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4VWX and 5 White Hake 1998 Stock Assessment

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Abstract

Commercial landings and catch rates, and research vessel survey abundance indices are at or near record lows for the 4VWX/5Zc white hake stock unit. For assessment purposes the stock unit has been partitioned into separate 4V, 4W, and 4X/5 components to reflect discontinuities in white hake distribution. The downward trends in abundance indices and catch rates for 4X/5 suggest that this portion of the stock may be at risk of collapse. Abundance indices of the 4W and 4V components of the stock have remained near record lows since 1995 and 1987 respectively, showing only weak signs of recovery. Current management measures will need to reduce removals significantly to sustain 4VWX/5 white hake.

Résumé

Les débarquements et les taux de capture de la pêche commerciale de même que les indices d'abondance des relevés par navire de recherche de l'unité du stock de merluche blanche de 4VWX/5Zc ont atteint ou presque atteint les niveaux records les plus faibles. Aux fins de l'évaluation, l'unité du stock a été divisée en éléments distincts pour 4V, 4W et 4X/5 afin de refléter les discontinuités de la répartition de la merluche blanche. Cette tendance à la baisse des indices d'abondance et des taux de capture en 4X/5 porte à croire à un risque d'effondrement pour cette partie du stock. Les indices d'abondance pour les éléments 4W et 4V sont demeurés à des niveaux faibles presque records depuis, respectivement, 1995 et 1987 et les signes de rétablissement sont limités. Des mesures de gestion devront être prises afin de réduire les prélèvements de façon appréciable et ainsi assurer le maintien de la merluche blanche en 4VWX/5.

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, and first assessed in 1996 (Fowler et al., 1996). 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 stock structure of white hake is not well understood, but does not appear to coincide with the boundaries of the current management regions. Based on a review of existing information pertaining to white hake stock distributions and spawning activity (Fowler et al., 1996), which demonstrated consistent discontinuities in distribution over time (Figure 1), and differences in patterns of abundance over time evidenced by summer research vessel (RV) surveys, we now assess 4V, 4W and 4X/5 as separate components of a stock complex. The present management units for white hake (*Urophycis tenuis*) are North Atlantic Fisheries Organization (NAFO) Divisions 4T, 4VWX+5Zc (Figure 2), and the United States part of 5Z plus 5Y and 6. It is likely that white hake in 4X/5 are contiguous with the US Gulf of Maine - Georges Bank stock unit, and that the 4V fish are contiguous with the 4T Gulf of St. Lawrence stock unit.

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 catches should be restricted to the average landings of 2,500t observed during the 1970s, a Total Allowable Catch (TAC) was implemented for the first time in 1996. The fixed gear under 65' fleet sector was allocated 3420t, with 2,000t for 4X , 920t for 5Zc, and 500t for 4VW. For 5Zc, the fixed gear quota in 1996 was set at double the 1994/95 landings. The rationale for the increase was that the cod and haddock TACs on Georges Bank were higher in 1996 relative to 1995. Other fleet sectors have been restricted with by-catch regulations: 20% limit for the ITQ fleet under 65', 10% limit for trawlers over 65'. In 1997 the fixed gear under 65' TAC was reduced to 3100t, with 2400t allocated to 4X/5Zc and 700t to 4VW. There have been no separate allocations for 5Zc since 1996. The 1998 TAC is 3500t. The fixed gear (less than 65') quota is allocated proportionally to each association based on number of vessels per group. Quota trades between groups are permitted.

The Fishery

Landings from 1966 to 1998 are shown by NAFO Divisions in Table 1. Most of the landings during the past three decades have come from 4X. Total landings have declined since 1995. Landings were already in decline throughout the 1990's in 4VW. Landings from 5Zc began to fall in 1994. Area closures in 4VW prompted a general shift in fishing effort to the 4X/5 region in 1995, primarily to the southwestern (more offshore) unit areas 4Xq, 4Xp and 4Xn (Table 2). Landings of white hake from 4X/5Y rose considerably in 1995 as a result, but then dropped in 1996 to the lowest level seen since 1983, and have since continued to fall. Landings in 4VWX/5 to date (1423t to Oct 7, 1998) suggest that 1998 may prove the lowest in three decades.

The seasonal characteristics of the Canadian fishery on white hake (Table 3) are difficult to interpret, being confounded by management measures applied to major stocks (cod, haddock, pollock) that can result in sudden redirections of effort onto or off of white hake. In 1995, for instance, the suggestion of a seasonal pattern of spring/early summer and fall peaks, often indicative of migratory movements of a population, actually reflects fishery responses to the end of March closure of Browns Bank and fall exhaustion of 4X cod/haddock/pollock TACs.

The 1993 to 1998 Canadian landings by unit area and gear type (Table 4) depict a transition in the fishery from initial domination by longliners with gillnets and otter trawlers secondary, to relative parity between longline and gillnet sectors by 1997. Concern has been expressed that the fishing mortality associated with the increased proportion of the landings being taken by the gillnet fleet may be greater than would be suggested by landings alone, due to a perceived practice of leaving active nets untended in order to return to port to offload. This matter should be investigated to ensure compliance with the 40 net per boat limitation, and otherwise dissuade any tendency to leave nets untended, should the allegations prove founded.

The proportion of the Canadian landings for which the logs indicate that white hake was directed for, is shown from 1966 to 1998 in Table 5. Until 1988 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. Some doubt exists regarding the accuracy of the reported landings in some years, especially when fishing was restricted by pollock quota. It has been suggested that some portion of the white hake landings might actually be misreported pollock ('black hake'), which would inflate both the total landings and the apparent proportions of directed catch of white hake in the relevant years.

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

increased from $0.37/kg in 1988 to $1.05/kg in 1995. The price has remained at about $1.00/kg since 1995. The landed value has been between 2 and 4 million dollars annually.

Length Composition of Landings

Sampling of the Canadian commercial landings for white hake length composition had been inconsistent over time, area and gear sector until the mid-90's (Table 7). The 1993 to 1998 samples allow some comparison between gear types and areas (Figures 3a-c). No clear trends with time are evident in the gillnet and otter trawl samples. We only have gillnet samples from 4X/5, and they exhibit a much narrower length range than other gears, with a mean of 69-70cm across all years. Samples from 4X/5 depict larger fish than 4V in both longline (59-67cm vs 51-58cm) and trawl (61-71cm vs 41-55cm) fisheries. Longliners in 4X/5 caught relatively more large fish in 1997-98 than in previous years, while those in 4V caught fewer large fish than in previous years. The increase in mean length of the size composition in 4X/5 may reflect a westerly shift in fishing effort in response to declines in more nearshore catches , as white hake tend to be larger to the west or offshore (Table 8).

Commercial Catch Rates

A dataset of 1990-98 catch per set for 144 identified vessels that directed for white hake for at least 5 successive years during 1989-98 (Table 9) was created to examine effort and catch per unit effort trends with time. This subset of the catch/effort database represents 17-54% of total landings by year since 1992, with coverage since 1995 at 41% or more. The commercial catch rates of these index fishers, illustrated in Figure 4, have declined since 1996 for all major fleets (longline, gillnet, otter trawl). The decline has been very extreme for longliners and gillnetters, and 1998 presents the lowest catch rates in the series (1990-98) for all fleets.

Analysis of variance using a generalized linear model (S-Plus), of just the 4X/5 catch rates (Table 10), was conducted to obtain standardized catch rates and fishing effort for the 1990-98 period. There were insufficient landings from 4VW to include in the analysis. The formulations are the same as achieved using STANDAR, but with the added flexibility of incorporating interaction effects into the model, and permitting iterative reduction in variance to determine order of entry of main effects. The resulting model demonstrates the critical role of gear sector, location and month of fishing on catch rates, as well as the significance of interactions between year and all other main effects. No attempt has been made to extend the analysis beyond two-way interactions, and a prediction for catch rates by year was generated from this model. The standardized catch rates suggest a cyclic pattern of peaks (1991,1996) and troughs (1994) that may reflect the passage of dominant cohorts, but the long-term trend (peak to peak) is downward.

Research Vessel Survey Abundance Trends

Summer research vessel (RV) survey biomass and catch rate estimates have been computed separately for 4V (strata 440-452), 4W (strata 453-466), and 4X (strata 470-495). The survey strata and their corresponding NAFO division associations are shown in Figure 5. An intercalibration study (Fanning, 1985) to compare catchability of the three different vessels used over the time series (1970-1998) suggests that no adjustment is required to standardize white hake catches across survey periods (catchability coefficient = 1.0). And based on catch distributions from recent 4X summer ITQ (Individual Transferable Quota) surveys (Figure 6), we feel confident that summer RV sampling of white hake (Figure 7) has not been confounded by the inability of research vessels to sample inshore areas. Very little white hake is caught outside the distributional limits of the summer RV survey.

Prior to at least 1981, no attempt was made to distinguish red hake (*Urophycis chuss*) from white hake on surveys. Since at least 1983 the policy was changed, such that the two species were intended to be identified, but some doubt exists as to the accuracy of the methods used to identify the two species. Based on one leg of the 1996 summer RV survey for which a proven technique (gill raker counts) was consistently used to separate the species, it is apparent that red hake can account for up to half the catch in numbers of the two species. As red hake rarely exceed 35cm, the risk of misidentification is limited to the pre-recruitment component of the white hake catch, but this confounds interpretations of potential recruitment for white hake. A study of identification error probabilities using the different methods should be conducted to quantify possible adjustments for this problem.

Summer RV biomass estimates for 4X (Table 11a and Figures 8-10) have dropped sharply since 1996, with the 1998 estimate of 7824t the lowest since 1971. The size composition (Figure 11) has shifted towards smaller fish since 1995, but with no evidence of a recruitment pulse since 1996. Biomass estimates from the Georges Bank RV survey in March (Table 9 and Figure 10) dropped since 1991 to a record low in 1996, and remain low. Summer RV estimates for 4W (Table 11b and Figure 8) declined from 1986 to a record low in 1995, and have since risen slightly but consistently each year thereafter (2655t in 1998), mostly due to growth rather than recruitment (Figure 12). They are still the lowest of the three components (4X, 4W, 4V) in the summer RV surveys. Summer RV estimates for 4V (Table 11c and Figure 8) dropped sharply from 1985 to 1987, and have since remained low but relatively stable (3096t in 1998). An increase in 1997, mostly attributable to fish of recruited size (Figure 12), was not maintained in 1998, possibly reflecting transiency of 4V white hake. The spring RV survey of 4VsW (Table 12 and Figure 13) indicates extreme decline in biomass since 1987 to a record low in 1993, and began to rise back in 1996. Catches in the 4VsW Sentinel survey (Figure 14) dropped from 1996 to 1997. Catches in the 4Vn Sentinel survey (Figure 15) dropped from 1994 through 1996, but rose in 1997. US spring and fall surveys from 1970 to 1997-8 (Figure 16) track reasonably well within themselves, but vary considerably from the Canadian summer RV survey, especially prior to 1982. Mean weights per tow for both US spring

and US fall surveys since 1983 are generally lower than previous years, and have been at or near record lows since 1994. Early (1978-84) Canadian spring and fall surveys (Table 13, Figures 10 and 13) also diverge from the Canadian summer survey, and although suggestive of some degree of correspondence with the US surveys, were not conducted for enough years to substantiate a relationship. Mean individual weights of white hake in summer RV surveys (Figure 17) in general have declined since 1984.

The declines in 4V may in part be due to colder water temperatures causing either expiration or relocation of white hake. 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, and far below the 4^{0}C threshold for large catches of this species from RV surveys. In 4W the temperature didn't fall below 5^{0}C, suggesting that declines were attributable to fishing. This may account for the slight but consistent recovery trend in 4W abundance estimates.

The standardized commercial and RV survey catch rates for 4X+5 and 4X respectively, track one another quite well in most years (Figure 18), giving some confidence that we are not seeing extreme anomalies. Survey catch rates for fish over 45cm, a compromise length to reflect fishable biomass without including misidentified red hake, show less correspondence with the commercial catch rate (mostly due to the 1996 datum).

Estimates of Fishing Mortality

Removals at length (Table 14 and Figure 19) for combined longline/gillnet/otter trawl fisheries from 1993 to 1997 (minimum 97% of landings in any year) were estimated by applying RV survey length-weight relationships to the commercial length frequencies, and bumping up the result in proportion to the landings. A von Bertalanffy growth equation for the US Gulf of Maine - Georges Bank white hake stock unit (Sosebee, 1998) was then used to assign ages to the removals at length, and mortality rates, just for the 4X/5 stock component, estimated using the linearized catch curve based on age composition. This method is described in section 4.4.5 of Sparre et al (1989). The same method was applied to the RV survey catch at age without weighting by landings. As well the traditional method of pooling ages according to

Z = natural log[number age 3-6 / number age 4-7]

, was applied to the unweighted RV catch at age for comparison.

Using either of the Jones or Sparre methods, the mortality rates for the 4X white hake derived from RV survey catch at length data depict an increase in fishing mortality from 1980-81 through 1993, followed by a decline through 1995, an increase in 1996, and

decline through 1997 or 1998 (Figure 20). From 1992 through 1996 the catch curve mortalities depict exploitation rates in excess of 50%. The mortality rates derived from commercial catch at length data for the 1993-1997 period in 4X/5 reflect the same pattern as the RV mortality rates, but are less indicative of a continuing decline after 1996. The overall patterns of mortality, regardless of data source or computational method, correspond with each other, and appear to broadly follow the pattern of landings as well.

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Table 1. White Hake Landings (metric tons) as reported to NAFO. Includes foreign landings through 1992. Landings for 1993-98 are Canadian only. NAFO area 5Zc (c=Canada) has only existed since 1986.

Area / Year	4Vn	4Vs	4W	4X/5Y	5Zc	TOTAL
1966	348	22	433	827		1630
1967	127	254	241	507		1129
1968	138	50	325	965		1478
1969	137	65	544	1710		2456
1970	189	83	741	2063		3076
1971	433	124	1458	3003		5018
1972	199	271	1298	4084		5852
1973	273	146	1450	3843		5712
1974	223	142	1331	4013		5709
1975	181	138	1338	2910		4567
1976	261	116	757	2214		3348
1977	288	152	848	2052		3340
1978	202	257	773	2534		3766
1979	338	182	367	2160		3047
1980	585	369	342	2603		3899
1981	564	222	413	2364		3563
1982	414	204	609	3575		4802
1983	401	315	630	2595		3941
1984	239	301	690	3419		4649
1985	346	542	1109	3109		5106
1986	397	538	1412	4833	648	7828
1987	587	751	1609	5278	555	8780
1988	333	379	789	4008	534	6043
1989	293	476	946	3425	583	5723
1990	191	311	1239	3735	547	6023
1991	172	301	1044	2860	563	4940
1992	158	304	810	3455	1138	5865
1993	129	281	768	3633	1681	6493
1994	169	212	598	3235	955	5168
1995	26	283	594	4242	481	5627
1996	69	126	522	2803	372	3892
1997	138	75	251	2688	290	3443
1998	105	68	95	587	53	908

Landings for 1998 as processed to end of July.

Table 2. Canadian landings (metric tons) of white hake by unit area for 1993 through the first half of 1998.

	1993	1994	1995	1996	1997	1998
4VB	1	3	2	0	0	1
4VC	261	142	179	101	63	67
4VE	4	.	7	1	.	.
4VN	129	169	26	69	138	105
4VU	15	67	96	24	13	1
4WD	9	4	2	1	14	1
4WE	31	22	5	0	1	2
4WF	28	2	10	2	2	0
4WG	8	11	52	10	16	4
4WH	37	20	25	14	5	5
4WJ	48	38	38	14	25	11
4WK	410	380	76	162	85	4
4WL	127	46	203	103	53	64
4WM	4	0	13	6	2	0
4WU	66	75	172	210	49	3
4XL	3	.	.	.	0	.
4XM	243	189	72	91	95	4
4XN	404	77	714	333	249	147
4XO	418	484	142	211	134	23
4XP	973	520	1721	905	600	199
4XQ	882	426	968	647	780	146
4XR	212	251	147	263	252	5
4XS	63	96	35	62	64	7
4XU	363	1094	394	230	366	48
5YB	73	98	47	60	136	8
5YC	.	.	.	.	.	0
5YF	.	.	.	.	1	1
5YU	.	0	.	.	9	.
5ZG	.	.	.	0	.	.
5ZH	.	0	0	.	.	3
5ZJ	1448	455	388	324	228	46
5ZM	125	13	85	20	38	1
5ZU	109	487	8	27	24	3
Total	*6493*	*5168*	*5627*	*3892*	*3443*	*908*

Table 3. Canadian landings (metric tons) of white hake by NAFO division and month for 1993 through the first half of 1998.

		4Vn	4Vs	4W	4X/5Y	5Zc	*Total*
1993	Jan	0	11	7	13	1	*31*
	Feb	0	12	2	21	0	*35*
	Mar	0	7	15	90	0	*112*
	Apr	2	67	38	150	1	*258*
	May	35	79	109	658	145	*1025*
	Jun	56	39	79	767	638	*1578*
	Jul	21	34	131	442	303	*931*
	Aug	5	19	206	645	129	*1004*
	Sep	5	8	129	501	44	*686*
	Oct	3	3	47	250	99	*402*
	Nov	2	0	5	84	256	*347*
	Dec	0	3	0	13	66	*82*
	Total	*129*	*281*	*768*	*3633*	*1681*	*6493*
1994	Jan	0	2	0	22	0	*25*
	Feb	0	21	18	43	0	*82*
	Mar	27	5	23	16	0	*72*
	Apr	49	7	32	260	0	*349*
	May	15	29	31	464	3	*542*
	Jun	34	44	21	380	468	*948*
	Jul	21	54	105	560	273	*1013*
	Aug	8	23	170	452	143	*796*
	Sep	11	12	135	419	48	*626*
	Oct	1	8	54	375	6	*444*
	Nov	1	0	9	141	9	*161*
	Dec	0	5	1	102	3	*111*
	Total	*169*	*212*	*598*	*3235*	*955*	*5168*
1995	Jan	0	23	13	19	0	*56*
	Feb	0	15	1	23	0	*40*
	Mar	0	7	29	34	0	*70*
	Apr	0	28	59	465	0	*552*
	May	0	20	28	287	0	*335*
	Jun	2	19	63	650	171	*904*
	Jul	12	57	106	524	155	*854*
	Aug	6	67	93	337	62	*566*
	Sep	3	29	108	876	35	*1050*
	Oct	3	10	66	592	15	*685*
	Nov	1	6	28	273	35	*343*
	Dec	0	1	1	161	9	*172*
	Total	*26*	*283*	*594*	*4242*	*481*	*5627*
1996	Jan	0	8	0	18	0	*26*
	Feb	0	7	1	32	0	*40*
	Mar	0	2	9	24	0	*35*
	Apr	0	5	3	43	0	*51*
	May	3	24	24	958	0	*1010*
	Jun	12	15	52	77	10	*165*
	Jul	19	30	105	758	113	*1026*
	Aug	22	24	281	311	80	*718*
	Sep	9	6	31	220	40	*305*
	Oct	2	1	13	238	54	*309*
	Nov	0	2	2	100	54	*158*
	Dec	0	2	1	25	21	*49*
	Total	*69*	*126*	*522*	*2803*	*372*	*3892*
1997	Jan	0	6	1	3	0	*11*
	Feb	0	5	4	54	0	*64*
	Mar	0	3	3	47	0	*53*
	Apr	0	2	15	190	0	*206*
	May	1	4	11	209	0	*225*
	Jun	7	9	9	415	56	*496*
	Jul	22	12	60	693	73	*860*
	Aug	31	21	82	399	43	*577*
	Sep	46	4	50	372	14	*486*
	Oct	30	0	12	145	17	*204*
	Nov	0	3	2	92	49	*146*
	Dec	0	4	3	68	38	*113*
	Total	*138*	*75*	*251*	*2688*	*290*	*3443*
1998	Jan	0	11	5	28	0	*43*
	Feb	0	0	16	84	0	*100*
	Mar	0	0	23	72	0	*95*
	Apr	1	14	17	55	0	*87*
	May	23	7	11	123	0	*164*
	Jun	72	37	20	169	38	*336*
	Jul	8	0	3	57	15	*83*
	Total	*105*	*68*	*95*	*587*	*53*	*908*

Table 4. Canadian landings (metric tons) of white hake by areas and gear sectors for 1993 through the first half of 1998. Gulf (4T) landings of 4Vn white hake not included.

