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Status of the Scotian Shelf Silver Hake Population in 1984

by

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INTRODUCTION

The Scotian Shelf silver hake fishery was once conducted over the total shelf. Evaluation of this fishery, in particular its compatibility with the International Commission for the Northwest Atlantic Fisheries (ICNAF) objectives of maximizing silver hake catches while minimizing by-catches, resulted in the establishment of the present day Small Mesh Gear Line (SMGL). This line loosely follows the 100 meter contour along the Scotian Shelf slope.

Several papers have been written evaluating the placement of the SMGL and its impact upon the silver hake fishery. Waldron & Sinclair (1984) summarized these and presented new analyses of a 1977-1979 joint Canada-Cuba-USSR research program on commercial vessels permitted to fish landward of the SMGL and subsequent observations of the SMGL fishery to 1983. These new analyses agreed with the original management objectives for the placement of the SMGL. The silver hake fishery commenced April 15 and continued until September each year. Catches along the shelf slope (ie seaward of the SMGL) were higher than those occurring landward of the SMGL. From 1977-1979, silver hake catches occurred along the slopes of Emerald and LaHave Basins beginning in June with peak catches in July. Although fairly good catches occurred these were not as great as those seaward of the SMGL. By September, the fishery along the slope was greatly reduced due to low catches. However, catches in the vicinity of Emerald Basin and further inshore were higher than those occurring seaward of the SMGL.

The above study showed a fishing pattern for silver hake predominately along the Scotian Shelf slope from April until June. In July fisheries were conducted predominately along the slope with a smaller fishery in the vicinity of Emerald and LaHave Basins. These results agree well with earlier work by Clay (1979) who compiled, from Soviet fishing reports, a spatial description of the silver hake fishery between 1961 and 1968. From January to March fishing occurred in areas landward of the present day SMGL. From April to June, the USSR fished for silver hake exclusively in areas seaward of the SMGL. During July and August 39 % of the catch was from areas landward of the SMGL. As the fishing season progressed more of the catch was reported in areas landward of the SMGL but fishing still occurred seaward of the SMGL. Monthly catches from the Soviet fishing atlas for 1961-1968 showed that approximately 70 % of the silver hake catch for the 1961-1968 period occurred between April and July in areas which were seaward of the present day SMGL.

Data as detailed as those above are not available for the 1969-1976 period. However, it is unlikely that the fishing pattern for 1969-1976 would not be substantially different from those reported for 1961-1968. Data presented by Waldron and Sinclair (1984) for the 1977-1983 also agrees with the 1961-1968 fishing pattern.

CATCH AND EFFORT

There has been a steady decrease in silver hake catches since 1970 except in 1973 when the highest catches were reported (Figure 1). Nominal catches since 1977 fluctuated between 33 and 60 thousand tons until 1984 when 74 thousand tons of silver hake were caught (Table 1). The decreasing trend in catches are in part due to the implementation of the SMGL management policy in 1977. The major participants in the fishery have been the Soviet Union and recently Cuba, although the USSR continues to have the major portion of the TAC (Table 2 and Figure 2).

A more realistic method of evaluating the post 1976 catches would be to evaluate catch success against the amount of silver hake allocated. Percent caught of the total allocations for non-Canadian fleets have fluctuated between 64 and 90%. The highest years are 1982 (60,000 t) and 1984 (74,000 t).

Waldron (1983) reported that the high catches of 1982 were the result of lower than normal water temperatures on the Scotian Shelf during the months of May and June. This cannot be said of 1984 when water temperatures during the peak period of the fishery showed no obvious anomalies compared to the 1970-1980 average (R. Trites, pers. comm.). The high catches in 1984 may be indicative of increased population size.

The 1984 fishery unlike that in 1983 remained strong until September and most of the allocations were taken. Monthly catches in 1984 were highest in July with 26 thousand tons (35%) caught (Table below). Catches in April to June accounted for 59% of the total yearly landings.

A multiplicative model (Gavaris, 1980) for the 1970 to 1983 catch and effort series was not run for this assessment. Using this model, Waldron and Harris (1984) presented a catch and effort time series standardized to June 1970 for Soviet tonnage class 7 vessels. Standard errors were such that most of the standardized mean catch rates overlapped each other, except the 1982 point which may have been an anomalous year as discussed above. Prior to 1977, catch and effort data for the USSR is confounded because all 400x silver hake is reported from mixed fisheries. Certain assumptions were necessary in order to interpret these catch and effort data. Since 1977, the catch and effort series can be interpreted for directed and mixed fisheries using IOP and DFO data sets. Also, the fishery is limited to a season which is 4-6 months in duration. There are no changes to the mesh size fished nor the vessels used in this fishery since 1977. Therefore, the need to employ the Gavaris model on catch and effort data since 1977 is not necessary for this stock.

Catch and effort for 1977 to 1983 are from NAFO Statistical Bulletins (Table 3). To date, effort data for the 1984 fishery have not been reported to the Northwest Atlantic Fisheries Organization (NAFO). The 1984 effort figures below are calculated from catch and effort observed aboard the small-meshed fishery by the Canadian International Observer Program (IOP).

MONTHS	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	Tot.
Observed (t)	1952	8961	8959	7962	1806	196	1	29843
Observed hrs.	613	2456	4045	3275	787	194	5	11669
Observed CPUE(t/hr)	3.18	3.65	2.21	2.43	2.29	1.01	-	2.56
Rptorted Catch (t)	2706	19529	22053	26042	3411	516	23	74280
Calculated hrs.	851	5433	9979	10717	1490	511	-	29016

SAMPLING INTENSITY 1984

Sampling for length and age was from the IOP. From the 74 thousand tons 30 thousand tons (40%) were observed. More than 200 thousand lengths and 1000 otoliths were taken from the catch (Table 4). Coverage levels for this 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 Tables 5 and 6. The matrix was calculated in the following manner. For 1984, length frequencies of silver hake collected during the small-meshed fishery were aggregated to produce a single monthly length frequency. These monthly length frequencies were weighted to the 1984 monthly catch (Table 3) using monthly weight-length relationships ($wt = aL^b$) (Table 7). The monthly weight-length relationships were based on individual silver hake lengths and weights measured at sea during the 1984 small-meshed silver hake fishery. The weighted monthly length frequencies were multiplied by monthly age-length keys to produce monthly catch numbers at age. These monthly vectors were summed to give final catch numbers at age for the year.

The catch numbers at age for 1972 to 1979 were prepared by Clay and Beanlands (1980), using age-length keys collected from Canadian July groundfish surveys. Silver hake length frequencies reported to ICNAF 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 on board the small-meshed fleets by the IOP and weight-length relationships from the Canadian July groundfish surveys.

Catch numbers at age for 1980 to 1983 (Waldron and Harris, 1984) used length frequencies and weight-length relationships collected on board the small-meshed fleets by the IOP. As in previous years, these were weighted to catch and used to construct the final catch numbers at age. Research vessel weights at length were not used as weights collected by the IOP were more representative of the weights at length during the fishery.

The catch-at-age matrix (Table 5) and percent catch at age (Table 6) indicates that the 1983 year class at age 1 is the largest since the 1975 year class at age 1. The 1980 and 1981 year classes in 1984 are the largest in the series at ages 3 and 4. The 1984 fishery is supported by these three large year classes. The 1985 fishery will be supported mostly by the 1983 year class and only moderately by the 1981 year class. Usually 80% of the catch is from ages 1 to 4, therefore the 1980 year class will give little support to the 1985 fishery. The 1986 fishery will be almost solely supported by the 1983 year class.

MEAN WEIGHT AT AGE

Weight-length relationships from the Canadian July groundfish surveys (1970-1979) and the IOP (1980-1984) were used to calculate the mean weights at age presented in Table 8. Waldron and Harris (1984) noted that fish older than age 5 weighted, on average, less after 1976 than before 1977. Silver hake less than 5 years old showed no such pattern. The implication of this is that the stock is increasing in abundance, probably due in part to the change in management since 1977.

There is reasonable agreement between the catch biomass and the reported catch per year as shown below.

YEAR	1977	1978	1979	1980	1981	1982	1983	1984
CATCH (T)	37095	48404	51751	44525	42927	60251	35839	74280
BIOMASS(T)	36838	47581	51179	44663	41030	59883	35189	74207

RESEARCH VESSEL INDICES

Adult Surveys

Because of changes in availability due to Canadian regulations since 1977 attempts have been made recently to calibrate VPA's using RV surveys. The usefulness of the RV surveys for this purpose is reduced by annual survey effects which make it very difficult to follow year classes by numbers (Tables 9 and 10).

Two series of surveys are available at present. The major series is the July stratified random groundfish survey conducted since 1970. Although the series is continuous there have been three vessels used over the years. From 1970 to 1981 the A.T.Cameron, using a Yankee 36 trawl, carried out the survey. The survey vessel in 1982 was the Lady Hammond and in 1983 and 1984 the Alfred Needler. Both of these latter vessels use a Western IIA survey trawl. The secondary series is the March stratified random groundfish survey conducted from 1979 to 1984 by the Lady Hammond.

The change in July survey vessels and trawls after 1981 was expected to cause a change in the survey abundance indices. To prepare for the change in vessels a series of comparative fishing experiments was conducted to calibrate the various sections of the series conducted by different vessels.

Analysis of the comparative fishing experiments (Fanning, 1985) resulted in a conversion factor of A.T.Cameron to Lady Hammond or Alfred Needler of 2.3 i.e. catches by the A.T.Cameron are multiplied by 2.3 to calibrate them to more recent catches by the other two vessels. Conversion of the historical survey data allows present and future survey results to be added directly to the existing series.

The abundances at age calculated from the July surveys are given in Table 9 and total abundance is plotted in Figure 3. The abundances at age calculated from March surveys are given in Table 11 and total abundance in March is given in Figure 4.

