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Scotian Shelf Silver Hake Population Size in 1986

by

L. P. Fanning, D. E. Waldron and C. Bourbonnais

Marine Fish Division, Dept. of Fisheries and Oceans, Bedford Institute of Oceanography
P. O. Box 1006, Dartmouth, Nova Scotia, Canada B2Y 4A2

Introduction

The Scotian Shelf silver hake fishery began in 1962. The fleets fishing silver hake on the Scotian Shelf have been, and continue to be, primarily non-Canadian. The Soviet Union was the first nation to fish for silver hake on the Scotian Shelf. It has been involved in the fishery since 1962 and continues to dominate the catch. Historically, the major fishing nations were the Soviet Union and Cuba with countries such as Portugal, Japan, and Spain catching various amounts. During the last 3 years, the Soviet Union and Cuba have been the main countries involved in this fishery.

The silver hake fishery has been geographically restricted since 1977. It was once conducted over the entire shelf with April to August being the time of the major fishery. Since 1977 the fishery continues to be restricted to seaward of the Small Meshed Gear Line (SMGL) (Figure 1). Further, Canada has established regulations which limit the codend mesh size to greater than 60 mm, the amount of by-catch in the fishery and the amount of fishing effort for each country. By-catches of cod, pollock, haddock, and redfish, among other species caught in this fishery, are monitored by Canada at the following levels: 1% for haddock, 1% for cod in NAFO Subarea 4X and 10% elsewhere, and all other species at 10 %. From 1977-1985, the fishing season has been from April 15 to November 15 each year. The season is now scheduled from April 1 to November 15 of each year.

The vessels used in this fishery are large Tonnage Class (TC) 7 vessels (greater than 2000 gross registered tons) usually between 80 and 100 meters in length. The gear most often used is a large bottom trawl with an average wing spread of 29 meters and an average head rope height of 8 meters. Using these nets, vessels have been observed to catch as much as 60 tons of silver hake in one day with one tow having as much as 25 tons of silver hake.

Commercial Fishery Data

Catch

Catches are highest during the period April to July of each year and come primarily from the NAFO Subarea 4W. The historical catches for this fishery have ranged from 300,000 tons in 1973 to 34,000 tons in 1983. There was a steady decrease in silver hake catches from 1973 to 1981 (Figure 2, Table 1). Nominal catches from 1977 until 1983 have fluctuated between 33 and 60 thousand tons. Starting in 1984 the catch was above 70 thousand tons. Below are reported catches ('000 t) and the Total Allowable Catch (TAC '000 t) since 1975.

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
TAC	70	80	70	90	80	80	80	100	100	100	100
CATCH	37	48	51	45	43	60	36	74	77[1]	82[1]	

[1] Reported to Canada as of February, 1987

Official NAFO catch statistics for 1984 were published late in 1986. Revised catches for 1985 were also available from NAFO during 1986. These updated catches and the catches used in the 1986 assessment document are presented in Table 2. Overall catch totals are similar to those used in the last assessment. Only certain monthly catches have changed from those used previously.

The low level of catches since 1976 is due in part to the amount of silver hake Canada allocates to other nations. A more informative method of viewing the post-1976 catches is to evaluate catch success against the amount of silver hake allocated. Percentages of their total allocations caught by non-Canadian fleets have ranged from 64% to 90%. The highest years are 1982, 1984, 1985, and 1986 (Table 3).

In 1984, 1985, and 1986 the USSR started fishing in May rather than early April. The USSR commenced fishing their 1987 allocations during the last week of May. This delay in fishing is reflected in the decreased catches during the months of April and May for those years (Table 2). Despite the late start for the Soviet fleet from 1984 to 1986 they still caught their allocations, as did the Cuban fleet (Figure 3). Consistent with recent fisheries for silver hake, the 1986 fishery remained strong until August with most of the allocations being taken (Table 2). Monthly catches in 1986 were highest in June when 42,000 tons or 50% of the catch was taken. Catches in April to June accounted for 80% of the total yearly landings.

Monthly catch and effort

Historical catches from this fishery indicate that the major fishing season was during the months of April until September (Table 2) with peak catches from May to July. This pattern continues to the present.

Reported (1970-1985) and observed (1986) catch rates (t/hr) for the USSR and Cuba from April until September are given in Table 4.

Catch rate standardization

A multiplicative model (Gavaris, 1980) was run on 1970 to 1986 monthly catch and effort data for TC 6-7 OTB2 vessels from the USSR and TC 7 OTB-2 vessels from Cuba (Waldron et al., 1986). The model was used to adjust for the effects of the change in fishing regimes after Canada declared its 200 mile zone in 1977 and to estimate a consistent catch rate series.

The monthly catch and effort data for 1986 are from the IOP while 1970 to 1985 are from NAFO. A regression analysis to compare monthly catch rates for the USSR from NAFO and the Canadian IOP was highly significant with a correlation of 0.96, a slope of 1 and intercept of 0 (Waldron and Parnell, 1986). On this basis the IOP catch rates have been used for the most recent year when USSR and Cuban catch and effort are not yet available from NAFO.

Catch and effort from 1970 to 1976 were classified as the "old" fishing regime when vessels were generally unrestricted in the area and season of fishing. Catch and effort after 1979 are classified as the "new", more restricted, fishing regime. The catch and effort from the 1977-1979 silver hake fishery is partitioned between the old regime and the new regime. During this time, Canada permitted 4 vessels from each of the two major silver hake fisheries, Cuba and USSR, to fish landward of the SMGL. Only certain vessels were licensed for this experiment. These vessels were directed by the Fleet Commanders to fish either to the landward or seaward of the SMGL depending upon the relative fishing success in either area.

Therefore, those vessels which were part of the experiment were classified as the old fishing regime. As these vessels were required to carry Observers they provide an excellent method of studying the transition between the old and new fishing regimes.

The regression results (Table 5.) indicate that there is a significant effect due to country in the model and in fact the Cuban catch rates are on average .75 of the USSR (exp(-.291)). There is also a significant effect of month due to better catch rates in April, the only month with a significant coefficient. The month effect was not significant in a similar analysis last year (Waldron et. al, 1986) when only the USSR data were used. The fact that April is the only significant month corresponds with the fact that the Cubans begin fishing earlier in the year than the USSR most years. There were no significant effects due to NAFO division, data source (NAFO or IOP) or fishing regime which was similar to Waldron et al (1986).

Catch rates for 1986 and 1982 are the highest in the series (Table 6, Figure 4). Since 1982 catch rates have been highly variable from year to year but at generally high levels. While there is no apparent trend over this time period the high catch rates would normally indicate a higher population biomass than in the period prior to 1982.

Commercial Sampling Intensity

Sampling for length and age commercial catches in 1986 was by the IOP (Table 7). The IOP observed 43% or 36,000t of the 83,000 t caught. More than 250,000 lengths and 1,900 otoliths were taken from the catch. Coverage levels for 1986 and previous years were above the NAFO standard. Samples were pooled for the months September to November.

Otoliths were aged using the ICNAF standards (Anon., 1977) by Mr. J. Hunt of the Canadian Department of Fisheries and Oceans, St. Andrews Laboratory, St. Andrews, New Brunswick.

Catch at age

The catch-at-age matrix used in this assessment is presented in Table 8. The matrix was calculated in the following manner. For 1986, length frequencies of silver hake collected during the small-meshed fishery were aggregated to produce a single monthly length frequency for each country. These monthly length frequencies were weighted to the 1986 monthly catch (Table 2) using a monthly weight-length relationships ($wt=aL^b$). The monthly weight-length relationships were based on individual silver hake lengths and weights measured at sea during the 1986 small-meshed silver hake fishery. For each month the weighted length frequencies were multiplied by age-length keys to produce catch numbers at age. These monthly vectors were summed to give final catch numbers at age for the year.

The catch numbers at age for 1970 to 1979 were prepared by Clay and Beanlands (1980). Catch at age for 1972-1979 were constructed from age-length keys collected during Canadian July groundfish surveys and silver hake length frequencies reported to ICNAF. The length frequencies were adjusted to catch using weight-length relationships from the Canadian July groundfish surveys. These weighted length frequencies were applied to the Canadian age-length keys to give yearly catch numbers at age. The catch numbers at age for 1970 and 1971 were calculated as above but used an aggregated age-length key from the Canadian July groundfish surveys from 1972 to 1976. Catch numbers at age for 1977 to 1979 used length frequencies collected aboard the small-meshed fleets by the IOP and weight-length relationships from the Canadian July groundfish surveys.

Catch numbers at age for 1980 to 1985 (Waldron and Fanning, 1986a) used length frequencies and weight-length relationships collected on board the small-meshed fleets by the IOP. As in previous years, these were weighted to catch and used to construct the final catch numbers at age. Research vessel weights at length were not used as weights collected by the IOP were more representative of the weights at length during the fishery.

The 1986 fishery was composed of two large year classes, the 1983 and 1985. The catch numbers at age matrix (Table 8) and percent catch numbers at age (Table 9) indicates that the 1983 year class, which was observed in the last assessment to be the largest since the 1975 year class remains the dominant year class in the 1986 fishery. The 1982 and 1984 year classes continue to appear weak compared to other year classes. The 1980 and 1981 year classes in 1986 are average.