		Otter Trawl	Gillnet	Longline	Other
1993	4V	43	0	315	46
	4W	5	55	704	4
	4Xm	1	84	157	2
	4Xnlx	7	51	346	2
	4Xo	15	147	242	14
	4Xp	189	298	486	1
	4Xq	309	337	219	17
	4Xr	86	14	101	11
	4Xs/5Y	88	47	0	0
	4Xunk	3	68	292	0
	5Zc	26	51	1603	1
	Total	*773*	*1153*	*4465*	*98*
	Percent	*12*	*18*	*69*	*2*
1994	4V	43	2	235	100
	4W	3	28	551	16
	4Xm	0	76	110	3
	4Xnlx	9	10	57	1
	4Xo	10	150	321	3
	4Xp	295	109	108	9
	4Xq	303	89	29	4
	4Xr	70	148	28	7
	4Xs/5Y	80	112	0	0
	4Xunk	2	412	679	0
	5Zc	27	50	874	4
	Total	*842*	*1185*	*2992*	*148*
	Percent	*16*	*23*	*58*	*3*
1995	4V	48	22	230	5
	4W	41	51	498	4
	4Xm	4	14	54	1
	4Xnlx	5	17	692	1
	4Xo	8	37	97	0
	4Xp	119	344	1257	2
	4Xq	100	424	444	1
	4Xr	53	90	4	0
	4Xs/5Y	19	59	5	0
	4Xunk	0	236	157	1
	5Zc	19	36	426	0
	Total	*415*	*1329*	*3863*	*15*
	Percent	*7*	*24*	*69*	*0*

		Otter Trawl	Gillnet	Longline	Other
1996	4V	20	9	106	9
	4W	115	57	345	4
	4Xm	3	60	28	0
	4Xnlx	6	35	291	0
	4Xo	10	79	122	0
	4Xp	102	373	430	0
	4Xq	150	344	152	1
	4Xr	68	165	30	0
	4Xs/5Y	39	73	10	0
	4Xunk	0	76	151	3
	5Zc	24	15	329	4
	Total	*537*	*1287*	*1993*	*23*
	Percent	*14*	*34*	*52*	*1*
1997	4V	11	3	121	2
	4W	2	37	210	2
	4Xm	2	60	33	0
	4Xnlx	21	44	185	0
	4Xo	8	44	81	1
	4Xp	80	219	300	1
	4Xq	177	510	85	9
	4Xr	88	160	4	0
	4Xs/5Y	52	157	2	0
	4Xunk	0	155	211	1
	5Zc	16	13	260	1
	Total	*457*	*1401*	*1492*	*17*
	Percent	*14*	*42*	*44*	*0*
1998	4V	1	1	123	4
	4W	1	15	79	0
	4Xm	1	1	2	0
	4Xnlx	24	12	111	0
	4Xo	1	8	13	0
	4Xp	98	64	37	0
	4Xq	99	35	12	0
	4Xr	3	2	0	0
	4Xs/5Y	2	12	1	0
	4Xunk	0	15	33	0
	5Zc	5	3	44	0
	Total	*235*	*168*	*455*	*4*
	Percent	*27*	*19*	*53*	*1*

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 1998, excluding 4T landings of 4Vn fish).

	Directed	Bycatch	Unknown	*Total*	% Directed	TAC
1966	.	124	1493	*1617*		
1967	.	143	773	*916*		
1968	.	1111	435	*1546*		
1969	.	1711	701	*2412*		
1970	.	887	2084	*2971*		
1971	618	1296	3090	*5004*		
1972	.	1146	4276	*5422*		
1973	.	852	4927	*5779*		
1974	652	1112	4127	*5891*		
1975	.	848	3829	*4677*		
1976	.	1130	2404	*3534*		
1977	100	874	2437	*3411*		
1978	521	810	2540	*3871*		
1979	368	880	2036	*3284*		
1980	611	897	2646	*4154*		
1981	527	2484	821	*3832*		
1982	866	1873	2616	*5355*		
1983	737	1957	1806	*4500*		
1984	1395	2500	1484	*5379*		
1985	1536	2112	2329	*5977*		
1986	3078	2194	2650	*7922*		
1987	2585	2109	3986	*8680*		
1988	2891	2884	240	*6015*	48.10%	
1989	2824	2624	226	*5674*	49.80%	
1990	3314	2419	148	*5881*	56.40%	
1991	2483	2140	293	*4916*	50.50%	
1992	3273	2098	487	*5858*	55.90%	
1993	4748	1740	.	*6488*	73.18%	
1994	3205	1963	.	*5168*	62.01%	
1995	4071	1551	.	*5622*	72.41%	
1996	2483	1358	.	*3841*	64.65%	3420
1997	1862	1505	.	*3367*	55.30%	3100
1998	338	525	.	*863*	39.21%	3500

Note that landings for 1988-1992 now contain essentially no (total 2 mt) unknown components in the Canadian Statistics (the landings reported to NAFO have not been updated since 1992).

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

	Metric Tons	$ Value	Price/Kg
1988	3336	1234844	$0.37
1989	3255	1864506	$0.57
1990	3425	2122445	$0.62
1991	2688	1937964	$0.72
1992	3428	2876639	$0.84
1993	4748	3575225	$0.75
1994	3205	2570356	$0.80
1995	4071	4283023	$1.05
1996	2793	2706889	$0.97
1997	2107	2106766	$1.00
1998	364	179547	$0.49

Table 7. National Sampling Program inventory of white hake sampling for the Scotian Shelf since 1985.

Number of samples

		4V	4W	4X/5
Longline	1988	.	.	1
	1989	.	.	1
	1993	1	.	4
	1994	1	1	6
	1995	.	7	14
	1996	1	1	8
	1997	3	1	12
	1998	6	.	6
Gillnet	1988	.	.	1
	1995	.	.	5
	1996	.	.	3
	1997	.	.	9
	1998	.	.	5
Trawl	1993	.	.	2
	1994	.	.	1
	1995	6	.	2
	1996	5	.	1
	1997	1	.	3
	1998	.	.	5

Number of fish measured

		4V	4W	4X/5
Longline	1988	.	.	265
	1989	.	.	173
	1993	268	.	1200
	1994	353	268	1595
	1995	.	1418	3673
	1996	109	9	1735
	1997	703	51	2721
	1998	1104	.	937
Gillnet	1988	.	.	34
	1995	.	.	1115
	1996	.	.	722
	1997	.	.	1871
	1998	.	.	1079
Trawl	1993	.	.	369
	1994	.	.	250
	1995	919	.	247
	1996	666	.	266
	1997	129	.	669
	1998	.	.	665

Table 8. Mean lengths from commercial sampling of the longline fishery in 4X/5.

		1993	1994	1995	1996	1997	1998
Eastern 4X	4Xn	57.3	58.5	56.0	58.4	58.8	59.8
	4Xo		57.9		57.2	73.9	
Western 4X/5	4Xp	62.9		61.2		69.8	66.5
	4Xq		66.7	72.9		64.5	81.1
	5Zj	63.3	68.9	69.8	64.9	69.8	63.4

Table 9. Mean catch per set, standard errors, and tons landed by index fishers in 4VWX & 5.

	Tonnage Class	1990	1991	1992	1993	1994	1995	1996	1997	1998	Max. No. Boats
Mean Catch per Set											
Trawler	25-49.9	1.034	0.372	0.387	0.591	0.446	0.881	0.187	0.354	0.728	
	50-99.9	1.705	0.524	0.603	0.337	0.467	0.633	0.456	0.299	0.059	
Gillnet	1-24.9	4.723	1.264	2.116	2.290	0.732	0.824	0.559	0.528	0.561	
	25-49.9	0.645	0.691	2.432	2.102	1.940	1.144	1.425	0.953	0.322	
	50-99.9	4.389	NA	NA	4.025	6.344	1.497	1.176	1.010	0.605	
Longliner	1-24.9	0.489	2.947	2.751	1.273	0.754	1.665	1.199	1.089	1.084	
	25-49.9	1.549	1.294	1.472	1.698	1.507	1.403	1.516	1.076	0.842	
	50-99.9	4.614	1.237	1.970	1.563	0.570	1.118	1.599	2.003	1.002	
	150-499.9	1.758	1.085	2.218	1.607	1.404	1.277	1.154	0.518	NA	
Standard Errors											
Trawler	25-49.9	0.146	0.036	0.016	0.150	0.061	0.350	0.061	0.127	0.417	
	50-99.9	1.306	0.142	0.055	0.029	0.029	0.106	0.125	0.075	0.028	
Gillnet	1-24.9	2.523	0.221	0.731	1.057	0.091	0.067	0.046	0.031	0.051	
	25-49.9	0.214	0.212	0.575	0.323	0.212	0.099	0.086	0.071	0.000	
	50-99.9	0.911	NA	NA	0.838	3.123	0.128	0.164	0.753	0.056	
Longliner	1-24.9	0.154	1.820	1.108	0.288	0.253	0.094	0.083	0.061	0.099	
	25-49.9	0.206	0.119	0.131	0.088	0.641	0.041	0.073	0.065	0.074	
	50-99.9	1.282	0.120	0.215	0.168	0.116	0.071	0.141	0.250	0.136	
	150-499.9	0.031	0.157	NA	0.567	0.519	0.339	0.272	0.367	NA	
Tons Landed											
Trawler	25-49.9	7	14	64	90	49	20	3	2	4	*7*
	50-99.9	5	11	105	31	53	23	10	4	1	*9*
Gillnet	1-24.9	57	27	51	167	112	136	67	84	2	*16*
	25-49.9	12	20	105	212	206	153	239	156	3	*17*
	50-99.9	57	NA	NA	72	38	99	27	2	2	*3*
Longliner	1-24.9	2	12	17	20	4	343	203	132	55	*29*
	25-49.9	54	74	194	652	47	1179	531	274	73	*51*
	50-99.9	37	75	195	166	26	222	101	130	26	*11*
	150-499.9	5	2	2	13	3	6	5	1	NA	*1*
Total Index Fishers		237	234	733	1425	536	2182	1186	786	164	
Total Directed Landings		3314	2483	3273	4749	3205	4076	2531	1934	383	
Percent Index of Directed		7%	9%	22%	30%	17%	54%	47%	41%	43%	

Table 10. Analysis of chnages in catch rates of 4X/5 index fishers over time.

Model		Df	Variance	Residual Df	Residual Variance	F	Significance
NULL MODEL				4352	6192.42		
MAIN EFFECTS	GEAR	2	1234.75	4350	4957.67	738.71	0.000
	AREA	7	332.28	4343	4625.39	56.80	0.000
	YEARL	8	101.01	4335	4524.38	15.11	0.000
	MONTHL	11	92.16	4324	4432.22	10.03	0.000
	TONCL	2	5.26	4322	4426.96	3.15	0.043
TWO-WAY INTERACTIONS	AREA:YEARL	54	309.64	4268	4117.32	6.86	0.000
	AREA:MONTHL	58	217.48	4210	3899.84	4.49	0.000
	GEAR:AREA	14	109.43	4196	3790.41	9.35	0.000
	YEARL:MONTHL	70	191.10	4126	3599.31	3.27	0.000
	GEAR:YEARL	15	79.49	4111	3519.82	6.34	0.000
	GEAR:MONTHL	16	49.59	4095	3470.23	3.71	0.000
	GEAR:TONCL	3	21.49	4092	3448.74	8.57	0.000
	YEARL:TONCL	16	42.24	4076	3406.50	3.16	0.000

Df = Degrees of Freedom

STANDARD for prediction: GEAR = Longline
AREA = 4Xq
MONTHL = July
TONCL = 25-49.9

YEARL	Standardized CPUE	Variance	Catch	Standardized Effort
1990	1.79	2.16	4282	2388.13
1991	4.69	18.27	3423	730.37
1992	2.54	4.21	4593	1806.37
1993	1.48	0.29	5315	3589.89
1994	0.33	0.76	4189	12739.28
1995	1.00	0.26	4723	4715.52
1996	2.08	2.49	3175	1529.59
1997	1.16	0.26	2978	2558.49
1998	0.49	0.75	640	1298.80

Table 11a. Mean weights and numbers per tow, trawlable abundance and biomass estimates, and survey diagnostics for 1970-98 4X white hake, assuming a constant catchability of 1.0.

Year	Mean Number per Tow	Mean Weight per Tow (kg)	Standard Error	Lower Confidence Interval	Upper Confidence Interval	Abundance Estimate	Biomass Estimate (metric tons)	Biomass Standard Error	Lower Confidence Interval	Upper Confidence Interval	Set Allocation per Strata Efficiency	Stratification versus Random Efficiency	Overall Efficiency
1970	23.78	30.27	23.26	5.90	54.62	37391865	47592	33707	8552	79163	-169.9	11.0	-158.9
1971	3.92	4.27	0.65	3.10	5.50	6163733	6716	972	4606	8156	-7.3	66.6	59.3
1972	4.70	6.73	1.29	4.79	10.07	7395599	10583	2022	7536	15841	2.6	38.9	41.5
1973	14.41	16.37	6.86	6.49	30.99	22662937	25733	10794	10211	48730	-67.2	9.2	-57.9
1974	8.27	8.16	1.43	5.59	11.20	13003309	12835	2242	8788	17609	9.3	21.7	31.0
1975	22.99	22.17	8.68	9.40	46.82	36157168	34865	13652	14783	73619	-38.2	20.7	-17.5
1976	5.77	7.47	1.59	4.39	10.52	9079390	11751	2436	6709	16075	-19.1	10.4	-8.6
1977	6.59	10.51	3.38	4.89	18.26	10368493	16529	5315	7692	28711	-15.2	-1.7	-16.9
1978	6.57	11.18	3.41	5.58	19.04	10336572	17585	5194	8501	28993	-33.3	1.2	-32.1
1979	4.22	7.43	1.46	4.88	10.66	6632012	11682	2112	7060	15427	-30.3	24.8	-5.5
1980	2.11	5.30	1.11	3.19	7.39	3312704	8338	1747	5015	11628	-34.1	27.6	-6.5
1981	5.26	9.23	3.93	3.46	19.01	8277435	14514	6176	5435	29890	-43.8	-1.0	-44.9
1982	6.88	9.31	2.07	5.93	13.88	10825293	14636	3258	9320	21821	-19.2	5.3	-13.9
1983	25.51	32.50	11.44	15.40	56.29	40109234	51107	17988	24212	88513	-83.7	23.4	-60.3
1984	10.89	15.93	4.45	8.67	25.87	17130390	25043	6929	13516	40323	-66.8	23.9	-42.9
1985	9.40	14.10	2.76	7.60	18.31	14787580	22167	4347	11956	28799	-11.5	50.9	39.5
1986	23.90	23.21	5.18	11.45	32.27	37578830	36500	8148	18002	50745	-2.4	39.3	36.9
1987	13.05	18.98	4.59	11.78	31.04	20526277	29847	7215	18516	48815	-32.2	31.4	-0.8
1988	7.94	12.01	4.64	5.67	25.78	12491001	18887	7298	8914	40545	-75.3	2.9	-72.4
1989	8.35	10.48	1.81	7.47	14.85	13122816	16483	2840	11745	23349	-7.3	13.1	5.8
1990	14.13	19.38	8.18	8.60	36.31	22216672	30472	12870	13526	57090	-125.1	26.3	-98.8
1991	19.43	21.92	10.23	5.72	42.15	30546470	34473	16084	8996	66277	-136.0	23.7	-112.3
1992	31.35	27.90	5.19	19.58	38.25	49298697	43866	8162	30790	60140	-25.3	85.4	60.1
1993	10.10	10.28	2.25	6.13	14.48	15886259	16161	3545	9635	22774	-56.9	45.1	-11.8
1994	8.89	6.91	0.75	5.45	8.39	13978078	10861	1178	8569	13192	-22.0	61.0	39.0
1995	12.37	13.48	2.07	9.77	17.11	19454487	21192	3262	15363	26909	-9.8	60.6	50.9
1996	14.77	20.69	2.93	13.54	25.05	23222890	32539	4365	20146	37254	-21.0	86.2	65.1
1997	4.59	5.96	2.02	2.96	10.73	7224043	9378	3175	4651	16872	-100.2	7.9	-92.3
1998	4.92	4.98	1.98	2.19	9.95	7738395	7824	3118	3439	15643	-45.2	5.5	-39.6

Table 11b. Mean weights and numbers per tow, trawlable abundance and biomass estimates, and survey diagnostics for 1970-98 4W white hake, assuming a constant catchability of 1.0.

