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Population Abundance of Scotian Shelf Silver Hake (*Merluccius Bilinearis*)  
in 1982 with Projections to 1984

by

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**Introduction**

Silver hake (*Merluccius bilinearis*) belongs to the gadidae family which also includes the common cod, haddock, and pollock. Species distribution ranges from the Grand Banks to Delaware (Liem and Scott 1966). Two stocks south of Browns Bank have been referred to by Anderson (1977). Although there is no specific delineation of a third stock silver hake on the Scotian Shelf have been historically regarded as a separate unit (Halliday *et al.* 1978). A distinct Scotian Shelf spawning concentration was observed as early as 1962 by research vessels from the USSR (Sarnits and Sauskan 1967). Sauskan (1964) also supports the theory of a separate Scotian Shelf stock. Current data from the Canadian Scotian Shelf ichthyoplankton surveys suggests three separate spawning locations, one each on Banquereau, Sable Island, and Browns Banks (Waldron 1981b). Waldron (1982) used morphometric variables to discriminate two possible stocks on the Scotian Shelf. These two potential stocks may be associated with the Southern Georges Bank stock identified by Almeida (1982).

Sarnits and Sauskan (1967) identified seasonal areas of silver hake stock concentrations as the Shelf break and the Sable Island Bank. Clay (1979) summarized 1961 to 1968 USSR scouting vessel data which described monthly concentrations of silver hake from May to July in an area seaward of the small mesh gear line. Recently, Scott (1967 and 1980) presented results from Canadian research vessel surveys which show that both adult

and juvenile (age 1) fish are highly concentrated on Emerald Bank and the Slope break.

Waldron (1979) and Waldron and Sinclair (1980) compared data collected by commercial trawlers fishing landward and seaward of the Scotian Shelf small mesh gear line. These data suggested two separate concentrations of silver hake (Figure 1). There is some possibility that the current silver hake fishery during the summer months is prosecuting a single stock.

Silver hake spawning occurs over the Scotian Shelf from May to October, peaking in June and August (Sarnits and Sauskan 1967; Noskov 1976; and Noskov et al. 1978). Sauskan (1968) suggests that silver hake females are sequential spawners with each female spawning at least twice. Hickling and Rutenburg (1971) support this hypothesis with observations on Merluccius merluccius. Data collected from the Scotian Shelf Ichthyoplankton Program (O'Boyle et al.) and Canada-Soviet Joint Research programs (Noskov et al. 1982) indicate a large spawning concentration on the Sable Island Bank, landward of the small mesh gear line. This spawning concentration is densest in September-October (O'Boyle pers. comm.) (Figure 2). Fleets wishing to optimize their CPUE in the fall would have moved onto the Sable Island Bank to catch the spawning silver hake. Clay (1979) substantiates this pattern of movement for the Soviet fleets (Figure 3).

The Scotian Shelf commercial fishery for silver hake is almost entirely conducted by otter trawlers. The introduction of the Soviet fleet in 1962 signaled the start of a truly directed fishery. Peak catches occurred in 1963 (123,000 t), 1970 (169,000 t) and the largest in 1973 (300,000 t). Under the recent allocation schedules catches have remained near 50,000 tons (Figure 4, Table 1). Although some country allocations have not always been caught, the USSR has been able to catch the major portion of their allocation.

When Canada proclaimed a 200 mile management zone in 1977, foreign fleets were restricted to the seaward side of what is now referred to as the small mesh gear line (SMGL) (Figure 5). Since 1977, a large body of data has been collected on catch, effort and morphological data by trained observers. This information has been and is used to evaluate the silver hake stock.

### Catch and Effort

Historical catches are presented in Table 1. Provisional 1982 catches were obtained from NAFO statistics, circular letters, and Canadian statistics (Table 2).

The CPUE series used in the previous assessment was discarded in favour of an overlapping NAFO and Observer data series.

Historically, the silver hake fishery has been prosecuted mainly by the USSR. Cuba has been involved in the fishery since 1976 but its fleet has progressed through a learning process since entering the fishery.

Catch and effort data for the USSR, OTB2 TC 7 vessels for 1970-1982 were used to determine silver hake catch per unit effort. This fleet component was chosen because it was the only one which gave a consistent time series of observations. Data was taken from NAFO Statistical bulletins for 1970-1980, preliminary NAFO tables for 1981, and from the international observer program for 1982.

The USSR reported directed species to NAFO as mixed for 1970-1978, then specified the directed species for 1979-1981. This caused problems in determining representative figures for the time series. Examination of the data records for USSR OTB2 TC 7 vessels revealed that between 80-100% of the silver hake catch for 1970-1978, except 1974, was accounted for in records where silver hake was greater than or equal to 50% of the total catch. Consequently it was assumed that these records would be representative of a directed commercial catch rate, and these were used in the analysis.

In 1977, foreign fishing for silver hake was restricted to the edge of the Scotian Shelf. All vessels were required to use a minimum mesh size of 60 mm (an increase from the usual 40) and the Fishing season was restricted to the April 15 to Nov. 15 period each year. The historical distribution of effort by the USSR was along the shelf edge from April to September (Clay 1979) with most of the silver hake catch taken in the above time period prior to 1977. In an attempt to minimize the effect of a change in effect of a change in fishing strategy (caused by a change in management) on the catch rate series, only data for the months of April to September were used.

A multiplicative model was used to analyse the data (Gavaris 1980). Two category types, month and year, were entered in the analysis. Relative

catch rates were standardized to June, 1970. The results are shown in Table 3 and plotted in Figure 6. Standardized catch rates fluctuated around 2.0 in the period 1970-1976, then decreased from 1976-1980. The highest catch rate was experienced in 1982 and this was more than 2.5 times as high as the 1981 value.

The high catch rate in 1982 can be equated to a temperature induced behaviour response. Literally a major portion of the 4VWX silver hake stock was held at the shelf slope by an abnormally cold (5.0 C) thermocline (Waldron *et al.* 1982). This provided the fleet with a rather unique opportunity to fish for silver hake. In April and May 1982 catch rates as high as 10 tons/hour were reported by Canadian observers.

#### 1982 Sampling Intensity

Sampling for catch, effort, length, and age was conducted by the Canadian Scotia-Fundy Observers. From the approximately 59,000 tons of silver hake reported caught, 27,000 tons, or 46 percent was observed for all fleets. Coverage levels from 1976 to 1981 are given in Waldron 1981a and Waldron and Harris 1982.

Sampling levels for lengths were above the NAFO recommended levels for all months (Table 4). Otolith samples were adequate for all months.

Ageing was done at the St. Andrews laboratory, New Brunswick, Canada.

#### Catch At Age

Length frequency data collected by the Observer program in 1982 were summarized by month for each country sampled. These monthly length summaries were adjusted to estimated monthly catches derived from various sources and reported in Table 2. Using monthly age-length keys supplied by the ageing group in St. Andrews, the numbers-at-age were calculated by multiplying the matrix of percent age-at-length by a numbers- at-length vector. Monthly numbers-at-age were weighted to catch for each country and summed in order to arrive at the estimated removals-at-age for 1982.

Removals-at-age for 1970 to 1978 were derived by Clay and Beanlands (1980). The 1979 to 1981 removals-at-age were presented by Waldron and Harris (1982) based on a 42,924 ton catch. These were adjusted downwards to the final 1982 catch of 41,007.

The matrix of 1970 to 1982 removals-at-age ('000) is presented in Table 5.

#### Mean Weights-At-Age

Mean weights-at-age for 1970 to 1979 were derived by Clay and Beanlands (1980). The 1980 mean weights-at-age were computed using the July, 1980 research vessel weight-length relationship for each sex applied to monthly commercial mean lengths. Mean weights-at-age for 1981-82 were calculated from weight-length relationships collected during the commercial fishery (Table 6). Mean weights for projections were averaged from 1977-1982.

| Age                  | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10    | 11*   | 12*   |
|----------------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| 1981                 | .036 | .143 | .193 | .248 | .318 | .369 | .672 | .550 | .794 | 1.107 | -     | -     |
| WT-AT-AGE (Kg)       |      |      |      |      |      |      |      |      |      |       |       |       |
| 1982                 | .056 | .147 | .223 | .289 | .329 | .399 | .481 | .582 | .949 | 1.127 | 1.400 | 2.100 |
| WT-AT-AGE (Kg)       |      |      |      |      |      |      |      |      |      |       |       |       |
| <u>Ave 1977-1982</u> |      |      |      |      |      |      |      |      |      |       |       |       |
|                      | .051 | .140 | .202 | .263 | .322 | .387 | .522 | .638 | .844 | .923  | 1.460 | 2.160 |

\*Data from R/V cruises in July

Catch biomass-at-age was calculated by multiplying the removals-at-age by the mean weights-at-age (Table 7). Agreement between reported nominal catch and calculated 1+ biomass was good considering possible sampling errors for the mean weights-at-age and errors in calculating nominal catch.

| YEARS | 1970   | 1971   | 1972   | 1973   | 1974  | 1975   | 1976  | 1977  | 1978  | 1979  | 1980  | 1981  | 1982  |
|-------|--------|--------|--------|--------|-------|--------|-------|-------|-------|-------|-------|-------|-------|
| CATCH | 169045 | 128657 | 114048 | 299530 | 95745 | 116394 | 97184 | 37095 | 48401 | 51751 | 44525 | 41006 | 58765 |
| EST   | 169663 | 127698 | 113188 | 299843 | 95598 | 116671 | 97243 | 36839 | 48094 | 51761 | 44727 | 41299 | 58900 |
| DIFF. | 7618   | 959    | 860    | 313    | 147   | 277    | 759   | 256   | 397   | 710   | 202   | 293   | 135   |

Silver hake have been observed at ages to 12 years. At this age they have an average wight and length of 1.4 kg, and 67 cm respectively. The maximum possible length ( $L_{\infty}$ ) has been calculated at 94 cm which suggests the terminal age to be 20 years.

#### Natural Mortality and CPUE-At-Age

The same M (0.4) as used in the previous assessment (Waldron 1982) was presented by Terre and Mari (1977). A CPUE-at-age matrix was calculated by dividing the catch removals-at-age (numbers) by the appropriate yearly standardized effort (Table 8). Paloheimo Z values were calculated ( $z = \ln[(C/F)2 + (C/F)1]$   $F = F_1 \times F_2 / 2$ ) and regressed against mean effort. The

intercept (M) and slope (F) were unrealistic and the original estimate of M=0.4 was again used for this analysis.

#### Canadian Research Vessel Indices of Abundance

A stratified-random survey using a Yankee 36 otter trawl has been conducted by Canada in the Scotian Shelf-Bay of Fundy area (Division 4WX) in July since 1970. Earlier analysis of research vessel (RV) estimates in relation to results of VPA failed to provide any significant correlation between indices of abundance from the two sets of data. A change in vessels as well as gear type occurred in 1982 and it will be necessary to standardize results and the present analysis was therefore limited to the time series from 1970-81.

Minimum population estimates in numbers derived from RV data are shown in Table 9. Subsets of these data were also calculated in an attempt to improve VPA and RV correlation. Included are estimates by approximate Division using appropriate strata, an index corresponding to the small mesh gear line area and CPUE for RV tows. Comparison of daylight versus night tows was also made to assess the effect of time of day on catch rates. A table of correlation coefficients is shown in Table 10 and indicates poor association between any of the RV indices and results of VPA and commercial catch rates. Graphs for selected pairs of observations are shown in Figure 7.

Results of the 1982 survey using a Western IIA bottom trawl are included with other RV data but note must be made of the difference in gear type and the potential effect on catch rates. Koeller (unpub.) has suggested a conversion factor of as high as 3 for silver hake for the two vessels and gear types.

Research numbers peaked at 228 million fish in 1973, which is also the peak fishing year. Since that time the estimated numbers have fluctuated until 1978 when they stabilized in the range of 43 to 48 million fish. However, both number and biomass trends have increased in 1982. This can be accounted for by not only the presence of the strong 1978 and 1979 year classes (Figure 8) but by one large catch in the Browns Bank area. This high value when adjusted to the stratified area has biased the 1982 point. Further analysis of the R/V data set is required. The use of the 1982 R/V numbers-at-age is not advised.

#### Comparison Ageing Between Canada and USSR

A sample of 49 silver hake otoliths, collected by the USSR in April 1981 from Division 4W, were aged by Canadian and Soviet readers. Whole, glycerin-stored otoliths were used for the comparison and readers had knowledge of the length and sex of each specimen at the time they were aged. Independent estimates of age were made to assess inter-reader agreement and, for Canadian ages, intra-reader agreement was assessed by a duplicate age reading.

Length of the samples ranged from 12 to 47 cm with a mean of 313 and consisted of 13 males and 36 females. Ages ranged from 1 to 7 for both readers with a mean of 3.76 for Soviet readings and 3.80 years for Canadian. Overall agreement between the Canadian and Soviet sets of readings was 76% and 88% between the two sets of Canadian readings.

Differences of interpretation appeared to be random and were usually within one year. Differing interpretation of the edge accounted for 4 of 12 differences, 6 were due to checks, splits or weak zones, 1 to the first annulus and 1 could not be specified.

The overall agreement of 76% and the apparent lack of bias suggests that estimates of age by readers from the two countries should be comparable.

#### Virtual Population Analysis (VPA), Terminal F, and Recruitment

Partial recruitment and F at age 10 used in the 1981 assessment (Waldron 1981a) were used for this assessment. F at age 10 was calculated by averaging F's from ages 2 to 6 for all years except 1982. These calculated F values were then used in the next VPA iteration. This process continued until no change in Fs at age 10 were noted.

In order to determine the terminal F for the VPA, 2+ fishable and 2+ population biomass were calculated for a range of F's from 0.01 to 0.9 (Tables 11 and 12). These biomass vectors for the years 1970-1981 were regressed against the standardized CPUE index derived above. The 1982 points were not included in the regression because of the anomalous CPUE value of 1982. Terminal F was evaluated on the best combination of significant r and the highest agreement of the 1981 data point to the line. The 2+ fishable biomass vs PCUE calculations suggests a terminal F between 0.35 and 0.40. The 2+ population biomass vs CPUE indicates a terminal F

between 0.4 and 0.45. The compromised terminal F of 0.4 was adapted for future projections.

