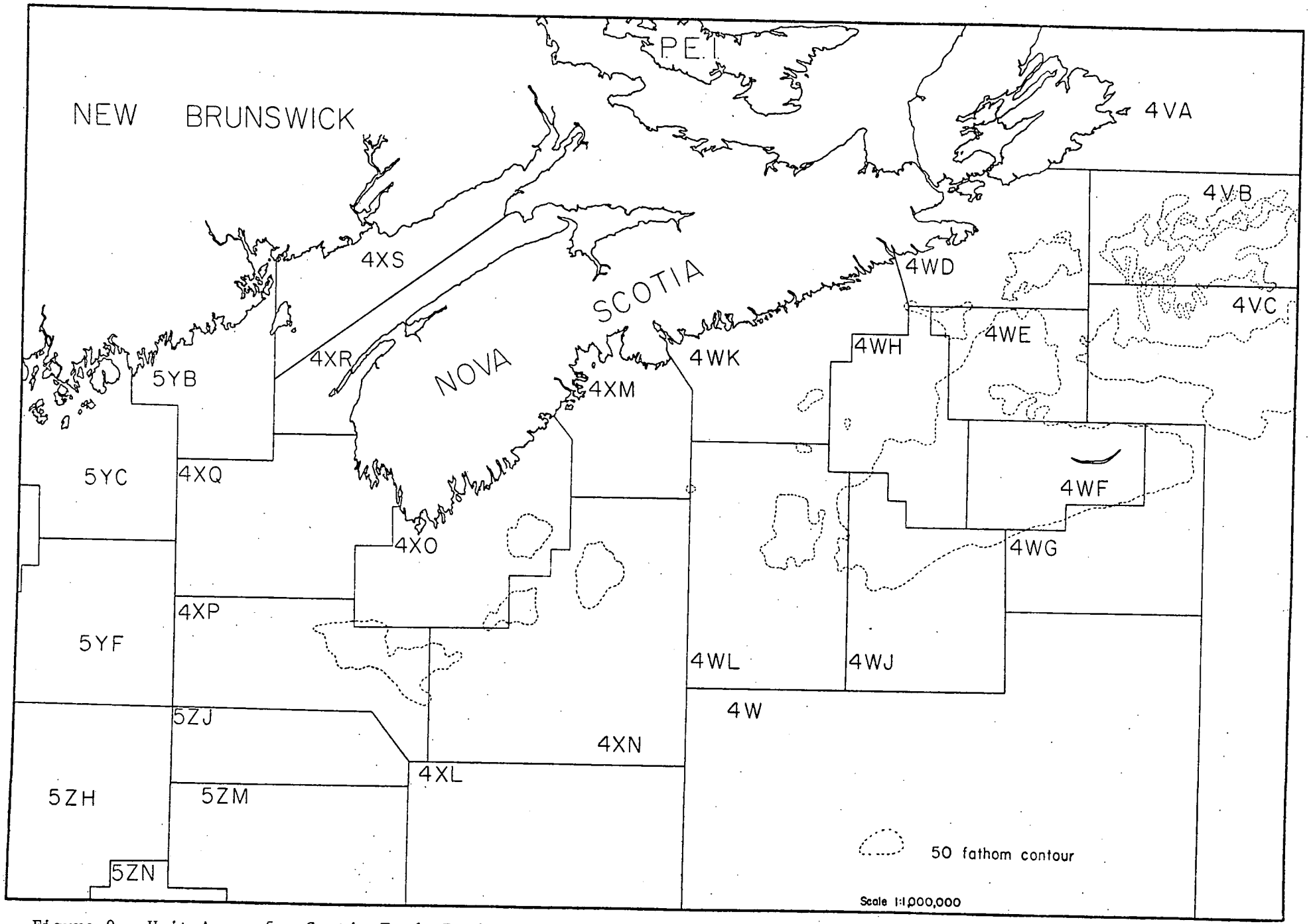


Figure 9. Unit Areas for Scotia-Fundy Region.

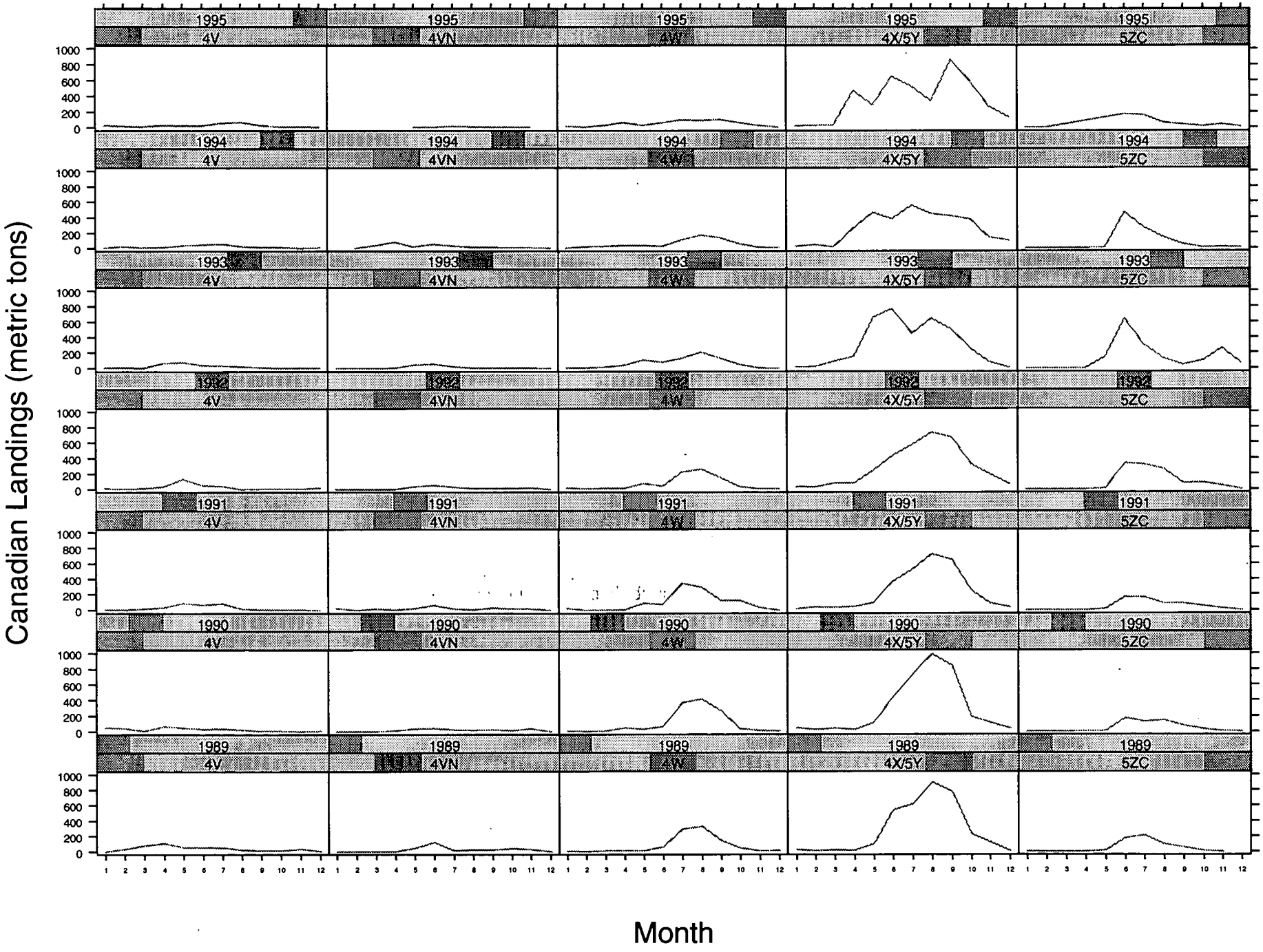


Figure 10. Canadian landings of white hake by month during 1989-95 in NAFO divisions 4V, 4Vn, 4W, 4X/5Y, and 5Zc

