A FIRST ASSESSMENT OF GULF WHITE HAKE: NAFO DIVISION 4T / 1985

by

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ABSTRACT

Since 1970 landings from this small vessel inshore fishery have ranged from 3,616 tonnes in 1970 to a high of 14,039 tonnes in 1981. The 1984 nominal landings were 6,353 tonnes, a drop of 1,100 tonnes (12%) from 1983. In 1982 the first precautionary TAC was set at 12,000 tonnes.

Gillnet fisherman landed 57% of the total 1984 catch. Otter trawlers are the only other major gear category in this fishery at present. The current market (1984) for Gulf hake is depressed, especially in the salt fish portion, which may have lead to a decline in effort.

A commercial catch rate series was derived from landings per purchase slip (receipt) using all available data (1978 to 1984). These data were the only independent data available to calibrate the VPA model. The terminal F was estimated to be between 0.325 and 0.425. The Fo.1 falls within this range at 0.39. The strong contribution to the landings of the gillnet portion of the fishing fleet probably leads to a dome shaped partial recruitment pattern.

Initial catch projections indicate the precautionary TAC of 12,000 tonnes may have been overly optimistic. More realistic long term TAC's will probably be in the range of 8,000 to 9,000 tonnes.

RESUME

Depuis 1970, les débarquements en provenance de cette pêche côtière exploitée par de petits bateaux ont varié de 3 616 tonnes, en 1970, pour monter à 14 039 tonnes en 1981. Les débarquements nominaux se sont chiffrés à 6 353 tonnes en 1984, ce qui représente une baisse de 1 100 tonnes (12 %) par comparaison à ceux de 1983. En 1982, on a fixé par prudence le premier TPA à 12 000 tonnes.

Les bateaux de pêche au filet maillant ont débarqué 57 % du total des prises de 1984. Les chalutiers à panneaux sont actuellement les seuls autres engins de pêche d'importance dans cette pêche. Le fait que le marché du merlu du Golfe soit actuellement (1984) faible, en particulier en ce qui concerne le poisson salé, a peut-être entraîné une baisse de l'effort de pêche.

On a déterminé les taux de capture commerciale d'après toutes les données qu'on avait (de 1978 à 1984) sur les débarquements par bordereau d'achat (reçu). C'était là les seules données indépendantes qu'on pouvait utiliser pour étalonner le modèle d'APV. Selon les estimations, le F terminal se situerait entre 0,325 et 0,425. Le $F_{0,1}$ se trouve entre ces deux limites : il est de 0,39. Il est probable qu'en raison de l'importante proportion des débarquements effectués par les bateaux de pêche au filet maillant, on obtient un recrutement partiel en cloche.

D'après les prévisions de prise initiales, on aurait été trop optimiste en fixant le TPA à 12 000 tonnes. A l'avenir, pour être plus réaliste, on devrait fixer le TPA autour de 8 000 ou 9 000 tonnes.

INTRODUCTION

The fishery for white hake (Urophycis tenuis, Mitchill) in the southern Gulf of St. Lawrence usually does not commence until May. Landings peak between July and September and decline through October and November; 1984 was exceptional as the proportion of landings in November was higher than usual (Fig 1). The fishery is carried out mainly by small inshore vessels making it extremely dependent upon weather and local market conditions. Winter ice precludes inshore fishing from December until April each year. The majority of the fishery is carried out in the Northumberland Strait area, and on both the eastern and western ends of P.E.I. This fishery tends to be carried out by tonnage class 0 and 1 vessels using two gear types. The first group uses gillnets and longlines in the summer and, if the weather permits, longlines in the fall; the second group (>30% of the fishery), particularly that based in New Brunswick and Nova Scotia, uses small (<20m) draggers (Fig 2). Gill netters have steadily increased their proportion of the catch from 25% in the early 1970's to over 50% in 1984.

The provisional catch in 1984 (Table 1) of 6353 tonnes is a drop of 12% from the 7453 tonne catch of 1983 (Table 2). This fishery was not managed by a TAC until the precautionary quota of 12,000 tonnes was placed upon this stock in 1981 for the 1982 season.

Strong efforts were made during the last year by several processors in affliation with provincial governments to develop markets for fresh white hake in the eastern U.S.A.. Although there are several new promising market possibilities, a significant portion (15.2%) of the catch is still being salted despite the fact that the salt-fish portion of the fishery appears (from personal observation) to be in serious decline.

CATCH PER EFFORT - COMMERCIAL

Commercial catch per unit of effort (CPUE) series may be an indicator of stock abundance. Gulf hake are caught mainly by tonnage class 0 and 1 vessels; these vessels are not required to complete log books and therefore no estimate of effort is normally available. Daily landings were recorded from the purchase slips for the inshore component of the fleet fishing the Northumberland Strait and surrounding areas (Table 3). These data came from the 'transaction files' of the DFO Statistics Branch of the Martimes region (1978 - 1983) and the Gulf region (1984) and they were transformed to NAFO Table 5 type format. Each purchase slip is assumed to represent 1 day's fishing effort or 1 trip for the small vessels of the inshore fleet and thus the catch and effort by trip were derived from this data. Due to the variable nature of this fishery no single fleet component makes up a large enough percentage of the catch to be taken as representative of the entire stock. The multiplicative model (Gavaris, 1980) was

used to develop a CPUE series based on all major fleet components of the fishery (Table 3). The X-matrix (raw catch and effort data prepared for the multiplicative model) was generated using the computer software package NAFO/SELECT.

All individual daily purchase slips showing catches of 40 kg or less were dropped from the time series. This was done because many fishermen take small catches of hake home for personal use, this results in catches of less than 40 kg not being totally accounted for in the transaction file data set. The summed fortnightly catch, from the remaining purchase slips, was expressed in hundreds of kg, rounded to the nearest hundred. Three observations with extreme values were dropped. The resulting CPUE series shows the highest level occurring in 1981 and the lowest level in 1984.

This model with standards for gear and time chosen as OTB-2 and August respectively, gives a low correlation coefficient ($r2 = 0.264$), however the residual plots indicate a relatively normal non-biased distribution. The un-weighted results (Table 4, Fig 3 and 4) did not change with weighting by the logarithm of the catch, however weighting by the 4th root of the catch x effort produced a considerable curve in the expected normal - residual plot. The unweighted CPUE and effort series was used for all tuning in the VPA runs (Fig 5).

A second CPUE series was developed dropping both Scottish and Danish seiners as gear categories. This was done as it was not known if seiners would necessarily follow the same catch/effort relationship as otter trawlers and gillnetters. No difference was apparent in the relative annual CPUE, and thus the seiner catches were left in the final series.

RESEARCH DATA

The September groundfish cruise in the southern Gulf of St. Lawrence in 1984 was more extensive than in previous years with an additional two weeks survey time available. This extra time was used to fish additional inshore areas and stations in the Northumberland Strait area. These data have yet to be analysed, however there is strong evidence that the inshore areas do have higher concentrations of hake and juveniles of other species than the offshore areas. Preliminary feeding data collected from hake caught on this cruise indicates a preponderence of large (>30cm) herring in their diet.

Annual fluctuations in the mean number of hake per standard tow are not consistent with the multiplicative model results (Fig 6). As many of these data points represent only 200 to 300 fish caught during the entire fall groundfish cruise (approximately 70 sets), it is not felt that they are adequate indicators of fishable population abundance. However, this difference may suggest that the commercial CPUE series may be influenced by economic factors as well as by abundance.

ESTIMATION OF PARAMETERS

Partial recruitment

The partial recruitment (PR) was estimated by two techniques. The first used the average of the last four years' catch at age, estimated from commercial sampling, divided by the population at age, estimated from research vessel surveys, standardized on a yearly basis to the largest age-group of the catch-at-age. In all cases between 1980 and 1984 this standardized group was age 6. The smoothed mean PR reflects the importance of the gillnet component of the fishery in its domed shape (Fig 7). The second technique used the RFNS (Ratio-Normalized by Fully recruited ages - Smoothed) method (Rivard, MS1984) and achieved nearly the same dome-shaped PR vector.

Mortality

The natural mortality (M) was assumed to be 0.2 as is the case with comparable gadoid stocks of the Northwest Atlantic. Using the linear regression model of total mortality on longevity proposed by Hoenig (1983), the total mortality (Z) for white hake along the eastern seaboard of the US is 0.19 assuming a maximum age of 23 years (McBride and Brown, 1980). In the southern Gulf with a maximum age of 18 years the estimated Z is 0.25; this implies a lower M than our assumption (possibly in the range of 0.15). However with no other basis than this model and its wide confidence limits, an M of 0.2 is considered the most suitable estimate for the present.

The fishing mortality (F) on the oldest age group (F old) was chosen by an iterative technique. A starting estimate of 0.5 was used for all years and a VPA run was carried out at a fully recruited F of 0.3. The F old between 1979 and the present was then calculated as 0.25 (PR of 13 year olds) of the mean F of ages 7 to 9 (the fully recruited ages). This procedure was repeated twice and no change was noted after the second iteration. Because the proportion of gillnetters was less in the early to mid 1970's the F oldest for those years was set at 35% (1970 to 1973) and 30% (1974 to 1978) of the fully recruited F to reflect the higher percentage of trawler catches.

The fully recruited F was chosen by regressing the commercial CPUE index, from the multiplicative model, against both the total 5+ and exploitable 3+ VPA population biomass (Fig 8 and 9) and the effort index against the mean F weighted by population numbers (Fig 10). The highest correlation coefficient and the lowest residual for the 1984 point were used as the evaluation criteria (Table 5). This tuning process resulted in a final fully recruited F of 0.375 being selected. The correlation coefficients indicate a low sensitivity of values to F between 0.3 and 0.4 (Table 5).

Catch and Weights at-age

The catch-at-age matrix (Table 6) for the Gulf hake ages 3 to 13 from 1970 to 1984 was taken from Clay et al (MS1985). The

percent composition of the catch-at-age (Appendix I: Table 1) indicates the stability of the stock over the last six years. The weights at age for all years were taken as equal to those of 1984 (Fig 11). Weights-at-age for 1970 to 1982 were extremely variable (Fig 12 and 13) and unrealistic due to the sparse and thus poor sampling data prior to 1983, especially in the older age groups.

Yield per recruit

The yield per recruit (YPR) was calculated using the 1984 weights-at-age and the partial recruitment developed above with M=0.2 (Fig 14). The Fo.1 level was 0.387 and the Fmax was 1.022.

Fo.1 YIELD =	0.9537 kg	Fo.1 =	0.3870
Fmax YIELD =	1.0545 kg	Fmax =	1.0224

Other YPR runs were carried out using the mean weights-at-age between 1980 and 1984 and the mean PR between 1981 and 1983. The values of Fo.1 and Fmax for all combinations changed only in the third decimal place and so these options were not considered further.

ASSESSMENT RESULTS

Virtual population analysis (using the VPA software package - Fortran version) gave estimates of population numbers at age (Table 7), fishing mortality-at-age (Table 8) and biomass-at-age (Tables 9 and 10) from the input parameters (Table 11) described above. The exploitable biomass (Table 12) was calculated from the population numbers (Table 7) multiplied by the historical partial recruitment (Table 13) calculated for each year by standardizing the annual mean F between ages 7 to 9 to 1.0 and setting all other values over 1.0 to 1.0. The percent composition of the population numbers, catch biomass, and population biomass are presented in Appendix I (Tables 2,3,4).

The VPA was calibrated by regressing the VPA population biomass on the CPUE and the weighted F (weighted on population numbers) on effort (taken from the multiplicative model). The VPA biomass was used in two different manners: first total 5+ biomass (Table 10) and secondly as exploitable 3+ biomass (Table 12). The calibration results (Table 5) of total biomass on CPUE indicate a terminal F of about 0.375 (Fig 8) and of weighted F on effort about the same (Fig 10). However, the exploitable biomass relationships do not agree with these; indicating a terminal F of over 0.6 with CPUE and under 0.3 with weighted F (weighted by exploited population numbers) and effort. These latter two relationships are felt to be unlikely as both the 1983 and 1984 points are well off the line (Fig 9) indicating some factor other than abundance may be affecting the relationship. It should be re-iterated that the price for white hake has not kept pace with inflation over the past 3 or 4 years and it has therefore become an economically less attractive fish.