Examination of each age group as percentages indicates that the 1981, 82 and 83 year classes are all stronger than any since 1977. Age groups 1 to 4 account for approximately 90% of the population abundance on average with ages 1 to 3 accounting for 75 to 80%. In numbers the 1983 year class is the largest seen at age 1 followed by 1981 and 1972.

In Figure 5 it is apparent that the 1973, 1977 and 1979 July surveys caught more silver hake at almost all ages than did the adjacent years in each case. This indicates an inter-annual survey effect which influences all ages similarly. However, it does appear certain that, regardless of how imprecisely, both surveys indicate a high abundance level since 1982. Although the 1983 July survey (Figure 3) shows a sharp drop in abundance from 1982, the March survey (Figure 4) indicates only a negligible drop in abundance in 1983. The March survey does not indicate as large an increase in 1984 as the July survey.

Overall the surveys have shown a strong upward trend in the last 6 years which may have levelled off in the last 2 years.

Juvenile Surveys

Since 1979, the USSR and Canada have been conducting joint surveys for Scotian Shelf juvenile silver hake. Initially the gear used was a Soviet designed juvenile bottom trawl. Although it fished well, there was some doubt as to it's ability to sample the total

juvenile population. Juvenile silver hake were found to be high in the water column at night and perhaps below the trawl during the day (Koeller, 1979). More probably, these juveniles were above the Soviet bottom survey trawl. In support of this contention, Fanning (1984) suggests that silver hake of age 1 are probably above the research gear used in the Canadian groundfish surveys. Since 1981 the 24 hour cruise design was replaced by a 12 hour night-time cruise using the International Young Gadoid Trawl (IGYPT) used by member countries of the International Council for the Exploration of the Sea (Koeller et al, 1984).

The juvenile silver hake survey is of a random stratified design similar to that reported by Halliday (1971) for the Canadian Scotian Shelf July groundfish surveys. Koeller et al. (1984) identified a "core" area (strata 60-78,) to survey determined from those locations where most of the silver hake juveniles were caught in both the joint USSR-Canada and Canadian Scotian Shelf ichthyoplankton Program surveys.

During the 1984 NAFO meeting of the Scientific Council questions concerning this assumption were raised. The 1984 survey conducted at the usual time, October-November, addressed this issue. It confirmed Koeller's concept of a core survey area as the area where the majority of silver hake juveniles were caught (Neilson, pers. com.).

The survey results presented in Koeller et al (1984) were recalculated by Dr. John Neilson of the DFO St. Andrew's Laboratory in New Brunswick. Below are those re-calculations.

Years	1978	1979	1980	1981	1982	1983	1984
Strat. mean catch/tow	241.47	56.01	26.64	562.73	8.26	248.79	43.85
Unstr. mean catch/tow	166.43	180.40	26.98	603.39	6.92	227.70	43.28

Only the series from 1981 to 1984, using the IGYPT gear will be used as an index of juvenile silver hake abundance. The series indicates that the 1981 and 1983 year classes are large relative to the 1982 and 1984 year classes. This observation agrees well with that seen in the Canadian July groundfish surveys.

PARTIAL RECRUITMENT

Partial recruitment presented in last years assessment was calculated by running one VPA at terminal $F = .25$ and averaging each age over the years 1977-1982. The age of full recruitment was determined as age 3 after examination of the F 's at age in each year (Waldron and Harris, 1984). Fishing mortalities at age for silver hake older than 3 were variable, some larger others smaller than the F 's at age 3. Because of this variability, all F 's at ages 3 and older were set to a partial recruitment of 1.000. This partial recruitment pattern is in agreement with previous assessments. Selectivity experiments reported by Clay (1979) indicated that the expected age of full recruitment of a silver hake fishery, using 60 mm codends, would be at age 3. There has been no change in the codend mesh size for the 4vwx silver hake fishery since 1977 and there is no reason to expect a significant change in the partial recruitment pattern since then.

The partial recruitment pattern and F 's at age 9 presented in last years assessment were used in a VPA at a terminal F of 0.25. A flat topped partial recruitment pattern was expected so final F 's at the oldest age were calculated by averaging fishing mortalities over the ages 3-8 and iterating until the difference between consecutive iterations was less than 0.0001. Examination of the F matrix suggested that full recruitment occurred between 3 and 4 years of age. The F matrix since 1977 was normalized to the F at age 3 in each year. Although, 1977 indicated dome shaped partial recruitment,

the remainder of the normalized F matrix indicated that F's in most instances continued to increase beyond age 3. This cannot be explained. The final F's at age were averaged across ages for 1977-1983 and are reported below as "1984 Iteration". For the purposes of this assessment, as in other assessments, all F's for silver hake older than age 3 were set to 1.000. The final 1984 partial recruitment at age is not significantly different than that presented in previous assessments.

Table of Partial Recruitment Patterns

AGE	1	2	3	4	5	6	7	8	9
1979 Assess.	0.150	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1980-81 Assess.	0.044	0.444	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1982 Assess.	0.030	0.250	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1983 Assess.	0.041	0.330	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1984 Iteration	0.035	0.350	1.000	1.000	1.000	1.000	1.000	1.000	1.000

NATURAL MORTALITY

Natural mortality for silver hake has been set at 0.400 since sequential population analysis has been used to assess this stock. This estimate is based upon work by Mari and Terri (1979). There is no new data which will permit the re-calculation of this parameter and M = 0.400 will be used in this assessment.

VIRTUAL POPULATION ANALYSIS and CALIBRATION

A virtual population analysis (Gulland, 1965) was used in an attempt to estimate the population size of silver hake in 1984. The input parameters were M = 0.400, the partial recruitment pattern developed above and terminal F's ranging from 0.100 to 0.900. For each terminal fishing mortality, F's were averaged over ages 3-7 until the difference for F's on the oldest age between consecutive VPA's was less than 0.001.

Several attempts were made to calibrate these population estimates. One method was to compare 3+ research vessel numbers and against 3+ mid year VPA numbers. Mid year population numbers were defined as the average numbers at age in Ricker (1975, page 12).

$$\text{Average } N = \frac{-Z}{N(1-e^{-Z})}$$

An example of a run at a terminal F at 0.250 are given in Tables 12a,b and 13b and Figure 6.

Another calibration technique is to compare fishable research vessel biomass against fishable VPA biomass. Fishable biomass (FB) is determined as per the following;

$$FB = \text{Mid year POP} \times (\text{Average Normalized F at age [1970-1976 \& 1977-1983]})$$

where

$$\text{Normalized F} = \frac{[F/\text{Weighted F}]}{\text{Max } [F/\text{Weighted F}]}$$

and

$$\text{Weighted F} = \frac{F[\text{ages 3-7}] \times \text{Pop}[\text{ages 3-7}]}{\text{Sum of Pop}[\text{ages 3-7}]}$$

where F and PDP are the F's at age and population numbers at age at the specified terminal F.

All normalized F's larger than 1.000 were set to 1.000. These were averaged at each age for 1970-1976 and 1977-1983. The averages at age for 1970-1976 and 1977-1983 were used as partial F's for the pre extended jurisdiction (1970-1976) and the post 1976 fisheries respectively.

An example of a run at a terminal F at 0.250 is given in Tables 12a-d, and 13a and Figure 7.

Attempts to calibrate the VPA using research vessel surveys were unsuccessful. The 1982-1984 data points are much larger than any in the series since 1977 and as a result the linear relationships are solely dependent upon the magnitude of these points in the above relationships.

Since the NAFO Scientific Council dismissed the use of the CPUE series as it was subject to bias due to the post 1977 management strategy, no attempts to calibrate the VPA with CPUE were made.

YIELD PER RECRUIT AND AVERAGE WEIGHTS AT AGE

A yield per recruit analysis using the Thompson and Bell yield model (Ricker, 1975 and Rivard, 1982) was conducted to evaluate where current average weights for the fishery were in relationship to the $F_{0.1}$ and F_{max} mean weights. The parameters used in the model were $M = 0.400$ and the averaged partial recruitment (1977-1983) and the average mean weights at age for the period 1977-1984. These were selected because the affects of the shift in management in 1977 would begin to be seen in the fishery (Table 14). This was repeated for the 1970-1976 period using average partial recruitments for 1970-1976 and mean weights at age for 1970-1976 (Table 15). Plotting average weights from the catch and at $F_{0.1}$ and F_{max} suggest that fishing since 1976 has been at F's below $F_{0.1}$ while prior to 1977 fishing was between $F_{0.1}$ and F_{max} (Fig. 8).

CONCLUSIONS

The 1984 fishery is supported by two large year classes (1981 and 1983) as suggested both by the research vessel and juvenile research surveys. These year classes will be in the fishery for 1985 but only one, the apparently strong 1983 year class will contribute significantly to the 1986 fishery. There is no confirmation to date of the size of the 1984 year class seen as weak in the 1984 juvenile survey. Mean weights at age for the 1980-1984 period suggest that the fishery is being conducted below $F_{0.1}$. There is some suggestion that the 1986 fishery would have an $F_{0.1}$ level below that calculated in Table 14. However, there is data to suggest the 1986 fishery will only be supported by one strong year class. The 1985 year class will not be assessed until November, 1985. There is no method to predict its relative size at this time. There is little change in the current calculation of $F_{0.1}$ as compared to that in previous assessments and it is suggested that at this time there is no reason to change the current TAC of 100,000 tons.

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Table 1. Nominal catches for 4WX silver hake 1970-1984 (1984 Preliminary).