Figure 11a. Canadian White Hake Gillnet Fishery Effort - Days Fished

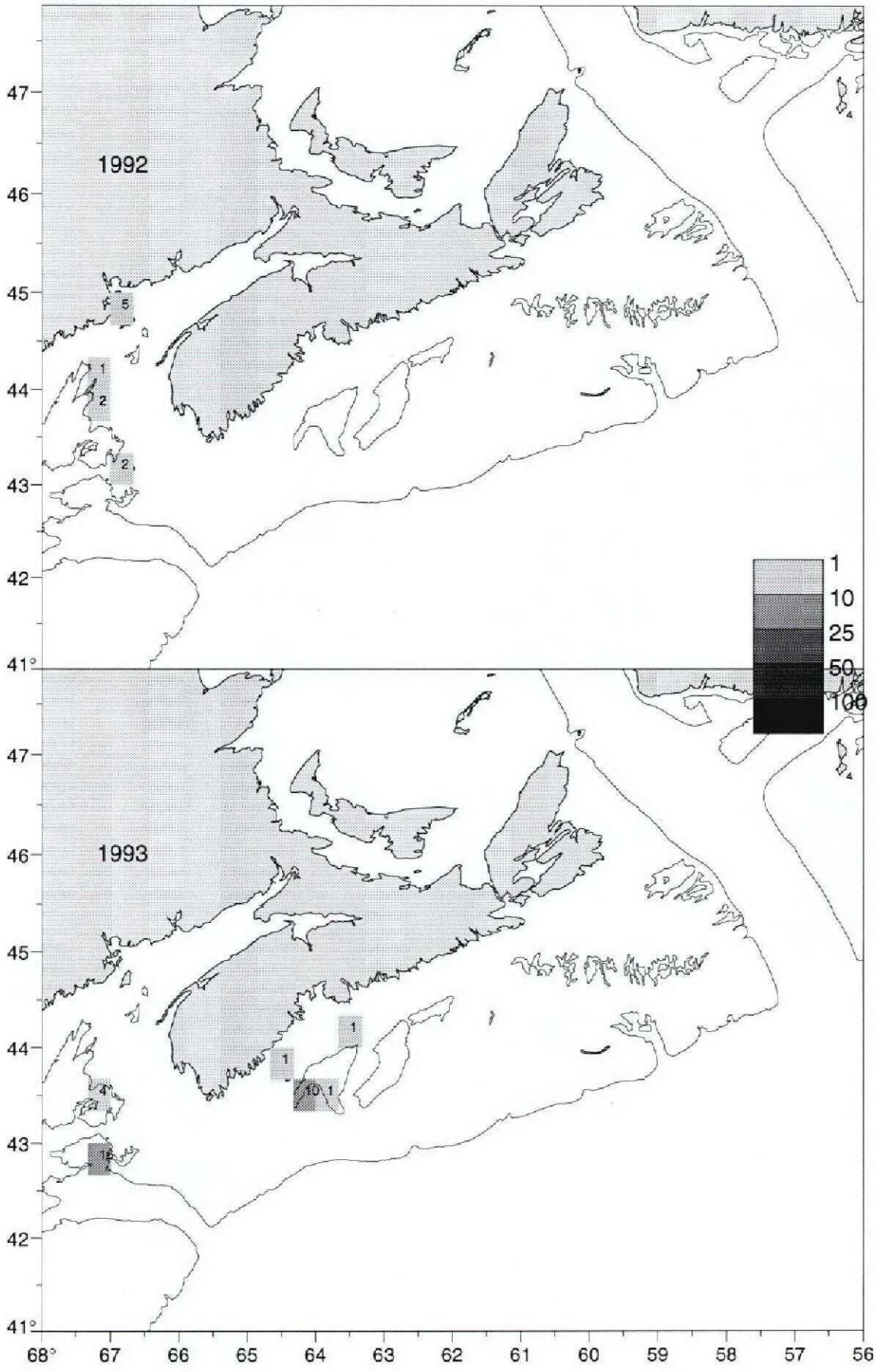


Figure 11b. Canadian White Hake Gillnet Fishery Effort - Days Fished

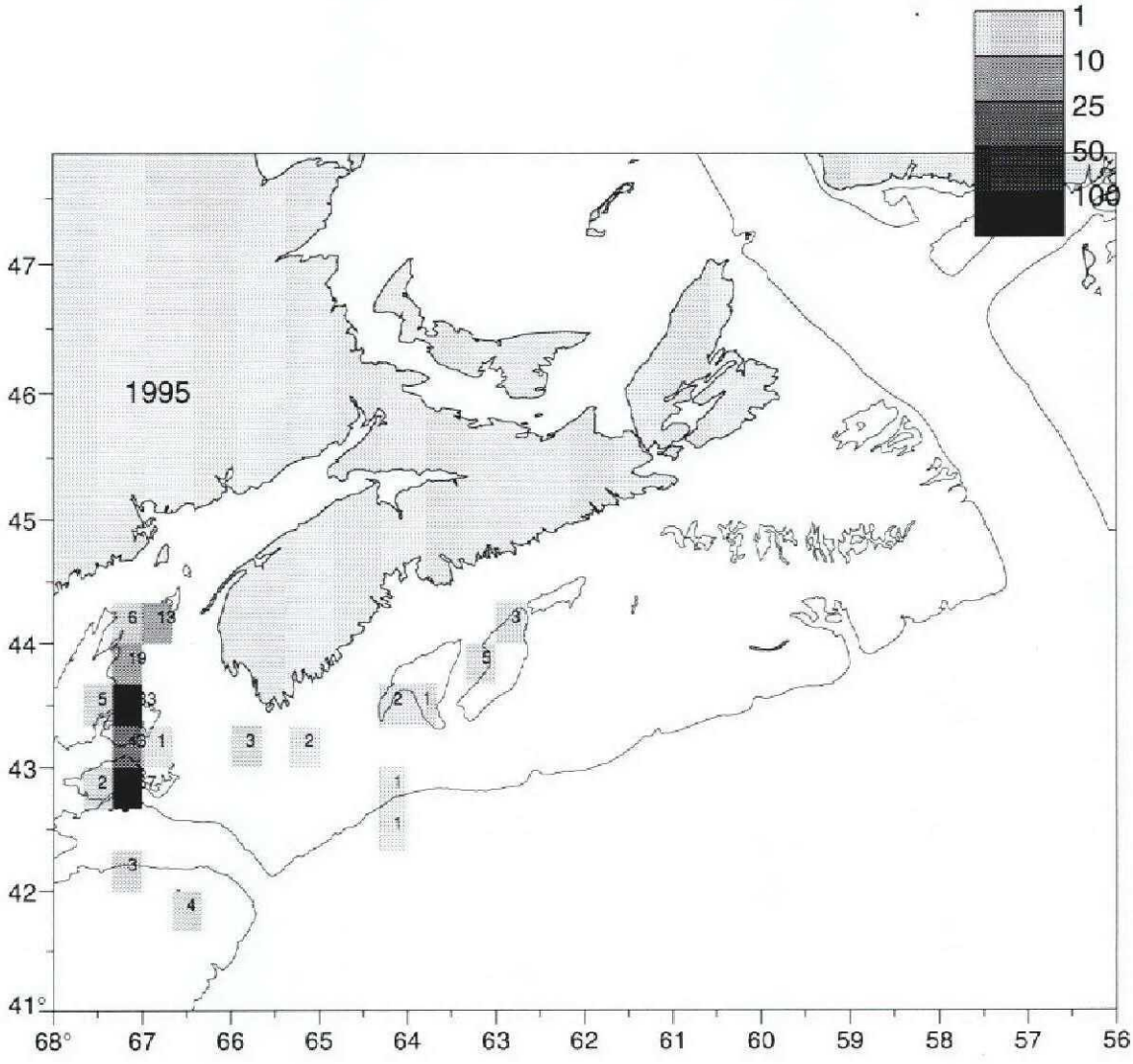


Figure 11c. Canadian White Hake Trawl Fishery Effort - Days Fished

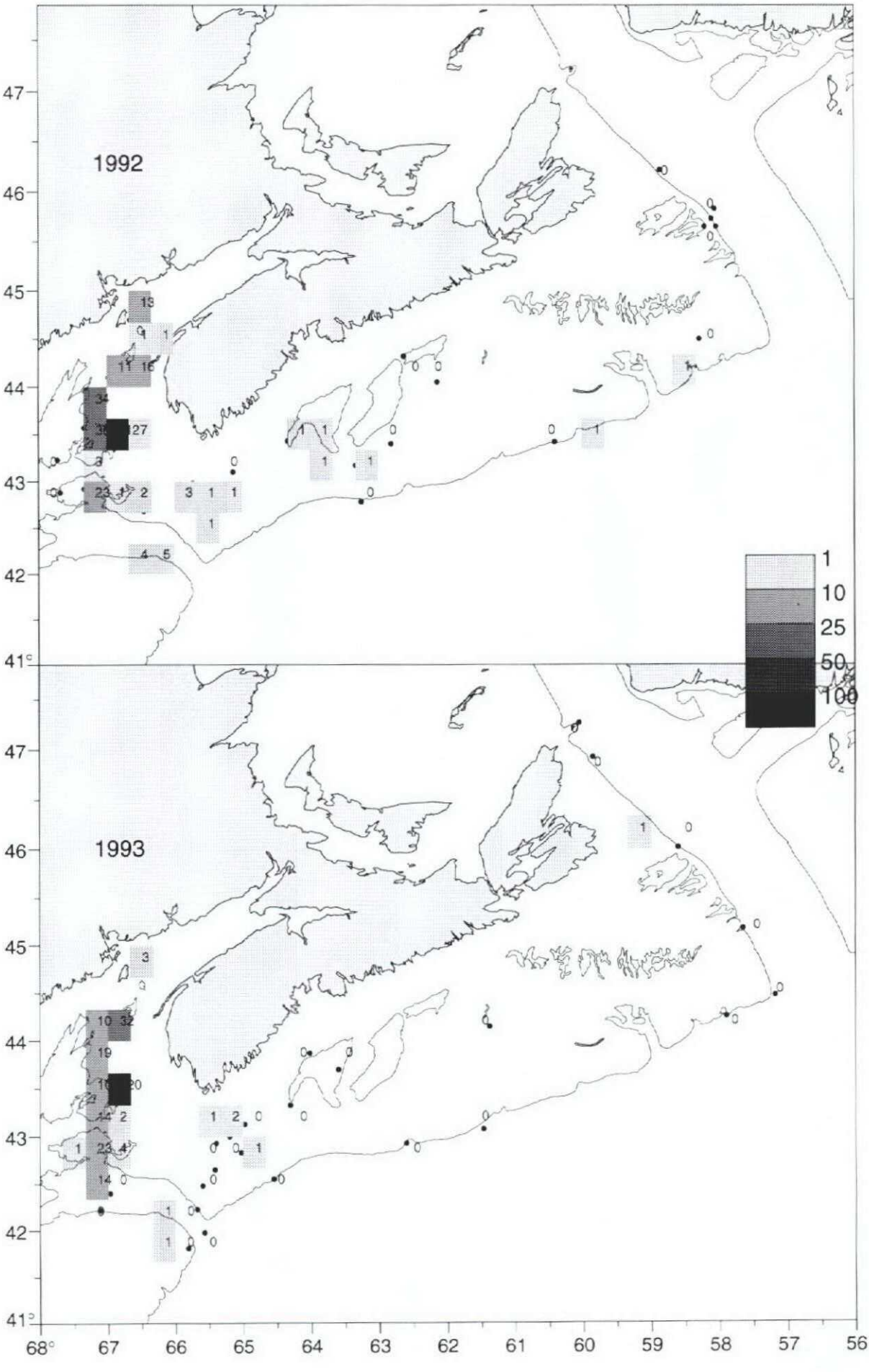


Figure 11d. Canadian White Hake Trawl Fishery Effort - Days Fished

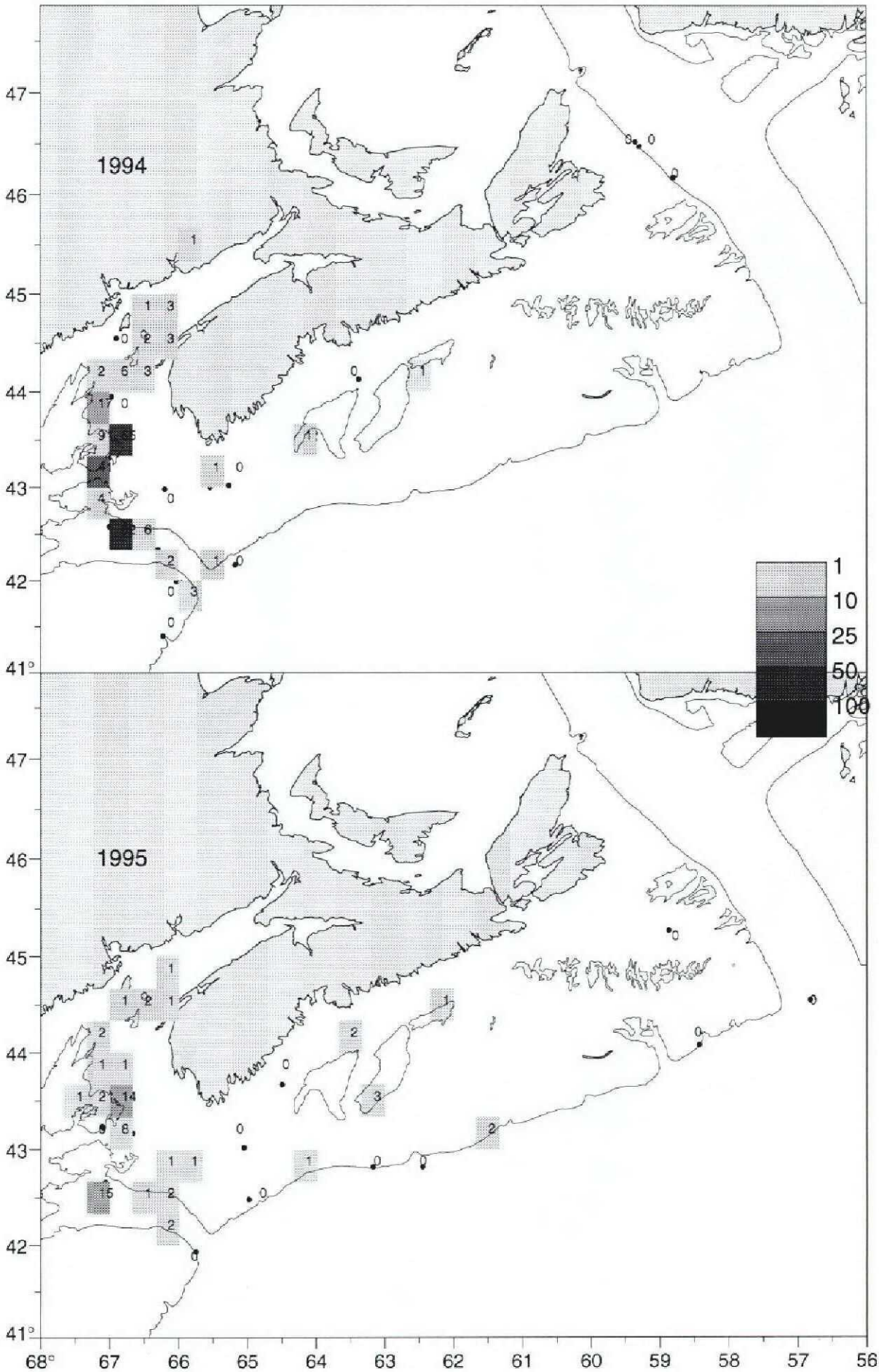


Figure 11e. Canadian White Hake Longline Fishery Effort - Days Fished

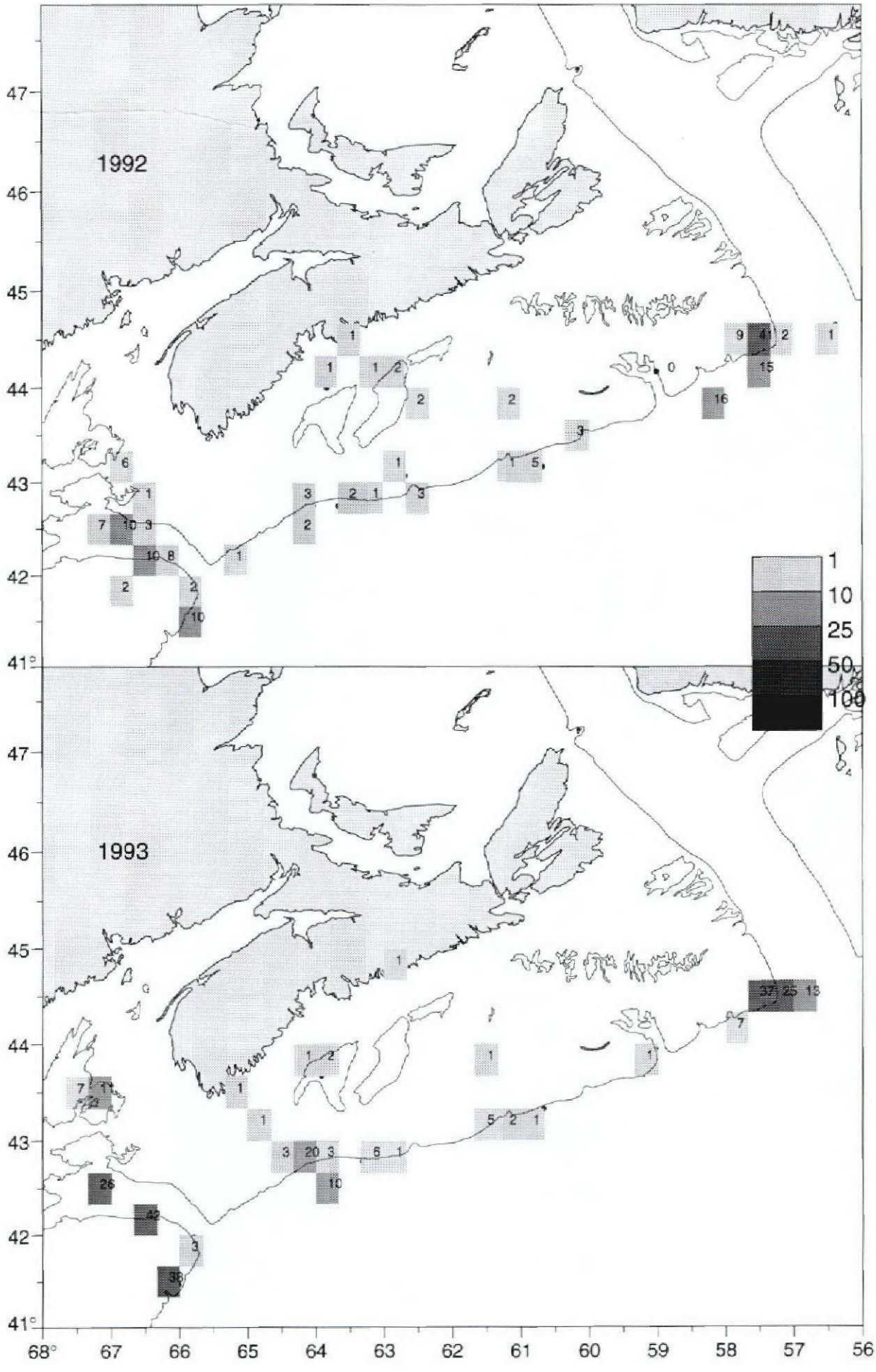


Figure 11f. Canadian White Hake Longline Fishery Effort - Days Fished

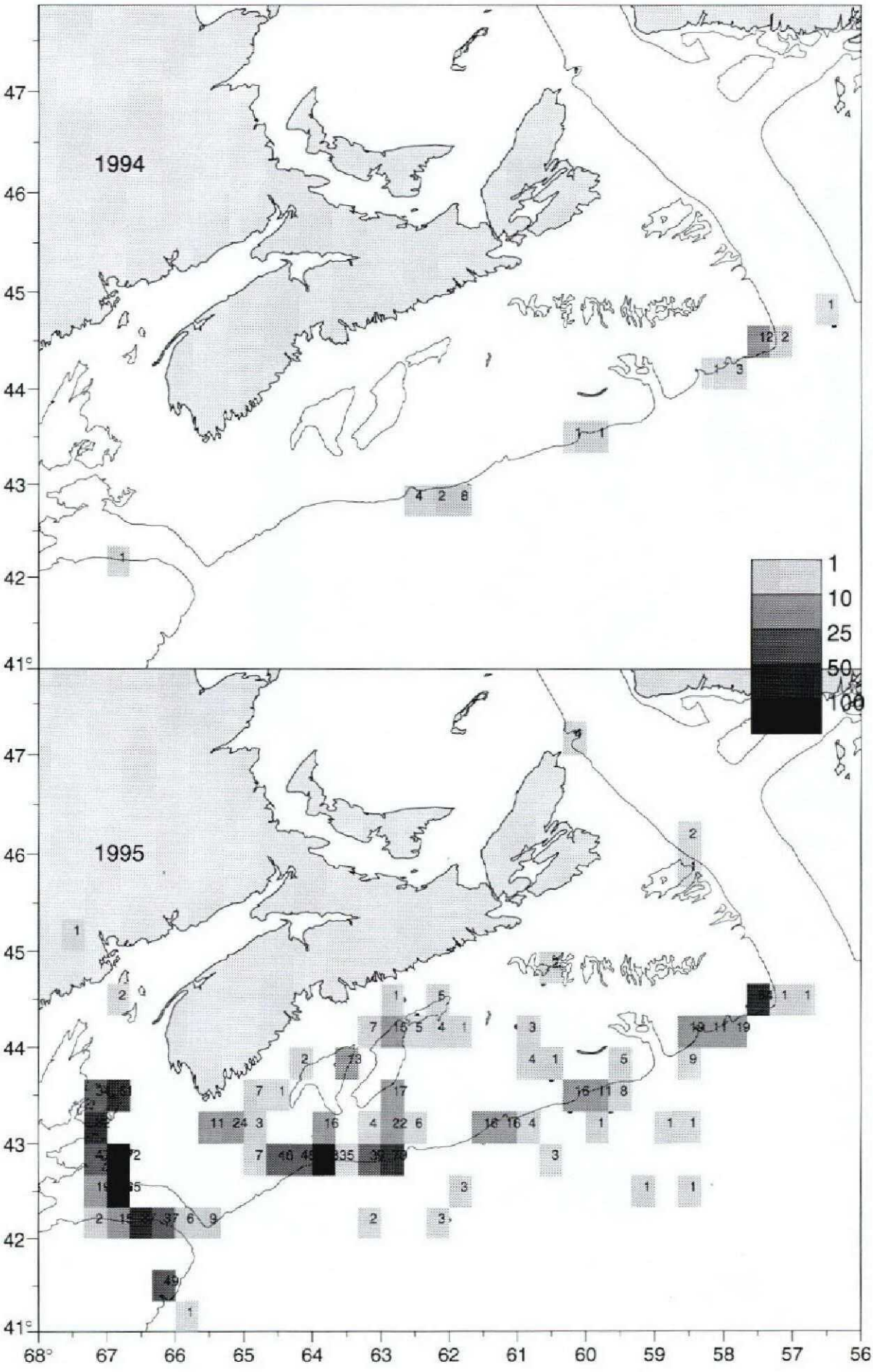


Figure 11g. Canadian White Hake Seine Fishery Effort - Days Fished

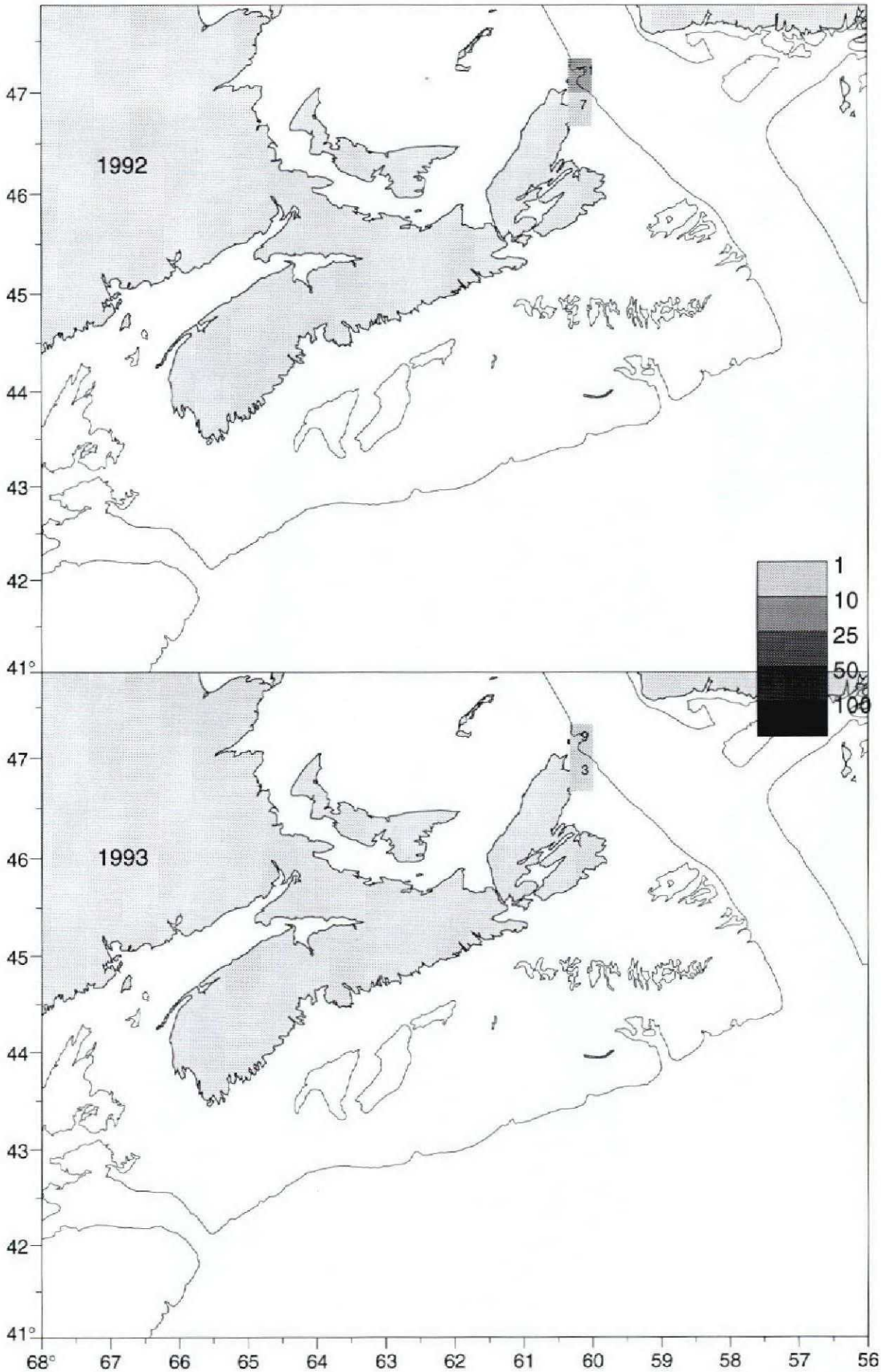
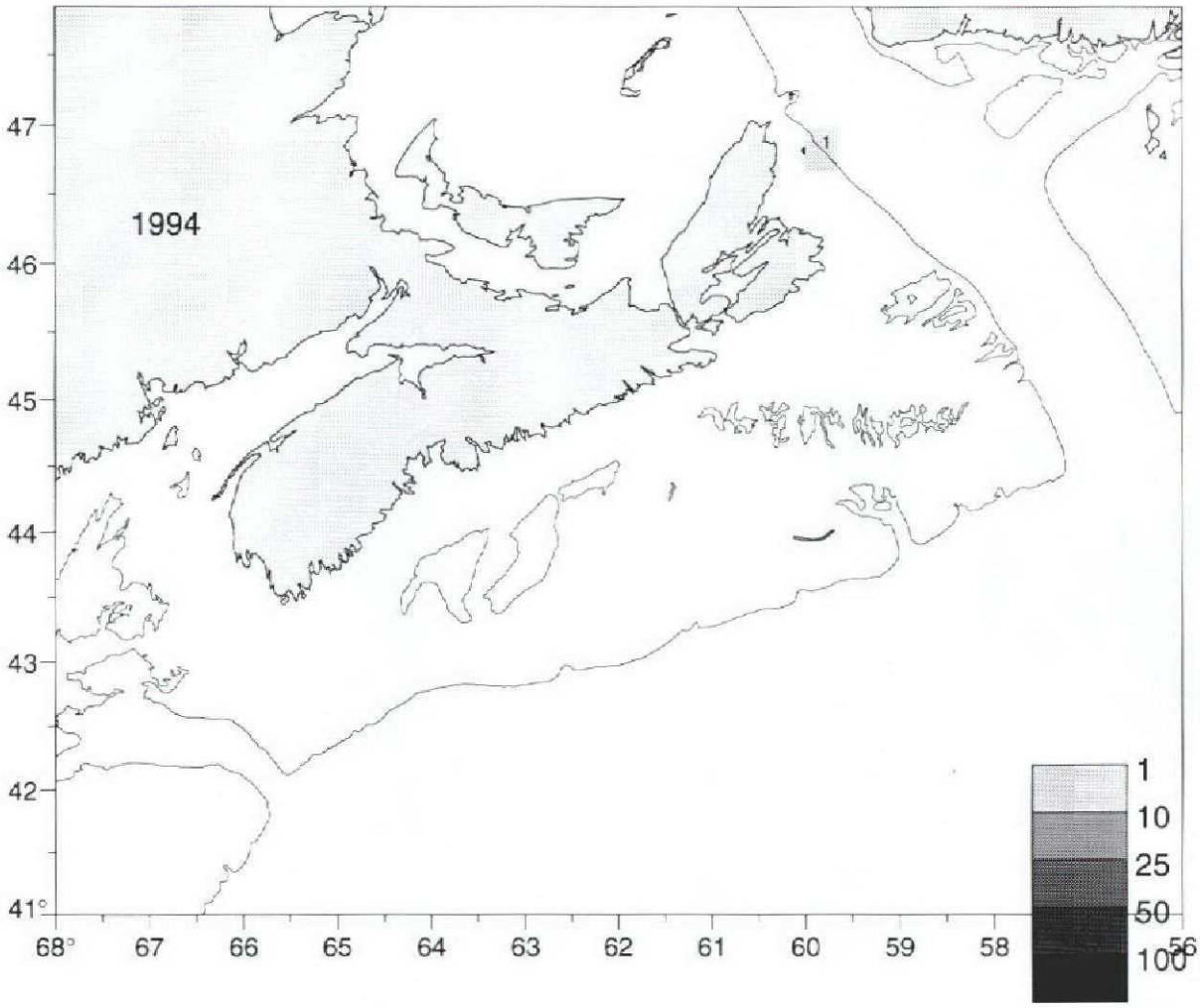