#### Partial Recruitment

The final partial recruitment for 1982 used in this assessment was the same as that used in the 1980 assessment (Waldron 1981). Full recruitment occurs at age 3 which is one year later than the average of Fs-at-age used in previous assessments (Clay and Beanlands 1979).

#### Partial Recruitment Used in This and Previous Assessments

| Age | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| PR  | 0.044 | 0.444 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| PR  | 0.150 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

1 Waldron (1981)

2 Clay and Beanlands (1979)

#### Validation of VPA

The fishable and population biomass at ages 2 to 10 were calculated for the years 1970 to 1982. The period 1962 to 1969 were omitted from all calculations because the fishery was developing. Further, during the years 1964 and 1965 there was a large Soviet haddock fishery which did mask some of the reported effort directed towards silver hake.

Regressing 2+ population biomass against standardized CPUE ( $r = 0.668$ ) and 2+ fishable biomass also against standardized CPUE ( $r = 0.559$ ) gave the best agreement between a significant  $r$  and predictability of the 1981 data point to the line at a terminal F of 0.40 and M = 0.4 (Tables 11 and 12; Figures 9 and 10).

The population numbers and F are given in Tables 13 and 14. The 1+ population numbers in 1982 (2.370 billion) is comparable to those estimated for 1976 to 1981 and only 43% of that estimated for the highest year 1972. The large 1977 and 1978 year classes are being caught at age 4 and 5 in the 1982 fishery and by 1983 will have effectively made their contribution to this Scotian Shelf fishery. The 1979 and 1980 year classes were half that estimated for the 1977 and 1978 year classes. These will make up the large part of the 1983 and 1984 fishery.

Research vessel percent-at-age (Table 15) suggests that the 1981 year

class is comparable to the above average 1974 year class. If true, the fishery in 1984 and 1985 should benefit from this year class.

#### **Yield Per Recruit**

The yield per recruit was calculated using the Thompson and Bell model. Mean weights-at-age for ages 1 to 12 were averaged for the years 1977-1981. Fully recruited  $F_{0.1}$  was 0.406 with a yield of 0.061 kg. The FMAX is 2.627 with a yield of 0.076 kg (Table 16).

#### **Recruitment**

Recruitment for silver hake has been relatively unstable since 1970 averaging 1.4 billion individuals. For projection purposes recruitment was taken as the average from 1970 to 1981 (1.2 Billion) and as a result it is possibly a close estimate of the 1981 year class. Noskov (1983) reporting on Soviet juvenile silver hake surveys conducted in 1982, indicates that the 1980 year class was weak while the 1981 year class is relatively strong. This further supports the VPA and R/V data that the 1981 year class may indeed be near the 1970-81 average.

#### **Catch Projection**

Catch projections until 1984 were calculated using the above partial recruitment,  $F_{0.1} = 0.406$ ,  $M = 0.4$ , mean weights-at-age ('77-81) and the mean of recruitment from 1970 to 1981 (1.2 Billion fish). Three options for the 1984 catch were generated. The first assumed the  $F_{0.1}$  catch of 55,194 tons in 1983 would predict an  $F_{0.1}$  catch in 1984 of 66,144 tons (option 1, Table 17). The second assumed the assigned 1983 TAC of 80,000 tons would be caught. This assumption predicted the 1984 catch would be 59,343 tons (Option 2, Table 17). The third assumes an average catch of 60,000 tons in 1983 would give a catch of 65,163 tons in 1984 (Option 3, Table 17).

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TABLE 1: NOMINAL CATCH OF 4VWX SILVER HAKE

| YEARS | 1970   | 1971   | 1972   | 1973   | 1974  | 1975   | 1976  | 1977  | 1978  | 1979  | 1980  | 1981  | 1982  |
|-------|--------|--------|--------|--------|-------|--------|-------|-------|-------|-------|-------|-------|-------|
| CATCH | 169045 | 128657 | 114048 | 299530 | 95745 | 116394 | 97184 | 37095 | 48401 | 51751 | 44525 | 41006 | 58765 |

Table 2. 1982 Provisional nominal catches (t) for 4VWX Silver Hake (data from NAFO and Canadian statistics).

| COUNTRY  | MONTHS |       |       |       |     |      |     |     |     |  |  |  | TOTAL |
|----------|--------|-------|-------|-------|-----|------|-----|-----|-----|--|--|--|-------|
|          | APRIL  | MAY   | JUNE  | JULY  | AUG | SEPT | OCT | NOV | DEC |  |  |  |       |
| Canada   | 0      | 0     | 0     | 0     | 7   | 10   | 5   | 14  | 2   |  |  |  | 38    |
| Cuba     | 0      | 2454  | 3801  | 5459  | 240 | 10   | 0   | 0   | 0   |  |  |  | 11964 |
| France   | 0      | 0     | 2     | 0     | 0   | 0    | 0   | 0   | 0   |  |  |  | 2     |
| Italy    | 0      | 0     | 0     | 0     | 20  | 0    | 0   | 0   | 0   |  |  |  | 20    |
| Japan    | 0      | 0     | 0     | 153   | 514 | 268  | 0   | 0   | 0   |  |  |  | 935   |
| Poland   | 0      | 0     | 0     | 17    | 3   | 0    | 0   | 0   | 0   |  |  |  | 20    |
| Portugal | 0      | 0     | 2     | 0     | 0   | 0    | 0   | 0   | 0   |  |  |  | 2     |
| USSR     | 2778   | 16784 | 20253 | 5918  | 51  | 0    | 0   | 0   | 0   |  |  |  | 45784 |
| TOTAL    | 2778   | 19238 | 24057 | 11547 | 835 | 288  | 5   | 14  | 2   |  |  |  | 58765 |

Table 3. Results of the silver hake commercial catch rate analysis of USSR OTB2 TC7 vessels using a multiplicative model with months (Apr-Aug) and years (70-82) as category types. Catch rates were standardized to June, 1970.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R ,....., 0.731  
MULTIPLE R SQUARED ,..., 0.535

ANALYSIS OF VARIANCE

| SOURCE OF VARIATION | DF  | SUMS OF SQUARES | MEAN SQUARES | F-VALUE |
|---------------------|-----|-----------------|--------------|---------|
| INTERCEPT           | 1   | 4.115E1         | 4.115E1      |         |
| REGRESSION          | 17  | 8.815E0         | 5.185E-1     | 7.028   |
| TYPE 1              | 5   | 1.104E1         | 2.208E0      | 29.927  |
| TYPE 2              | 12  | 4.771E0         | 3.975E-1     | 5.388   |
| RESIDUALS           | 104 | 7.673E0         | 7.378E-2     |         |
| TOTAL               | 122 | 5.763E1         |              |         |

PREDICTED CATCH RATE

STANDARDS USED VARIABLE NUMBERS: 0

| YEAR | TOTAL CATCH | PROP. | CATCH RATE |       |        |
|------|-------------|-------|------------|-------|--------|
|      |             |       | MEAN       | S.E.  | EFFORT |
| 1970 | 169045      | 0.901 | 2.417      | 0.223 | 69938  |
| 1971 | 128657      | 0.531 | 1.695      | 0.201 | 75908  |
| 1972 | 114048      | 0.879 | 1.856      | 0.202 | 61461  |
| 1973 | 299530      | 0.891 | 2.399      | 0.244 | 124853 |
| 1974 | 95745       | 0.240 | 1.560      | 0.258 | 61365  |
| 1975 | 116394      | 0.743 | 1.485      | 0.175 | 78369  |
| 1976 | 97184       | 0.429 | 2.039      | 0.208 | 47668  |
| 1977 | 37095       | 0.703 | 1.979      | 0.191 | 18741  |
| 1978 | 48401       | 0.866 | 1.577      | 0.148 | 30686  |
| 1979 | 51751       | 0.869 | 1.818      | 0.180 | 28473  |
| 1980 | 44525       | 0.920 | 1.223      | 0.129 | 36409  |
| 1981 | 41006       | 0.906 | 1.451      | 0.143 | 28251  |
| 1982 | 58765       | 0.332 | 3.882      | 0.565 | 15138  |

AVERAGE C.V. FOR THE MEAN: 0.111

TABLE 4. 1982 4-mm SILVER-HAKE COMMERCIAL SAMPLING SUMMARY.

| COUNTRY | OBS.         | MONTHS OF 1982 |       |       |       |        |           | TOTAL  |
|---------|--------------|----------------|-------|-------|-------|--------|-----------|--------|
|         |              | APRIL          | MAY   | JUNE  | JULY  | AUGUST | SEPTEMBER |        |
| CANADA  | MEASUREMENTS | 7              | 0     | 0     | 0     | 0      | 0         | 343    |
|         | NO. OTOLITHS | 7              | 0     | 0     | 0     | 0      | 104       | 1068   |
| CUBA    | MEASUREMENTS | 0              | 15015 | 8527  | 14041 | 0      | 407       | 0      |
|         | NO. OTOLITHS | 0              | 155   | 140   | 244   | 0      | 27        | 190    |
| ITALY   | MEASUREMENTS | 0              | 0     | 0     | 0     | 536    | 290       | 3790   |
|         | NO. OTOLITHS | 0              | 0     | 0     | 0     | 38     | 0         | 566    |
| JAPAN   | MEASUREMENTS | 0              | 0     | 0     | 0     | 4261   | 1613      | 826    |
|         | NO. OTOLITHS | 0              | 0     | 0     | 0     | 111    | 31        | 38     |
| POLAND  | MEASUREMENTS | 0              | 0     | 0     | 422   | 1534   | 0         | 584    |
|         | NO. OTOLITHS | 0              | 0     | 0     | 38    | 40     | 0         | 142    |
| USSR    | MEASUREMENTS | 7273           | 13813 | 15592 | 15763 | 705    | 0         | 1956   |
|         | NO. OTOLITHS | 67             | 693   | 275   | 162   | 4      | 0         | 2215   |
| TOTAL   | MEASUREMENTS | 7280           | 28828 | 24119 | 30226 | 7036   | 2310      | 100850 |
|         | NO. OTOLITHS | 74             | 848   | 415   | 444   | 193    | 58        | 343    |
|         |              |                |       |       |       | 104    | 79        | 0      |

TABLE 5. 4VWX SILVER HAKE COMMERCIAL REMOVALS-AT-AGE ('000).

## YEARS

| AGE   | 1970    | 1971   | 1972   | 1973    | 1974   | 1975   | 1976   | 1977   | 1978   | 1979   | 1980   | 1981   | 1982   | MEAN   |
|-------|---------|--------|--------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1     | 187298  | 219607 | 379314 | 246148  | 101158 | 145091 | 153535 | 2131   | 28704  | 9667   | 6272   | 1553   | 19383  | 149986 |
| 2     | 748021  | 410149 | 460610 | 1482925 | 390044 | 365964 | 381651 | 43535  | 90777  | 48341  | 60576  | 19530  | 50825  | 455295 |
| 3     | 216246  | 175005 | 71536  | 96784   | 150741 | 52837  | 72418  | 78239  | 89717  | 69058  | 82013  | 111209 | 65866  | 133167 |
| 4     | 59832   | 74755  | 47903  | 106675  | 7095   | 60806  | 31295  | 29561  | 42878  | 46547  | 35888  | 38534  | 65136  | 64690  |
| 5     | 20695   | 22035  | 17822  | 96940   | 9789   | 38646  | 5582   | 6981   | 19442  | 29656  | 15293  | 14266  | 34202  | 33135  |
| 6     | 9636    | 1877   | 7452   | 19671   | 3245   | 4803   | 2669   | 2004   | 8587   | 16964  | 6179   | 5548   | 8778   | 9741   |
| 7     | 3608    | 5139   | 1160   | 15203   | 93     | 311    | 514    | 483    | 3222   | 5079   | 1682   | 679    | 2744   | 3992   |
| 8     | 1988    | 1333   | 437    | 5475    | 109    | 363    | 105    | 564    | 2009   | 1765   | 344    | 132    | 1029   | 1565   |
| 9     | 1114    | 2062   | 607    | 484     | 60     | 360    | 522    | 420    | 1151   | 90     | 61     | 124    | 74     | 74     |
| 10    | 680     | 1900   | 2000   | 818     | 77     | 1001   | 82     | 1      | 643    | 489    | 44     | 243    | 7      | 799    |
| TOTAL | 1249118 | 913862 | 988841 | 2071123 | 662411 | 670183 | 648241 | 164022 | 286398 | 228718 | 208380 | 191757 | 248094 |        |

TABLE 6. 4VWX SILVER HAKE MEAN WEIGHTS-AT-AGE (KG.).

