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Assessment of the 4VWX Silver Hake Population in 1994

by

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Management and Current Fishery

The silver hake fishery on the Scotian Shelf has traditionally been pursued by large (TC 7) vessels of the distant waters fleets of Russia, Cuba, and Japan. Prior to 1977, fishing on the Scotian Shelf was unrestricted in terms of area, mesh size, and season. During this period fishing occurred over the entire shelf, and the use of trawl mesh as small as 40 mm was common. In 1977, Canada implemented the Coastal Fisheries Protection Act, which restricted fishing for this species to the seaward side of the Small Mesh Gear Line (Figure 1), west of 60° W longitude, with a minimum mesh size of 60 mm. On an experimental basis a portion (4-6 vessels) of the fleet was allowed to fish inside the line during 1978 and 1979. From 1980 through 1983 fishing was permitted by condition of licence in an eastern extension of the box as far as 57° W longitude; from 1984 to present this eastern extension has been restricted to 59° W longitude.

By regulation the fishery opens April 1 and closes November 15 each year; however, in recent years vessels have been allowed to commence fishing under experimental permit in March.

Canadian processors have been active in the harvesting of this species since 1990. However, the long distance to the primary fishing area and deep water preferred by silver hake have caused difficulty for the smaller Canadian vessels. As a result, most of the harvesting under Canadian allocations has been through charter arrangements with fishing companies of Russia and Cuba. These arrangements proved successful and have continued into 1994. Although allocations to foreign nations have been substantially reduced since 1990, the overall vessel and gear composition of the fleet harvesting this stock has remained the same.

TAC's for cod, haddock, and pollock stocks on the Scotian Shelf have decreased markedly in recent years. As a result, bycatches of these species in the silver hake fishery has been of great concern to Canadian fishermen. In 1994 Canada implemented regulatory changes designed to minimize incidental catches of cod, haddock and pollock in this fishery. As higher bycatch is associated with shallow depth, the silver hake box was modified to prevent fishing in depths of less than 190 m (Figure 1). In addition, use of a separator grate in the lengthening piece of the trawl was mandatory.

Nominal catches from this stock have ranged from 300,000 tons in 1973 to 29,000 tons in 1993. Effort in the 1994 fishery was greatly reduced over historical levels, with only seven Cuban vessels as active participants. Due to delays in allocations, the fishery in 1994 did not commence until late April, and as a result no fishing occurred during a period of traditionally high catch rates. In addition, Canadian companies had difficulty making charter arrangements due to the late start,

as many vessels which might have fished silver hake were committed to other ventures by late April. As a result of these factors, the provisional catch in 1994 was only 8,000 tons compared to a total allocation of 30,000 tons (Table 1). The NAFO Scientific advice (tons) on catch levels, Total Allowable Catches (TAC's) established, and total catches from 1984 are as follows:

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Advice	100	100	100	100	167	235		100	105	75	51	79
TAC	100	100	100	100	120	135	135	100	105	86	30	60
Catch	74	75	83	62	74	88	70	65	32[1]	29[1]	8[1]	na

[1] Preliminary

Removals and Weights at Age

Sampling for length composition and otoliths in 1994 commercial catch was conducted by Canadian observers. More than 1,100 samples (138,199 lengths; 914 otolith pairs) were collected during the 1994 fishery. A summary of length and age sampling is presented in Table 2.

The commercial removals at age for 1994 were calculated using Canadian length frequency data and an age/length key constructed from Canadian aging data. In past assessments of this resource removals at age have been calculated using a combined Russian-Canadian age length key. This was not possible for the current assessment, as Russia did not participate in the 1994 fishery, and hence no commercial samples were collected by Russians. Regressions of lengths and weights from the Canadian July research vessel survey were used to calculate yearly alpha and beta values (Table 3) used in the calculation of sample weights and weight-at-age. In the past assessment (Showell and Bourbonnais, 1994), removals at age were calculated using a yearly age-length key. In the current document, the removals at age for 1992 through 1994 were calculated using monthly age-length keys, in order to improve the precision of the estimate. The removals at age and weight-at-age for 1977-1991 were taken from the previous assessment (Showell *et al.*, 1994) to provide estimates for the period 1977-94 inclusive (Table 4,5; Figure 2).

Commercial Catch Rates

The APL workspace STANDARD was used to standardize catch rates for the period 1977 through 1994. Factors found to be significant in the past were included in the model: country, area, month and year. To quantify the effect of the 1994 modifications to the fishing regulations, two other factors were added to the model: data for the 18 years in the time series were categorized as i) inshore/offshore of the new silver hake line, and ii) for the presence/absence of a separator grate. Data used in the analysis were from the Canadian observer program.

Examination of the regression results (Table 6 and accompanying graphs) show country, area, month and year were found to have a significant effect ($p > 0.05$) on the model. The effect of fishing location relative to the new silver hake line was not significant. The presence of a separator grate was similarly not significant, although the data were confounded in that very few cases exist in the data set where vessels using a grate fished at the same time as others not using a grate.

Standardized catch rates for this stock have dropped from high levels in the period 1984-89, to relatively low levels in 1992 though 1994. The catch rate in 1994 was the same as 1993, at 1.7 tons/hour.

Canadian Bottom Trawl Surveys

The July stratified random groundfish survey has been conducted on the Scotian Shelf from 1970 using three Canadian research vessels (*A.T. Cameron*, *Lady Hammond*, and the *Alfred Needler*). A conversion factor of 2.3 is applied to the series prior to 1982 to account for the effect of vessel and gear changes between the *A.T. Cameron* and the other two vessels (Fanning, 1985). No conversion factor is required between the *Lady Hammond* and the *Alfred Needler*.

Survey trends in both total numbers and biomass show relatively high abundance in the early to mid 80's, followed by a decline to relatively low levels (Figure 3). Results of the 1994 survey indicate a drop in total numbers and biomass over those seen in 1993.

In numbers at age (Table 7) the 1990 and 1991 year classes appear average in size at age 3 and 4 respectively.

Juvenile Survey

A standardized IYGPT O-group survey for this species has been conducted since 1981 (1992 excluded) during the October-November period. Recent results suggest the 1994 year class is below average in size for the 1981-1993 times series, with a stratified mean number per tow of 105.4. These data, as well as those of previous years for the core strata (60-78) are presented in Table 8.

Estimation of Parameters

Sequential Population Analysis

In previous assessments of this resource (Showell *et al.*, 1993, Showell & Bourbonnais 1994) using the ADAPT program of Gavaris, 1988, the fully recruited F's derived from SPA have shown a strong retrospective pattern, where F was consistently underestimated by 40-60%. Several approaches were undertaken in the current assessment to investigate this pattern. Examination of the ADAPT results for the 1977-93 data set from the previous assessment (Showell & Bourbonnais, 1994) showed large residuals associated with the 1977 and 1978 points for both the survey and CPUE tuning indices, and these points were removed from the analysis. Gavaris, 1993 introduced a modified version of ADAPT which calculates and adjusts for bias associated with the analysis, and suggested this technique might reduce the retrospective effect in some cases. The population analysis was therefore conducted using three techniques: ADAPT:1988, Laurec-Shepherd, and ADAPT:1993. The formulation for each included a catch at age from 1979 to 1994, ages 1 to 9, fully recruited ages 3, 4 and 5, natural mortality of 0.4, and a dome shaped recruitment pattern, with F at age 9 set at 10% of fully recruited. Comparison of age 3-5 F's from 1979 to 1994 is presented in Figure 4. In addition, a retrospective analysis was conducted for each of the three methods (Figure 5). The analysis using the bias adjusted ADAPT formulation appears to reduce the retrospective effect substantially, while the non-adjusted ADAPT and Laurec-Shepherd analyses show strong retrospective patterns. Based on this comparison, the bias-adjusted ADAPT method was used for the SPA. Results of this analysis are shown in Table 9.

Population numbers, biomass, and fishing mortality at age are shown in Table 10. In 1994 the estimated average F over ages 3-5 was extremely low, at 0.1.

Recruiting Yearclass Sizes

The 1994 yearclass will make a significant contribution to the catch in 1996 at age 2. Based on the O-group survey, this yearclass appears to be below average in size. The 1993 yearclass will be fully recruited at age 3 in 1996, but cannot be reliably estimated in the SPA. The estimates of the 1992 and earlier yearclasses can be accepted from the SPA; however, the strength of the 1993 yearclass is inferred from July RV data.

Yearclass estimates from the survey at age 1 were regressed against estimates from the SPA for the 1982-1992 yearclasses, using the model SPA=a + b(lnRV) (Table 11). Data for yearclasses prior to 1982 were excluded due to questions of comparability between research vessels. The data fit the model well (R^2=0.69), and the predicted size of the 1993 yearclass was 0.79 billion fish based on this relationship. It is recognised that there is an element of circularity in this calculation, as the survey age 1 estimates contributed to the SPA calibration. However, the RV index was one of several data elements contributing to the SPA estimates.