COUNTRY	Y E A R															
	1970	1971	1972	1972	1972	1973	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Bulgaria	0	0	0	0	0	0	1722	3088	862	606	4639	817	0	0	0	0
Canada	0	0	0	0	11	101	101	26	10	26	13	104	6	38	15	11
Cuba	0	0	201	909	0	1724	12572	1847	3436	3436	1798	2287	642	11969	7418	14496
France	0	0	0	0	0	0	0	0	15	0	0	0	0	2 ¹	0	0
FRG	0	0	10	0	296	106	97	684	0	0	0	0	0	0	0	0
GDR	0	0	0	0	0	0	0	0	0	3 ¹	0	0	0	0	0	93
Ireland	0	0	0	0	0	0	108	106	0	0	0	0	0	0	0	0
Italy	0	0	0	0	0	0	0	0	38	106	5	0	460 ¹	37 ¹	2 ²	0
Japan	129	8	63	88	67	54	78	19	161	161	219	239	120	937	649	542 ²
Poland	0	0	0	0	0	0	0	0	295	2	0	0	1 ¹	31 ²	0	0
Portugal	0	0	0	0	0	0	0	0	0	0	0	56	1460 ¹	2 ¹	378	1715 ²
Romania	0	0	0	0	0	0	0	0	10	0	1	0	0	0	0	0
Spain	0	11	0	0	0	0	6	0	0	2	0	40	0	0	0	0
USA	0	1	0	0	0	0	7	1	14	0	0	0	3	2	0	0
USSR	168916	128633	113774	298533	95371	112566	81216	33301	44062	44062	45076	40982	40235	47261	27377	57423
<u>TOTAL</u>	169045	128653	114048	299530	95745	116394	97184	37095	48404	48404	51751	44525	42927	60251	35839	74280

¹ Observer Program Data (data not reported to NAFO)

² FLASH Data

Table 2. Nominal catch and allocations (t) (in parenthesis) for 4VWX silver hake.
1984 Preliminary.

COUNTRY	1977	1978	1979	1980	1981	1982	1983	1984
Bulgaria	862 (950)	606 (1000)	4639 (6860)	817 (1200)	0 (1000)	0 (1000)	0	-
Canada	10 (15190)	26 (16700)	13 (10000)	104 (20000)	6 (20000)	38 (13000)	15 (1000)	11 (1000)
<u>Cdn. Reserve</u>							(11808)	(13000)
Cuba	1847 (8910)	3436 (10300)	1798 (8070)	2287 (11200)	642 (9500)	11969 (13500)	7418 (9500)	14496 (15200)
EEC	-	-	-	(100)	-	-	-	-
France ⁴	15	0	0 (100) ³	0 (100) ³	0 (100) ³	2 ¹ (100) ³	0 (100) ³	0 (100)
FRG	684	0	0	0	0	0	0	0
GDR	0	3 ¹	0	0	0	0	0 (2000)	93 (100)
Italy ⁴	38	106	5	0	460 ¹	37 ¹	2 ²	0
Japan	19	161	219	239	120	937 (2000)	649 (5000)	542 (10000) ²
Poland	295	2	0	0	1 ¹	31	0	0
Portugal	0	0	0	56	1460 ¹	2 ¹ (2000)	378 (3000)	1715 (4000) ²
Romania	10	0	1	0	0	0	0	0
Spain	0	2	0	40	0	0	0 (4000)	0
USA	14	0	0	0	3	2	0	0
			(2)					
USSR	33301 (44950)	44062 (52000)	45076 (44940)	40982 (56600)	40235 (48400)	47261 (48400)	27377 (43400)	57423 (56600)
Others			(30)	(900)	(1000)	-	(192)	-
Total Catch and TAC	37095 (70000)	48404 (80000)	51751 (70000)	44525 (90000)	42927 (80000)	60251 (80000)	35839 (80000)	74280 (100000)
% Catch Divided by TAC	53	61	74	50	54	75	45	74
% Catch Divided by sum of allocations (discounted Can. Alloc. + reserve)	68	76	86	64	72	90	53	86

¹ Observed by Canadian Observers but not reported to NAFO

² Reported to Canada (FLASH System)

³ France, St. Pierre, and Miguelon vessels only

⁴ EEC allocations

⁵ Reported

TABLE 3: 4WVX SILVER HAKE CATCH (T), EFFORT (HRS) AND CPUE (T/HR)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
CATCH	153054.000	68344.000	100201.000	266854.000	23021.000	86473.000	41243.000	26072.000	41924.000	44980.000	40947.000	37166.000	58765.000	8764.000	74280.000
EFFORT	72867.000	46345.000	56924.000	101760.000	16082.000	60665.000	20304.000	13335.000	28451.000	24787.000	34762.000	23560.000	15907.000	5104.000	29016.000
CPUE(T/HR)	2.100	1.475	1.760	2.622	1.431	1.425	2.031	1.955	1.474	1.815	1.178	1.578	3.694	1.756	2.560

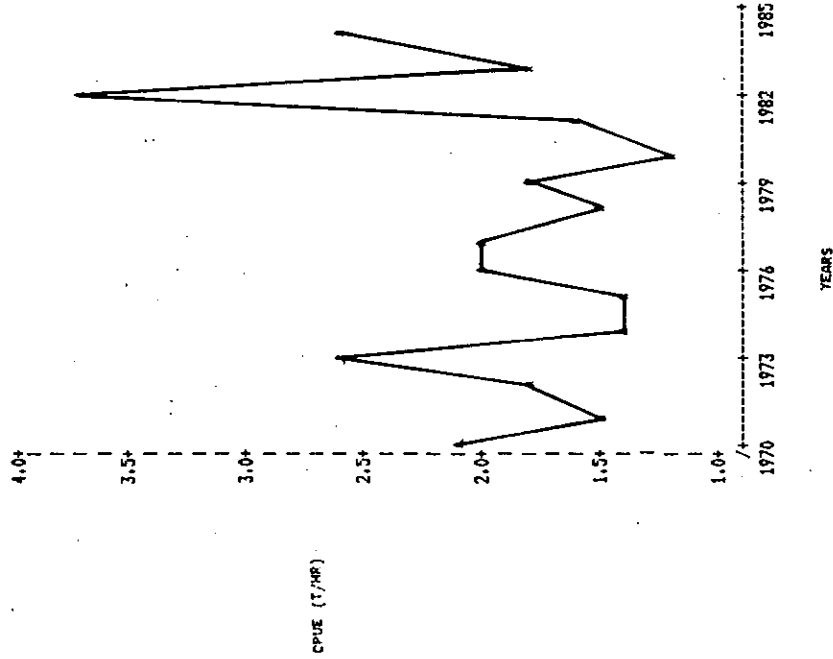


Table 4. Summary of 1984 Observer Program Silver Hake Sampling

Country	Sample	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	TOTALS
Canada	Meas.	-	1	113	-	-	103	116	254	311	676	752	90	2416
	Otoliths taken	-	1	22	-	-	-	-	-	-	-	-	-	23
	Otoliths aged	-	1	22	-	-	-	-	-	-	-	-	-	23
Cuba	Meas.	-	-	-	21222	23007	17893	1758	-	-	-	-	-	63880
	Otoliths taken	-	-	-	102	159	141	8	-	-	-	-	-	410
	Otoliths aged	-	-	-	102	159	141	8	-	-	-	-	-	410
France	Meas.	5	4	-	-	-	-	-	-	-	-	-	-	9
	Otoliths taken	-	2	-	-	-	-	-	-	-	-	-	-	2
	Otoliths aged	-	2	-	-	-	-	-	-	-	-	-	-	2
GDR	Meas.	-	-	-	-	2263	-	-	-	-	-	-	-	2263
	Otoliths taken	-	-	-	-	21	-	-	-	-	-	-	-	21
	Otoliths aged	-	-	-	-	21	-	-	-	-	-	-	-	21
Japan	Meas.	-	-	-	-	-	-	-	4484	2445	1283	75	2186	10473
	Otoliths taken	-	-	-	-	-	-	-	70	26	-	27	27	150
	Otoliths aged	-	-	-	-	-	-	-	70	26	-	-	-	96
Portugal	Meas.	-	-	-	-	-	14801	2360	-	-	-	-	142	17303
	Otoliths taken	-	-	-	-	-	113	-	-	-	-	-	-	113
	Otoliths aged	-	-	-	-	-	113	-	-	-	-	-	-	113
USSR	Meas.	-	-	-	-	44208	43499	56753	10475	-	-	-	-	154935
	Otoliths taken	-	-	-	-	241	445	133	34	-	-	-	-	853
	Otoliths aged	-	-	-	-	241	445	133	34	-	-	-	-	853
TOTAL	Meas.	5	5	113	21222	69478	76296	60987	15213	2756	1959	827	2418	251279
	Otoliths taken	-	3	22	102	421	699	141	104	26	-	27	27	1572
	Otoliths aged	-	3	22	102	421	699	141	104	26	-	-	-	1518

TABLE 5 4VMA SILVER HAKE CATCH

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1 1	187298	219607	379314	246148	101158	145091	153535	2131	28704	9667	6272	1553	19708	3333	99217
2 1	748021	410149	460610	1482925	390044	365964	381651	43535	90777	48341	60576	19530	51680	86085	40265
3 1	216246	175005	71536	96784	150741	52837	72418	78239	89717	69058	82013	111209	66973	51617	191048
4 1	59832	74755	47903	106675	7095	60806	31295	29561	42878	46547	35888	38534	66230	28354	71739
5 1	20695	22035	17822	96940	9789	38646	5582	6981	19442	29656	15293	14266	34777	13036	19200
6 1	9636	1877	7452	19671	3245	4803	2669	2004	8587	16964	6179	5548	8925	4431	5392
7 1	3608	5139	1160	15203	93	311	514	463	3222	5079	1682	679	2790	1150	1006
8 1	1988	1333	437	5475	109	363	105	564	2009	1765	344	132	1047	475	176
9 1	1114	2062	607	484	60	360	390	522	420	1151	90	61	127	69	3
1+1	1248438	911962	986841	2070305	662334	669181	648159	164020	285756	228228	208337	191512	252257	188549	428046
2+1	1061140	692355	607527	1824157	561176	524090	494624	161889	257052	218561	202065	189959	232549	185217	328829
3+1	313119	282206	146917	341232	171132	158126	112973	118354	166275	170220	141489	170429	180869	99131	288564
4+1	96873	107201	75381	244448	20391	105289	40555	40115	76558	101162	59476	59220	113896	47515	97516
5+1	37041	32446	27478	137773	13296	44483	9260	10554	33680	54615	23588	20686	47666	19160	25777
6+1	16346	10411	9656	40833	3507	5837	3678	3573	14238	24959	8295	6420	12889	6125	6577
7+1	6710	8534	2204	21162	262	1034	1009	1569	5651	7995	2116	872	3964	1694	1185
8+1	3102	3395	1044	5959	169	723	495	1086	2429	2916	434	193	1174	544	179