Mean weight at age

Monthly mean weights at age were weighted by monthly catch (Table 10). Waldron and Fanning (1986a) noted that fish age 4 and 5 in 1985 were below weights calculated for the 1982 fishery. This trend has continued in the 1986 fishery (Figure 5). Age 2 fish continue to show an increase in mean weight at age.

The catch biomass at age is given in Table 11. As suggested in last year's assessment, the 1986 fishery was strongly supported by the 1983 year class. The catch from the 1985 year class at age 1 was larger than the catch from the large 1983 year class at age 1.

There is good agreement between the catch biomass and the reported catch per year as shown below. The difference between reported and calculated catch in 1986 (1.7%) could be the result of discrepencies between the catch reported to Canada and available NAFO statistics. As more data becomes available these estimates will be adjusted by recalculating the catch at age for 1986.

Year	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch	37095	48404	51751	44525	42927	60251	35839	74280	75492	82855
Biomass	36838	47581	51179	44663	41030	59883	35189	74207	77391	81482
Difference	257	823	572	-138	1897	368	650	73	-1899	1373

Research Vessel Indices

Adult Surveys

The July stratified random groundfish survey is a major index of adult abundance. From 1970 to 1986 there have been three vessels used to conduct this survey. Analysis of comparative fishing experiments between pairs of vessels (Fanning, 1985) indicated that a conversion factor for the series prior to 1982 of 2.3 was required to adjust for the effect of the vessel and gear changes in the time series. By converting the historical catches the current data can be added to the series unchanged.

The estimated numbers and biomass at age from the July survey are given in Tables 12 and 13. The total numbers and biomass are plotted in Figure 6. The percent at age by numbers and biomass are given in Tables 14 and 15.

In terms of either numbers at age or biomass at age the 1985 year class is the largest seen in the survey to date. It constitutes 74% of the total numbers and 49% of the total biomass in the survey estimates. The 1983 year class at age 3 is well above average and the 1981 year class was the largest in the series at each of ages 2 and 3 and is above average at age 5. The 1982 and 1984 year classes continue to appear weak with 1984 being the smallest at age 2 since the 1978 year class.

A stratified random groundfish survey was conducted in March from 1979 to 1985 and no new data is available beyond what was presented in Waldron and Fanning (1986a). The estimated total numbers in the March surveys were:

Year	1979	1980	1981	1982	1983	1984	1985
Numbers	381469	192500	335821	998784	964176	960484	379573

Juvenile Surveys

A joint USSR/Canada juvenile silver hake survey has been conducted from 1978 to the present. The gear used from 1978 to 1980 was a groundfish trawl which was replaced in 1981 with the International Young Gadoid Pelagic Trawl (IYGPT). Since 1981 the survey has been conducted on a 12-hour night-time only basis. The survey index based on the core strata (60-78) (Koeller et al., 1984) from 1978 to 1985 was recalculated in 1986 (Koeller et al, 1986) and the same method was used for the 1986 survey. The resulting juvenile abundance series is presented below. The survey in 1986 was hampered by operational problems and minimal sampling was possible outside the core strata (Figure 7).

Years	1978	1979	1980	1981	1982	1983	1984	1985	1986
Stratified Mean catch/tow	235.7	56.3	26.6	579.0	8.8	232.2	43.4	284.8	231.9

Only the estimates from 1981 to 1986, using the IGYPT gear, will be used as a series for juvenile silver hake abundance. This series indicates that the 1981, 1983, 1985, and 1986 year classes are large relative to the 1982 and 1984 year classes. This observation agrees well with that seen in the Canadian July groundfish surveys and the commercial catch. The low values of the 1982 and 1984 year classes relative to other year classes since 1981 are also seen in the commercial fishery and research vessel data sets. Based upon the observed consistency between this recruitment index and subsequent performance of individual year classes, the 1987 and 1988 fishery will have 2 strong year classes similar to the 1983 year class

Stock Assessment

The last time an SPA was accepted by the NAFO Scientific Council was 1983. Since that time the calibration of the SPA using commercial catch rates was not accepted because of suspected biases caused by the introduction of the SMGL. In June 1986 the Scientific Council (NAFO Sci. Coun. Rep. 1986, p60) reviewed and accepted a catch rate series which had been standardized using a multiplicative model regression. The same technique was used in this assessment to calibrate an SPA with the catch rate series.

Estimation of parameters

Natural mortality - As in previous years a natural mortality of 0.4 on all ages was assumed.

F at the oldest ages - This was determined using the APL function AUTOF (Rivard, 1982) to iterate the F's on ages 3+.

Partial recruitment - The partial recruitment of ages 1 and 2 was calculated from the ratio of F on ages 1 and 2 to average F on ages 3 and 4. This PR was input back into an SPA and the procedure repeated until there was no further change in the PR. The resulting input partial recruitment in the final year was:

Age	1	2	3-9
Partial Recruitment	0.080	0.580	1.0

The PR used to calculate exploitable biomass was based on annual PR vectors which were also calculated as the ratio of F on ages 1 and 2 to average F on the fully recruited ages (3-9). The PR's of ages 3-9 were set to 1.0 as were PR for any years where the ratios of F's for ages 1 or 2 were greater than 1.

Terminal F - The standardized catch rate series based on the USSR and Cuban catch and effort given above was used for calibration purposes. It was considered however that the 1982 value was not representative of biomass levels in that year because it far exceeded the catch rates in the 2 adjacent years. The accuracy of the data from 1970 to 1976 was questionable, particularly 1973 (299,000 tons caught), however there was no means to assess this. It was recognised that no SPA tuning was going to

produce a relationship in which 1982 and the pre-1977 data were compatible with each other. As a result three calibration datasets from 1970 to 1986 were chosen; i. exclude 1982 ii. exclude 1970 to 1976 iii. exclude 1970 to 1976 and 1982. Relationships of standardized CPUE with SPA fishable biomass and also RV age 4+ numbers with SPA age 4+ numbers were examined.

The results of calibration of 4VWX silver hake with commercial catch rates are in Table 14 and research vessel surveys are in Table 15. The research vessel calibrations have non-significant slopes for all levels of terminal F and all combinations of excluded years. The R^2 criterion was for selecting a terminal F was not used since the recent years were all at the high end of the CPUE range. The intercept was closest to 0 at F_t=0.25 and this was chosen as the best estimate from these data. The tuning plot for F_t=0.25 of fishable biomass and standardized CPUE with 1982 excluded from the regression is given in Figure 8. The resulting F matrix and numbers at age are given in Table 16.

Yield per recruit

The Thompson and Bell yield per recruit was calculated using the most recent partial recruitment, natural mortality of 0.4 and mean weights at age from the commercial fishery from 1977 to 1986. The $F_{0.1}$ level is 0.474 and the yield per recruit would be 0.063 kg. at that level of F. These are unchanged from the previous assessment (Waldron and Fanning, 1986b).

Conclusions

Year Class Strengths

The 1986 fishery was supported strongly by the 1983 year class. This is consistent with the indications of this year class in the juvenile survey and the July adult survey.

The 1988 fishery will be supported by 2 strong year classes, 1985 and 1986, which both appear to be as strong as the 1983 year class. The 1983 year class will be essentially gone by 1988. The indications are that the 1988 fishery will be very good although this depends to a great deal on the juvenile survey estimate of the strength of the 1986 year class. The strength of the 1985 year class was indicated by the juvenile survey, the July survey and the 1986 catch at age 1. The catch of the 1985 year class in 1986 was the largest at age in any year since 1973 (1972 year class) when the total catch was almost 300,000 tonnes.

The 4VWX silver hake stock biomass in the 1980's has been above the average levels seen in the 1970's. The current TAC of 100,000 tons, established in 1983, was based upon recruitment indices which suggested that the 1983 year-class would be much higher than those seen since 1978.

Projections

The input parameters for the catch projections are given below.

Age	Population in 1987 (000's)	Mean weight kg.	Partial Recruitment
1	2,526,686	0.067	0.08
2	1,593,140	0.154	0.58
3	354,663	0.199	1.00
4	489,281	0.239	1.00
5	195,717	0.275	1.00
6	83,710	0.331	1.00
7	29,830	0.425	1.00
8	6,111	0.562	1.00
9	2,471	0.678	1.00

The population vector at age for 1986 was generated from the SPA at F_t=0.25

except for the recruitment at age 1. The 1986 number at age 1 in the SPA was almost double the largest recruitment seen previously (1971 year class). Since the juvenile surveys have indicated that the 1983, 1985 and 1986 year classes are similar in size as 0-group it was assumed for projection purposes that the 1985 and 1986 year classes were in fact equal to the 1983 year class at age 1. The high juvenile survey estimate for the 1981 year class and the low estimate for the 1982 year class were not consistent with year class sizes calculated from the SPA. The July survey estimates of these and the 1983 and 1984 year classes were more consistent with SPA numbers however and the juvenile estimates from the 1981 and 1982 year classes were discounted. Recruitment in 1988 was assumed to be equal to the geometric mean of the recruitment from 1970 to 1984 (1.4 billion). The mean weights at age were averaged over 1984-1986. The partial recruitment vector was the same one used in the current assessment.