## YEARS

| AGE     | 1970  | 1971  | 1972  | 1973  | 1974  | 1975  | 1976  | 1977  | 1978  | 1979  | 1980  | 1981  | 1982  | MEAN  |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1       | 0.060 | 0.040 | 0.056 | 0.045 | 0.063 | 0.067 | 0.063 | 0.062 | 0.049 | 0.061 | 0.041 | 0.036 | 0.056 | 0.070 |
| 2       | 0.126 | 0.128 | 0.119 | 0.128 | 0.129 | 0.155 | 0.148 | 0.147 | 0.110 | 0.154 | 0.141 | 0.143 | 0.147 | 0.178 |
| 3       | 0.167 | 0.188 | 0.209 | 0.216 | 0.204 | 0.243 | 0.237 | 0.231 | 0.210 | 0.174 | 0.200 | 0.213 | 0.193 | 0.223 |
| 4       | 0.222 | 0.254 | 0.246 | 0.250 | 0.310 | 0.237 | 0.273 | 0.290 | 0.226 | 0.245 | 0.280 | 0.248 | 0.289 | 0.336 |
| 5       | 0.303 | 0.315 | 0.274 | 0.295 | 0.396 | 0.477 | 0.407 | 0.397 | 0.283 | 0.285 | 0.322 | 0.318 | 0.329 | 0.440 |
| 6       | 0.404 | 0.450 | 0.557 | 0.439 | 0.539 | 0.457 | 0.516 | 0.528 | 0.329 | 0.344 | 0.366 | 0.369 | 0.399 | 0.570 |
| 7       | 0.470 | 0.587 | 0.483 | 0.485 | 0.975 | 1.133 | 0.838 | 0.667 | 0.382 | 0.411 | 0.520 | 0.672 | 0.481 | 0.810 |
| 8       | 0.705 | 0.832 | 1.263 | 0.875 | 1.156 | 1.257 | 1.077 | 0.498 | 0.520 | 0.601 | 0.550 | 0.582 | 1.117 |       |
| 9       | 0.828 | 0.612 | 0.886 | 1.174 | 0.001 | 1.635 | 0.859 | 1.089 | 0.784 | 0.553 | 0.892 | 0.794 | 0.949 | 1.106 |
| 10      | 0.875 | 0.712 | 0.001 | 1.726 | 1.508 | 0.946 | 1.818 | 0.001 | 0.659 | 1.189 | 1.452 | 1.107 | 1.127 | 1.312 |
| MEAN 1+ | 0.416 | 0.412 | 0.409 | 0.563 | 0.528 | 0.661 | 0.643 | 0.446 | 0.349 | 0.396 | 0.483 | 0.443 | 0.458 |       |

TABLE 7. *4WXX SILVER HAKE CATCH BIOMASS (T.)*

|       | AGE    | YEARS  |        |        |       |        |       |       |       |       |       | MEAN  |       |
|-------|--------|--------|--------|--------|-------|--------|-------|-------|-------|-------|-------|-------|-------|
|       |        | 1970   | 1971   | 1972   | 1973  | 1974   | 1975  | 1976  | 1977  | 1978  | 1979  | 1980  |       |
| 1     | 11238  | 8784   | 21242  | 11077  | 6373  | 9721   | 9673  | 132   | 1407  | 590   | 257   | 56    | 1083  |
| 2     | 94251  | 52499  | 54813  | 189814 | 50316 | 56724  | 56484 | 6400  | 9985  | 745   | 8541  | 2793  | 7497  |
| 3     | 36113  | 32901  | 14951  | 20905  | 30751 | 12839  | 17815 | 16430 | 15611 | 13812 | 17469 | 21463 | 59756 |
| 4     | 13283  | 18988  | 11497  | 26669  | 2199  | 14411  | 8544  | 8573  | 9690  | 11404 | 10049 | 9556  | 18850 |
| 5     | 6271   | 6941   | 4883   | 28597  | 3876  | 18434  | 2272  | 2772  | 5502  | 8452  | 4924  | 4537  | 11256 |
| 6     | 3893   | 845    | 4151   | 8635   | 1749  | 2195   | 1409  | 1034  | 2825  | 5836  | 2261  | 2047  | 4038  |
| 7     | 1696   | 3017   | 560    | 7374   | 91    | 353    | 431   | 322   | 1231  | 2088  | 875   | 456   | 1320  |
| 8     | 1402   | 1109   | 552    | 4790   | 126   | 457    | 131   | 608   | 1000  | 918   | 206   | 73    | 599   |
| 9     | 922    | 1262   | 538    | 569    | 0     | 589    | 335   | 569   | 329   | 637   | 80    | 48    | 118   |
| 10    | 595    | 1353   | 2      | 1413   | 116   | 947    | 149   | 0     | 424   | 582   | 64    | 269   | 8     |
| TOTAL | 169663 | 127698 | 113188 | 299843 | 95598 | 116671 | 97243 | 36839 | 48004 | 51761 | 44727 | 41299 | 58900 |

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TABLE 8. *4WXX SILVER HAKE CATCH CPUE-AT-AGE (T/HRS.)*

|         | AGE   | YEARS |       |       |       |       |       |       |       |       |       | MEAN  |       |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|         |       | 1970  | 1971  | 1972  | 1973  | 1974  | 1975  | 1976  | 1977  | 1978  | 1979  | 1980  |       |
| 1       | 0.161 | 0.116 | 0.346 | 0.089 | 0.104 | 0.124 | 0.203 | 0.007 | 0.046 | 0.021 | 0.007 | 0.002 | 0.072 |
| 2       | 1.348 | 0.692 | 0.892 | 1.520 | 0.820 | 0.724 | 1.185 | 0.341 | 0.325 | 0.262 | 0.235 | 0.099 | 0.495 |
| 3       | 0.516 | 0.433 | 0.243 | 0.167 | 0.501 | 0.164 | 0.374 | 0.877 | 0.509 | 0.485 | 0.480 | 0.759 | 0.648 |
| 4       | 0.190 | 0.250 | 0.187 | 0.214 | 0.036 | 0.184 | 0.179 | 0.457 | 0.316 | 0.401 | 0.276 | 0.338 | 1.245 |
| 5       | 0.090 | 0.091 | 0.079 | 0.229 | 0.063 | 0.235 | 0.048 | 0.148 | 0.179 | 0.297 | 0.135 | 0.161 | 0.250 |
| 6       | 0.056 | 0.011 | 0.068 | 0.069 | 0.028 | 0.028 | 0.030 | 0.055 | 0.092 | 0.205 | 0.062 | 0.072 | 0.231 |
| 7       | 0.024 | 0.040 | 0.009 | 0.059 | 0.001 | 0.004 | 0.009 | 0.017 | 0.040 | 0.073 | 0.024 | 0.016 | 0.041 |
| 8       | 0.020 | 0.015 | 0.009 | 0.038 | 0.002 | 0.006 | 0.003 | 0.032 | 0.033 | 0.032 | 0.006 | 0.003 | 0.040 |
| 9       | 0.013 | 0.017 | 0.009 | 0.005 | 0.000 | 0.008 | 0.007 | 0.030 | 0.011 | 0.022 | 0.002 | 0.002 | 0.013 |
| 10      | 0.009 | 0.018 | 0.000 | 0.011 | 0.002 | 0.012 | 0.003 | 0.000 | 0.014 | 0.020 | 0.002 | 0.010 | 0.010 |
| MEAN 1+ | 0.243 | 0.168 | 0.184 | 0.240 | 0.156 | 0.149 | 0.204 | 0.197 | 0.156 | 0.182 | 0.123 | 0.146 | 0.389 |

TABLE 9. 4VWX SILVER HAKE MIN. POP. NUMBERS (\*'000) FROM JULY R/V SURVEYS.

## YEARS

| <u>AGE</u> | 1972  | 1973   | 1974   | 1975  | 1976  | 1977  | 1978  | 1979   | 1980  | 1981   | 1982   | MEAN  |
|------------|-------|--------|--------|-------|-------|-------|-------|--------|-------|--------|--------|-------|
| 1          | 27717 | 69273  | 37346  | 17591 | 17338 | 3770  | 13357 | 44383  | 7392  | 16376  | 230081 | 48462 |
| 2          | 45667 | 130968 | 120211 | 16722 | 49123 | 14507 | 12339 | 75438  | 11272 | 43909  | 361683 | 88184 |
| 3          | 6779  | 8900   | 17114  | 2658  | 4523  | 10569 | 8232  | 36406  | 14768 | 68530  | 102357 | 28084 |
| 4          | 3657  | 7394   | 2137   | 1494  | 2055  | 2159  | 4403  | 10001  | 4234  | 29338  | 75938  | 14281 |
| 5          | 1577  | 6880   | 2114   | 768   | 609   | 743   | 3444  | 7132   | 2174  | 8449   | 17944  | 5183  |
| 6          | 906   | 3179   | 2407   | 445   | 350   | 697   | 1459  | 2837   | 1596  | 2670   | 9400   | 2595  |
| 7          | 140   | 1108   | 443    | 128   | 94    | 442   | 601   | 1560   | 770   | 1471   | 5749   | 1251  |
| 8          | 330   | 684    | 254    | 202   | 132   | 173   | 233   | 496    | 446   | 436    | 7852   | 1124  |
| 9          | 58    | 61     | 0      | 19    | 89    | 146   | 469   | 107    | 189   | 254    | 382    | 178   |
| 10         | 225   | 343    | 22     | 0     | 0     | 181   | 221   | 504    | 331   | 227    | 242    | 230   |
| TOTAL      | 87056 | 228789 | 182047 | 40028 | 74313 | 33387 | 44757 | 178864 | 43173 | 171660 | 811628 |       |

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TABLE 10a. 4VWX SILVER HAKE MIN. POP. BIOMASS (T) FROM JULY R/V SURVEYS.

## YEARS

| <u>AGE</u> | 1972  | 1973  | 1974  | 1975 | 1976  | 1977 | 1978 | 1979  | 1980 | 1981  | 1982   | MEAN  |
|------------|-------|-------|-------|------|-------|------|------|-------|------|-------|--------|-------|
| 1          | 1552  | 3117  | 2353  | 1179 | 1092  | 234  | 654  | 2707  | 303  | 590   | 12862  | 2664  |
| 2          | 5434  | 16764 | 15507 | 2592 | 7270  | 2133 | 1357 | 11617 | 1589 | 6279  | 53348  | 12389 |
| 3          | 1417  | 1922  | 3491  | 646  | 1113  | 2219 | 1432 | 7281  | 3146 | 13226 | 22795  | 5869  |
| 4          | 878   | 1848  | 662   | 354  | 561   | 626  | 995  | 2450  | 1186 | 7276  | 21976  | 3881  |
| 5          | 432   | 2030  | 837   | 366  | 248   | 295  | 975  | 2033  | 700  | 2687  | 5905   | 1651  |
| 6          | 505   | 1396  | 1297  | 203  | 185   | 360  | 480  | 976   | 584  | 985   | 3750   | 1072  |
| 7          | 68    | 537   | 432   | 145  | 78    | 295  | 230  | 641   | 400  | 989   | 2765   | 658   |
| 8          | 416   | 598   | 293   | 254  | 166   | 186  | 116  | 258   | 268  | 240   | 4568   | 736   |
| 9          | 52    | 72    | 0     | 31   | 77    | 159  | 368  | 59    | 169  | 202   | 362    | 155   |
| 10         | 0     | 592   | 33    | 0    | 0     | 0    | 145  | 599   | 481  | 251   | 273    | 238   |
| TOTAL      | 10754 | 28876 | 24906 | 5771 | 10789 | 6507 | 6752 | 28622 | 8826 | 32724 | 128604 |       |

Table 10b Population estimates from research vessel and VPA results

| Year                            | #1     | #2     | #3     | #4   | #5   | #6   | #7   | #8    | #9   | #10  | #11    | #12  | #13    | #14    | #15    | #16       | #17 |
|---------------------------------|--------|--------|--------|------|------|------|------|-------|------|------|--------|------|--------|--------|--------|-----------|-----|
| 1970                            | 142179 | 104212 | 30563  | 3533 | 4367 | .43  | 1.51 | 25.6  | 35.4 | 29.4 | 84883  | 24.0 | 130615 | +      | + 1734 | 1788      |     |
| 1971                            | 53301  | 20945  | 18173  | 3183 | 3624 | .46  | .21  | 11.8  | 28.8 | 10.4 | 35697  | 10.7 | 45804  | +      | + 1697 | 1011      |     |
| 1972                            | 67831  | 70778  | 10701  | 2013 | 5526 | .34  | 1.45 | 14.9  | 20.9 | 19.9 | 125919 | 5.2  | 25725  | 27717  | 45667  | 3853 960  |     |
| 1973                            | 229808 | 63845  | 153511 | 5052 | 4345 | 1.27 | 1.61 | 54.6  | 42.8 | 38.3 | 204550 | 28.2 | 169514 | 69273  | 130968 | 1451 2276 |     |
| 1974                            | 183438 | 107832 | 58566  | 6835 | 2673 | .31  | .65  | 36.3  | 73.3 | 15.0 | 63178  | 36.2 | 162176 | 37345  | 120211 | 1390 775  |     |
| 1975                            | 41739  | 28129  | 11503  | 508  | 2793 | .56  | .71  | 7.4   | 4.8  | 6.1  | 27549  | 8.2  | 48599  | 17591  | 16722  | 1526 850  |     |
| 1976                            | 95104  | 52638  | 19905  | 7898 | 2225 | .67  | 1.19 | 19.0  | 43.6 | 26.1 | 114153 | 9.0  | 45604  | 17338  | 49123  | 1092 905  |     |
| 1977                            | 33404  | 14281  | 9677   | 584  | 1820 | .19  | .81  | 7.2   | 5.9  | 5.4  | 21432  | 6.1  | 29119  | 3770   | 14507  | 1020 608  |     |
| 1978                            | 45073  | 24636  | 13899  | 961  | 2178 | .42  | .78  | 9.0   | 10.2 | 8.9  | 46671  | 10.8 | 40181  | 13357  | 12339  | 1271 682  |     |
| 1979                            | 179521 | 110065 | 54701  | 1976 | 2446 | .85  | .90  | 35.0  | 20.4 | 23.2 | 160978 | 21.4 | 165662 | 44383  | 75438  | 2178 828  |     |
| 1980                            | 43315  | 34862  | 3010   | 1097 | 2031 | .44  | .62  | 7.3   | 28.3 | 15.0 | 37950  | 4.3  | 44864  | 7392   | 11272  | 727 1451  |     |
| 1981                            | 173608 | 157942 | 11686  | 2699 | 1755 | .30  | .72  | 27.3  | 14.9 | 17.7 | 94787  | 31.7 | 165220 | 16376  | 43909  | 353 482   |     |
| 1982                            | 811626 | 285423 | 503503 | 2615 | 2371 | .34  | 3.80 | 180.2 | 25.7 | -    | -      | -    | -      | 235081 | 36163  | 347 377   |     |
| Variables                       | #1     | #2     | #3     | #4   | #5   | #6   | #7   | #8    | #9   | #10  | #11    | #12  | #13    | #14    | #15    | #16       | #17 |
| #1 = RV numbers for LKX         |        |        |        |      |      |      |      |       |      |      |        |      |        |        |        |           |     |
| #2 = RV numbers for LN          | #2     | .78    | +      | +    | +    | +    | +    | +     | +    | +    | +      | +    | +      | +      | +      | +         | +   |
| #3 = RV numbers for LX          | #3     | .77    | .20    | +    | +    | +    | +    | +     | +    | +    | +      | +    | +      | +      | +      | +         | +   |
| #4 = RV numbers for SMGL        | #4     | .53    | .32    | .41  | +    | +    | +    | +     | +    | +    | +      | +    | +      | +      | +      | +         | +   |
| #5 = 1982 VPA numbers           | #5     | .26    | .10    | .01  | .37  | .25  | +    | +     | +    | +    | +      | +    | +      | +      | +      | +         | +   |
| #6 = 1982 mean F                | #6     | .05    | .01    | .01  | .33  | .01  | +    | +     | +    | +    | +      | +    | +      | +      | +      | +         | +   |
| #7 = Commercial CFUE numbers    | #7     | .39    | .11    | .05  | .23  | .81  | .49  | +     | +    | +    | +      | +    | +      | +      | +      | +         | +   |
| #8 = RV CFUE numbers in LWK     | #8     | .97    | .61    | .70  | .57  | .67  | .45  | +     | +    | +    | +      | +    | +      | +      | +      | +         | +   |
| #9 = RV CFUE numbers in SMGL    | #9     | .56    | .32    | .48  | .86  | .20  | .20  | .50   | +    | +    | +      | +    | +      | +      | +      | +         | +   |
| #10 = RV CFUE for night tows    | #10    | .78    | .42    | .70  | .53  | .44  | .73  | .75   | .80  | .45  | +      | +    | +      | +      | +      | +         | +   |
| #11 = RV numbers for night tows | #11    | .79    | .43    | .74  | .42  | .43  | .77  | .68   | .82  | .21  | +      | +    | +      | +      | +      | +         | +   |
| #12 = RV CFUE for day tows      | #12    | .88    | .39    | .58  | .49  | .01  | .32  | .08   | .56  | .46  | 42     | +    | +      | +      | +      | +         | +   |
| #13 = RV numbers for day tows   | #13    | .94    | .80    | .65  | .38  | .01  | .42  | .14   | .88  | .46  | .61    | .58  | +      | +      | +      | +         | +   |
| #14 = RV number at age 1        | #14    | .94    | .36    | .93  | .56  | .80  | .62  | .92   | .49  | .82  | .84    | .61  | .71    | +      | +      | +         | +   |
| #15 = RV number at age 2        | #15    | .91    | .50    | .86  | .45  | .57  | .45  | .77   | .72  | .78  | .79    | .90  | +      | +      | +      | +         | +   |
| #16 = VPA number at age 1       | #16    | .02    | .01    | .05  | .05  | .03  | .03  | .03   | .19  | .33  | .22    | .17  | .32    | .15    | .48    | .27       | .48 |
| #17 = VPA number at age 2       | #17    | .37    | -.34   | .66  | .35  | .66  | .66  | .66   | .69  | .49  | .35    | .69  | .67    | .49    | .35    | .66       | .69 |