The 1994 year-class will make a significant contribution to the catch in 1996 at age 2. Size of this yearclass was calculated from a linear relationship between the O-group survey and SPA numbers at age 1, where SPA=a + b(O-Grp);R^2=0.57 (Table 12). Based on this relationship, the 1994 yearclass was estimated at 0.79 billion fish.

The size of the 1995 yearclass at age 1 in 1996 was set at the 10 year geometric mean of 957,000 fish.

Projection

An $F_{0.1}$ value of 0.70 was used, based on the yield-per-recruit analysis conducted during

the previous assessment. As the commercial mean weights-at-age have declined sharply since 1992, and appear to be a biological phenomenon rather than a result of sampling or aging biases, mean weights-at-age for projection were taken as the average of only the three most recent years (1992-94). The partial recruitment pattern was taken as the averge of the period 1990-94. Weight-at-age and partial recruitment were:

	Avg weight (kg)	PR
1	0.063	0.02
2	0.117	0.30
3	0.157	0.88
4	0.190	1.00
5	0.227	0.87
6	0.277	0.85
7	0.377	0.61
8	0.383	0.56
9	0.789	0.09

The 1995 silver hake fishery is still in progress, and the exact total catch cannot be determined at this time. Based on preliminary catch rates, level of participation, and historical trends in resource availability, the final catch was predicted to be 16 000 tons. A catch of this size will result in a fully recruited fishing mortality of F = 0.14. The catch at a target fishing level of $F_{0.1}$ in 1996 is estimated to be 64 000 tons.

References

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Table 1. Nominal catches for 4VWX silver hake 1970-1994 (1992-1994 preliminary).

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Bulgaria	0	0	0	0	0	1722	3088	862	606	4639	817	0
Canada	0	0	0	0	11	101	26	10	26	13	104	6
Cuba	0	0	201	0	0	1724	12572	1847	3436	1798	2287	642
France	0	0	0	0	0	0	0	15	0	0	0	0
FRG	0	0	10	0	296	106	97	684	0	0	0	0
GDR	0	0	0	0	0	0	0	0	3	0	0	0
Ireland	0	0	0	0	0	108	106	0	0	9	0	0
Italy	0	0	0	0	0	0	0	38	106	5	0	541
Japan	129	8	63	88	67	54	78	19	161	219	239	120
Poland	0	0	0	0	0	0	0	295	2	0	0	1[1]
Portugal	0	0	0	0	0	0	0	0	0	0	56	2044
Romania	0	0	0	0	0	0	0	10	0	1	0	0
Spain	0	15	0	0	0	6	0	0	2	0	40	0
USA	0	1	1	1	1	7	1	14	0	0	0	3
USSR	168916	128633	113774	298533	95371	112566	81216	33301	44062	45076	40982	41243
Total	169045	128657	114048	298621	95745	116394	97184	37095	48404	51760	44525	44600

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Bulgaria	0	0	0	0	0	0	0	0	88	0	0	0	0
Canada	38	15	10	2	9	13	9	337	10	34	4[1]	73[1]	57[1]
Cuba	11969	7418	14496	17683	16041	20219	9016	14541	13888	23708	16528[1]	22018[1]	7788[1]
France	2[1]	0	0	0	0	0	0	0	0	0	0	0	0
FRG	0	0	0	0	0	0	0	0	0	0	0	0	0
GDR	0	0	93	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0
Italy	37[1]	2[2]	0	0	0	0	0	0	0	0	0	0	0
Japan	937	649	530	120	66	144	0	194	315	781	547[1]	0	0
Poland	31[2]	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	2[1]	378	1714	1338	0	0	0	0	0	0	0	0	0
Romania	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	0	0	0	0	0	0	0	0	0	0	0
USA	2	0	0	0	1	0	0		0	0	0	0	0
USSR	47261	27377	57423	56337	66571	41329	65349	72917	55429	40786	14716[1]	7139[1]	0
Total	60251	35839	74266	75480	82688	61705	74374	87989	69730	65309	31795	29230	7845

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

Table 2. Sampling used in this assessment.

Year	No. Lengths	No. Ages
1977	34379	600
1978	137468	674
1979	101908	1108
1980	247369	1462
1981	195493	987
1982	160878	1152
1983	134226	986
1984	203314	1255
1985	216912	1163
1986	197654	1311
1987	377527	681
1988	309767	1158
1989	300100	1135
1990	447587	1817
1991	556765	1712
1992	336562	1721
1993	350440	1563
1994	138199	914

Table 3: Male and female Alpha and Beta's used in the construction of the silver hake catch at age used in this assessment. Lengths (cm) and weights (kg) used were from the Canadian July Research Vessel Survey of the Scotian Shelf (4VWX).

Year	Male - Alpha	Female - Alpha	Male - Beta	Female - Beta
1977	0.000006260	0.000006930	3.0626	3.0350
1978	0.000004630	0.000003070	3.1366	3.2531
1979	0.000010200	0.000005880	2.9001	3.0675
1980	0.000002330	0.000001800	3.3417	3.3989
1981	0.000006830	0.000005080	3.0206	3.1172
1982	0.000011600	0.000006740	2.8575	3.0232
1983	0.000006480	0.000003320	2.9935	3.2034
1984	0.000018300	0.000006490	2.7052	3.0284
1985	0.000013500	0.000004530	2.7848	3.1235
1986	0.000007970	0.000003820	2.9384	3.1685
1987	0.000009990	0.000004240	2.8798	3.1456
1988	0.000014300	0.000004800	2.7942	3.1241
1989	0.000006750	0.000004440	3.0114	3.1416
1990	0.000034320	0.000021000	2.5234	2.6958
1991	0.000007773	0.000003488	2.9582	3.2036
1992	0.000003938	0.000003157	3.1824	3.2533
1993	0.000003461	0.000003089	3.178	3.2202
1994	0.000003336	0.000003147	3.2009	3.2228

Table 4: Commercial catch numbers at age for 4VWX silver hake.

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	17911	20940	20569	16588	2358	20189	5849	59588	14970
2	72529	70302	57893	70696	25214	52976	96852	45828	130814
3	59862	80196	72891	70391	109035	75876	56158	206900	98346
4	15070	35025	36669	32032	37573	68400	29282	82911	128365
5	2218	12709	22380	14465	11928	31752	11388	19344	34110
6	725	5227	9970	5184	3234	5945	3395	4268	9327
7	97	1906	3168	1431	1201	2042	819	1038	2344
8	91	1168	495	451	290	465	253	183	226
9	4	338	374	98	141	64	88	10	85
Age	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	45598	6804	5110	24264	6516	5738	7461	31572	1651
2	70269	214235	62791	85846	209620	117305	74491	83140	13265
3	229126	114417	265307	158745	142862	201243	73526	70735	35250
4	84097	54211	39242	145105	41215	46414	27777	35222	8847
5	28635	13063	21303	20025	11741	12154	3461	5511	1283
6	8760	6045	3106	9369	1648	3954	1247	595	150
7	1436	347	2133	1569	640	290	159	71	18
8	497	156	208	1166	107	181	33	30	8
9	111	117	143	39	40	50	5	3	0

Table 5: Silver hake commercial mean weights at age.