Because of doubts surrounding the 1984 (and 1983) catch rate level no accurate estimate can be made of the terminal F in 1984. It is felt that the value of 0.375 may be reasonably close with a possible range of 0.325 to 0.425.

The population numbers indicate a marked change in recruitment over the last 15 years, however, those estimates from 1977 onwards are the only ones assumed to be representative of the fishery. The GM recruitment from 1977 to 1983 is approximately 9.5 million fish at age 3. Recruitment appears relatively strong in 1977 and 1978 (the 74 and 75 year classes) and again in 1982 and 1983 (the 79 and 80 year classes). This agrees quite well with the research vessel numbers per standard tow (Fig 6) and indicates a potential recruitment index for this stock. In general the recruitment at age 3 appears to be stable with fluctuations in the order of <25% of the mean. Interpretations such as these must be viewed very critically, for as was pointed out by Clay et al (MS1985), there are great changes in the length frequency distribution between NAFO sub-divisions and between months. Thus, inconsistent sampling could produce the illusion of strong or weak year classes from time to time.

CATCH PROJECTIONS

Two series of catch projections were run. The first used a catch level set at an Fo.1 of 0.387. With the geometric mean (GM) recruitment of 9.542 million fish (GM of 1977 to 1983), an M = 0.2, and the partial recruitment and weights at age of 1984 the projected catch for 1986 is 8,870 tonnes with steady small increases into the future (Table 14). The population biomass (Table 15) also shows a steady increase (nearly 1000 tonnes per annum). The second scenario with a fixed catch level of 10,000 tonnes (less than the 12,000 tonne provisional quota) results in a steadily decreasing population biomass, falling at nearly 600 tonnes per annum.

As the inshore fleet fishes a mix of stocks and is relatively stable in both composition and size, there seems to be built in regulator that has kept the exploitation of the hake at close to the optimal level. However if some factor arose that permitted the fleet to catch the precautionary quota in most years, this analysis shows there could be serious harm done to the stock. It is therefore advisable to consider a more conservative quota that may be adjusted every one or two years, as data indicate changes are required.

The recommended long term TAC would therefore be in the range of 8000 to 9000 tonnes - a 3 to 4 thousand tonne reduction from the current estimate.

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Table 1. Nominal landings of white hake from NAFO division 4T in 1984 by gear and month. All data are provisional statistics. Quebec (460 tonnes) and Scotia-Fundy (11 tonnes) data are combined on a monthly basis. No landings were reported from Newfoundland.

			GULF REGION			
YEAR::GEAR	TRAWL	SEINE	LINE	GILLNET	OTHER	TOTAL
JANUARY	0	2	6	5	0	13
FEBRUARY	0	0	0	7	0	7
MARCH	0	0	0	0	0	0
APRIL	0	2	4	0	0	6
MAY	2	14	2	15	0	33
JUNE	118	58	16	236	7	435
JULY	548	27	25	891	6	1497
AUGUST	309	28	50	904	4	1295
SEPTEMBER	112	22	50	585	2	771
OCTOBER	225	175	153	182	22	757
NOVEMBER	280	103	270	385	11	1049
DECEMBER	0	0	1	13	0	14
UNKNOWN	0	1	1	2	1	5
sub-total	1594	432	578	3225	53	5882
		QUEBEC -	SCOTIA FUNDY	REGIONS		
MAY	0	0	1	52	0	53
JUNE	0	0	6	57	1	64
JULY	0	2	9	46	22	79
AUGUST	1	0	8	104	4	117
SEPTEMBER	1	0	5	96	2	104
OCTOBER	0	0	8	36	0	44
NOVEMBER	0	0	8	0	0	8
DECEMBER	0	0	2	0	0	2
sub-total	2	2	47	391	29	471
TOTAL	1596	434	625	3616	82	6353

Table 2. Nominal landings of white hake from NAFO division 4T by gear and by year. All data from 1984 are provisional.

YEAR::GEAR	TRAWL	SEINE	LINE	GILLNET	OTHER	TOTAL
1970	1463	382	385	2149	1289	5668
1971	1523	632	702	1622	1228	5707
1972	1140	863	1604	1190	960	5757
1973	2468	211	1045	1265	713	5702
1974	1454	305	345	1100	412	3616
1975	1576	306	324	1285	634	4125
1976	1429	398	183	1147	601	3758
1977	1227	408	231	1300	818	3984
1978	1303	729	456	1829	508	4825
1979	2826	912	479	3189	704	8110
1980	3430	1615	832	4831	1715	12423
1981	4733	1922	799	6174	411	14039
1982	2956	998	1173	4668	558	10353
1983	2177	907	856	2967	546	7453
1984	1596	434	625	3616	82	6353
AVERAGE	2087	735	669	2556	745	6792
PERCENT	31	11	10	38	11	

Table 3. The three category types and their associated categories used to run the Gavaris multiplicative model for the Gulf hake using commercial catch and effort data from 1978 to 1984. (Note: fourth category type is years.)

STATISTICAL DISTRICT

CODE	AREA
2	CHETICAMP
3	EAST ST GEORGES BAY
12	PICTOU
13	WEST ST GEORGES BAY
75	RICHIBUCTO
76	BOUCTOUCHE
77	SHEDIAC
80	CAPE TORMENTINE
82	TIGNISH
87	MURRAY HARBOUR
88	SOURIS
92	COW POND

GEAR

CODE	NAME
6	GN
11	OTB-1
12	OTB-2
17	SDN
18	SSC

TIME PERIODS

CODE	PERIOD
1	MAY 15-MAY 31
2	JUN 1-JUN 14
3	JUN 15-JUN 30
4	JUL 1-JUL 14
5	JUL 15-JUL 31
6	AUG 1-AUG 14
7	AUG 15-AUG 31
8	SPT 1-SPT 14
9	SPT 15-SPT 30
10	OCT 1-OCT 14
11	OCT 15-OCT 31
12	NOV 1-DEC 31

Table 4. Output for Gulf hake catch and effort data from 1978 to 1984 from the multiplicative model.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R.....0.514
MULTIPLE R SQUARED.....0.264

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	4.222E3	4.222E3	
REGRESSION	32	4.284E2	1.339E1	15.409
TYPE 1	11	2.029E2	1.845E1	21.233
TYPE 2	4	1.959E1	4.899E0	5.638
TYPE 3	11	6.515E1	5.923E0	6.817
TYPE 4	6	8.889E1	1.482E1	17.052
RESIDUALS	1375	1.195E3	8.688E-1	
TOTAL	1408	5.845E3		

REGRESSION COEFFICIENTS

VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
INTERCEPT	0.856	0.170	1408
1	-0.515	0.093	173
2	0.365	0.151	58
3	-0.080	0.115	129
4	-0.551	0.146	56
5	0.227	0.150	55
6	0.745	0.244	17
7	0.337	0.173	39
8	-0.558	0.108	136
9	0.565	0.095	216
10	0.139	0.098	203
11	-0.468	0.129	79
12	-0.167	0.081	249
13	-0.191	0.078	275
14	-0.005	0.078	288
15	0.521	0.121	75
16	0.544	0.170	101
17	0.746	0.164	137
18	0.791	0.163	148
19	0.707	0.162	164
20	0.658	0.165	136
21	0.647	0.164	139
22	0.527	0.168	119
23	0.825	0.166	123
24	0.753	0.168	115
25	1.122	0.170	102
26	1.541	0.177	80
27	0.143	0.096	198
28	0.303	0.095	204
29	0.478	0.092	246
30	0.190	0.097	213
31	0.185	0.103	171
32	-0.080	0.100	190

Table 5. The correlation coefficient and residuals for selected fully recruited F levels. These regressions were run for the CPUE series from the multiplicative model and the 5+ total VPA population biomass, the 3+ exploitable VPA population biomass and the F (weighted by VPA population numbers) and effort.

	CPUE vs total VPA bio.				CPUE vs exploitable VPA bio.		
F fully rec.	r^2	Res84	Res83	:	r^2	Res84	Res83
.2	0.08	10980	336	:			
.3	0.56	3515	4021	:	0.36	6631	4168
.35	0.62	1392	5080	:	0.53	4854	4585
.375	0.61	147	5728	:	0.59	4142	4746
.4	0.61	195	5863	:	0.64	3523	4892
.45	0.57	1681	6622	:	0.69	2482	5126
.5	0.55	2667	7113	:	0.72	1655	
.6				:	0.73	407	

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	F wt.(tot.pop.numb.) vs effort				F wt.(exp.pop.numb.) vs effort		
F fully rec.	r2	Res84	Res83	:	r2	Res84	Res83
.2	0.69	0.088	0.001	:			
.3	0.76	0.063	0.041	:	0.70	0.113	0.079
.35	0.76	0.047	0.060	:	0.67	0.099	0.100
.375	0.75	0.035	0.074	:	0.66	0.091	0.110
.4	0.75	0.029	0.078	:	0.64	0.082	0.120
.45	0.69	0.010	0.094	:	0.60	0.064	0.137
.5	0.64	0.010	0.109	:	0.56	0.044	
.6				:	0.47	0.015	
.7				:	0.39	0.044	

Table 6. Catch numbers at age of Gulf hake from NAFO Division 4T by year.

Catch numbers in thousands of GULF hake DATE = 3.5.85:6

YEAR :	70	71	72	73	74	75	76
AGE :							
3 :	90.	88.	95.	83.	51.	58.	84.
4 :	740.	748.	662.	519.	259.	222.	310.
5 :	834.	835.	781.	690.	393.	404.	450.
6 :	477.	469.	507.	479.	307.	356.	346.
7 :	390.	396.	422.	472.	324.	393.	303.
8 :	150.	151.	173.	199.	141.	177.	137.
9 :	77.	81.	88.	112.	81.	102.	70.
10 :	44.	45.	46.	52.	34.	43.	29.
11 :	13.	15.	13.	13.	8.	8.	5.
12 :	7.	8.	8.	9.	5.	7.	9.
13 :	6.	6.	6.	8.	5.	5.	3.
3+ :	2828.	2842.	2801.	2636.	1608.	1775.	1746.
4+ :	2738.	2754.	2706.	2553.	1557.	1717.	1662.
5+ :	1998.	2006.	2044.	2034.	1298.	1495.	1352.
6+ :	1164.	1171.	1263.	1344.	905.	1091.	902.

YEAR :	77	78	79	80	81	82	83	84
AGE :								
3 :	90.	83.	94.	94.	68.	5.	60.	54.
4 :	346.	370.	489.	469.	442.	123.	135.	381.
5 :	490.	605.	866.	1066.	1112.	596.	627.	714.
6 :	376.	569.	1011.	1723.	2043.	1239.	829.	776.
7 :	314.	360.	699.	1240.	1438.	1204.	642.	471.
8 :	142.	180.	328.	560.	625.	601.	419.	239.
9 :	69.	64.	105.	142.	159.	163.	246.	142.
10 :	30.	27.	49.	78.	97.	86.	75.	48.
11 :	5.	4.	8.	7.	4.	23.	5.	18.
12 :	8.	8.	11.	6.	1.	10.	4.	9.
13 :	3.	2.	7.	9.	13.	16.	1.	1.
3+ :	1873.	2272.	3667.	5394.	6002.	4066.	3043.	2853.
4+ :	1783.	2189.	3573.	5300.	5934.	4061.	2983.	2799.
5+ :	1437.	1819.	3084.	4831.	5492.	3938.	2848.	2418.
6+ :	947.	1214.	2218.	3765.	4380.	3342.	2221.	1704.

Table 7. Population numbers at age of Gulf hake from NAFO Division 4T by year.

Population numbers in thousands of GULF hake DATE = 3.5.85:6

YEAR :	70	71	72	73	74	75	76
AGE :							
3 :	5667.	5313.	4755.	3966.	4884.	7263.	9937.
4 :	4857.	4558.	4270.	3808.	3172.	3952.	5894.
5 :	3103.	3310.	3059.	2900.	2650.	2363.	3036.
6 :	1816.	1791.	1960.	1802.	1754.	1815.	1571.
7 :	1013.	1058.	1045.	1149.	1046.	1160.	1166.
8 :	477.	481.	512.	478.	519.	565.	597.
9 :	258.	256.	258.	264.	213.	298.	304.
10 :	166.	142.	137.	132.	116.	102.	153.
11 :	85.	97.	76.	71.	62.	64.	45.
12 :	59.	58.	66.	51.	46.	43.	46.
13 :	51.	42.	40.	46.	33.	33.	29.
3+ :	17552.	17106.	16178.	14667.	14495.	17660.	22778.
4+ :	11885.	11793.	11422.	10702.	9611.	10398.	12841.
5+ :	7028.	7235.	7152.	6894.	6439.	6445.	6947.
6+ :	3925.	3925.	4093.	3994.	3789.	4082.	3911.