Year	Mean Number per Tow	Mean Weight per Tow (kg)	Standard Error	Lower Confidence Interval	Upper Confidence Interval	Abundance Estimate	Biomass Estimate (metric tons)	Biomass Standard Error	Lower Confidence Interval	Upper Confidence Interval	Set Allocation per Strata Efficiency	Stratification versus Random Efficiency	Overall Efficiency
1970	3.99	6.92	2.39	2.98	11.05	5845073	10134	3505	4357	16170	-67.2	17.9	-49.3
1971	1.34	1.50	0.55	0.56	2.51	1962410	2202	810	825	3669	-28.3	22.9	-5.4
1972	1.65	2.68	0.71	1.45	4.37	2408732	3926	1035	2129	6404	-62.8	26.1	-36.7
1973	2.10	3.01	1.03	1.28	4.94	3067456	4405	1510	1867	7225	-46.1	26.1	-20.0
1974	4.15	6.21	2.76	2.50	11.69	6078408	9093	3720	3371	15775	-30.1	25.6	-4.5
1975	1.85	2.67	0.74	1.24	4.03	2702669	3908	1077	1816	5895	2.8	18.1	21.0
1976	2.62	2.64	0.70	1.44	3.88	3828794	3864	1021	2103	5673	-30.5	55.9	25.5
1977	2.46	4.57	1.54	1.95	7.23	3595459	6688	2253	2860	10581	-39.3	37.0	-2.4
1978	3.79	3.62	0.98	2.29	5.79	5544256	5298	1438	3358	8482	-32.1	34.8	2.7
1979	1.26	2.02	0.43	1.27	2.84	1839010	2958	631	1853	4156	10.0	46.5	56.5
1980	1.55	2.38	0.86	0.87	3.83	2274499	3486	1260	1268	5605	-15.6	0.4	-15.2
1981	4.19	3.76	1.23	2.09	7.19	6136961	5506	1806	3062	10532	-107.6	9.1	-98.5
1982	4.58	4.37	1.25	2.03	6.87	6702585	6397	1834	2968	10052	-39.8	29.5	-10.3
1983	5.42	4.29	1.30	2.02	6.80	7938643	6278	1897	2952	9959	-58.7	37.0	-21.7
1984	5.77	8.91	3.20	4.39	16.16	8443371	13047	4681	6425	23651	-109.3	12.3	-97.0
1985	3.50	4.47	0.84	2.86	6.10	5130578	6545	1227	4188	8936	-15.1	58.8	43.7
1986	8.60	9.30	2.51	5.10	15.61	12585278	13614	3669	7465	22846	-37.5	19.4	-18.0
1987	3.91	5.16	1.19	2.85	7.48	5725039	7555	1739	4177	10947	-31.2	47.2	16.0
1988	5.74	5.18	1.16	2.90	7.35	8407800	7578	1692	4249	10763	-19.7	36.7	17.0
1989	5.60	4.01	1.00	2.19	5.83	8203742	5869	1465	3202	8533	-45.5	24.2	-21.3
1990	4.61	4.21	1.18	2.49	6.83	6752501	6162	1607	3399	9333	-78.3	35.8	-42.5
1991	2.56	3.19	0.50	2.12	4.12	3751796	4670	733	3106	6035	-17.8	76.5	58.7
1992	2.12	1.30	0.28	0.73	1.81	3103027	1905	413	1062	2655	-42.3	48.7	6.4
1993	2.45	1.74	0.60	0.74	3.00	3586091	2545	874	1087	4394	-75.6	19.1	-56.5
1994	2.49	1.49	0.48	0.80	2.73	3651085	2179	705	1166	3995	-63.2	24.0	-39.2
1995	2.35	0.93	0.35	0.29	1.63	3437805	1365	511	418	2384	-101.5	-7.7	-109.3
1996	1.98	1.05	0.38	0.35	1.78	2897212	1534	553	513	2612	-51.2	29.6	-21.7
1997	1.56	1.37	0.76	0.23	2.64	2282843	1999	1114	333	3872	-113.6	0.6	-113.0
1998	3.33	1.81	0.54	0.83	2.87	4873676	2655	787	1208	4207	-47.7	19.0	-28.7

Table 11c. Mean weights and numbers per tow, trawlable abundance and biomass estimates, and survey diagnostics for 1970-98 4V white hake, assuming a constant catchability of 1.0.

Year	Mean Number per Tow	Mean Weight per Tow (kg)	Standard Error	Lower Confidence Interval	Upper Confidence Interval	Abundance Estimate	Biomass Estimate (metric tons)	Biomass Standard Error	Lower Confidence Interval	Upper Confidence Interval	Set Allocation per Strata Efficiency	Stratification versus Random Efficiency	Overall Efficiency
1970	1.85	1.80	0.86	0.57	3.82	2226590	2165	1027	673	4552	33.6	1.4	34.9
1971	2.53	1.73	0.99	0.15	3.31	3048097	2079	1189	178	3979	31.8	2.8	34.6
1972	2.77	2.79	2.46	0.15	5.43	3335853	3359	2960	186	6531	-39.5	-0.6	-40.0
1973	3.99	3.90	1.19	1.57	6.43	4802675	4694	1437	1893	7733	24.3	13.1	37.4
1974	8.55	4.97	3.25	0.98	11.75	10284724	5977	3914	1180	14146	36.3	4.6	40.9
1975	2.51	1.62	0.57	0.55	2.82	3015482	1948	684	660	3398	28.2	26.0	54.3
1976	7.60	5.63	2.96	1.36	12.25	9147781	6771	2725	1251	11274	14.7	16.0	30.6
1977	6.15	5.61	3.40	0.95	13.79	7401386	6753	4091	1147	16601	25.5	0.1	25.7
1978	3.12	3.72	2.07	0.85	8.48	3751420	4475	2471	1015	10100	35.5	9.6	45.1
1979	2.04	2.23	0.83	0.93	4.24	2455856	2679	1000	1116	5099	20.6	17.4	38.0
1980	3.33	2.68	1.52	0.64	5.81	4002951	3222	1835	767	6993	9.7	7.9	17.7
1981	13.30	11.43	5.21	3.37	24.11	16011083	13752	6274	4057	29012	45.7	7.4	53.1
1982	13.94	8.52	3.88	2.33	18.02	16771693	10249	4620	2777	21471	18.5	10.2	28.7
1983	22.44	9.61	1.19	7.04	11.57	27000576	11570	1432	8468	13922	1.9	94.5	96.4
1984	15.67	12.72	6.06	4.74	25.38	18856511	15308	7294	5702	30539	41.4	18.6	60.0
1985	32.44	25.05	9.03	9.48	41.48	39038554	30144	10871	11405	49926	32.7	27.1	59.8
1986	17.29	15.59	5.94	8.08	33.10	20813879	18760	7151	9728	39832	21.9	23.8	45.7
1987	5.53	4.12	0.97	2.42	6.31	6656181	4956	1166	2918	7593	17.1	37.9	55.0
1988	10.03	5.88	2.38	2.50	11.44	12074685	7077	2869	3004	13765	34.2	18.4	52.6
1989	12.85	6.07	2.96	0.95	12.34	15462529	7307	3559	1138	14856	21.8	20.5	42.3
1990	3.64	2.56	0.90	0.97	4.54	4385182	3087	1086	1170	5467	13.8	36.2	50.1
1991	5.44	3.50	0.87	1.95	5.26	6549912	4211	1044	2345	6329	9.8	63.6	73.4
1992	8.25	3.90	1.50	1.83	5.99	9934025	4689	1808	2203	7204	13.3	58.0	71.3
1993	7.45	3.98	2.34	0.91	10.52	8960276	4787	2816	1096	12661	21.4	-0.8	20.6
1994	5.11	2.52	0.69	1.11	3.73	6152036	3030	830	1331	4489	9.0	54.7	63.7
1995	10.04	4.31	2.14	1.15	8.77	12077092	5184	2570	1380	10551	27.0	19.5	46.5
1996	9.37	3.97	1.14	2.02	6.10	11272675	4779	1374	2429	7339	8.5	51.1	59.5
1997	19.33	9.01	5.01	0.90	17.18	23268291	10849	5538	995	18972	27.9	0.6	28.4
1998	5.36	2.57	1.19	0.80	5.55	6452670	3096	1437	968	6676	23.4	15.3	38.7

Table 12. Historical and bootstrapped mean weights and numbers of white hake per tow, and survey diagnostics for the spring Georges Bank and 4VsW Cod Research Vessel surveys, assuming a constant catchability of 1.0.

	Year	Mean Number per Tow	Mean Weight per Tow (kg)	Standard Error	Lower Confidence Interval	Upper Confidence Interval	Set Allocation per Strata Efficiency	Stratification versus Random Efficiency	Overall Efficiency
GEORGES BANK	87	1.28	1.00	0.36	0.36	1.81	7.9	26.4	34.3
	88	3.02	1.48	0.34	0.82	2.15	-36.3	35.6	-0.8
	89	2.99	1.70	0.51	0.91	2.81	-22.6	37.0	14.3
	90	2.79	0.97	0.17	0.67	1.32	-22.3	37.6	15.4
	91	6.89	1.97	0.40	1.41	3.03	-30.4	21.1	-9.3
	92	6.25	1.51	0.56	0.51	2.66	-118.6	54.3	-64.3
	93	2.06	0.44	0.22	0.20	0.74	-248.3	42.7	-205.6
	94	2.59	0.79	0.16	0.53	1.17	-20.4	43.5	23.0
	95	1.53	0.56	0.15	0.27	0.87	-39.9	42.6	2.7
	96	0.65	0.35	0.14	0.09	0.63	-90.6	16.2	-74.4
	97	1.04	0.56	0.19	0.21	0.94	-94.7	46.2	-48.4
4VsW COD	86	2.41	0.95	0.44	0.19	2.02	-18.6	2.7	-15.9
	87	8.75	10.06	8.78	0.59	32.67	9.7	1.0	10.6
	88	2.07	0.79	0.20	0.49	1.32	26.3	45.9	72.2
	89	12.26	3.10	1.90	0.79	8.87	-49.2	4.4	-44.8
	90	1.25	0.44	0.08	0.29	0.59	3.3	88.4	91.8
	91	2.71	0.70	0.20	0.41	1.22	14.2	61.8	76.0
	92	0.53	0.11	0.06	0.04	0.27	-3.8	-1.5	-5.4
	93	0.44	0.10	0.07	0.02	0.31	-2.1	6.3	4.2
	94	0.81	0.20	0.10	0.07	0.59	-8.4	-1.1	-9.4
	95	0.72	0.18	0.07	0.09	0.36	62.7	17.7	80.4
	96	1.81	0.55	0.20	0.25	1.02	50.6	18.8	69.4
	97	2.53	0.74	0.25	0.38	1.55	14.0	15.5	29.5

Table 13. Historical and bootstrapped mean weights and numbers of white hake per tow, and survey diagnostics for spring and fall Research Vessel surveys.

	Year	Mean Number per Tow	Mean Weight per Tow (kg)	Standard Error	Lower Confidence Interval	Upper Confidence Interval	Set Allocation per Strata Efficiency	Stratification versus Random Efficiency	Overall Efficiency
4VW,SPRING	79	4.37	5.72	3.70	0.70	13.90	45.6	8.0	53.6
	80	2.44	4.03	2.11	1.63	6.46	-31.9	32.0	0.1
	81	22.99	19.52	4.90	10.77	27.57	28.5	41.8	70.3
	82	2.82	2.13	0.99	0.56	3.71	38.0	-1.3	36.8
	83	6.56	7.79	1.69	3.93	10.31	9.5	66.0	75.5
	84	6.83	11.93	2.00	8.81	16.66	15.9	68.6	84.5
4VW,FALL	78	7.41	10.20	4.57	3.80	19.96	41.0	9.0	50.0
	79	3.93	6.70	1.41	3.56	9.17	12.1	48.6	60.8
	80	2.69	3.47	1.12	1.78	6.38	2.7	11.5	14.2
	81	4.77	5.11	1.10	3.16	7.61	5.2	29.9	35.1
	82	2.78	2.61	0.46	1.76	3.60	14.0	40.1	54.1
	83	10.09	7.15	1.57	3.99	10.03	5.0	39.4	44.4
	84	7.15	6.41	1.18	4.17	8.88	12.0	24.4	36.4
4X,SPRING	79	10.07	15.97	3.41	8.44	21.72	-35.3	55.6	20.3
	80	5.27	6.99	3.48	2.38	14.53	-67.7	18.0	-49.7
	81	3.35	5.28	3.70	0.38	10.13	-37.4	-5.9	-43.3
	82	6.25	10.59	3.73	4.65	20.03	-23.2	10.1	-13.0
	83	7.90	11.80	2.02	8.25	15.88	-7.8	61.9	54.1
	84	6.47	15.18	5.12	6.87	26.58	-36.8	18.1	-18.8
4X,FALL	79	5.02	9.13	2.69	5.09	15.40	3.7	10.2	13.8
	80	4.66	8.44	2.09	4.67	12.14	-39.7	17.0	-22.7
	81	10.38	21.62	3.49	15.75	29.14	-26.2	61.6	35.5
	82	10.69	13.43	1.83	9.93	17.07	-8.3	41.4	33.1
	83	9.80	11.59	2.20	8.09	16.64	-29.1	17.6	-11.4
	84	14.37	17.04	2.63	12.52	23.20	-19.9	59.5	39.6

Table 14. Numbers of white hake at length and age caught by most of the fishery (longliners,gillnetters and trawlers) in 4VWX/5.

Length	Age	1993	1994	1995	1996	1997
31	2	0	0	0	0	460
34	2	0	0	0	0	37
37	2	0	324	1323	1513	0
40	3	18968	9949	7076	7626	291
43	3	52955	7354	40328	18464	2662
46	3	81707	27559	119194	38102	11348
49	3	135939	33888	168156	70648	38752
52	3	178630	44745	151754	100851	60907
55	4	185113	62885	195435	145664	66247
58	4	155302	76726	179939	154329	76841
61	4	225840	116788	173983	161157	99927
64	5	303553	135695	178831	133246	142379
67	5	285782	186287	199128	181917	140420
70	5	223149	178086	198973	151046	141956
73	6	156002	146160	130725	101765	116443
76	6	88826	122320	78027	42183	67742
79	6	43937	86506	42112	22628	38974
82	7	22760	43615	25926	11836	16926
85	7	21505	28923	20468	2956	9357
88	8	12842	13415	11236	2335	2242
91	8	1515	7355	7113	1869	2079
94	9	917	2841	7030	385	1007
97	10	2553	2812	4677	2124	2189
100	10	0	1885	1796	1205	1144
103	11	1683	775	2275	371	1486
106	12	0	835	1058	0	2105
109	13	0	918	655	0	1978
112	14	0	0	217	0	520
115	16	1680	735	768	0	297
118	18	129	907	1225	0	559
121	21	0	0	433	0	162
124	28	0	0	433	611	0
	2		324	1323	1513	497
	3	468199	123495	486508	235691	113960
	4	566256	256398	549357	461151	243015
	5	812484	500068	576932	466210	424755
	6	288764	354987	250864	166576	223158
	7	44265	72537	46393	14792	26284
	8	14357	20770	18350	4203	4321
	9	917	2841	7030	385	1007
	10	2553	4698	6473	3329	3333
	11	1683	775	2275	371	1486
	12	0	835	1058	0	2105
	13	0	918	655	0	1978
	14	0	0	217	0	520
	16	1680	735	768	0	297
	18	129	907	1225	0	559
	21	0	0	433	0	162
	28	0	0	433	611	0
Total		*2201288*	*1340288*	*1952433*	*1354832*	*1047736*

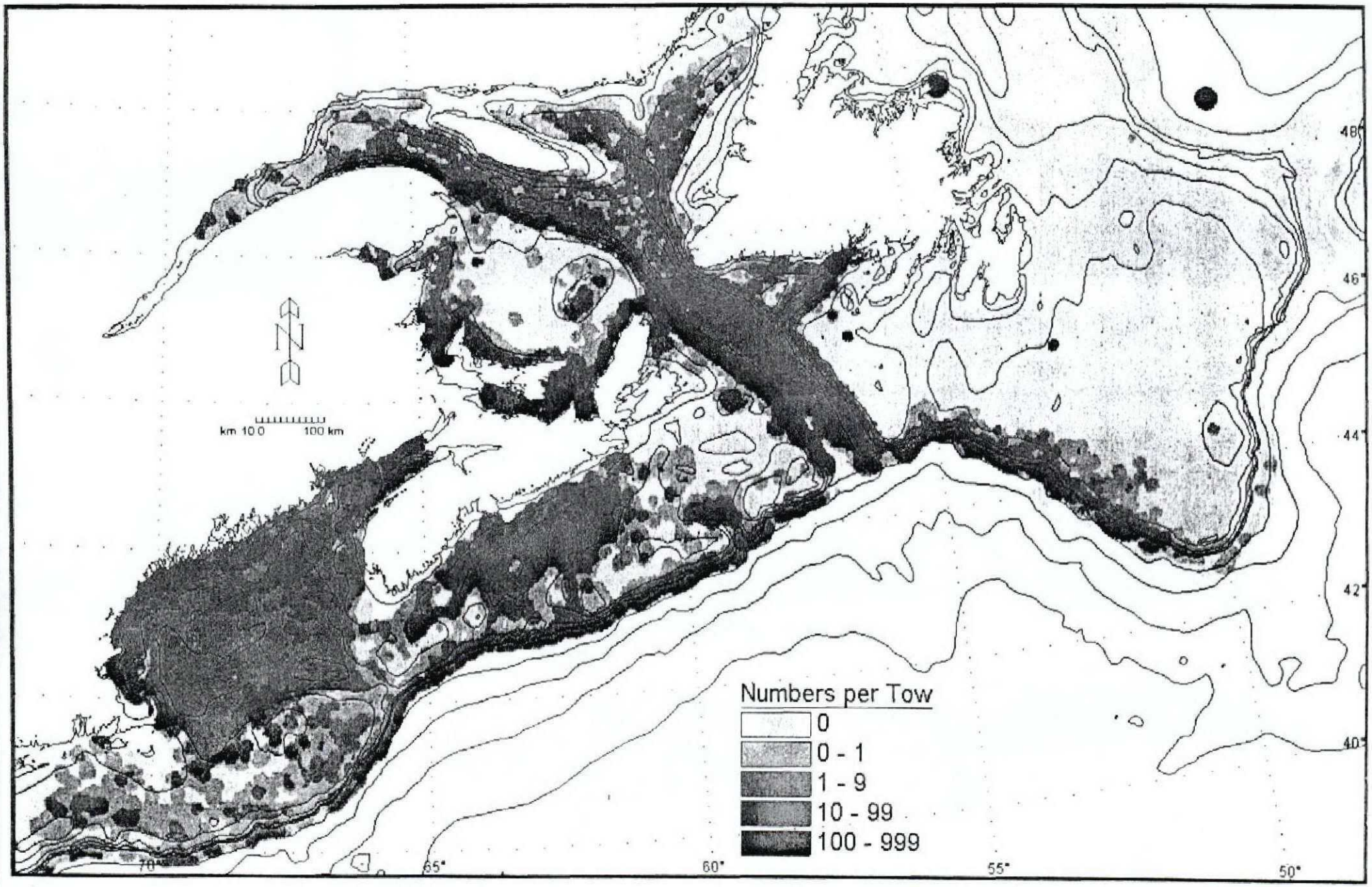


Figure 1. Composite distribution of white hake as determined by Canadian and US research vessel surveys from 1975 to 1994. Some of the fish will be misidentified red hake, especially prior to 1983.