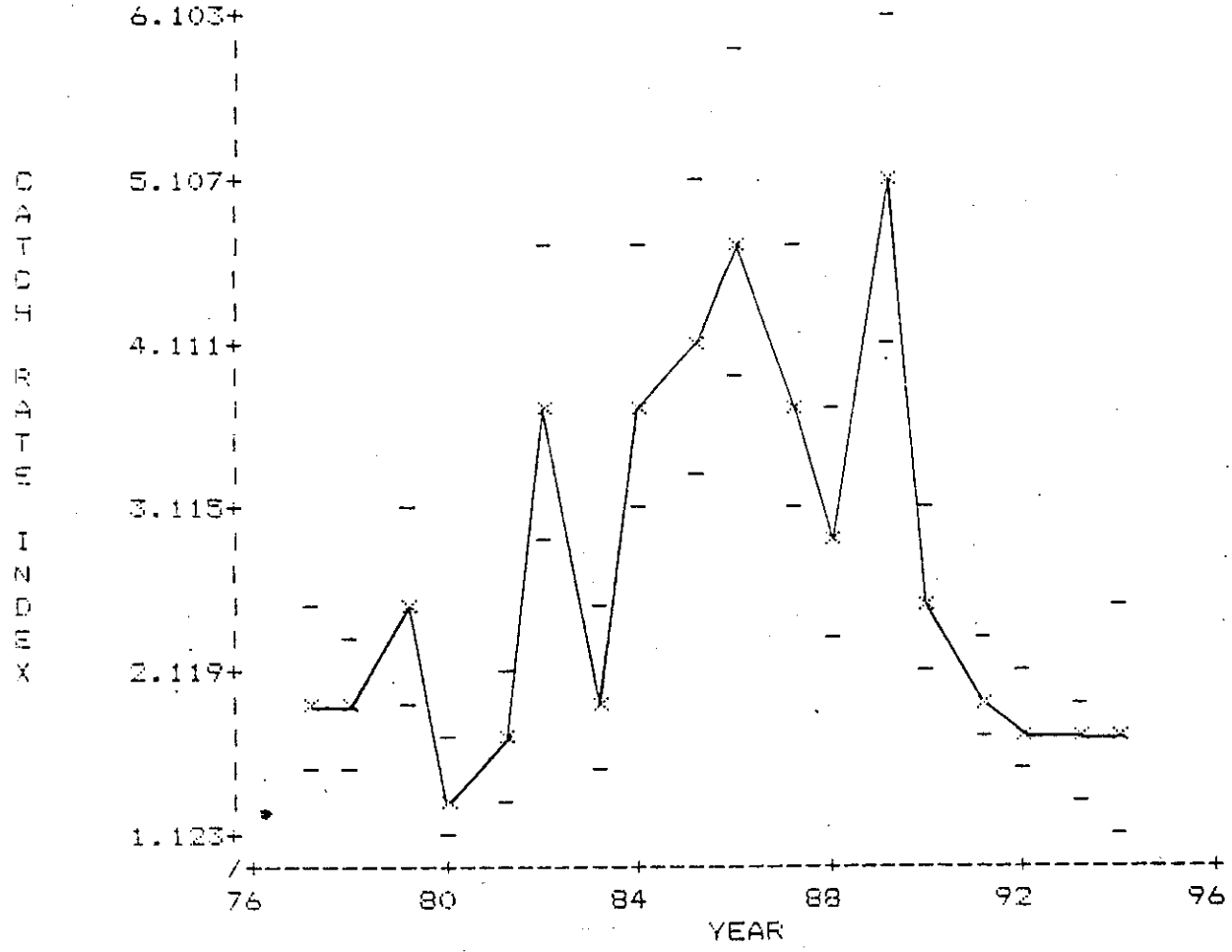
Age	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.065	0.074	0.076	0.040	0.061	0.066	0.067	0.070	0.068
2	0.183	0.153	0.178	0.151	0.168	0.169	0.128	0.146	0.136
3	0.264	0.229	0.227	0.223	0.215	0.231	0.196	0.181	0.177
4	0.340	0.266	0.274	0.287	0.276	0.275	0.239	0.224	0.210
5	0.446	0.335	0.304	0.341	0.326	0.317	0.289	0.272	0.244
6	0.632	0.405	0.389	0.391	0.401	0.394	0.365	0.353	0.295
7	0.886	0.438	0.455	0.531	0.553	0.446	0.395	0.405	0.410
8	0.922	0.540	0.838	0.839	0.923	0.513	0.457	0.624	0.582
9	2.120	0.892	0.838	0.859	1.137	0.506	0.444	0.650	0.669
Age	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.053	0.045	0.045	0.060	0.063	0.047	0.080	0.060	0.050
2	0.145	0.119	0.139	0.135	0.139	0.139	0.140	0.110	0.100
3	0.184	0.168	0.185	0.195	0.184	0.189	0.190	0.150	0.130
4	0.250	0.211	0.227	0.224	0.217	0.215	0.210	0.190	0.170
5	0.250	0.248	0.260	0.278	0.240	0.263	0.260	0.230	0.190
6	0.274	0.286	0.292	0.349	0.315	0.314	0.280	0.280	0.270
7	0.392	0.453	0.401	0.403	0.370	0.471	0.370	0.380	0.380
8	0.514	0.422	0.497	0.511	0.401	0.511	0.410	0.320	0.420
9	0.644	0.518	0.688	0.820	0.545	0.568	0.690	0.960	0.717

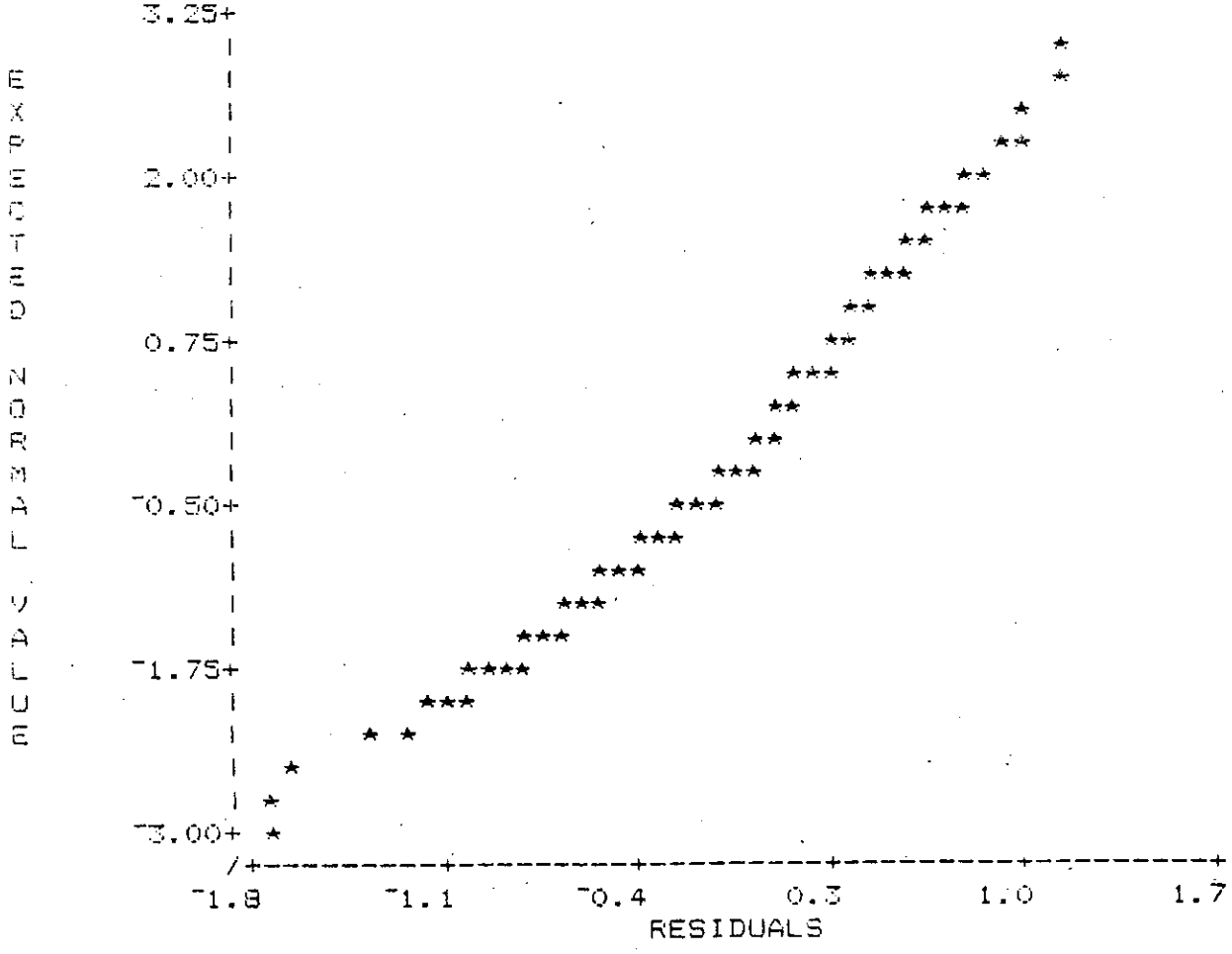
Table 6: CPUE standardization results for the 4VWX silver hake population. Includes years: 1977-1994.

Key
Type 1: Country
Type 2: Area
Type 3: Month
Type 4: Year
Type 5: Grate
Type 6: ' rule'

PREDICTED CATCH RATE

	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
77	0.5285	0.0248	1.883	0.295	37095	19704
78	0.5110	0.0151	1.859	0.228	48404	26041
79	0.7991	0.0197	2.474	0.346	51760	20924
80	0.1986	0.0136	1.361	0.158	44525	32712
81	0.3764	0.0184	1.622	0.220	44600	27495
82	1.1953	0.0191	3.677	0.506	60251	16384
83	0.5279	0.0271	1.879	0.308	35839	19072
84	1.2273	0.0159	3.803	0.479	74266	19527
85	1.2954	0.0186	4.066	0.552	75480	18565
86	1.4575	0.0176	4.784	0.632	82688	17285
87	1.2169	0.0176	3.761	0.498	61705	16408
88	0.9736	0.0157	2.951	0.368	74374	25200
89	1.5127	0.0128	5.067	0.571	87989	17364
90	0.8045	0.0135	2.495	0.289	70289	28172
91	0.5856	0.0125	2.005	0.224	67899	33857
92	0.4658	0.0131	1.778	0.203	31795	17878
93	0.4037	0.0122	1.672	0.184	29230	17480
94	0.4570	0.0469	1.733	0.372	7845	4526


6.103+
5.107+
4.111+
3.115+
2.119+
1.123+
76
80
84
88
92
96
YEAR


3.25+
2.00+
0.75+
-0.50+
-1.75+
-3.00+
-1.8
-1.1
-0.4
0.3
1.0
1.7
RESIDUALS

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.725
MULTIPLE R SQUARED..... 0.526