Projections to estimate the $F_{0.1}$ catch in 1988 using the above input parameters were run under three different scenarios, firstly, the $F_{0.1}$ catch is taken in 1987, secondly, the TAC is taken in 1987 and thirdly, the 1987 catch equal to the 1986 catch. The results are given below.

1987 Catch scenario	Catch in 1987	F in 1987	$F_{0.1}$ Catch in 1988
$F_{0.1}$	143,928	0.474	147,542
TAC	100,000	0.31	161,561
Equal 1986	83,000	0.252	167,014

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References

Clay, D. and D. Beanlands. 1980. Silver hake (Merluccius bilinearis) in Division 4VWX. A stock assessment and estimate of the total allowable catch (TAC) for 1981. NAFO SCR Doc. 80/VI/87. 14p.

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

Koeller, P.A., J. D. Neilson and D.E. Waldron. 1985. The Canadian-USSR juvenile silver hake (Merluccius bilinearis) surveys on the Scotian Shelf: abundance indices, distribution, and comparison with independent estimates of juvenile abundance, 1978-83. NAFO SCR Doc. 84/87. 9p.

Koeller, P.A., P. Perley and J. D. Neilson. 1986. Canadian Juvenile Silver Hake abundance estimates from joint Canada-USSR surveys on the Scotian Shelf. NAFO SCR Doc. 86/54: 12p.

Waldron, D.E. and L.P. Fanning. 1985. Status of the Scotian Shelf silver hake population in 1984. NAFO SCR. Doc. 85/68. 28p.

Waldron, D.E. and L.P. Fanning. 1986 a. Assessment of the Scotian Shelf silver hake population in 1985. NAFO SCR. Doc. 86/62. 27p.

Waldron, D.E. and L.P. Fanning. 1986 b. Calibration of Division 4VWX silver hake VPA including calculations of yield per recruit. NAFO SCR Doc. 86/88. 15p.

Waldron, D.E., P. Fanning and J. Parnell. 1986. Standardization of 4VWX silver hake catch rates from the Scotian Shelf small meshed fishery. NAFO SCR Doc. 86/85. 13p.

Table 1. Nominal catches for 4VWX silver hake 1970-1986 (1986 preliminary).

	Year																
Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Bulgaria	0	0	0	0	0	1722	3088	862	606	4639	817	0	0	0	0	0	0
Canada	0	0	0	0	11	101	26	10	26	13	104	6	38	15	10	0	9[3]
Cuba	0	0	201	0	0	1724	12572	1847	3436	1798	2287	642	11969	7418	14496	17683	16153[2]
France	0	0	0	0	0	0	0	15	0	0	0	0	2[1]	0	0	0	0
FRG	0	0	10	0	296	106	97	684	0	0	0	0	0	0	0	0	0
GDR	0	0	0	0	0	0	0	0	3[1]	0	0	0	0	0	93	0	0
Ireland	0	0	0	0	0	108	106	0	0	9	0	0	0	0	0	0	0
Italy	0	0	0	0	0	0	0	38	106	5	0	541	37[1]	2[2]	0	0	0
Japan	129	8	63	88	67	54	78	19	161	219	239	120	937	649	530	120	72[2]
Poland	0	0	0	0	0	0	0	295	2	0	0	1[1]	31[2]	0	0	0	0
Portugal	0	0	0	0	0	0	0	0	0	0	56	2044	2[1]	378	1714	1338	0
Romania	0	0	0	0	0	0	0	10	0	1	0	0	0	0	0	0	0
Spain	0	15	0	0	0	6	0	0	2	0	40	0	0	0	0	0	0
USA	0	1	0	0	0	7	1	14	0	0	0	3	2	0	0	0	1[3]
USSR	168916	128633	113774	298533	95371	112566	81216	33301	44062	45076	40982	41243	47261	27377	57423	56337	66630[2]
TOTAL	169045	128657	114048	298621	95745	116394	97184	37095	48404	51760	44525	44600	60251	35839	74266	75478	82855

[1] Observer Program Data (data not reported to NAFO)

[2] FLASH data

[3] NAFO Circular Letters and provisional reporting to NAFO.

Table 2. Scotian Shelf silver hake reported monthly catch (t) (monthly catch reported in previous year's assessment in parenthesis).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979[3]	1980	1981[3]	1982[3]	1983[3]	1984	1985	1986[1]
Jan.	12	3	-	-	1088	2850	982	-	-	-	-	-	-	-	-	-	-
Feb.	43	3555	43	103	261	1416	1174	2	-	6	-	-	-	-	-	-	-
Mar.	4335	30821	7199	12133	7345	2808	15028	3718	-	2	-	-	-	-	1[2]	-	25
Apr.	16682	19415	12129	91367	10182	13565+ 108	10344	8142	2118	2190	1558	981	2409	6990	2614	3207	4902
May	19880	11742	21303	72443	15766	14715	7860	5714	8761	13000	9809	15332	19482	16369	22079 (19529)	15491 (11323)	21382
June	19115	9419	16982	41948	14369	11364	7030	3284	13591	17651	13875	13669	24786	11274	24054[2] (22000)	33318 (30483)	41594
July	34873	22118	26425	42955	10676	26874	22531	11990	14449	14417	15011	13654	12607	543	22020 (26041)	17638 (25600)	13572
Aug.	43814	21621	14610	13394	10365	23904	8895	2805	8851	2930	4025	909	641	490	3248[2] (3411)	5766 (4891)	893
Sept.	19028	8258	11481	8656	14871	18076	6480	1046	236	903	103	41	260	156	245 (516)	54 (22)	483
Oct.	6132	1092	3223	5493	4981	139	7625	190	285	403	84	8	7	7	2 (17)	-	1
Nov.	4115	613	452	1078	5256	26	3900	201	55	248	60	3	13	8	2 (4)	1	-
Dec.	1016	-	-	9050	10585	549	5335	3	55	1	-	2	2	-	1 (2)	3 (10)	2
Total	169045	128657	114048	298621	95745	116394	97184	37095	48404	51751	44525	44599	60207	35837	74266 (74226)	75478 (75492)	82855

[1] Reported to Canada (FLASH System). Note: catch was updated and is not reflected in this column.

[2] 5 tons were reported for Canada but no months were assigned, thus IOP data used to locate appropriate months.

[3] Some countries did not report catches by months.

Table 3. Nominal catch and allocations (t) (in parenthesis) for 4VWX silver hake. 1986 Preliminary.

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Bulgaria	862 (950)	606 (1000)	4639 (6860)	817 (1200)	0 (1000)	0 (1000)	0	0	0	0
Canada	10 (15190)	26 (16700)	13 (10000)	104 (20000)	6 (20000)	38 (13000)	15 (1000)	10 (1000)	0 (1000)	9 (1000)
Cdn. Reserve							(11808)	(13000)	(8100)	(4600)
Cuba	1847 (8910)	3436 (10300)	1798 (8070)	2287 (11200)	642 (9500)	11969 (13500)	7418 (9500)	14496 (15200)	17683 (15200)	16153 (17700)
EEC	0	0	0	0 (100)	0	0	0	0	0	0
France[4]	15	0	0 (100)[3]	0 (100)[3]	0 (100)[3]	2[1] (100)[3]	0 (100)[3]	0 (100)	0 (100)	0 (100)
FRG	684	0	0	0	0	0	0	0	0	0
GDR	0	3[1]	0	0	0	0	0 (2000)	93 (100)	0	0
Italy[4]	38	106	5	0	541	37[1]	2[2]	0	0	0
Japan	19	161	219	239	120	937 (2000)	649 (5000)	530 (10000)[2]	120 (10000)	72 (10000)
Poland	295	2	0	0	1[1]	31	0	0	0	0
Portugal	0	0	0	56	2044	2[1] (2000)	378 (3000)	1714 (4000)[2]	1338 (4000)	0
Romania	10	0	1	0	0	0	0	0	0	0
Spain	0	2	0	40	0	0	0 (4000)	0	0 (5000)	0
USA	14	0	0 (2)	0	3	2	0	0	0	1
USSR	33301 (44950)	44062 (52000)	45076 (44940)	40982 (56600)	41243 (48400)	47261 (48400)	27377 (43400)	57423 (56600)	56337 (56600)	66571 (66600)
Others	0	0	9 (30)	0 (900)	0 (1000)	0	0 (192)	0	0	0
Total Catch and TAC	37095 (70000)	48404 (80000)	51760 (70000)	44525 (90000)	44600 (80000)	60251 (80000)	35839 (80000)	74266 (100000)	75478 (100000)	82806 (100000)
Sum of Catch Divided by TAC (%)	53	61	74	50	54	75	45	74	75	83
Sum of Catch Divided by Sum of Allocation (discounted Can. Alloc. + reserve) (%)	68	76	86	64	72	90	53	86	83	87

[1] Observed by Canadian Observers but not reported to NAFO
[2] Reported to Canada (FLASH System)
[3] France, St. Pierre, and Miquelon vessels only
[4] EEC allocations

Table 4. Reported (1970–1985) and observed (1986) catch rates (t/hr) for USSR and Cuban Fleets from April until September.