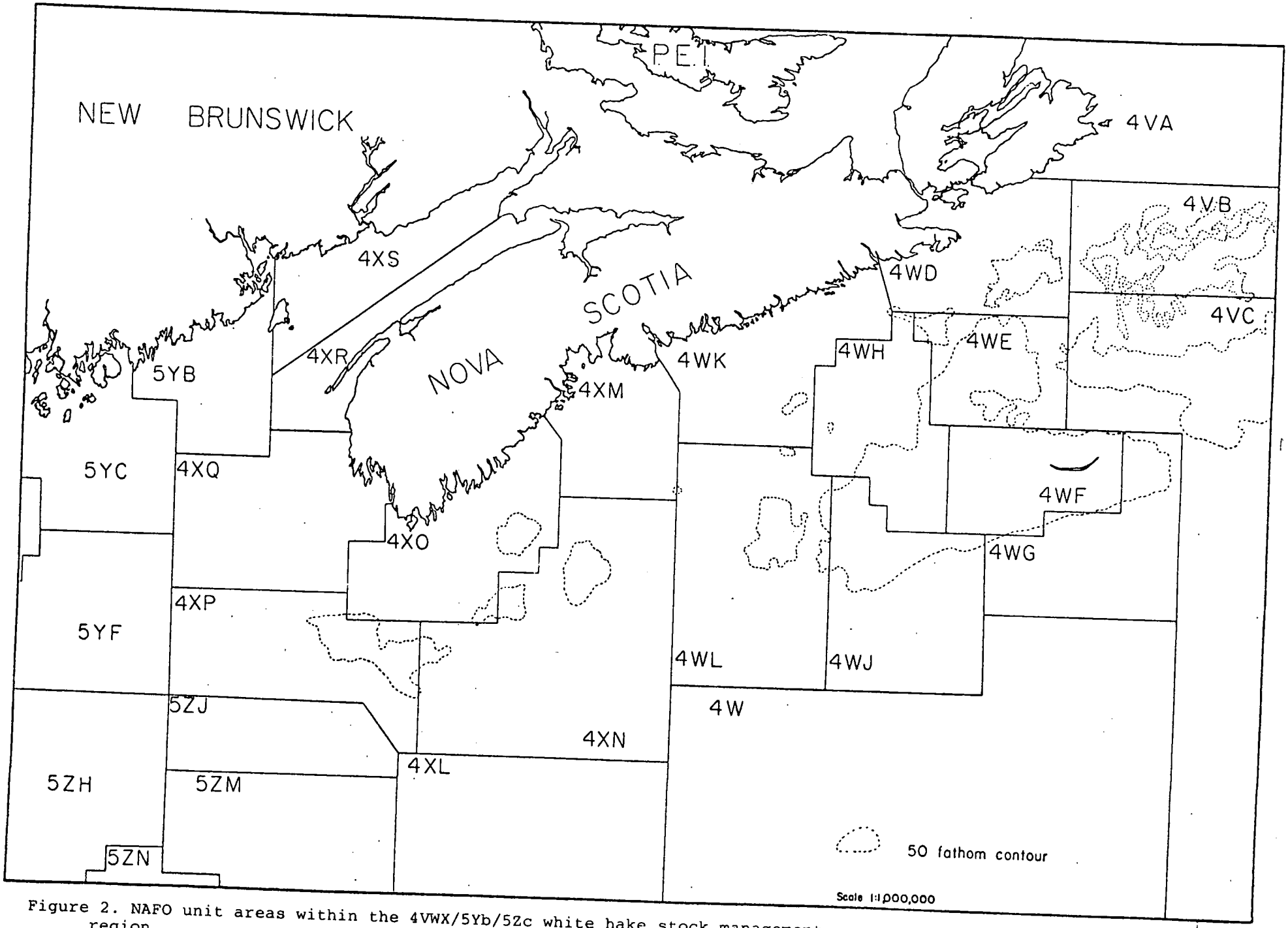


Figure 2. NAFO unit areas within the 4VWX/5Yb/5Zc white hake stock management region.

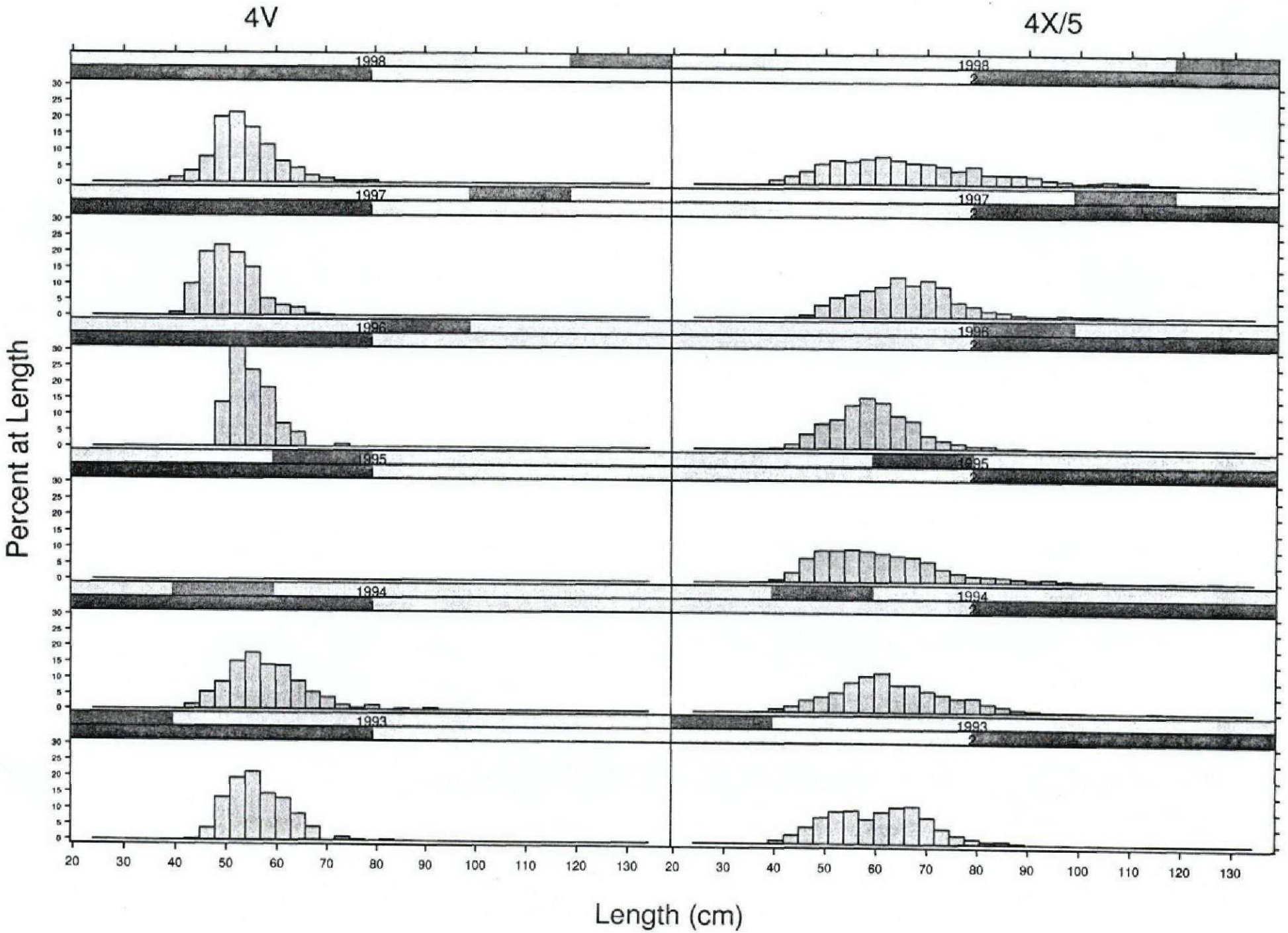


Figure 3a. Length frequencies of white hake from 1993-98 commercial sampling of longliners.

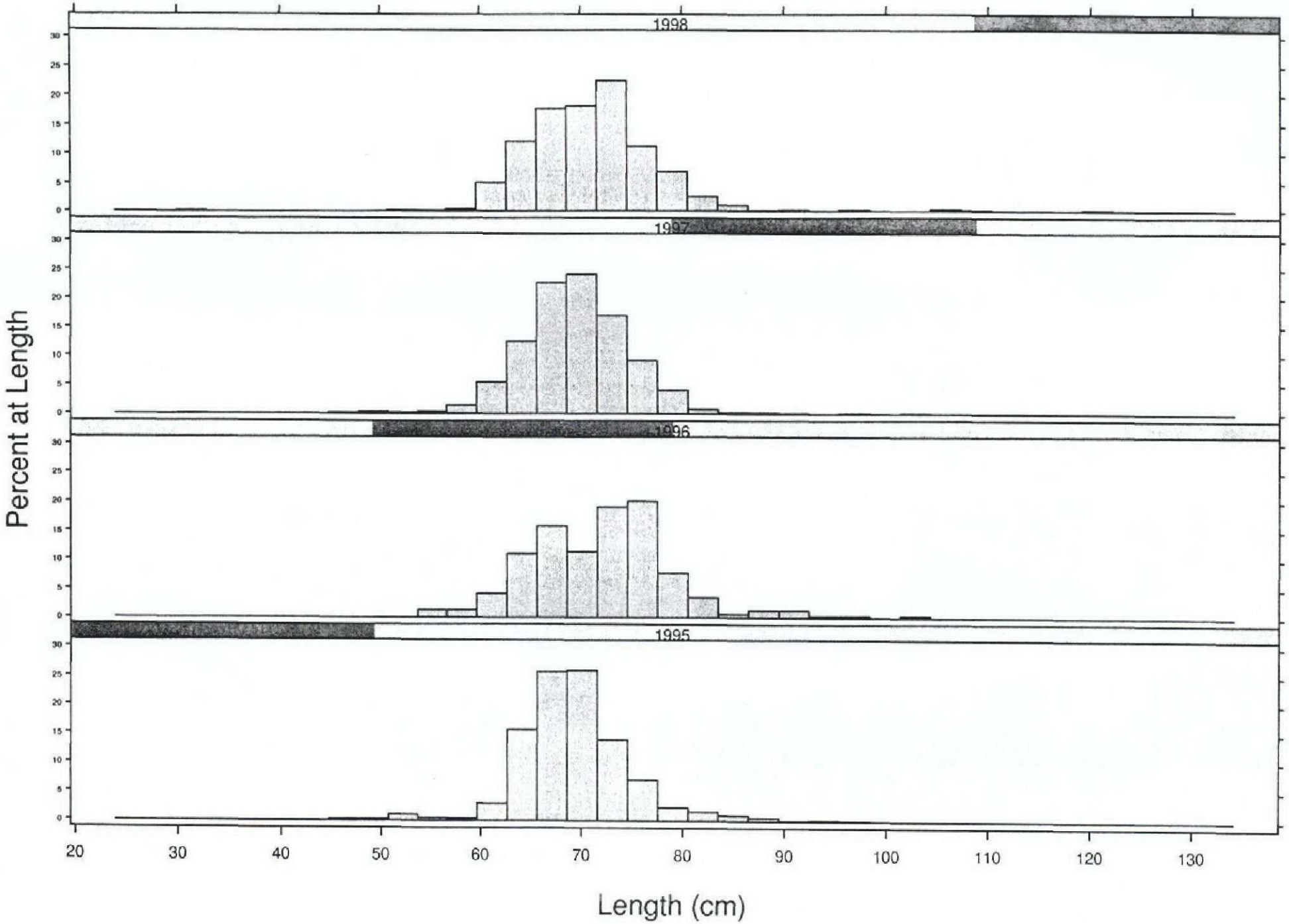


Figure 3b. Length frequencies of white hake from 1995-98 commercial sampling of gillnets in 4X/5.

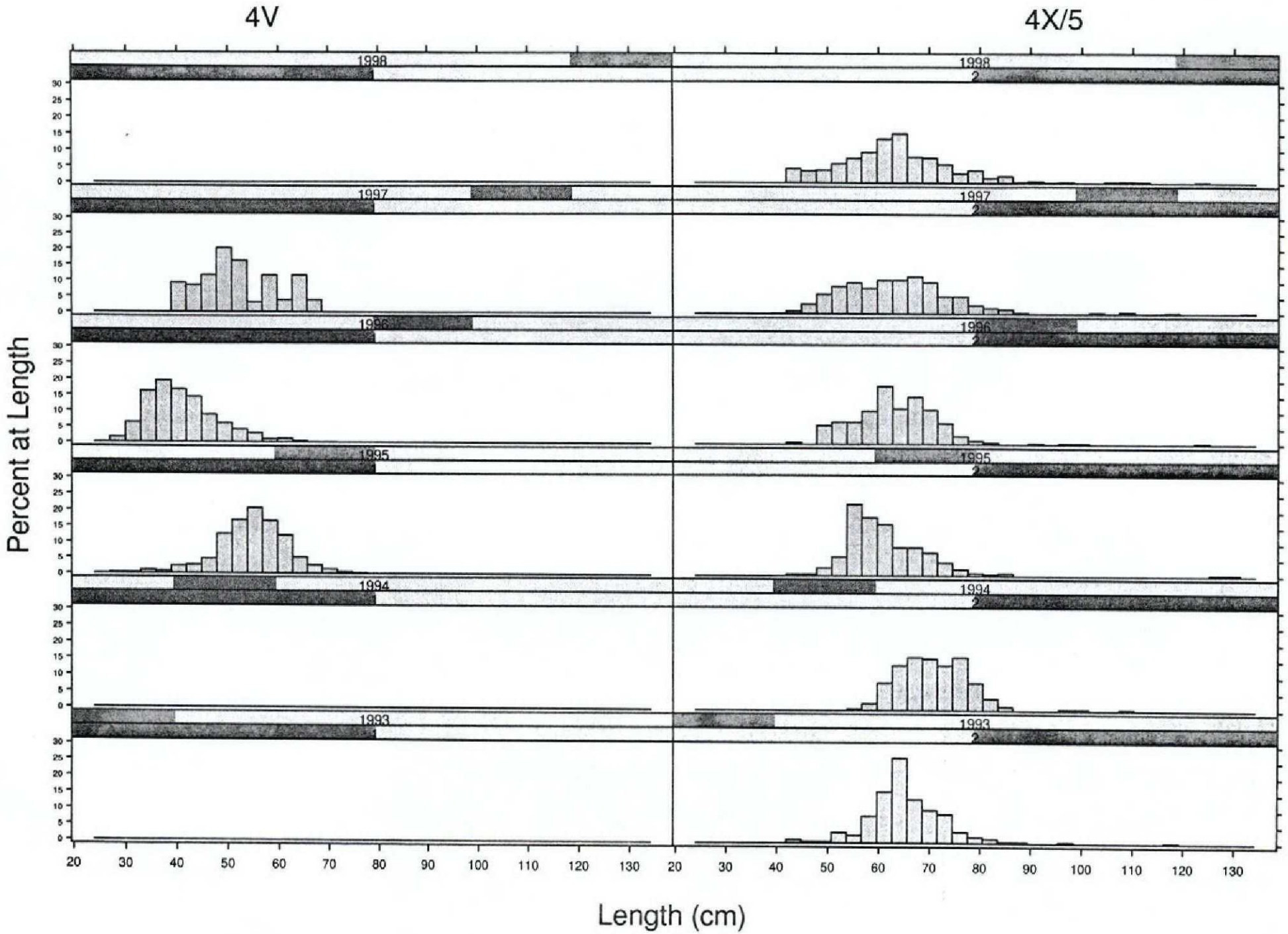


Figure 3c. Length frequencies of white hake from 1993-98 commercial sampling of otter trawlers.

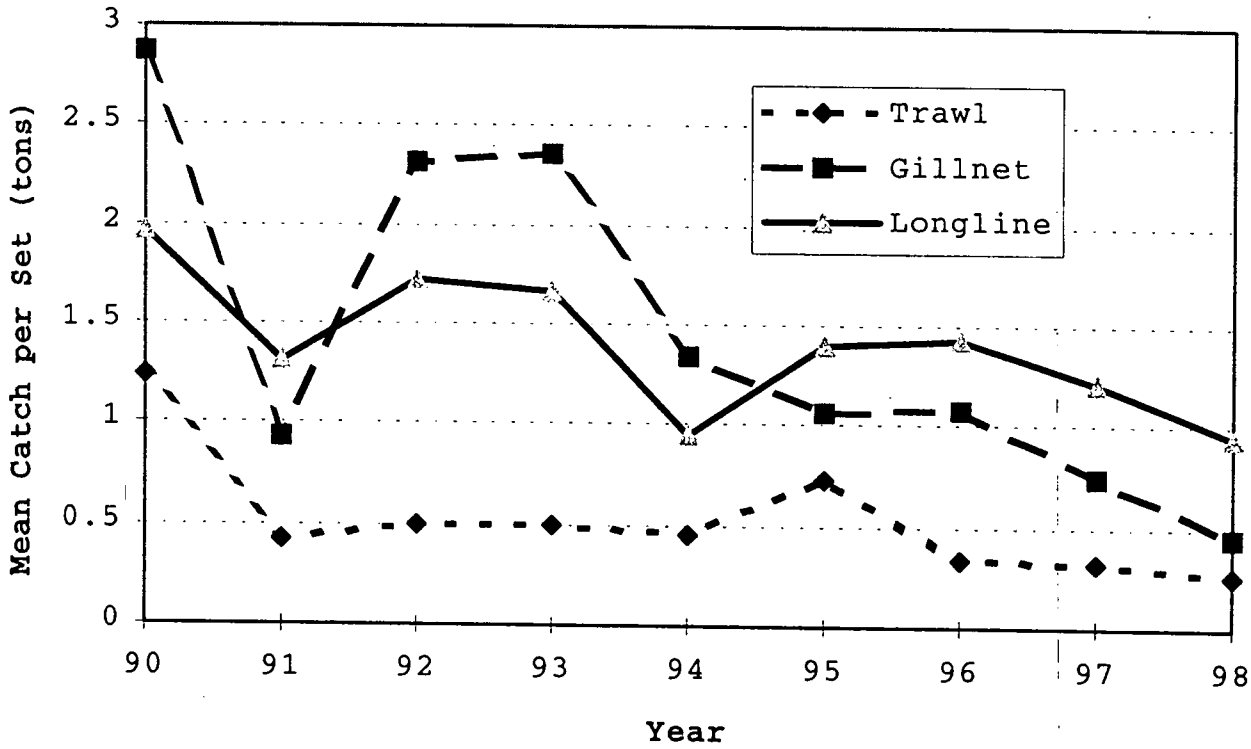


Figure 4. Catch rates of index fishers throughout 4VWX/5.