Table 11. Summary results of 2+ fishable population, biomass vs standardized CPUE.

| TERM/HFL   | 0.01                 | 0.03      | 0.05      | 0.10      | 0.15     | 0.20      | 0.25     | 0.30     | 0.35     | 0.40     | 0.45    | 0.50      | 0.60      | 0.70      | 0.80      | 0.90   |
|------------|----------------------|-----------|-----------|-----------|----------|-----------|----------|----------|----------|----------|---------|-----------|-----------|-----------|-----------|--------|
| YEARS      | 1981                 | 1981      | 1981      | 1981      | 1981     | 1981      | 1981     | 1981     | 1981     | 1981     | 1981    | 1981      | 1981      | 1981      | 1981      | 1981   |
| OBSERVED   | 4291570              | 1458113   | 997411    | 463369    | 324687   | 253853    | 211364   | 183052   | 162444   | 147703   | 135912  | 125548    | 112498    | 102513    | 95071     | 89726  |
| PREDICTED  | 1826931              | 682635    | 455544    | 285150    | 224071   | 195319    | 178057   | 165546   | 159225   | 152163   | 147334  | 145518    | 137524    | 133755    | 130722    | 128880 |
| DIFFERENCE | 2464439              | 775478    | 437867    | 194859    | 100416   | 58533     | 33307    | 16506    | 4519     | -4460    | -11432  | -17000    | -25226    | -31242    | -35651    | -39554 |
| TERM F     | 0.009                | 0.026     | 0.043     | 0.082     | 0.118    | 0.151     | 0.180    | 0.208    | 0.234    | 0.257    | 0.279   | 0.300     | 0.336     | 0.369     | 0.397     | 0.422  |
| EFFORT     | 28261                | 28261     | 28261     | 28261     | 28261    | 28261     | 28261    | 28261    | 28261    | 28261    | 28261   | 28261     | 28261     | 28261     | 28261     | 28261  |
| STD CPUE   | 1.451                | 1.451     | 1.451     | 1.451     | 1.451    | 1.451     | 1.451    | 1.451    | 1.451    | 1.451    | 1.451   | 1.451     | 1.451     | 1.451     | 1.451     | 1.451  |
| Rx2        | 0.318                | 0.382     | 0.239     | 0.101     | 0.003    | 0.039     | 0.135    | 0.218    | 0.275    | 0.312    | 0.338   | 0.356     | 0.380     | 0.394     | 0.403     | 0.409  |
| R          | 0.564                | 0.531     | 0.489     | 0.318     | 0.058    | 0.198     | 0.359    | 0.467    | 0.524    | 0.559    | 0.581   | 0.597     | 0.616     | 0.627     | 0.635     | 0.640  |
| INTERCEPT  | 4926181.731576386.59 | 901127.28 | 463458.07 | 338293.73 | 15475.72 | 104597.15 | 71194.77 | 47352.99 | 29489.55 | 15613.71 | 4531.42 | -12945.05 | -23320.28 | -32595.57 | -39368.35 |        |

Table 12. Summary results of 2+ population biomass against CPUE for 4VW silver hake.

| TERM/HFL   | 0.01                           | 0.03      | 0.05      | 0.10      | 0.15      | 0.20     | 0.25     | 0.30     | 0.35     | 0.40      | 0.45      | 0.50      | 0.60      | 0.70      | 0.80   | 0.90   |  |
|------------|--------------------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|--------|--------|--|
| YEARS      | 1981                           | 1981      | 1981      | 1981      | 1981      | 1981     | 1981     | 1981     | 1981     | 1981      | 1981      | 1981      | 1981      | 1981      | 1981   | 1981   |  |
| OBSERVED   | 6456415                        | 2206109   | 1355692   | 717981    | 505512    | 399357   | 335730   | 293348   | 243159   | 240546    | 222997    | 208994    | 198079    | 173243    | 162205 | 155700 |  |
| PREDICTED  | 2835548                        | 1058711   | 702185    | 4345211   | 345211    | 300536   | 273734   | 255875   | 245130   | 235584    | 226711    | 202023    | 211407    | 205127    | 200452 | 195847 |  |
| DIFFERENCE | 3618867                        | 1147398   | 653507    | 283458    | 160301    | 98821    | 61996    | 37493    | 20029    | 6962      | -3174     | -11259    | -23328    | -31885    | -38247 | -43147 |  |
| TERM F     | 0.009                          | 0.026     | 0.043     | 0.082     | 0.118     | 0.151    | 0.180    | 0.208    | 0.234    | 0.257     | 0.279     | 0.300     | 0.336     | 0.369     | 0.397  | 0.422  |  |
| EFFORT     | 28261                          | 28261     | 28261     | 28261     | 28261     | 28261    | 28261    | 28261    | 28261    | 28261     | 28261     | 28261     | 28261     | 28261     | 28261  | 28261  |  |
| STD CPUE   | 1.451                          | 1.451     | 1.451     | 1.451     | 1.451     | 1.451    | 1.451    | 1.451    | 1.451    | 1.451     | 1.451     | 1.451     | 1.451     | 1.451     | 1.451  | 1.451  |  |
| Rx2        | 0.296                          | 0.248     | 0.194     | 0.056     | 0.001     | 0.086    | 0.219    | 0.327    | 0.399    | 0.446     | 0.478     | 0.500     | 0.526     | 0.542     | 0.551  | 0.557  |  |
| R          | 0.544                          | 0.498     | 0.441     | 0.237     | 0.036     | 0.293    | 0.468    | 0.571    | 0.632    | 0.668     | 0.691     | 0.707     | 0.726     | 0.736     | 0.742  | 0.746  |  |
| INTERCEPT  | 7524900,412384897,471357322,46 | 586904,21 | 330228,03 | 201969,88 | 125078,59 | 73876,08 | 37353,98 | 10008,97 | 11216,68 | -28157,82 | -53468,05 | -71430,86 | -84798,37 | -95102,87 |        |        |  |

TABLE 13 : POPULATION NUMBERS ('000) FOR 4VWX SILVER HAKE

|      | 1970    | 1971    | 1972    | 1973    | 1974    | 1975    | 1976    | 1977    | 1978    | 1979    | 1980    | 1981    | 1982    |
|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1 +  | 1727406 | 1692930 | 3830813 | 1435620 | 1374844 | 1528061 | 936714  | 813914  | 1111136 | 1203581 | 575274  | 563913  | 1347187 |
| 2 +  | 1782053 | 1007634 | 957204  | 2260678 | 764259  | 839538  | 906873  | 503835  | 543850  | 721413  | 798925  | 390520  | 376739  |
| 3 +  | 518552  | 599761  | 349009  | 277132  | 366014  | 204408  | 272396  | 304452  | 302526  | 291012  | 444372  | 486427  | 239220  |
| 4 +  | 174997  | 175614  | 261703  | 176310  | 108665  | 125417  | 94608   | 124437  | 141229  | 130617  | 139526  | 231725  | 236568  |
| 5 +  | 70380   | 82777   | 58303   | 136785  | 35000   | 67098   | 36008   | 39393   | 59640   | 60190   | 50381   | 64693   | 124221  |
| 6 +  | 24698   | 30585   | 37792   | 24803   | 17111   | 15606   | 14680   | 19628   | 20099   | 24366   | 16901   | 21517   | 31879   |
| 7 +  | 12462   | 8878    | 18979   | 19326   | 1727    | 8953    | 6617    | 7687    | 11534   | 6624    | 3222    | 6398    | 9966    |
| 8 +  | 31660   | 5460    | 1921    | 11781   | 1424    | 1082    | 5682    | 4019    | 4761    | 5137    | 562     | 933     | 3739    |
| 9 +  | 10685   | 12909   | 2588    | 936     | 3571    | 866     | 435     | 3723    | 2238    | 1589    | 2032    | 108     | 452     |
| 10 + | 1846    | 6260    | 4988    | 1247    | 246     | 2345    | 294     | 6       | 2074    | 1161    | 179     | 1289    | 25      |
| 1 +  | 4366738 | 3622806 | 5525299 | 4344616 | 2672842 | 2793292 | 2274307 | 1820184 | 2199086 | 2445690 | 2031376 | 1757424 | 2369995 |
| 2 +  | 2637332 | 1929876 | 1694486 | 2908996 | 1298018 | 1265231 | 1337593 | 1006270 | 1087950 | 1242109 | 1456100 | 1193511 | 1022808 |
| 3 +  | 855279  | 922243  | 737282  | 648319  | 533758  | 425663  | 430720  | 502335  | 544100  | 520696  | 637175  | 812991  | 646070  |
| 4 +  | 336728  | 322462  | 388273  | 371167  | 167744  | 221255  | 158324  | 197883  | 241574  | 229684  | 212803  | 326564  | 403850  |
| 5 +  | 141731  | 146663  | 126570  | 194877  | 59079   | 95839   | 63716   | 73446   | 100345  | 99067   | 73278   | 94839   | 170282  |

TABLE 14 : FISHING MORTALITIES FOR 4VWX SILVER HAKE

|      | 1970  | 1971  | 1972  | 1973  | 1974  | 1975  | 1976  | 1977  | 1978  | 1979  | 1980  | 1981  | 1982  |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1 +  | 0.140 | 0.170 | 0.127 | 0.230 | 0.093 | 0.122 | 0.220 | 0.003 | 0.032 | 0.010 | 0.013 | 0.003 | 0.018 |
| 2 +  | 0.499 | 0.460 | 0.840 | 1.421 | 0.919 | 0.726 | 0.691 | 0.110 | 0.225 | 0.085 | 0.096 | 0.064 | 0.178 |
| 3 +  | 0.683 | 0.429 | 0.293 | 0.536 | 0.671 | 0.370 | 0.383 | 0.358 | 0.440 | 0.335 | 0.251 | 0.321 | 0.400 |
| 4 +  | 0.457 | 0.703 | 0.249 | 1.217 | 0.082 | 0.848 | 0.502 | 0.335 | 0.453 | 0.553 | 0.369 | 0.223 | 0.400 |
| 5 +  | 0.433 | 0.384 | 0.455 | 1.679 | 0.408 | 1.119 | 0.207 | 0.247 | 0.495 | 0.870 | 0.451 | 0.308 | 0.400 |
| 6 +  | 0.623 | 0.077 | 0.271 | 2.264 | 0.259 | 0.458 | 0.247 | 0.132 | 0.710 | 1.623 | 0.571 | 0.370 | 0.400 |
| 7 +  | 0.425 | 1.131 | 0.077 | 2.208 | 0.067 | 0.043 | 0.099 | 0.079 | 0.409 | 2.067 | 0.952 | 0.137 | 0.400 |
| 8 +  | 0.118 | 0.346 | 0.319 | 0.793 | 0.097 | 0.511 | 0.023 | 0.185 | 0.687 | 0.527 | 1.246 | 0.212 | 0.400 |
| 9 +  | 0.135 | 0.214 | 0.331 | 0.935 | 0.021 | 0.680 | 3.940 | 0.185 | 0.257 | 1.782 | 0.055 | 1.078 | 0.400 |
| 10 + | 0.577 | 0.451 | 0.419 | 1.423 | 0.468 | 0.704 | 0.406 | 0.238 | 0.465 | 0.693 | 0.348 | 0.257 | 0.400 |
|      | 0.451 | 0.383 | 0.271 | 0.977 | 0.413 | 0.380 | 0.439 | 0.124 | 0.186 | 0.145 | 0.140 | 0.150 | 0.147 |