Figure 11h. Canadian White Hake Seine Fishery Effort - Days Fished



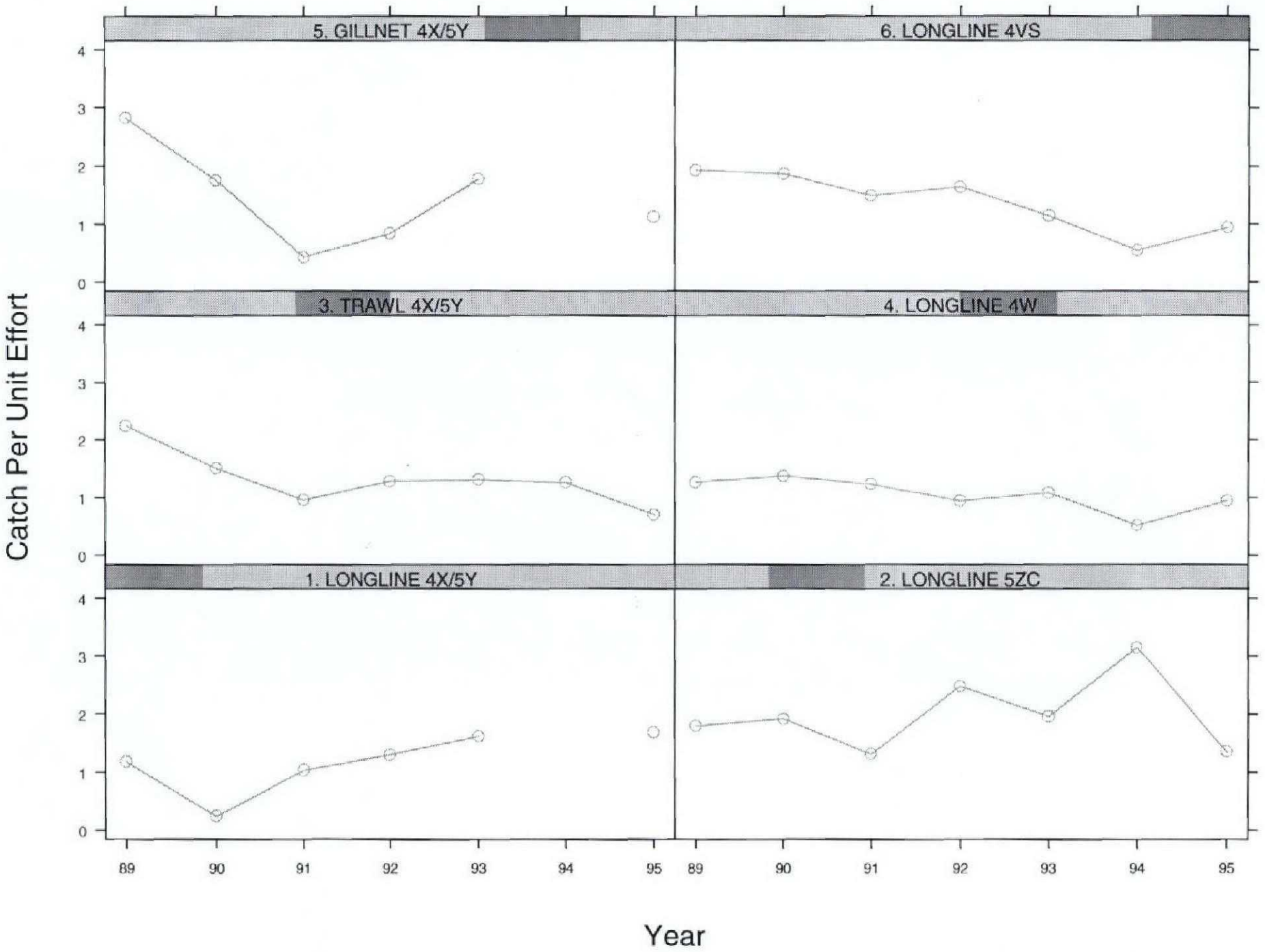


Figure 12. Canadian catch per unit effort (metric tons/days fished) of white hake for the years 1989-95 by fishery and area.

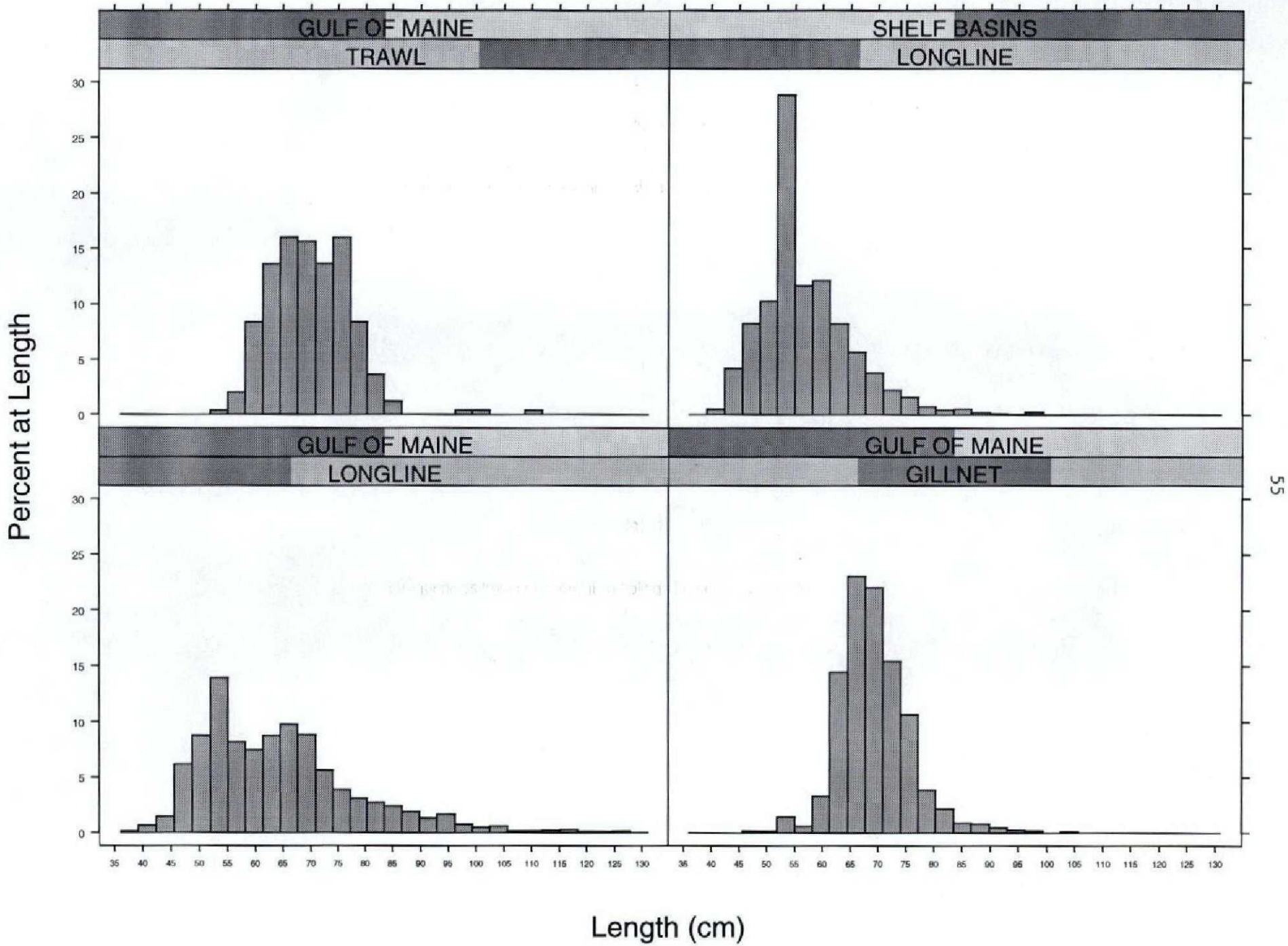


Figure 13. White hake length-frequencies from commercial sampling of recent (mostly 1995) landings. The trawl sample was taken in 1994.

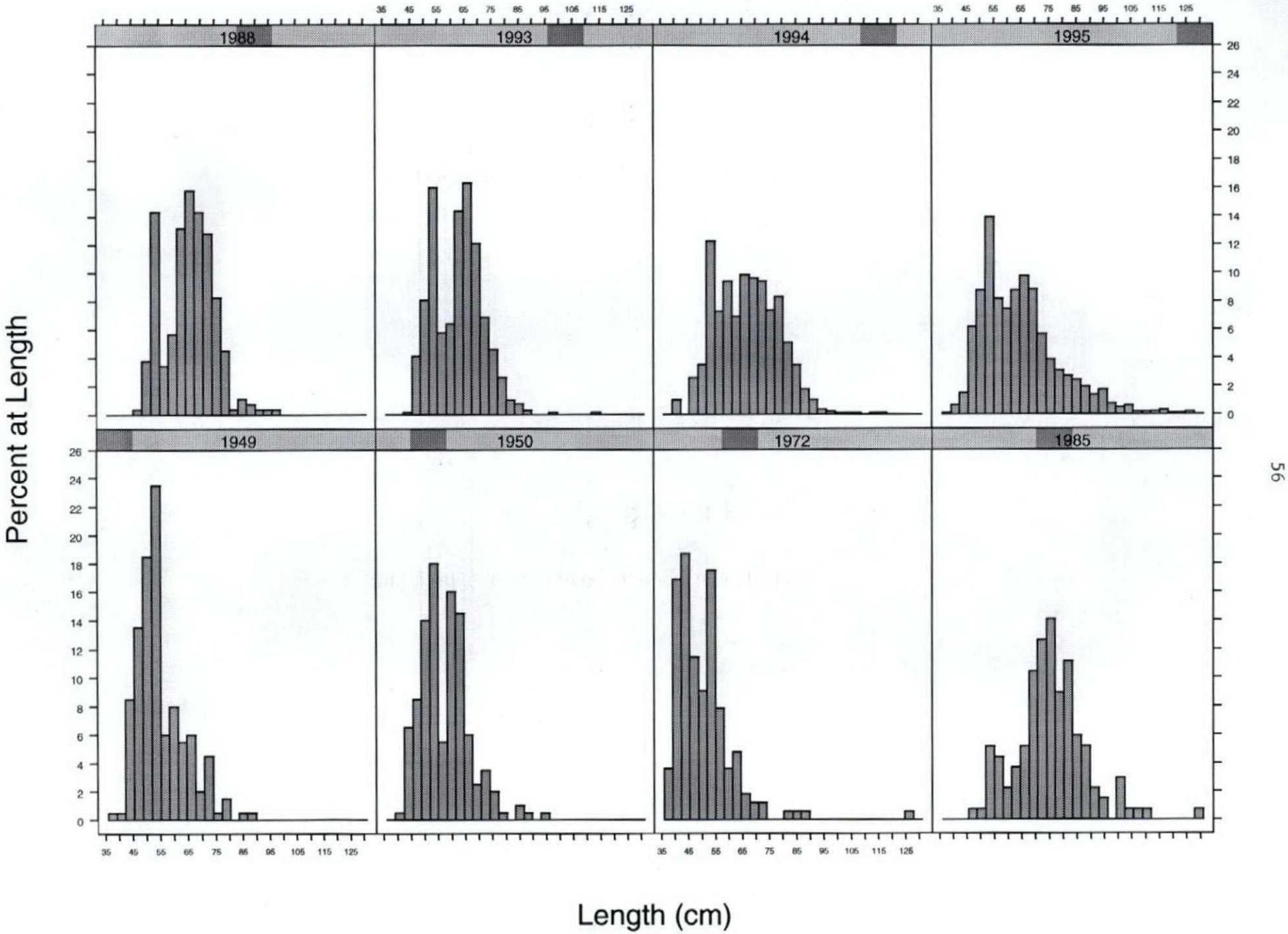


Figure 14a. White hake length-frequencies from commercial sampling of longline/handline fishery in 5Zj & 4Xpqr

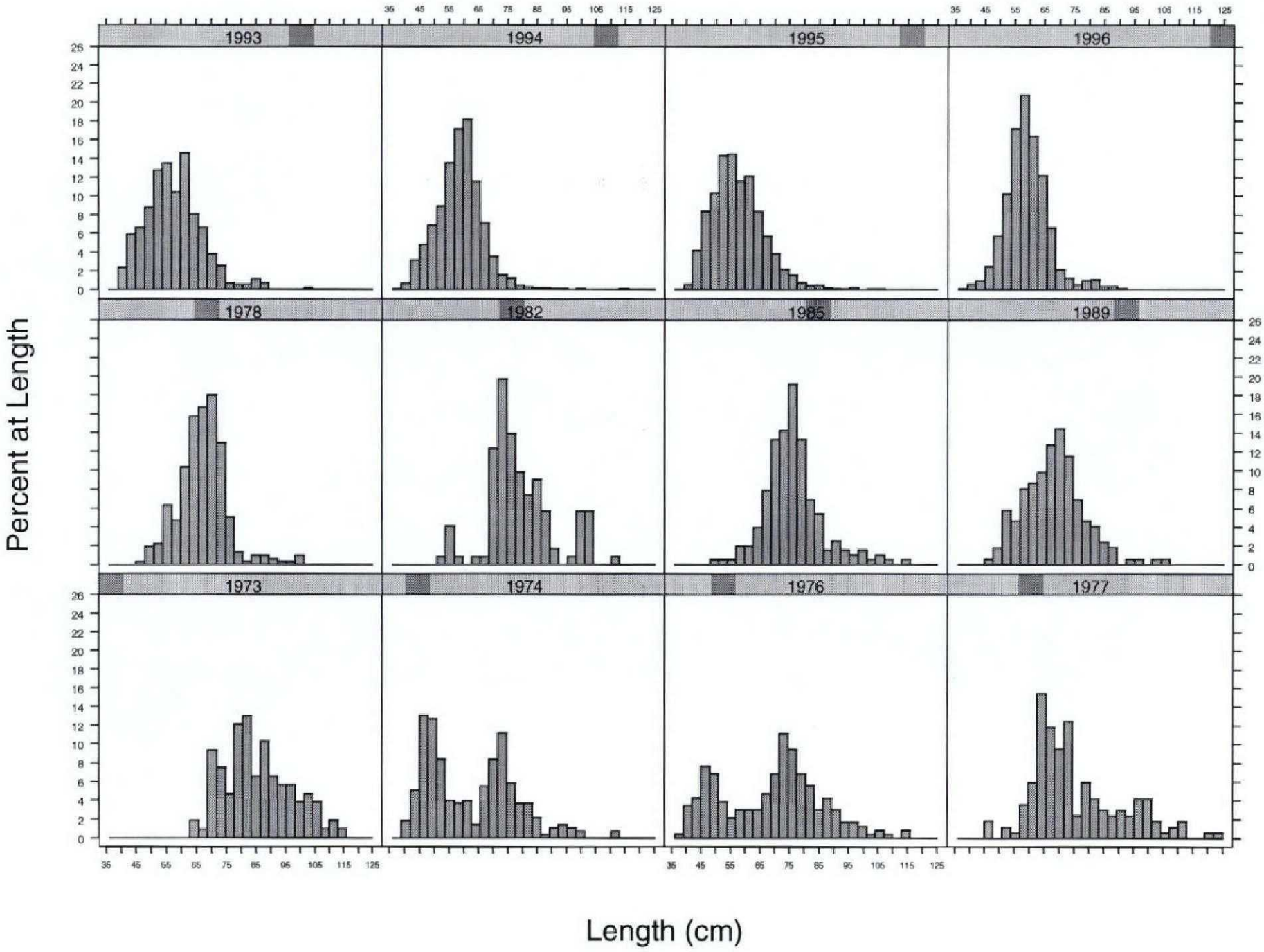


Figure 14b. White hake length-frequencies from commercial sampling of longline/handline fishery in 4Wkl & 4Xmno