TABLE 6 4VMA SILVER HAKE CATCH PERCENT AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1 1	15.00	24.08	38.44	11.89	15.27	21.68	23.69	1.30	10.04	4.24	3.01	0.81	7.81	1.77	23.18
2 1	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
3 1	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
4 1	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
5 1	1.66	2.42	1.81	4.68	1.48	5.78	0.86	4.26	6.80	12.99	7.34	7.45	13.79	6.91	4.49
6 1	0.77	0.21	0.76	0.95	0.49	0.72	0.41	1.22	3.01	7.43	2.97	2.90	3.54	2.35	1.26
7 1	0.29	0.56	0.12	0.73	0.01	0.05	0.08	0.29	1.13	2.23	0.81	0.35	1.11	0.61	0.24
8 1	0.16	0.15	0.04	0.26	0.02	0.05	0.02	0.34	0.70	0.77	0.17	0.07	0.42	0.25	0.04
9 1	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	0.04	0.00
1+1	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2+1	85.00	75.92	61.56	88.11	84.73	78.32	76.31	98.70	89.96	95.76	96.99	99.19	92.19	98.23	76.82
3+1	25.08	30.94	14.89	16.48	25.84	23.63	17.43	72.16	58.19	74.58	67.91	68.99	71.70	52.58	67.41
4+1	7.76	11.75	7.64	11.81	3.08	15.73	6.26	24.46	26.79	44.32	28.55	30.92	45.15	25.20	22.78
5+1	2.97	3.56	2.78	6.65	2.01	6.65	1.43	6.43	11.79	23.93	11.32	10.80	18.90	10.16	6.02
6+1	1.31	1.14	0.98	1.97	0.53	0.87	0.57	2.18	4.98	10.94	3.98	3.35	5.11	3.25	1.54
7+1	0.54	0.94	0.22	1.02	0.04	0.15	0.16	0.96	1.98	3.50	1.02	0.46	1.57	0.90	0.28
8+1	0.25	0.37	0.11	0.29	0.03	0.11	0.08	0.66	0.85	1.28	0.21	0.10	0.47	0.29	0.04

Table 7 α and β 's for 1984 silver hake. Data from IOP.

Month	α	β
April	.00395	3.14324
May	0.00412	3.16443
June	.00174	3.40298
July	0.00674	3.02368
Aug-Nov	0.05754	2.35879

TABLE 8a 4VWX SILVER HAKE MEAN WEIGHTS AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
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	0.054	0.063
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	0.130	0.147
3	0.167	0.188	0.209	0.216	0.204	0.243	0.246	0.210	0.174	0.200	0.213	0.193	0.223	0.203	0.190
4	0.222	0.254	0.240	0.250	0.310	0.237	0.273	0.290	0.226	0.245	0.280	0.248	0.289	0.246	0.249
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	0.303	0.278
6	0.404	0.450	0.557	0.439	0.539	0.457	0.528	0.516	0.329	0.344	0.366	0.369	0.399	0.362	0.366
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	0.387	0.454
8	0.705	0.832	1.263	0.875	1.156	1.257	1.251	1.077	0.498	0.520	0.601	0.550	0.582	0.653	0.597
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	0.809	0.753

TABLE 8b 4VWX SILVER HAKE CATCH BIOMASS (T)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	11238	8784	21242	11077	6373	9721	9673	132	1406	590	257	56	1102	180	6251
2	94251	52499	54813	189814	50316	56724	56484	6400	9985	7445	8541	2793	7623	11191	5919
3	36113	32901	14951	20905	30751	12839	17815	16430	15611	13812	17469	21463	14915	10478	36299
4	13283	18988	11497	26669	2199	14411	8544	8573	9690	11404	10049	9556	19167	6975	17863
5	6271	6941	4883	28597	3876	18434	2272	2771	5502	8452	4924	4537	11445	3950	5338
6	3893	845	4151	8636	1749	2195	1409	1034	2825	5836	2262	2047	3560	1604	1973
7	1696	3017	560	7373	91	352	431	322	1231	2087	875	456	1342	445	457
8	1402	1109	552	4791	126	456	131	607	1000	918	207	73	609	310	105
9	922	1262	538	568	0	589	335	568	329	637	80	48	120	56	2
1+	169068	126345	113186	298430	95481	115722	97094	36836	47581	51179	44663	41030	59883	35189	74207
2+	157830	117561	91944	287354	89109	106001	87421	36706	46174	50589	44406	40974	58781	35009	67956
3+	63579	65062	37132	97539	38793	49277	30937	30306	36189	43145	35865	38181	51158	23818	62037
4+	27466	32161	22181	76634	8042	36437	13122	13876	20578	29333	18396	16718	36244	13340	25738
5+	14183	13173	10684	49965	5842	22026	4578	5304	10888	17929	8348	7161	17077	6365	7875
6+	7913	6232	5801	21368	1966	3592	2306	2532	5586	9477	3423	2625	5632	2415	2538
7+	4020	5388	1650	12732	217	1397	897	1498	2561	3642	1162	577	2071	811	564
8+	2324	2371	1090	5359	126	1045	466	1176	1330	1554	287	121	730	366	107

TABLE 9. SILVER HAKE JULY SURVEY ABUNDANCE IN THOUSANDS

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	54818	114479	60085	37609	44552	56879	26774	86755	14787	32930	191964	117816	427311
2	88955	256653	203557	32854	108961	83741	24163	148112	22094	86213	298055	108591	102616
3	13204	17477	27540	5206	14228	54417	16119	71487	28944	134563	81956	40180	327936
4	7130	14515	3442	2985	11307	16460	8678	19634	8303	57609	64841	18767	54040
5	3071	13474	3558	1502	4047	10589	6726	11579	4264	16670	14633	9574	15061
6	1766	6226	3875	870	1807	4763	2854	5576	3128	5246	10155	3028	10562
7	271	2172	713	253	357	2594	1177	3064	1512	2888	5532	803	4578
8	642	1332	410	397	236	974	458	974	875	860	6723	406	1755
9	113	120	35	38	290	213	922	213	370	499	393	361	908
10	436	668	0	0	0	503	450	503	652	252	156	12	1881
1+	170406	427117	303218	81714	185787	231132	88322	347897	84929	337730	674408	299537	946668
2+	115588	312638	243133	44105	141235	174253	61548	261142	70142	304799	482445	181721	519357
3+	26633	55985	39576	11251	32274	90513	37385	113030	48048	218586	184390	73131	416741
4+	13429	38508	12036	6045	18046	36095	21266	41543	19104	84023	102434	32951	88805
5+	6299	23993	8594	3060	6739	19635	12588	21909	10802	26415	37593	14184	34765
6+	3228	10518	5036	1558	2692	9047	5861	10330	6538	9745	22960	4610	19705

TABLE 10 RESEARCH VESSEL PERCENT AT AGE FOR 4YRK SILVER HAKE

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	52.25	30.00	20.51	46.03	23.98	11.40	30.47	25.06	17.55	9.75	28.45	38.51	45.23
2	52.34	57.10	66.05	40.21	58.65	43.75	27.30	42.58	26.22	25.56	44.49	36.75	10.86
3	7.77	3.89	9.40	6.37	7.66	31.79	18.34	20.55	34.34	39.89	12.59	13.60	34.71
4	4.20	3.23	1.18	3.65	6.09	6.43	9.88	5.65	9.85	17.08	9.34	6.35	5.72
5	1.81	3.00	1.15	1.84	2.18	2.24	7.65	3.33	5.06	4.92	2.21	3.24	1.59
6	1.04	1.39	1.32	1.06	0.97	2.10	3.25	1.60	3.71	1.56	1.16	1.02	1.12
7	0.16	0.48	0.24	0.31	0.19	1.33	1.34	0.88	1.79	0.86	0.72	0.27	0.49
8	0.38	0.30	0.14	0.49	0.13	0.52	0.52	0.28	1.04	0.26	1.00	0.14	0.19
9	0.07	0.03	0.00	0.05	0.16	0.44	1.05	0.06	0.44	0.15	0.06	0.12	0.10
1+	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2+	67.75	69.40	79.49	53.97	76.02	88.60	69.53	74.94	82.45	90.25	71.55	61.49	54.77
3+	15.41	12.31	13.44	13.77	17.37	44.85	42.03	32.35	56.24	64.69	27.06	24.74	43.91
4+	7.64	8.42	4.04	7.40	9.71	13.06	25.89	11.80	21.89	24.81	14.47	11.15	9.20
5+	3.45	5.19	2.86	3.74	3.63	6.63	13.81	6.15	12.04	7.73	5.13	4.80	3.48
6+	1.64	2.19	1.71	1.91	1.45	4.40	6.16	2.83	6.98	2.81	2.93	1.56	1.89
7+	0.60	0.81	0.38	0.84	0.48	2.29	2.91	1.22	3.27	1.26	1.77	0.53	0.77