TABLE 15A : R/V SURVEYS PERCENT-AT-AGE FOR 4VWX SILVER HAKE,

|    | 1972  | 1973  | 1974  | 1975  | 1976  | 1977  | 1978  | 1979  | 1980  | 1981  | 1982  |
|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1  | 31.84 | 30.28 | 20.51 | 43.95 | 23.33 | 11.29 | 29.84 | 24.81 | 17.12 | 9.54  | 28.35 |
| 2  | 52.46 | 57.24 | 66.03 | 41.78 | 66.10 | 43.45 | 27.57 | 42.18 | 26.11 | 25.58 | 44.56 |
| 3  | 7.79  | 3.89  | 9.40  | 6.64  | 6.09  | 31.66 | 18.39 | 20.35 | 34.21 | 39.92 | 12.61 |
| 4  | 4.20  | 3.23  | 1.17  | 3.73  | 2.77  | 6.47  | 9.84  | 5.59  | 9.81  | 17.09 | 9.36  |
| 5  | 1.81  | 3.01  | 1.16  | 1.92  | 0.82  | 2.23  | 7.69  | 3.99  | 5.04  | 4.92  | 2.21  |
| 6  | 1.04  | 1.39  | 1.32  | 1.11  | 0.47  | 2.09  | 3.26  | 1.59  | 3.70  | 1.56  | 1.16  |
| 7  | 0.16  | 0.48  | 0.24  | 0.32  | 0.13  | 1.32  | 1.34  | 0.87  | 1.78  | 0.86  | 0.71  |
| 8  | 0.38  | 0.30  | 0.14  | 0.51  | 0.18  | 0.52  | 0.52  | 0.28  | 1.03  | 0.25  | 0.97  |
| 9  | 0.07  | 0.03  | 0.00  | 0.05  | 0.12  | 0.44  | 1.05  | 0.06  | 0.44  | 0.15  | 0.05  |
| 10 | 0.26  | 0.15  | 0.01  | 0.00  | 0.00  | 0.54  | 0.49  | 0.28  | 0.77  | 0.13  | 0.03  |

TABLE 15B: VPA PERCENT-AT-AGE FOR 4VWX SILVER HAKE,

|    | 1970  | 1971  | 1972  | 1973  | 1974  | 1975  | 1976  | 1977  | 1978  | 1979  | 1980  | 1981  | 1982  |
|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1  | 39.60 | 46.73 | 69.33 | 33.04 | 51.44 | 54.70 | 41.19 | 44.72 | 50.53 | 49.21 | 28.32 | 32.09 | 56.84 |
| 2  | 40.81 | 27.81 | 17.32 | 52.03 | 28.59 | 30.06 | 39.87 | 27.69 | 24.73 | 29.50 | 39.33 | 21.65 | 15.90 |
| 3  | 11.88 | 16.56 | 6.32  | 6.38  | 13.69 | 7.32  | 11.98 | 16.73 | 13.76 | 11.90 | 21.88 | 27.68 | 10.09 |
| 4  | 4.47  | 4.85  | 4.74  | 4.06  | 4.07  | 4.49  | 4.16  | 6.84  | 6.42  | 5.34  | 6.87  | 13.19 | 9.98  |
| 5  | 1.61  | 2.28  | 1.06  | 3.15  | 1.31  | 2.40  | 1.58  | 2.11  | 2.71  | 2.46  | 2.48  | 3.68  | 5.24  |
| 6  | 0.57  | 0.84  | 0.68  | 0.57  | 0.64  | 0.56  | 0.65  | 1.08  | 0.91  | 1.00  | 0.83  | 1.22  | 1.35  |
| 7  | 0.29  | 0.25  | 0.34  | 0.44  | 0.06  | 0.32  | 0.29  | 0.42  | 0.52  | 0.27  | 0.16  | 0.36  | 0.42  |
| 8  | 0.50  | 0.15  | 0.03  | 0.27  | 0.05  | 0.04  | 0.25  | 0.22  | 0.22  | 0.21  | 0.03  | 0.05  | 0.16  |
| 9  | 0.24  | 0.36  | 0.05  | 0.02  | 0.13  | 0.03  | 0.02  | 0.20  | 0.10  | 0.06  | 0.10  | 0.01  | 0.02  |
| 10 | 0.04  | 0.17  | 0.13  | 0.03  | 0.01  | 0.08  | 0.01  | 0.00  | 0.09  | 0.05  | 0.01  | 0.07  | 0.00  |

TABLE 15C : REMOVALS PERCENT-AT-AGE FOR 4VWX SILVER HAKE,

|    | 1970  | 1971  | 1972  | 1973  | 1974  | 1975  | 1976  | 1977  | 1978  | 1979  | 1980  | 1981  | 1982  |
|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1  | 14.99 | 24.03 | 38.36 | 11.88 | 15.27 | 21.65 | 23.68 | 1.30  | 10.02 | 4.23  | 3.01  | 0.81  | 7.31  |
| 2  | 59.88 | 44.88 | 46.58 | 71.60 | 58.88 | 54.61 | 58.87 | 26.54 | 31.70 | 21.14 | 29.07 | 10.19 | 20.49 |
| 3  | 17.31 | 19.15 | 7.23  | 4.67  | 22.76 | 7.88  | 11.17 | 47.70 | 31.33 | 30.19 | 39.36 | 57.79 | 26.55 |
| 4  | 4.79  | 8.18  | 4.84  | 5.15  | 1.07  | 9.07  | 4.83  | 18.02 | 14.97 | 20.35 | 17.22 | 20.10 | 26.25 |
| 5  | 1.66  | 2.41  | 1.80  | 4.68  | 1.48  | 5.77  | 0.86  | 4.26  | 6.79  | 12.97 | 7.34  | 7.44  | 13.79 |
| 6  | 0.77  | 0.21  | 0.75  | 0.95  | 0.49  | 0.72  | 0.41  | 1.22  | 3.00  | 7.42  | 2.97  | 2.89  | 3.54  |
| 7  | 0.29  | 0.56  | 0.12  | 0.73  | 0.01  | 0.05  | 0.08  | 0.29  | 1.13  | 2.22  | 0.81  | 0.35  | 1.11  |
| 8  | 0.16  | 0.15  | 0.04  | 0.26  | 0.02  | 0.05  | 0.02  | 0.34  | 0.70  | 0.77  | 0.16  | 0.07  | 0.41  |
| 9  | 0.09  | 0.23  | 0.06  | 0.02  | 0.01  | 0.05  | 0.06  | 0.32  | 0.15  | 0.50  | 0.04  | 0.03  | 0.05  |
| 10 | 0.05  | 0.21  | 0.20  | 0.04  | 0.01  | 0.15  | 0.01  | 0.00  | 0.22  | 0.21  | 0.02  | 0.13  | 0.00  |

TABLE 16: YIELD PER RECRUIT OF SILVER HAKE IN NAFO DIVISIONS 4VWX

| FISHING<br>MORTALITY | CATCH<br>(NUMBER) | YIELD<br>(KG) | AVG. WEIGHT<br>(KG) | YIELD PER<br>UNIT EFFORT |
|----------------------|-------------------|---------------|---------------------|--------------------------|
|                      | 0.200             | 0.18941       | 0.046               | 0.245                    |
|                      | 0.400             | 0.28800       | 0.061               | 0.211                    |
| F0.1---              | 0.406             | 0.29022       | 0.061               | 0.210                    |
|                      | 0.600             | 0.34960       | 0.067               | 0.192                    |
|                      | 0.800             | 0.39262       | 0.071               | 0.180                    |
|                      | 1.000             | 0.42490       | 0.073               | 0.171                    |
|                      | 1.200             | 0.45038       | 0.074               | 0.164                    |
|                      | 1.400             | 0.47126       | 0.075               | 0.159                    |
|                      | 1.600             | 0.49883       | 0.075               | 0.154                    |
|                      | 1.800             | 0.50396       | 0.076               | 0.150                    |
|                      | 2.000             | 0.51721       | 0.076               | 0.147                    |
|                      | 2.200             | 0.52897       | 0.076               | 0.144                    |
|                      | 2.400             | 0.53954       | 0.076               | 0.141                    |
|                      | 2.500             | 0.54911       | 0.076               | 0.139                    |
| FMAX---              | 2.627             | 0.55032       | 0.076               | 0.138                    |
|                      | 2.800             | 0.55786       | 0.076               | 0.137                    |
|                      | 3.000             | 0.56591       | 0.076               | 0.135                    |
|                      | 3.200             | 0.57335       | 0.076               | 0.133                    |
|                      | 3.400             | 0.58028       | 0.076               | 0.131                    |
|                      | 3.600             | 0.58875       | 0.076               | 0.129                    |
|                      | 3.800             | 0.59282       | 0.076               | 0.128                    |
|                      | 4.000             | 0.59853       | 0.076               | 0.126                    |

TABLE 17 : PROJECTIONS OF SILVER HAKE CATCHES (T) IN NAFO DIVISIONS 4UWX

| AGE     | 1       | 2      | 3      | 4      | 5      | 6     | 7     | 8     | 9     | 10    |
|---------|---------|--------|--------|--------|--------|-------|-------|-------|-------|-------|
| MATAGE  | 1347187 | 376739 | 239220 | 233568 | 124221 | 31879 | 9966  | 3739  | 452   | 25    |
| CATCH   | 19383   | 50825  | 65866  | 65136  | 34202  | 8778  | 2744  | 1029  | 124   | 7     |
| MATAGE  | 0.051   | 0.140  | 0.202  | 0.263  | 0.322  | 0.387 | 0.522 | 0.638 | 0.844 | 0.923 |
| FARREC  | 0.044   | 0.444  | 1.000  | 1.000  | 1.000  | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| RECRUIT | 1222920 |        |        |        |        |       |       |       |       |       |
| LOGREC  | 14.0168 |        |        |        |        |       |       |       |       |       |
| STDREC  | 19.8291 |        |        |        |        |       |       |       |       |       |

| YEAR | POP     | POP     | CATCH   | CATCH   | MATURE |
|------|---------|---------|---------|---------|--------|
|      | NUMBERS | BIOMASS | NUMBERS | BIOMASS | F      |

|      |         |        |        |          |        |
|------|---------|--------|--------|----------|--------|
| 1982 | 2369995 | 292321 | 248094 | 55193.39 | 0.4000 |
| 1983 | 2611940 | 325563 | 279060 | 56643.94 | 0.4060 |
| 1984 | 2743816 | 353775 | 328863 | 66143.57 | 0.4060 |

1

| YEAR | POP     | POP     | CATCH   | CATCH   | MATURE |
|------|---------|---------|---------|---------|--------|
|      | NUMBERS | BIOMASS | NUMBERS | BIOMASS | F      |

|      |         |        |        |          |        |
|------|---------|--------|--------|----------|--------|
| 1982 | 2369995 | 292321 | 248094 | 55193.39 | 0.4000 |
| 1983 | 2611940 | 325563 | 398332 | 80000.16 | 0.6173 |
| 1984 | 2654212 | 329845 | 303551 | 59343.35 | 0.4060 |

2

| YEAR | POP     | POP     | CATCH   | CATCH   | MATURE |
|------|---------|---------|---------|---------|--------|
|      | NUMBERS | BIOMASS | NUMBERS | BIOMASS | F      |

3

|      |         |        |        |          |        |
|------|---------|--------|--------|----------|--------|
| 1982 | 2369995 | 292321 | 248094 | 55193.39 | 0.4000 |
| 1983 | 2611940 | 325563 | 296023 | 60000.14 | 0.4344 |
| 1984 | 2735303 | 350183 | 325239 | 65162.52 | 0.4060 |

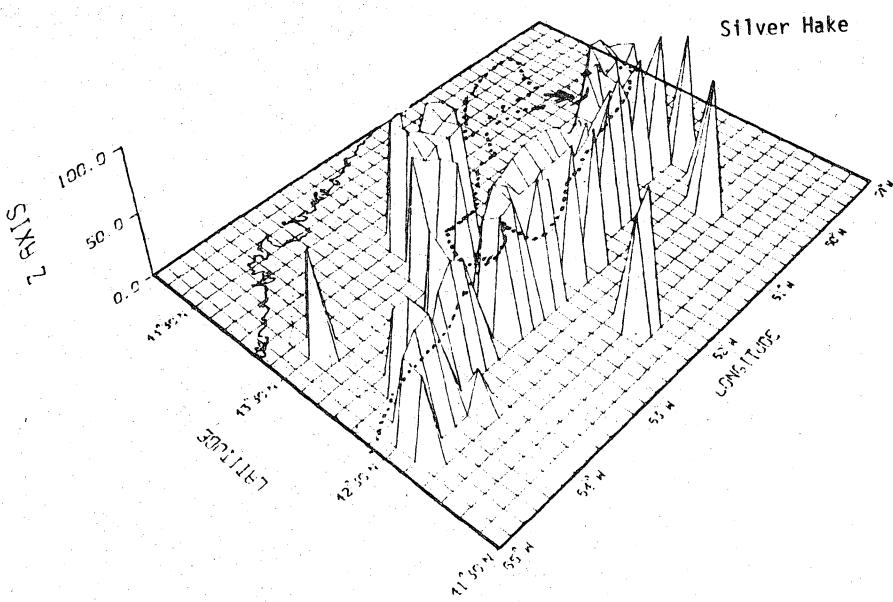


Figure 1. Distribution of silver hake catches on the  
Scotian Shelf. (The arrow indicates Sable Island.)