USSR

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Apr.	2.46	1.66	2.25	4.66	1.11	1.17	2.26	1.96	1.39	1.71	1.30	1.23	5.61	2.97	-	-	-
May	1.80	1.35	1.66	2.92	-	1.17	1.61	1.89	1.35	1.85	1.15	2.19	4.27	2.18	4.15	2.27	4.21
June	1.83	2.05	2.44	1.64	1.64	-	-	2.09	1.36	1.77	1.30	1.35	3.86	1.44	2.44	2.49	3.61
July	2.38	1.39	1.43	2.12	-	1.78	1.91	1.99	1.43	1.98	1.38	1.40	2.83	-	2.46	1.17	3.32
Aug.	2.48	1.45	1.58	1.38	-	1.60	2.17	2.01	2.15	1.45	.64	1.40	-	-	3.22	2.78	-
Sept.	1.53	-	2.16	2.41	2.31	1.28	2.58	1.51	-	1.73	-	-	-	-	-	-	-

CUBA

	1982	1983	1984	1985	1986
Apr.	-	3.04	3.61	3.35	5.48
May	3.61	1.91	2.65	2.01	2.92
June	2.31	0.97	2.30	2.51	1.89
July	2.15	1.91	1.11	2.02	-
Aug.	-	-	-	-	1.14
Sept.	0.21	-	-	-	0.97

Table 5. Regression results from catch rate standardization for 4VWX silver hake using USSR and Cuban data.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... .658
MULTIPLE R SQUARED..... .433

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	6.851E0001	6.851E0001	
REGRESSION	22	1.398E0001	6.353E-001	5.629
TYPE 1	0	0.0		
TYPE 2	5	1.574E0000	3.148E-001	2.789
TYPE 3	16	1.214E0001	7.591E-001	6.726
TYPE 4	0	0.0		
TYPE 5	0	0.0		
TYPE 6	1	8.578E-001	8.578E-001	7.600
RESIDUALS	162	1.829E0001	1.129E-001	
TOTAL	185	1.008E0002		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	1	INTERCEPT	0.819	0.099	185
2	5				
3	70				
4	450				
5	1				
6	1				
Month	4	1	0.178	0.086	28
	6	2	-0.056	0.078	39
	7	3	-0.058	0.078	38
	8	4	-0.088	0.085	29
	9	5	-0.159	0.110	14
Year	71	6	-0.328	0.154	7
	72	7	-0.226	0.146	8
	73	8	0.048	0.136	10
	74	9	-0.328	0.213	3
	75	10	-0.445	0.146	8
	76	11	-0.076	0.136	10
	77	12	-0.184	0.118	17
	78	13	-0.389	0.108	26
	79	14	-0.324	0.113	21
	80	15	-0.646	0.141	9
	81	16	-0.460	0.141	9
	82	17	0.520	0.161	7
	83	18	-0.171	0.157	8
	84	19	0.287	0.156	8
	85	20	0.149	0.156	8
	86	21	0.415	0.146	10
Country	2	22	-0.291	0.106	20

Table 6. Standardized mean catch rate series for 4VWX silver hake from 1970 to 1986.

PREDICTED CATCH RATE

STANDARDS USED VARIABLE NUMBERS: 1 4 450 1 1

YEAR	TOTAL CATCH	PROP.	CATCH RATE MEAN	S.E.	EFFORT
1970	169045	0.905	2.855	0.298	59211
1971	128653	0.531	2.049	0.280	62782
1972	114048	0.879	2.271	0.295	50216
1973	299530	0.891	2.990	0.359	100162
1974	95745	0.240	2.026	0.406	47266
1975	116394	0.743	1.822	0.245	63869
1976	97184	0.424	2.641	0.321	36793
1977	37095	0.703	2.375	0.245	15616
1978	48404	0.879	1.937	0.172	24985
1979	51760	0.827	2.066	0.201	25059
1980	44525	0.920	1.492	0.191	29847
1981	44600	0.833	1.797	0.231	24815
1982	60251	0.957	4.774	0.713	12622
1983	35839	0.921	2.396	0.340	14961
1984	74266	0.967	3.786	0.550	19618
1985	75478	0.981	3.295	0.479	22907
1986	82806	0.426	4.307	0.585	19224

AVERAGE C.V. FOR THE MEAN: .130

Table 7. 1986 International Observer Program silver hake sampling.

Country	Sample	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Totals
Canada	No. Meas.							84	318	161	27	590
	otoliths taken							0	0	10	0	10
	otoliths aged							0	0	0	0	0
Cuba	No. Meas.		15895	14949	7226		14378	6676				59124
	otoliths taken		133	107	214		142	6				602
	otoliths aged		133	88	113		125	6				465
Japan	No. Meas.	1251	1694			45		400		48		3438
	otoliths taken	22	7			14		55		0		98
	otoliths aged	22	7			9		0		0		38
USSR	No. Meas.			57267	91577	44699						193543
	otoliths taken			287	548	338						1209
	otoliths aged			206	390	275						871
Total	No. Meas.	1251	17589	72216	98803	44744	14378	7160	318	209	27	256695
	otoliths taken	22	140	394	798	352	142	61	0	10	0	1919
	otoliths aged	22	140	294	503	284	125	6	0	0	0	1374

Table 8. 4VWX silver hake catch at age.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	187298	219607	379314	246148	101158	145091	153535	2131	28704	9667	6272	1553	19708	3333	99217	38273	123882
2	748021	410149	460610	1482925	390044	365964	381651	43535	90777	48341	60576	19530	51680	86085	40265	175423	68374
3	216246	175005	71536	96784	150741	52837	72418	78239	89717	69058	82013	111209	66973	51617	191048	67117	172291
4	59832	74755	47903	106675	7095	60806	31295	29561	42878	46547	35088	38534	66230	28354	71739	91516	68918
5	20695	22035	17822	96940	9789	38646	5582	6981	19442	29656	15293	14266	34777	13036	19200	22953	29477
6	9636	1877	7452	19671	3245	4803	2669	2004	8587	16964	6179	5548	8925	4431	5392	8958	10504
7	3608	5139	1160	15203	93	311	514	483	3222	5079	1682	679	2790	1150	1006	3399	2152
8	1988	1333	437	5475	109	363	105	564	2009	1765	344	132	1047	475	176	644	870
9	1114	2062	607	484	60	360	390	522	420	1151	90	61	127	69	3	364	84
1+	1248438	911962	986841	2070305	662334	669181	648159	164020	285756	228228	208337	191512	252257	188550	428046	408647	476552
2+	1061140	692355	607527	1824157	561176	524090	494624	161889	257052	218561	202065	189959	232549	185217	328829	370374	352670
3+	313119	282206	146917	341232	171132	158126	112973	118354	166275	170220	141489	170429	180869	99132	288564	194951	284296
4+	96873	107201	75381	244448	20391	105289	40555	40115	76558	101162	59476	59220	113896	47515	97516	127834	112005
5+	37041	32446	27478	137773	13296	44483	9260	10554	33680	54613	23588	20686	47666	19161	25777	36318	43087

Table 9. 4VWX silver hake percent at age in the catch by numbers

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	15.0	24.1	38.4	11.9	15.3	21.7	23.7	1.3	10.0	4.2	3.0	.8	7.8	1.8	23.2	9.4	26.0
2	59.9	45.0	46.7	71.6	58.9	54.7	58.9	26.5	31.8	21.2	29.1	10.2	20.5	45.7	9.4	42.9	14.3
3	17.3	19.2	7.2	4.7	22.8	7.9	11.2	47.7	31.4	30.3	39.4	58.1	26.5	27.4	44.6	16.4	36.2
4	4.8	8.2	4.9	5.2	1.1	9.1	4.8	18.0	15.0	20.4	17.2	20.1	26.3	15.0	16.8	22.4	14.5
5	1.7	2.4	1.8	4.7	1.5	5.8	.9	4.3	6.8	13.0	7.3	7.4	13.8	6.9	4.5	5.6	6.2
6	.8	.2	.8	1.0	.5	.7	.4	1.2	3.0	7.4	3.0	2.9	3.5	2.4	1.3	2.2	2.2
7	.3	.6	.1	.7	.0	.0	.1	.3	1.1	2.2	.8	.4	1.1	.6	.2	.8	.5
8	.2	.1	.0	.3	.0	.1	.0	.3	.7	.8	.2	.1	.4	.3	.0	.2	.2
9	.1	.2	.1	.0	.0	.1	.1	.3	.1	.5	.0	.0	.1	.0	.0	.1	.0