TABLE 11. SILVER HAKE MARCH SURVEY ABUNDANCE IN THOUSANDS

	1979	1980	1981	1982	1983	1984
1	256456	14057	61534	345431	390796	437416
2	84668	101844	113543	110382	212362	127627
3	19323	40070	137086	346088	283186	64797
4	8497	16457	18286	108476	39223	248823
5	5444	10337	4238	54960	21855	58462
6	3442	5657	739	21021	8613	13087
7	2127	1170	209	8779	4759	6953
8	780	267	138	1680	2109	2588
9	323	830	0	1459	959	563
10	410	1810	48	508	315	166
1+	381469	192500	335821	998784	964176	960484
2+	125013	178443	274287	653353	573380	523068
3+	40346	76599	160743	542971	361019	395441
4+	21023	36529	23658	196883	77833	330644
5+	12526	20072	5372	88407	38610	81821
6+	7082	9734	1134	33447	16754	23358

TABLE 12c 4VWX SILVER HAKE FISHABLE RESEARCH VESSEL BIOMASS [T]

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	19186	48133	21030	13163	15593	171	616	2005	340	757	4414	2617	9828
2	88955	256653	193512	32854	108961	6860	5799	35547	5302	20691	72022	26062	24628
3	13204	17477	27552	5206	14228	13894	10784	47825	19364	90023	56796	26880	219389
4	7130	14515	3462	2985	11307	3622	7489	16944	7165	49716	54341	16196	46636
5	3071	13474	3372	1502	4047	1462	6726	11579	4264	16586	14878	9574	15061
6	1766	6226	3875	870	1807	1374	2854	5576	3128	5246	7795	3028	10562
7	271	2172	715	253	357	867	1177	3064	1512	2888	4843	803	4598
8	642	1332	410	397	236	342	458	974	875	860	6723	406	1755
1+	113	120	0	38	290	289	922	213	370	499	393	361	908
2+	134338	360103	253928	57268	156829	28882	36825	123727	42321	167266	222204	85927	333366
3+	115152	311970	232898	44105	141235	28711	36209	121722	41981	186509	217790	83310	323537
4+	26197	55317	39386	11251	32274	21851	30410	86175	36678	165818	145768	57248	298910
5+	12993	37839	11834	6045	18046	7957	19626	38350	17314	75795	88973	30368	79520
6+	5863	23324	8372	3060	6739	4334	12137	21406	10149	26079	34632	14172	32884

4VWX SILVER HAKE FISHABLE POPULATION BIOMASS [T]

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	27563	18185	57621	16808	23821	27181	14128	800	721	1113	655	1038	2620	890	16430
2	135133	77426	66008	129163	54936	77536	78458	12574	8748	14623	16910	15598	28873	41207	16235
3	55284	75029	50659	39665	41991	34831	45861	27877	20818	21017	29624	33405	39531	68634	97136
4	29177	29427	44854	19860	27446	13962	17159	21644	16707	14154	15600	19937	25758	30190	61663
5	9968	18169	12422	15586	7647	17240	7774	11358	10853	7873	7260	7811	10198	12810	21350
6	5996	6580	15449	5927	5432	3348	6227	5137	4079	3322	2458	2756	2802	3172	7894
7	4428	2412	4151	3393	3685	6253	2645	4512	1651	1099	689	1568	822	653	1827
8	5618	3718	1404	1686	1357	2925	4429	1789	1667	448	231	197	439	96	420
9	1665	2218	1995	387	0	925	1068	2269	559	543	105	99	122	155	9
1+	274832	233162	254564	232475	166316	184202	177749	87960	65802	64193	73533	82408	111165	157806	222965
2+	247269	214977	196943	215668	142495	157021	163621	87160	65081	63080	72878	81370	108545	156916	206535
3+	112136	137551	130935	86505	87559	79485	85163	74586	56334	48456	55968	65772	79673	115710	190300
4+	56851	62523	80275	46840	45567	44653	39303	46709	35515	27439	26343	32368	40141	47076	93164
5+	27674	33096	35421	26979	18122	30691	22143	25065	18808	13284	10743	12431	14383	16886	31501

TABLE 13a SUMMARY RESULTS OF FISHABLE POPULATION & FISHABLE RESEARCH VESSEL BIOMASSES (T).

TERMINALF	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
OBSERVED	376718	211115	127891	99993	86004	77606	72017	68039	63070	62777
PREDICTED	116601	117513	114445	110174	105220	102072	104829	112954	121042	126505
DIFFERENCE	103603	104692	107760	112030	116785	120132	117375	109250	101163	95699
SLOPE	0.097	0.196	0.381	0.459	0.201	0.746	2.354	3.756	4.379	4.553
R ²	0.083	0.073	0.050	0.023	0.002	0.012	0.076	0.165	0.231	0.265
R	0.288	0.271	0.224	0.151	0.042	0.109	0.276	0.406	0.480	0.514
INTERCEPT	82184.45	76066.06	63714.84	64249.33	67901.40	159988.36	274350.64	368476.59	405963.58	406028.72

TABLE 13b SUMMARY RESULTS OF VPA 3+ & RESEARCH VESSEL 3+ NUMBERS ('000)

TERMINALF	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
OBSERVED	7166881	3666916	1918695	1337498	1048045	875276	789836	679715	619408	572966
PREDICTED	168434	151587	157123	168897	180075	183574	153935	111910	91582	87881
DIFFERENCE	266426	263273	255737	245963	234784	231286	236925	302950	323276	326979
SLOPE	0.008	0.018	0.045	0.086	0.147	0.212	0.191	0.054	0.050	0.095
R ²	0.017	0.018	0.019	0.020	0.019	0.016	0.007	0.001	0.001	0.003
R	0.131	0.133	0.137	0.140	0.139	0.126	0.084	0.023	0.023	0.051
INTERCEPT	90158.08	85473.01	72899.65	54004.73	26474.83	2176.50	10563.19	75319.15	122636.00	142571.02

TABLE 14 AVERAGE WEIGHTS AT AGE (KG) FOR 1977-1984 USED IN Y/R BELOW 6/ 6/85

	1	2	3	4	5	6	7	8	9
1	0.053	0.140	0.201	0.259	0.314	0.381	0.497	0.635	0.828

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	0.300	0.23358	0.053	0.225	1.000
F0.1---	0.489	0.30411	0.062	0.205	0.725
	0.600	0.33412	0.066	0.197	0.625
	0.900	0.39171	0.071	0.181	0.449
	1.200	0.43048	0.073	0.170	0.348
	1.500	0.45919	0.075	0.163	0.284
	1.800	0.48180	0.076	0.157	0.239
	2.100	0.50039	0.076	0.152	0.206
	2.400	0.51615	0.076	0.148	0.181
	2.700	0.52981	0.076	0.144	0.161
	3.000	0.54186	0.076	0.141	0.145
FMAX---	3.076	0.54470	0.076	0.140	0.142
	3.300	0.55264	0.076	0.138	0.132
	3.600	0.56238	0.076	0.136	0.121
	3.900	0.57128	0.076	0.134	0.112
	4.200	0.57945	0.076	0.132	0.103
	4.500	0.58700	0.076	0.130	0.096
	4.800	0.59403	0.076	0.128	0.090
	5.100	0.60058	0.076	0.126	0.085
	5.400	0.60673	0.076	0.125	0.080
	5.700	0.61251	0.075	0.123	0.075
	6.000	0.61797	0.075	0.122	0.072

TABLE 15 AVERAGE WEIGHTS AT AGE (KG) FOR 1970-1976 USED IN Y/R BELOW

	1	2	3	4	5	6	7	8	9
	0.056	0.133	0.210	0.255	0.352	0.482	0.710	1.048	0.856

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	0.080	0.12908	0.029	0.224	1.000
	0.160	0.22401	0.045	0.202	0.781
	0.240	0.29633	0.055	0.184	0.628
	0.320	0.35317	0.060	0.170	0.518
F0.1---	0.332	0.36057	0.061	0.168	0.504
	0.400	0.39907	0.063	0.158	0.436
	0.480	0.43699	0.065	0.149	0.374
	0.560	0.46893	0.066	0.141	0.326
	0.640	0.49628	0.067	0.135	0.288
	0.720	0.52002	0.067	0.129	0.257
	0.800	0.54088	0.067	0.124	0.232
FMAX---	0.816	0.54480	0.067	0.123	0.227
	0.880	0.55939	0.067	0.120	0.211
	0.960	0.57597	0.067	0.116	0.193
	1.040	0.59092	0.067	0.113	0.177
	1.120	0.60451	0.067	0.110	0.164
	1.200	0.61693	0.066	0.107	0.153
	1.280	0.62835	0.066	0.105	0.142
	1.360	0.63889	0.066	0.103	0.133
	1.440	0.64867	0.065	0.101	0.125
	1.520	0.65778	0.065	0.099	0.118
	1.600	0.66629	0.065	0.097	0.112