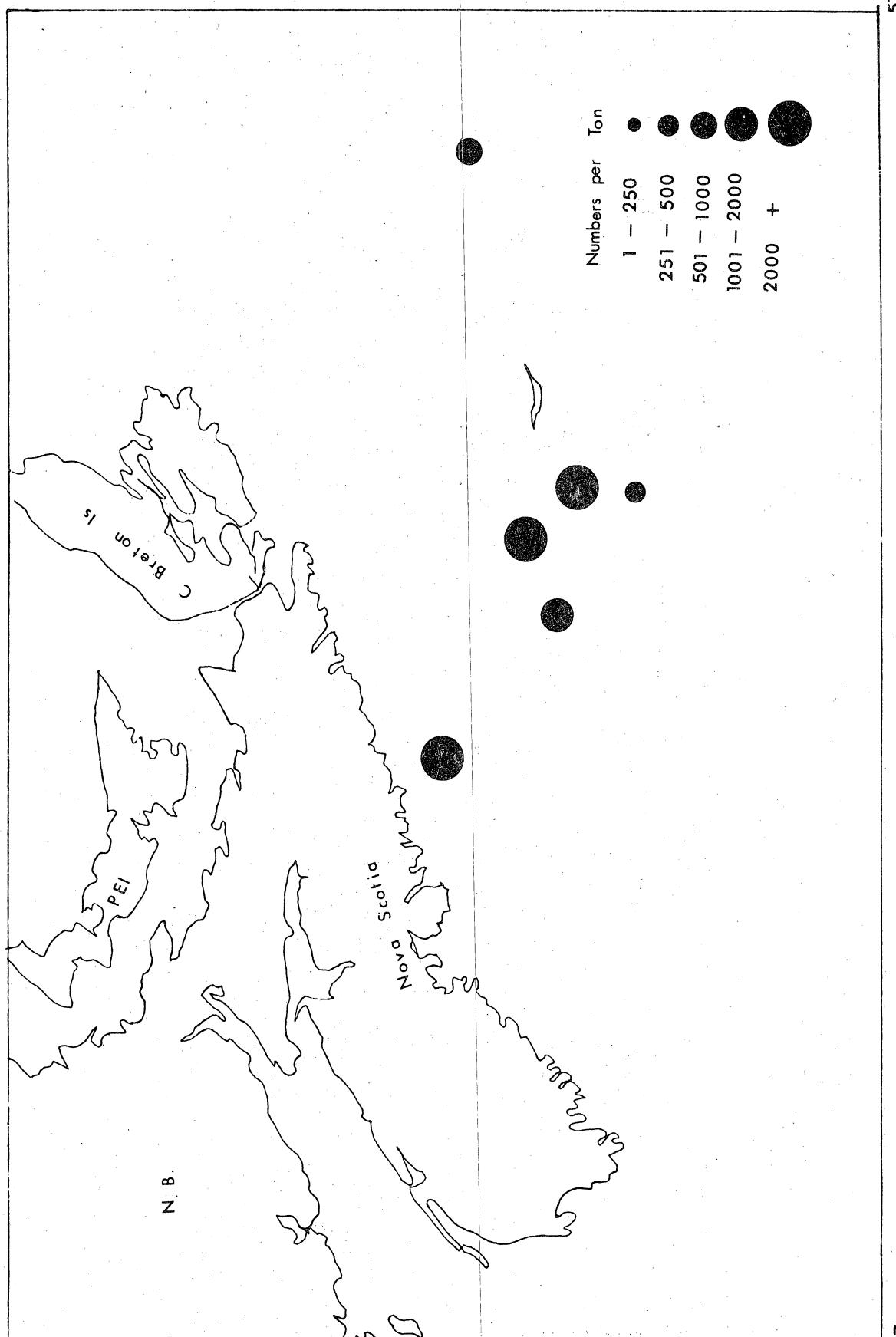


Figure 2. Silver hake egg distributions from the Lady Hammond (Sept.-Oct./1979 Cruises). (O'Boyle, pers. comm.)

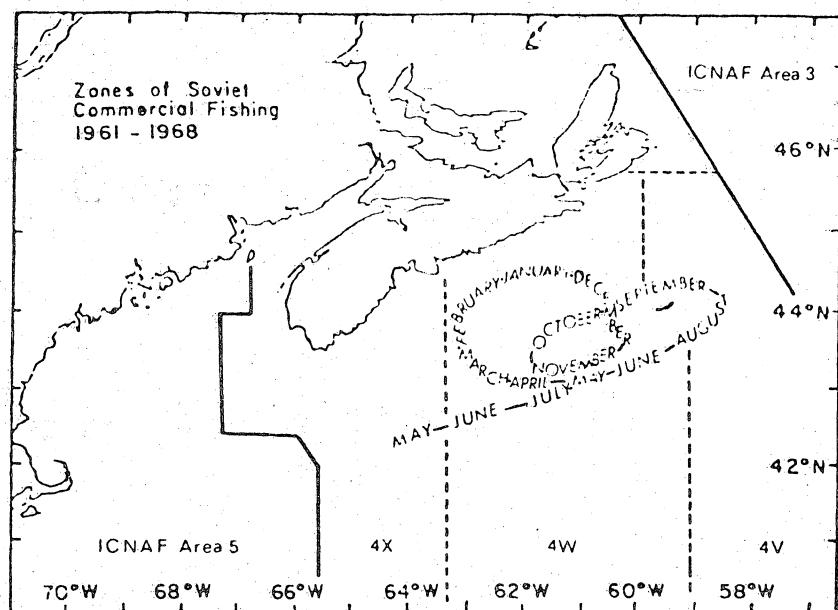


Figure 3. Summary of the annual movements of the Soviet commercial fleet from 1961-1968 in ICNAF Subarea 4. (From Clay 1979).

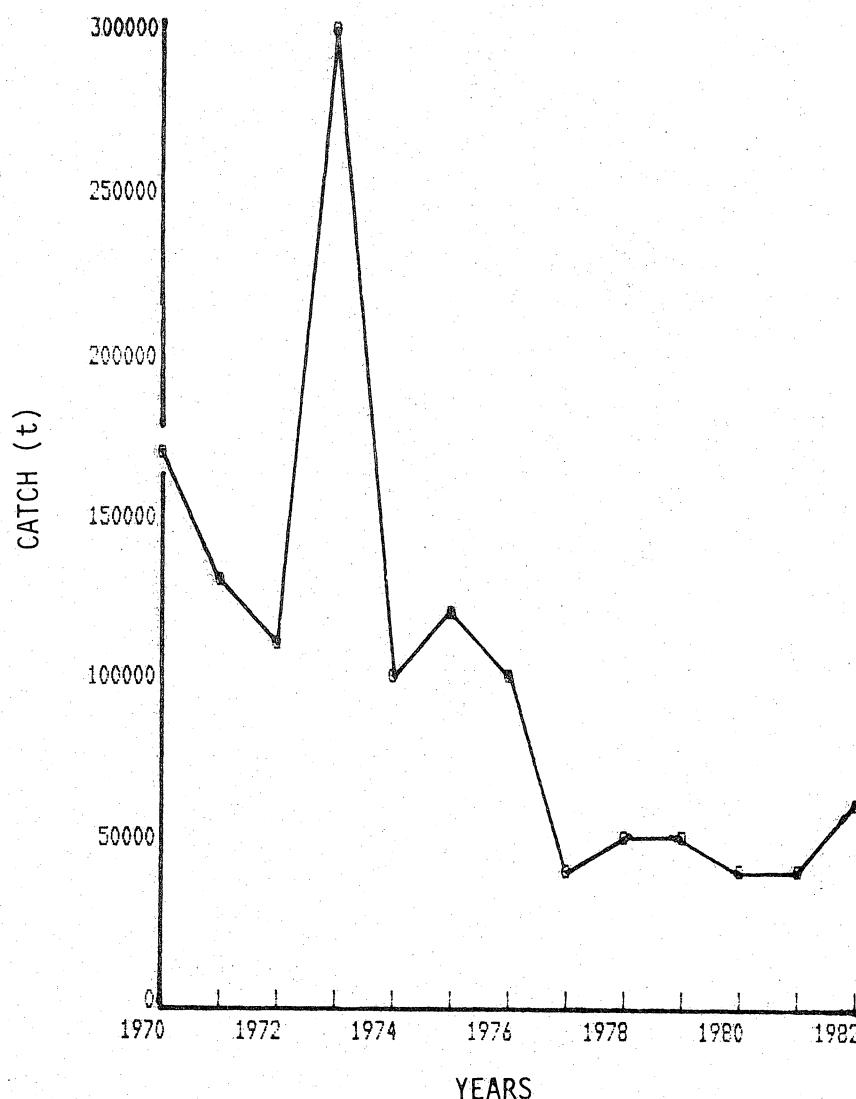


Figure 4. 4VNX silver hake nominal catches.

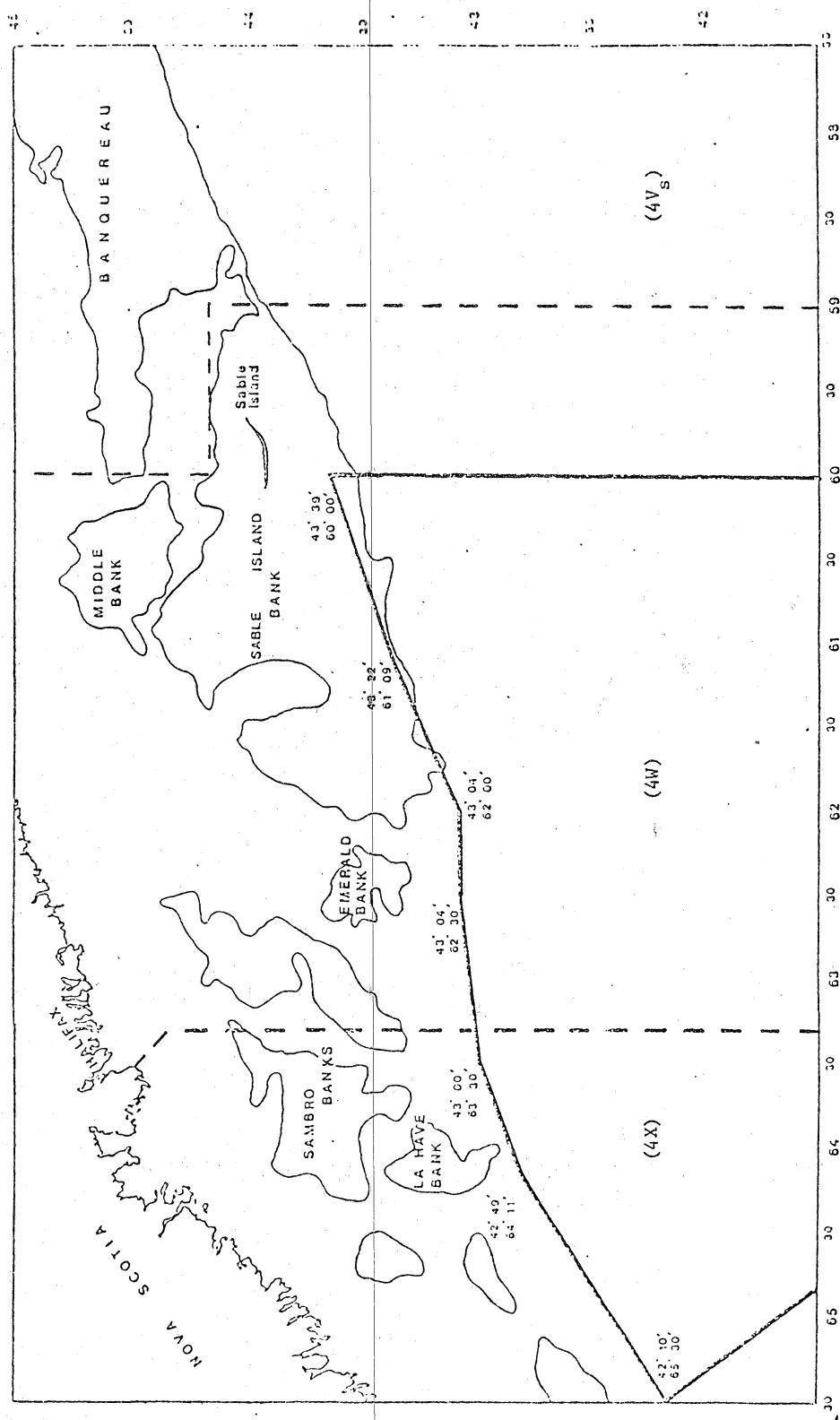


Figure 5: Scotian Shelf small meshed gear line.

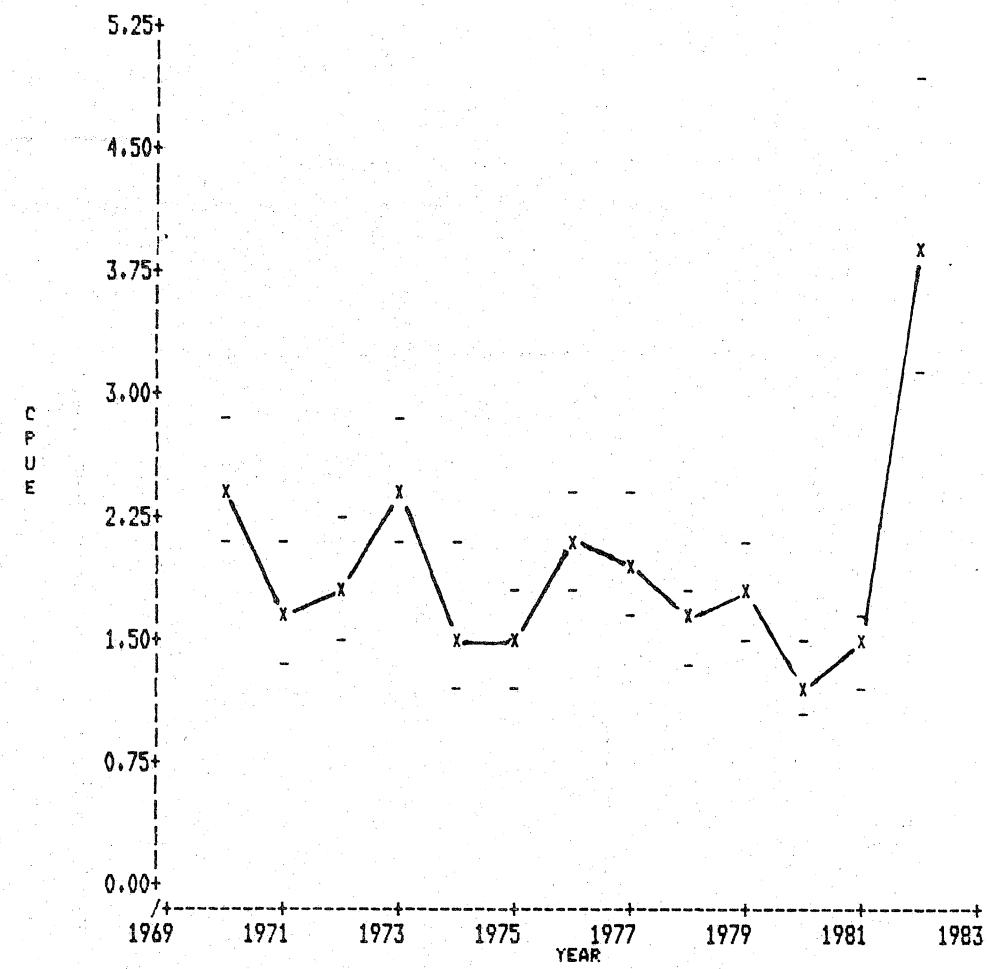


Figure 6. Plot of standardized silver hake catch rates from 1970-1982.