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE	
INTERCEPT	1	1.154E2	1.154E2		
REGRESSION	30	9.558E1	3.186E0	13.707	
TYPE 1 cty	1	3.758E0	3.758E0	16.167	3.84 *
TYPE 2 area	2	3.250E0	1.625E0	6.992	3 *
TYPE 3 mon	8	2.186E1	2.733E0	11.758	1.94 *
TYPE 4 yr	17	6.162E1	3.625E0	15.594	1.83 *
TYPE 5 grade	1	1.079E-3	1.079E-3	0.005	3.84
TYPE 6 'rule'	1	8.646E-1	8.646E-1	3.720	3.84
RESIDUALS	371	8.623E1	2.324E-1		
TOTAL	402	2.972E2			

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	4	INTERCEPT	0.529	0.157	402
2	460				
3	4				
4	77				
5	1				
6	1				
1	20	1	0.203	0.051	217
2	450	2	0.612	0.216	6
	470	3	0.160	0.059	102
3	3	4	0.410	0.153	13
	5	5	-0.296	0.084	91
	6	6	-0.437	0.083	106
	7	7	-0.451	0.086	84
	8	8	-0.761	0.105	41
	9	9	-0.841	0.183	9
	10	10	-0.174	0.367	2
	11	11	0.290	0.502	1
4	78	12	-0.018	0.171	29
	79	13	0.271	0.181	21
	80	14	-0.330	0.169	28
	81	15	-0.152	0.182	18
	82	16	0.667	0.184	17
	83	17	-0.001	0.209	10
	84	18	0.699	0.177	21
	85	19	0.767	0.185	17
	86	20	0.929	0.179	19
	87	21	0.688	0.180	19
	88	22	0.445	0.178	21
	89	23	0.984	0.172	27
	90	24	0.276	0.170	28
	91	25	0.057	0.168	32
	92	26	-0.063	0.170	28
	93	27	-0.125	0.169	44
	94	28	-0.072	0.263	11
5	2	29	0.010	0.153	26
6	2	30	-0.097	0.050	176

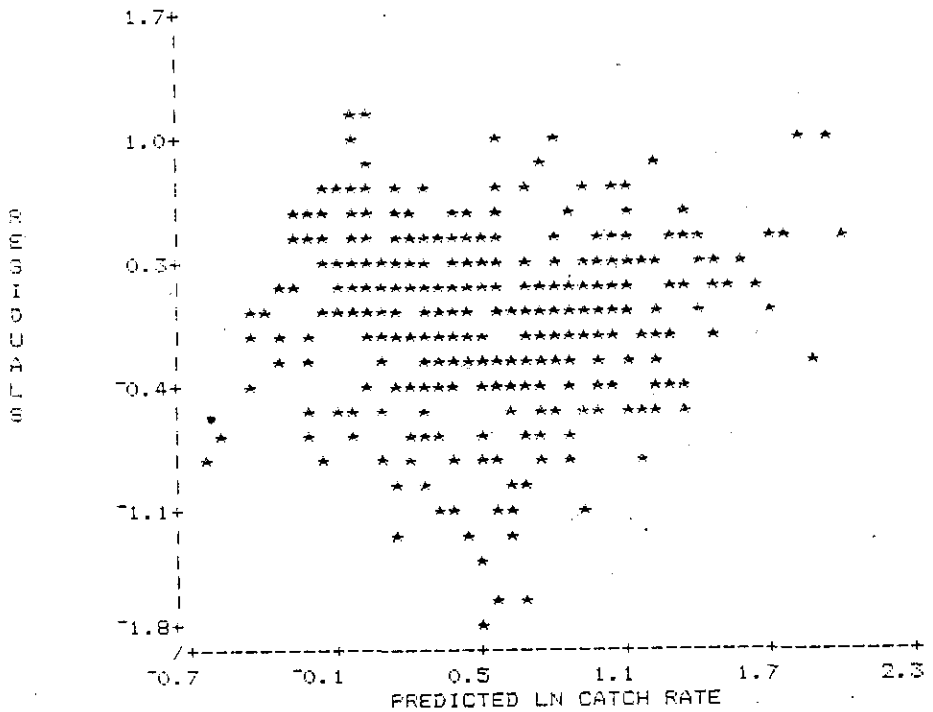


Table 7: Scotian Shelf silver hake Canadian July research vessel survey catch *numbers* ('000) at age.

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	7737	26740	89437	17730	32839	192025	114273	188970	102726
2	27660	23257	152705	55638	84724	293420	108957	70369	172576
3	21421	16266	67003	97253	131420	80348	38209	208723	34402
4	4592	8874	20048	45862	60469	60487	19340	37926	71191
5	1348	6733	11522	10684	16241	32426	10632	11828	21488
6	1278	3046	5055	4525	5127	8257	2882	7942	9445
7	984	1286	2664	2001	2367	3549	876	2860	2667
8	336	502	969	589	794	2535	401	1136	1175
9	283	865	275	385	564	327	337	522	215
1+	65639	87569	349678	234667	334545	673374	295907	530276	415885
Age	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	552598	146007	69740	172095	117089	66678	45284	166402	78069
2	84325	266663	89508	63810	125952	84743	56347	91306	59547
3	70625	46095	81458	24151	42329	35293	46180	74838	37734
4	22623	18982	16709	13405	13022	13257	11097	25736	15082
5	13448	6048	14249	4130	4173	6577	4477	3296	6734
6	4235	4168	2502	1868	1169	2456	2237	805	1173
7	1622	1199	2338	769	432	402	424	524	305
8	673	672	468	282	227	143	139	98	204
9	376	471	121	129	82	124	192	38	131
1+	750525	490305	277093	280639	304475	209904	168890	363061	199067

Table 8: Stratified mean catch per tow for the Canada-Russia juvenile silver hake survey, core strata (60-78).

Year Class	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992[1]	1993	1994
mean catch/tow	579.0	8.8	232.2	43.4	284.8	198.0	102.0	204.8	131.5	187.4	78.6	-	186.5	105.4
std.error	64.4	1.2	24.4	7.1	62.2	37.9	23.0	35.3	19.0	24.1	10.4	-	17.2	8.4
CV	0.11	0.14	0.11	0.16	0.22	0.19	0.23	0.17	0.14	0.13	0.13	-	0.09	0.08
number of sets	77	61	64	71	82	74	105	79	74	68	71	-	95	73
July RV age 1 #'s (10^6)	192	114	189	103	553	146	70	172	117	67	45	166	78	-

[1] no survey in 1992.

Table 9: Analytical summary of bias adjusted ADAPT run for 4VWX silver hake, using July RV, commercial CPUE, and 0-group survey.

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.001489
MEAN SQUARE RESIDUALS 0.562465

PAR. EST.	STD. ERR.	REL. ERR.	BIAS	REL. BIAS
1.323E1	4.504E_1	3.405E_2	4.184E_3	3.162E_4
1.304E1	3.963E_1	3.040E_2	4.074E_3	3.125E_4
1.218E1	3.149E_1	2.585E_2	1.328E_2	1.090E_3
1.119E1	3.477E_1	3.108E_2	6.143E_3	5.491E_4
1.012E1	3.939E_1	3.892E_2	_5.836E_3	_5.765E_4
8.078E0	4.241E_1	5.250E_2	_4.599E_3	_5.693E_4
6.445E0	4.032E_1	6.256E_2	_9.837E_3	_1.526E_3
1.320E_4	2.919E_5	2.212E_1	2.585E_6	1.959E_2
1.282E_5	2.463E_6	1.922E_1	1.843E_7	1.438E_2
2.142E_5	4.072E_6	1.901E_1	3.068E_7	1.432E_2
2.813E_5	5.322E_6	1.892E_1	4.053E_7	1.441E_2
3.579E_5	6.792E_6	1.898E_1	5.537E_7	1.547E_2
4.814E_5	9.162E_6	1.903E_1	8.162E_7	1.696E_2
5.935E_5	1.133E_5	1.910E_1	1.134E_6	1.911E_2
6.313E_5	1.202E_5	1.904E_1	1.302E_6	2.063E_2
5.181E_5	9.803E_6	1.892E_1	1.103E_6	2.130E_2
4.034E_5	7.626E_6	1.890E_1	8.549E_7	2.119E_2
7.422E_7	1.426E_7	1.922E_1	1.067E_8	1.438E_2
7.992E_6	1.519E_6	1.901E_1	1.145E_7	1.432E_2
2.625E_5	4.968E_6	1.892E_1	3.784E_7	1.441E_2
3.495E_5	6.632E_6	1.898E_1	5.407E_7	1.547E_2
3.502E_5	6.665E_6	1.903E_1	5.938E_7	1.696E_2
3.114E_5	5.947E_6	1.910E_1	5.951E_7	1.911E_2
1.976E_5	3.761E_6	1.904E_1	4.076E_7	2.063E_2
1.024E_5	1.938E_6	1.892E_1	2.182E_7	2.130E_2
5.254E_6	9.933E_7	1.890E_1	1.113E_7	2.119E_2