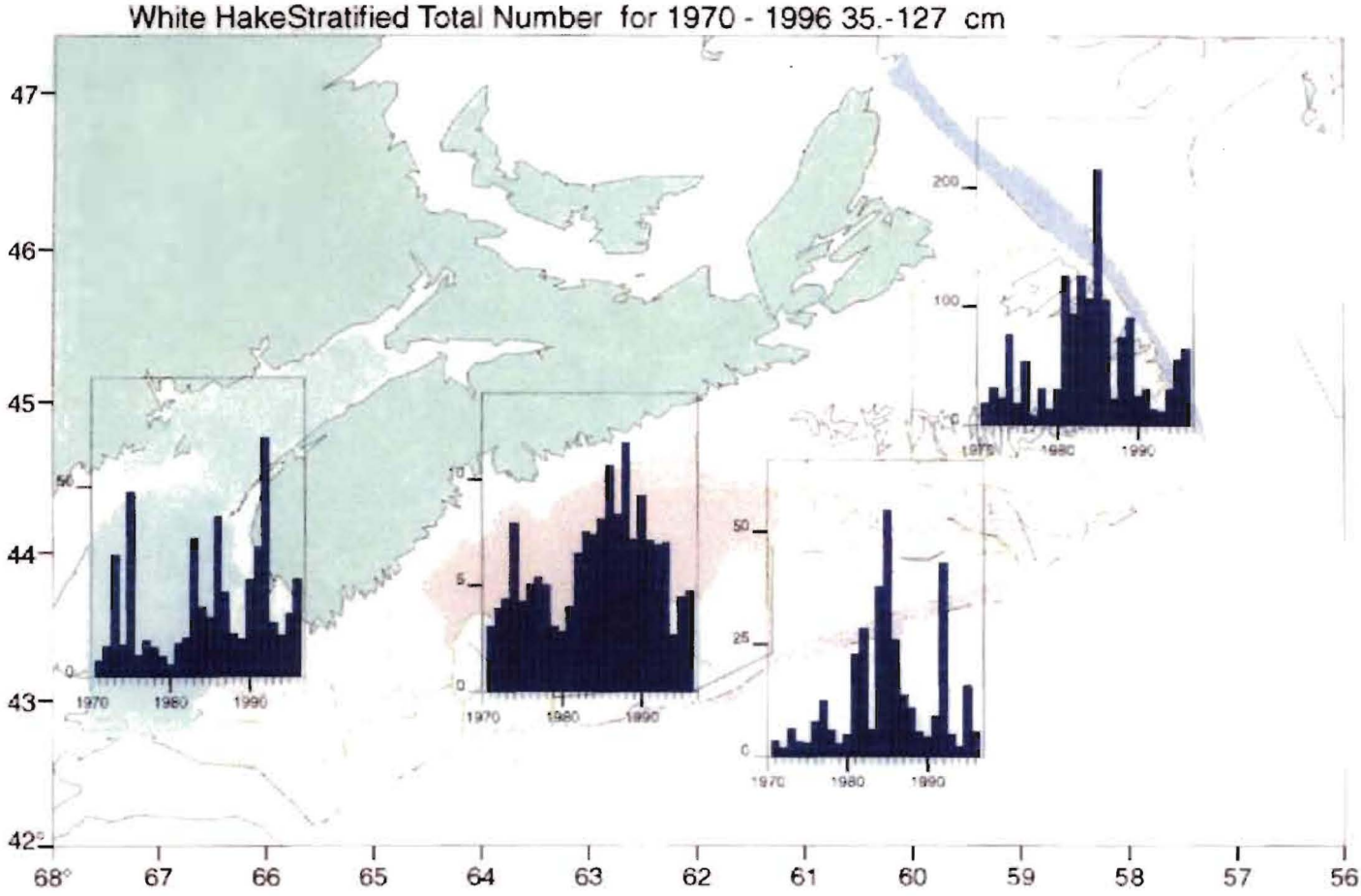


Figure 15a. Stratified abundances of adult white hake as determined by Research Vessel surveys from 1970 to 1996.

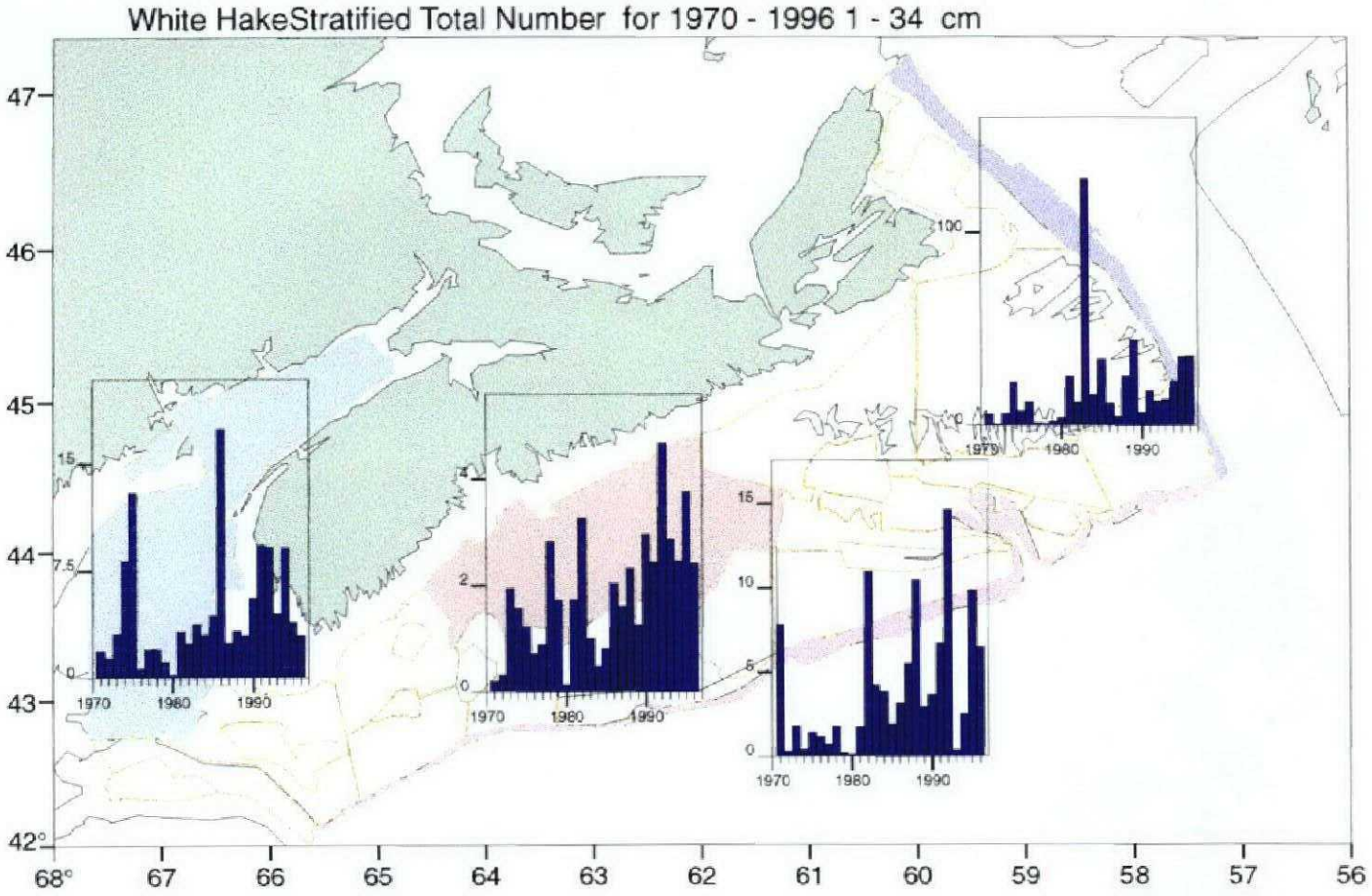


Figure 15b. Stratified abundances of juvenile white hake as determined by Research Vessel surveys from 1970 to 1996.

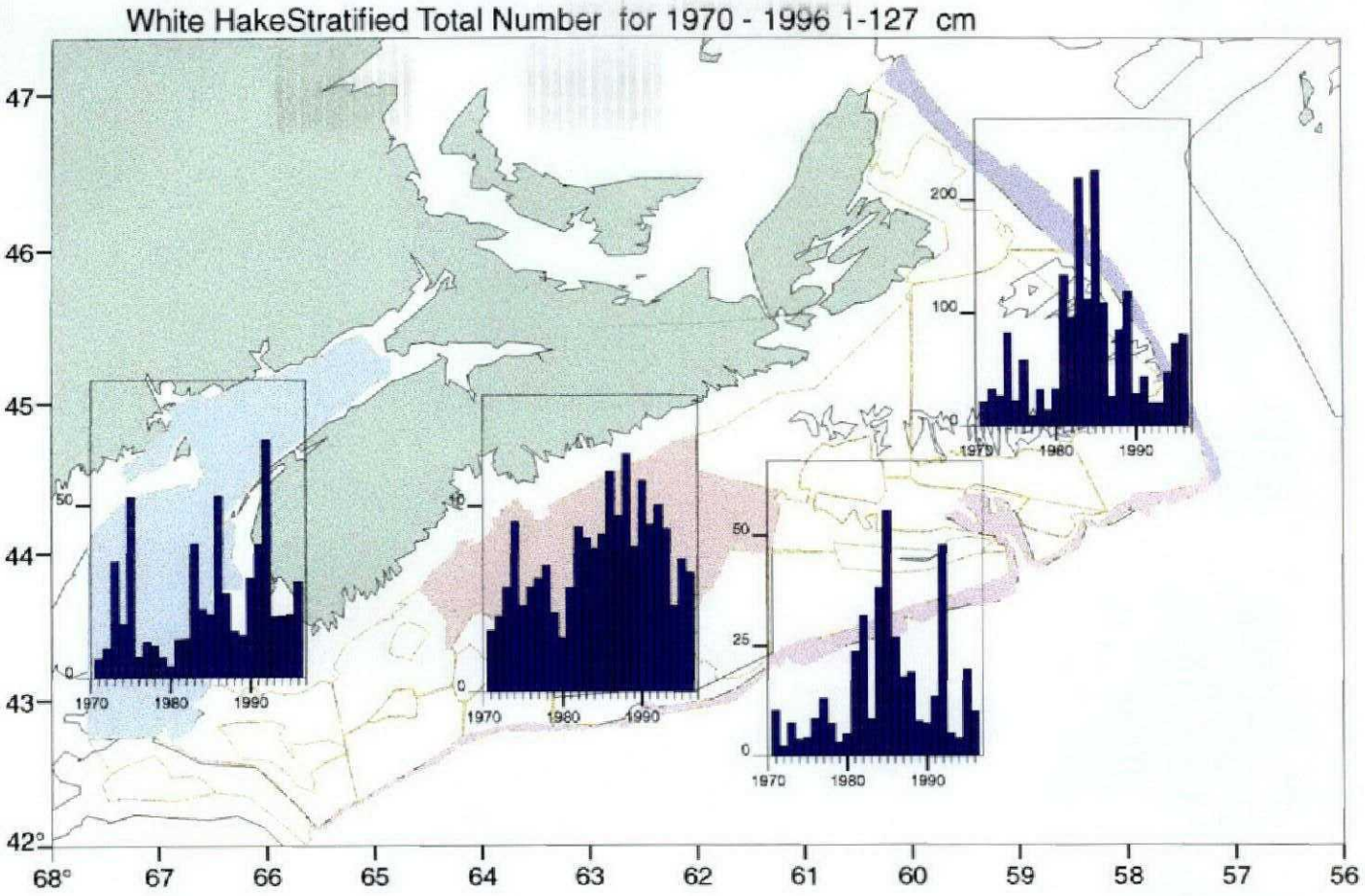


Figure 15c. Stratified abundances of white hake as determined by Research Vessel surveys from 1970 to 1996.

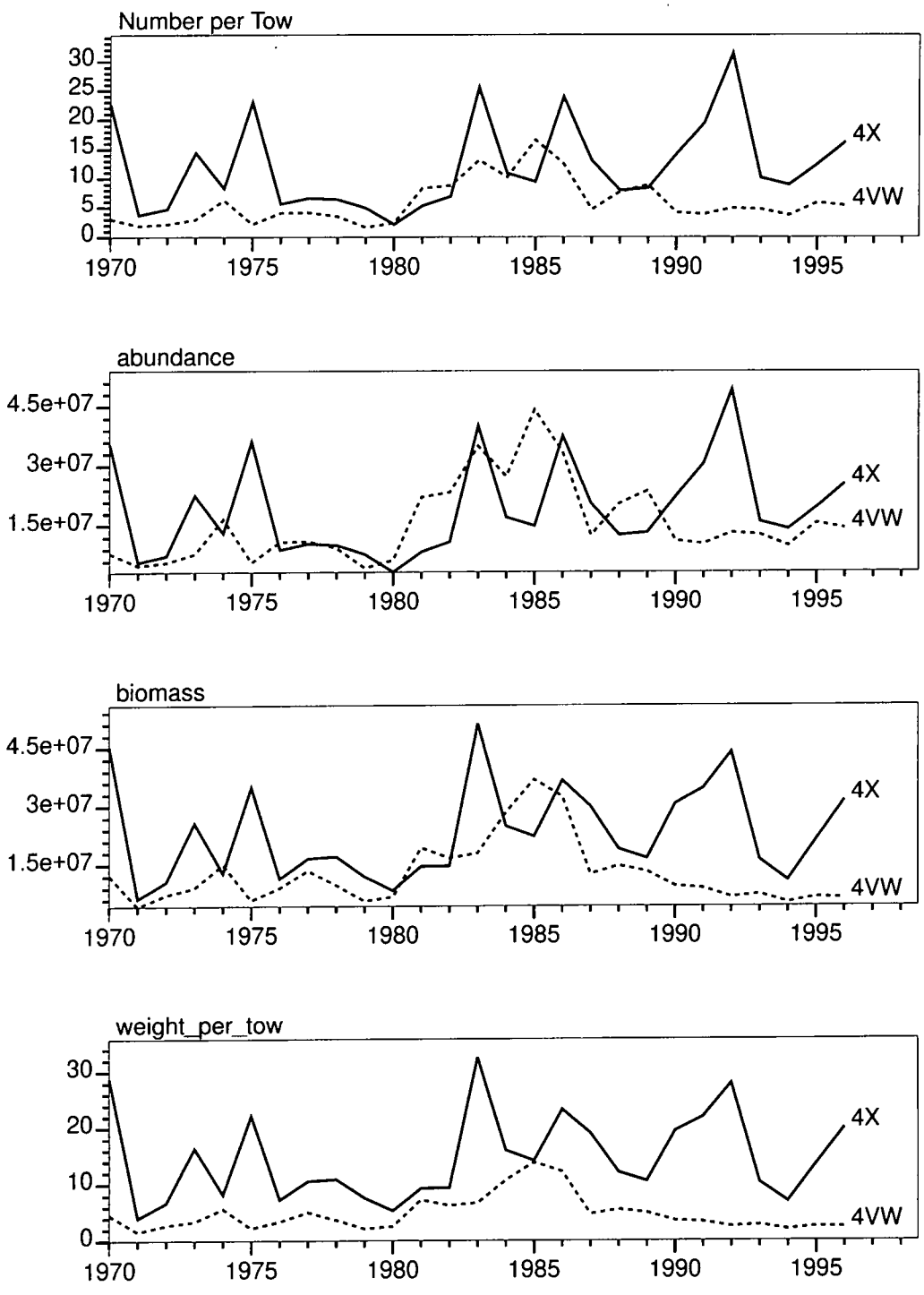


Figure 16. Abundance and biomass estimates for white hake as derived from the summer Research Vessel surveys from 1970 to 1996.

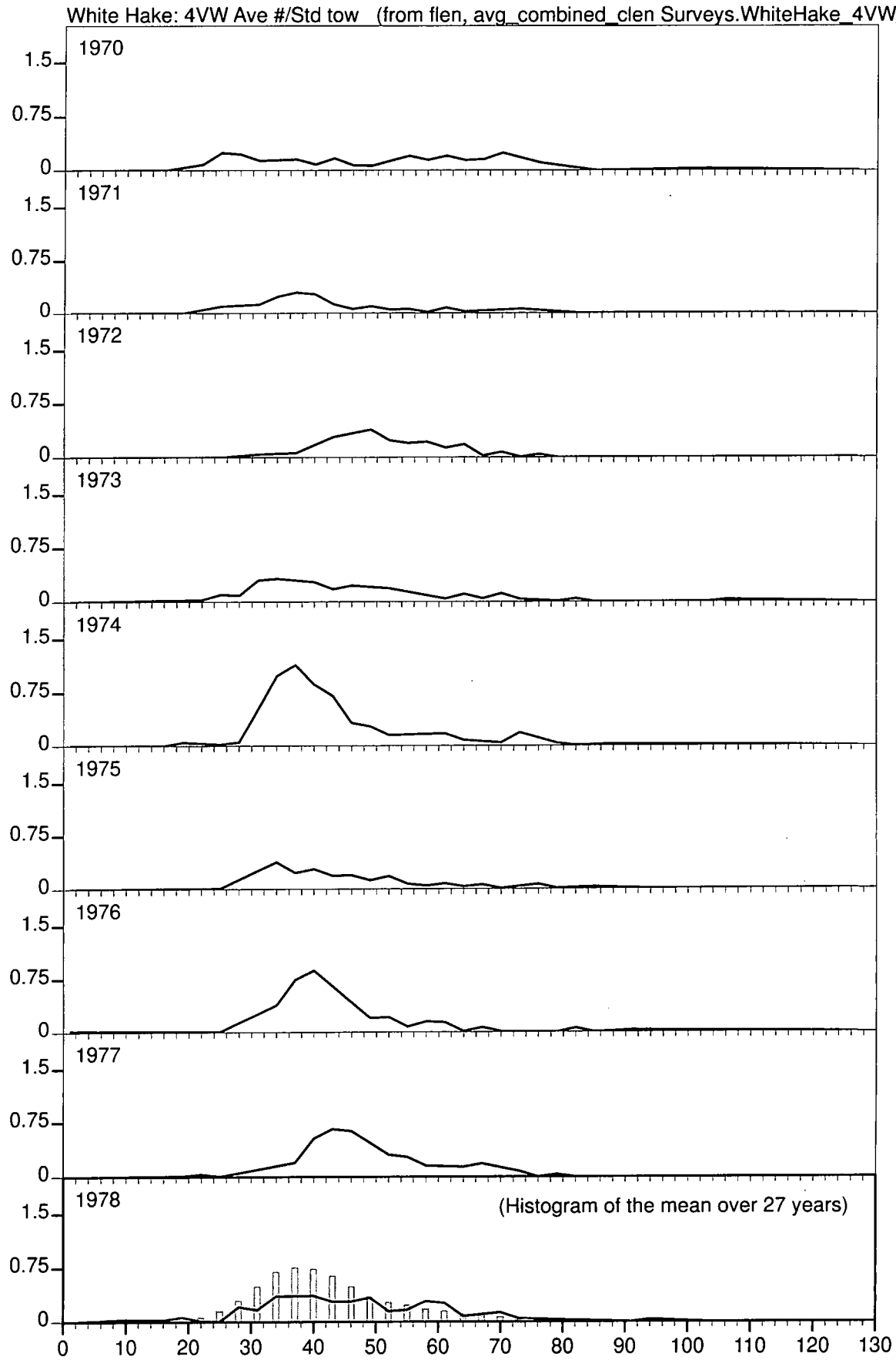


Figure 17a. Length frequencies of 4VW white hake caught during summer Research Vessel surveys from 1970 to 1978.

