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# Size of the Scotian Shelf Silver Hake Population in 1987

by

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## Introduction

Foreign fleets were the first to develop a silver hake fishery on the Scotian Shelf commencing in 1962. Today the fleets fishing silver hake on the Scotian Shelf are primarily non-Canadian although the Canadian industry has started a program to harvest the response. Historically, the major fishing nations have been the Soviet Union and Cuba with countries such as Portugal, Japan, and Spain catching various amounts. The Soviet Union was the first nation to fish for silver hake on the Scotian Shelf, and continues to dominate the catch. During the last 5 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 i) the minimum codend mesh size to 60 mm, ii) the amount of by-catch in the fishery and iii) the amount of fishing effort for each country. By-catches of cod, pollock, haddock, and redfish, among other species caught in this fishery, are regulated by Canada. For the 1988 fishery, by-catches were regulated at the following levels: 1% for haddock, 1% for cod in NAFO Div. 4X and 10% elsewhere, and all other species at 5% (10% prior to 1988). 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.

## Current Fishery

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.

Catches are highest during the period April to July of each year, and come primarily

from the NAFO Div. 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 catch from 1973 to 1981 (Figure 2, Table 1). Nominal catches from 1977 until 1983 have fluctuated between 33 and 60 thousand tons. Below are reported catches ('000 t) and the Total Allowable Catch (TAC '000 t) since 1977.

| YEAR | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAC | 70 | 80 | 70 | 90 | 80 | 80 | 80 | 100 | 100 | 100 | 100 | 120[2] |
| CATCH | 37 | 48 | 51 | 45 | 43 | 60 | 36 | 74 | 76 | 83[1] | 62[1] | |

[1] Preliminary
[2] NAFO recommended $F_{0.1}$ TAC was 161,000 t. Canada allocated only 120,000 t as of June, 1988.

Official NAFO catch statistics for 1985 were published late in 1987. Revised catches for 1986 were also available from NAFO during 1987. These updated catches and the catches used in the 1987 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 1979, 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). In 1987 the Soviet fleet fell short of their allocation due to the delay in fishing. Monthly catches in 1987 were highest in June and July when 41,000 tons or 66% of the catch was taken. Catches in May to July accounted for 87% of the total yearly landings. Catches decreased this year since the Canadian allocation was increased but never caught.

Historical catches from this fishery indicate that the major fishing season was between April and August (Table 2) with peak catches from May to July. This pattern continues to the present. Reported (1970-1986) and observed (1987) catch rates (t/hr) for the USSR and Cuba from April until September are given in Table 4.

**Commercial Sampling**

Sampling for length and age commercial catches in 1987 was conducted by the Canadian International Observer Program (IOP) (Table 5). The IOP observed 95% or 58,349t of the

62,000 t caught. More than 470,000 lengths and 2,800 otoliths were taken from the catch. Coverage levels for 1987 and previous years were above the NAFO standard.

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 6. The matrix was calculated in the following manner. For 1987, length frequency samples for 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 1987 monthly catch (Table 2) using a monthly weight-length relationship. The monthly weight-length relationships were based on individual silver hake lengths and weights measured at sea during the 1987 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.

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 1987 (Waldron and Fanning, 1986a; Fanning et. al., 1987) 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 data collected by the IOP were more representative of the fishery for this parameter.

In numbers, the 1987 fishery was composed of one large (1985), and one average (1984) year class. The catch numbers at age matrix (Table 6) and percent catch numbers at age (Table 7) indicate the 1985 year class has replaced 1983 as the dominant year class in the fishery. The 1985 year class is the largest age 2 group since the 1974 year class. The 1982 and 1984 year classes continue to appear weak compared to other year classes. The 1980 and 1981 year classes in 1987 are average.

Monthly mean weights at age were weighted by monthly catch (Table 8, Figure 4). Fanning et al. (1987) noted that fish age 4 and 5 in 1985 and 1986 were below weights calculated for the 1982 fishery. For 1987, mean weight at age for these ages continued to drop, with values of 0.223 and 0.261 seen for ages 4 and 5 respectively. From 1980 to 1986, age 2 fish showed an increasing mean weight at age. In 1987 however, the mean weight at age for this age group dropped to 0.127 from 0.159 in 1986.

The catch biomass at age is given in Table 9. The 1987 fishery was strongly supported by the 1984 and 1985 year class. The catch from the 1983 year class, which made up the bulk of the fishery in 1986, dropped sharply.

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 1987 (1.1%) could be the result of discrepancies 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 1987.

| Year | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Catch | 37095 | 48404 | 51751 | 44525 | 42927 | 60251 | 35839 | 74280 | 75492 | 82689 | 61704 |
| Biomass | 36838 | 47581 | 51179 | 44663 | 41030 | 59883 | 35189 | 74207 | 77391 | 81482 | 62413 |
| Difference | 257 | 823 | 572 | -138 | 1897 | 368 | 650 | 73 | -1899 | 1207 | -709 |

## Indices of Abundance

### Commercial Catch and Effort

The 1986 and 1987 CPUE were calculated with monthly catch and effort data from the IOP database. With one exception, the 1970 to 1985 CPUE used catch and effort reported to NAFO. The exception was the 1985 reported effort, which varied from that licensed and reported to Canada (FLASH) by the USSR. FLASH reports 56865 t. caught, 2287 days licenced, 1761 days on ground, and 1578 days fished. The 1985 NAFO Statistical Bulletin reports 56337 t. caught, 2493 days on ground, and 2100 days days fished. Data collected by the IOP shows that the Soviet fleet fished an average of 12.97 hours per day. The observed difference between the days fished reported to FLASH and NAFO suggests the hours fished could be inflated in the NAFO statistics by as much as 6770 hours. With such a large difference in hours fished the 1985 observed catch and effort from the IOP was used as inputs to the catch rate standardization analysis.

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 when Soviet and Cuban catch and effort are not yet available from NAFO.

**Catch Rate Standardization:**

Inputs

Catch and effort were categorized to enhance catch rate standardization (Waldron et. al., 1986). 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 were classified as the "new", more restricted, fishing regime. Using IOP observations, the catch and effort from the 1977-1979 silver hake fishery was partitioned between the old and the new regimes. During this period, 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 licenced for this experiment. These vessels were directed by the Fleet Commanders to fish either 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.

Analysis

An initial analysis using a multiplicative model was run using the GLIM software package. This was utilized in preference to the APL workspace STANDARD because of its greater flexibility and diagnostic features. After each model was fit the leverage statistics were calculated. These statistics measure the influence of the individual observations on the parameter estimates. A total of 3 points were identified as having significantly large leverage and were in fact all the data from 1974. Because of the mixed catches reported at that time there were only 3 months when the silver hake catches could be considered a directed fishery (i.e. greater than 50% of the catch).

These 3 points were dropped from the analysis prior to fitting the final model. The last fit was done using the STANDARD software to allow calculation of the standardized catch rate and effort. Note however that there are no estimates of catch rate or effort associated with 1974.

The regression results (Table 10) indicate that there is a significant effect due to country in the model. 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 analyses by Waldron and Parnell (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 1987 and 1986 are the highest in the series (Table 11, Figure 5). 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.

## Abundance Surveys

### Canadian Adult Surveys

The July stratified random groundfish survey is another 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.

A NAFO recommendation from the 1987 June meeting of STACFIS was to investigate the use of the July survey in the calibration of the SPA. The 1972-1987 survey data set was re-edited using more stringent editing criteria than had been previously used. The numbers at age and mean weights at age were recalculated. The revised estimates of numbers and biomass at age from the July survey are given in Tables 12 and 13 and Figure 6. The percent at age by numbers is presented in Table 14.

In terms of either numbers at age or biomass at age the 1985 year class is the largest seen in the survey to date (Figure 6). 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. The 1986 year class (age 1) would appear to be of average size from the July survey.

A stratified random groundfish survey was conducted in March from 1979 to 1985. However, no new data are 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 |

### Joint USSR-Canada juvenile silver hake survey

A joint USSR-Canada juvenile silver hake survey has been conducted from 1978 to the

present (Table 15). From 1978 to 1980 the survey was conducted over a 24 hour period, using a groundfish trawl. In 1981 a gear change was made, substituting an International Young Gadoid Pelagic Trawl (IYGPT) for the bottom trawl. Since 1981 the survey has been conducted on a 12-hour night-time only basis, using the IGYPT. 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 and 1987 surveys (Table below). The survey in 1987 went smoothly, unlike the 1986 survey where operational problems reduced coverage. Stations sampled during 1987 survey are shown in Figure 7.

Only the estimates from 1981 to 1987 (IGYPT.) gear are used as a series for juvenile silver hake abundance. The 1986 index as reported in the 1987 assessment was preliminary, as the final data set was not available. The 1986 index has been recalculated, and the table updated. This series indicates that the 1981, 1983, 1985, and 1986 year classes are large relative to the 1982 and 1984 year classes. The 1987 year class is 1/2 that of the 1986 and 1/3 that of the 1985 year classes.

## Sequential Population Analysis

An SPA was accepted by the NAFO Scientific Council in 1987 using a catch rate series which had been standardized by means of a multiplicative model regression. The same technique was employed in this assessment to calibrate an SPA with the catch rate series.

### Mortality

As in previous years a natural mortality of 0.4 on all ages was assumed. F at the oldest age was determined using the APL function AUTOF (Rivard, 1982) to iterate the F's on ages 3+.

### Partial recruitment

The partial recruitment for ages 1 and 2 in 1987 was calculated from the ratio of F on ages 1 and 2 to average F on fully recruited ages (3 to 6) for years 1982 to 1986. 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 below that used in the previous assessment but is not outside of the range of partial recruitments from other assessments.

Partial Recruitment Patterns
for Silver Hake
by Assessment Year

| | Age | | |
|---|---|---|---|
| Assessment | 1 | 2 | 3-9 |
| Current | 0.045 | 0.213 | 1.000 |
| Previous | 0.080 | 0.580 | 1.000 |
| 1986 | 0.041 | 0.304 | 1.000 |
| 1985 | 0.035 | 0.350 | 1.000 |
| 1984 | 0.030 | 0.250 | 1.000 |
| 1983 | 0.030 | 0.250 | 1.000 |
| 1981-82 | 0.044 | 0.444 | 1.000 |
| 1979 | 0.150 | 1.000 | 1.000 |

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). PR's greater than 1.000, were set 1.0.