Table 10. 4VWX silver hake mean weight at age in the catch

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	.060	.040	.056	.045	.063	.067	.063	.062	.049	.061	.041	.036	.056	.054	.063	.077	.062
2	.126	.128	.119	.128	.129	.155	.148	.147	.110	.154	.141	.143	.148	.130	.147	.156	.159
3	.167	.188	.209	.216	.204	.243	.246	.210	.174	.200	.213	.193	.223	.203	.190	.206	.201
4	.222	.254	.240	.250	.310	.237	.273	.290	.226	.245	.280	.248	.289	.246	.249	.240	.229
5	.303	.315	.274	.295	.396	.477	.407	.397	.283	.285	.322	.318	.329	.303	.278	.276	.272
6	.404	.450	.557	.439	.539	.457	.528	.516	.329	.344	.366	.369	.399	.362	.366	.326	.300
7	.470	.587	.483	.485	.975	1.133	.838	.667	.382	.411	.520	.672	.481	.387	.454	.417	.403
8	.705	.832	1.263	.875	1.156	1.257	1.251	1.077	.498	.520	.601	.550	.582	.653	.597	.599	.490
9	.828	.612	.886	1.174	.001	1.635	.859	1.089	.784	.553	.892	.794	.949	.809	.753	.630	.650

Table 11. 4VWX silver hake biomass at age in the catch.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	11238	8784	21242	11077	6373	9721	9673	132	1406	590	257	56	1102	180	6251	2947	7681
2	94251	52499	54813	189814	50316	56724	56484	6400	9985	7445	8541	2793	7623	11191	5919	27366	10871
3	36113	32901	14951	20905	30751	12839	17815	16430	15611	13812	17469	21463	14915	10478	36299	13826	34630
4	13283	18988	11497	26669	2199	14411	8544	8573	9690	11404	10049	9556	19167	6975	17863	21964	15782
5	6271	6941	4883	28597	3876	18434	2272	2771	5502	8452	4924	4537	11445	3950	5338	6335	8018
6	3893	845	4151	8636	1749	2195	1409	1034	2825	5836	2262	2047	3560	1604	1973	2920	3151
7	1696	3017	560	7373	91	352	431	322	1231	2087	875	456	1342	445	457	1417	867
8	1402	1109	552	4791	126	456	131	607	1000	918	207	73	609	310	105	386	426
9	922	1262	538	568	0	589	335	568	329	637	80	48	120	56	2	229	55
1+	169068	126345	113186	298430	95481	115722	97094	36838	47581	51179	44663	41030	59883	35189	74207	77391	81482
2+	157830	117561	91944	287354	89109	106001	87421	36706	46174	50589	44406	40974	58781	35009	67956	74444	73801
3+	63579	65062	37132	97539	38793	49277	30937	30306	36189	43145	35865	38181	51158	23818	62037	47078	62930
4+	27466	32161	22181	76634	8042	36437	13122	13876	20578	29333	18396	16718	36244	13340	25738	33252	28299
5+	14183	13173	10684	49965	5842	22026	4578	5304	10888	17929	8348	7161	17077	6365	7875	11288	12517

Table 12. Estimates of silver hake numbers (000's) from July research surveys.

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	55507	114479	60085	37611	44552	56879	26774	86755	14787	32930	191964	117816	427311	102496	552598
2	88955	256653	203557	33014	108935	83741	24163	148112	22094	86213	298055	108591	102616	173893	77033
3	13204	17477	27540	5234	14653	54417	16119	71487	28944	134563	81956	40180	327936	35040	77497
4	7130	14515	3442	2993	11307	16460	8722	19634	8264	57609	64841	18767	54040	72226	19398
5	3071	13474	3558	1592	4176	10589	6679	11579	4256	16670	14633	9574	15061	21840	15150
6	1766	6226	3875	870	1679	4763	2854	5576	3128	5246	10155	3028	10562	9499	4725
7	630	2172	715	301	357	2594	1177	3064	1512	2888	5532	803	4598	2633	1606
8	362	1332	410	397	236	974	458	974	875	860	6723	406	1755	1113	686
9	34	120	35	38	290	213	922	213	370	499	393	361	908	207	293
1+	170659	426448	303217	82050	186185	230630	87868	347394	84230	337478	674252	299526	944787	418947	748986
2+	115152	311969	243132	44439	141633	173751	61094	260639	69443	304548	482288	181710	517476	316451	196388
3+	26197	55316	39575	11425	32698	90010	36931	112527	47349	218335	184233	73119	414860	142558	119355
4+	12993	37839	12035	6191	18045	35593	20812	41040	18405	83772	102277	32939	86924	107518	41858
5+	5863	23324	8593	3198	6738	19133	12090	21406	10141	26163	37436	14172	32884	35292	22460

Table 13. Estimates of silver hake biomass (tons) from July research surveys.

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	3108	5152	3785	2520	2807	3526	1312	5292	606	1185	10750	6362	26921	7892	36969
2	10586	32852	26259	5117	16122	12310	2658	22809	3115	12328	44112	14117	15085	27127	10307
3	2760	3775	5618	1272	3605	11428	2805	14297	6165	25971	18276	8157	62308	7218	15298
4	1711	3629	1067	709	3087	4773	1971	4810	2314	14287	18739	4617	13456	17334	4991
5	841	3975	1409	759	1700	4204	1890	3300	1370	5301	4814	2901	4187	6028	4665
6	984	2733	2089	398	887	2458	939	1918	1145	1936	4052	1096	3866	3097	1787
7	304	1053	697	341	299	1730	450	1259	786	1941	2661	311	2087	1098	708
8	457	1166	474	499	295	1049	228	506	526	473	3913	265	1048	667	572
9	30	141	0	62	249	232	723	118	330	396	373	292	684	130	182
1+	20782	54475	41398	11677	29050	41710	12975	54311	16358	63818	107690	38117	129641	70592	75479
2+	17673	49323	37613	9158	26243	38184	11663	49019	15752	62633	96940	31755	102720	62699	38510
3+	7088	16472	11354	4040	10121	25874	9006	26209	12636	50304	52828	17638	87635	35572	28203
4+	4328	12697	5736	2769	6516	14446	6201	11912	6471	24334	34552	9482	25328	28354	12906
5+	2617	9068	4669	2059	3430	9673	4230	7102	4157	10047	15813	4865	11872	11020	7914

Table 14. Calibration results for 4VWX silver hake standardized catch rates (including Cuba) and SPA exploitable biomass calculated with annual PR vectors.

	Years Excluded		
	1982 (n=16)	1970-76 (n=10)	1970-76, 82 (n=9)
Ft = 0.05			
Intercept	-802,204	-339,812 (n.s.)	-866,087
Slope	459,560	271,800 (n.s.)	508,677
R2	0.69	0.34	0.79
RMSE4	350,882	488,451	322,465
Ft = 0.15			
Intercept	-135,261	-30,694	-195,652
Slope	136,907	80,379 (n.s.)	154,627
R2	0.71	0.32	0.81
RMSE4	91,504	460,019	90,351
Ft = 0.20			
Intercept	-58,275 (n.s.)	620 (n.s.)	-121,242 (n.s.)
Slope	98,053	57,582 (n.s.)	112,242
R2	0.62	0.31	0.81
RMSE4	62,798	104,206	62,539
Ft = 0.25			
Intercept	-1,934 (n.s.)	30,956 (n.s.)	-61,725 (n.s)
Slope	72,370	42,109 (n.s.)	83,825
R2	0.50	0.30	0.81
RMSE4	46,469	77,847	45,160
Ft = 0.35			
Intercept	55,241 (n.s.)	57,398 (n.s.)	-4,291 (n.s.)
Slope	44,694	25,697 (n.s.)	53,463
R2	0.28	0.27	0.81
RMSE4	34,656	49,803	27,223
Ft = 0.45			
Intercept	87,032 (n.s.)	72,109 (n.s.)	27,645 (n.s.)
Slope	29,307 (n.s.)	16,569 (n.s.)	36,582
R2	0.13	0.22	0.77
RMSE4	33,326	35,242	19,075
Ft = 0.55			
Intercept	107,261 (n.s.)	81,478	47,972
Slope	19,517 (n.s.)	10,760 (n.s.)	25,841
R2	0.06	0.17	0.71
RMSE4	34,878	27,074	15,851

Table 15. Calibration results for 4VWX silver hake SPA mid-year 4+ numbers and RV survey 4+ numbers.