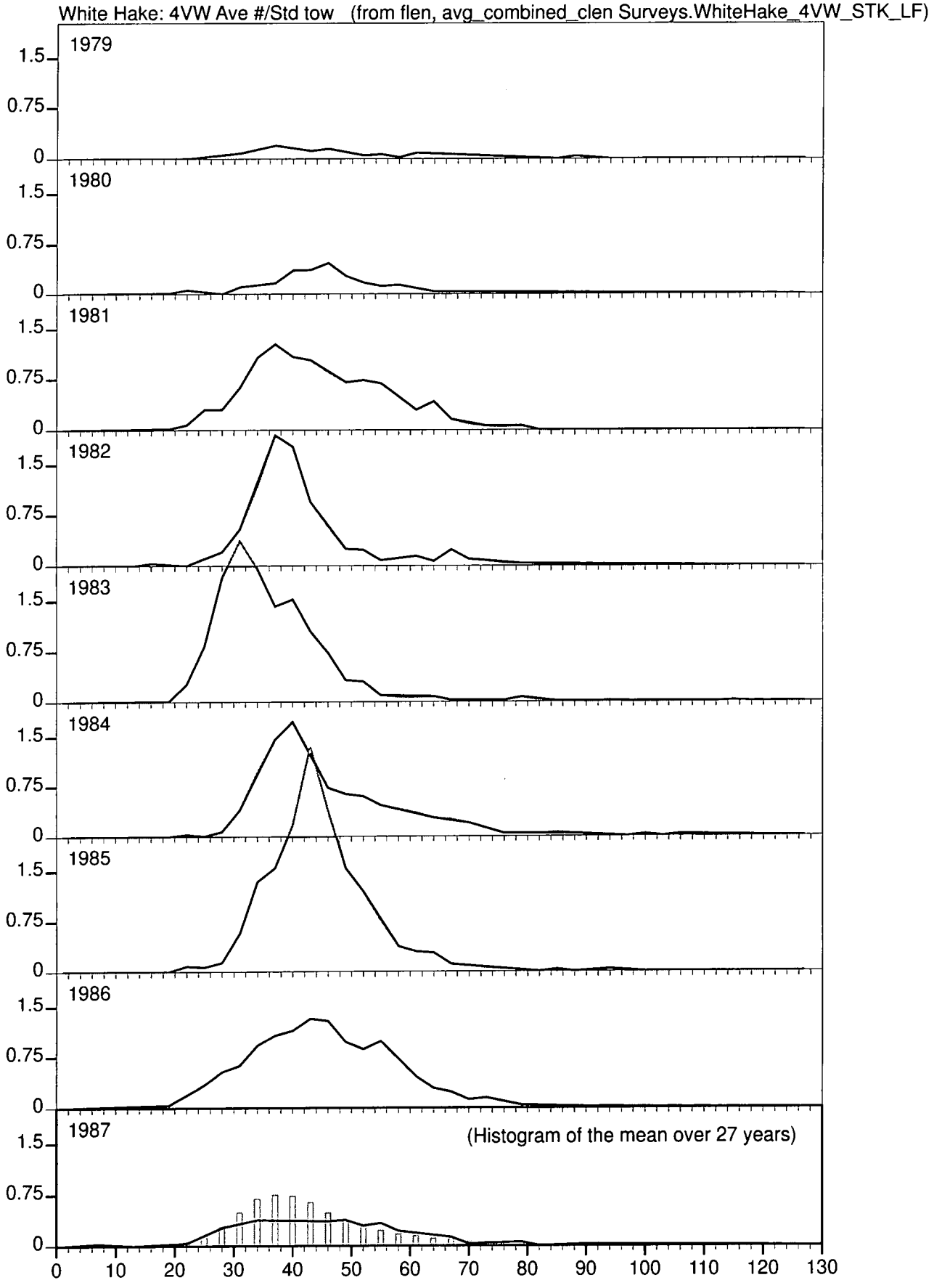


Figure 17b. Length frequencies of 4VW white hake caught during summer Research Vessel surveys from 1979 to 1987.

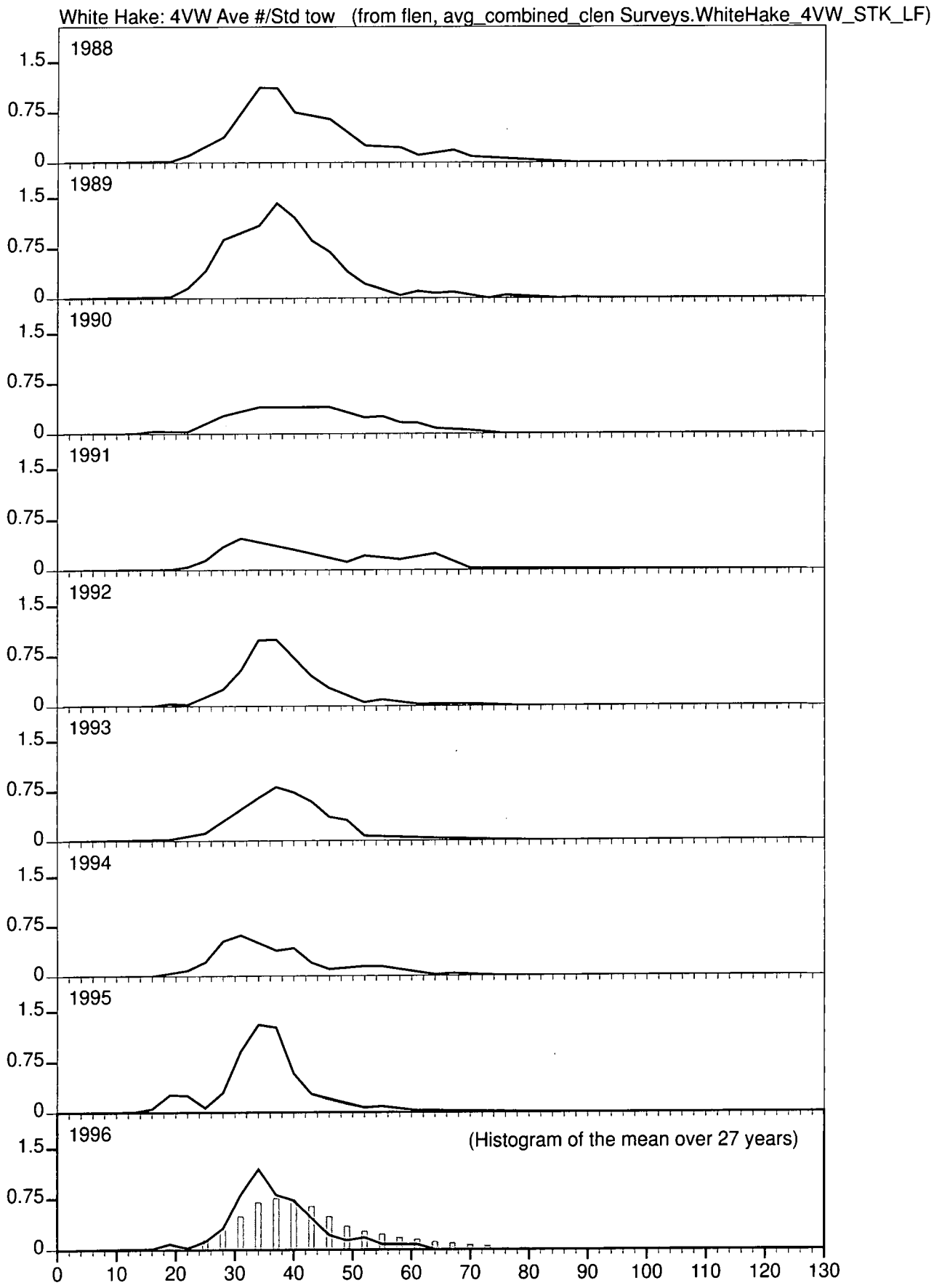


Figure 17c. Length frequencies of 4VW white hake caught during summer Research Vessel surveys from 1988 to 1996.

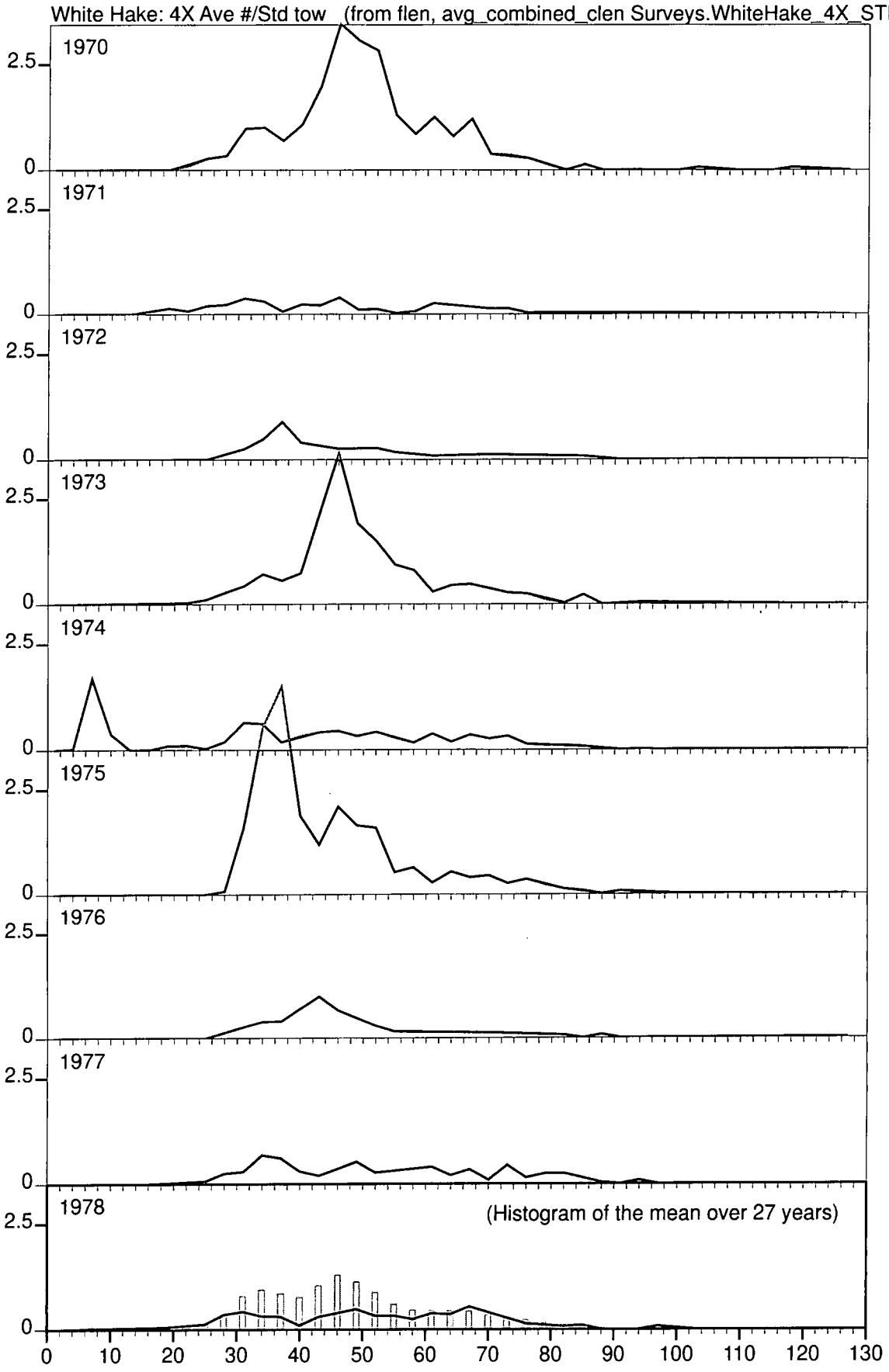


Figure 17d. Length frequencies of 4X white hake caught during summer Research Vessel surveys from 1970 to 1978.

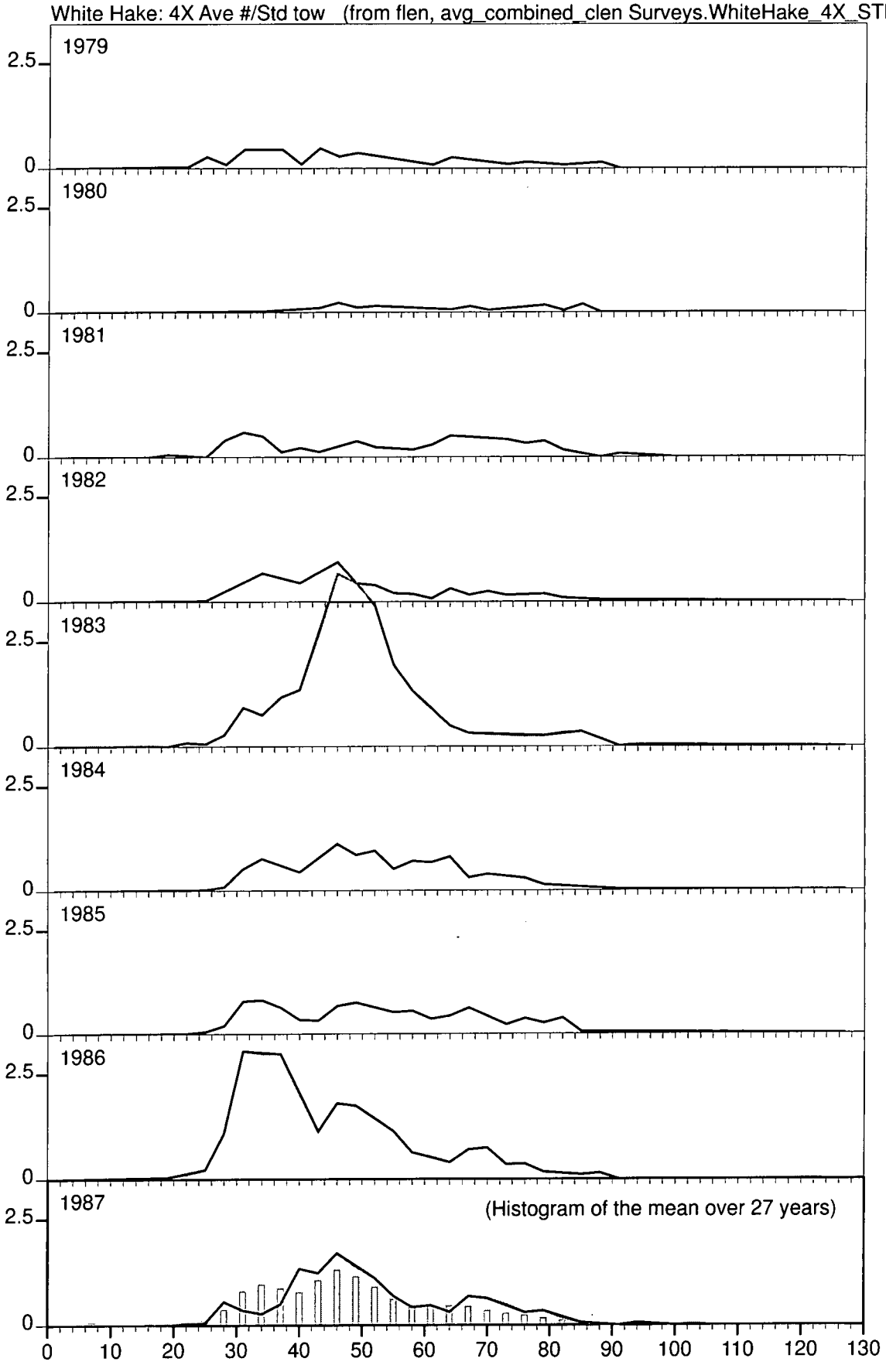


Figure 17e. Length frequencies of 4X white hake caught during summer Research Vessel surveys from 1979 to 1987.