**Terminal F**

Two methods of age aggregated tuning were employed. The standardized catch rates were regressed on the fishable biomass. Fishable biomass was calculated with annual PR vectors derived from the F matrix. The RV 3+ numbers were regressed on SPA 3+ numbers as the second means of tuning.

The accuracy of catch at age in the period 1970-1976 had been questioned in STACFIS last year and tuning relationships including these years were compared to those with 1970-1976 excluded. There were some suggestions that the two time periods showed separate relationships between CPUE and SPA, however STACFIS elected to use the entire time series pending investigation of the early years of data. Review of documents from the late 1970's indicates that catch at age in the years 1972-1976 were constructed using the July RV age/length key applied to the yearly length frequencies. In 1970-1971 there were no survey ages available so, an average age/length key from 1972-1976 was used to generate the catch at age. Since 1977 the catch at age has been constructed in a consistent manner using age and length samples collected from the fishery. Initial SPA runs using the 1970-1987 catch at age showed even more strongly the separation of the pre- and post- 1977 data. It was therefore concluded that only 1977-1987 catch and sampling data should be used in tuning the SPA in the current assessment.

The 1982 CPUE was not used in the tuning by catch rate because it had been considered by STACFIS to be too high and not reflective of changes in abundance. Results of tuning with CPUE are given in Table 16 and the tuning plot at $F_t$=0.300 in Figure 8.

The results of tuning using the RV 3+ numbers on SPA 3+ numbers are given in Table 17 and the tuning plot at $F_t$= 0.300 in Figure 9.

**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 (Table 18). The $F_{a1}$ level is 0.53 and the yield per recruit would be 0.062 kg. at that level of F. These are changed from the previous assessment (Fanning et. al., 1987) where $F_{a1}$ was 0.474 and the yield per recruit was calculated as 0.063kg.

## Year Class Strengths

The 1987 fishery was supported by two year classes: 1984 and 1985. The strength of the 1985 year class is consistent with the indications of this group in the juvenile and the July adult surveys. The 1983 year class was a strong year class but its contribution to the 1987 fishery was lower than expected.

Juvenile and July surveys indices suggest that the 1986 year class should also be stong in 1987. However, the catch of this group at age 1 in 1987 was only 1/7 th the size of the 1985 year class at age 1 (Table 16). The previous assessment of this population suggested the 1988 fishery would be supported by two large year classes, the 1985 and 1986. From observed data from the IOP, the 1988 fishery is very good with catch rates as high as those observed in 1986 and 1987. Year class strengths cannot be calculated at this time so the contribution of the 1985 and 1986 year classes cannot be evaluated.

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.

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## References

Anon. 1977. Report of the ad hoc working group on silver hake in Divisions 4VWX. ICNAF Redbook (1977): Appendix II: 19-23. (mimeo)

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. (mimeo)

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

Fanning, P.F. D.E. Waldron and C. Bourbonnais. 1987. Scotian Shelf silver hake population size in 1986. NAFO SCR Doc. 87/56. No. N1345. 26p. (mimeo)

Gavaris, S. 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. Can. J. Fish. Aquat. Sci.37: 2272-2275.

Koeller, P.A., J. D. Neilson and D.E. Waldron. 1984. 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. (mimeo)

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. (mimeo)

Rivard, D. 1982. APL programs for stock assessment (revised). Can. Tech. Rep. Fish. Aquat. Sci. No. 1091. 146p.

Waldron, D.E. and J. Parnell. 1986. Comparison of Division 4VWX silver hake catch rates from the Scotian Shelf small meshed fishery. NAFO SCR. Doc. 86/82. 8p. (mimeo)

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

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

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

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. (mimeo)

. Nominal catches for 4VWX silver hake 1970-1987 (1987 preliminary).

| | Year | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
| a | 0 | 0 | 0 | 0 | 0 | 1722 | 3088 | 862 | 606 | 4639 | 817 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 11 | 101 | 26 | 10 | 26 | 13 | 104 | 6 | 38 | 15 | 10 | 2 | 9 | 11[3] |
| | 0 | 0 | 201 | 0 | 0 | 1724 | 12572 | 1847 | 3436 | 1798 | 2287 | 642 | 11969 | 7418 | 14496 | 17683 | 16041 | 20219[3] |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 2[1] | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 10 | 0 | 296 | 106 | 97 | 684 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3[1] | 0 | 0 | 0 | 0 | 0 | 93 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 108 | 106 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 106 | 5 | 0 | 541 | 37[1] | 2[2] | 0 | 0 | 0 | 0 |
| | 129 | 8 | 63 | 88 | 67 | 54 | 78 | 19 | 161 | 219 | 239 | 120 | 937 | 649 | 530 | 120 | 67 | 145[2] |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 295 | 2 | 0 | 0 | 1[1] | 31[2] | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 56 | 2044 | 2[1] | 378 | 1714 | 1338 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 15 | 0 | 0 | 0 | 6 | 0 | 0 | 2 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 1 | 0 | 0 | 0 | 7 | 1 | 14 | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 1 | 0 |
| | 168916 | 128633 | 113774 | 298533 | 95371 | 112566 | 81216 | 33301 | 44062 | 45076 | 40982 | 41243 | 47261 | 27377 | 57423 | 56337 | 66571 | 41329[3] |
| | 169045 | 128657 | 114048 | 298621 | 95745 | 116394 | 97184 | 37095 | 48404 | 51760 | 44525 | 44600 | 60251 | 35839 | 74266 | 75480 | 82689 | 61704 |

ver Program Data (data not reported to NAFO)

data

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 | 1987[5,1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. | 12 | 3 | - | - | 1088 | 2850 | 982 | - | - | - | - | - | - | - | - | - | - | 1[4] |
| Feb. | 43 | 3555 | 43 | 103 | 261 | 1416 | 1174 | 2 | - | 6 | - | - | - | - | - | - | - | - |
| Mar. | 4335 | 30821 | 7199 | 12133 | 7345 | 2808 | 15028 | 3718 | - | 2 | - | - | - | - | 1[2] | - | 17 | 3[4] |
| Apr. | 16682 | 19415 | 12129 | 91367 | 10182 | 13673 | 10344 | 8142 | 2118 | 2190 | 1558 | 981 | 2409 | 6990 | 2614 | 3207 | (25) 5751 (4902) | 4967 |
| May | 19880 | 11742 | 21303 | 72443 | 15766 | 14715 | 7860 | 5714 | 8761 | 13000 | 9809 | 15332 | 19482 | 16369 | 22079 (19529) | 15491 (11323) | 27723 (21382) | 12793 |
| June | 19115 | 9419 | 16982 | 41948 | 14369 | 11364 | 7030 | 3284 | 13591 | 17651 | 13875 | 13669 | 24786 | 11274 | 24054[2] (22000) | 33319 (30483) | 34810 (41594) | 21611 |
| July | 34873 | 22118 | 26425 | 42955 | 10676 | 26874 | 22531 | 11990 | 14449 | 14417 | 15011 | 13654 | 12607 | 543 | 22020 (26041) | 17639 (25600) | 13088 (13572) | 19247 |
| Aug. | 43814 | 21621 | 14610 | 13394 | 10365 | 23904 | 8895 | 2805 | 8851 | 2930 | 4025 | 909 | 641 | 490 | 3248[2] (3411) | 5766 (4891) | 933 (893) | 3081 |
| Sept. | 19028 | 8258 | 11481 | 8656 | 14871 | 18076 | 6480 | 1046 | 236 | 903 | 103 | 41 | 260 | 156 | 245 (516) | 54 (22) | 361 (483) | 1 |
| 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 | 4 | - |
| Dec. | 1016 | - | - | 9050 | 10585 | 549 | 5335 | 3 | 55 | 1 | - | 2 | 2 | - | 1 (2) | 3 (10) | 2 (2) | - |
| Total | 169045 | 128657 | 114048 | 298621 | 95745 | 116394 | 97184 | 37095 | 48404 | 51751 | 44525 | 44599 | 60207 | 35837 | 74266 (74226) | 75480 (75492) | 82689 (82855) | 61704[3] |

[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.

[4] 8 Tons were reported for Canada but no months were assigned, thus IOP data used to locate appropriate months.

[5] Soviet catch was not reported by month, thus was prorated to the Flash data.

Table 3. Nominal catch and allocations (t) (in parenthesis) for 4VWX silver hake. 1987 Preliminary.

| Country | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bulgaria | 862 (950) | 606 (1000) | 4639 (6860) | 817 (1200) | 0 (1000) | 0 (1000) | 0 | 0 | 0 | 0 | 0 |
| Canada | 10 (15190) | 26 (16700) | 13 (10000) | 104 (20000) | 6 (20000) | 38 (13000) | 15 (1000) | 10 (1000) | 2 (1000) | 9 (1000) | 11 (19500) |
| 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) | 16041 (17700) | 20219 (20200) |
| EEC | 0 | 0 | 0 | 0 (100) | 0 | 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) | 0 (100) |
| FRG | 684 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GDR | 0 | 3[1] | 0 | 0 | 0 | 0 | 0 (2000) | 93 (100) | 0 | 0 | 0 |
| Italy[4] | 38 | 106 | 5 | 0 | 541 | 37[1] | 2[2] | 0 | 0 | 0 | 0 |
| Japan | 19 | 161 | 219 | 239 | 120 | 937 (2000) | 649 (5000) | 530 (10000)[2] | 120 (10000) | 67 (10000) | 145 (7500) |
| Poland | 295 | 2 | 0 | 0 | 1[1] | 31 | 0 | 0 | 0 | 0 | 0 |
| Portugal | 0 | 0 | 0 | 56 | 2044 | 2[1] (2000) | 378 (3000) | 1714 (4000)[2] | 1338 (4000) | 0 | 0 |
| Romania | 10 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain | 0 | 2 | 0 | 40 | 0 | 0 | 0 (4000) | 0 | 0 (5000) | 0 | 0 |
| USA | 14 | 0 | 0 (2) | 0 | 3 | 2 | 0 | 0 | 0 | 1 | 0 |
| USSR | 33301 (44950) | 44062 (52000) | 45076 (44940) | 40982 (56600) | 41243 (48400) | 47261 (48400) | 27377 (43400) | 57423 (56600) | 56337 (56600) | 66571 (66600) | 41329 (52700) |
| Others | 0 | 0 | 9 (30) | 0 (900) | 0 (1000) | 0 | 0 (192) | 0 | 0 | 0 | 0 |
| Total Catch and TAC | 37095 (70000) | 48404 (80000) | 51760 (70000) | 44525 (90000) | 44600 (80000) | 60251 (80000) | 35839 (80000) | 74266 (100000) | 75480 (100000) | 82689 (100000) | 61704 (100000) |
| Sum of Catch Divided by TAC (%) | 53 | 61 | 74 | 50 | 54 | 75 | 45 | 74 | 75 | 83 | 62 |
| Sum of Catch Divided by Sum of Allocation (discounted Can. Alloc. + reserve) (%) | 68 | 76 | 86 | 64 | 72 | 90 | 53 | 86 | 83 | 87 | 77 |

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 (1970-1986) and observed (1987) catch rates (t/hr) for USSR and Cuban fleets from April until September.