PAR. EST.	STD. ERR.	REL. ERR.	BIAS	REL. BIAS
1100000	0	0.00	0	0.00
556456	250665	0.45	58779	0.11
458842	181835	0.40	37895	0.08
194811	61344	0.31	12244	0.06
72153	25087	0.35	4804	0.07
24890	9805	0.39	1786	0.07
3223	1367	0.42	275	0.09
629	254	0.40	45	0.07
755	142	0.19	_3	0.00
10	2	0.17	0	_0.02
47	7	0.15	_1	_0.01
58	5	0.09	0	0.01
214	5	0.02	0	0.00
293	3	0.01	0	0.00
175	1	0.00	0	0.00
1535	2	0.00	0	0.00
1293	2	0.00	0	0.00
710	0	0.00	0	0.00
797	0	0.00	0	0.00
147	0	0.00	0	0.00
1894	1	0.00	0	0.00
605	0	0.00	0	0.00
2188	0	0.00	0	0.00
1434	0	0.00	0	0.00
4065	0	0.00	0	0.00
0	0	1.00	0	1.00

RESIDUALS (BEGINNING OF YEAR INDICES)

1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0.00	0.00	0.00	1.02	_2.53	0.24	_0.84	0.15	0.60	0.00	0.31	0.28	0.67	_0.42

1993	1994
0.00	0.53

RESIDUALS (MID-YEAR INDICES)

RV

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	_0.08	_1.38	_1.05	0.15	0.26	0.28	0.26	1.05	0.52	_0.16	0.37
2	0.66	_0.58	0.12	1.08	_0.47	_0.29	0.20	0.05	0.33	_0.01	_0.25
3	0.48	0.59	0.71	0.42	_0.67	0.61	_0.62	_0.08	_0.01	_0.29	_0.70
4	0.00	0.79	0.68	0.73	_0.46	_0.08	0.42	_0.12	_0.44	_0.14	_0.80
5	_0.37	0.21	0.40	0.92	_0.22	_0.42	0.37	_0.17	_0.25	0.11	_0.27
6	_0.16	_0.57	0.39	0.56	_0.37	0.07	0.15	0.30	_0.36	_0.20	_0.50
7	_0.71	0.07	_0.58	1.20	_0.79	0.39	_0.30	_0.76	0.59	0.01	_0.25
8	_0.48	_1.37	0.12	0.24	0.64	0.26	0.36	_0.77	_0.88	0.63	_0.72
9	_2.03	_0.64	_0.68	0.04	_1.04	1.94	_0.65	0.00	_0.35	_1.88	0.31

	1990	1991	1992	1993	1994
1	0.39	_0.14	_0.74	0.39	_0.12
2	0.15	0.11	_0.32	_0.06	_0.72
3	0.02	_0.20	0.02	0.38	_0.65
4	_0.21	0.30	0.03	0.10	_0.80
5	_0.30	0.27	0.78	_0.25	_0.80
6	0.32	0.89	0.29	_0.09	_0.72
7	_0.07	0.69	1.54	_0.55	_0.48
8	_0.17	0.34	0.91	1.75	_0.86
9	_0.63	0.06	1.87	0.46	3.23

CPUE

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.56	0.22	_1.84	0.25	_0.51	1.31	0.56	0.85	_0.19	_0.85	0.71
2	_0.07	_0.54	_1.11	_0.14	_0.24	_0.40	0.29	0.30	0.60	_0.30	0.48
3	_0.11	_0.85	_0.42	_0.06	_0.86	0.00	_0.12	0.62	0.47	0.04	0.70
4	_0.11	_0.74	_0.79	0.38	_0.66	0.06	0.42	0.67	0.13	_0.19	1.05
5	_0.13	_0.35	_0.60	0.72	_0.48	_0.28	0.53	0.36	0.34	_0.09	1.07
6	0.43	_0.98	_0.43	0.38	_0.20	_0.57	0.16	1.12	0.16	_0.26	1.20
7	_0.12	_0.28	_1.10	1.32	_0.34	_0.13	0.11	_0.27	0.01	0.16	1.07
8	_0.26	_1.18	_0.23	_0.34	1.14	_0.65	_0.30	0.01	_1.16	0.48	1.77
9	_0.42	_1.16	_1.07	_0.02	_0.91	0.02	_0.07	0.20	_0.21	_0.54	0.48

	1990	1991	1992	1993	1994
1	_0.69	_0.96	_0.08	1.07	_0.41
2	0.61	0.20	0.39	0.20	_0.27
3	0.26	0.39	_0.03	_0.14	0.12
4	_0.07	0.36	0.36	_0.19	_0.69
5	0.01	_0.02	0.26	0.03	_1.38
6	0.26	0.79	_0.35	_0.09	_1.62
7	0.46	0.36	1.26	_1.55	_0.95
8	_0.29	0.91	0.59	1.78	_2.26
9	_0.69	_0.42	0.95	1.16	2.70

Parameter Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00	0.04	0.03	0.02	0.02	0.00	0.00	_0.17	_0.16	_0.01	_0.01	0.00
2	0.04	1.00	0.00	0.00	0.02	0.01	0.01	_0.01	_0.13	_0.13	0.00	0.00
3	0.03	0.00	1.00	_0.17	0.01	0.01	0.04	_0.08	_0.07	_0.07	_0.09	0.01
4	0.02	0.00	_0.17	1.00	0.00	_0.02	0.01	_0.05	_0.05	_0.05	_0.07	_0.11
5	0.02	0.02	0.01	0.00	1.00	_0.02	_0.01	_0.04	_0.04	_0.04	_0.06	_0.09
6	0.00	0.01	0.01	_0.02	_0.02	1.00	0.01	0.00	0.00	_0.01	_0.01	_0.04
7	0.00	0.01	0.04	0.01	_0.01	0.01	1.00	_0.01	_0.01	_0.01	_0.01	_0.02
8	_0.17	_0.01	_0.08	_0.05	_0.04	0.00	_0.01	1.00	0.04	0.01	0.02	0.01
9	_0.16	_0.13	_0.07	_0.05	_0.04	0.00	_0.01	0.04	1.00	0.03	0.01	0.01

10	_0.01	_0.13	_0.07	_0.05	_0.04	_0.01	_0.01	0.01	0.03	1.00	0.01	0.01
11	_0.01	0.00	_0.09	_0.07	_0.06	_0.01	_0.01	0.02	0.01	0.01	1.00	0.01
12	0.00	0.00	0.01	_0.11	_0.09	_0.04	_0.02	0.01	0.01	0.01	0.01	1.00
13	0.00	_0.01	_0.02	_0.01	_0.13	_0.10	_0.06	0.01	0.01	0.01	0.01	0.02
14	0.00	_0.01	_0.04	_0.03	0.00	_0.14	_0.11	0.01	0.01	0.01	0.01	0.01
15	0.00	_0.01	_0.06	_0.05	_0.02	_0.02	_0.15	0.01	0.01	0.01	0.01	0.01
16	_0.01	_0.01	_0.08	_0.07	_0.04	_0.05	_0.04	0.01	0.01	0.01	0.02	0.01
17	0.00	0.00	_0.05	_0.05	_0.05	_0.07	_0.05	0.01	0.01	0.01	0.01	0.02
18	_0.16	_0.13	_0.07	_0.05	_0.04	0.00	_0.01	0.04	0.05	0.03	0.01	0.01
19	_0.01	_0.13	_0.07	_0.05	_0.04	_0.01	_0.01	0.01	0.03	0.03	0.01	0.01
20	_0.01	0.00	_0.09	_0.07	_0.06	_0.01	_0.01	0.02	0.01	0.01	0.02	0.01
21	0.00	0.00	0.01	_0.11	_0.09	_0.04	_0.02	0.01	0.01	0.01	0.01	0.02
22	0.00	_0.01	_0.02	_0.01	_0.13	_0.10	_0.06	0.01	0.01	0.01	0.01	0.02
23	0.00	_0.01	_0.04	_0.03	0.00	_0.14	_0.11	0.01	0.01	0.01	0.01	0.01
24	0.00	_0.01	_0.06	_0.05	_0.02	_0.02	_0.15	0.01	0.01	0.01	0.01	0.01
25	_0.01	_0.01	_0.08	_0.07	_0.04	_0.05	_0.04	0.01	0.01	0.01	0.02	0.01
26	0.00	0.00	_0.05	_0.05	_0.05	_0.07	_0.05	0.01	0.01	0.01	0.01	0.02