15

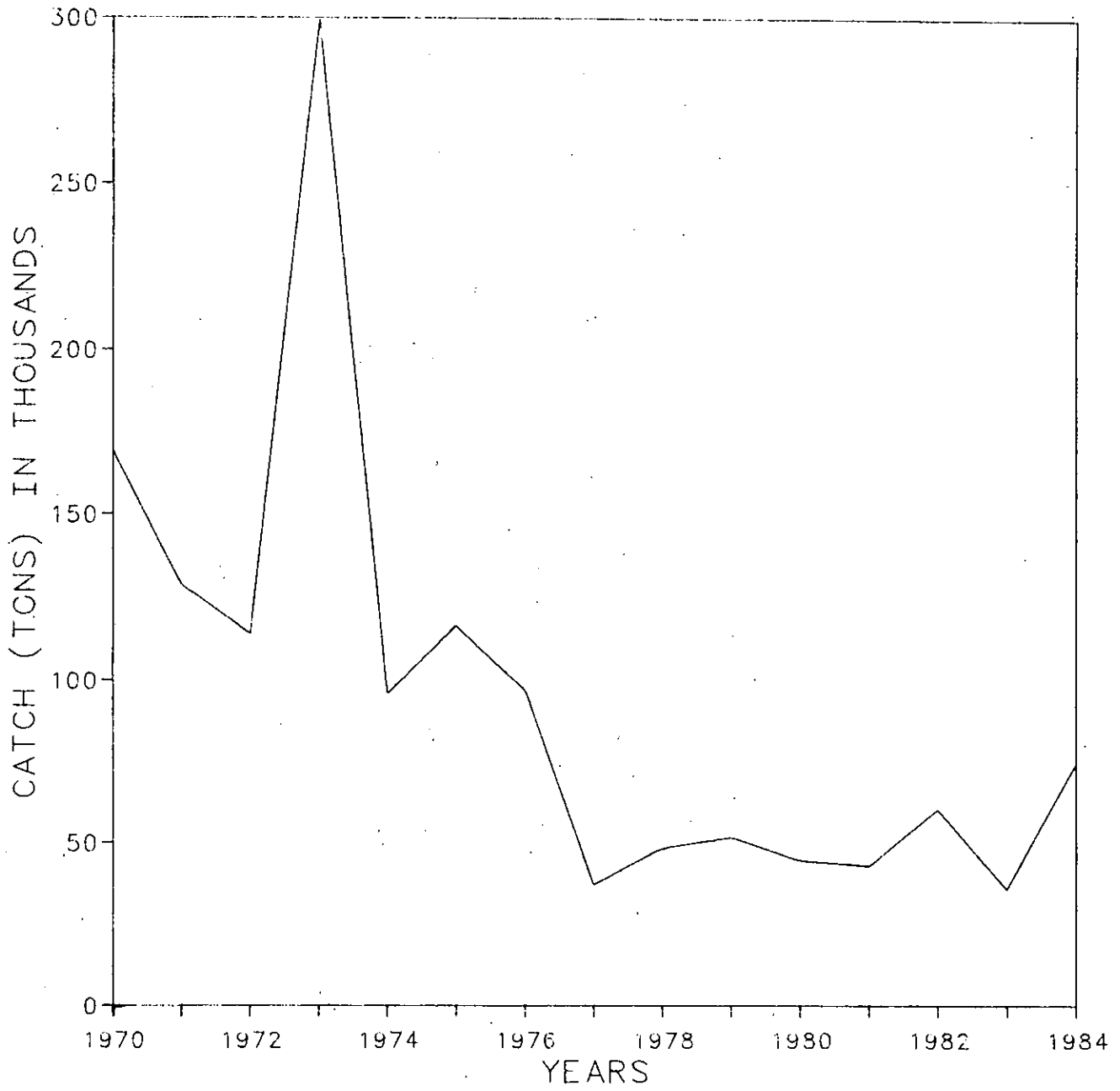


Figure 1. Nominal catches (t) of 4WX silver hake.

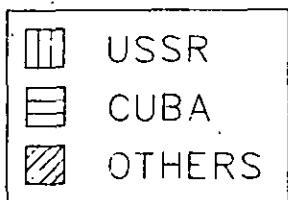
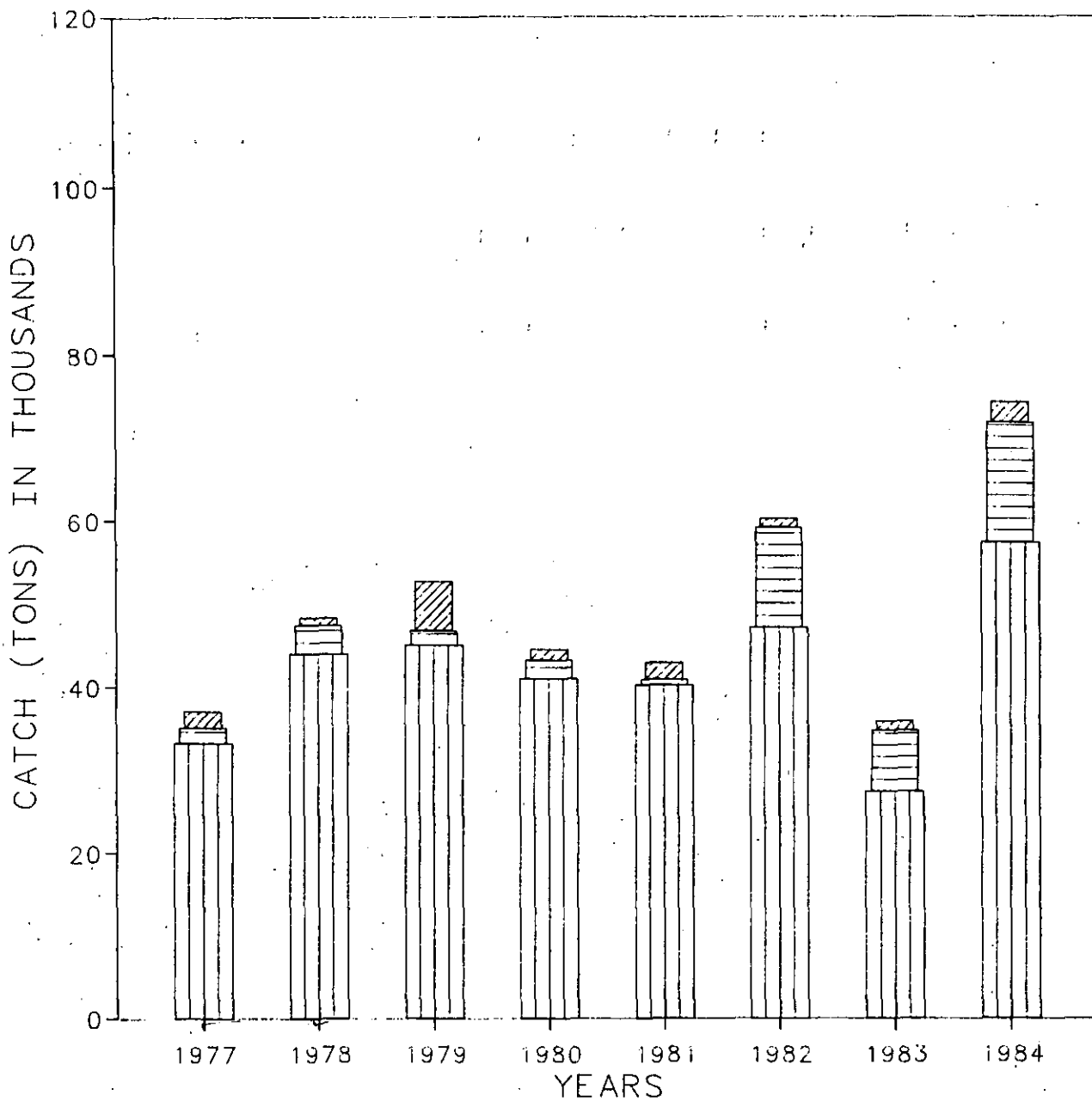


Figure 2. Nominal catches (t) of 4VHX silver hake by country.