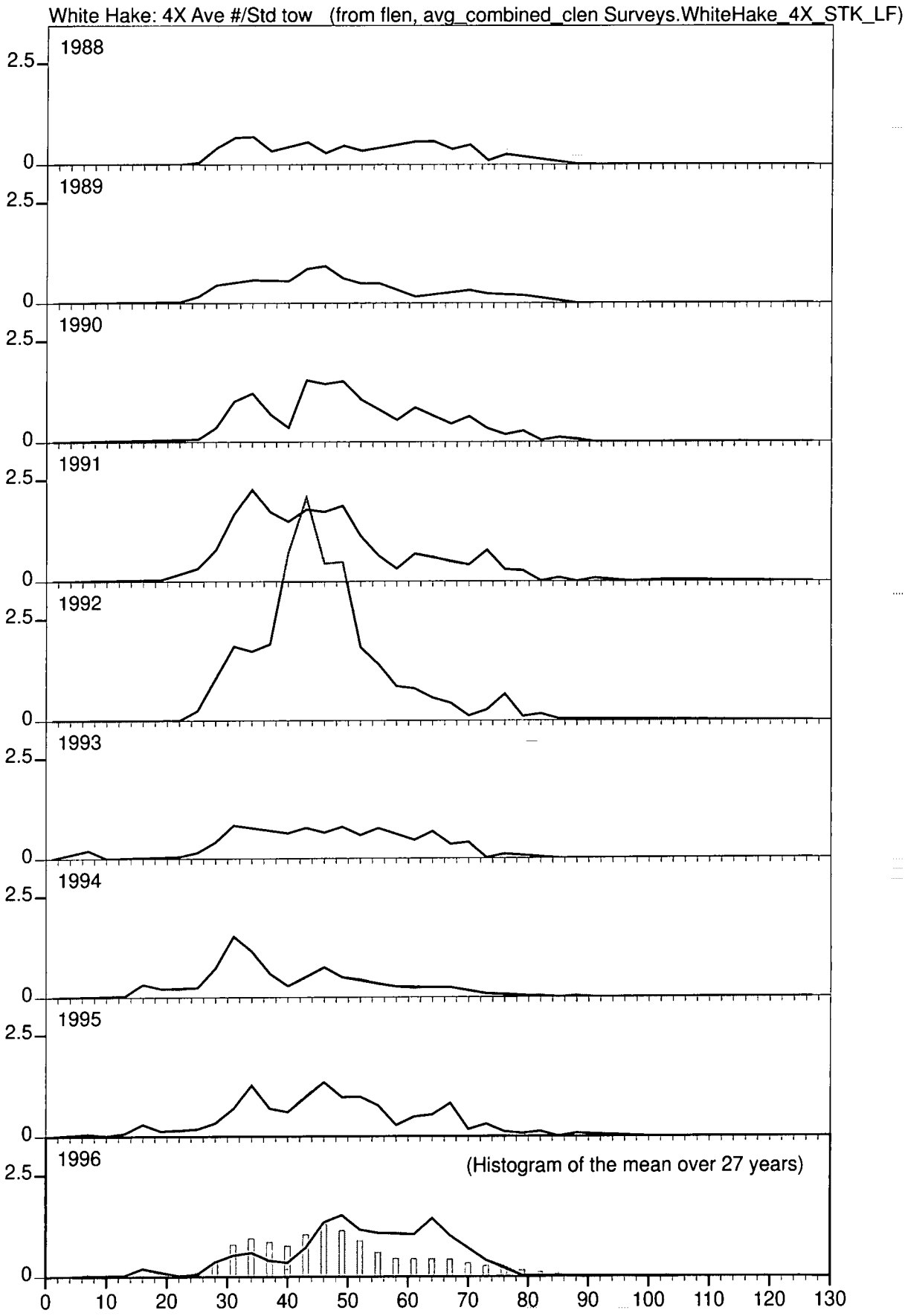


Figure 17f. Length frequencies of 4X white hake caught during summer Research Vessel surveys from 1988 to 1996.

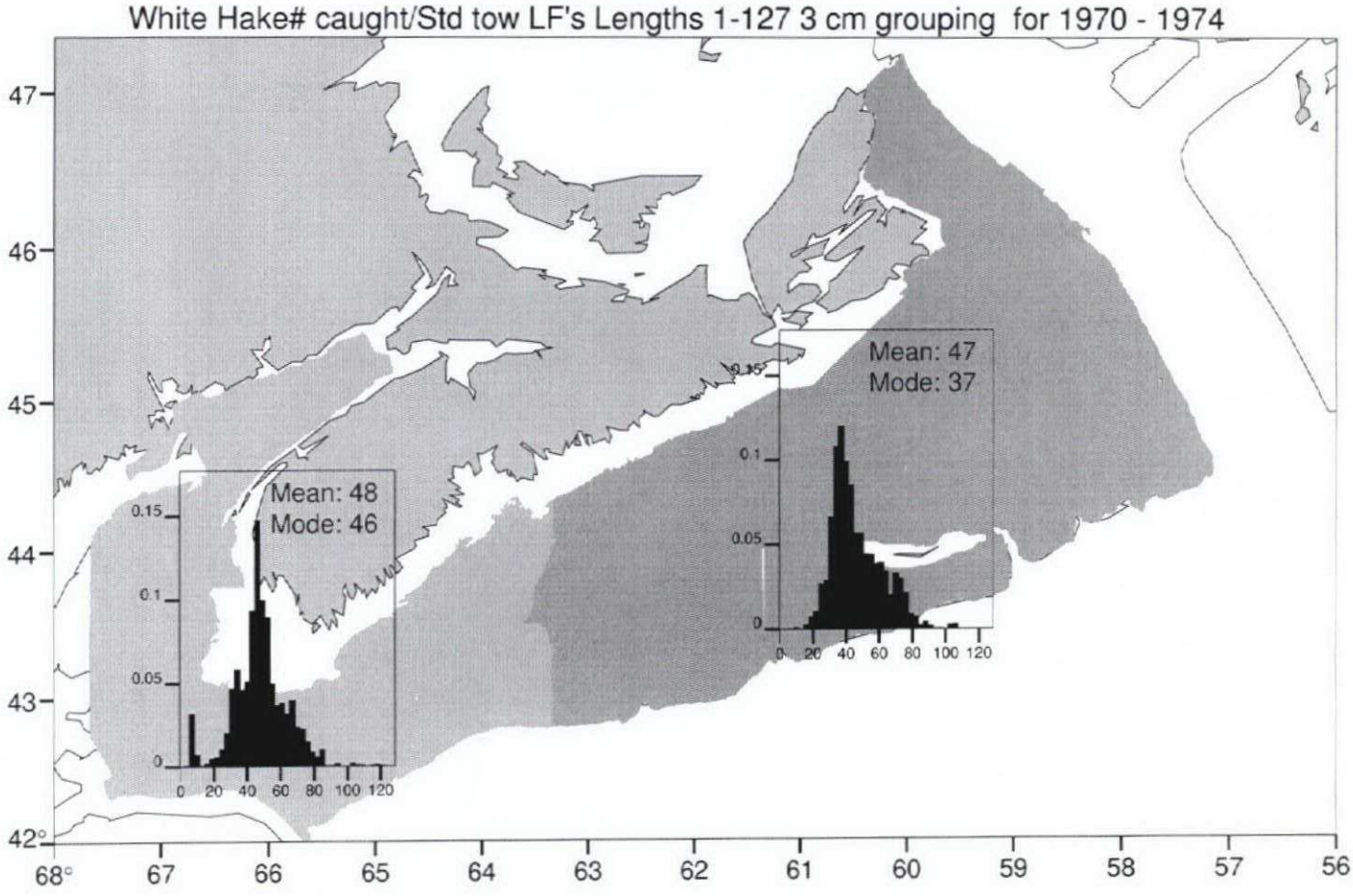


Figure 18a. Composite length frequencies (proportions at length) of 4X versus 4VW white hake from Research Vessel surveys during 1970 through 1974.

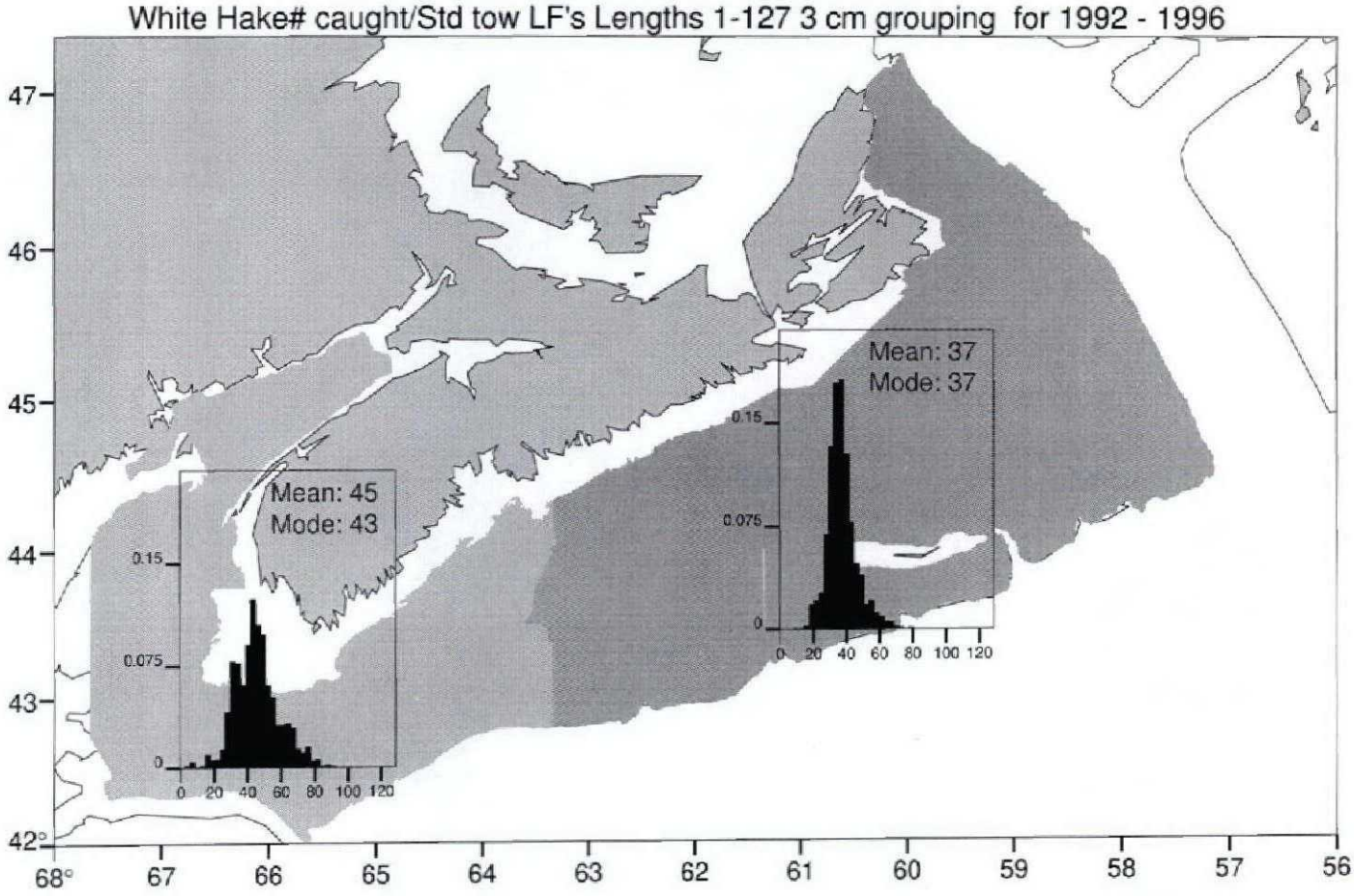


Figure 18b. Composite length frequencies (proportions at length) of 4X versus 4VW white hake from Research Vessel surveys during 1992 through 1996.

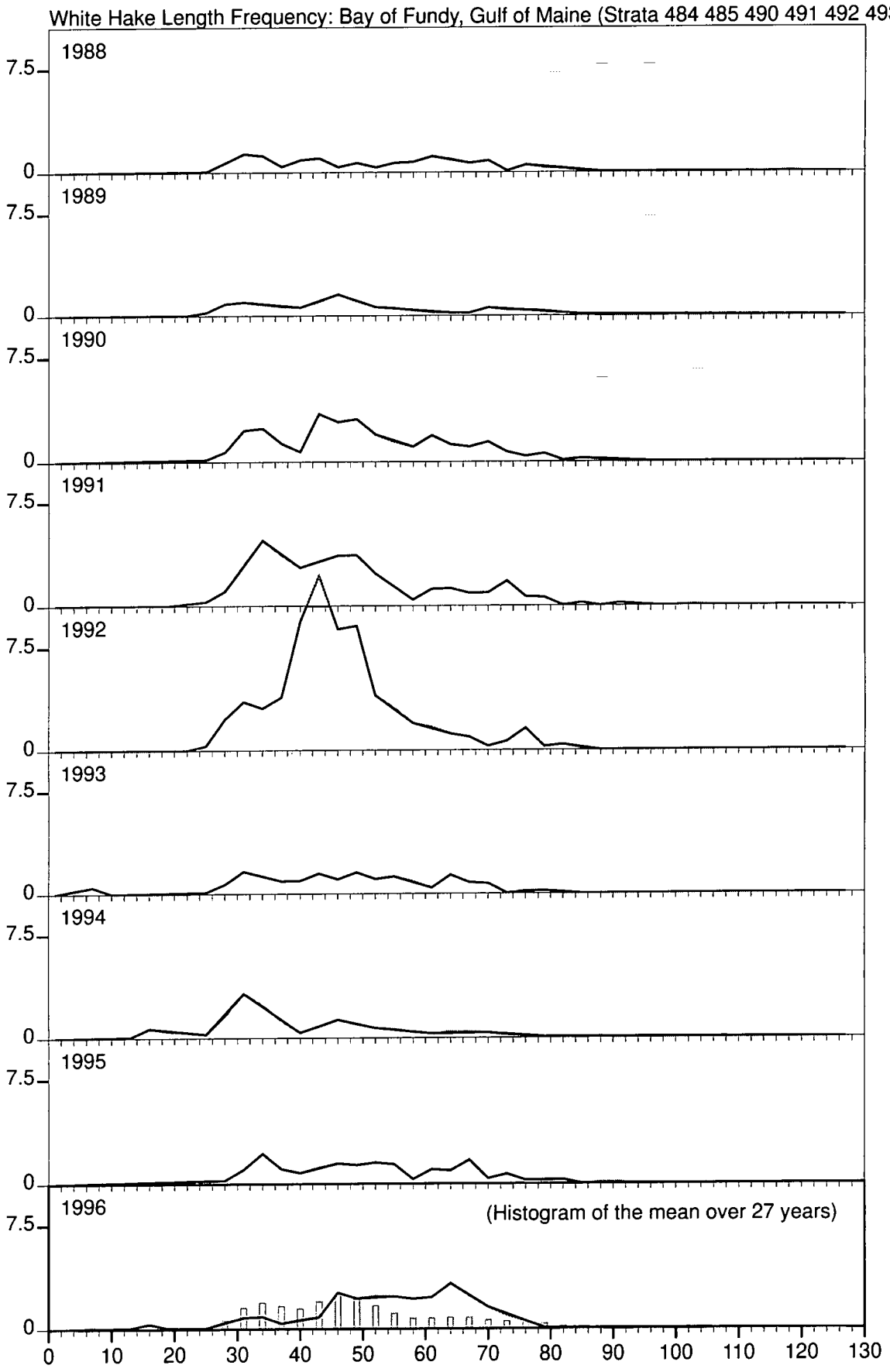


Figure 19a. Length frequencies of Gulf of Maine / Bay of Fundy white hake caught during summer Research Vessel surveys from 1988 to 1996.

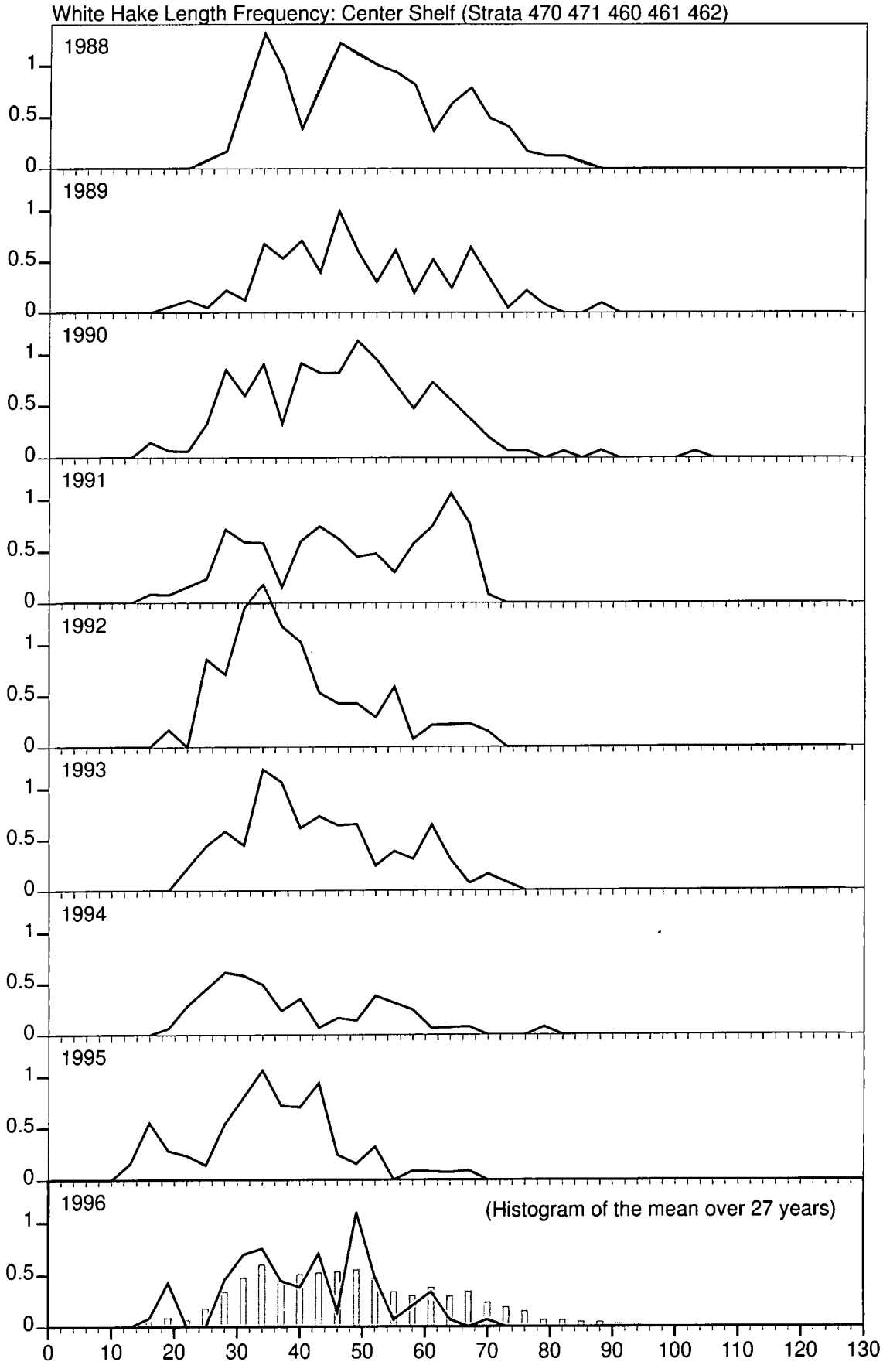


Figure 19b. Length frequencies of Shelf 'Basins' white hake caught during summer Research Vessel surveys from 1988 to 1996.