	13	14	15	16	17	18	19	20	21	22	23	24
1	0.00	0.00	0.00	_0.01	0.00	_0.16	_0.01	_0.01	0.00	0.00	0.00	0.00
2	_0.01	_0.01	_0.01	_0.01	0.00	_0.13	_0.13	0.00	0.00	_0.01	_0.01	_0.01
3	_0.02	_0.04	_0.06	_0.08	_0.05	_0.07	_0.07	_0.09	0.01	_0.02	_0.04	_0.06
4	_0.01	_0.03	_0.05	_0.07	_0.05	_0.05	_0.05	_0.07	_0.11	_0.01	_0.03	_0.05
5	_0.13	0.00	_0.02	_0.04	_0.05	_0.04	_0.04	_0.06	_0.09	_0.13	0.00	_0.02
6	_0.10	_0.14	_0.02	_0.05	_0.07	0.00	_0.01	_0.01	_0.04	_0.10	_0.14	_0.02
7	_0.06	_0.11	_0.15	_0.04	_0.05	_0.01	_0.01	_0.01	_0.02	_0.06	_0.11	_0.15
8	0.01	0.01	0.01	0.01	0.01	0.04	0.01	0.02	0.01	0.01	0.01	0.01
9	0.01	0.01	0.01	0.01	0.01	0.05	0.03	0.01	0.01	0.01	0.01	0.01
10	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.01	0.01	0.01	0.01	0.01
11	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01
12	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.01
13	1.00	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.02	0.02
14	0.02	1.00	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.04	0.02
15	0.02	0.02	1.00	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.03
16	0.01	0.02	0.02	1.00	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.02
17	0.02	0.02	0.02	0.02	1.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02
18	0.01	0.01	0.01	0.01	0.01	1.00	0.03	0.01	0.01	0.01	0.01	0.01
19	0.01	0.01	0.01	0.01	0.01	0.03	1.00	0.01	0.01	0.01	0.01	0.01
20	0.01	0.01	0.01	0.02	0.01	0.01	0.01	1.00	0.01	0.01	0.01	0.01
21	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	1.00	0.02	0.01	0.01
22	0.03	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.02	1.00	0.02	0.02
23	0.02	0.04	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	1.00	0.02
24	0.02	0.02	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	1.00
25	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.02
26	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02

	25	26
1	_0.01	0.00
2	_0.01	0.00
3	_0.08	_0.05
4	_0.07	_0.05
5	_0.04	_0.05
6	_0.05	_0.07
7	_0.04	_0.05
8	0.01	0.01
9	0.01	0.01
10	0.01	0.01
11	0.02	0.01
12	0.01	0.02
13	0.01	0.02
14	0.02	0.02
15	0.02	0.02
16	0.02	0.02
17	0.02	0.02
18	0.01	0.01
19	0.01	0.01
20	0.02	0.01
21	0.01	0.02
22	0.01	0.02
23	0.02	0.02
24	0.02	0.02
25	1.00	0.02
26	0.02	1.00

Table 10: Silver hake population numbers, biomass, and fishing mortality.

Population Numbers (Bias Adjusted)

	1979	1980	1981	1982	1983	1984	1985	1986
1	927469	675342	890125	1575936	838648	1381740	758900	1865511
2	482466	604860	439114	594738	1039852	557374	877422	496449
3	224787	276008	347569	273704	355292	617738	336098	481052
4	91454	91001	127383	143712	121347	192181	244687	144774
5	56456	31282	34774	54625	40332	57367	60941	58922
6	18831	19521	9126	13544	10620	17712	22617	12923
7	12338	4460	8841	3469	4211	4339	8378	7524
8	3975	5677	1818	4943	654	2152	2059	3697
9	6521	2259	3436	981	2933	231	1293	1195
1+	1824299	1714476	1863620	2667840	2414493	2832728	2312541	3072845
2+	896830	1039133	973495	1091904	1575846	1450988	1553641	1207334
3+	414363	434273	534381	497166	535994	893614	676219	710884
4+	189577	158265	186812	223463	180702	275876	340121	229833

	1987	1988	1989	1990	1991	1992	1993	1994
1	825877	775382	1138452	742877	704474	862570	999567	744463
2	1213157	548031	515571	743261	492630	467525	572089	644181
3	275249	637803	315948	275313	326601	234179	252404	315414
4	134866	90828	210317	81817	67582	54163	96777	111278
5	28192	46019	28755	22178	21099	7301	13565	36034
6	16052	8203	13406	2880	5253	4192	2060	4581
7	1490	5811	2955	1316	581	284	1789	894
8	3868	715	2149	697	358	152	60	1141
9	2071	2465	309	486	379	92	75	16
1+	2501533	2116550	2229397	1870998	1619251	1630672	1938444	1858050
2+	1675656	1341168	1090945	1128121	914777	768102	938877	1113587
3+	462499	793136	575374	384860	422147	300577	366788	469406
4+	187251	155334	259427	109548	95546	66398	114384	153992

Population Biomass (Bias Adjusted)

	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	50007	13181	32621	74688	38064	69391	35340	65984	21146
2	56116	64796	35997	60386	95576	55126	85610	49296	96345
3	45185	54990	62625	53919	64663	94026	54029	76097	42960
4	22808	23227	31602	34945	28512	40268	47704	30454	26574
5	16294	9562	10637	16158	11370	14627	14247	13501	7020
6	6476	6730	3375	4854	3612	5657	6407	3341	4292
7	5191	2027	4111	1467	1661	1668	3187	2559	525
8	2455	3508	1273	2633	295	1069	1000	1697	1573
9	5465	1917	3356	671	1400	126	835	732	1069
1+	209996	183345	186844	252615	245381	282741	248474	244214	201985
2+	159989	170164	154223	177927	207317	213350	213134	178230	180839
3+	103873	105367	118226	117541	111741	158223	127524	128933	84494
4+	58688	50377	55601	63623	47078	64197	73494	52836	41534

	1988	1989	1990	1991	1992	1993	1994
1	20145	44878	31508	19184	58848	46456	34600
2	43343	40185	67877	46100	37924	53667	49898
3	94634	52016	43391	52937	38057	36577	37718
4	17737	42814	16830	13442	10791	18388	17770
5	10779	7224	5142	5041	1726	2981	6846
6	2207	4038	852	1442	1138	556	1141
7	1968	1014	473	224	97	584	292
8	339	973	280	156	67	21	456
9	1328	197	256	181	55	47	8
1+	193153	194687	166795	138871	148846	159321	148799
2+	173008	149809	135287	119686	89998	112866	114199
3+	129665	109625	67410	73586	52074	59199	64301
4+	35031	57608	24018	20650	14017	22622	26583

Population Numbers (Mid-Year Bias Adjusted)

	1979	1980	1981	1982	1983	1984	1985	1986
1	754708	548781	732532	1289373	688461	1110561	618421	1516013
2	369678	464396	349917	464780	810558	437448	659503	375039
3	147947	192213	230829	187310	265436	402826	227164	272224
4	56089	58448	85930	81359	85400	114268	130474	71255
5	34780	17985	22515	26869	27488	37335	30961	32967
6	9978	13483	5849	7989	7017	12468	13714	5293
7	8581	2944	6704	1687	3068	3059	5722	5495
8	3037	4463	1357	3851	406	1686	1588	2806
9	5197	1816	2765	778	2375	186	1025	932
1+	1389994	1304528	1438399	2063997	1890209	2119836	1688572	2282025
2+	635286	755748	705867	774624	1201748	1009275	1070152	766012
3+	265608	291351	355949	309844	391190	571827	410648	390972
4+	117661	99139	125120	122533	125754	169001	183484	118748

	1987	1988	1989	1990	1991	1992	1993	1994
1	677485	636666	926857	609211	577927	707418	808905	612810
2	894863	421391	382962	506696	347533	348983	431090	524673
3	166338	385326	173290	147897	151629	155489	172315	242968
4	82631	53969	83635	44802	27089	29323	61484	87483
5	16191	26443	11245	11751	10462	4142	8275	29092
6	10079	5140	5209	1436	1704	2822	1397	3704
7	1056	3681	1563	736	320	144	1441	728
8	3114	484	1118	522	196	109	33	937
9	1651	1964	236	381	288	73	60	13
1+	1853409	1535064	1586115	1323432	1117148	1248504	1485001	1502408
2+	1175924	898398	659258	714221	539221	541087	676097	889598
3+	281061	477007	276295	207525	191688	192103	245006	364925
4+	114723	91681	103006	59629	40059	36615	72691	121957

Population Biomass (Mid-Year Bias Adjusted)

	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	57358	21951	44684	85099	46127	77739	42053	80349	30487
2	65803	70124	58786	78548	103751	63867	89692	54381	106489
3	33584	42863	49628	43269	52025	72911	40208	50089	27945
4	15368	16775	23717	22374	20411	25596	27400	17814	17435
5	10573	6133	7340	8517	7944	10155	7555	8242	4015
6	3881	5272	2345	3148	2561	4401	4046	1450	2883
7	3904	1563	3707	752	1212	1239	2346	2154	478
8	2545	3745	1252	1975	186	1052	924	1442	1314
9	4355	1560	3144	394	1055	121	686	600	855
1+	197371	169985	194605	244076	235272	257082	214909	216521	191901
2+	140013	148034	149920	158977	189145	179343	172856	136172	161415
3+	74211	77910	91134	80429	85393	115475	83164	81791	54926
4+	40627	35047	41506	37161	33368	42564	42956	31702	26981