YEAR :	77	78	79	80	81	82	83	84
AGE :								
3 :	12497.	12392.	8869.	7009.	7259.	8604.	9444.	6384.
4 :	8060.	10150.	10071.	7176.	5653.	5882.	7039.	7678.
5 :	4546.	6287.	7976.	7804.	5452.	4230.	4705.	5641.
6 :	2080.	3280.	4602.	5750.	5429.	3464.	2926.	3287.
7 :	975.	1365.	2173.	2858.	3161.	2615.	1726.	1652.
8 :	683.	517.	794.	1152.	1232.	1304.	1066.	838.
9 :	366.	431.	262.	357.	444.	451.	531.	498.
10 :	186.	238.	295.	120.	165.	221.	224.	215.
11 :	99.	125.	170.	198.	29.	49.	104.	116.
12 :	33.	76.	99.	132.	156.	21.	19.	81.
13 :	29.	19.	55.	71.	103.	126.	8.	12.
3+ :	29553.	34880.	35366.	32627.	29084.	26967.	27792.	26402.
4+ :	17056.	22488.	26497.	25619.	21824.	18363.	18348.	20018.
5+ :	8996.	12338.	16427.	18442.	16171.	12481.	11309.	12340.
6+ :	4450.	6051.	8450.	10639.	10719.	8251.	6604.	6698.

Table 8. Fishing mortality at age for Gulf hake from NAFO Division 4T by year. Highest F level for each year in bold face type.

Fishing mortality of GULF hake DATE = 3.5.85:6

YEAR :	70	71	72	73	74	75	76
AGE :							
3 :	0.017	0.018	0.022	0.023	0.011	0.008	0.009
4 :	0.183	0.199	0.187	0.163	0.094	0.063	0.059
5 :	0.349	0.324	0.329	0.303	0.178	0.208	0.178
6 :	0.340	0.339	0.334	0.345	0.214	0.243	0.277
7 :	**0.546**	**0.526**	**0.582**	0.596	0.415	0.464	**0.336**
8 :	0.422	0.422	0.462	0.606	0.354	0.420	0.290
9 :	0.396	0.426	0.468	**0.622**	**0.536**	0.470	0.291
10 :	0.343	0.425	0.459	0.561	0.388	**0.615**	0.234
11 :	0.185	0.187	0.208	0.225	0.154	0.147	0.130
12 :	0.139	0.165	0.144	0.217	0.127	0.195	0.245
13 :	0.140	0.170	0.180	0.210	0.180	0.180	0.120
MEAN :	0.278	0.291	0.307	0.352	0.241	0.274	0.197
MEAN/POP:	0.207	0.213	0.224	0.236	0.138	0.127	0.093

YEAR :	77	78	79	80	81	82	83	84
AGE :								
3 :	0.007	0.007	0.011	0.014	0.010	0.000	0.007	0.009
4 :	0.048	0.041	0.055	0.074	0.090	0.023	0.021	0.056
5 :	0.126	0.112	0.127	0.163	0.254	0.168	0.159	0.150
6 :	0.222	0.212	0.276	0.398	0.530	0.497	0.372	0.300
7 :	**0.435**	0.342	0.434	0.642	0.686	0.697	0.522	**0.375**
8 :	0.259	**0.480**	**0.600**	0.754	0.804	0.699	0.561	**0.375**
9 :	0.232	0.178	0.577	0.571	0.498	0.503	**0.704**	**0.375**
10 :	0.195	0.134	0.201	**1.207**	**1.017**	0.554	0.458	0.281
11 :	0.057	0.035	0.053	0.039	0.162	0.721	0.054	0.188
12 :	0.314	0.123	0.131	0.051	0.007	**0.756**	0.256	0.131
13 :	0.120	0.120	0.150	0.150	0.150	0.150	0.150	0.093
MEAN :	0.183	0.162	0.238	0.370	0.383	0.434	0.297	0.212
MEAN/POP:	0.076	0.078	0.130	0.223	0.289	0.212	0.145	0.134

Table 9. Catch biomass in tonnes of Gulf hake from NAFO Division 4T by year.

Catch biomass in tonnes of GULF hake DATE = 3.5.85:6

YEAR :	70	71	72	73	74	75	76
AGE :							
3 :	94.	92.	99.	86.	53.	60.	87.
4 :	955.	965.	854.	670.	334.	286.	400.
5 :	1393.	1394.	1304.	1152.	656.	675.	752.
6 :	1054.	1036.	1120.	1059.	678.	787.	765.
7 :	1045.	1061.	1131.	1265.	868.	1053.	812.
8 :	485.	488.	559.	643.	455.	572.	443.
9 :	272.	286.	311.	395.	286.	360.	247.
10 :	193.	198.	202.	228.	149.	189.	127.
11 :	60.	69.	60.	60.	37.	37.	23.
12 :	42.	48.	48.	54.	30.	42.	54.
13 :	54.	54.	54.	72.	45.	45.	27.
3+ :	**5646.**	**5691.**	**5742.**	**5684.**	**3593.**	**4106.**	**3737.**
4+ :	5552.	5599.	5643.	5598.	3540.	4046.	3649.
5+ :	4598.	4635.	4789.	4928.	3206.	3759.	3249.
6+ :	3205.	3240.	3485.	3776.	2549.	3084.	2498.

YEAR :	77	78	79	80	81	82	83	84
AGE :								
3 :	94.	86.	98.	98.	71.	5.	62.	56.
4 :	446.	477.	631.	605.	570.	159.	174.	491.
5 :	818.	1010.	1446.	1780.	1857.	995.	1047.	1192.
6 :	831.	1257.	2234.	3808.	4515.	2738.	1832.	1715.
7 :	842.	965.	1873.	3323.	3854.	3227.	1721.	1262.
8 :	459.	581.	1059.	1809.	2019.	1941.	1353.	772.
9 :	244.	226.	371.	501.	561.	575.	868.	501.
10 :	132.	119.	215.	342.	426.	378.	329.	211.
11 :	23.	18.	37.	32.	18.	106.	23.	83.
12 :	48.	48.	66.	36.	6.	60.	24.	54.
13 :	27.	18.	63.	81.	117.	144.	9.	9.
3+ :	**3963.**	**4807.**	**8094.**	**12416.**	**14014.**	**10328.**	**7443.**	**6347.**
4+ :	3869.	4720.	7996.	12318.	13944.	10323.	7381.	6291.
5+ :	3423.	4243.	7365.	11713.	13374.	10165.	7207.	5799.
6+ :	2605.	3233.	5919.	9933.	11516.	9169.	6160.	4607.

Table 10. Population biomass in tonnes of Gulf hake in NAFO Division 4T by year.

Population biomass in tonnes of GULF hake DATE = 3.5.85:6

YEAR :	70	71	72	73	74	75	76
AGE :							
3 :	5893.	5526.	4946.	4124.	5079.	7553.	10335.
4 :	6265.	5880.	5509.	4912.	4092.	5099.	7603.
5 :	5181.	5528.	5108.	4843.	4425.	3947.	5069.
6 :	4013.	3958.	4331.	3983.	3877.	4012.	3472.
7 :	2716.	2836.	2801.	3080.	2802.	3109.	3125.
8 :	1540.	1552.	1653.	1544.	1675.	1826.	1930.
9 :	912.	903.	911.	932.	754.	1052.	1073.
10 :	729.	625.	601.	581.	509.	449.	670.
11 :	389.	443.	350.	325.	284.	296.	208.
12 :	356.	347.	394.	305.	278.	261.	274.
13 :	457.	381.	362.	419.	302.	302.	264.
3+ :	28453.	27980.	26964.	25048.	24076.	27904.	34022.
4+ :	22559.	22454.	22019.	20924.	18997.	20351.	23688.
5+ :	16294.	16574.	16510.	16012.	14905.	15252.	16085.
6+ :	11113.	11046.	11402.	11169.	10480.	11306.	11015.

YEAR :	77	78	79	80	81	82	83	84
AGE :								
3 :	12997.	12888.	9224.	7289.	7550.	8948.	9822.	6639.
4 :	10397.	13094.	12991.	9258.	7293.	7588.	9081.	9905.
5 :	7591.	10499.	13321.	13033.	9105.	7064.	7857.	9421.
6 :	4597.	7249.	10170.	12707.	11998.	7655.	6467.	7264.
7 :	2614.	3657.	5824.	7660.	8473.	7009.	4625.	4426.
8 :	2205.	1669.	2564.	3722.	3979.	4212.	3444.	2707.
9 :	1292.	1522.	924.	1259.	1567.	1593.	1874.	1758.
10 :	817.	1043.	1296.	529.	724.	970.	981.	944.
11 :	453.	575.	781.	907.	135.	224.	477.	532.
12 :	196.	459.	595.	794.	935.	123.	117.	484.
13 :	264.	176.	499.	642.	928.	1142.	71.	111.
3+ :	43422.	52830.	58189.	57799.	52686.	46528.	44816.	44191.
4+ :	30425.	39942.	48966.	50511.	45136.	37580.	34994.	37552.
5+ :	20028.	26848.	35974.	41253.	37843.	29992.	25913.	27647.
6+ :	12436.	16349.	22654.	28220.	28738.	22929.	18056.	18226.

Table 11. Initial input parameters for the VPA run used for the selected run.

PARAMETERS USED IN VIRTUAL POPULATION ANALYSIS OF :- RUN = 3.5.85:6

GULF hake / NAFO Division 4T 1984

FOR 11 AGE GROUPS AND 15 YEARS

NATURAL MORTALITY **M** = **0.20** AND A FULLY RECRUITED F = **0.350**

AGE	3	4	5	6	7	8	9	10	11
PARTIAL RECRUITMENT	0.025	0.150	0.400	0.800	1.000	1.000	1.000	0.750	0.500
WEIGHT AT AGE(84)	1.040	1.290	1.670	2.210	2.680	3.230	3.530	4.390	4.590

AGE	12	13
PARTIAL RECRUITMENT	0.350	0.250
WEIGHT AT AGE(84)	6.010	9.030

YEAR	70	71	72	73	74	75	76	77	78
F OLDEST AGE GROUP	0.140	0.170	0.180	0.210	0.180	0.180	0.120	0.120	0.120

YEAR	79	80	81	82	83	84
F OLDEST AGE GROUP	0.150	0.150	0.150	0.150	0.150	0.087

Table 12. Fishable population biomass of Gulf hake from NAFO Division 4T by year. Population numbers from Table 7 multiplied by the partial recruitment from Table 13.

YEAR :	70	71	72	73	74	75	76	77
AGE :								
3 :	228.	222.	218.	158.	134.	147.	314.	332.
4 :	2527.	2554.	2043.	1313.	886.	722.	1485.	1629.
5 :	3981.	3911.	3333.	2411.	1812.	1821.	2952.	3104.
6 :	2999.	2926.	2870.	2258.	1904.	2158.	3145.	3297.
7 :	2715.	2835.	2801.	3016.	2674.	3109.	3125.	2613.
8 :	1431.	1432.	1517.	1539.	1365.	1700.	1830.	1853.
9 :	792.	840.	845.	932.	752.	1052.	1023.	971.
10 :	550.	578.	548.	535.	454.	448.	515.	516.
11 :	158.	182.	144.	121.	101.	96.	88.	84.
12 :	109.	126.	114.	109.	80.	112.	221.	198.
13 :	142.	141.	129.	143.	123.	119.	103.	102.
3+ :	**15632.**	**15748.**	**14561.**	**12536.**	**10285.**	**11483.**	**14801.**	**14701.**
4+ :	15404.	15526.	14343.	12378.	10151.	11336.	14486.	14369.
5+ :	12878.	12971.	12300.	11065.	9265.	10614.	13001.	12739.
6+ :	8897.	9061.	8967.	8654.	7453.	8793.	10049.	9635.
7+ :	5897.	6134.	6096.	6396.	5548.	6635.	6904.	6338.