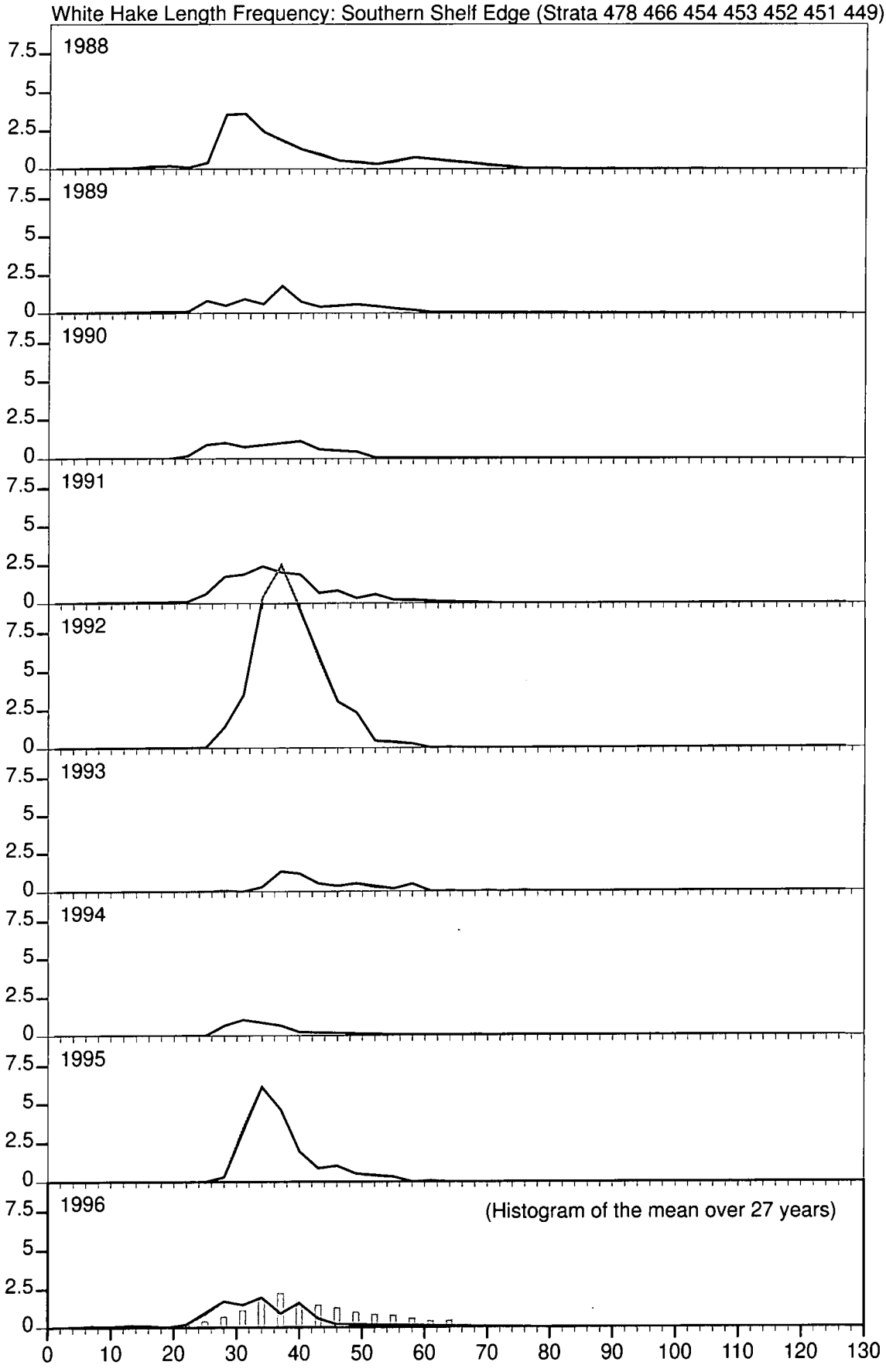


Figure 19c. Length frequencies of white hake caught along the southern edge of the Scotian Shelf during summer Research Vessel surveys from 1988 to 1996.

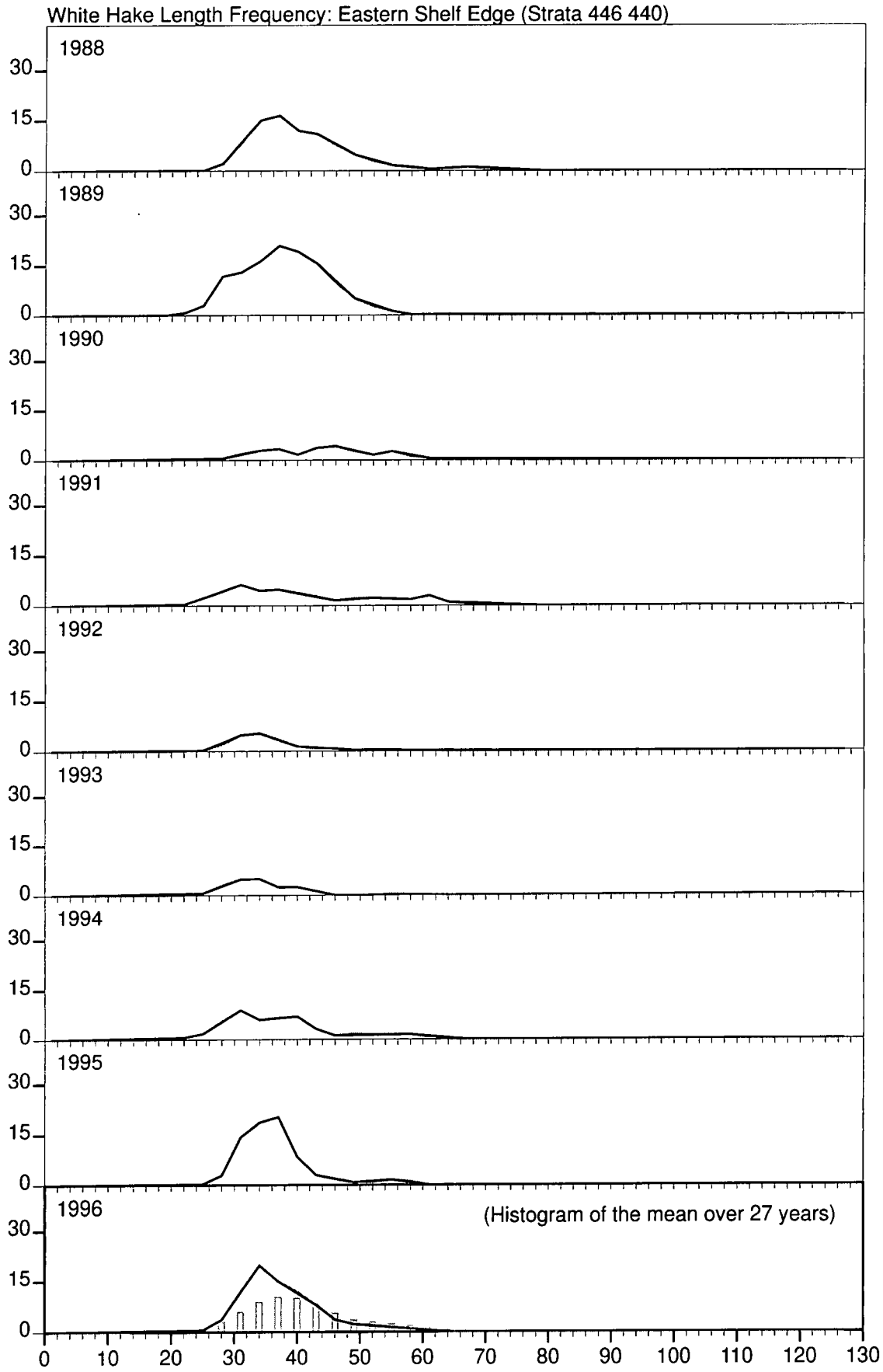


Figure 19d. Length frequencies of white hake caught along the eastern edge of the Scotian Shelf during summer Research Vessel surveys from 1988 to 1996.

Figure 20. Estimation of fishing mortality from length ('age') frequency (simulation assuming $F_{0.1}$).

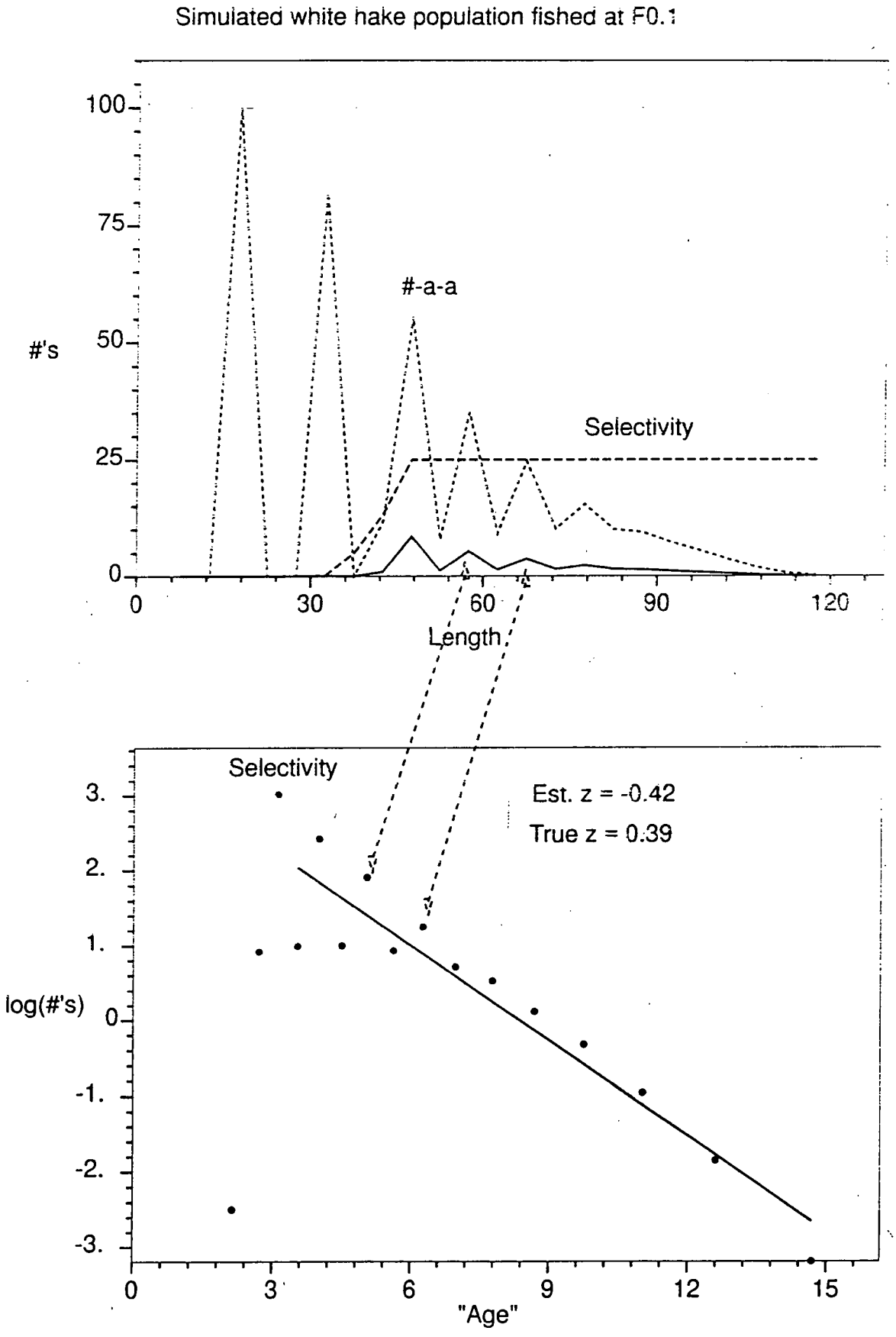
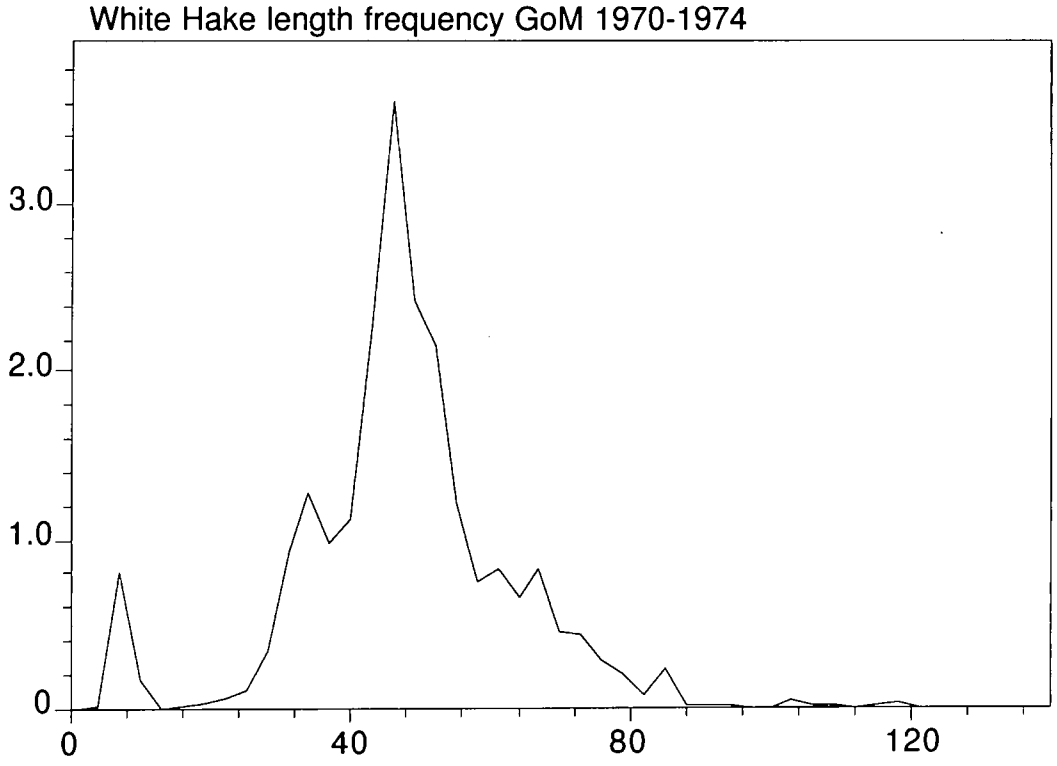


Figure 21a. Estimation of fishing mortality for Gulf of Maine white hake across years 1970-74.



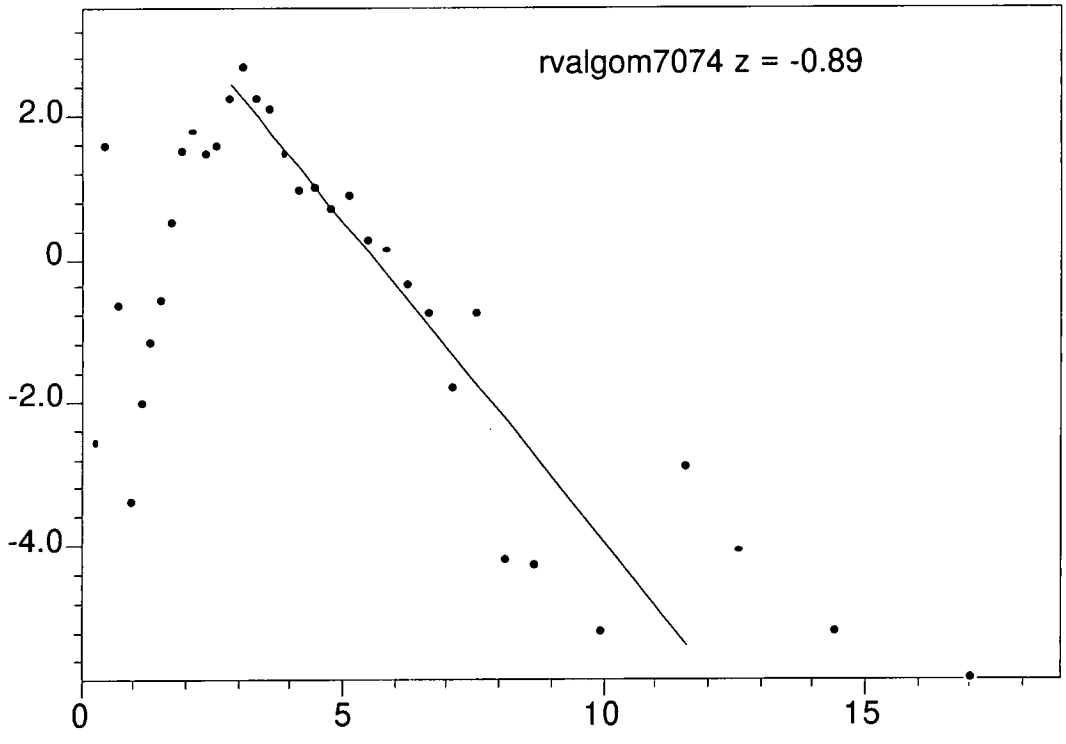
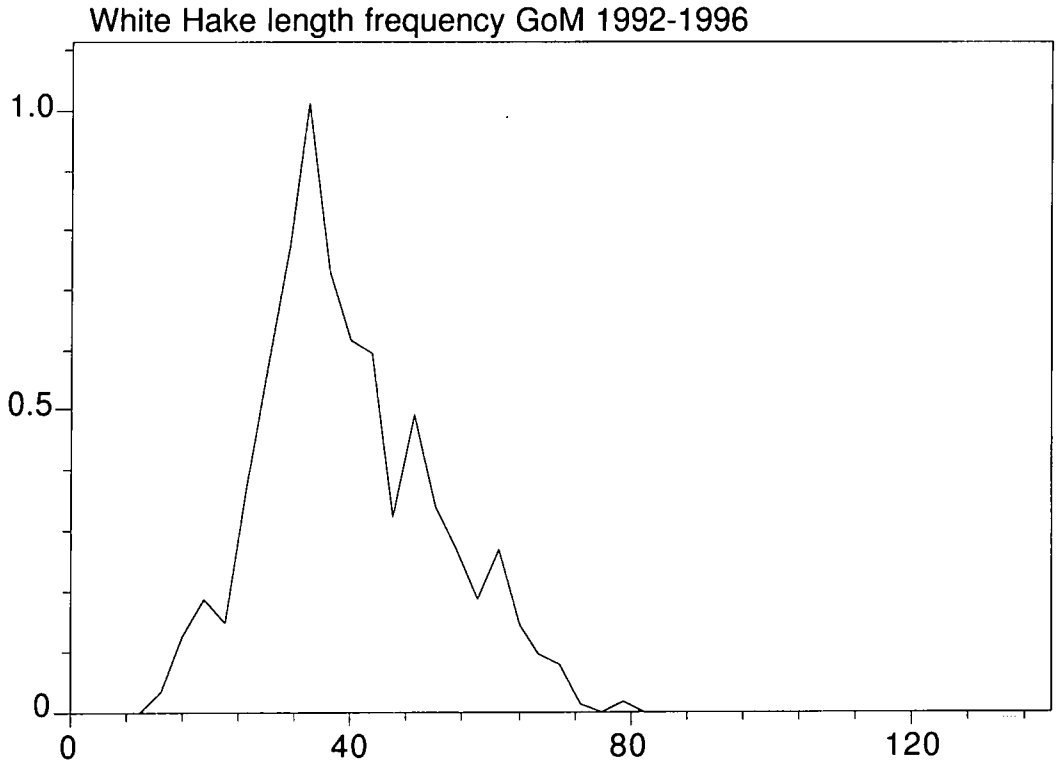


Figure 21b. Estimation of fishing mortality for Gulf of Maine white hake across years 1992-96.