	Years Excluded		
	1982 (n=14)	1970-76 (n=10)	1970-76, 82 (n=9)
Ft = 0.05			
Intercept	30,707	51,824	43,930
Slope	0.023 (n.s.)	0.010 (n.s.)	0.015 (n.s.)
R2	0.19	0.04	0.11
RMSE4	36,561	31,975	33,305
Ft = 0.15			
Intercept	24,776 (n.s.)	48,689	38,803 (n.s.)
Slope	0.077 (n.s.)	0.037 (n.s.)	0.056 (n.s.)
R2	0.18	0.05	0.13
RMSE4	35,956	31,689	32,979
Ft = 0.20			
Intercept	23,581 (n.s.)	47,805	36,785 (n.s.)
Slope	0.099 (n.s.)	0.052 (n.s.)	0.081 (n.s.)
R2	0.16	0.04	0.14
RMSE4	35,722	31,464	32,691
Ft = 0.25			
Intercept	19,142 (n.s.)	44,126 (n.s.)	30,714 (n.s.)
Slope	0.133 (n.s.)	0.077 (n.s.)	0.122 (n.s.)
R2	0.16	0.05	0.15
RMSE4	11,182	31,252	32,442
Ft = 0.35			
Intercept	16,913 (n.s.)	37,447 (n.s.)	17,449 (n.s.)
Slope	0.167 (n.s.)	0.138 (n.s.)	0.234 (n.s.)
R2	0.12	0.05	0.18
RMSE4	35,673	30,562	31,468
Ft = 0.45			
Intercept	20,378 (n.s.)	28,394 (n.s.)	-3,984 (n.s.)
Slope	0.152 (n.s.)	0.222 (n.s.)	0.421 (n.s.)
R2	0.06	0.06	0.22
RMSE4	37,504	29,519	29,567
Ft = 0.55			
Intercept	27,567 (n.s.)	20,162 (n.s.)	-31,241 (n.s.)
Slope	0.100 (n.s.)	0.307 (n.s.)	0.674 (n.s.)
R2	0.02	0.05	0.25
RMSE4	39,665	28,447	26,393

Table 16a. Fishing mortality on 4VWX silver hake.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	.140	.162	.124	.227	.091	.121	.237	.003	.045	.013	.012	.002	.013	.003	.049	.050	.020
2	.700	.672	.801	1.481	.919	.725	.706	.120	.207	.124	.126	.056	.091	.089	.050	.143	.145
3	.656	.436	.287	.486	.725	.363	.377	.377	.497	.303	.407	.458	.346	.152	.369	.137	.250
4	.447	.651	.253	1.345	.071	1.022	.489	.327	.468	.689	.320	.433	.727	.302	.418	.383	.250
5	.616	.370	.395	2.023	.492	.909	.279	.235	.477	.957	.665	.254	1.311	.377	.440	.284	.250
6	.622	.122	.256	1.598	.397	.626	.166	.189	.668	1.586	.690	.716	.314	.723	.332	.486	.250
7	.395	1.162	.128	2.200	.028	.072	.150	.050	.693	1.824	.855	.178	1.537	.073	.445	.462	.250
8	.220	.311	.326	3.241	.090	.182	.038	.307	.382	1.700	.744	.172	.594	2.618	.018	.767	.250
9	.588	.467	.279	.952	.498	.599	.377	.337	.494	.491	.406	.338	.308	.082	.126	.056	.250

Table 16b. Beginning of year numbers (000's) from SPA for 4VWX silver hake.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	1755527	1790958	3960307	1483164	1417241	1550452	889931	886669	790408	944174	666322	1088359	1865588	1504606	2526686	959229	7585648
2	1815735	1023418	1020716	2344117	792665	867184	920508	470834	592607	506325	624984	441514	728277	1234405	1005838	1612456	611655
3	548790	604696	350216	307091	357193	211999	281665	304566	279966	322915	299822	369344	279966	445867	756966	641267	937237
4	202822	190817	262058	176188	126609	116017	98848	129515	140100	114213	159916	133830	156528	132834	256613	350993	374904
5	54956	86969	66705	136443	30764	79060	27985	40637	62614	58806	38450	77812	58160	50700	65827	113278	160351
6	25399	19895	40257	30122	12093	12607	21355	14189	21524	26054	15139	13253	40479	10513	23312	28405	57140
7	13496	9136	11799	20884	4086	5449	4519	12129	7870	7398	3575	5089	4341	19827	3419	11212	11707
8	12284	6093	1917	6959	1552	2663	3398	2608	7735	2638	801	1019	2855	626	12349	1468	4733
9	2984	6607	2993	927	182	951	1488	2192	1286	3540	323	255	575	1057	31	8134	457
1+	4431993	3738590	5716967	4505895	2742386	2846381	2249695	1863339	1904111	1986062	1809331	2130475	3136770	3400433	4651041	3726442	9743831
2+	2676467	1947631	1756660	3022731	1325144	1295930	1359765	976670	1113704	1041888	1143009	1042116	1271183	1895828	2124355	2767213	2158183
3+	860732	924213	735944	678614	532479	428746	439256	505836	521096	535563	518025	600602	542905	661423	1118517	1154757	1546526
4+	311942	319517	385728	371523	175286	216747	157592	201270	241130	212648	218204	231259	262939	215556	361551	513490	609291
5+	109120	128700	123670	195335	48677	100730	58744	71755	101030	98435	58287	97429	106411	82722	104937	162497	234387

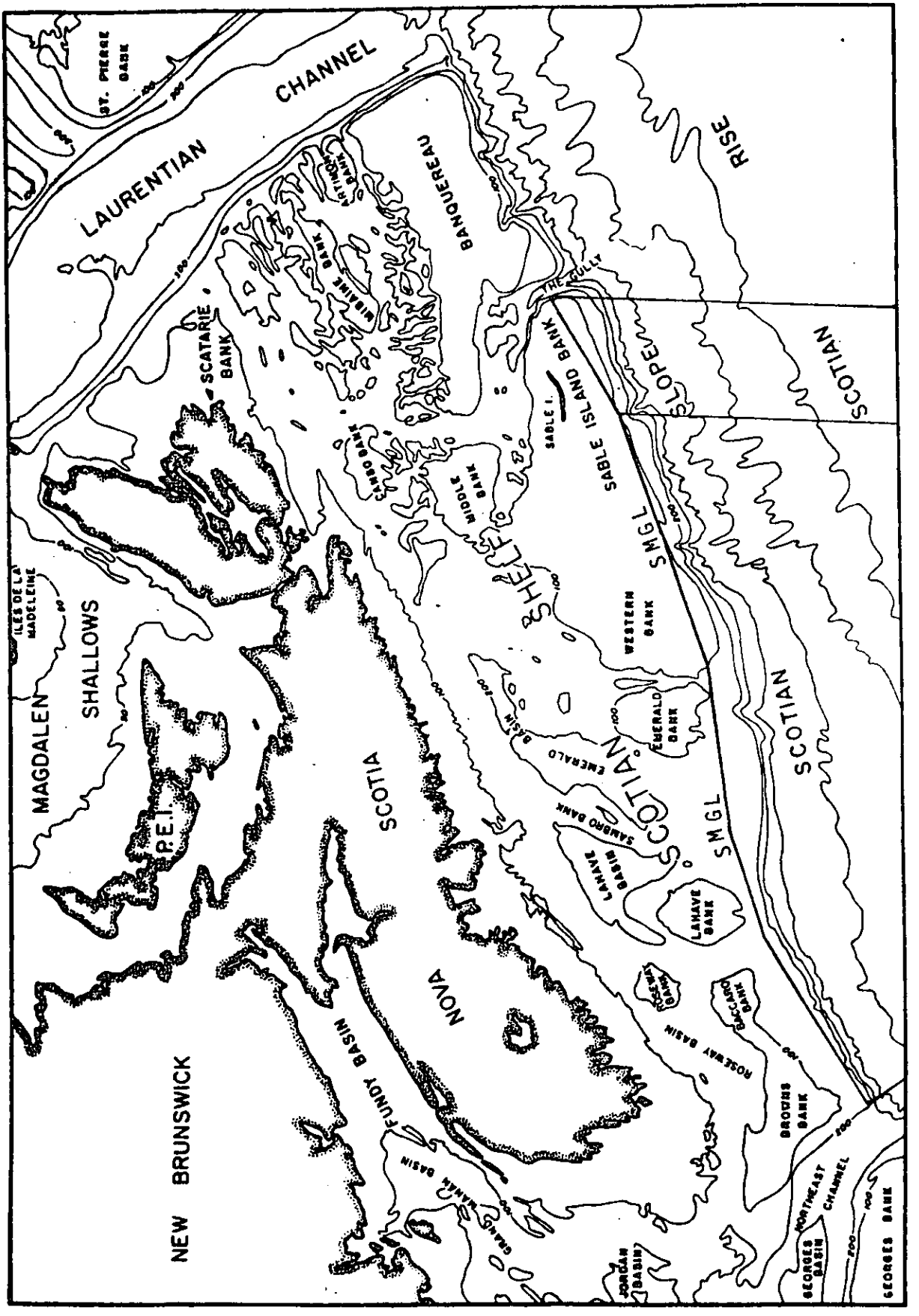


Figure 1. Bathymetric map of the Scotian Shelf and the Bay of Fundy showing the Small Mesh Gear Line (SMGL)

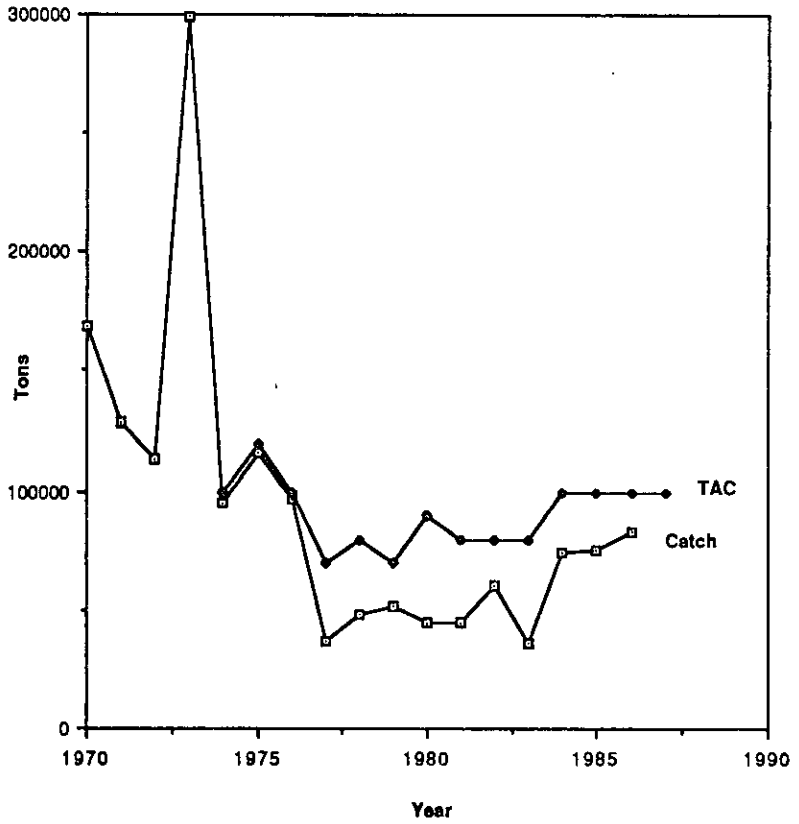


Figure 2. Catches and TAC for 4VWX silver hake.