**USSR**

| Month | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| April | 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 | 5.31 |
| 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 | 3.62 | 2.35 |
| 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 | 3.33 | 2.46 |
| August | 2.48 | 1.45 | 1.58 | 1.38 | - | 1.60 | 2.17 | 2.01 | 2.15 | 1.45 | 0.64 | 1.40 | - | - | 3.22 | 2.78 | - | 0.52 |
| September | 1.53 | - | 2.16 | 2.41 | 2.31 | 1.28 | 2.58 | 1.51 | - | 1.73 | - | - | - | - | - | - | - | - |

**CUBA**

| Month | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| April | | | | | | | | | | | | | - | 3.04 | 3.61 | 2.00 | 5.48 | 7.03 |
| May | | | | | | | | | | | | | 3.61 | 1.91 | 2.65 | 2.01 | 2.92 | 5.68 |
| June | | | | | | | | | | | | | 2.31 | 0.97 | 2.30 | 2.51 | 1.89 | 1.93 |
| July | | | | | | | | | | | | | 2.15 | 1.91 | 1.11 | 2.02 | - | 1.96 |
| August | | | | | | | | | | | | | - | - | - | - | 1.15 | - |
| September | | | | | | | | | | | | | 0.21 | - | - | - | 0.97 | - |

ble 5. 1987 International Observer Program silver hake sampling.

| UNTRY | SAMPLE | FEB. | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPT. | NOV. | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. meas. | 65 | 571 | 0 | 368 | 0 | 3 | 0 | 0 | 216 | 1223 |
| nada | Otoliths taken | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Otoliths aged | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ba | No. meas. | 0 | 0 | 34146 | 54706 | 23715 | 813 | 0 | 0 | 0 | 113380 |
| | Otoliths taken | 0 | 0 | 159 | 170 | 80 | 6 | 0 | 0 | 0 | 415 |
| | Otoliths aged | 0 | 0 | 128 | 80 | 33 | 0 | 0 | 0 | 0 | 241 |
| pan | No. meas. | 0 | 0 | 1134 | 533 | 0 | 0 | 1161 | 77 | 0 | 2905 |
| | Otoliths taken | 0 | 0 | 43 | 3 | 0 | 0 | 0 | 26 | 0 | 72 |
| | Otoliths aged | 0 | 0 | 43 | 3 | 0 | 0 | 0 | 0 | 0 | 46 |
| SR | No. meas. | 0 | 0 | 0 | 22424 | 136621 | 176356 | 20013 | 0 | 0 | 355414 |
| | Otoliths taken | 0 | 0 | 0 | 219 | 1117 | 877 | 177 | 0 | 0 | 2390 |
| | Otoliths aged | 0 | 0 | 0 | 108 | 523 | 443 | 87 | 0 | 0 | 1161 |
| tal | No. meas. | 65 | 571 | 35280 | 78031 | 160336 | 177172 | 21174 | 77 | 216 | 472922 |
| | Otoliths taken | 0 | 0 | 202 | 392 | 1197 | 883 | 177 | 26 | 0 | 2877 |
| | Otoliths aged | 0 | 0 | 171 | 191 | 556 | 443 | 87 | 0 | 0 | 1448 |

Table 6: Commercial catch numbers ('000) at age for 4VWX silver hake

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 187298 | 219607 | 379314 | 246148 | 101158 | 145091 | 153535 | 2131 | 28704 | 9667 | 6272 | 1553 | 19708 | 3333 | 99217 |
| 2 | 748021 | 410149 | 460610 | 1482925 | 390044 | 365964 | 381651 | 43535 | 90777 | 48341 | 60576 | 19530 | 51680 | 86085 | 40265 |
| 3 | 216246 | 175005 | 71536 | 96784 | 150741 | 52837 | 72418 | 78239 | 89717 | 69058 | 82013 | 111209 | 66973 | 51617 | 191048 |
| 4 | 59832 | 74755 | 47903 | 106675 | 7095 | 60806 | 31295 | 29561 | 42878 | 46547 | 35888 | 38534 | 66230 | 28354 | 71739 |
| 5 | 20695 | 22035 | 17822 | 96940 | 9789 | 38646 | 5582 | 6981 | 19442 | 29656 | 15293 | 14266 | 34777 | 13036 | 19200 |
| 6 | 9636 | 1877 | 7452 | 19671 | 3245 | 4803 | 2669 | 2004 | 8587 | 16964 | 6179 | 5548 | 8925 | 4431 | 5392 |
| 7 | 3608 | 5139 | 1160 | 15203 | 93 | 311 | 514 | 483 | 3222 | 5079 | 1682 | 679 | 2790 | 1150 | 1006 |
| 8 | 1988 | 1333 | 437 | 5475 | 109 | 363 | 105 | 564 | 2009 | 1765 | 344 | 132 | 1047 | 475 | 176 |
| 9 | 1114 | 2062 | 607 | 484 | 60 | 360 | 390 | 522 | 420 | 1151 | 90 | 61 | 127 | 69 | 3 |
| 1+ | 1248438 | 911962 | 986841 | 2070305 | 662334 | 669181 | 648159 | 164020 | 285756 | 228228 | 208337 | 191512 | 252257 | 188550 | 428046 |
| 2+ | 1061140 | 692355 | 607527 | 1824157 | 561176 | 524090 | 494624 | 161889 | 257052 | 218561 | 202065 | 189959 | 232549 | 185217 | 328829 |
| 3+ | 313119 | 282206 | 146917 | 341232 | 171132 | 158126 | 112973 | 118354 | 166275 | 170220 | 141489 | 170429 | 180869 | 99132 | 288564 |
| 4+ | 96873 | 107201 | 75381 | 244448 | 20391 | 105289 | 40555 | 40115 | 76558 | 101162 | 59476 | 59220 | 113896 | 47515 | 97516 |
| 5+ | 37041 | 32446 | 27478 | 137773 | 13296 | 44483 | 9260 | 10554 | 33680 | 54615 | 23588 | 20686 | 47666 | 19161 | 25777 |

| | 1985 | 1986 | 1987 |
|---|---|---|---|
| 1 | 38273 | 123882 | 18364 |
| 2 | 175423 | 68374 | 224958 |
| 3 | 67117 | 172291 | 97196 |
| 4 | 91516 | 68918 | 43628 |
| 5 | 22953 | 29477 | 13740 |
| 6 | 8958 | 10504 | 7639 |
| 7 | 3399 | 2152 | 580 |
| 8 | 644 | 870 | 272 |
| 9 | 364 | 84 | 339 |
| 1+ | 408647 | 476552 | 406716 |
| 2+ | 370374 | 352670 | 388352 |
| 3+ | 194951 | 284296 | 163394 |
| 4+ | 127834 | 112005 | 66198 |
| 5+ | 36318 | 43087 | 22570 |

Table 7: Commercial catch percent at age for 4VWX silver hake

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15.00 | 24.08 | 38.44 | 11.89 | 15.27 | 21.68 | 23.69 | 1.30 | 10.04 | 4.24 | 3.01 | .81 | 7.81 | 1.77 | 23.18 | 9.37 | 26.00 | 4.52 |
| 2 | 59.92 | 44.97 | 46.68 | 71.63 | 58.89 | 54.69 | 58.88 | 26.54 | 31.77 | 21.18 | 29.08 | 10.20 | 20.49 | 45.66 | 9.41 | 42.93 | 14.35 | 55.31 |
| 3 | 17.32 | 19.19 | 7.25 | 4.67 | 22.76 | 7.90 | 11.17 | 47.70 | 31.40 | 30.26 | 39.37 | 58.07 | 26.55 | 27.38 | 44.63 | 16.42 | 36.15 | 23.90 |
| 4 | 4.79 | 8.20 | 4.85 | 5.15 | 1.07 | 9.09 | 4.83 | 18.02 | 15.01 | 20.39 | 17.23 | 20.12 | 26.25 | 15.04 | 16.76 | 22.39 | 14.46 | 10.73 |
| 5 | 1.66 | 2.42 | 1.81 | 4.68 | 1.48 | 5.78 | .86 | 4.26 | 6.80 | 12.99 | 7.34 | 7.45 | 13.79 | 6.91 | 4.49 | 5.62 | 6.19 | 3.38 |
| 6 | .77 | .21 | .76 | .95 | .49 | .72 | .41 | 1.22 | 3.01 | 7.43 | 2.97 | 2.90 | 3.54 | 2.35 | 1.26 | 2.19 | 2.20 | 1.88 |
| 7 | .29 | .56 | .12 | .73 | .01 | .05 | .08 | .29 | 1.13 | 2.23 | .81 | .35 | 1.11 | .61 | .24 | .83 | .45 | .14 |
| 8 | .16 | .15 | .04 | .26 | .02 | .05 | .02 | .34 | .70 | .77 | .17 | .07 | .42 | .25 | .04 | .16 | .18 | .07 |
| 9 | .09 | .23 | .06 | .02 | .01 | .05 | .06 | .32 | .15 | .50 | .04 | .03 | .05 | .04 | .00 | .09 | .02 | .08 |