	1988	1989	1990	1991	1992	1993	1994
1	28650	55611	38380	27163	56593	48534	30641
2	58573	51700	70431	48307	48858	47420	52467
3	71285	33791	27213	28658	29543	25847	31586
4	12251	18734	9722	5824	6158	11682	14872
5	6875	3126	2820	2752	1077	1903	5527
6	1501	1818	452	535	790	391	1000
7	1476	630	272	151	53	548	277
8	241	572	209	100	45	11	393
9	1351	193	208	164	51	58	9
1+	182203	166176	149708	113653	143168	136394	136773
2+	153553	110564	111328	86490	86574	87860	106132
3+	94980	58864	40897	38183	37717	40440	53665
4+	23695	25073	13684	9525	8174	14593	22079

Fishing Mortality (Bias Adjusted)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.03	0.03	0.00	0.02	0.01	0.05	0.02	0.03	0.01	0.01	0.03	0.01	0.01
2	0.16	0.15	0.07	0.12	0.12	0.11	0.20	0.19	0.24	0.15	0.23	0.42	0.34
3	0.50	0.37	0.48	0.41	0.21	0.53	0.44	0.87	0.71	0.71	0.95	1.00	1.40
4	0.67	0.56	0.45	0.87	0.35	0.75	1.02	1.24	0.68	0.75	1.85	0.96	1.83
5	0.66	0.83	0.54	1.24	0.42	0.53	1.15	0.90	0.83	0.83	1.90	1.04	1.22
6	1.04	0.39	0.57	0.77	0.50	0.35	0.70	1.76	0.62	0.62	1.92	1.20	2.52
7	0.38	0.50	0.18	1.27	0.27	0.35	0.42	0.27	0.33	0.59	1.05	0.90	0.94
8	0.16	0.10	0.22	0.12	0.64	0.11	0.14	0.18	0.05	0.44	1.09	0.21	0.96
9	0.07	0.05	0.05	0.08	0.04	0.05	0.08	0.12	0.07	0.07	0.17	0.11	0.18

	1992	1993	1994
1	0.01	0.04	0.00
2	0.22	0.20	0.03
3	0.48	0.42	0.15
4	0.98	0.59	0.10
5	0.87	0.69	0.04
6	0.45	0.43	0.04
7	1.15	0.05	0.02
8	0.31	0.93	0.01
9	0.07	0.05	0.01

Table 11: Regression of ln(rv) age 1 numbers vs SPA numbers.

* * * * M U L T I P L E R E G R E S S I O N * * * *

Listwise Deletion of Missing Data

Equation Number 1 Dependent Variable.. SPA

Block Number 1. Method: Stepwise Criteria PIN .0500 POUT .1000

Variable(s) Entered on Step Number
1.. LRV

Multiple R .83171
R Square .69174
Adjusted R Square .66091
Standard Error 219613.07508

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	1082274549117.39500	1082274549117.40
Residual	10	482299027458.27200	48229902745.8272

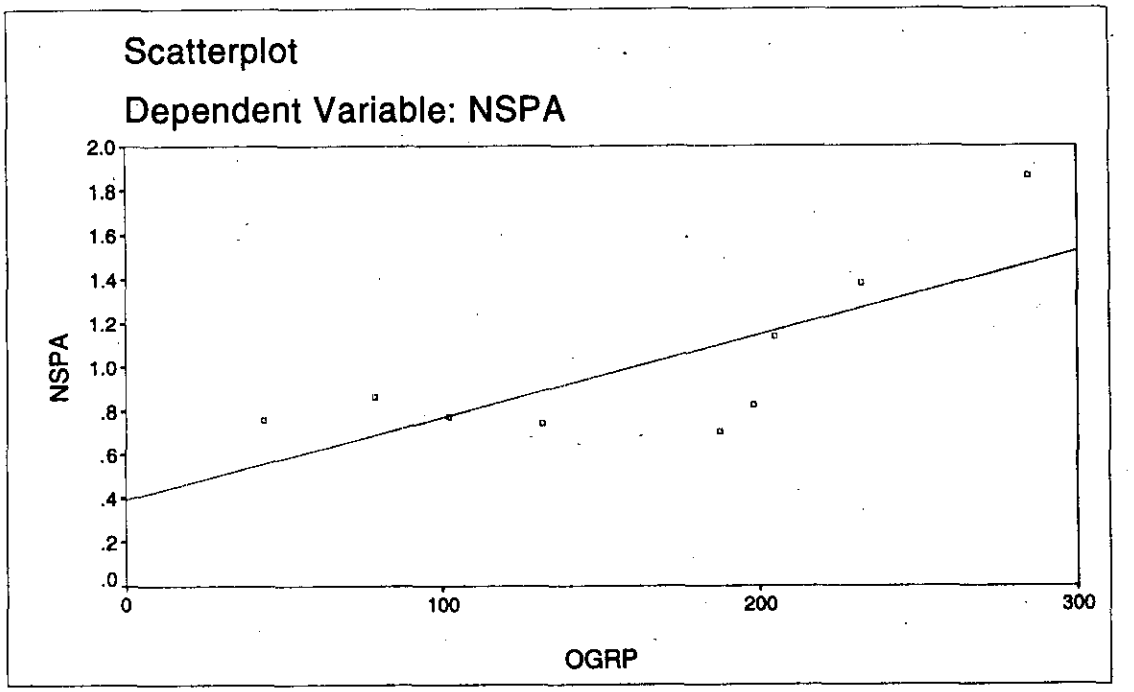
F = 22.43991 Signif F = .0008

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
LRV	486754.62293	102754.1936	.831708	4.737	.0008
(Constant)	-4694167.744	1211968.428		-3.873	.0031

End Block Number 1 POUT = .100 Limits reached.

Table 12: Relationship between O-group survey and age 1 numbers from VPA for 4VWX silver hake.



Listwise Deletion of Missing Data

Equation Number 1 Dependent Variable.. NSPA

Block Number 1. Method: Enter

Variable(s) Entered on Step Number 1.. OGRP

Multiple R	.75903	Analysis of Variance			
R Square	.57613		DF	Sum of Squares	Mean Squar
Adjusted R Square	.51558	Regression	1	.70570	.7057
Standard Error	.27234	Residual	7	.51920	.0741

F = 9.51445 Signif F = .0177

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
OGRP	.003782	.001226	.759032	3.085	.0177
(Constant)	.391495	.218988		1.788	.1170

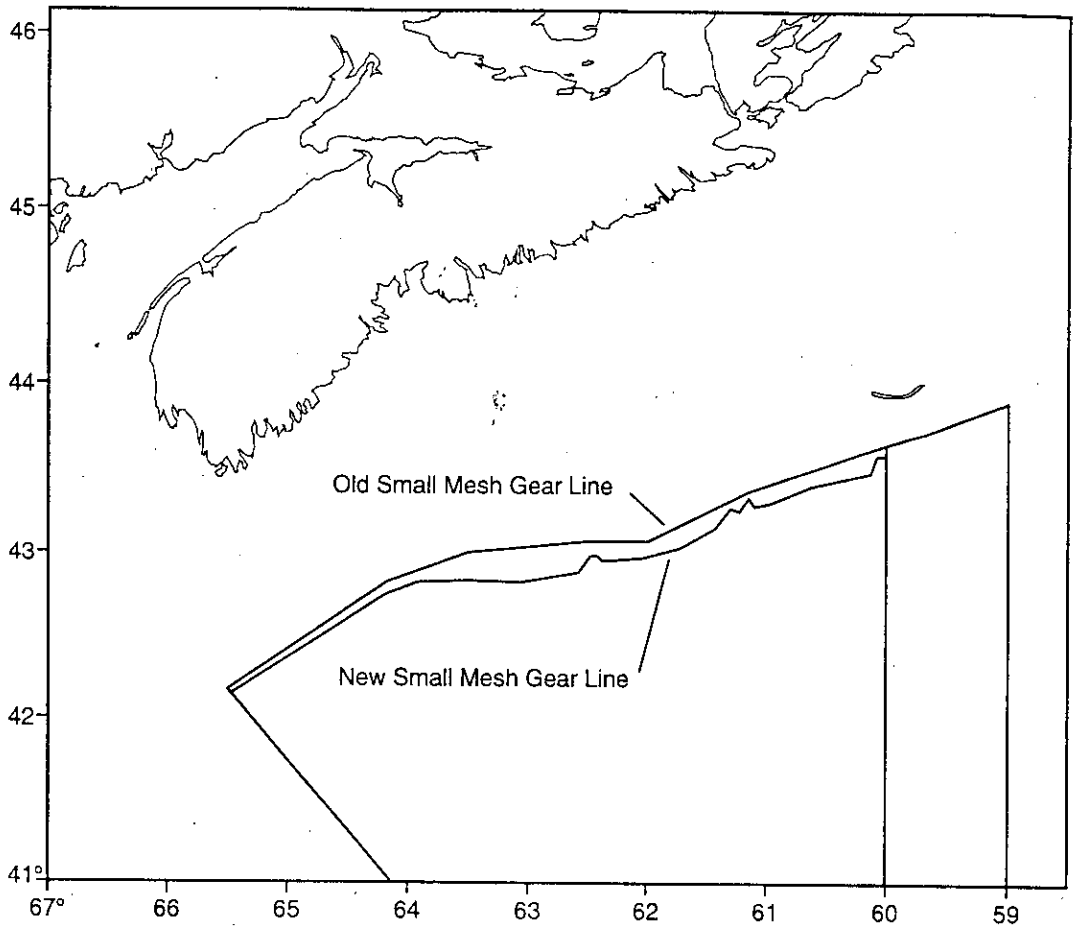


Figure 1: The old and new Small Mesh Gear Line (SMGL).