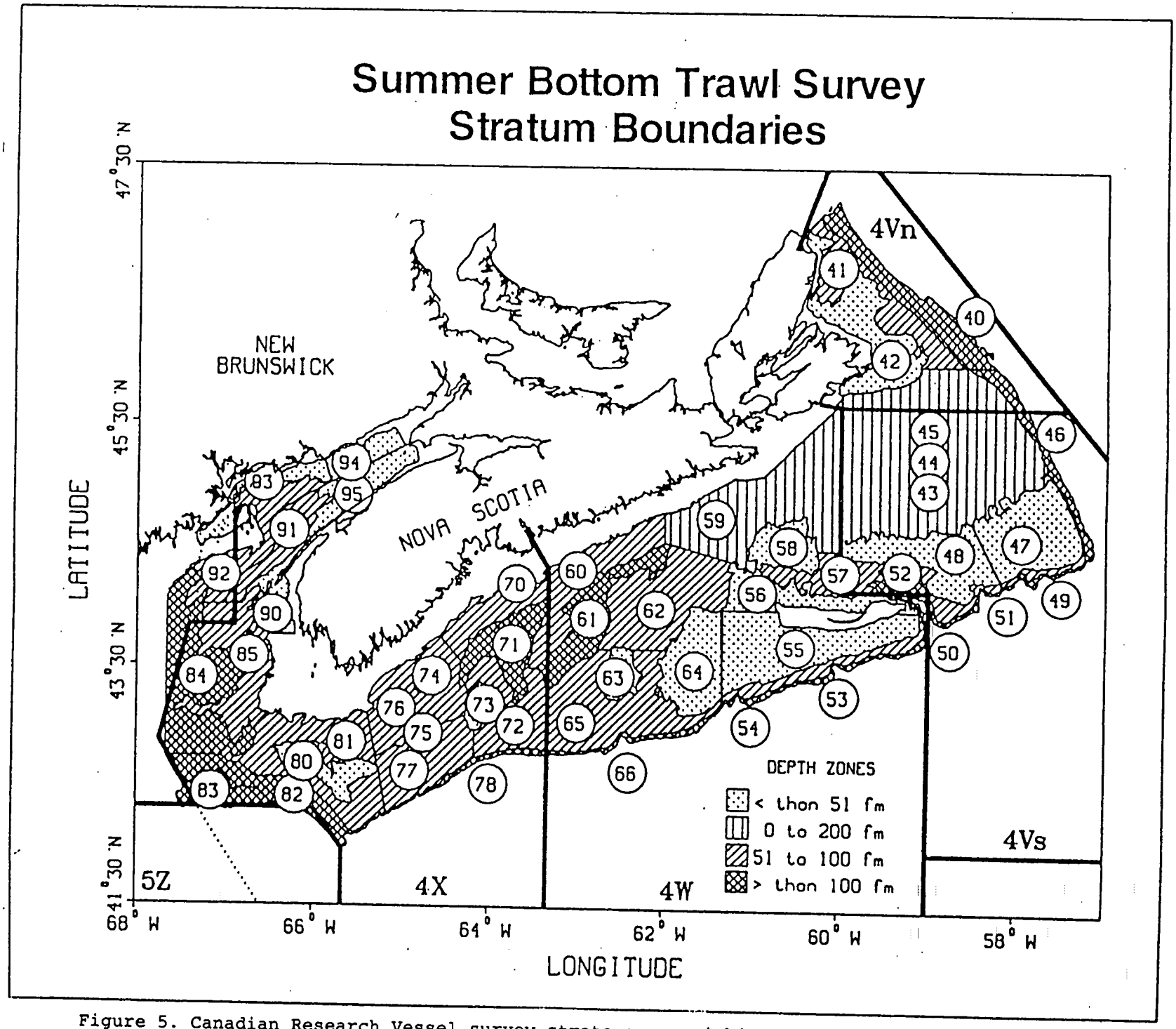


Figure 5. Canadian Research Vessel survey strata areas within the 4VWX/5Yb/5Zc white hake stock management region.

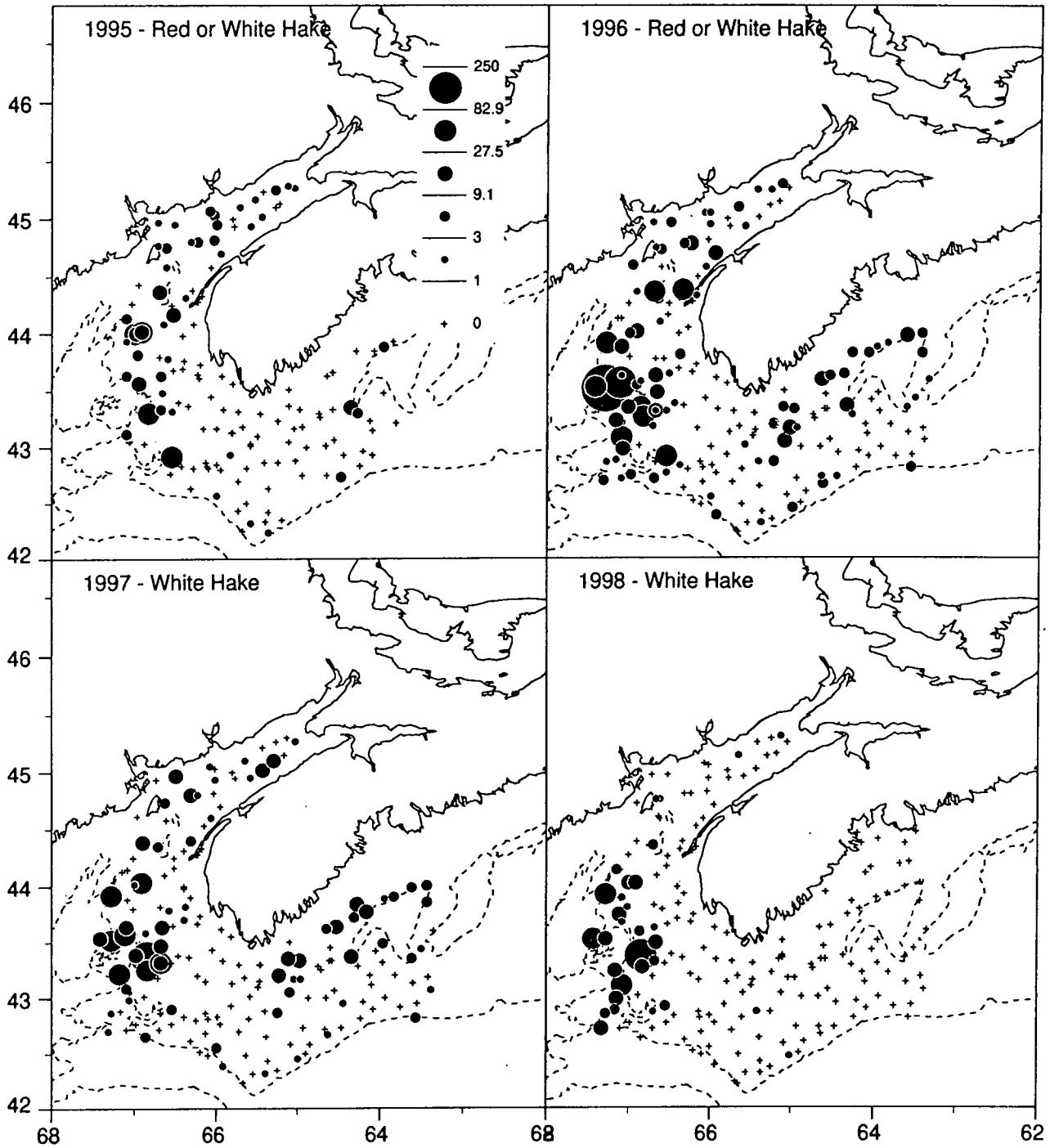


Figure 6. Red/white hake distribution (catch in kg) from ITQ surveys

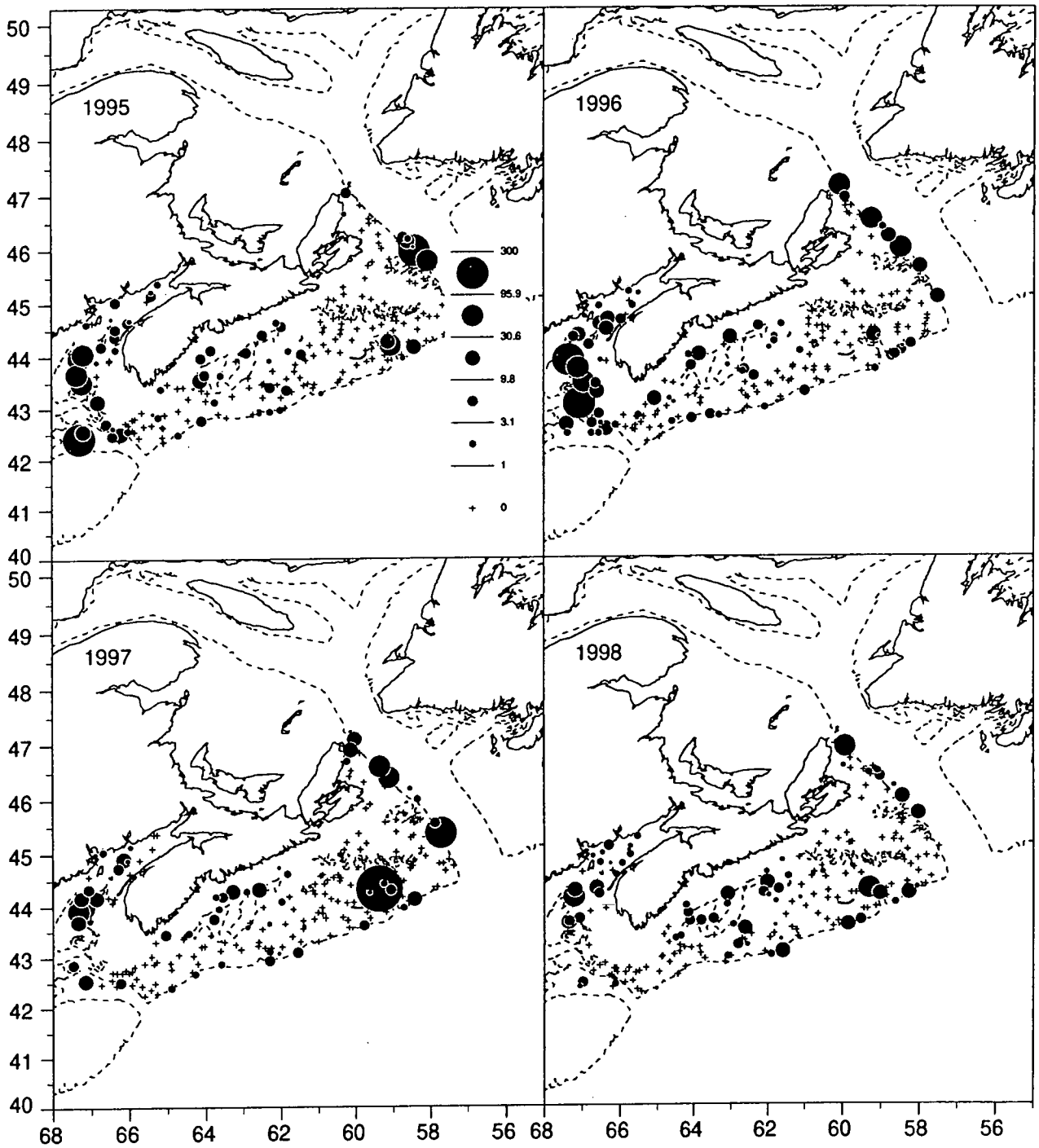
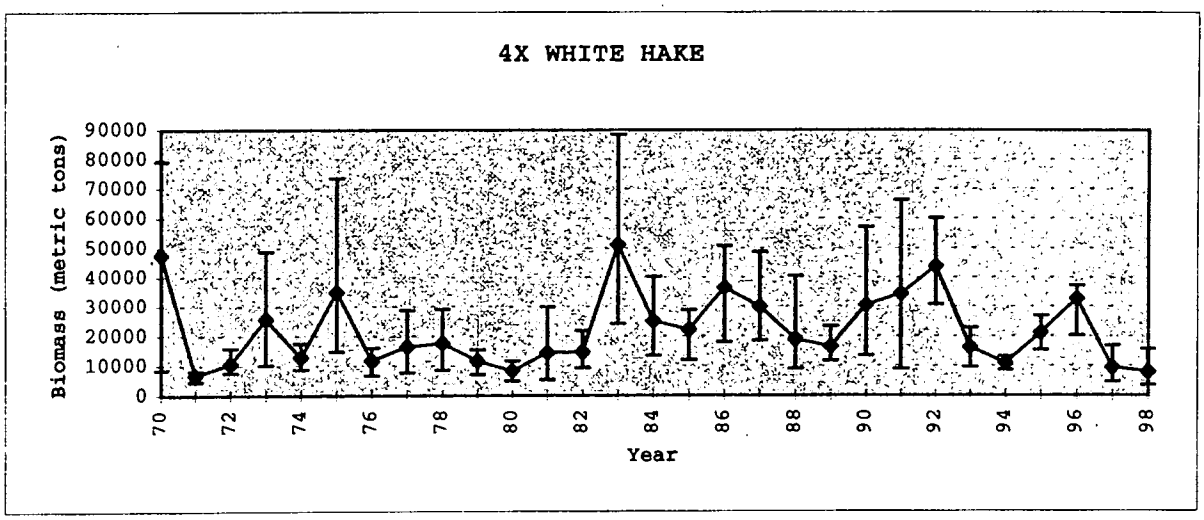
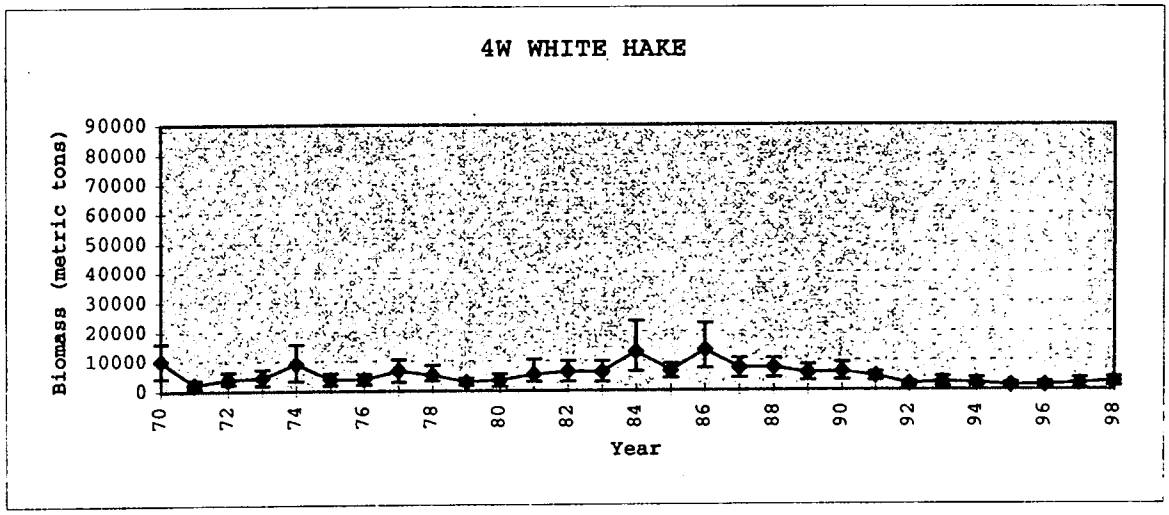


Figure 7. White hake distribution (catch in kg) from summer research vessel surveys.





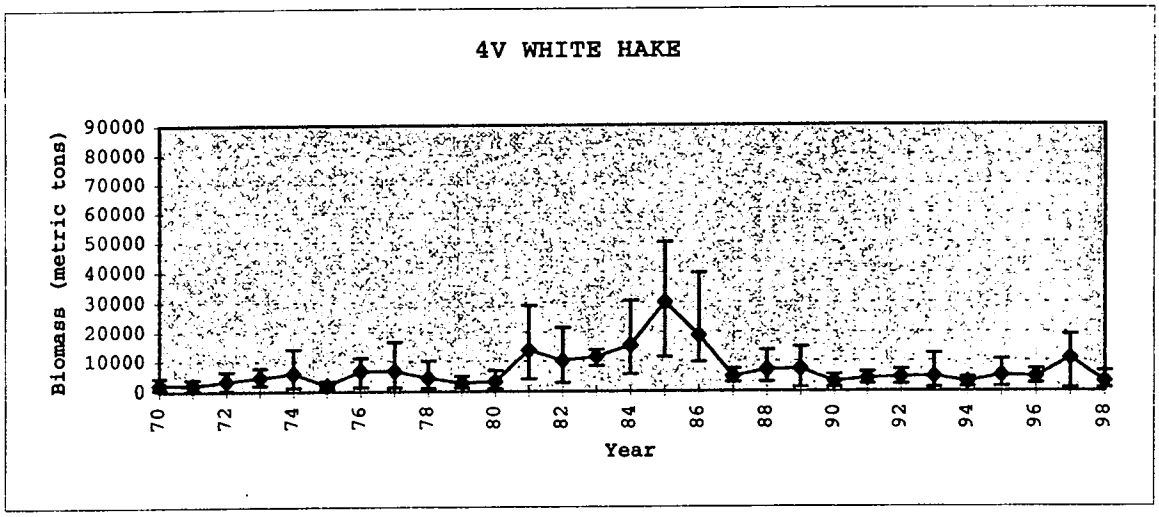


Figure 8. Biomass estimates for white hake derived from summer research vessel surveys.