Table 8: Commercial mean weight (Kg) at age for 4VWX silver hake

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .060 | .040 | .056 | .045 | .063 | .067 | .063 | .062 | .049 | .061 | .041 | .036 | .056 | .054 | .063 | .077 | .062 | .045 |
| 2 | .126 | .128 | .119 | .128 | .129 | .155 | .148 | .147 | .110 | .154 | .141 | .143 | .148 | .130 | .147 | .156 | .159 | .127 |
| 3 | .167 | .188 | .209 | .216 | .204 | .243 | .246 | .210 | .174 | .200 | .213 | .193 | .223 | .203 | .190 | .206 | .201 | .174 |
| 4 | .222 | .254 | .240 | .250 | .310 | .237 | .273 | .290 | .226 | .245 | .280 | .248 | .289 | .246 | .249 | .240 | .229 | .223 |
| 5 | .303 | .315 | .274 | .295 | .396 | .477 | .407 | .397 | .283 | .285 | .322 | .318 | .329 | .303 | .278 | .276 | .272 | .261 |
| 6 | .404 | .450 | .557 | .439 | .539 | .457 | .528 | .516 | .329 | .344 | .366 | .369 | .399 | .362 | .366 | .326 | .300 | .300 |
| 7 | .470 | .587 | .483 | .485 | .975 | 1.133 | .838 | .667 | .382 | .411 | .520 | .672 | .481 | .387 | .454 | .417 | .403 | .434 |
| 8 | .705 | .832 | 1.263 | .875 | 1.156 | 1.257 | 1.251 | 1.077 | .498 | .520 | .601 | .550 | .582 | .653 | .597 | .599 | .490 | .399 |
| 9 | .828 | .612 | .886 | 1.174 | .001 | 1.635 | .859 | 1.089 | .784 | .553 | .892 | .794 | .949 | .809 | .753 | .630 | .650 | .406 |

Table 9: Commercial catch biomass (tons) at age for 4VWX silver hake

| | 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 | 11131 | 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 |

| | 1987 |
|---|---|
| 1 | 826 |
| 2 | 28570 |
| 3 | 16912 |
| 4 | 9729 |
| 5 | 3586 |
| 6 | 2292 |
| 7 | 252 |
| 8 | 109 |
| 9 | 138 |
| 1+ | 62413 |
| 2+ | 61587 |
| 3+ | 33017 |
| 4+ | 16105 |
| 5+ | 6376 |

Table 10. CPUE standardization results for the 4VWX silver hake population. Includes years 1977-1987.

Key
Type 1: Data Source, NAFO or IOP
Type 2: Month
Type 3: Year
Type 4: Area
Type 5: Regime either Old or New
Type 6: Country

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... .741
MULTIPLE R SQUARED..... .548

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DF | SUMS OF SQUARES | MEAN SQUARES | F-VALUE |
|---|---|---|---|---|
| INTERCEPT | 1 | 5.374E0001 | 5.374E0001 | |
| REGRESSION | 20 | 1.683E0001 | 8.416E-001 | 6.740 |
| TYPE 1 | 1 | 8.449E-002 | 8.449E-002 | 0.677 |
| TYPE 2 | 5 | 2.279E0000 | 4.558E-001 | 3.650 |
| TYPE 3 | 10 | 1.010E0001 | 1.010E0000 | 8.092 |
| TYPE 4 | 2 | 9.427E-001 | 4.713E-001 | 3.775 |
| TYPE 5 | 1 | 2.872E-001 | 2.872E-001 | 2.300 |
| TYPE 6 | 1 | 1.207E0000 | 1.207E0000 | 9.666 |
| RESIDUALS | 111 | 1.386E0001 | 1.249E-001 | |

REGRESSION COEFFICIENTS

| CATEGORY | CODE | VARIABLE | COEFFICIENT | STD. ERROR | NO. OBS. |
|---|---|---|---|---|---|
| 1 | 1 | INTERCEPT | 1.155 | 0.183 | 132 |
| 2 | 4 | | | | |
| 3 | 77 | | | | |
| 4 | 460 | | | | |
| 5 | 1 | | | | |
| 6 | 1 | | | | |
| 1 | 2 | 1 | -0.102 | 0.124 | 54 |
| 2 | 5 | 2 | -0.170 | 0.110 | 29 |
| | 6 | 3 | -0.263 | 0.108 | 33 |
| | 7 | 4 | -0.311 | 0.111 | 30 |
| | 8 | 5 | -0.396 | 0.125 | 18 |
| | 9 | 6 | -0.646 | 0.188 | 5 |
| 3 | 78 | 7 | -0.303 | 0.120 | 26 |
| | 79 | 8 | -0.162 | 0.122 | 21 |
| | 80 | 9 | -0.461 | 0.152 | 9 |
| | 81 | 10 | -0.339 | 0.153 | 9 |
| | 82 | 11 | 0.614 | 0.173 | 7 |
| | 83 | 12 | -0.078 | 0.168 | 8 |
| | 84 | 13 | 0.397 | 0.167 | 8 |
| | 85 | 14 | 0.540 | 0.170 | 9 |
| | 86 | 15 | 0.689 | 0.194 | 10 |
| | 87 | 16 | 0.675 | 0.196 | 9 |
| 4 | 450 | 17 | 0.125 | 0.131 | 10 |
| | 470 | 18 | -0.184 | 0.081 | 31 |
| 5 | 2 | 19 | -0.211 | 0.139 | 111 |
| 6 | 2 | 20 | -0.322 | 0.104 | 24 |

Table 11. Standardized mean catch rate series for 4VWX silver hake from 1977- 1987

PREDICTED CATCH RATE

STANDARDS USED VARIABLE NUMBERS: 1 4 460 1 1

| YEAR | TOTAL CATCH | PROP. | CATCH RATE MEAN | S.E. | EFFORT |
|---|---|---|---|---|---|
| 1977 | 37095 | 0.702 | 3.323 | 0.607 | 11162 |
| 1978 | 48404 | 0.879 | 2.461 | 0.417 | 19669 |
| 1979 | 51751 | 0.827 | 2.821 | 0.544 | 18347 |
| 1980 | 44525 | 0.920 | 2.089 | 0.421 | 21318 |
| 1981 | 44599 | 0.833 | 2.359 | 0.478 | 18907 |
| 1982 | 60207 | 0.958 | 6.098 | 1.322 | 9873 |
| 1983 | 35837 | 0.921 | 3.058 | 0.644 | 11720 |
| 1984 | 74266 | 0.967 | 4.909 | 1.056 | 15130 |
| 1985 | 75480 | 0.529 | 5.620 | 1.390 | 13430 |
| 1986 | 82689 | 0.427 | 6.454 | 1.846 | 12812 |
| 1987 | 61704 | 0.926 | 6.362 | 1.814 | 9698 |

AVERAGE C.V. FOR THE MEAN: .219

Table 12: July research vessel survey catch numbers ('000) at age for 4VWX silver hake

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 55508 | 137524 | 59388 | 37637 | 44719 | 7399 | 26774 | 87163 | 14635 | 32888 | 191940 | 114006 | 189724 | 99810 | 560759 |
| 2 | 0 | 0 | 88950 | 256530 | 194085 | 32856 | 109508 | 28469 | 24159 | 148115 | 22101 | 86211 | 300011 | 108443 | 68526 | 154974 | 77027 |
| 3 | 0 | 0 | 13204 | 17604 | 27680 | 5210 | 14186 | 20861 | 16045 | 71479 | 28955 | 135005 | 84949 | 40348 | 212335 | 36114 | 77052 |
| 4 | 0 | 0 | 7123 | 14518 | 3438 | 2983 | 11332 | 4283 | 8731 | 19637 | 8303 | 57102 | 62934 | 18715 | 36788 | 82184 | 19332 |
| 5 | 0 | 0 | 3070 | 13478 | 3402 | 1504 | 4011 | 1461 | 6764 | 11578 | 4260 | 16742 | 14775 | 9562 | 11317 | 26409 | 15110 |
| 6 | 0 | 0 | 1769 | 6231 | 3871 | 872 | 1955 | 1371 | 2861 | 5571 | 3130 | 5187 | 7966 | 3133 | 7537 | 4193 | 4699 |
| 7 | 0 | 0 | 274 | 2171 | 713 | 253 | 448 | 867 | 1178 | 3064 | 1511 | 2829 | 4846 | 831 | 2934 | 2645 | 1609 |
| 8 | 0 | 0 | 642 | 1339 | 409 | 398 | 145 | 338 | 455 | 975 | 874 | 856 | 6512 | 415 | 1077 | 893 | 692 |
| 9 | 0 | 0 | 115 | 120 | 0 | 37 | 195 | 288 | 920 | 253 | 370 | 499 | 317 | 364 | 564 | 119 | 293 |
| 1+ | 0 | 0 | 170655 | 449514 | 292986 | 81749 | 186500 | 65336 | 87888 | 347836 | 84139 | 337318 | 674250 | 295817 | 530802 | 407341 | 756573 |
| 2+ | 0 | 0 | 115147 | 311990 | 233599 | 44112 | 141781 | 57937 | 61113 | 260673 | 69504 | 304430 | 482310 | 181811 | 341078 | 307531 | 195814 |
| 3+ | 0 | 0 | 26197 | 55460 | 39514 | 11256 | 32274 | 29468 | 36954 | 112557 | 47403 | 218219 | 182299 | 73368 | 272552 | 152557 | 118787 |
| 4+ | 0 | 0 | 12993 | 37856 | 11833 | 6047 | 18087 | 8607 | 20909 | 41078 | 18448 | 83214 | 97350 | 33020 | 60217 | 116443 | 41735 |
| 5+ | 0 | 0 | 5870 | 23338 | 8395 | 3064 | 6755 | 4324 | 12178 | 21441 | 10145 | 26112 | 34416 | 14305 | 23429 | 34259 | 22403 |

| | 1987 |
|---|---|
| 1 | 148244 |
| 2 | 263934 |
| 3 | 45392 |
| 4 | 19672 |
| 5 | 6606 |
| 6 | 4480 |
| 7 | 1039 |
| 8 | 595 |
| 9 | 464 |
| 1+ | 490426 |
| 2+ | 342182 |
| 3+ | 78248 |
| 4+ | 32856 |
| 5+ | 13184 |