Figure 7. Comparison of population abundance estimators

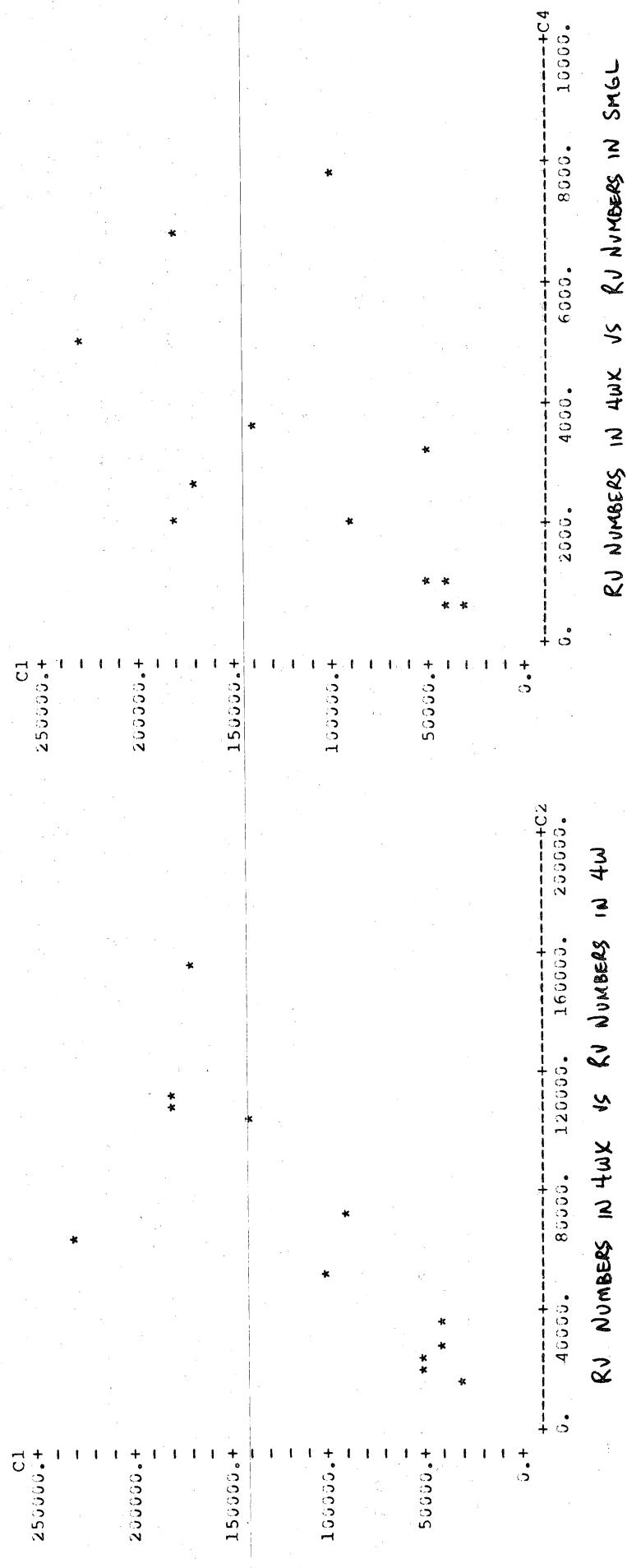


Figure 7. Cont'd.

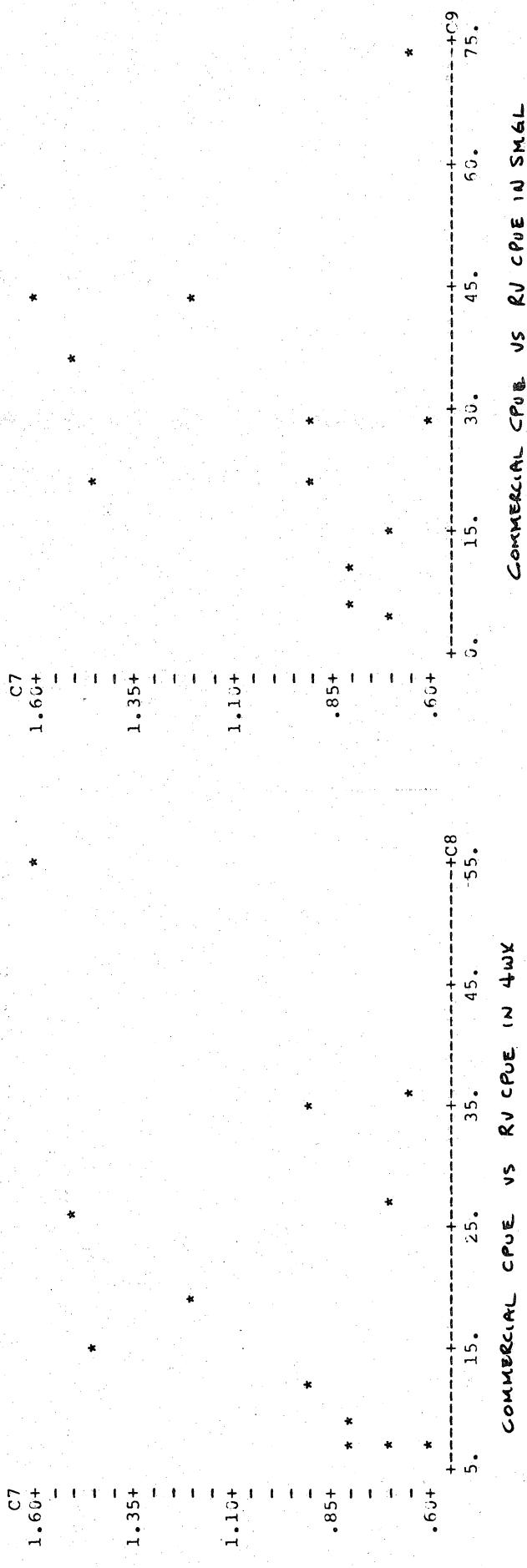


Figure 7. Contd

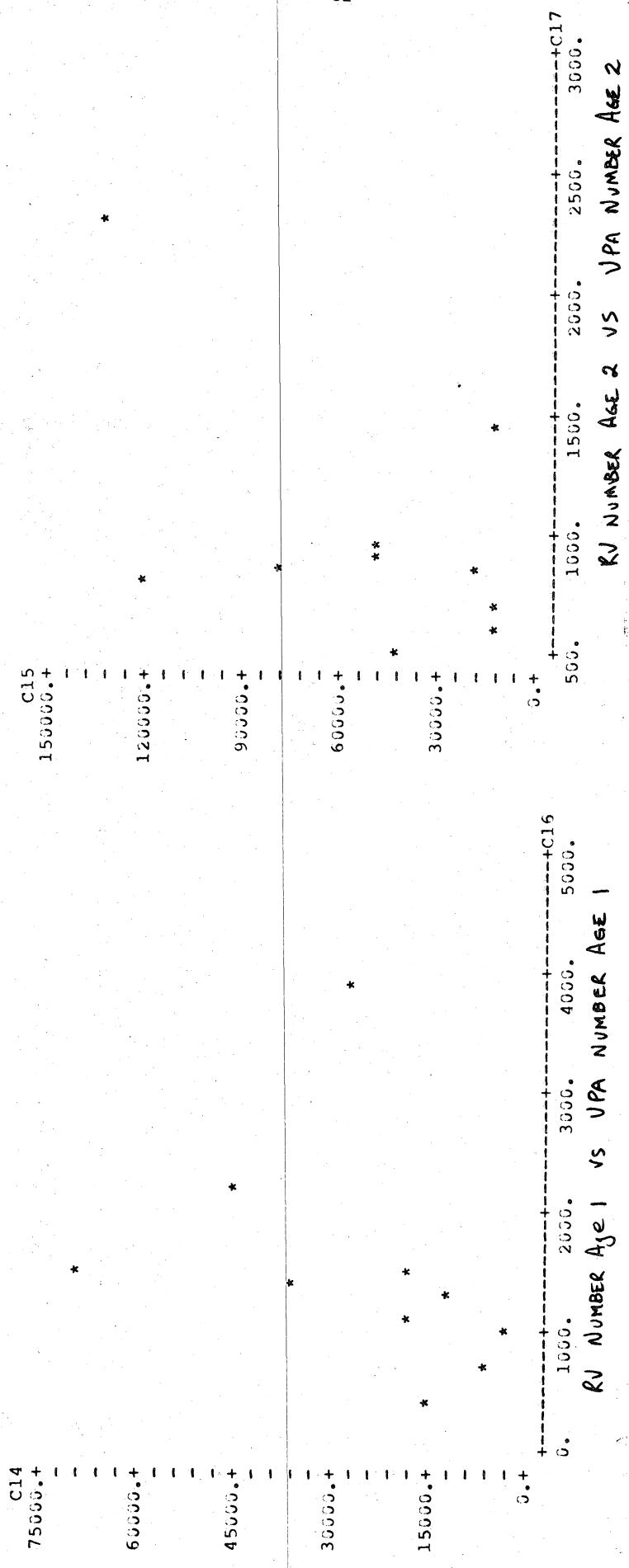


Figure 7. Cont'd

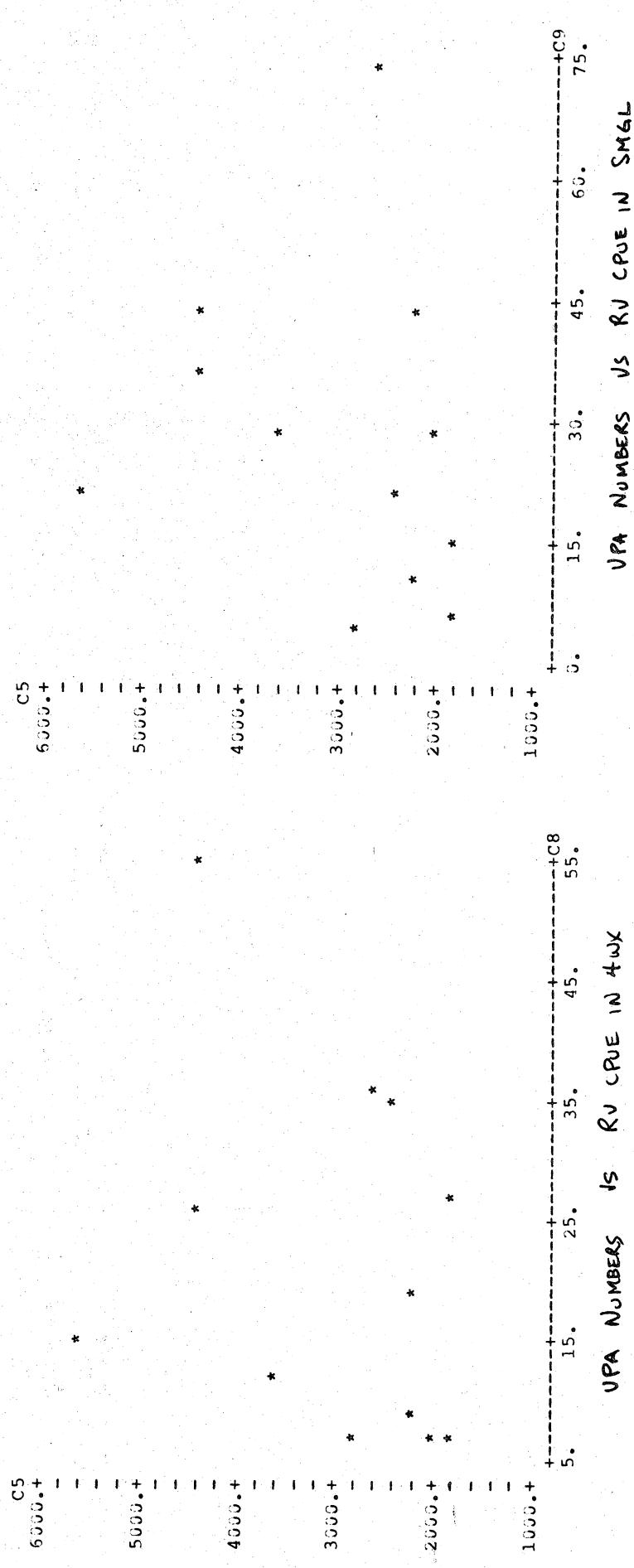
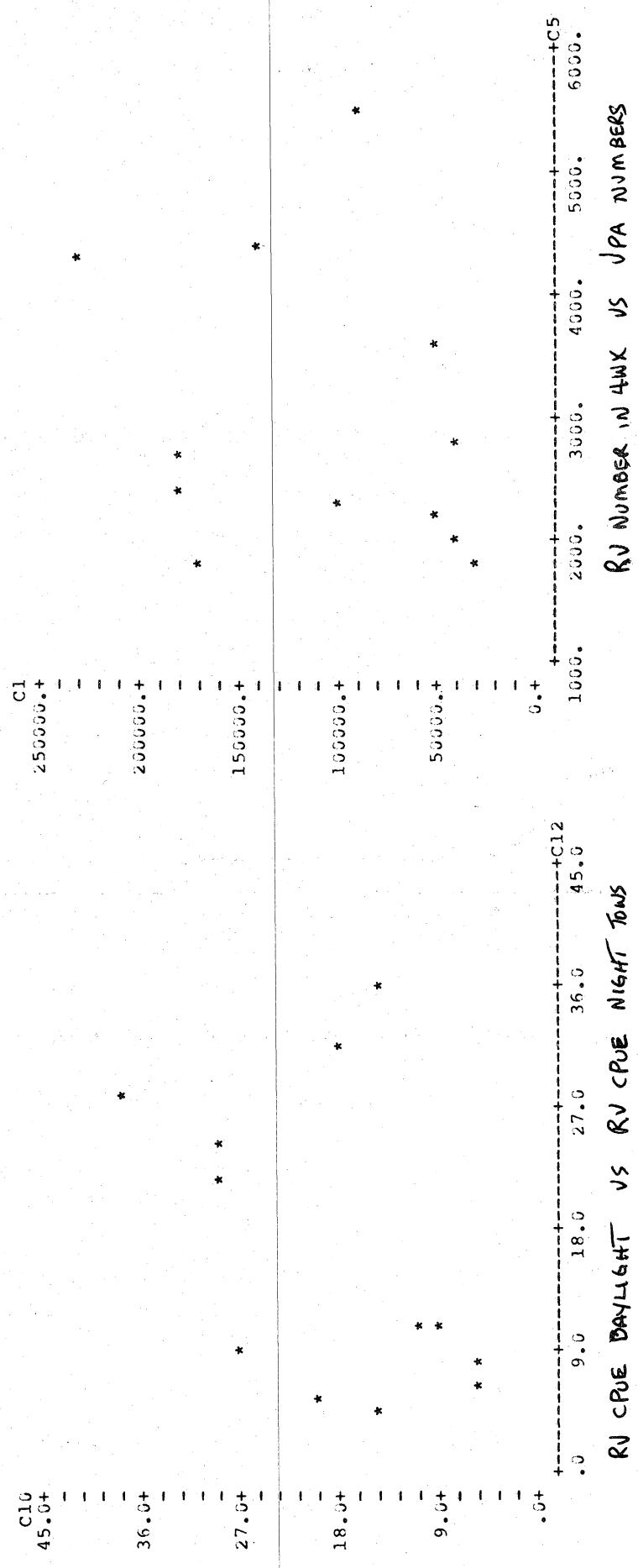