YEAR :	78	79	80	81	82	83	84
AGE :							
3 :	286.	201.	166.	117.	8.	115.	165.
4 :	1611.	1330.	1055.	991.	279.	325.	1484.
5 :	3528.	3157.	3238.	3487.	1881.	2091.	3768.
6 :	4602.	5228.	7717.	9606.	6008.	4037.	5811.
7 :	3658.	4710.	7496.	8471.	7008.	4055.	4427.
8 :	1670.	2565.	3721.	3979.	4212.	3244.	2707.
9 :	814.	925.	1098.	1177.	1265.	1874.	1758.
10 :	419.	486.	527.	724.	850.	755.	708.
11 :	62.	77.	55.	32.	225.	44.	266.
12 :	168.	145.	62.	10.	126.	49.	170.
13 :	62.	139.	147.	211.	270.	18.	27.
3+ :	**16878.**	**18961.**	**25280.**	**28807.**	**22132.**	**16608.**	**21292.**
4+ :	16592.	18761.	25114.	28690.	22123.	16492.	21128.
5+ :	14982.	17430.	24060.	27699.	21844.	16168.	19643.
6+ :	11454.	14273.	20822.	24212.	19963.	14077.	15875.
7+ :	6852.	9046.	13105.	14606.	13955.	10040.	10064.

Table 13. Historical partial recruitment by year calculated from the fishing mortality (Table 8). Standardized to the mean F of age groups 7 to 9 with all values over 1.0 set to 1.0.

YEAR :	70	71	72	73	74	75	76	77
AGE:								
3 :	0.0387	0.0401	0.0440	0.0383	0.0264	0.0195	0.0304	0.0255
4 :	0.4033	0.4344	0.3709	0.2672	0.2166	0.1416	0.1953	0.1567
5 :	0.7682	0.7075	0.6525	0.4978	0.4094	0.4615	0.5823	0.4089
6 :	0.7474	0.7394	0.6626	0.5669	0.4913	0.5380	0.9058	0.7171
7 :	**1.0000**	**1.0000**	**1.0000**	**0.9795**	**0.9538**	**1.0000**	**1.0000**	**1.0000**
8 :	**0.9290**	**0.9214**	**0.9170**	**0.9971**	**0.8140**	**0.9314**	**0.9490**	**0.8402**
9 :	**0.8701**	**0.9295**	**0.9280**	**1.0000**	**1.0000**	**1.0000**	**0.9532**	**0.7518**
10 :	0.7546	0.9280	0.9107	0.9234	0.8910	1.0000	0.7668	0.6320
11 :	0.4059	0.4091	0.4124	0.3705	0.3533	0.3256	0.4239	0.1858
12 :	0.3061	0.3611	0.2864	0.3572	0.2910	0.4331	0.8001	1.0000
13 :	0.3078	0.3711	0.3572	0.3454	0.4138	0.3990	0.3925	0.3885

YEAR :	78	79	80	81	82	83	84
AGE:							
3 :	0.0222	0.0217	0.0227	0.0155	0.0009	0.0117	0.0248
4 :	0.1230	0.1024	0.1139	0.1359	0.0368	0.0357	0.1499
5 :	0.3360	0.2370	0.2484	0.3830	0.2662	0.2662	0.4000
6 :	0.6348	0.5140	0.6073	0.8006	0.7848	0.6243	0.8000
7 :	**1.0000**	**0.8087**	**0.9786**	**1.0000**	**1.0000**	**0.8767**	**1.0000**
8 :	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**0.9421**	**1.0000**
9 :	**0.5349**	**1.0000**	**0.8714**	**0.7512**	**0.7943**	**1.0000**	**1.0000**
10 :	0.4011	0.3751	1.0000	1.0000	0.8760	0.7682	0.7501
11 :	0.1074	0.0990	0.0607	0.2440	1.0000	0.0914	0.5000
12 :	0.3678	0.2430	0.0782	0.0107	1.0000	0.4303	0.3501
13 :	0.3600	0.2793	0.2288	0.2265	0.2370	0.2517	0.2499

Table 14. Catch biomass in tonnes of Gulf hake from NAFO Division 4T by year as projected to 1990 using an Fo.1 of 0.387.

Catch biomass in tonnes of GULF hake <PROJECTIONS DATE = 4.5.85:3

YEAR :	85	86	87	88	89	90
AGE :						
3 :	82.	82.	82.	82.	82.	82.
4 :	355.	492.	492.	492.	492.	492.
5 :	1410.	942.	1313.	1313.	1313.	1313.
6 :	2504.	2601.	1748.	2437.	2437.	2437.
7 :	1915.	2267.	2368.	1592.	2219.	2219.
8 :	1079.	1275.	1519.	1587.	1067.	1487.
9 :	598.	652.	775.	923.	964.	648.
10 :	331.	308.	338.	402.	479.	500.
11 :	109.	141.	132.	144.	172.	204.
12 :	59.	67.	87.	81.	89.	106.
13 :	47.	45.	51.	67.	62.	68.
3+ :	**8488.**	**8870.**	**8904.**	**9119.**	**9375.**	**9556.**
4+ :	8406.	8788.	8823.	9037.	9293.	9475.
5+ :	8051.	8296.	8330.	8545.	8801.	8982.
6+ :	6641.	7355.	7018.	7232.	7488.	7670.

Table 15. Population biomass in tonnes of Gulf hake in NAFO Division 4T by year as projected to 1990 using an Fo.1 of 0.387.

Population biomass in tonnes of GULF hake <PROJECTIONS DATE = 4.5.85:3

YEAR :	85	86	87	88	89	90
AGE :						
3 :	9924.	9924.	9924.	9924.	9924.	9924.
4 :	7159.	9981.	9981.	9981.	9981.	9981.
5 :	10654.	7160.	9982.	9982.	9982.	9982.
6 :	9463.	9888.	6645.	9264.	9264.	9264.
7 :	5788.	6894.	7203.	4841.	6749.	6749.
8 :	3261.	3878.	4620.	4827.	3244.	4522.
9 :	1809.	1982.	2357.	2807.	2933.	1971.
10 :	1335.	1251.	1370.	1629.	1941.	2028.
11 :	659.	855.	801.	877.	1043.	1243.
12 :	508.	582.	755.	707.	775.	922.
13 :	563.	546.	625.	811.	760.	833.
3+ :	**51122.**	**52940.**	**54263.**	**55652.**	**56597.**	**57419.**
4+ :	41198.	43016.	44339.	45728.	46673.	47495.
5+ :	34039.	33035.	34358.	35747.	36692.	37515.
6+ :	23385.	25875.	24376.	25765.	26710.	27532.

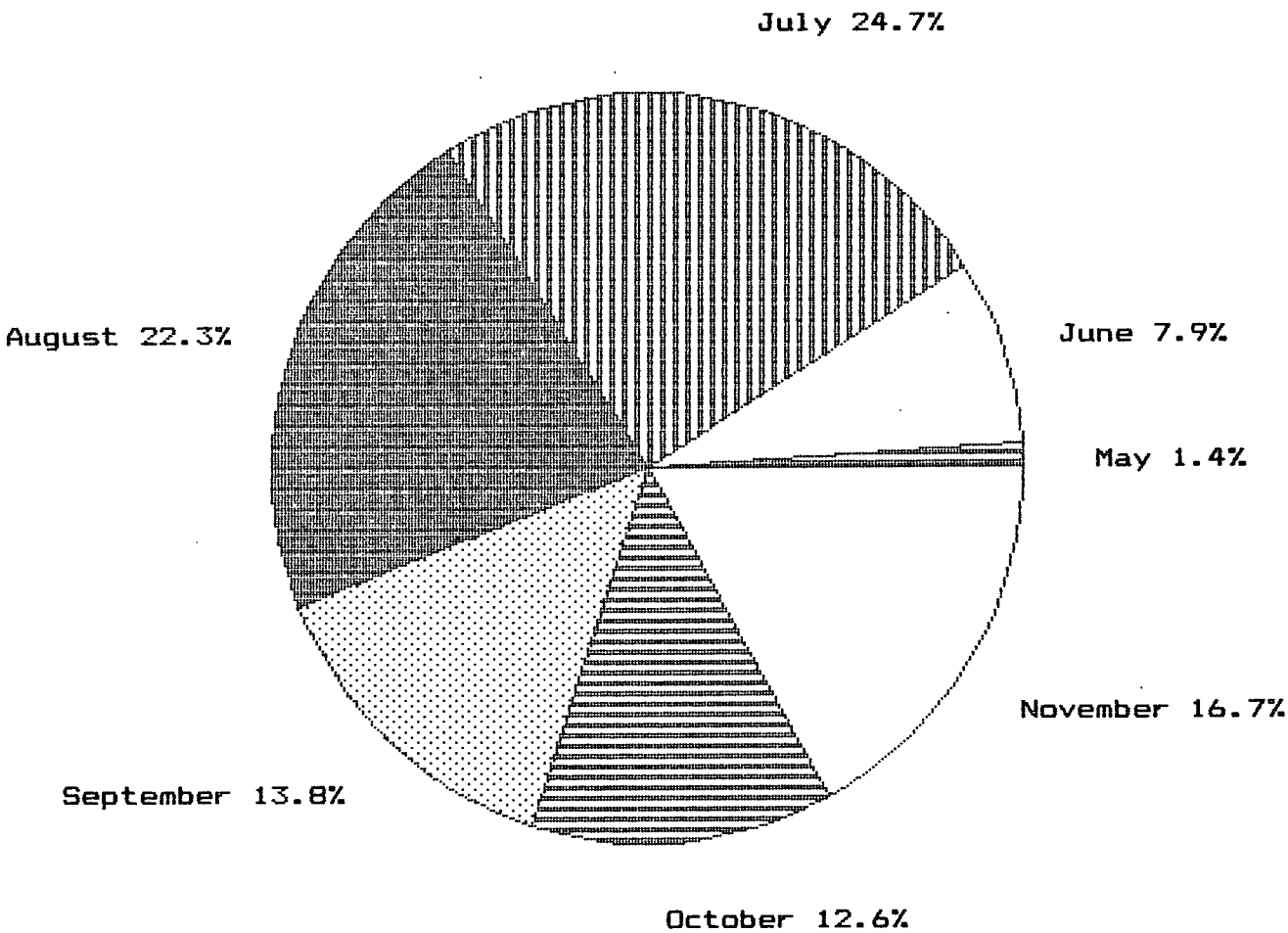

Figure 1. Monthly catches of Gulf hake 1984.