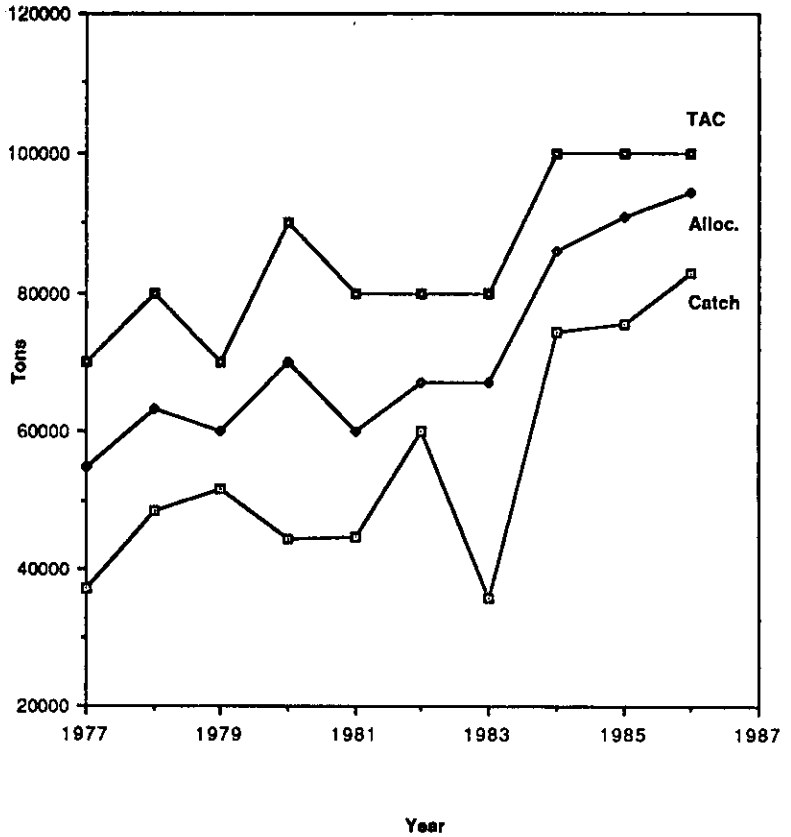


Figure 3. TAC, allocations and catches for 4VWX silver hake.

Figure 4. Standardized catch rates for 4VWX silver hake.

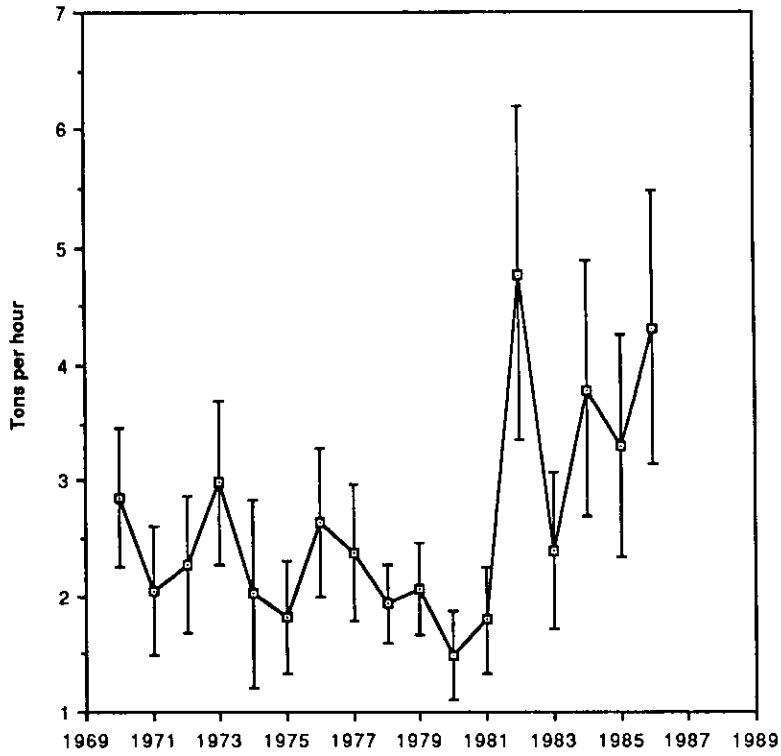


Figure 5. Mean weight at age in the catch of 4VWX silver hake from 1970 to 1986

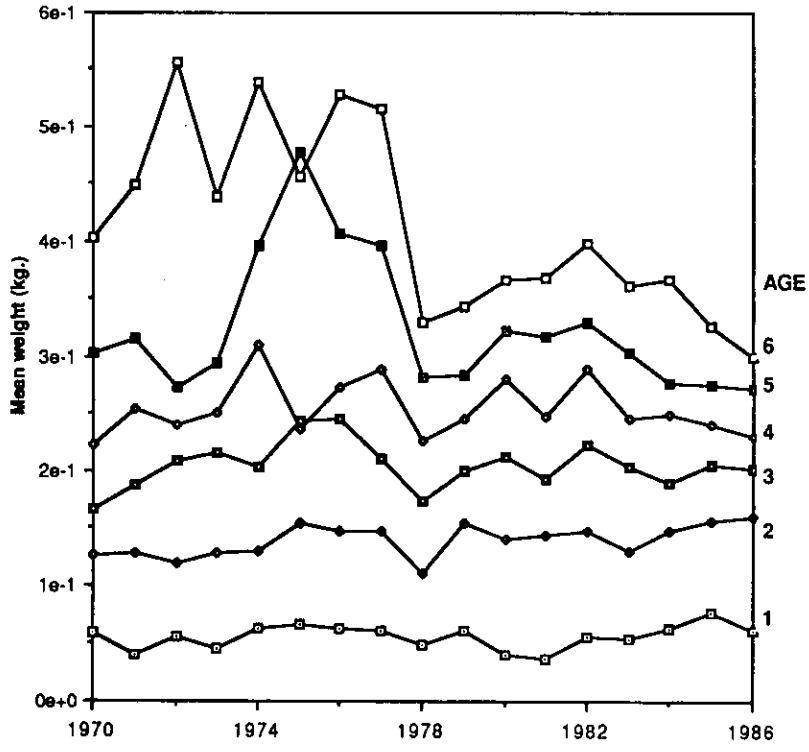


Figure 6. July RV survey estimates of numbers and biomass of 4VWX silver hake.