Fig: 3 SILVER HAKE ABUNDANCE ESTIMATES FROM JULY RV SURVEYS

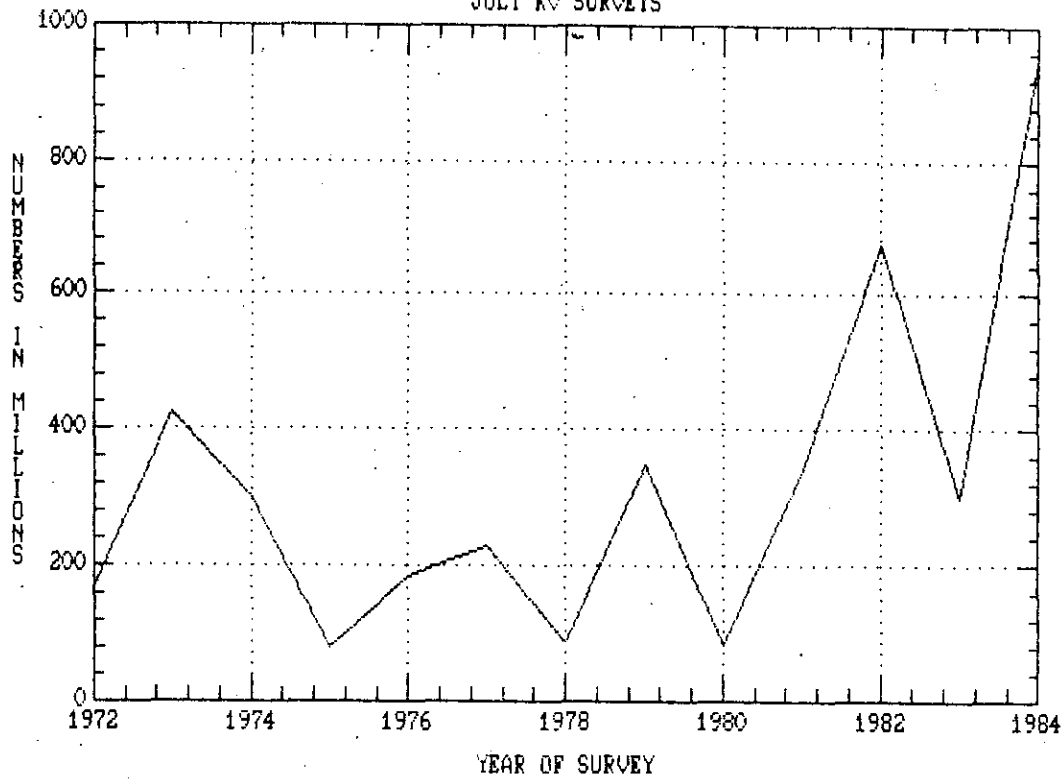


Fig: 4 SILVER HAKE ABUNDANCE ESTIMATES FROM MARCH RV SURVEYS

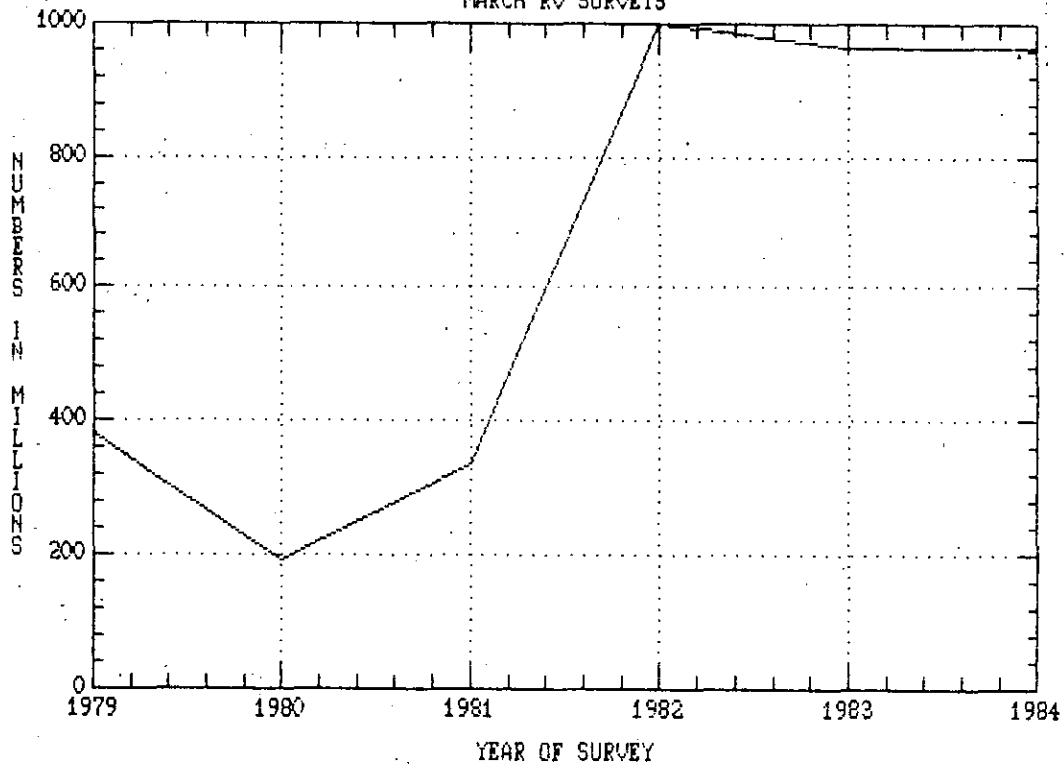
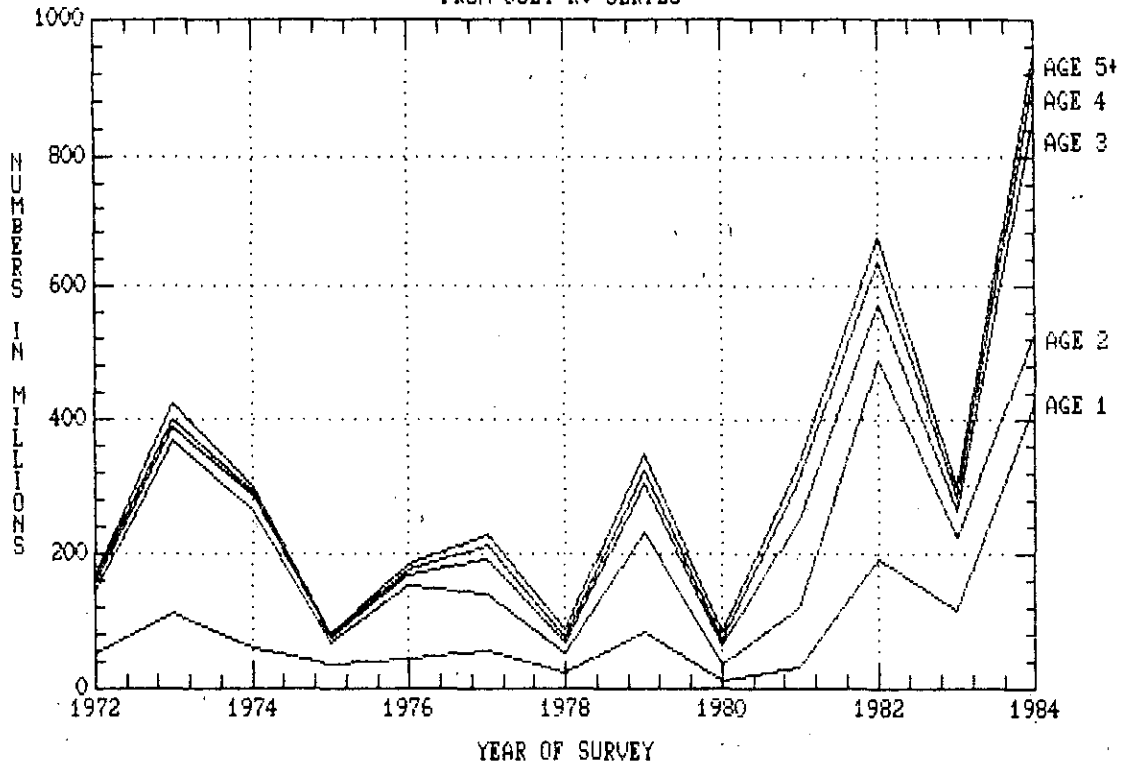


Fig. 5 SILVER HAKE CUMULATIVE ABUNDANCE AT AGE
FROM JULY RV SERIES



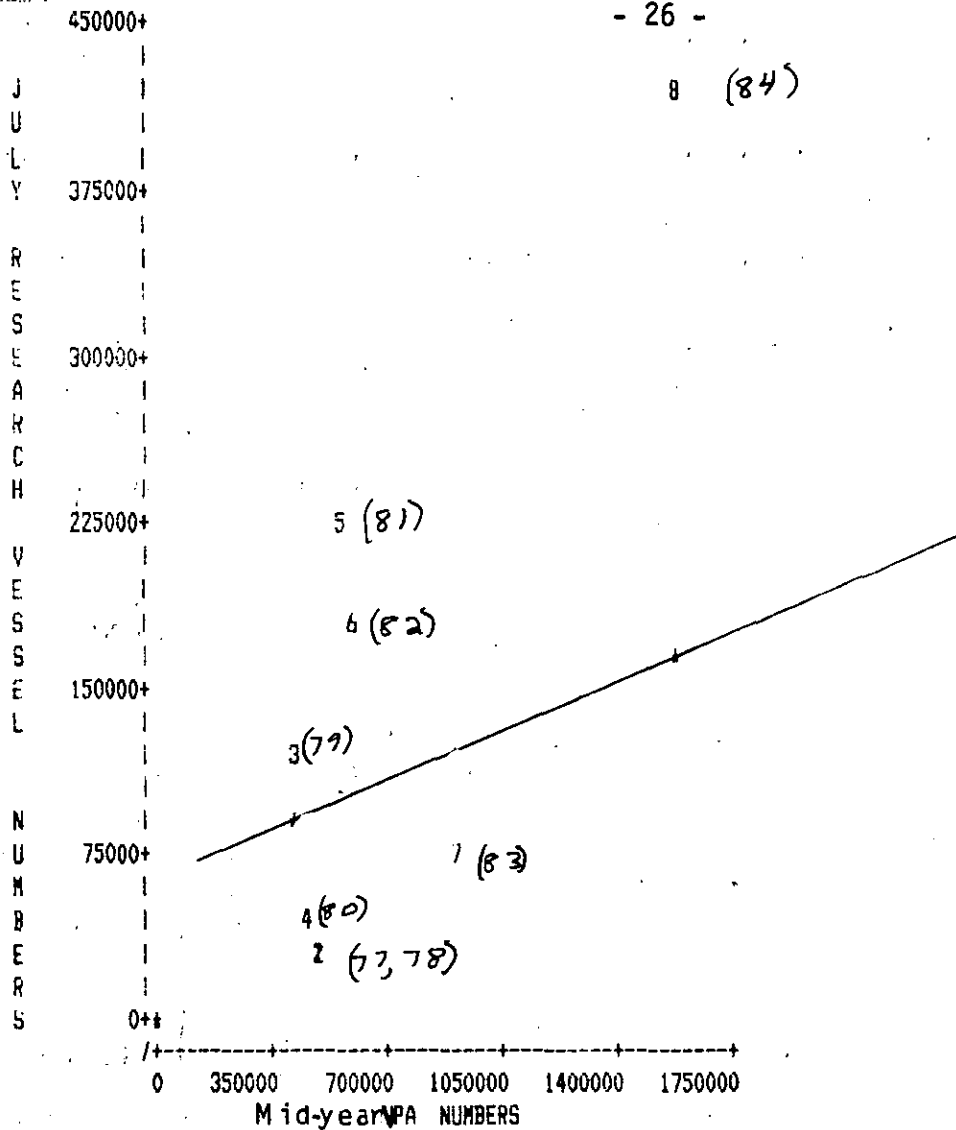


FIG. 6 CALCULATED AGES 3 - 9 RV NUMBERS ('000) AGAINST VPA NUMBERS ('000) FOR THE 4VMX SILVER HAKE STOCK. (R = .0.139).
 YEARS USED IN THE REGRESSION ANALYSIS ARE 1977 1978 1979 1980 1981 1982 1983

CALCULATED FOR AGES 3 - 9 NUMBERS ('000) FROM VPA AND RESEARCH VESSEL FOR THE 4VMX SILVER HAKE STOCK.