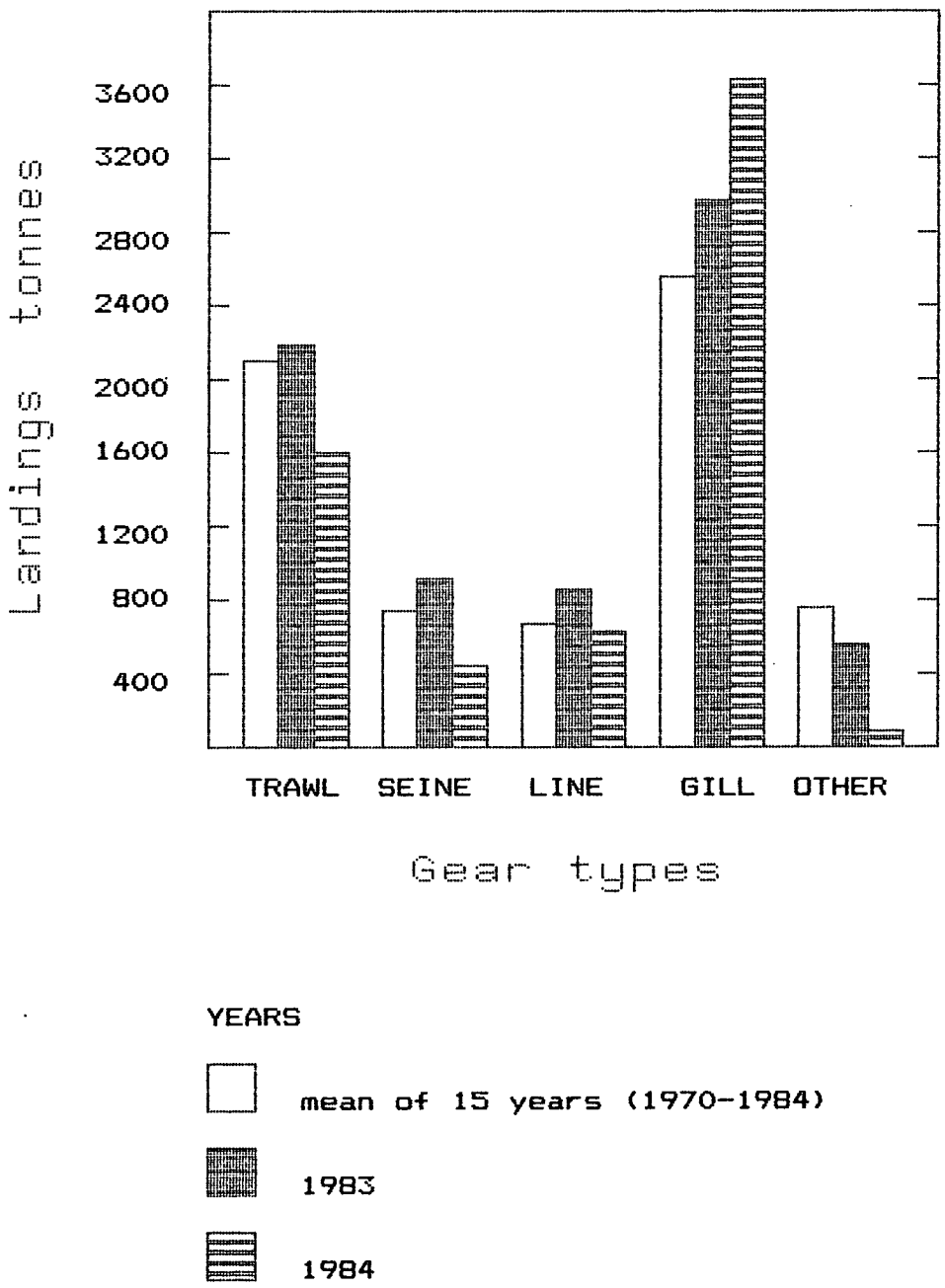

Figure 2. Landings of Gulf hake from NAFO Division 4T separated by gear.

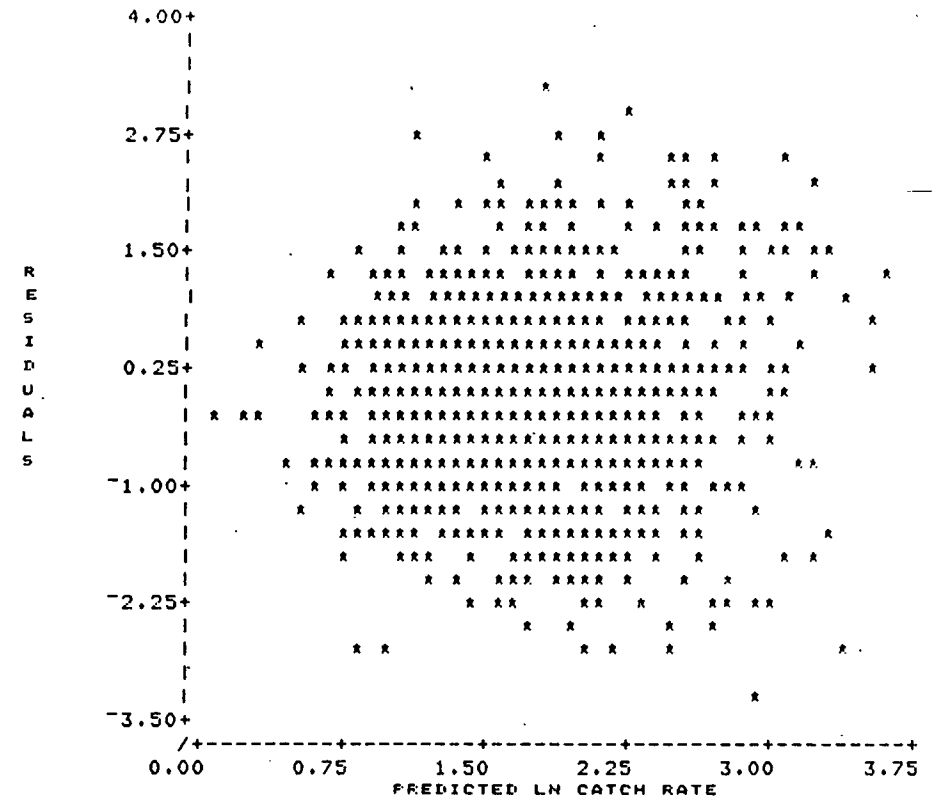

Figure 3. Residual plot from multiplicative model on Gulf hake. Data covers period 1978 to 1984.

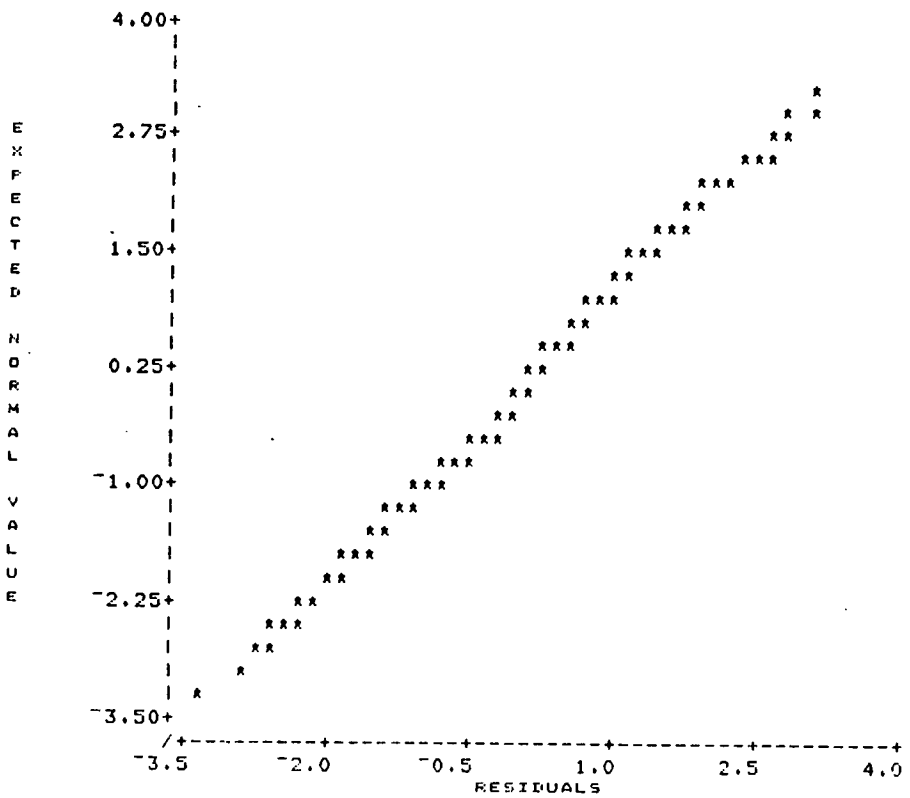

Figure 4. Residual - expected normal plot of data shown in Figure 3.

Figure 5. Catch rates from multiplicative model for Gulf hake in NAFO Division 4T.

PREDICTED CATCH RATE

STANDARDS USED VARIABLE NUMBERS: 1 13 20

YEAR	TOTAL CATCH	PROP.	CATCH RATE MEAN	S.E.	EFFORT
78	48250	0.569	3.428	0.498	14076
79	81100	0.623	3.955	0.568	20505
80	124230	0.662	4.638	0.682	26785
81	140390	0.695	5.533	0.787	25371
82	103530	0.671	4.147	0.579	24962
83	74530	0.632	4.126	0.583	18062
84	63530	0.594	3.165	0.445	20073

AVERAGE C.V. FOR THE MEAN:0.143

PLOTEST
NUMBER OF LINES AND COLUMNS FOR GRAPH (2 ELEMENT VECTOR)
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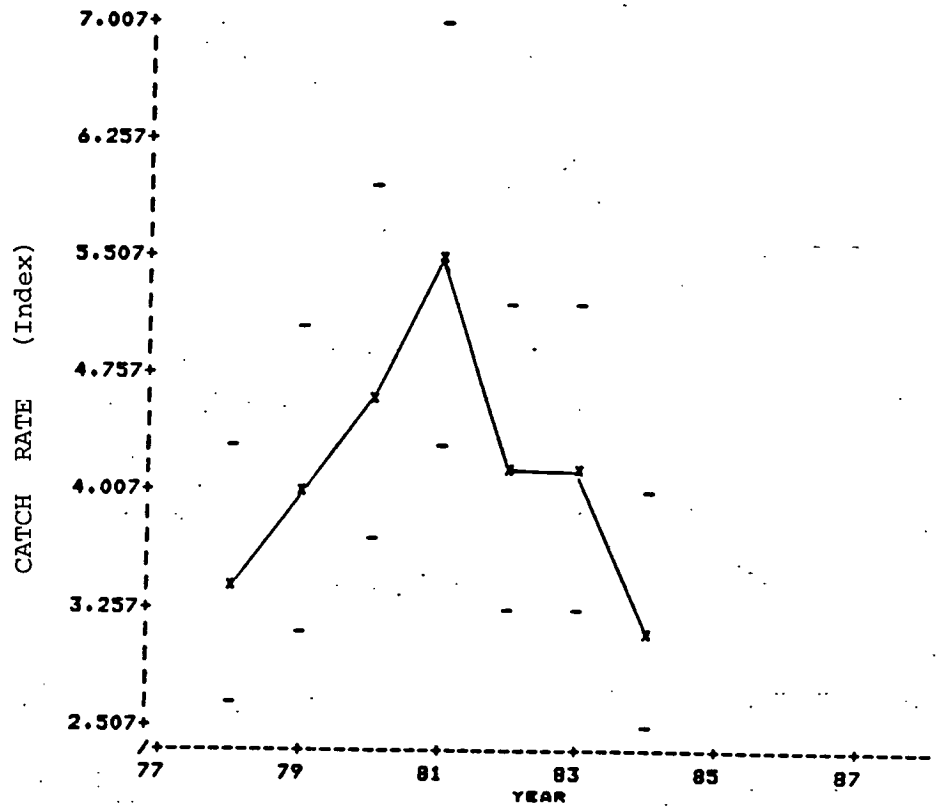

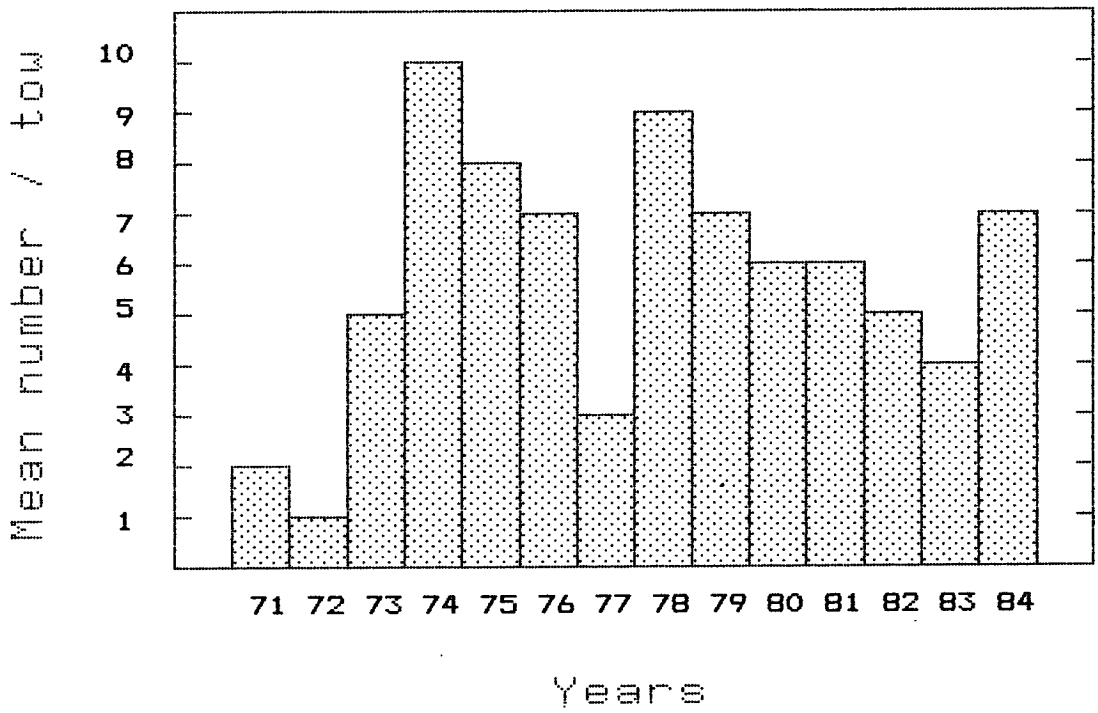

Figure 6. Mean number of Gulf hake per standard tow of September groundfish cruise in the southern Gulf of St. Lawrence.