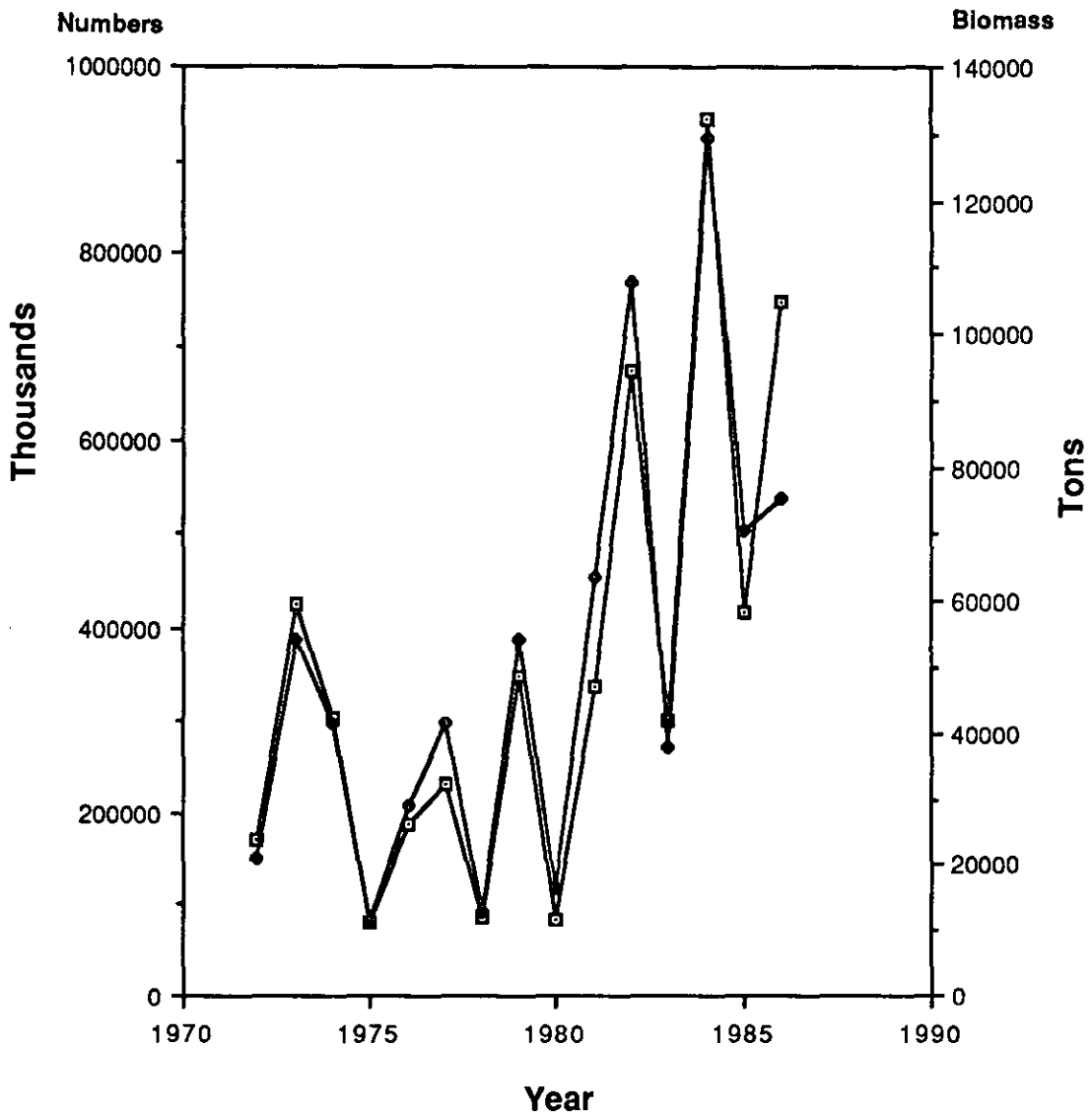
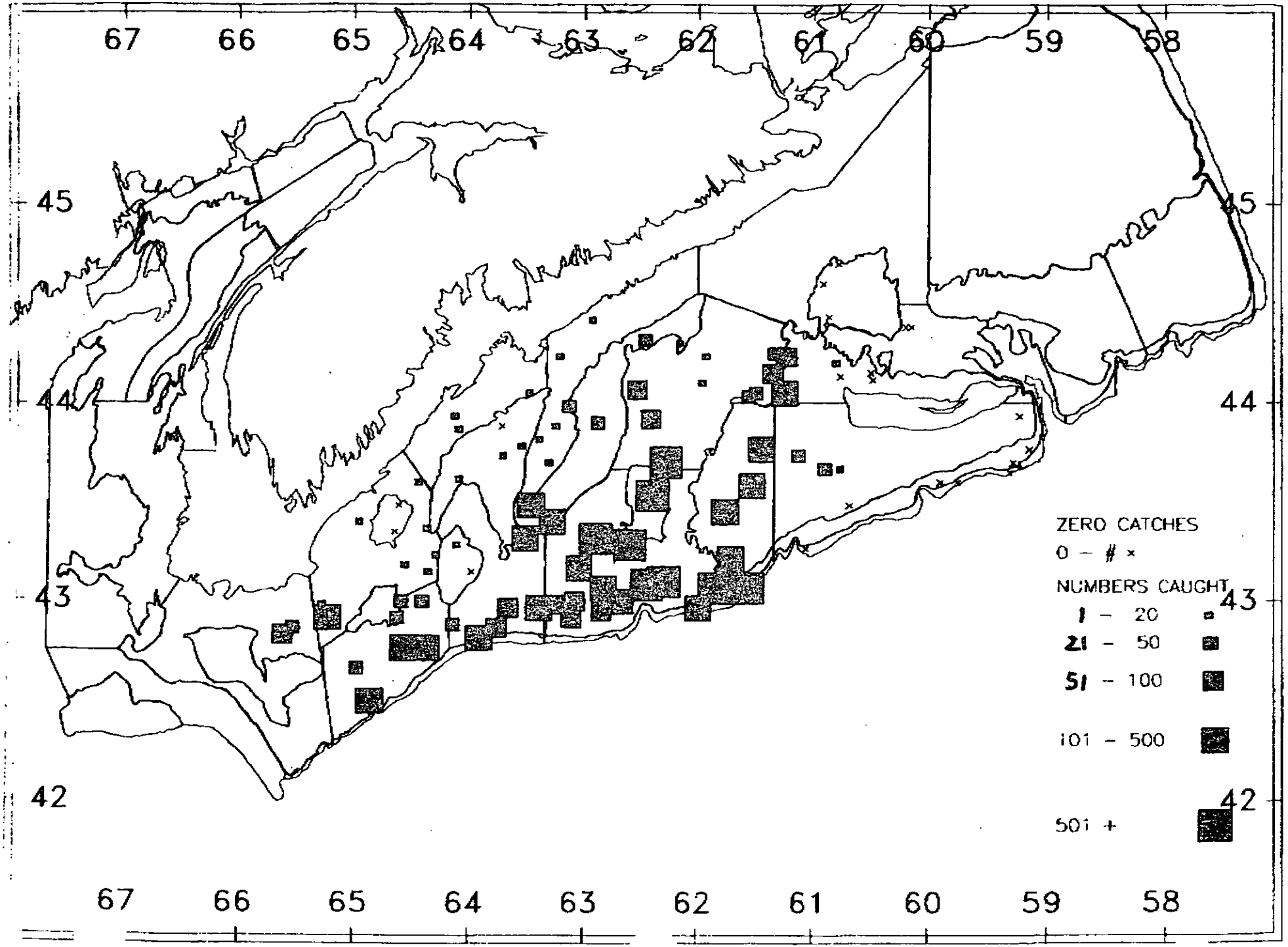


FIGURE 7. *Distribution of 0-group silver hake – 1986*



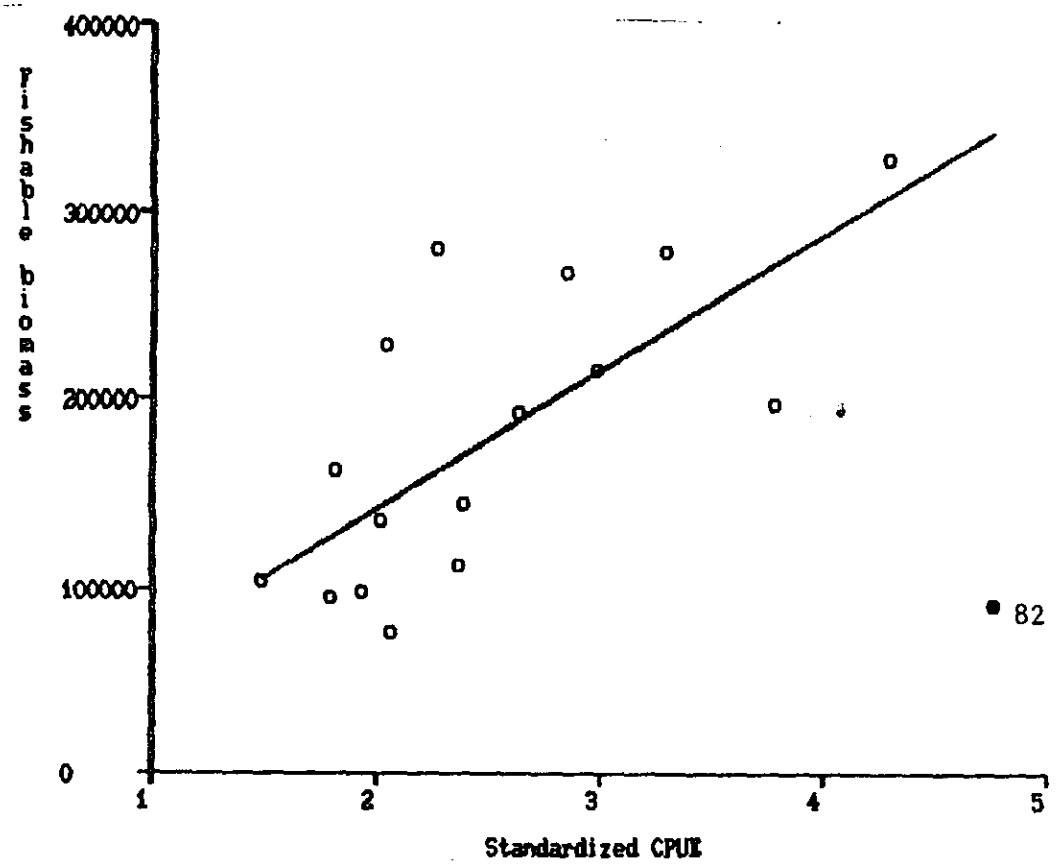


Figure 8. Calibration plot of SPA fishable biomass with standardized catch rate. 1982 was excluded from the regression.