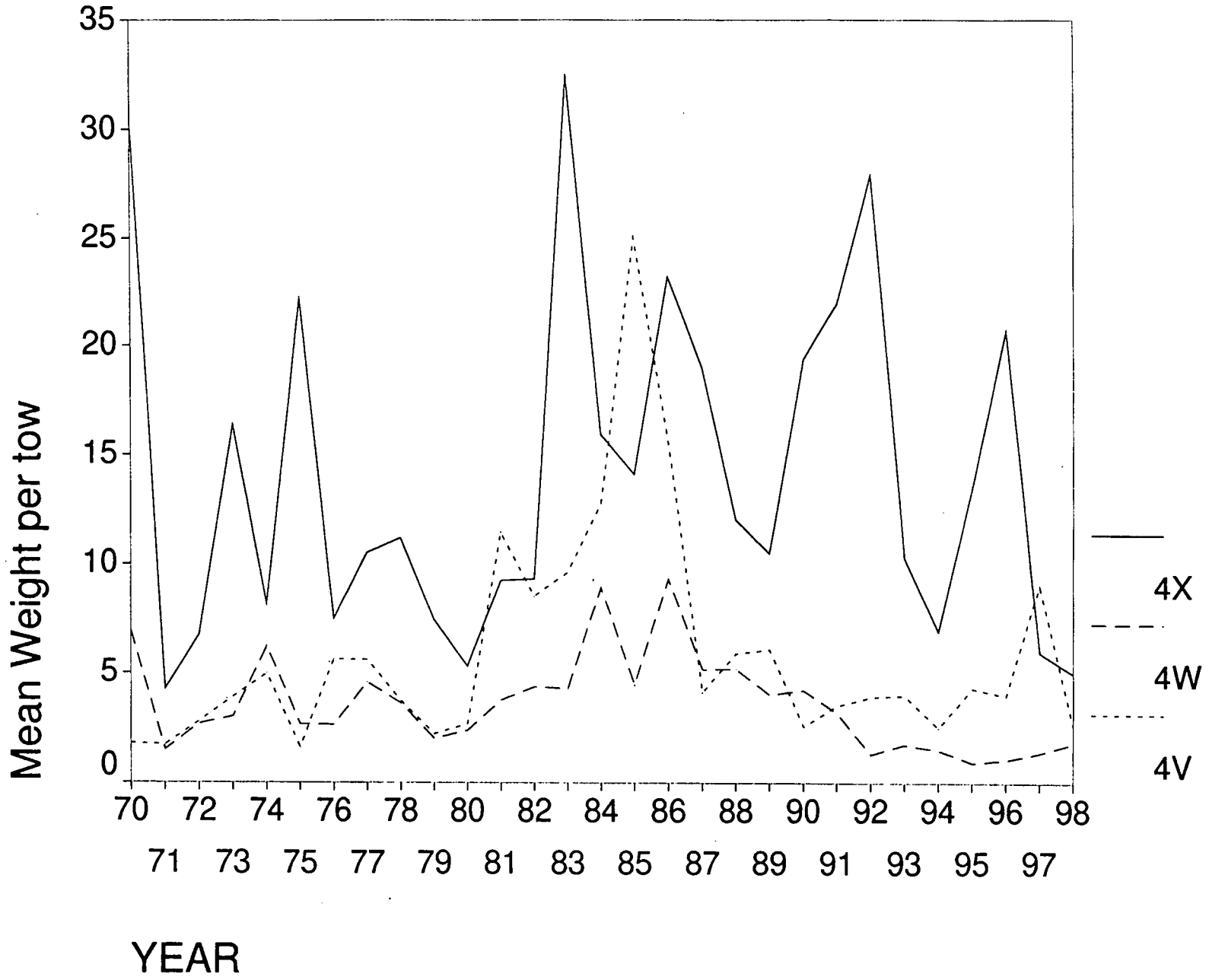


Figure 9. Mean weight per tow for white hake from summer research vessel surveys.

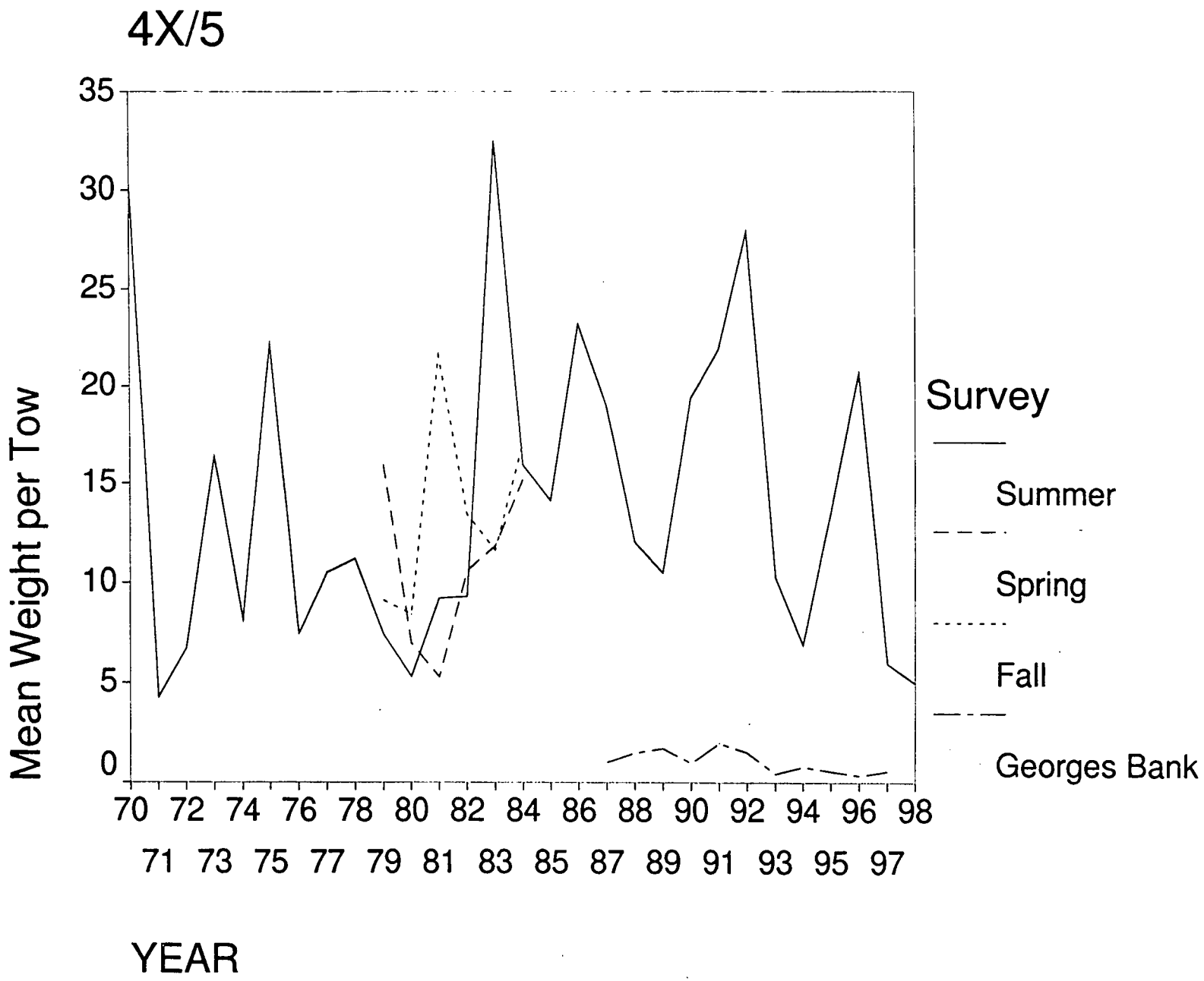


Figure 10. Mean weight per tow for 4X/5 white hake from research vessel surveys.

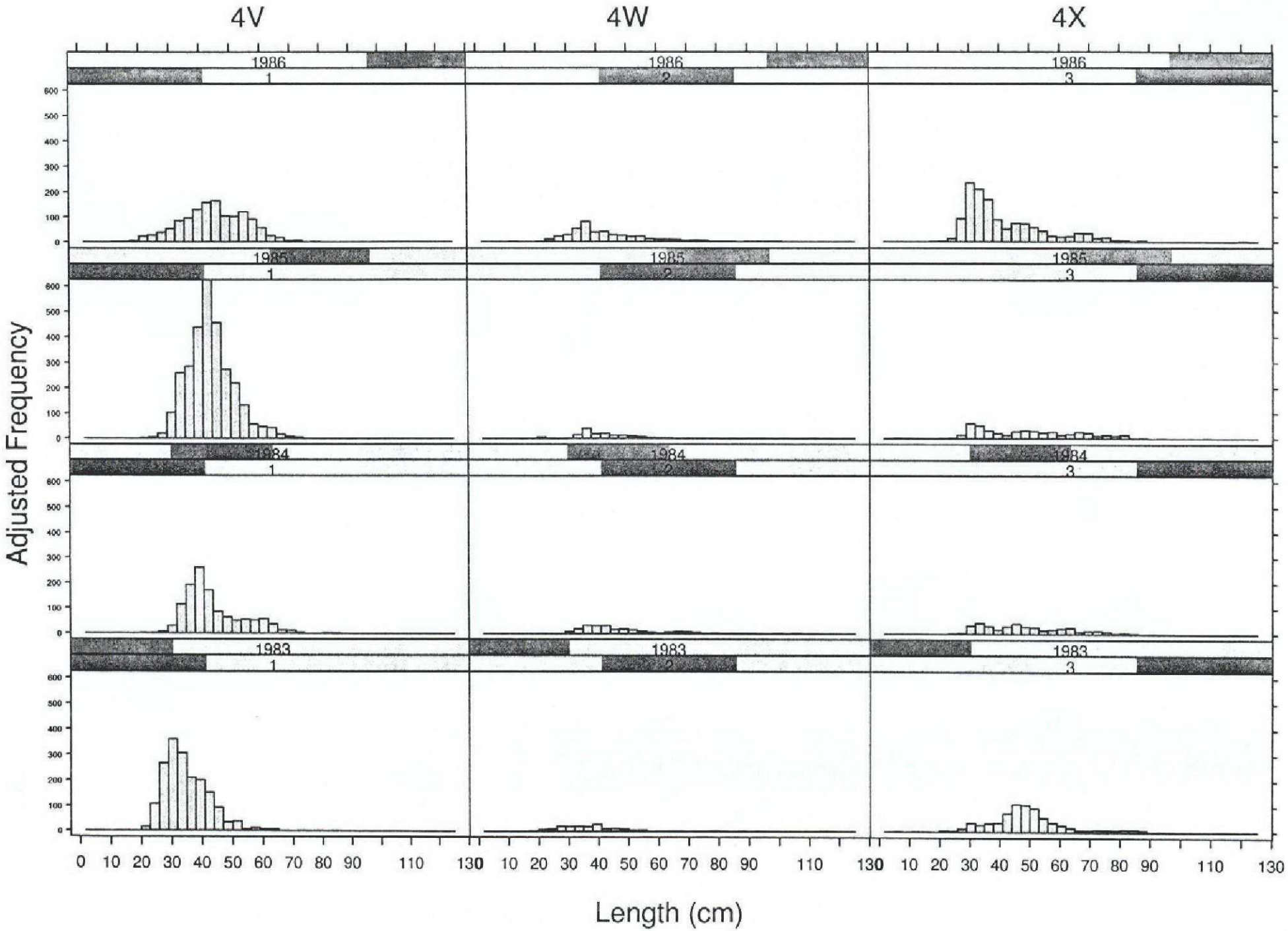


Figure 11. Length frequencies of white hake from 1983-98 summer research vessel surveys.

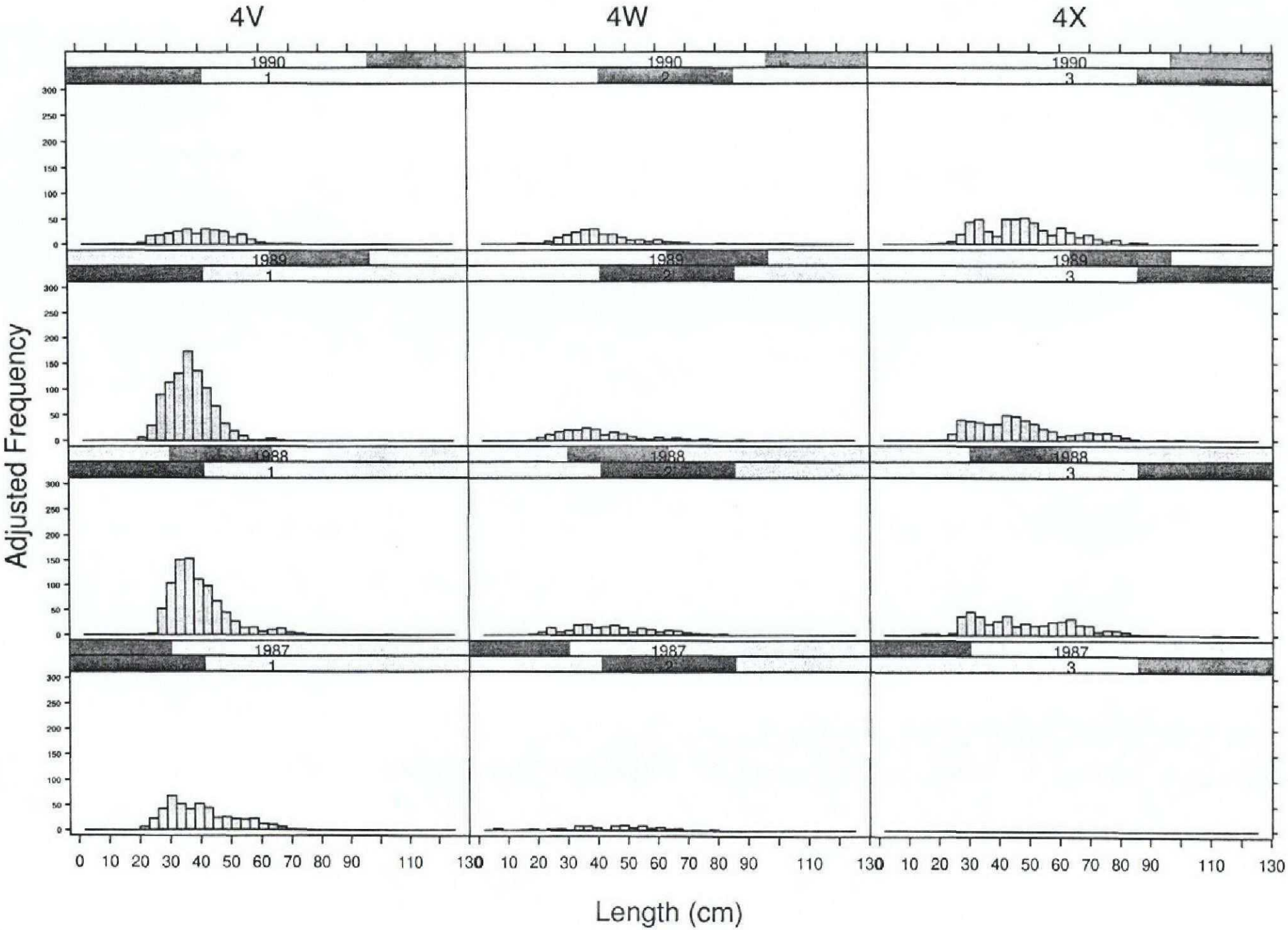


Figure 11. (con't).

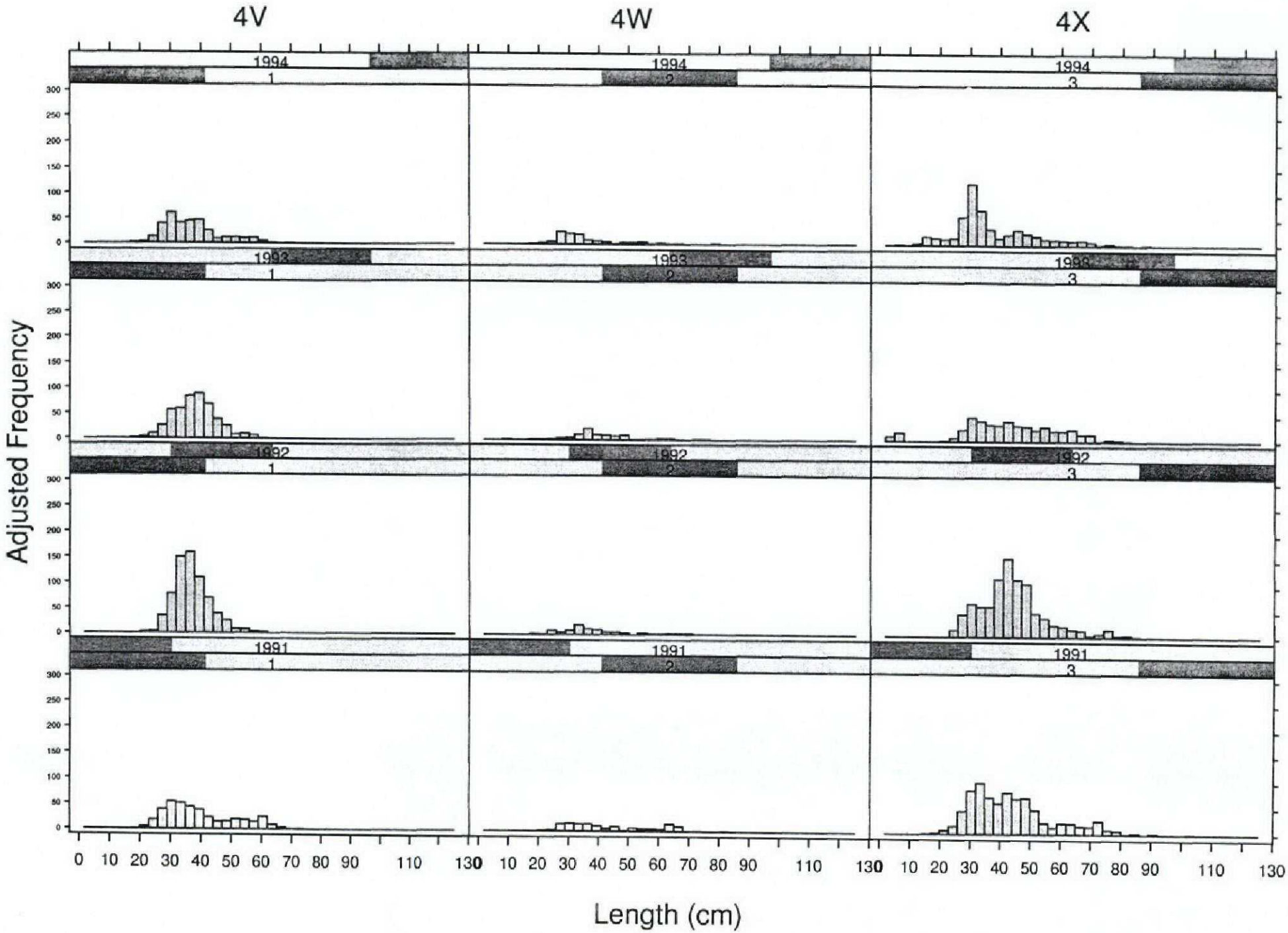


Figure 11. (con't).