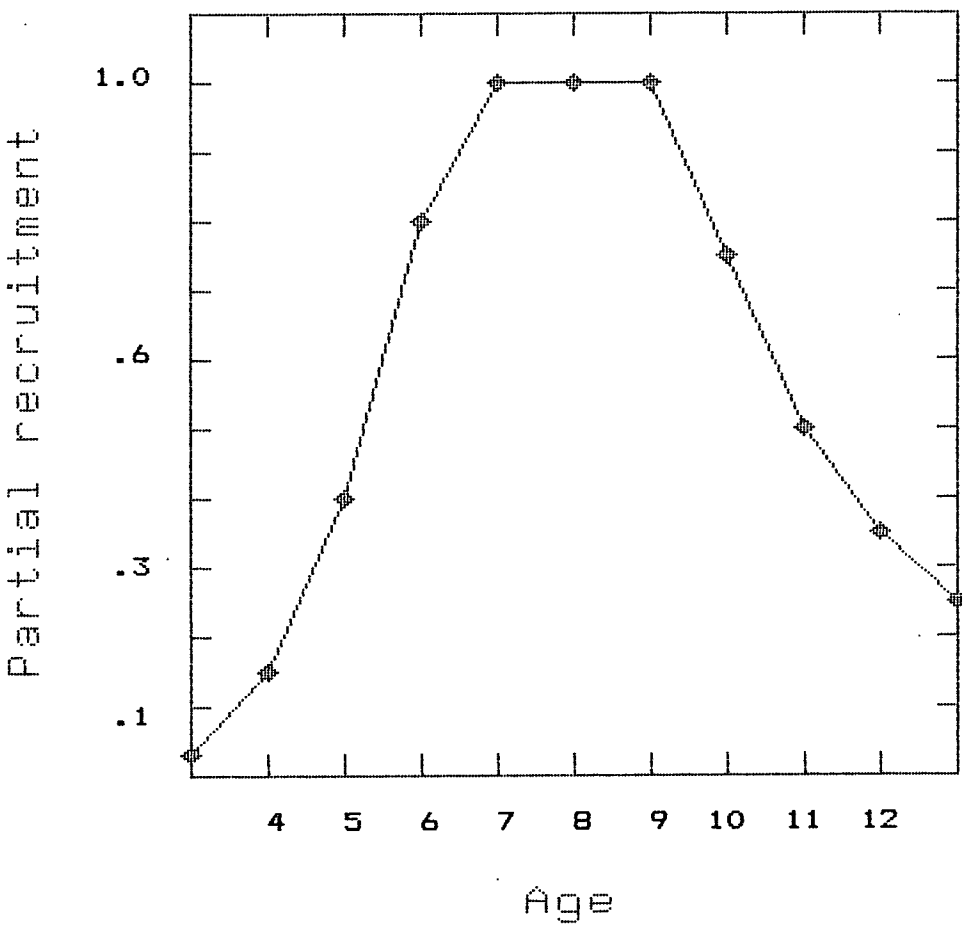

Figure 7. Partial recruitment of Gulf hake from NAFO Division 4T as calculated from 4 year average of standardized commercial catch at age over standardized population at age (see text).

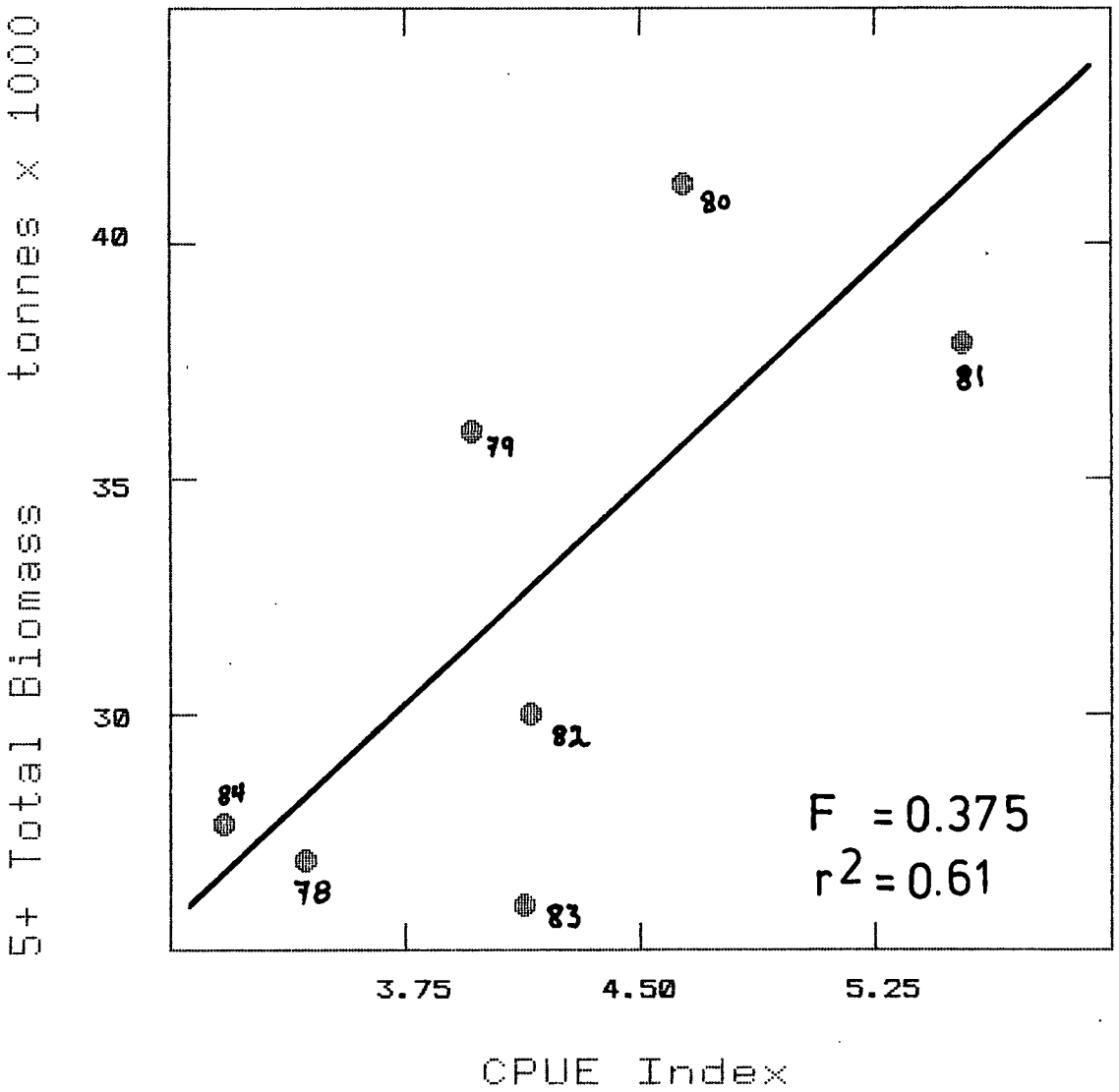

Figure 8. CPUE index from the multiplicative model and the 5+ VPA population biomass for Gulf hake from NAFO Division 4T.

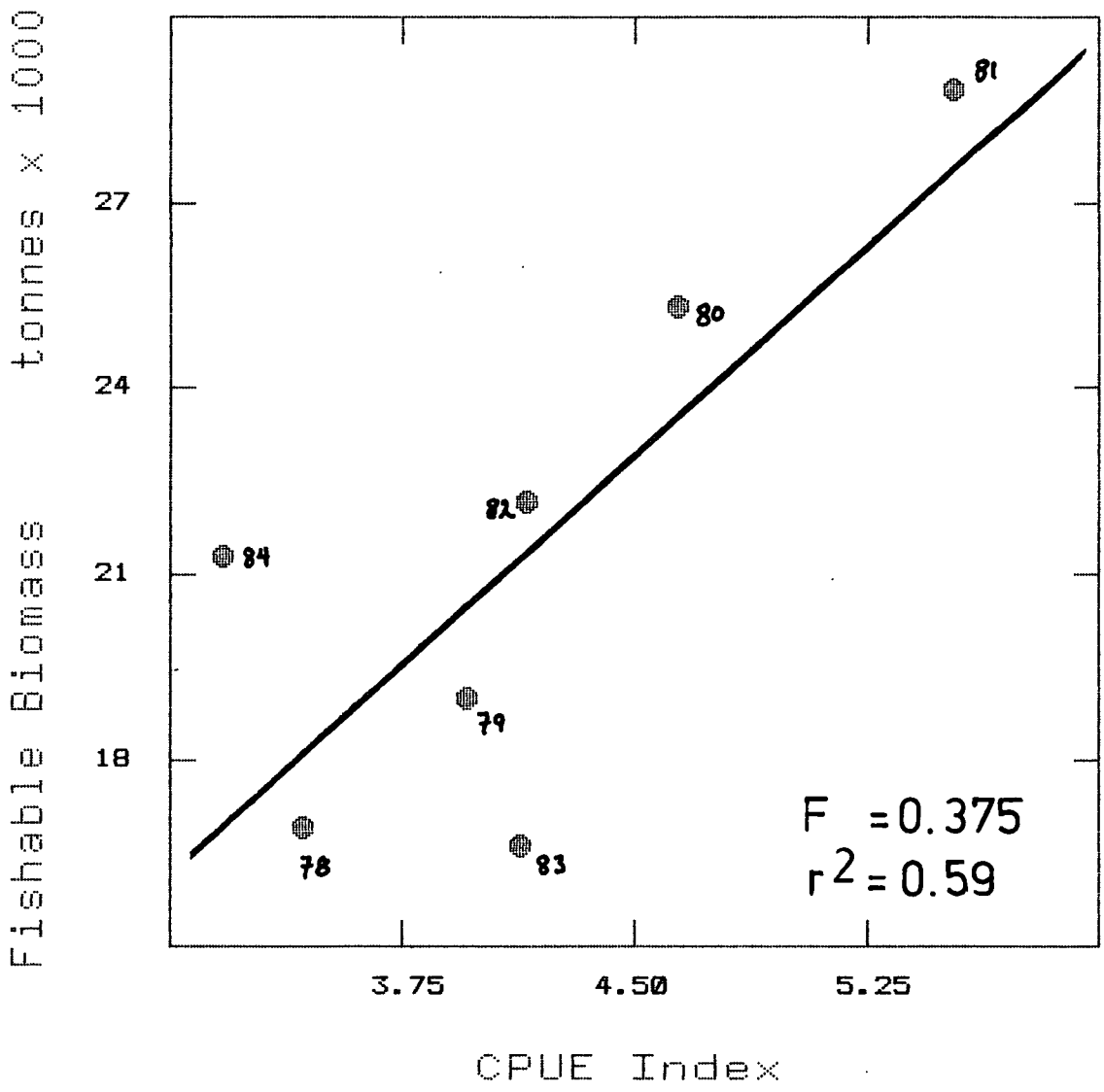

Figure 9. CPUE index from the multiplicative model and the 3- VPA fishable population biomass for Gulf hake from NAFO Division 4T.