Table 13: July research vessel survey catch biomass (tons) at age for 4VWX silver hake

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 3108 | 6189 | 3741 | 2522 | 2817 | 459 | 1312 | 5317 | 600 | 1184 | 10749 | 6156 | 11953 | 7685 | 37515 | 6795 |
| 2 | 0 | 0 | 10585 | 32836 | 25037 | 5093 | 16207 | 4185 | 2658 | 22810 | 3116 | 12328 | 44402 | 14098 | 10073 | 24176 | 10306 | 34320 |
| 3 | 0 | 0 | 2760 | 3803 | 5647 | 1266 | 3490 | 4381 | 2792 | 14296 | 6167 | 26056 | 18944 | 8191 | 40344 | 7439 | 15210 | 8841 |
| 4 | 0 | 0 | 1710 | 3629 | 1066 | 707 | 3094 | 1242 | 1973 | 4811 | 2325 | 14161 | 18188 | 4604 | 9160 | 19724 | 4974 | 4648 |
| 5 | 0 | 0 | 841 | 3976 | 1347 | 718 | 1633 | 580 | 1914 | 3300 | 1372 | 5324 | 4861 | 2897 | 3146 | 7289 | 4653 | 1744 |
| 6 | 0 | 0 | 985 | 2735 | 2086 | 398 | 1032 | 707 | 941 | 1916 | 1146 | 1914 | 3178 | 1134 | 2759 | 1367 | 1777 | 1318 |
| 7 | 0 | 0 | 132 | 1053 | 695 | 287 | 376 | 578 | 450 | 1259 | 786 | 1901 | 2331 | 322 | 1332 | 1103 | 709 | 406 |
| 8 | 0 | 0 | 810 | 1171 | 473 | 500 | 181 | 364 | 227 | 507 | 525 | 471 | 3790 | 271 | 643 | 535 | 577 | 264 |
| 9 | 0 | 0 | 102 | 140 | 0 | 60 | 168 | 313 | 721 | 140 | 330 | 396 | 301 | 294 | 425 | 75 | 182 | 161 |
| 1+ | 0 | 0 | 21034 | 55532 | 40093 | 11550 | 28998 | 12809 | 12988 | 54356 | 16367 | 63735 | 106743 | 37967 | 79834 | 69394 | 75904 | 58499 |
| 2+ | 0 | 0 | 17925 | 49344 | 36352 | 9028 | 26180 | 12350 | 11676 | 49039 | 15767 | 62551 | 95994 | 31811 | 67882 | 61708 | 38389 | 51704 |
| 3+ | 0 | 0 | 7340 | 16508 | 11315 | 3936 | 9973 | 8165 | 9019 | 26229 | 12651 | 50223 | 51593 | 17713 | 57808 | 37532 | 28083 | 17384 |
| 4+ | 0 | 0 | 4581 | 12705 | 5668 | 2670 | 6484 | 3785 | 6227 | 11933 | 6483 | 24167 | 32649 | 9522 | 17465 | 30093 | 12873 | 8542 |
| 5+ | 0 | 0 | 2871 | 9076 | 4602 | 1963 | 3390 | 2543 | 4254 | 7122 | 4159 | 10006 | 14461 | 4919 | 8304 | 10369 | 7899 | 3894 |

Table 14: July research vessel survey percent catch numbers at age for 4VWX silver hake

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 00.00 | 00.00 | 32.53 | 30.59 | 20.27 | 46.04 | 23.98 | 11.32 | 30.46 | 25.06 | 17.39 | 9.75 | 28.47 | 38.54 | 35.74 | 24.50 | 74.12 | 30.23 |
| 2 | 00.00 | 00.00 | 52.12 | 57.07 | 66.24 | 40.19 | 58.72 | 43.57 | 27.49 | 42.58 | 26.27 | 25.56 | 44.50 | 36.66 | 12.91 | 38.05 | 10.18 | 53.82 |
| 3 | 00.00 | 00.00 | 7.74 | 3.92 | 9.45 | 6.37 | 7.61 | 31.93 | 18.26 | 20.55 | 34.41 | 40.02 | 12.60 | 13.64 | 40.00 | 8.87 | 10.18 | 9.26 |
| 4 | 00.00 | 00.00 | 4.17 | 3.23 | 1.17 | 3.65 | 6.08 | 6.55 | 9.93 | 5.65 | 9.87 | 16.93 | 9.33 | 6.33 | 6.93 | 20.18 | 2.56 | 4.01 |
| 5 | 00.00 | 00.00 | 1.80 | 3.00 | 1.16 | 1.84 | 2.15 | 2.24 | 7.70 | 3.33 | 5.06 | 4.96 | 2.19 | 3.23 | 2.13 | 6.48 | 2.00 | 1.35 |
| 6 | 00.00 | 00.00 | 1.04 | 1.39 | 1.32 | 1.07 | 1.05 | 2.10 | 3.26 | 1.60 | 3.72 | 1.54 | 1.18 | 1.06 | 1.42 | 1.03 | .62 | .91 |
| 7 | 00.00 | 00.00 | .16 | .48 | .24 | .31 | .24 | 1.33 | 1.34 | .88 | 1.80 | .84 | .72 | .28 | .55 | .65 | .21 | .21 |
| 8 | 00.00 | 00.00 | .38 | .30 | .14 | .49 | .08 | .52 | .52 | .28 | 1.04 | .25 | .97 | .14 | .20 | .22 | .09 | .12 |
| 9 | 00.00 | 00.00 | .07 | .03 | .00 | .05 | .10 | .44 | 1.05 | .07 | .44 | .15 | .05 | .12 | .11 | .03 | .04 | .09 |

Table 15: Stratified mean catch/tow for the joint Canada-USSR juvenile silver hake survey. Strata 60-78 only.

| Year Class | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|
| Stratified Mean catch/tow | 579.0 | 8.8 | 232.2 | 43.4 | 284.8 | 198.0 (231.9)[1] | 102.0 |
| Standard Error of Mean | 0.11 | 0.14 | 0.11 | 0.16 | 0.22 | 0.19 | 0.11 |
| Number of Sets | 77 | 61 | 64 | 71 | 82 | 74 | 105 |
| July R/V age 1 numbers ($10^{-6}$) | 192 | 114 | 190 | 100 | 561 | 148 | -- |
| Commercial catch Age 1 numbers ($10^{-6}$) | 19.7 | 3.3 | 99.2 | 38.3 | 123.9 | 18.3 | -- |

[1] Preliminary value used in 1987 assessment.

Table 16 a. Population numbers for 4VWX silver hake with M=0.4 and Ft = 0.20

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1702326 | 1708957 | 3786598 | 1438376 | 1369358 | 1488758 | 867564 | 696173 | 763173 | 919541 | 583283 | 783736 | 1600360 | 982478 |
| 2 | 1759310 | 989493 | 967938 | 2231055 | 765506 | 835892 | 880432 | 457663 | 464926 | 488261 | 608528 | 385887 | 524091 | 1056733 |
| 3 | 533600 | 584754 | 337024 | 284166 | 344278 | 205221 | 269713 | 287013 | 271517 | 238472 | 288142 | 358851 | 242818 | 309454 |
| 4 | 194522 | 185555 | 251706 | 168298 | 113107 | 111077 | 95112 | 122647 | 129584 | 110232 | 104471 | 127357 | 151468 | 109013 |
| 5 | 52379 | 82461 | 64868 | 130098 | 29673 | 70063 | 26622 | 38718 | 58440 | 52562 | 36886 | 41343 | 54491 | 48938 |
| 6 | 24106 | 18626 | 37581 | 29177 | 12882 | 12059 | 16575 | 13349 | 20322 | 23623 | 11942 | 12561 | 16311 | 9436 |
| 7 | 12853 | 8485 | 10966 | 19185 | 4307 | 6027 | 4258 | 8955 | 7329 | 6796 | 2768 | 3131 | 4016 | 3913 |
| 8 | 13514 | 5721 | 1669 | 6411 | 1315 | 2811 | 3788 | 2439 | 5611 | 2355 | 663 | 541 | 1552 | 535 |
| 9 | 2944 | 7452 | 2762 | 768 | 210 | 793 | 1591 | 2454 | 1181 | 2157 | 226 | 173 | 256 | 228 |
| 1+ | 4295553 | 3591504 | 5461112 | 4307536 | 2640637 | 2732702 | 2165655 | 1629411 | 1722083 | 1843999 | 1636909 | 1713579 | 2595362 | 2520728 |
| 2+ | 2593228 | 1882547 | 1674514 | 2869159 | 1271278 | 1243944 | 1298091 | 933238 | 958910 | 924458 | 1053626 | 929844 | 995003 | 1538250 |
| 3+ | 833918 | 893054 | 706576 | 638104 | 505773 | 408052 | 417659 | 475574 | 493984 | 436197 | 445098 | 543956 | 470912 | 481517 |
| 4+ | 300318 | 308301 | 369552 | 353938 | 161495 | 202831 | 147946 | 188562 | 222467 | 197725 | 156956 | 185105 | 228094 | 172063 |
| 5+ | 105796 | 122745 | 117846 | 185640 | 48387 | 91754 | 52834 | 65915 | 92883 | 87492 | 52485 | 57748 | 76626 | 63051 |

| | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|
| 1 | 1857929 | 1608105 | 6645120 | 2486080 |
| 2 | 655864 | 1164893 | 1046848 | 4353680 |
| 3 | 638577 | 406975 | 639124 | 646267 |
| 4 | 165764 | 274925 | 218617 | 290087 |
| 5 | 50296 | 54127 | 111089 | 91359 |
| 6 | 22336 | 18407 | 18037 | 50793 |
| 7 | 2815 | 10636 | 5253 | 3856 |
| 8 | 1701 | 1084 | 4409 | 1809 |
| 9 | 9 | 997 | 222 | 2254 |
| 1+ | 3395292 | 3540150 | 8688719 | 7926185 |
| 2+ | 1537362 | 1932045 | 2043599 | 5440105 |
| 3+ | 881498 | 767152 | 996751 | 1086424 |
| 4+ | 242921 | 360177 | 357627 | 440158 |
| 5+ | 77157 | 85251 | 139010 | 150070 |