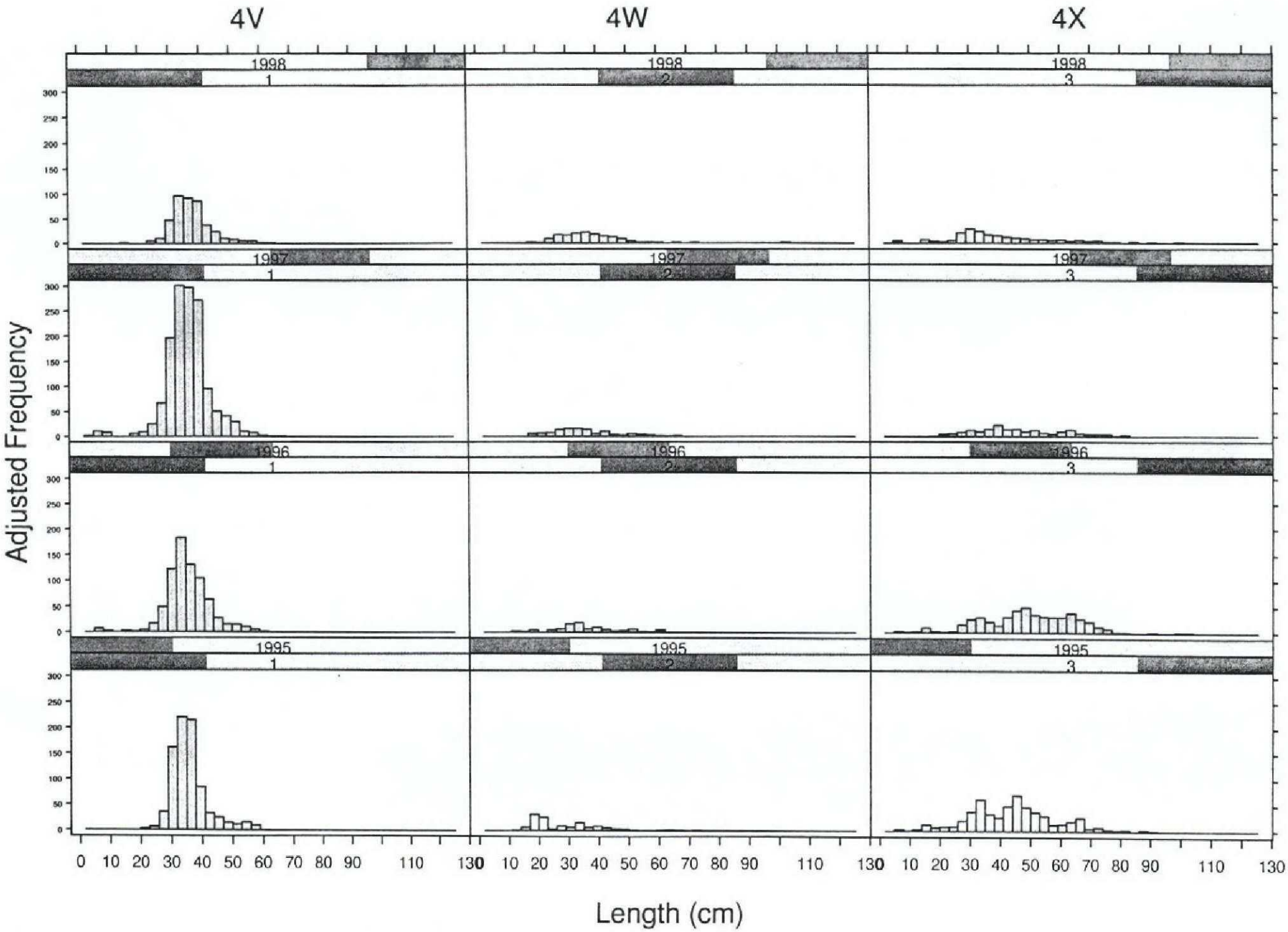
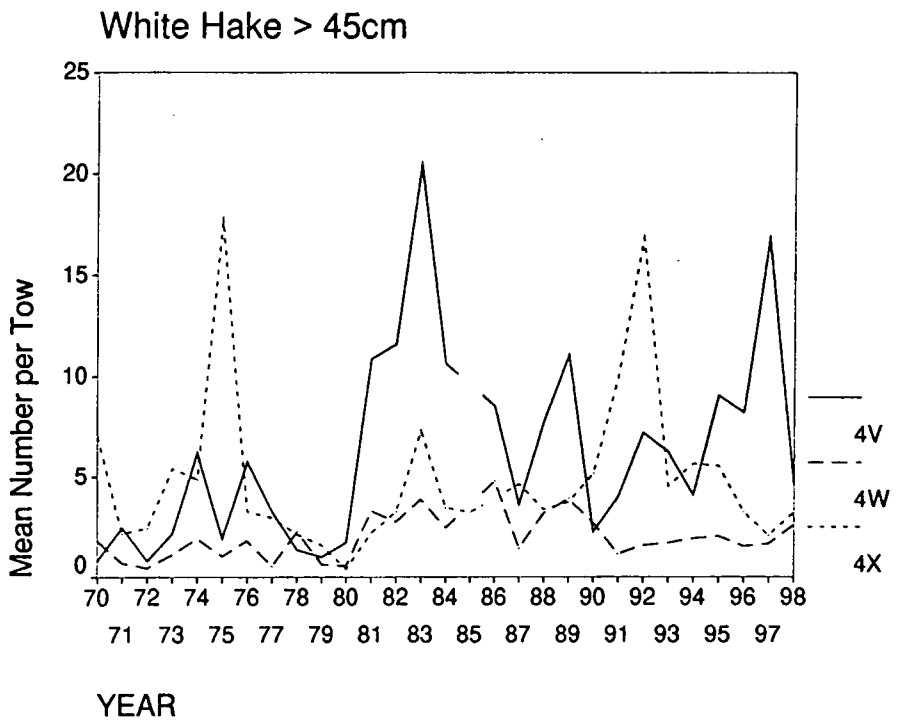


Figure 11. (con't).



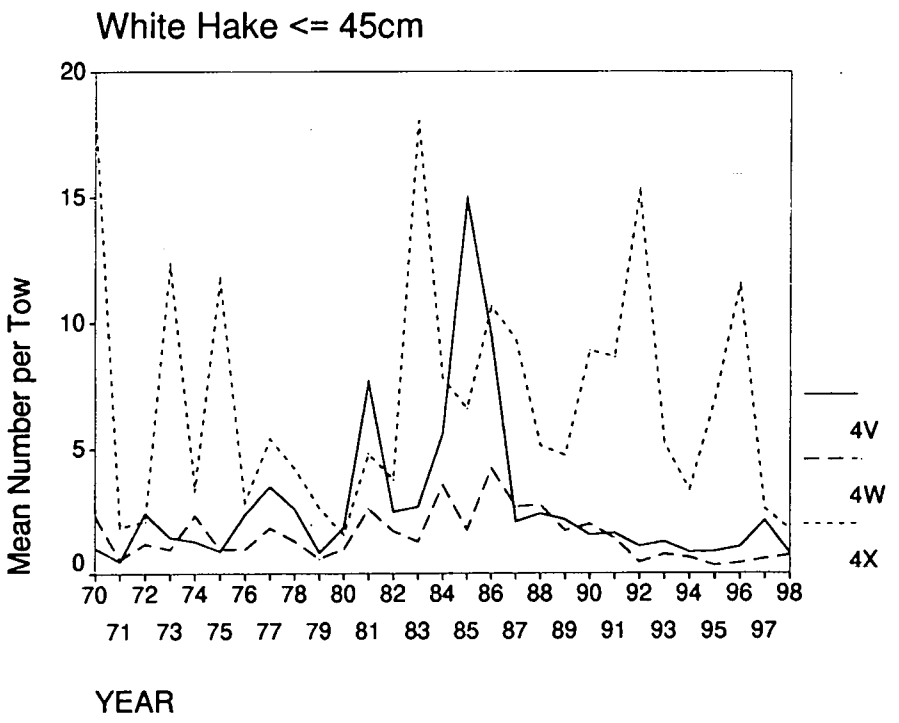


Figure 12. Mean number per tow for white hake by size group from summer research vessel surveys.

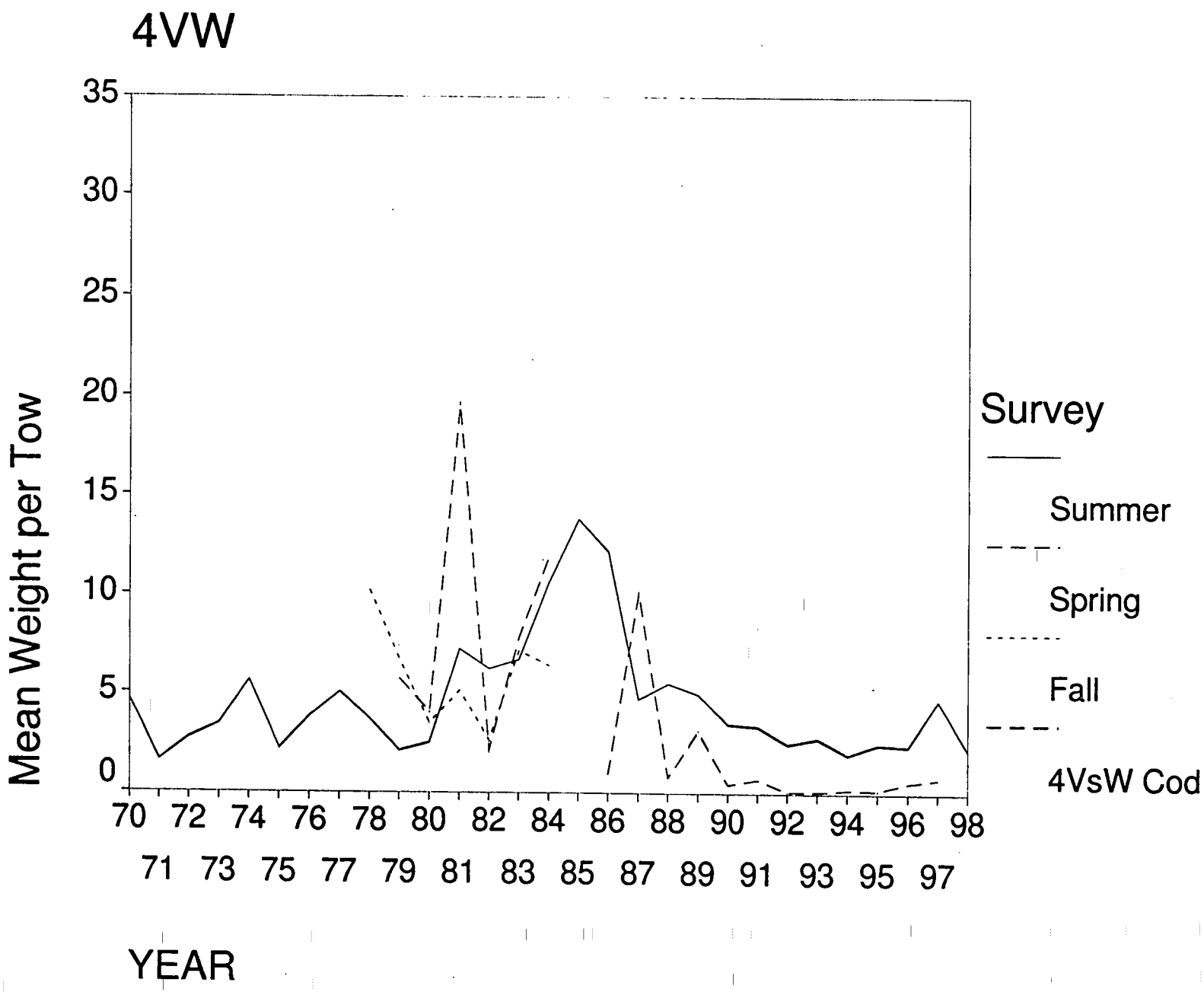


Figure 13. Mean weight per tow for 4VW white hake from research vessel surveys.

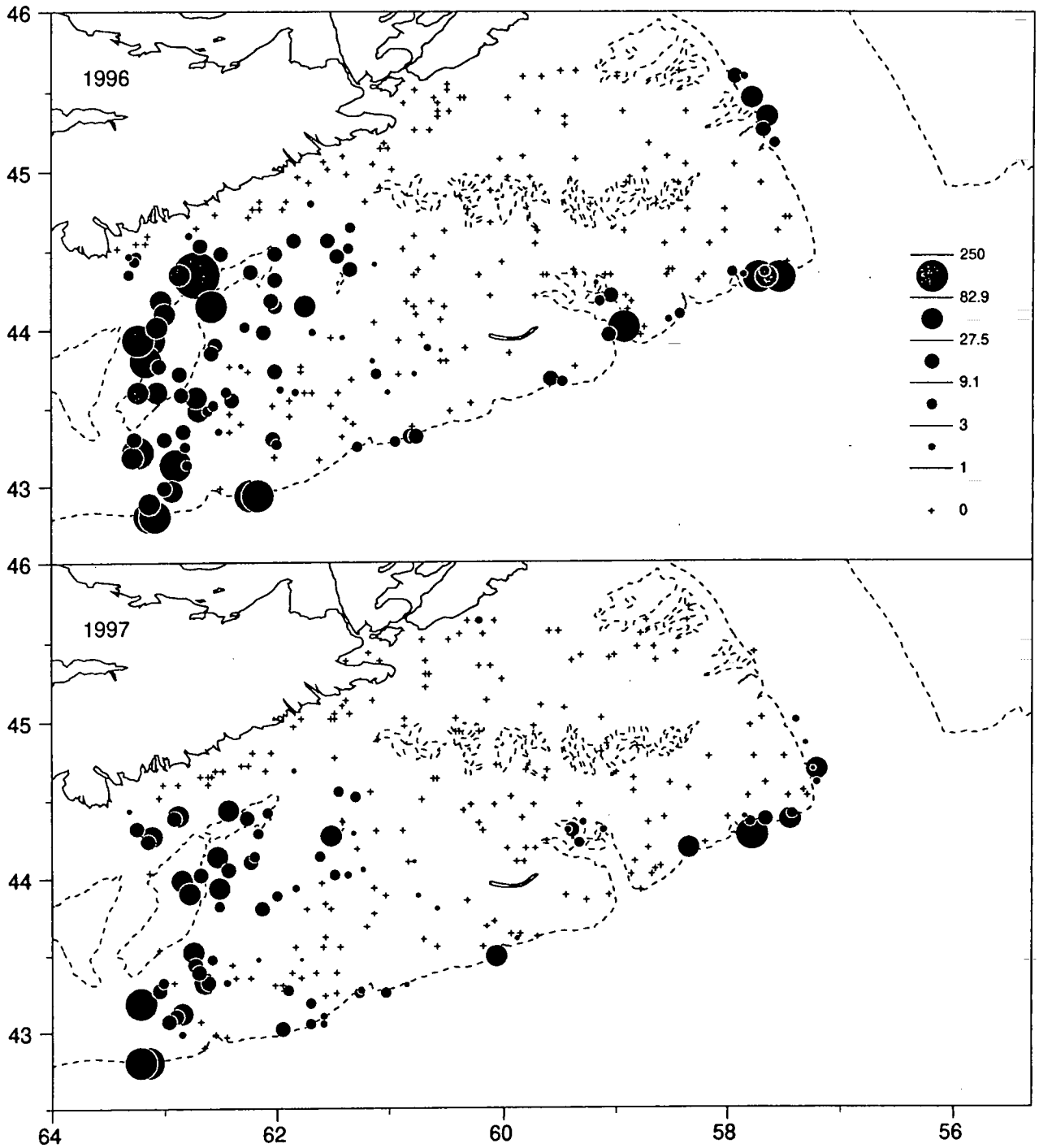


Figure 14. White hake distribution (catch in kg) from 4VsW Sentinel surveys.

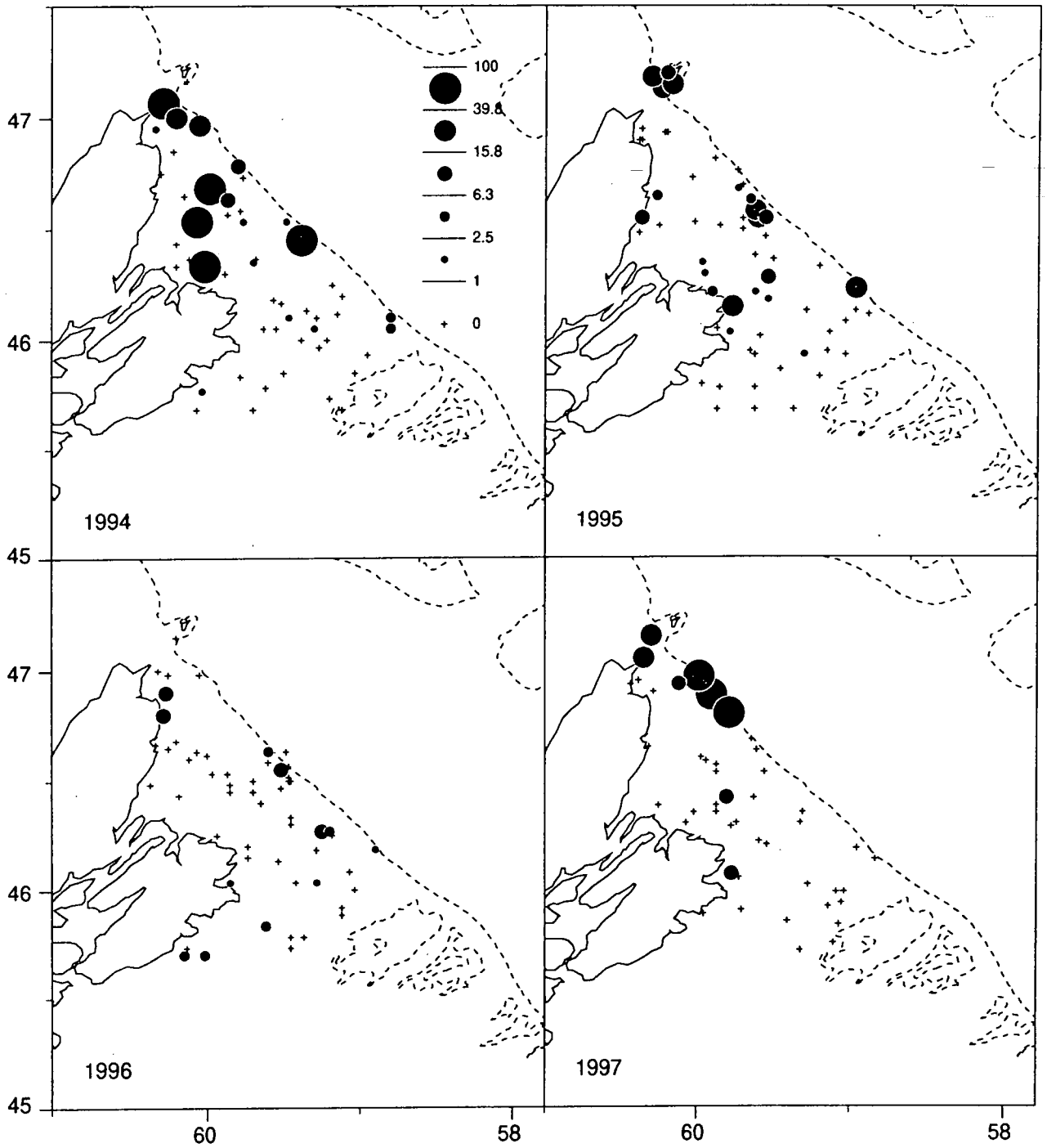


Figure 15. White hake distribution (catch in kg) from 4Vn fall Sentinel surveys.