Figure 7. Contd



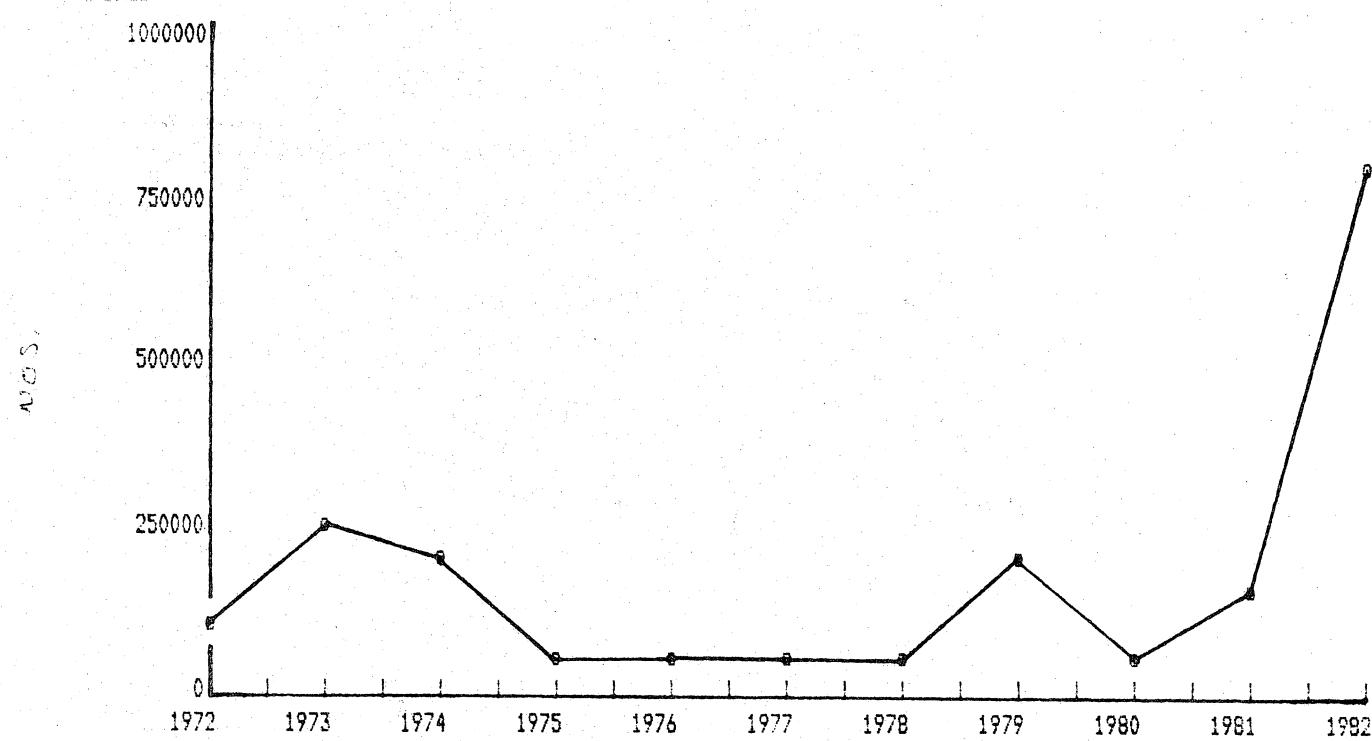


Figure 8. July research vessel numbers ('000) for 4VWX silver hake.

2+ BIOMASS

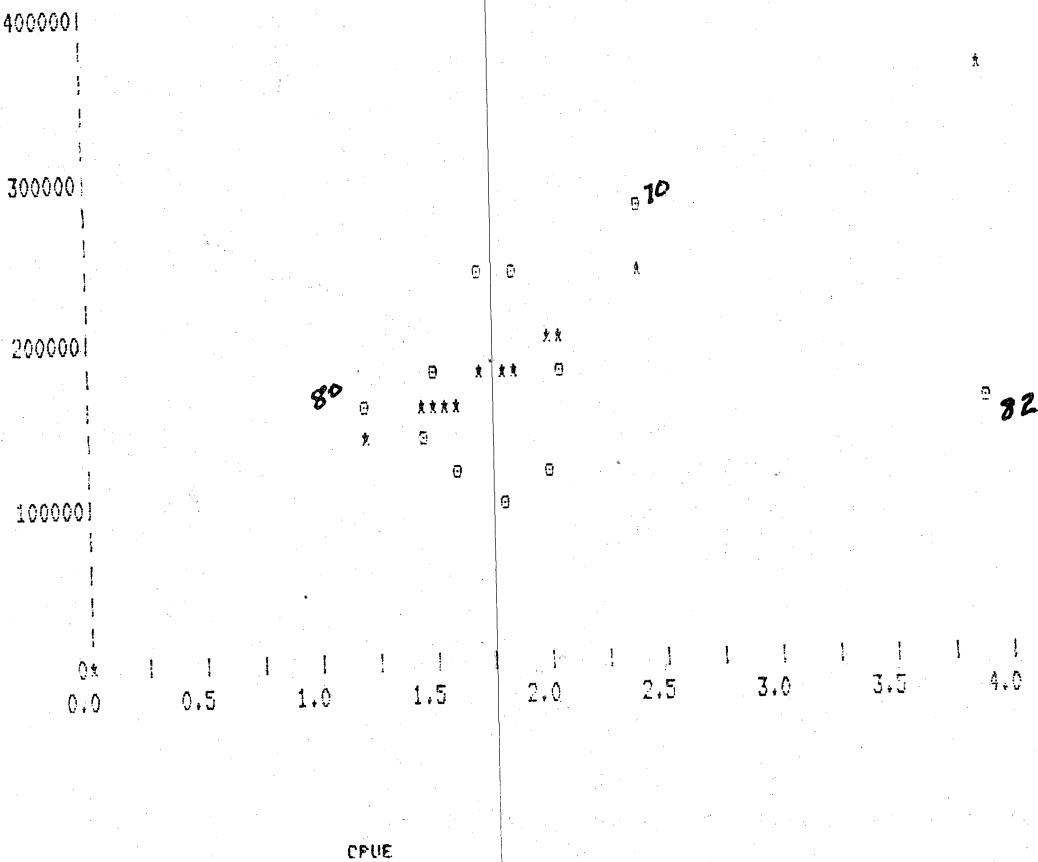


FIGURE 9. 2+ FISHABLE POPULATION BIOMASS AND DIRECTED CPUE FOR THE  
4VWX SILVER HAKE, ( $R = 0.559$ )  
SPANNING THE YEARS 1970 - 1982.

2+ FISHABLE POPULATION BIOMASS AND OBSERVED AND PREDICTED CPUE  
FOR THE 4VWX SILVER HAKE STOCK,  
(THE FOLLOWING YEARS WERE USED IN THE REGRESSION EQUATION)  
YEARS = 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981

| YEAR       | 1970   | 1971   | 1972   | 1973   | 1974   | 1975   | 1976   | 1977   | 1978   | 1979   | 1980   | 1981   | 1982   |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| BIOMASS    | 280259 | 242312 | 236635 | 233832 | 154917 | 176170 | 188750 | 129033 | 112406 | 108599 | 160879 | 147703 | 152804 |
| PRED BIOMS | 233932 | 172792 | 186403 | 232311 | 161378 | 155037 | 201875 | 193902 | 162815 | 183190 | 132887 | 152163 | 357889 |
| DIFFERENCE | 46427  | 69520  | 50232  | 1522   | 76461  | 21133  | 713125 | 767769 | 750410 | 774602 | 27992  | 74460  | 204885 |
| STD. CPUE  | 2.417  | 1.695  | 1.856  | 2.399  | 1.560  | 1.485  | 2.039  | 1.979  | 1.577  | 1.818  | 1.223  | 1.451  | 3.882  |
| PLOT ORDER | 1980   | 1981   | 1975   | 1974   | 1978   | 1971   | 1979   | 1972   | 1977   | 1976   | 1973   | 1970   | 1982   |
| CPUE ORDER | 1.223  | 1.451  | 1.495  | 1.560  | 1.577  | 1.695  | 1.818  | 1.856  | 1.979  | 2.039  | 2.399  | 2.417  | 3.882  |

REGRESSION OF 2+ FISHABLE BIOMASS AGAINST CPUE FOR THE 4VWX SILVER HAKE STOCK,  
(THE DATA USED IN THE REGRESSION INCLUDES THE YEARS AS FOLLOWS)  
YEARS = 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981

REGRESSION COEFFICIENT 84543.97166  
INTERCEPT 29489.55375  
T-VALUE 2.13048614  
STANDARD ERROR 39682.94844  
DEGREES OF FREEDOM 11  
OBSERVATIONS 12  
 $R^2$  0.3121934237  
 $R$  0.5587427169

2+ BIOMASS

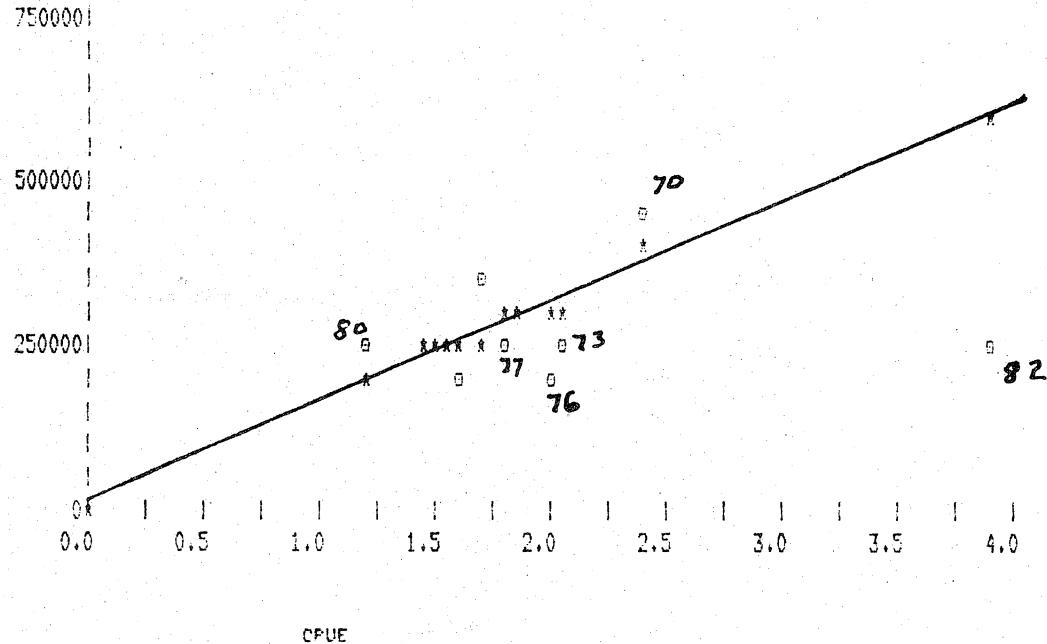


FIGURE 10. 2 + POPULATION BIOMASS AND CPUE FOR THE 4VWX SILVER HAKE STOCK,  
( $R = 0.668$ );  
SPANNING THE YEARS 1970 - 1982;

REGRESSION OF YEARLY 2+ POPBIOMASS AGAINST YEARLY CPUE FOR THE 4VWX SILVER HAKE STOCK,

| YEAR       | 1970   | 1971   | 1972   | 1973   | 1974   | 1975   | 1976   | 1977   | 1978   | 1979   | 1980   | 1981   | 1982    |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| BIOMASS    | 417320 | 348287 | 300577 | 467476 | 233730 | 263685 | 263022 | 212976 | 177769 | 234490 | 272832 | 240546 | 238328  |
| PRED BIOMS | 382428 | 271180 | 295987 | 379354 | 250379 | 238822 | 324184 | 314939 | 252998 | 290132 | 198453 | 233584 | 608160  |
| DIFFERENCE | 34892  | 77108  | 4589   | 87822  | 16649  | 24863  | 51162  | 101963 | 75229  | 55642  | 74409  | 6962   | 3369831 |
| STD. CPUE  | 2.417  | 1.695  | 1.856  | 2.399  | 1.560  | 1.495  | 2.039  | 1.979  | 1.577  | 1.818  | 1.223  | 1.451  | 3.882   |
| PLOT ORDER | 1980   | 1981   | 1975   | 1974   | 1978   | 1971   | 1979   | 1972   | 1977   | 1976   | 1973   | 1970   | 1982    |
| CPUE ORDER | 1.223  | 1.451  | 1.485  | 1.560  | 1.577  | 1.695  | 1.818  | 1.856  | 1.979  | 2.039  | 2.399  | 2.417  | 3.882   |

REGRESSION OF YEARLY 2+ POPBIOMASS AGAINST YEARLY CPUE FOR THE 4VWX SILVER HAKE STOCK,

REGRESSION COEFFICIENT 154083.1158

INTERCEPT 10008.96788

T-VALUE 2.839633541

STANDARD ERROR 54261.6199

DEGREES OF FREEDOM 11

OBSERVATIONS 12

R<sup>2</sup> 0.4463980027

R 0.6681302289