Table 16 b. Population biomass (T) for 4VWX silver hake with M=0.4 and Ft = 0.20

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 102140 | 68358 | 212049 | 64727 | 86270 | 99747 | 54657 | 43163 | 37395 | 56092 | 23915 | 28214 | 89460 | 53054 | 117050 | 123824 |
| 2 | 221673 | 126655 | 115185 | 285575 | 98750 | 129563 | 130304 | 67276 | 51142 | 75192 | 85802 | 55182 | 77303 | 137375 | 96412 | 181723 |
| 3 | 89111 | 109934 | 70438 | 61380 | 70233 | 49869 | 66349 | 60273 | 47244 | 47694 | 61374 | 69258 | 54075 | 62819 | 121330 | 83837 |
| 4 | 43184 | 47131 | 60409 | 42075 | 35063 | 26325 | 25966 | 35568 | 29286 | 27007 | 29252 | 31585 | 43835 | 26817 | 41275 | 65982 |
| 5 | 15871 | 25975 | 17774 | 38379 | 11750 | 33420 | 10835 | 15371 | 16539 | 14980 | 11877 | 13147 | 17933 | 14828 | 13982 | 14939 |
| 6 | 9739 | 8382 | 20933 | 12809 | 6944 | 5511 | 8751 | 6888 | 6686 | 8126 | 4371 | 4635 | 6507 | 3416 | 8175 | 6001 |
| 7 | 6041 | 4981 | 5296 | 9305 | 4199 | 6829 | 3569 | 5973 | 2800 | 2793 | 1439 | 2104 | 1931 | 1514 | 1278 | 4435 |
| 8 | 9527 | 4760 | 2109 | 5610 | 1520 | 3534 | 4739 | 2626 | 2794 | 1224 | 398 | 297 | 903 | 349 | 1015 | 649 |
| 9 | 2438 | 4561 | 2447 | 902 | 0 | 1297 | 1367 | 2672 | 926 | 1193 | 202 | 137 | 243 | 185 | 7 | 628 |
| 1+ | 499723 | 400736 | 506640 | 520761 | 314729 | 356095 | 306536 | 239810 | 194812 | 234302 | 218631 | 204560 | 292190 | 300358 | 400524 | 482019 |
| 2+ | 397584 | 332378 | 294591 | 456034 | 228460 | 256348 | 251879 | 196648 | 157416 | 178210 | 194716 | 176345 | 202730 | 247304 | 283474 | 358195 |
| 3+ | 175911 | 205723 | 179406 | 170459 | 129709 | 126785 | 121575 | 129371 | 106274 | 103018 | 108914 | 121163 | 125427 | 109929 | 187062 | 176472 |
| 4+ | 86799 | 95789 | 108968 | 109079 | 59477 | 76916 | 55226 | 69099 | 59030 | 55324 | 47540 | 51905 | 71351 | 47110 | 65733 | 92635 |
| 5+ | 43615 | 48658 | 48559 | 67004 | 24413 | 50591 | 29260 | 33531 | 29744 | 28317 | 18288 | 20321 | 27517 | 20293 | 24457 | 26653 |

| | 1986 | 1987 |
|---|---|---|
| 1 | 411997 | 111874 |
| 2 | 166449 | 552917 |
| 3 | 128464 | 112450 |
| 4 | 50063 | 64689 |
| 5 | 30216 | 23845 |
| 6 | 5411 | 15238 |
| 7 | 2117 | 1674 |
| 8 | 2160 | 722 |
| 9 | 145 | 915 |
| 1+ | 797023 | 884324 |
| 2+ | 385025 | 772450 |
| 3+ | 218576 | 219533 |
| 4+ | 90112 | 107082 |
| 5+ | 40049 | 42393 |

Table 16 C. Fishing mortality at age for the 4VWX silver hake population.

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .143 | .168 | .129 | .231 | .094 | .125 | .240 | .004 | .047 | .013 | .013 | .002 | .015 | .004 | .067 | .029 | .023 | .009 |
| 2 | .701 | .677 | .826 | 1.469 | .916 | .731 | .721 | .122 | .268 | .127 | .128 | .063 | .127 | .104 | .077 | .200 | .082 | .065 |
| 3 | .656 | .443 | .294 | .521 | .731 | .369 | .388 | .395 | .501 | .425 | .416 | .463 | .401 | .224 | .443 | .221 | .390 | .200 |
| 4 | .458 | .651 | .260 | 1.336 | .079 | 1.028 | .499 | .341 | .502 | .695 | .527 | .449 | .730 | .374 | .719 | .506 | .473 | .200 |
| 5 | .634 | .386 | .399 | 1.912 | .500 | 1.042 | .290 | .245 | .506 | 1.082 | .677 | .530 | 1.353 | .384 | .605 | .699 | .383 | .200 |
| 6 | .644 | .130 | .272 | 1.513 | .360 | .641 | .216 | .200 | .695 | 1.744 | .939 | .740 | 1.028 | .809 | .342 | .854 | 1.143 | .200 |
| 7 | .409 | 1.226 | .137 | 2.280 | .027 | .065 | .157 | .068 | .735 | 1.928 | 1.233 | .302 | 1.616 | .433 | .555 | .481 | .666 | .200 |
| 8 | .195 | .328 | .376 | 3.017 | .106 | .169 | .034 | .325 | .556 | 1.943 | .944 | .347 | 1.516 | 3.715 | .134 | 1.184 | .271 | .200 |
| 9 | .598 | .402 | .306 | 1.321 | .418 | .770 | .348 | .295 | .551 | .987 | .640 | .545 | .878 | .448 | .527 | .570 | .597 | .200 |

Table 17. Results from Thompson and Bell Yield per Recruit analysis for 4VWX silver hake

| AGE | WEIGHT-AT-AGE | PARTIAL RECRUITMENT |
|---|---|---|
| 1 | .055 | .045 |
| 2 | .142 | .301 |
| 3 | .199 | 1.000 |
| 4 | .251 | 1.000 |
| 5 | .302 | 1.000 |
| 6 | .362 | 1.000 |
| 7 | .475 | 1.000 |
| 8 | .597 | 1.000 |
| 9 | .755 | 1.000 |

NATURAL MORTALITY RATE : 0.4
F0.1 COMPUTED AS .5072 AT Y/R OF .0617
FMAX COMPUTED AS 3.0104 AT Y/R OF .0759

YIELD PER RECRUIT ANALYSIS

| | FISHING MORTALITY | CATCH (NUMBER) | YIELD (KG) | AVG. WEIGHT (KG) | YIELD PER UNIT EFFORT |
|---|---|---|---|---|---|
| | .1000 | .104 | .026 | .252 | 2.157 |
| | .2000 | .177 | .042 | .235 | 1.711 |
| | .3000 | .231 | .051 | .221 | 1.400 |
| | .4000 | .271 | .057 | .211 | 1.176 |
| | .5000 | .304 | .061 | .202 | 1.010 |
| F0.1--- | .5072 | .306 | .062 | .202 | 1.000 |
| | .6000 | .330 | .064 | .195 | .883 |
| | .7000 | .352 | .067 | .189 | .783 |
| | .8000 | .371 | .068 | .184 | .703 |
| | .9000 | .388 | .070 | .180 | .637 |
| | 1.0000 | .402 | .071 | .176 | .582 |
| | 1.1000 | .415 | .072 | .173 | .536 |
| | 1.2000 | .426 | .072 | .170 | .496 |
| | 1.3000 | .437 | .073 | .167 | .462 |
| | 1.4000 | .447 | .074 | .165 | .432 |
| | 1.5000 | .455 | .074 | .162 | .406 |
| FMAX--- | 3.0104 | .541 | .076 | .140 | .207 |