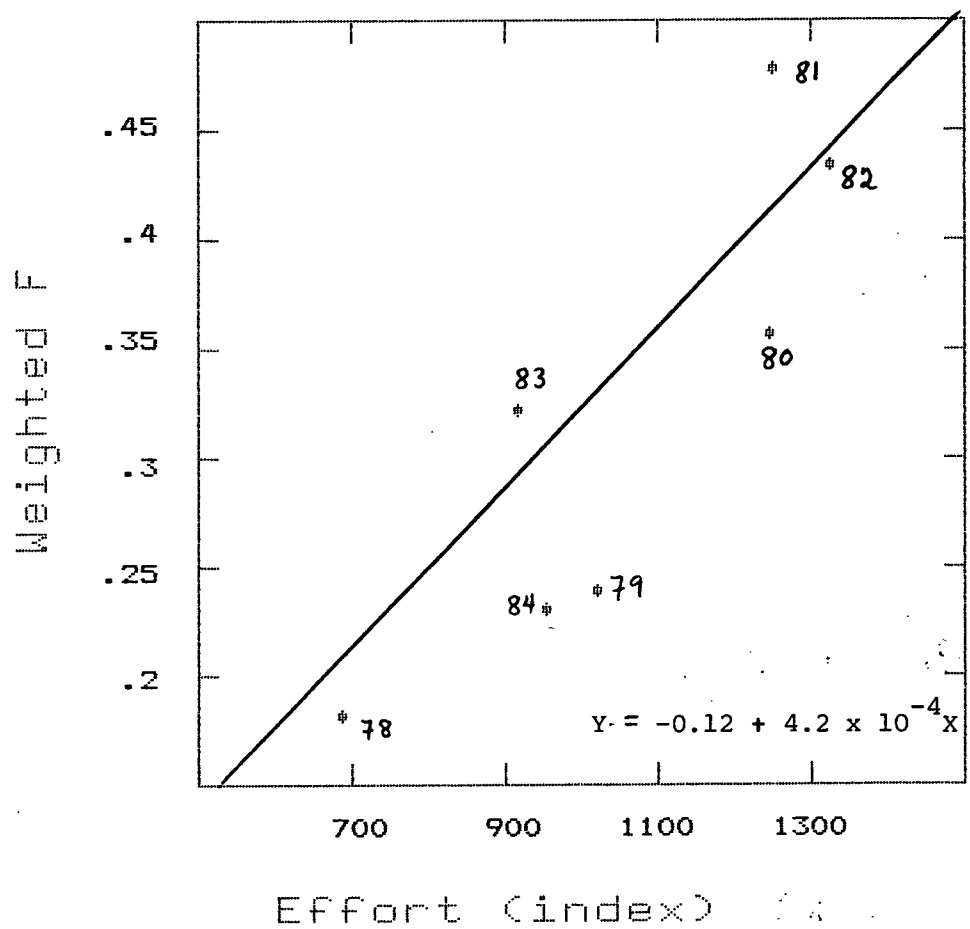

Figure 10. F weighted by total population numbers and effort index derived from the multiplicative model for Gulf hake in NAFO Division 4T.

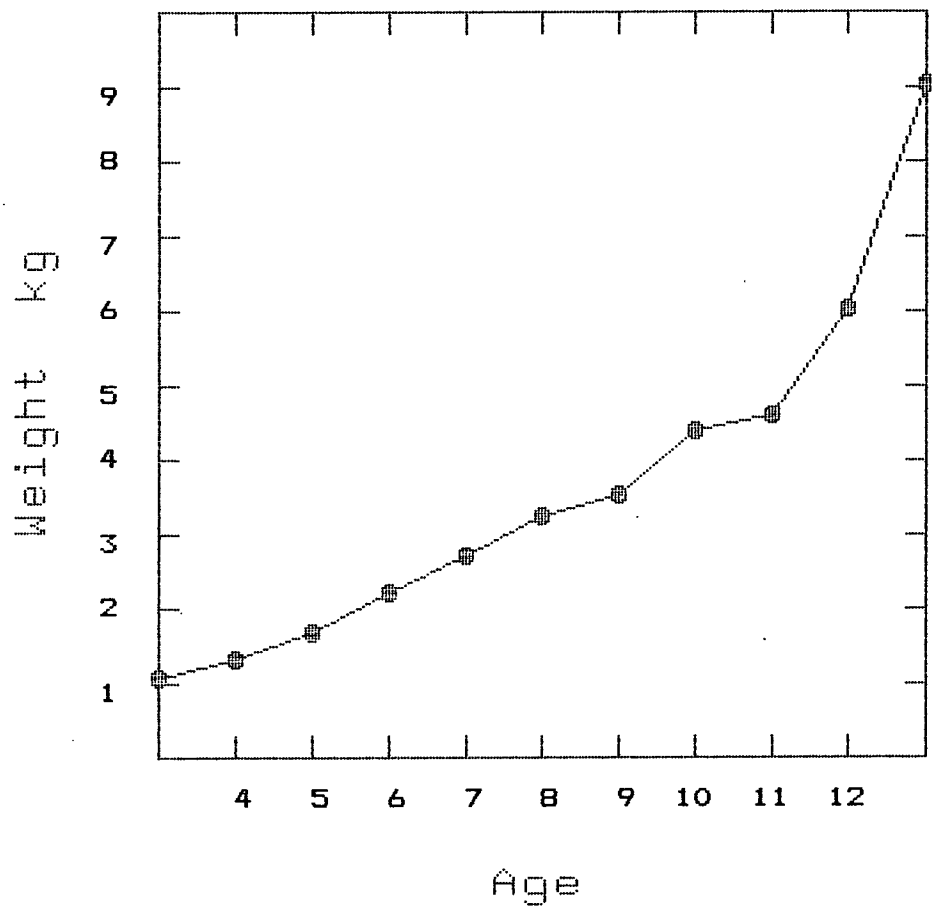

Figure 11. The 1984 weights at age for Gulf hake from NAFO Division 4T. These are taken from the calculated weights from the commercial catch-at-age samples.

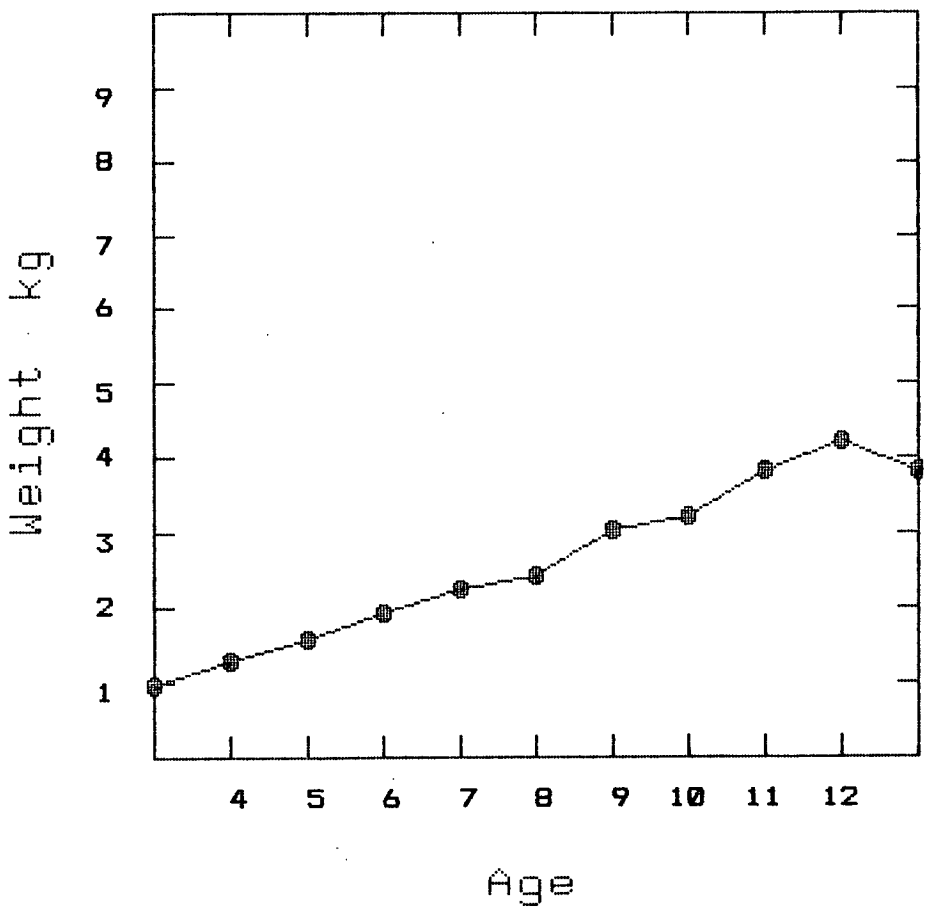

Figure 12. Weights at age from 1970 to 1977 calculated from commercial samples from Gulf hake from NAFO Division 4T.

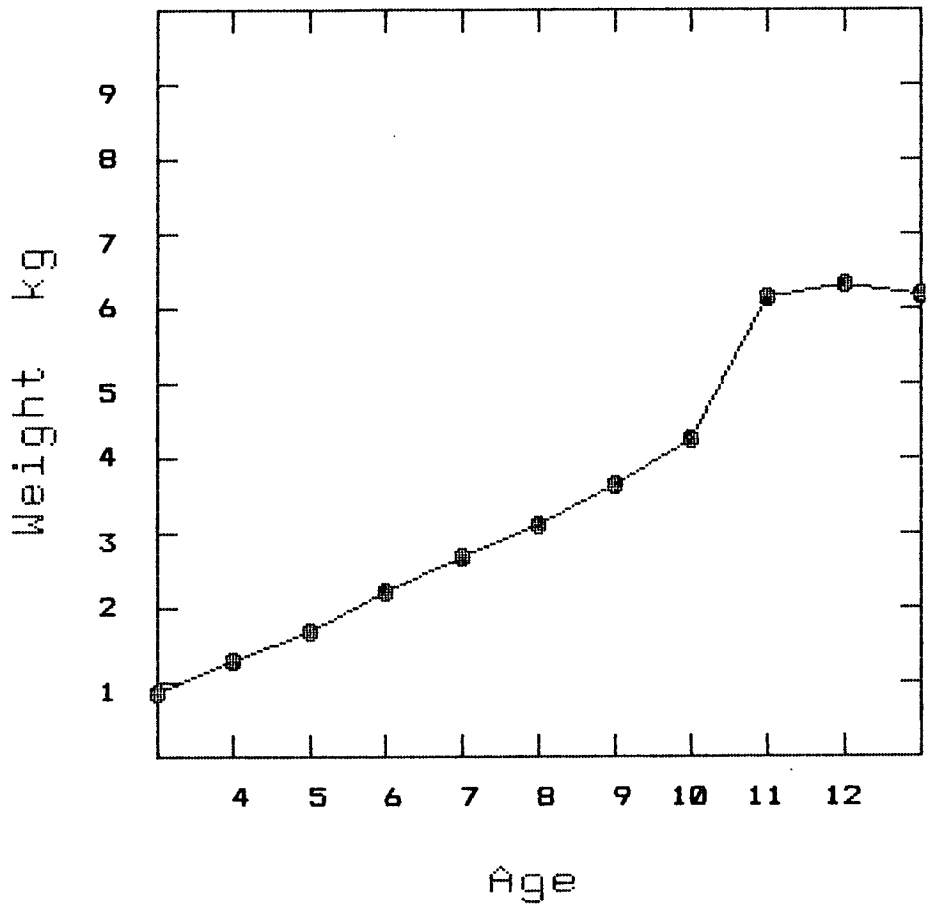

Figure 13. Weights at age from 1978 to 1984 calculated from commercial samples for Gulf hake from NAFO Division 4T.