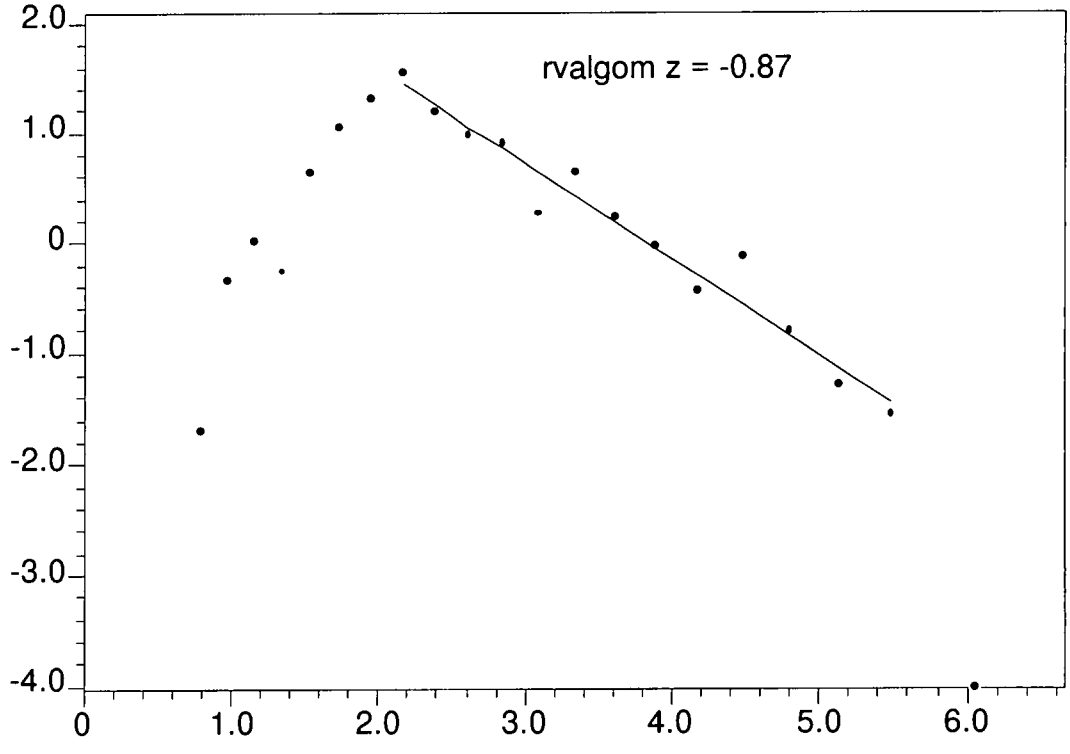
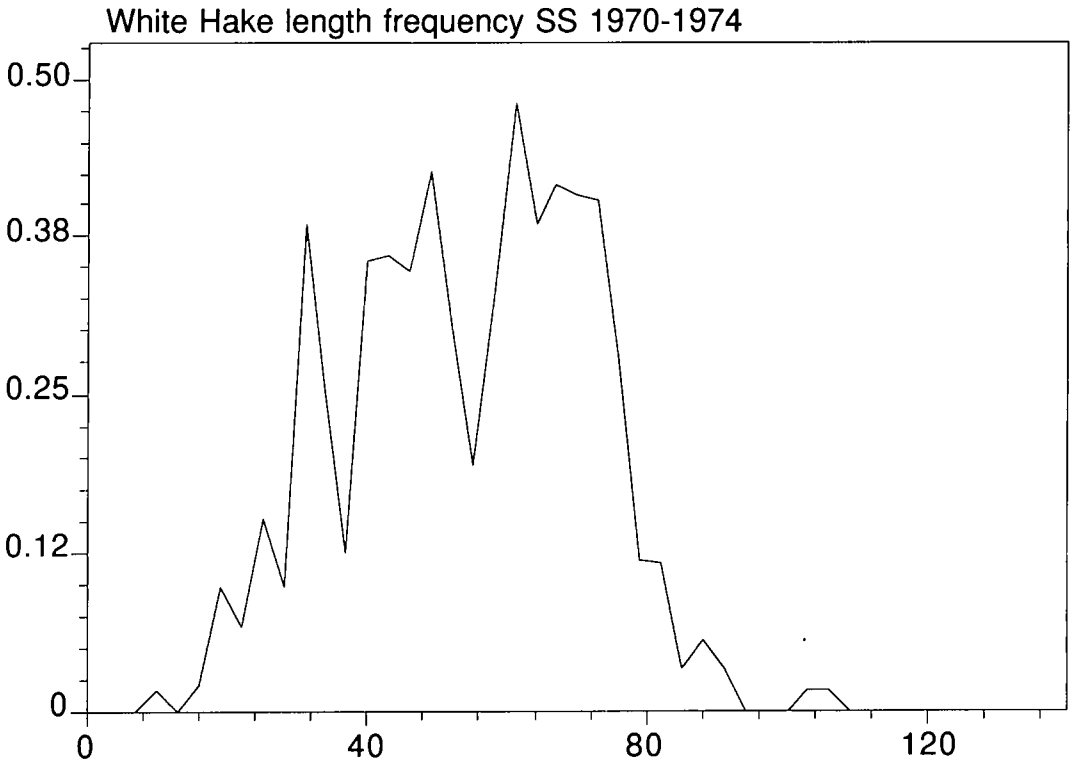


Figure 21c. Estimation of fishing mortality for Scotian Shelf 'Basins' white hake across years 1970-74.



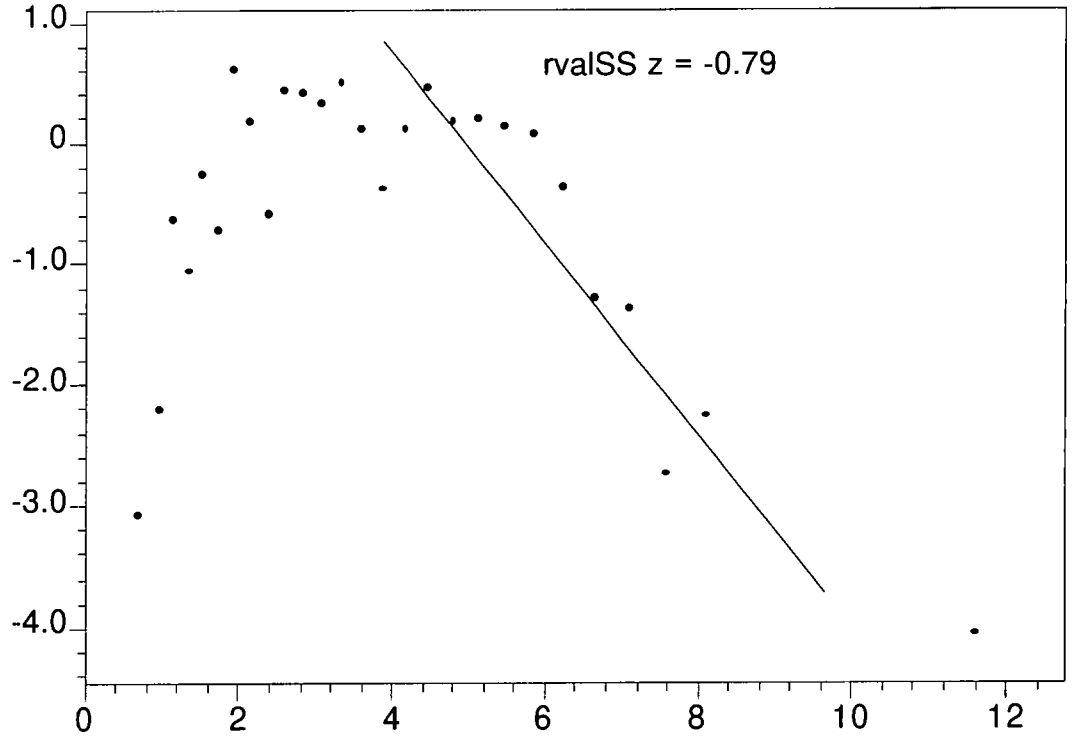
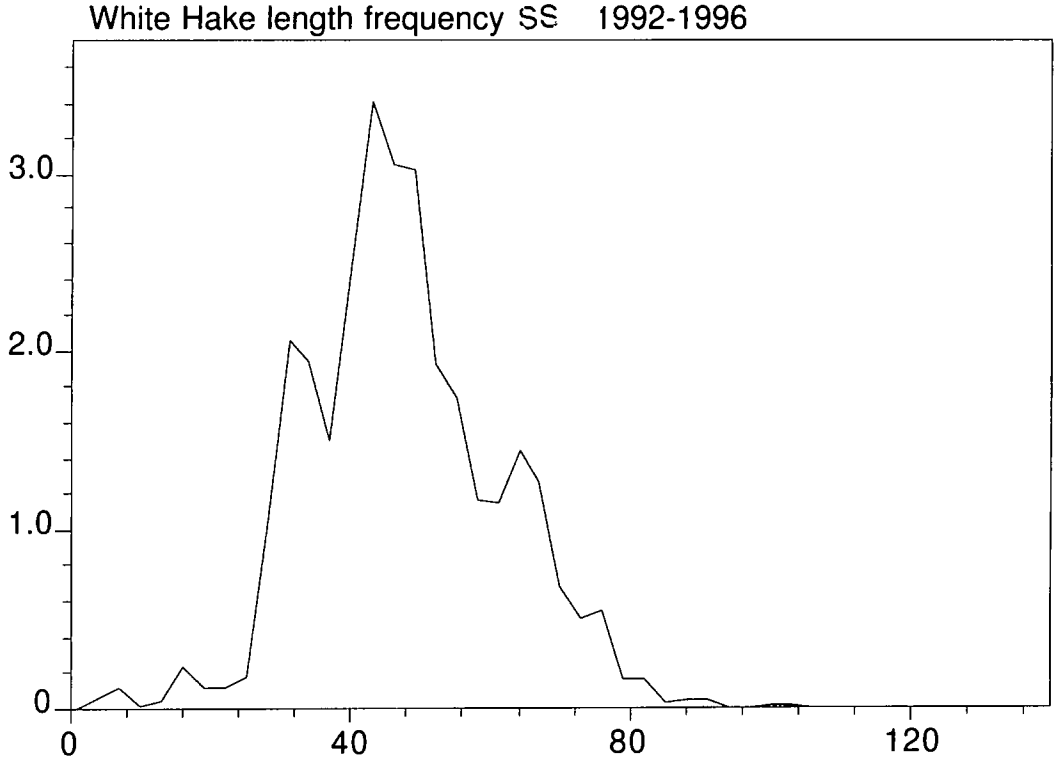


Figure 21d. Estimation of fishing mortality for Scotian Shelf 'Basins' white hake across years 1992-96.



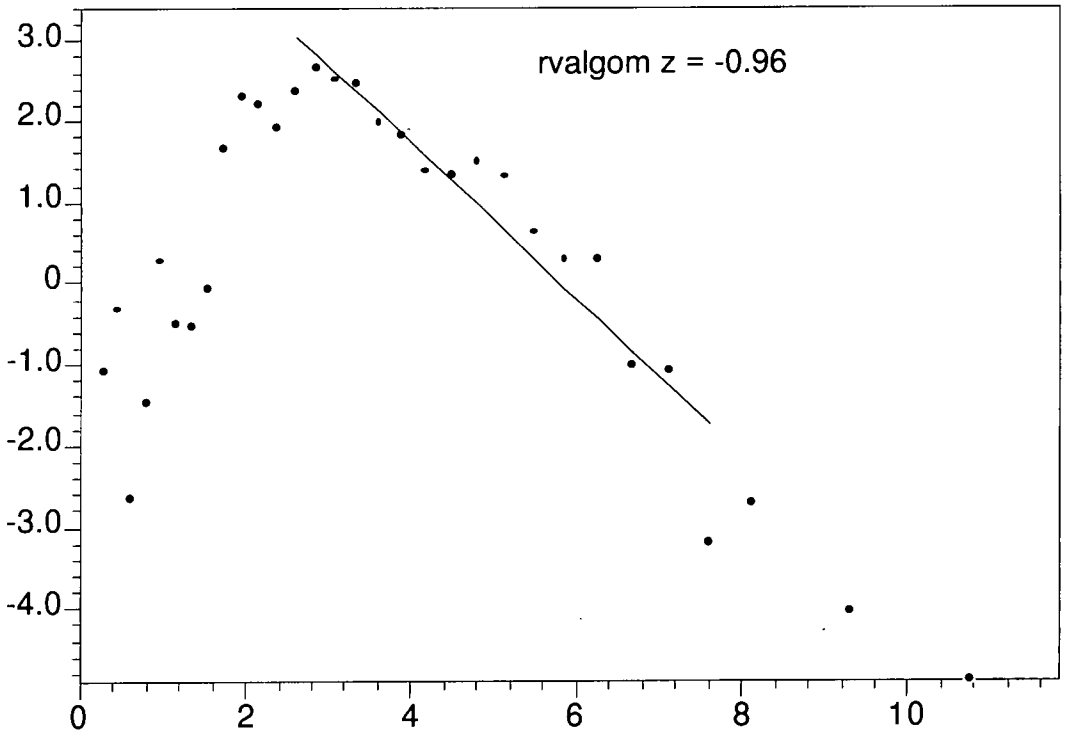
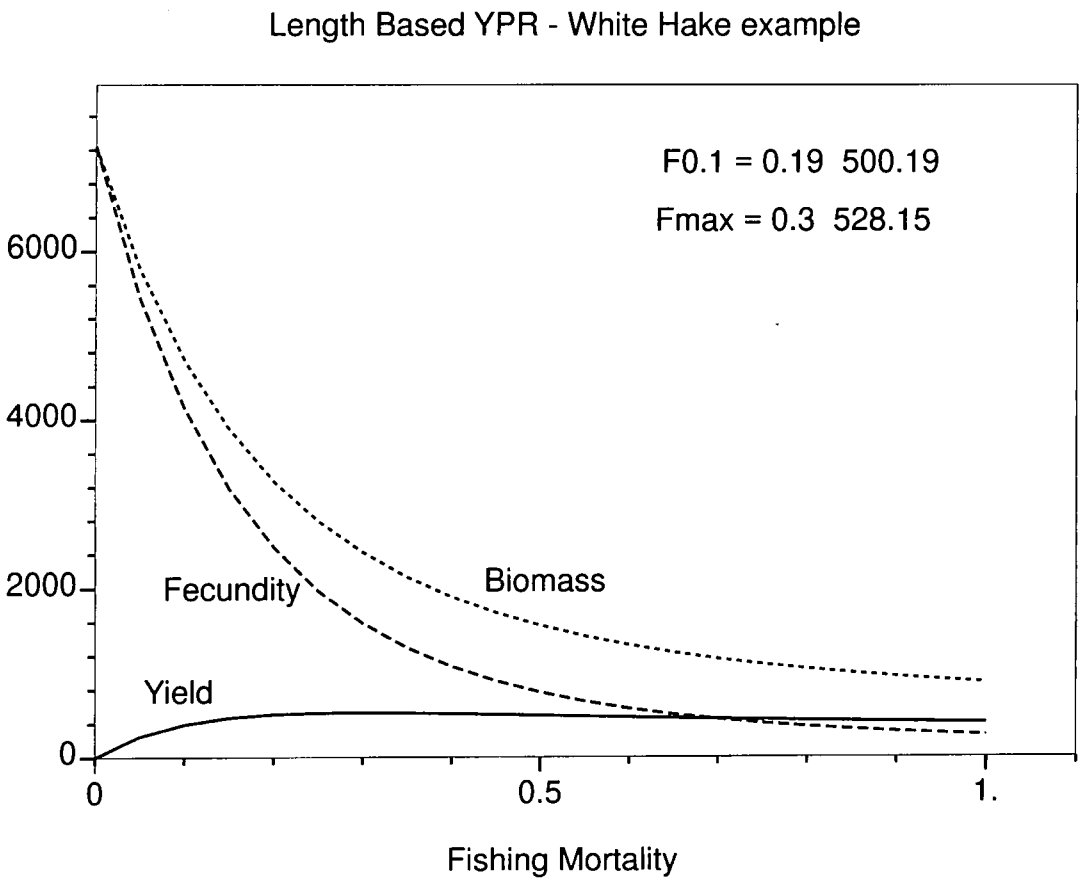


Figure 22. Projected trends in biomass, fecundity, and yield with fishing mortality for Scotia/Fundy white hake.



F	Biom.	Fec.
0.	1.	1.
0.1	0.64	0.56
0.2	0.45	0.34
0.3	0.33	0.21
0.4	0.26	0.14
0.5	0.21	0.1
0.6	0.18	0.07
0.7	0.16	0.06
0.8	0.14	0.05
0.9	0.13	0.04
1.	0.12	0.03