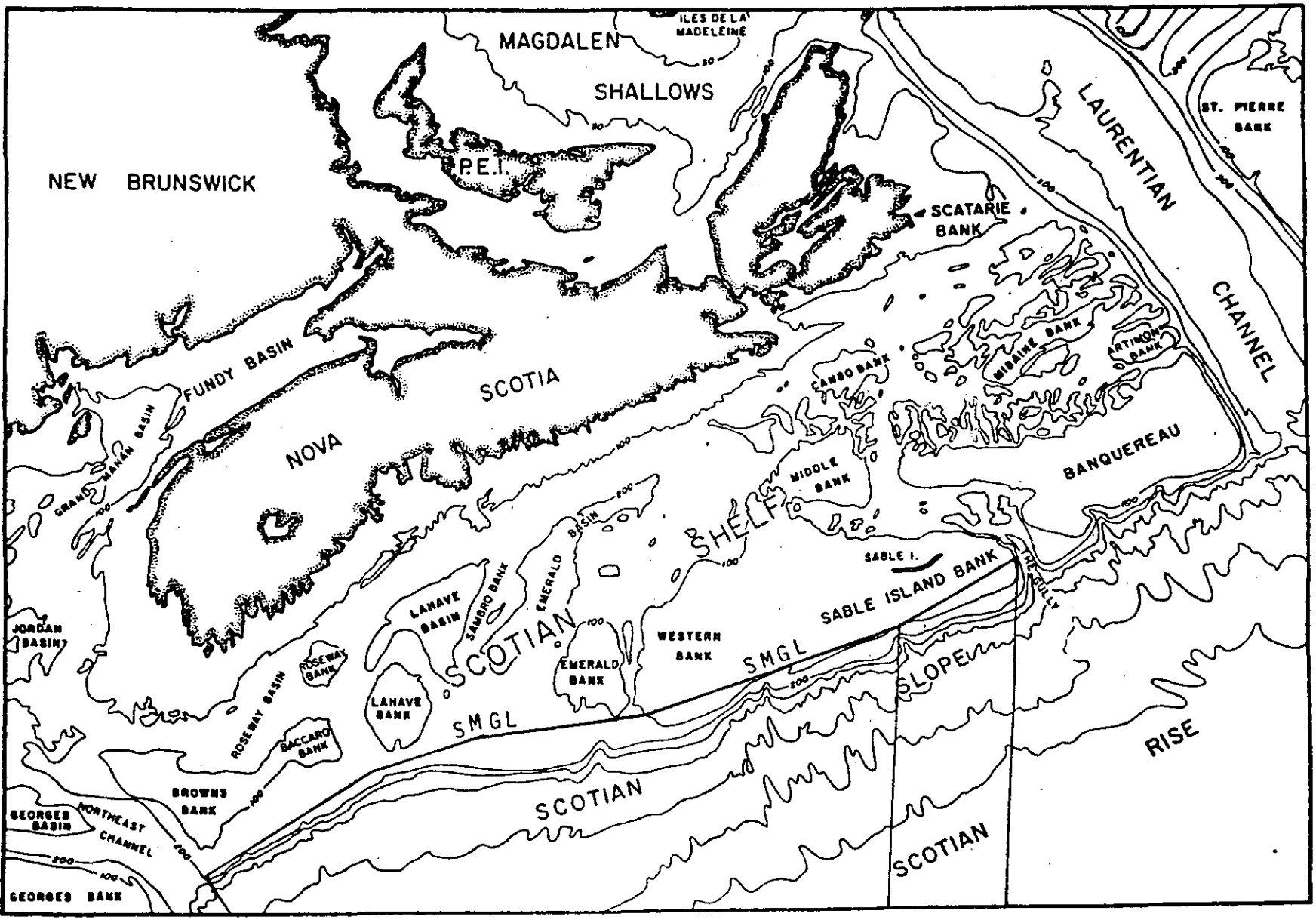


Figure 1 Bathymetric map of the Scotian Shelf and the Bay of Fundy showing the Small Mesh Gear Line (SMGL)

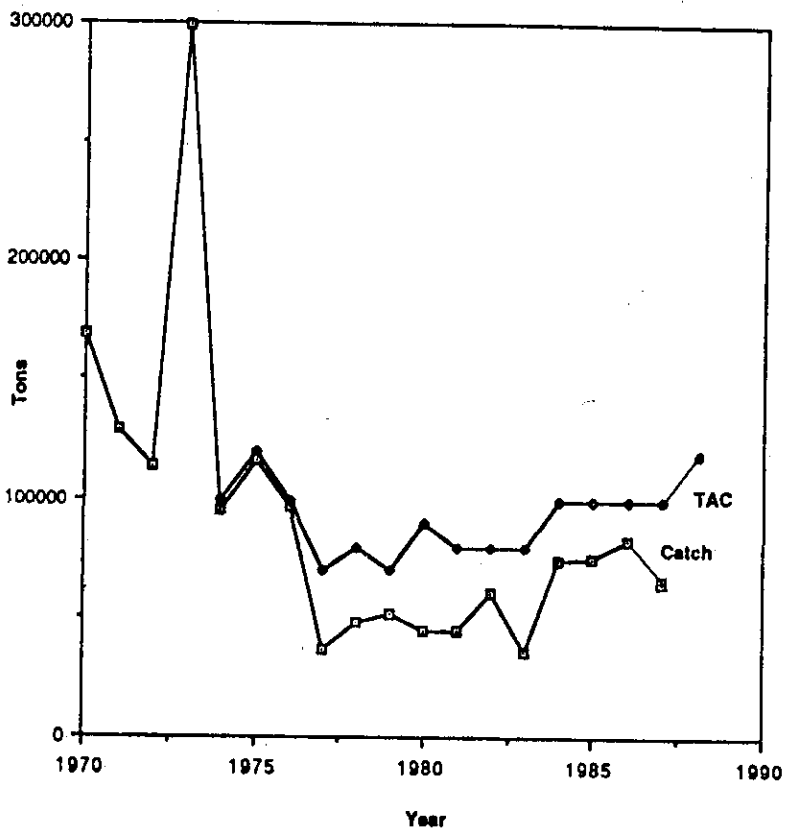


Figure 2. Catches and TAC for 4VWX silver hake.

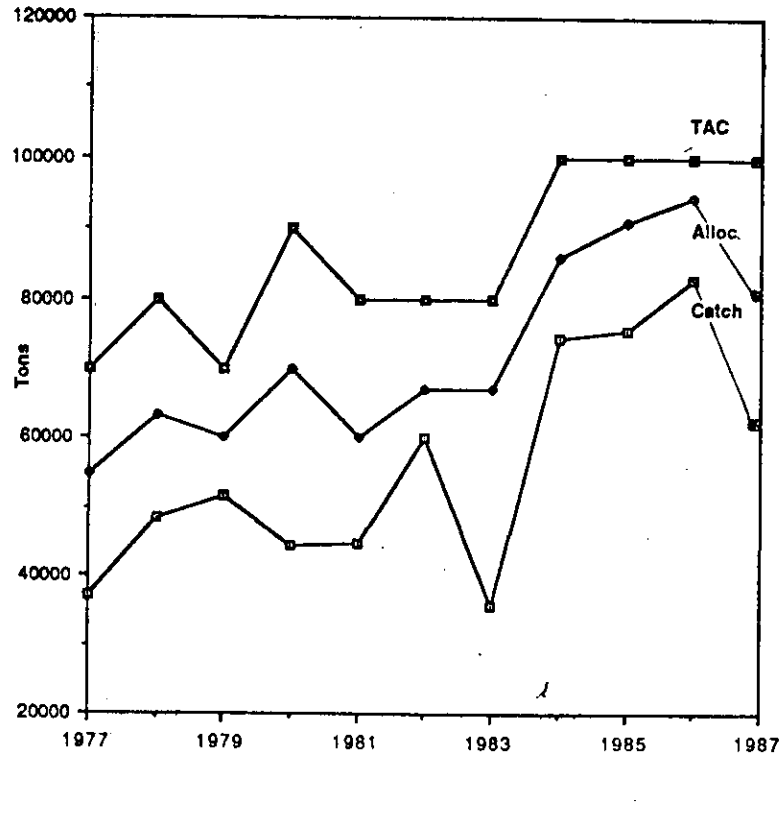


Figure 3. TAC, allocations and catches for 4VWX silver hake.

Figure 4: Mean weight at age in the catch of 4VWX silver hake from 1970-1987.

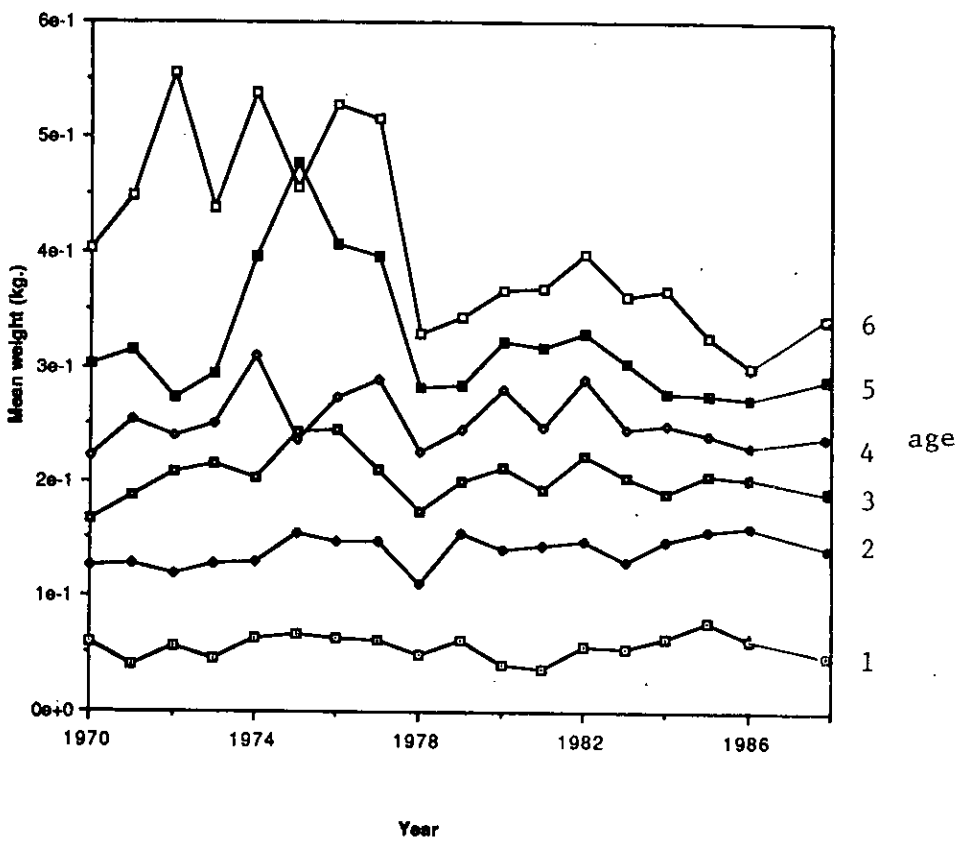

Figure 5 : Standardized catch rate for 4VWX silver hake, 1970-1987.