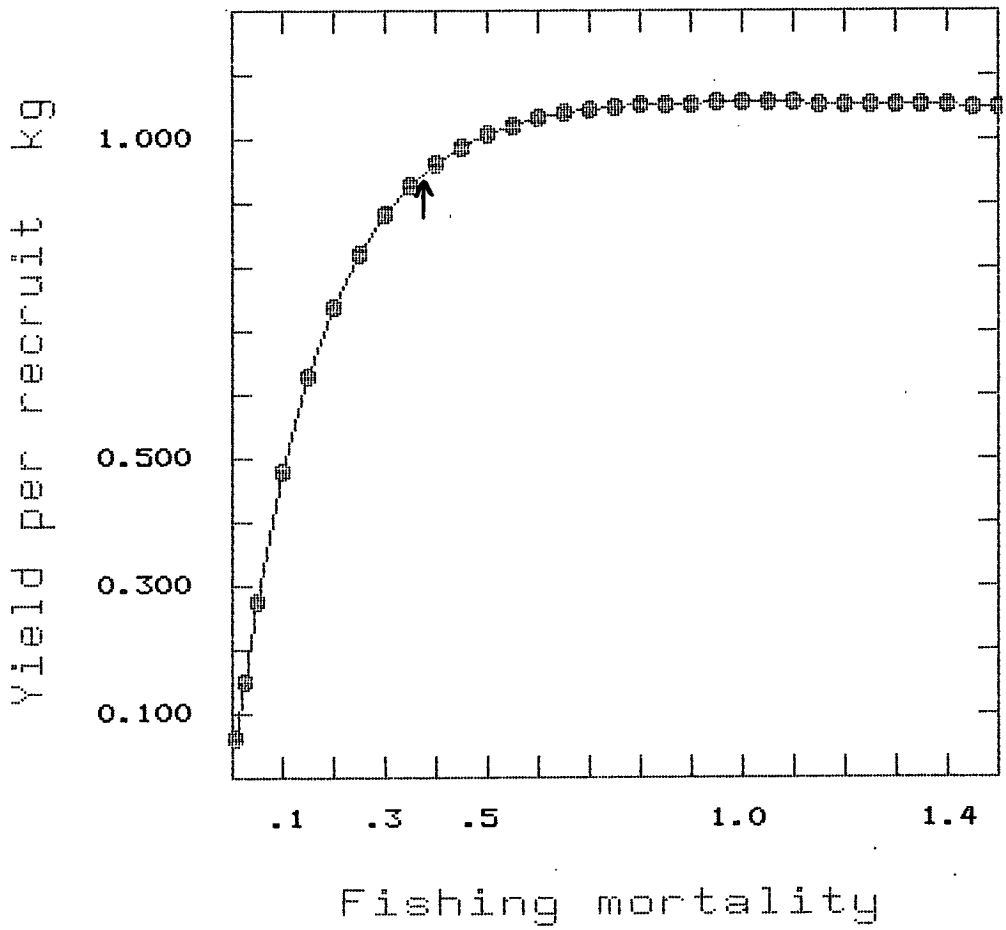

Figure 14. Yield per recruit for Gulf hake in NAFO Division 4T. The arrow indicates the position of Fo.1 in 1984.

APPENDIX I

Table 1. Percentage composition of catch-at-age matrix of NAFO division 4T Gulf hake. Major contributing year class in bold face type, secondary year class underlined.

YEAR :	70	71	72	73	74	75	76	77
AGE:								
3 :	0.0318	0.0309	0.0339	0.0314	0.0317	0.0326	0.0481	0.0480
4 :	0.2617	0.2632	0.2363	0.1969	0.1611	0.1251	0.1775	0.1847
5 :	**0.2949**	**0.2938**	**0.2788**	**0.2618**	**0.2444**	**0.2276**	**0.2577**	**0.2616**
6 :	0.1687	0.1650	0.1810	0.1817	0.1909	0.2006	0.1982	0.2007
7 :	0.1379	0.1393	0.1507	0.1791	0.2015	0.2214	0.1735	0.1676
8 :	0.0530	0.0531	0.0617	0.0754	0.0876	0.0997	0.0784	0.0758
9 :	0.0272	0.0285	0.0314	0.0424	0.0503	0.0574	0.0400	0.0368
10 :	0.0155	0.0158	0.0164	0.0197	0.0211	0.0242	0.0166	0.0160
11 :	0.0045	0.0052	0.0046	0.0049	0.0049	0.0045	0.0028	0.0026
12 :	0.0024	0.0028	0.0028	0.0034	0.0031	0.0039	0.0051	0.0042
13 :	0.0021	0.0021	0.0021	0.0030	0.0031	0.0028	0.0017	0.0016

YEAR :	78	79	80	81	82	83	84
AGE:							
3 :	0.0365	0.0256	0.0174	0.0113	0.0012	0.0197	0.0189
4 :	0.1629	0.1334	0.0869	0.0736	0.0302	0.0443	0.1335
5 :	**0.2663**	0.2362	0.1976	0.1853	0.1466	0.2060	0.2503
6 :	0.2504	**0.2757**	**0.3194**	**0.3404**	**0.3047**	**0.2724**	**0.2720**
7 :	0.1585	0.1906	0.2299	0.2396	0.2961	0.2110	0.1651
8 :	0.0792	0.0894	0.1038	0.1041	0.1478	0.1377	0.0837
9 :	0.0281	0.0286	0.0263	0.0264	0.0400	0.0808	0.0497
10 :	0.0118	0.0133	0.0144	0.0161	0.0211	0.0246	0.0168
11 :	0.0017	0.0021	0.0012	0.0006	0.0056	0.0016	0.0063
12 :	0.0035	0.0030	0.0011	0.0001	0.0024	0.0013	0.0031
13 :	0.0008	0.0019	0.0016	0.0021	0.0039	0.0003	0.0003

Table 2. Percentage composition of population numbers at age of NAFO division 4T Gulf hake.

YEAR :	70	71	72	73	74	75	76	77
AGE:								
3 :	0.3229	0.3106	0.2939	0.2704	0.3369	0.4113	0.4363	0.4229
4 :	0.2767	0.2665	0.2639	0.2596	0.2188	0.2238	0.2588	0.2727
5 :	0.1768	0.1935	0.1891	0.1977	0.1828	0.1338	0.1333	0.1538
6 :	0.1035	0.1047	0.1212	0.1229	0.1210	0.1028	0.0689	0.0703
7 :	0.0577	0.0618	0.0645	0.0783	0.0721	0.0656	0.0511	0.0329
8 :	0.0271	0.0281	0.0316	0.0325	0.0358	0.0320	0.0262	0.0231
9 :	0.0147	0.0149	0.0159	0.0180	0.0146	0.0168	0.0133	0.0123
10 :	0.0094	0.0083	0.0084	0.0090	0.0080	0.0057	0.0067	0.0062
11 :	0.0048	0.0056	0.0046	0.0048	0.0042	0.0036	0.0019	0.0033
12 :	0.0033	0.0033	0.0040	0.0034	0.0031	0.0024	0.0020	0.0011
13 :	0.0029	0.0024	0.0024	0.0031	0.0022	0.0018	0.0012	0.0009

YEAR :	78	79	80	81	82	83	84
AGE:							
3 :	0.3553	0.2508	0.2148	0.2496	0.3191	0.3398	0.2418
4 :	0.2910	0.2848	0.2199	0.1944	0.2181	0.2533	0.2908
5 :	0.1802	0.2255	0.2392	0.1875	0.1569	0.1693	0.2137
6 :	0.0940	0.1301	0.1762	0.1867	0.1285	0.1053	0.1245
7 :	0.0391	0.0614	0.0876	0.1087	0.0969	0.0621	0.0625
8 :	0.0148	0.0224	0.0353	0.0423	0.0483	0.0383	0.0317
9 :	0.0123	0.0074	0.0109	0.0152	0.0167	0.0191	0.0188
10 :	0.0068	0.0083	0.0036	0.0056	0.0081	0.0080	0.0081
11 :	0.0035	0.0048	0.0060	0.0009	0.0018	0.0037	0.0043
12 :	0.0021	0.0027	0.0040	0.0053	0.0007	0.0006	0.0030
13 :	0.0005	0.0015	0.0021	0.0035	0.0046	0.0002	0.0004

Table 3. Percentage composition of catch biomass at age of NAFO division 4T Gulf hake. Major contributing year class in bold face type.

YEAR :	70	71	72	73	74	75	76	77
AGE:								
3 :	0.0165	0.0160	0.0172	0.0151	0.0147	0.0146	0.0233	0.0236
4 :	0.1691	0.1696	0.1487	0.1178	0.0929	0.0697	0.1070	0.1126
5 :	**0.2467**	**0.2450**	**0.2272**	**0.2027**	0.1827	0.1643	0.2011	0.2065
6 :	0.1867	0.1821	0.1951	0.1862	0.1888	0.1916	0.2046	0.2097
7 :	0.1851	0.1865	0.1970	0.2225	**0.2417**	**0.2565**	**0.2173**	**0.2124**
8 :	0.0858	0.0857	0.0973	0.1131	0.1268	0.1392	0.1184	0.1157
9 :	0.0481	0.0502	0.0541	0.0695	0.0795	0.0876	0.0661	0.0614
10 :	0.0342	0.0347	0.0351	0.0401	0.0415	0.0459	0.0340	0.0332
11 :	0.0105	0.0121	0.0103	0.0105	0.0102	0.0089	0.0061	0.0057
12 :	0.0074	0.0084	0.0083	0.0095	0.0083	0.0102	0.0144	0.0121
13 :	0.0095	0.0095	0.0094	0.0127	0.0125	0.0110	0.0072	0.0068

YEAR :	78	79	80	81	82	83	84
AGE:							
3 :	0.0179	0.0120	0.0078	0.0050	0.0005	0.0083	0.0088
4 :	0.0993	0.0779	0.0487	0.0406	0.0153	0.0234	0.0774
5 :	0.2102	0.1787	0.1434	0.1325	0.0963	0.1407	0.1879
6 :	**0.2616**	**0.2761**	**0.3067**	**0.3222**	0.2651	**0.2461**	**0.2702**
7 :	0.2007	0.2315	0.2677	0.2750	**0.3124**	0.2312	0.1989
8 :	0.1210	0.1309	0.1457	0.1440	0.1880	0.1818	0.1216
9 :	0.0470	0.0458	0.0403	0.0400	0.0557	0.1167	0.0789
10 :	0.0246	0.0265	0.0275	0.0303	0.0365	0.0442	0.0332
11 :	0.0038	0.0045	0.0025	0.0013	0.0102	0.0030	0.0130
12 :	0.0100	0.0081	0.0029	0.0004	0.0058	0.0032	0.0085
13 :	0.0037	0.0078	0.0065	0.0083	0.0139	0.0012	0.0014

Table 4. Percentage composition of population biomass at age of NAFO division 4T Gulf hake.

YEAR :	70	71	72	73	74	75	76	77
AGE:								
3 :	0.2071	0.1975	0.1834	0.1647	0.2110	0.2708	0.3038	0.2993
4 :	0.2202	0.2101	0.2043	0.1961	0.1700	0.1828	0.2235	0.2394
5 :	0.1821	0.1976	0.1894	0.1934	0.1838	0.1415	0.1490	0.1748
6 :	0.1410	0.1415	0.1606	0.1590	0.1610	0.1438	0.1020	0.1059
7 :	0.0954	0.1013	0.1039	0.1230	0.1164	0.1115	0.0918	0.0601
8 :	0.0541	0.0555	0.0613	0.0616	0.0696	0.0654	0.0566	0.0508
9 :	0.0320	0.0323	0.0337	0.0372	0.0312	0.0377	0.0315	0.0297
10 :	0.0256	0.0222	0.0223	0.0231	0.0211	0.0160	0.0197	0.0188
11 :	0.0137	0.0159	0.0129	0.0130	0.0118	0.0105	0.0060	0.0104
12 :	0.0124	0.0124	0.0147	0.0122	0.0114	0.0092	0.0081	0.0045
13 :	0.0161	0.0135	0.0133	0.0165	0.0123	0.0106	0.0076	0.0060

YEAR :	78	79	80	81	82	83	84
AGE:							
3 :	0.2440	0.1585	0.1261	0.1433	0.1923	0.2192	0.1502
4 :	0.2479	0.2233	0.1602	0.1384	0.1631	0.2026	0.2241
5 :	0.1988	0.2289	0.2255	0.1728	0.1518	0.1753	0.2132
6 :	0.1372	0.1748	0.2199	0.2277	0.1645	0.1443	0.1644
7 :	0.0692	0.1001	0.1325	0.1608	0.1506	0.1032	0.1002
8 :	0.0316	0.0440	0.0643	0.0755	0.0905	0.0768	0.0612
9 :	0.0288	0.0158	0.0218	0.0297	0.0342	0.0418	0.0397
10 :	0.0197	0.0222	0.0091	0.0137	0.0208	0.0219	0.0213
11 :	0.0108	0.0134	0.0157	0.0025	0.0048	0.0106	0.0120
12 :	0.0086	0.0102	0.0137	0.0177	0.0027	0.0025	0.0110
13 :	0.0032	0.0085	0.0110	0.0176	0.0244	0.0016	0.0024