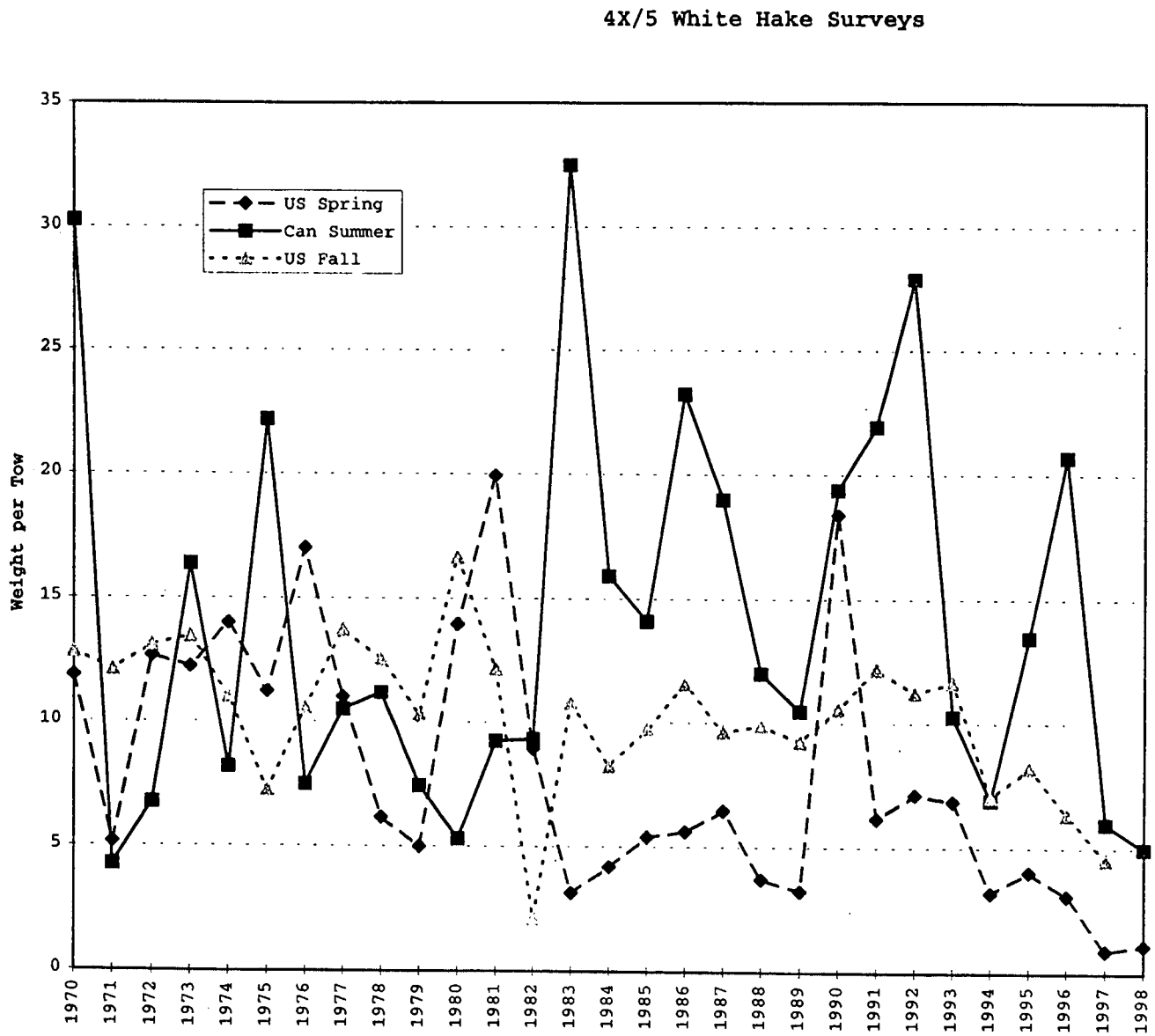


Figure 16. Mean weight per tow of white hake caught during US and Canadian research vessel surveys.

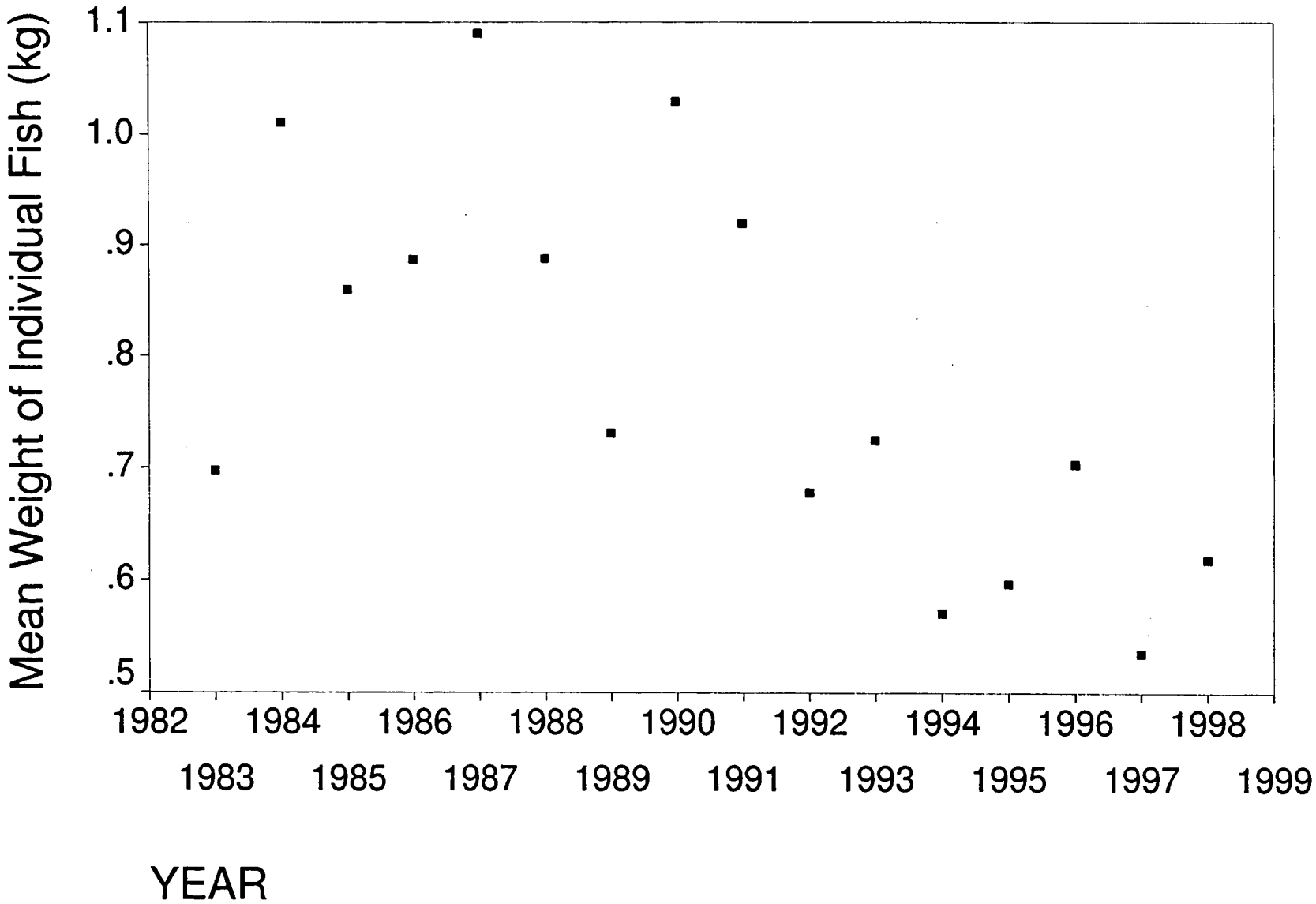


Figure 17. Mean individual weights of white hake caught during summer research vessel surveys since 1983.

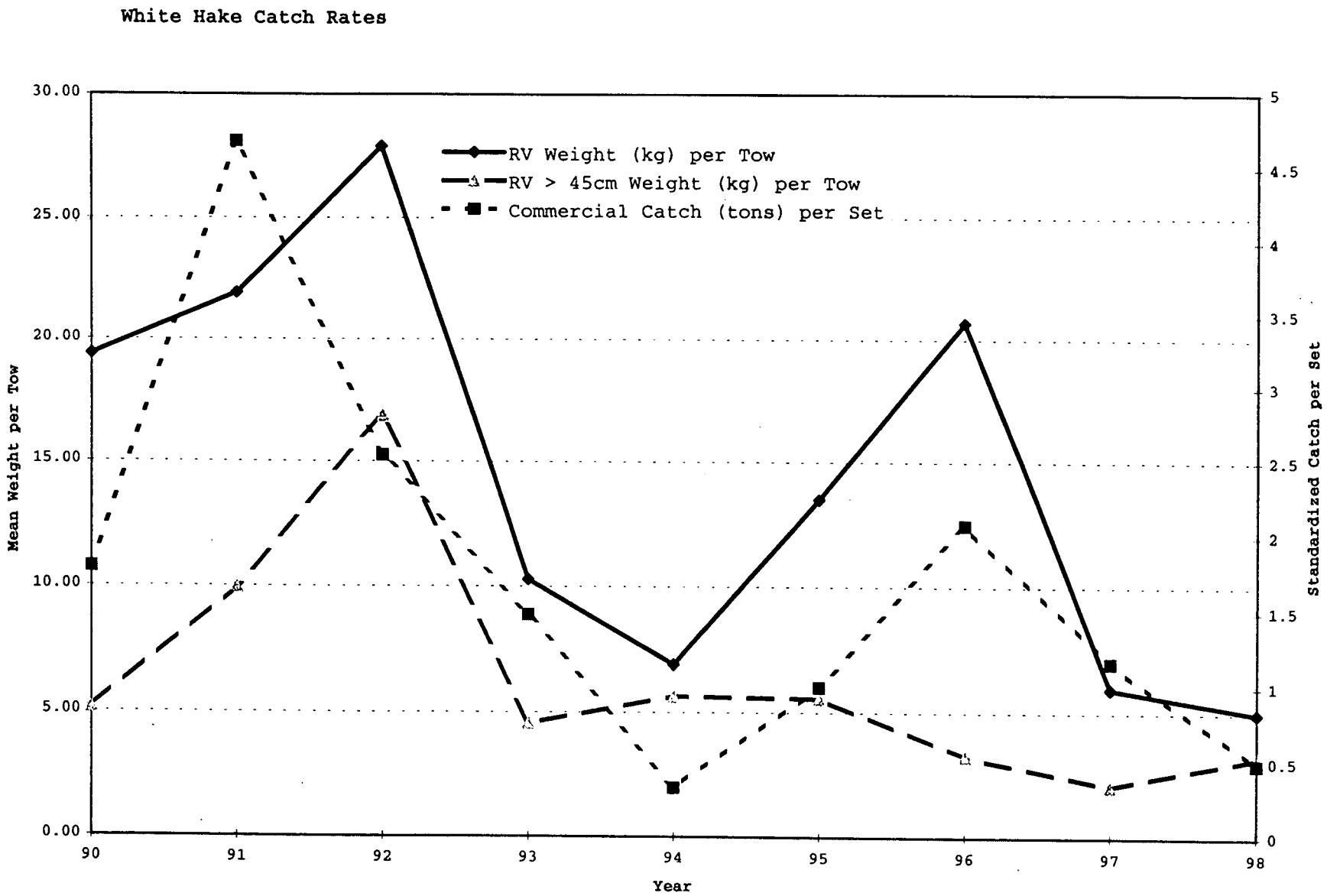


Figure 18. Catch rates of 4X/5 white hake by summer research vessel surveys and index commercial fishers.

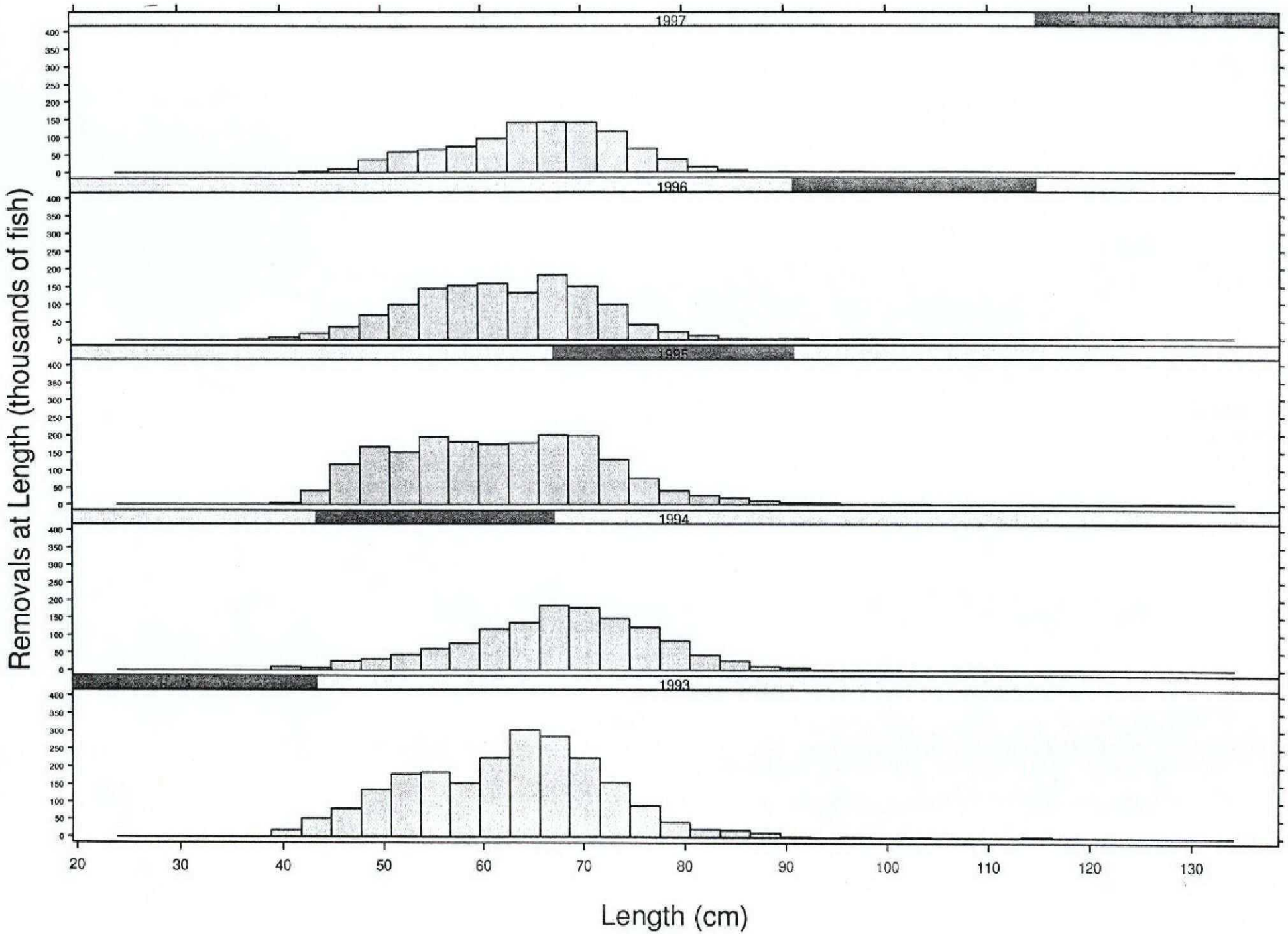


Figure 19. Estimated commercial removals at length from the 4X/5 white hake population component from 1993-98.

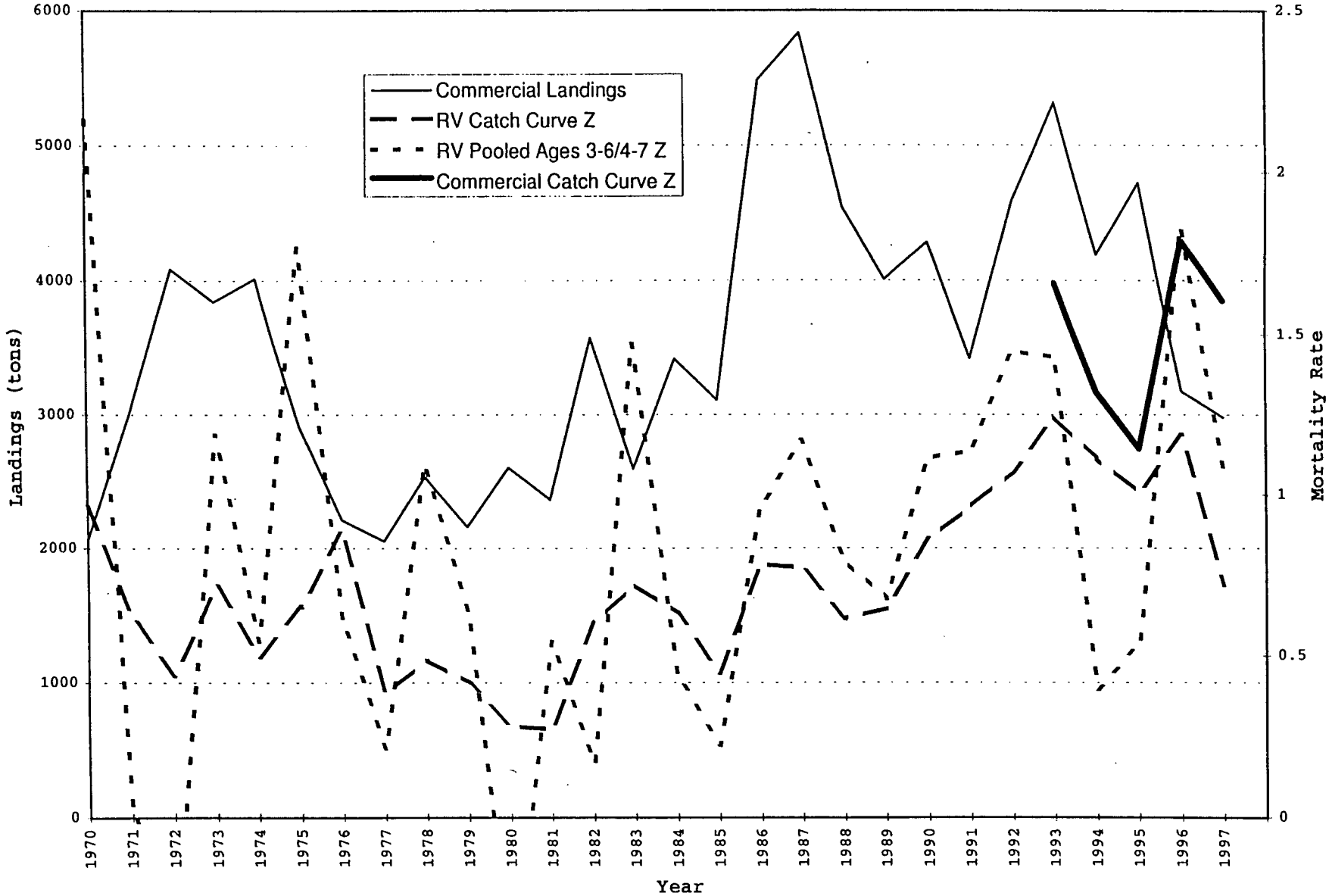


Figure 20. Commercial and research vessel (RV) estimates of mortality rate (Z) of 4X/5 white hake in relation to commercial landings.