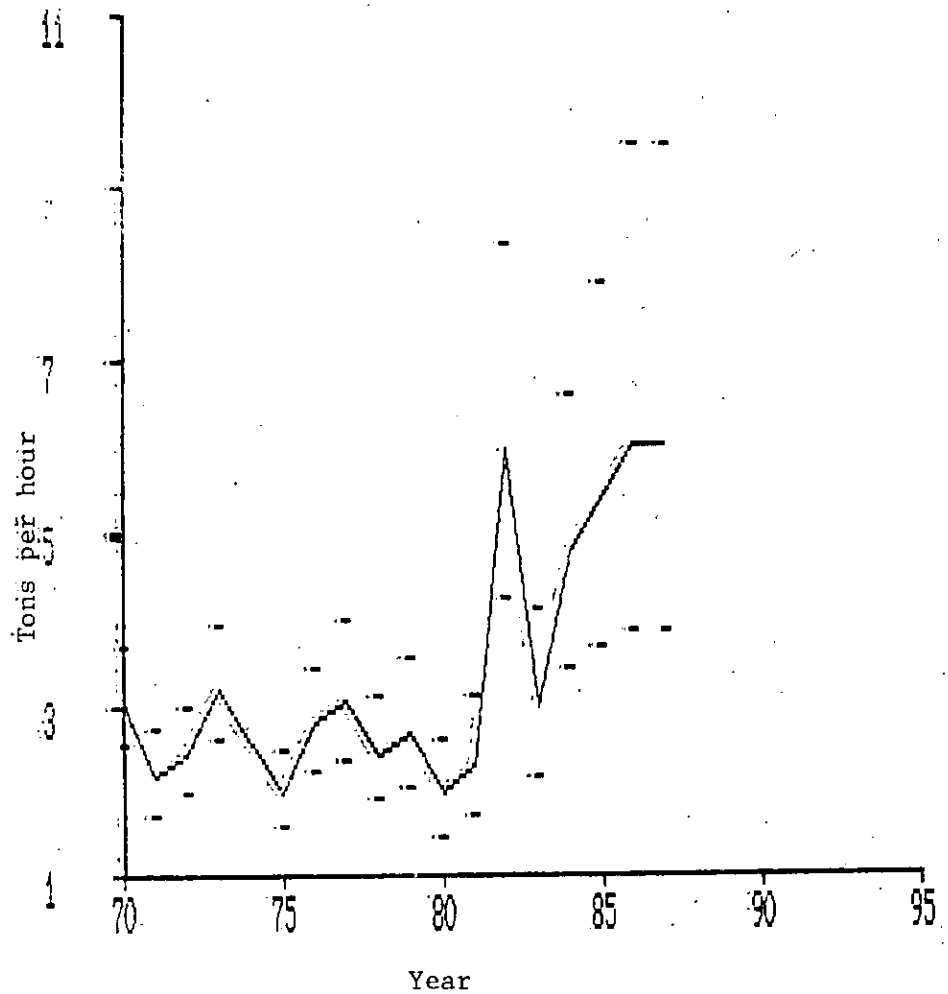

Figure 6. July RV survey estimates of numbers and biomass of 4VWX silver hake.

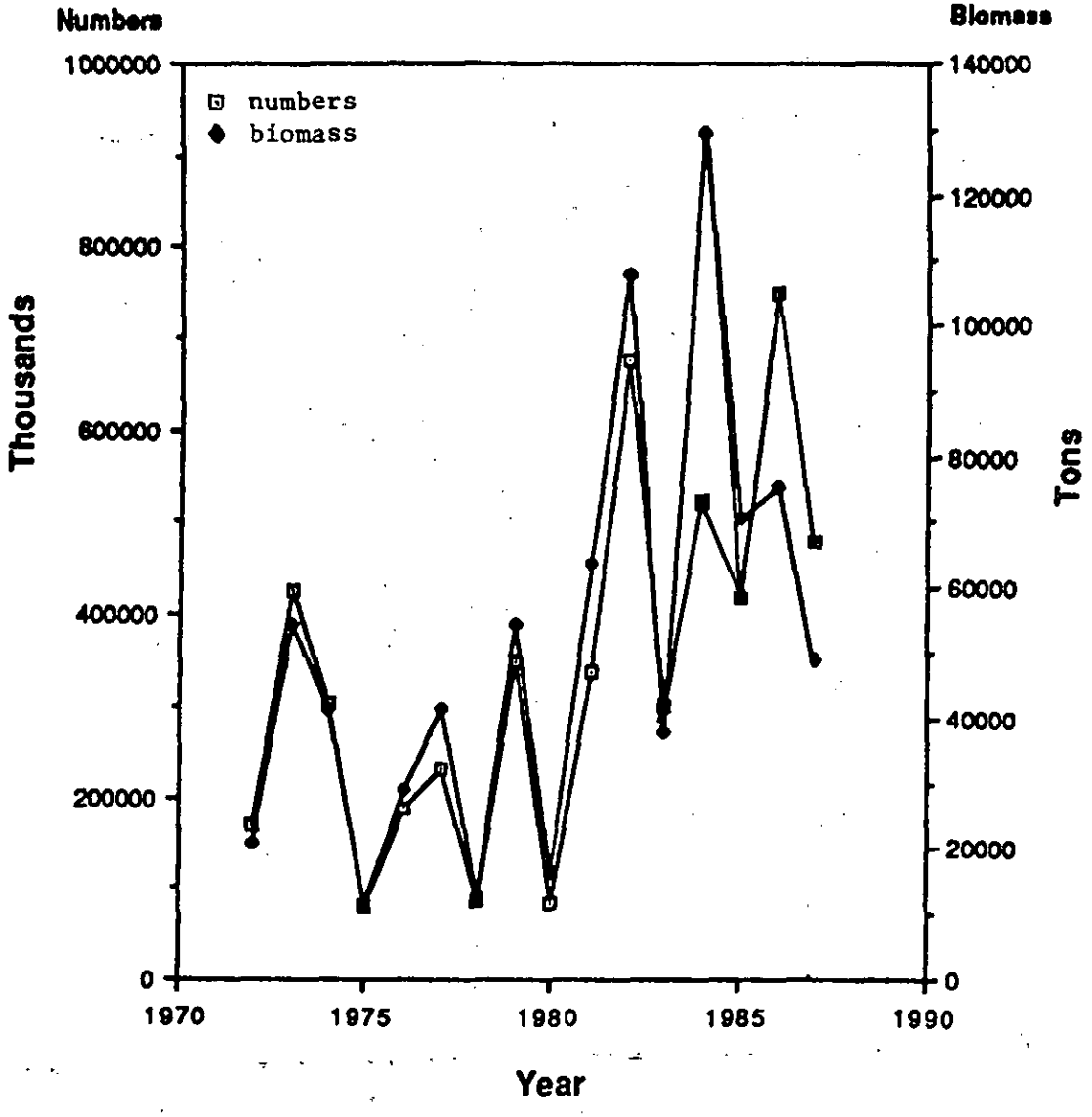

Figure 7: Survey locations for 1987 4VWX silver hake juvenile survey.

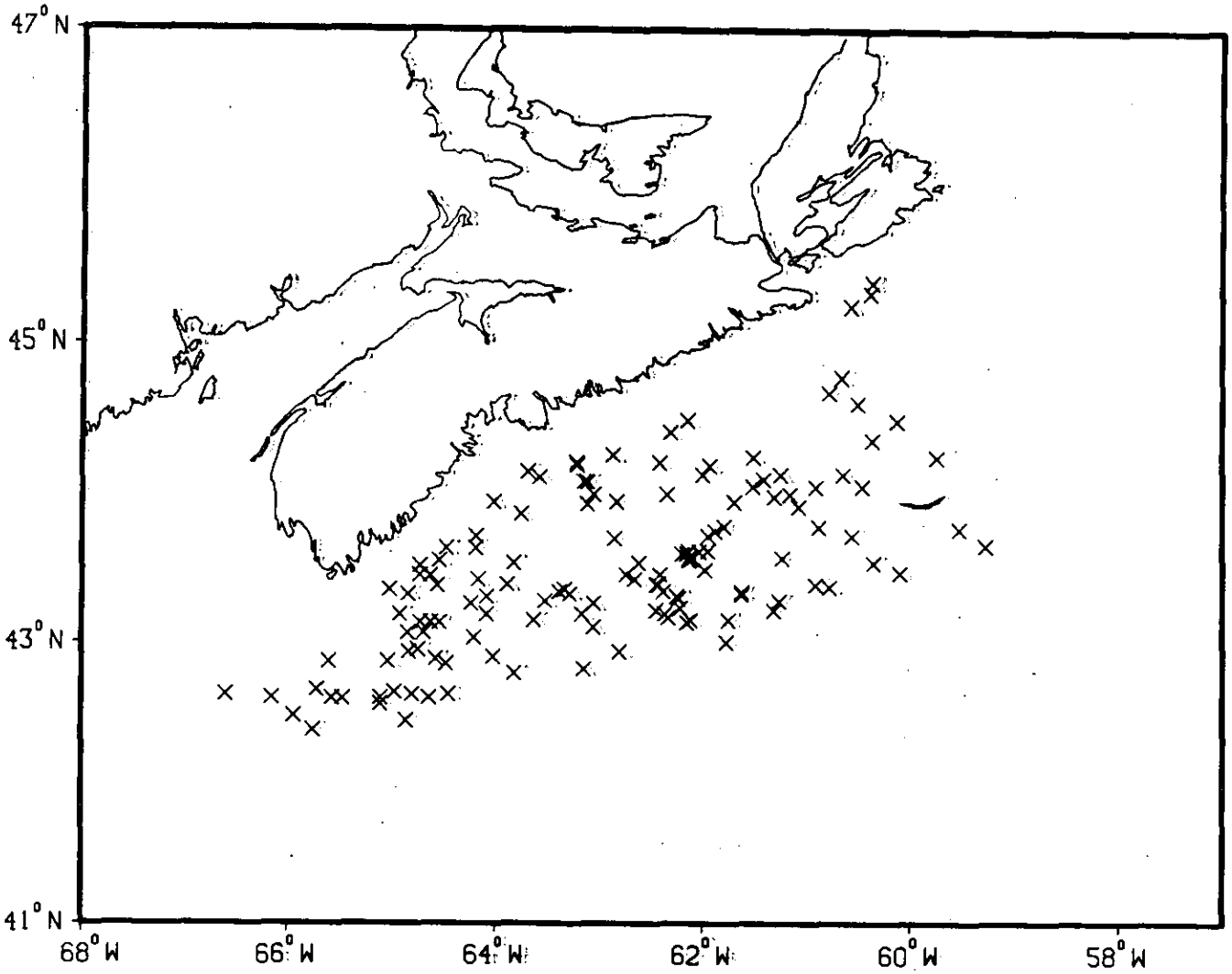

Figure 8 RV 3+ numbers on VPA 3+ numbers (1977-87) Ft=.4