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
PRED	109374	104789	96383	90222	90816	94515	95653	91605	93145	100594	102874	121636	163710
VPA	710698	638197	505302	407902	417280	475763	493761	429762	454112	571886	607930	904559	1569745
DIFF	-83178	-49472	-56997	-78971	-58542	-65215	-58718	20922	-45749	117656	79621	-48517	251150
RES	26197	55317	39386	11251	32274	29300	36935	112527	47396	218251	182496	73119	414860

REGRESSION OF AGES 3 - 9 RESEARCH VESSEL AGAINST VPA NUMBERS ('000) FOR 4VMX SILVER HAKE:
 THE FOLLOWING YEARS WERE USED IN THE REGRESSION ANALYSIS
 1977 1978 1979 1980 1981 1982 1983

REGRESSION COEFFICIENT 0.06325054331
 INTERCEPT 64422.37072
 T-VALUE 0.313277461
 STANDARD ERROR 0.201899438
 DEGREES OF FREEDOM 6
 OBSERVATIONS 7
 R² 0.01925069031

• (84)

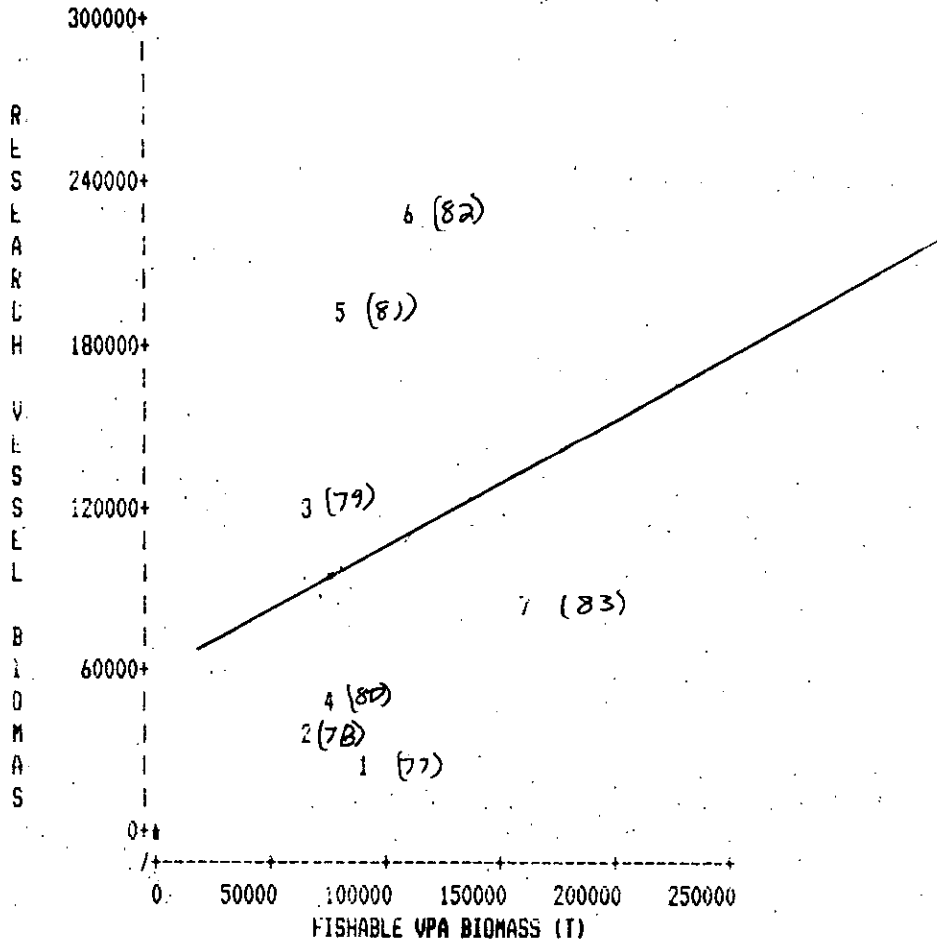


FIG. 7. CALCULATED FISHABLE RESEARCH VESSEL BIOMASS (T) ('000) AGAINST FISHABLE POP BIOMASS (T) ('000) FOR THE 4VMX SILVER HAKE STOCK. (R = 0.191).

CALCULATED FISHABLE POP BIOMASS ('000T) FROM VPA AND FISHABLE RESEARCH VESSEL BIOMASS ('000T) FOR THE 4VMX SILVER HAKE STOCK.

YEARS USED IN THE REGRESSION ARE 1977 1978 1979 1980 1981 1982 1983

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
PRED	176075	166275	136922	144858	141995	102158	92327	91613	95757	99695	112454	133147	162056
VPA	254564	232475	166316	184202	177749	87960	65802	64193	73533	82408	111165	157806	222965
DIFF	41737	193828	117006	78590	14834	73276	55502	32113	53437	87571	109751	747220	171310
RES	134338	360103	253928	57268	156829	28892	36825	123727	42321	187266	222204	85927	333366

REGRESSION OF RV FISHABLE BIOMASS ('000T) AGAINST POPULATION FISHABLE BIOMASS ('000T) FOR 4VMX SILVER HAKE:

REGRESSION COEFFICIENT 0.4436684362
 INTERCEPT 63132.98858
 T-VALUE 0.4355199264
 STANDARD ERROR 1.018709844
 DEGREES OF FREEDOM 6
 OBSERVATIONS 7
 R*2 0.03654901531
 R 0.1911779676

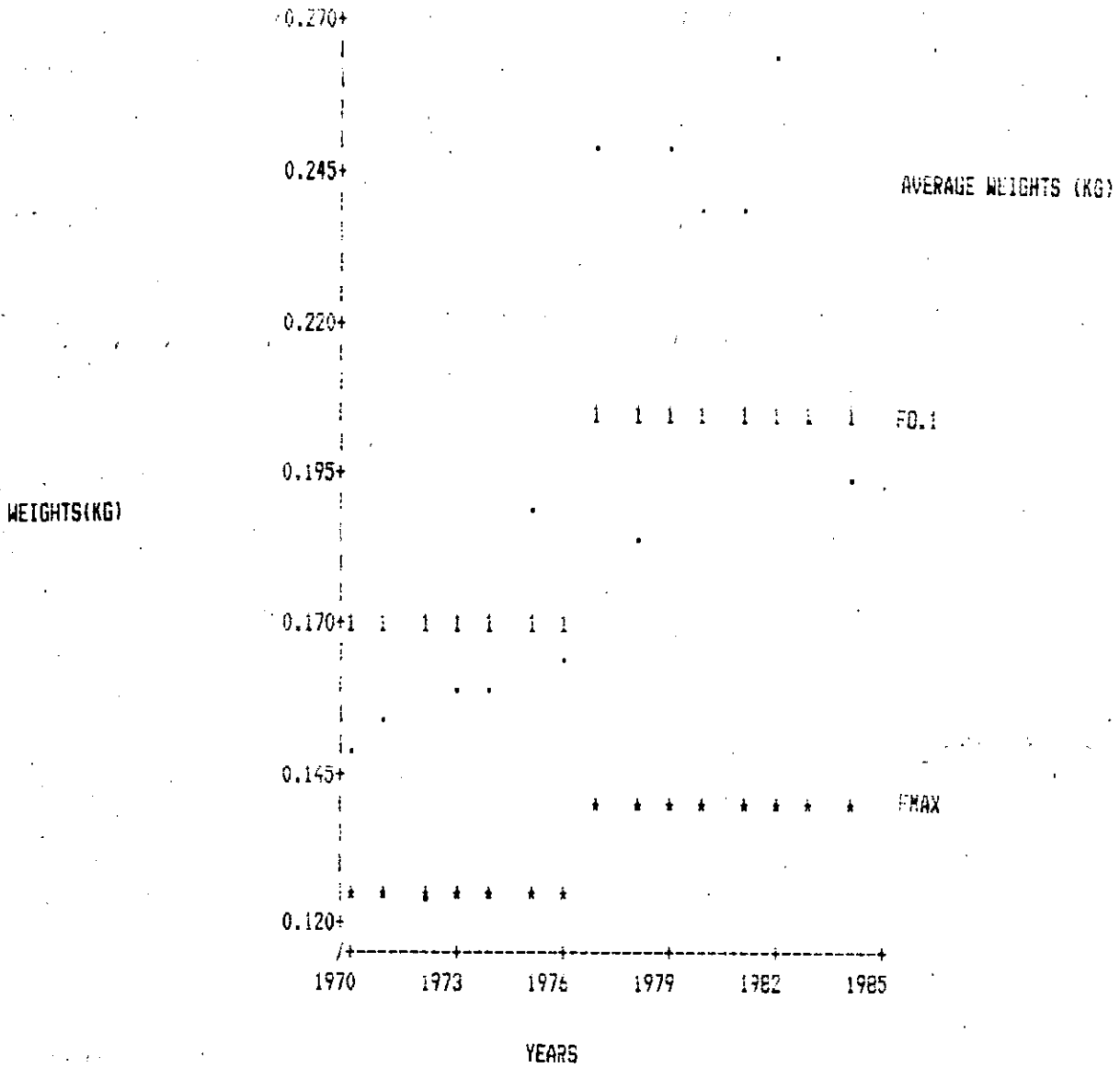


FIG 8 PLOT OF AVERAGE WEIGHT (KG) IN THE CATCH, AT F0.1 AND FMAX FOR SILVER HAKE.

AVERAGE WEIGHTS WEIGHTED BY CATCH FOR SILVER HAKE

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0.150	0.154	0.127	0.160	0.160	0.192	0.166	0.250	0.185	0.249	0.238	0.238	0.264	0.207	0.193