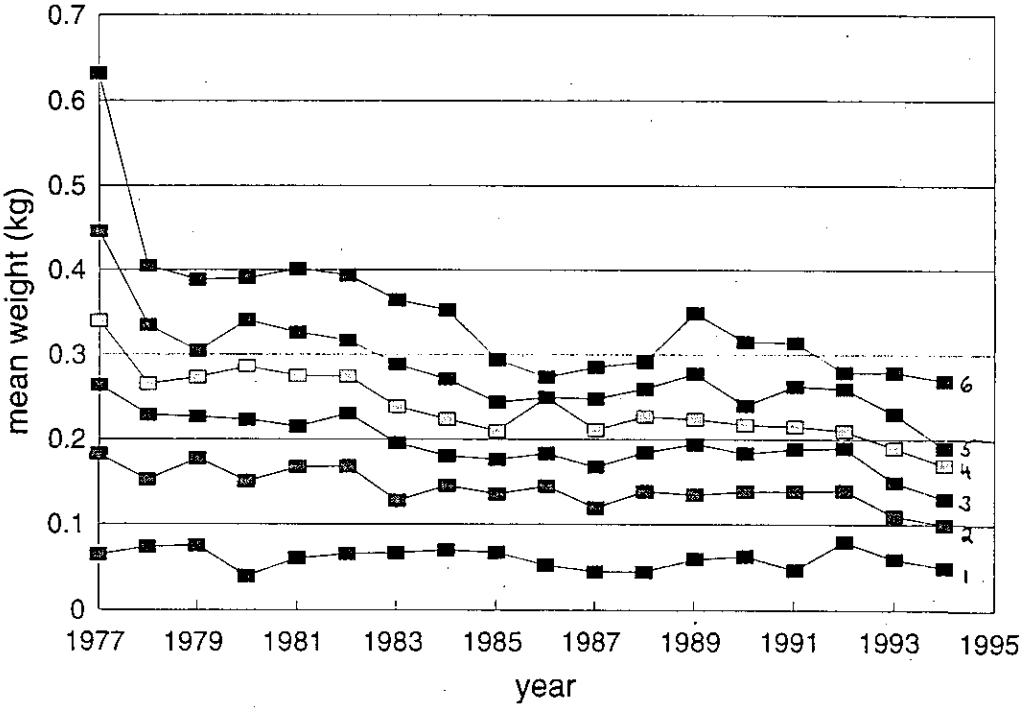


Figure 2: Mean weight at age for 4VWX silver hake.

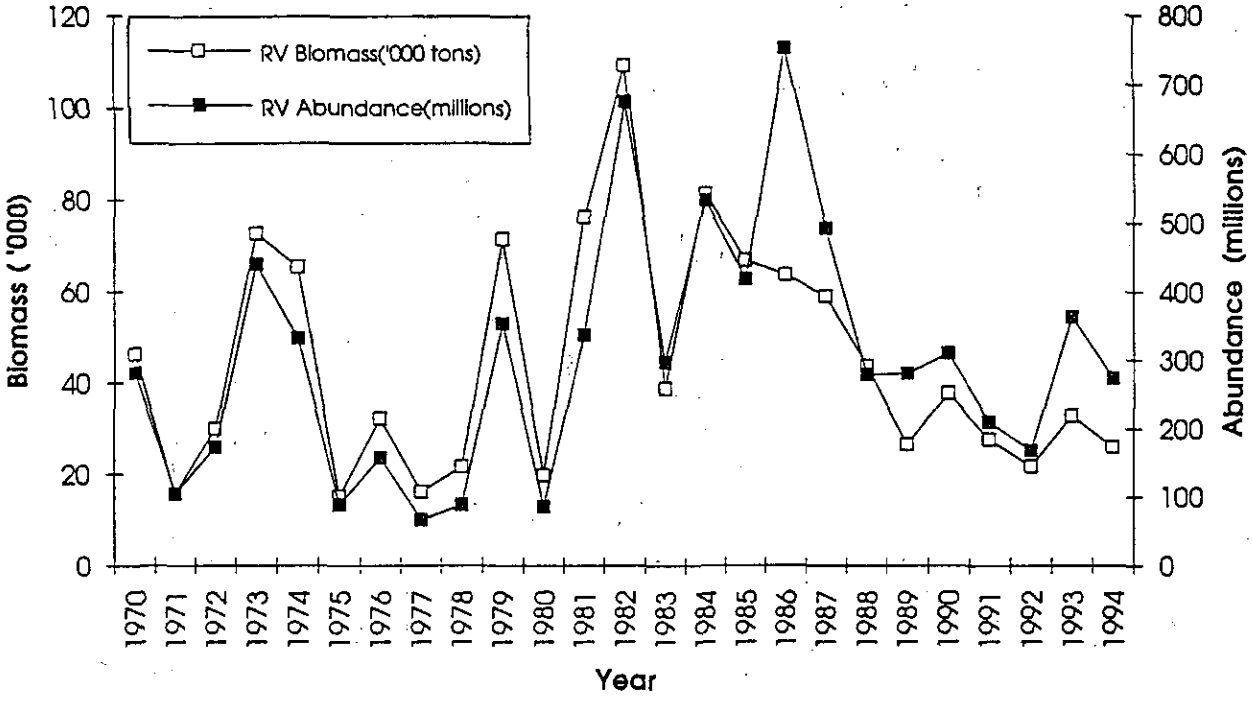


Figure 3: 4VWX silver hake July survey estimates of 1+ numbers and biomass.

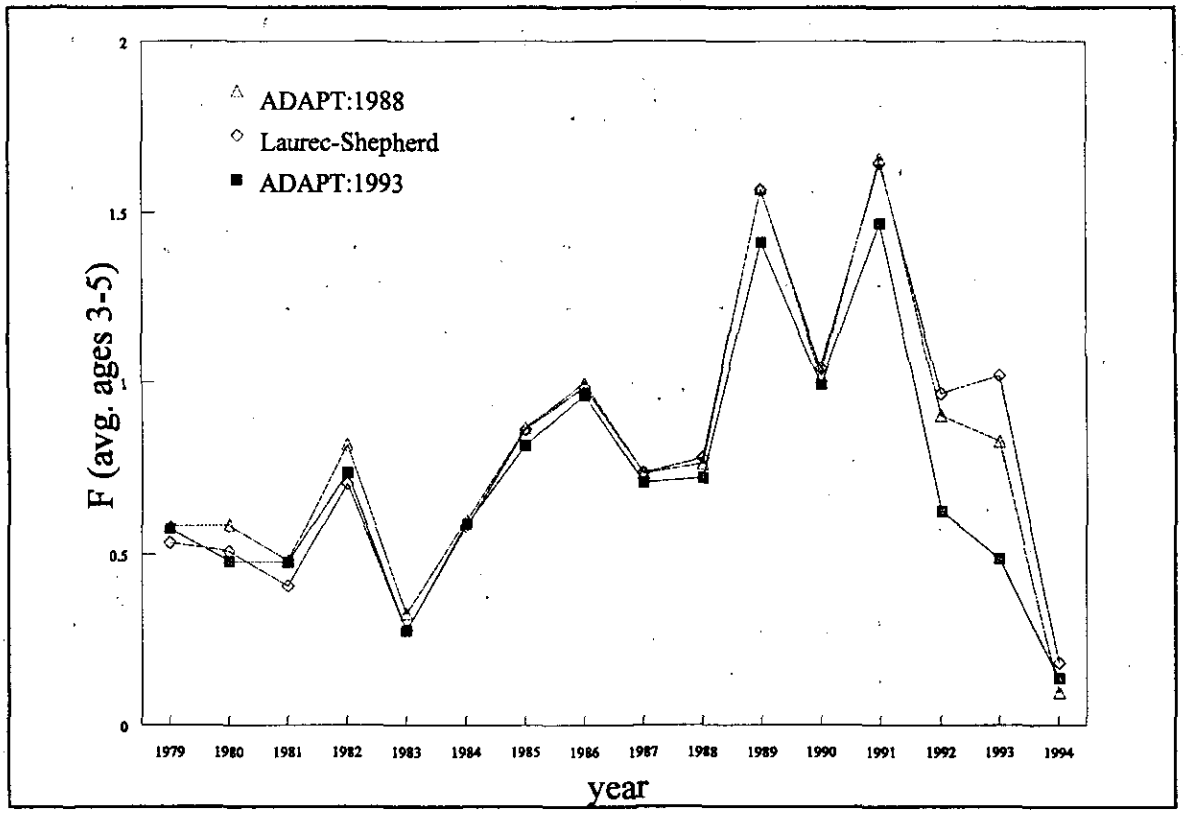


Figure 4: Comparison of fully recuited F derived from ADAPT, Laurec-Shepherd, and bias corrected ADAPT analyses.

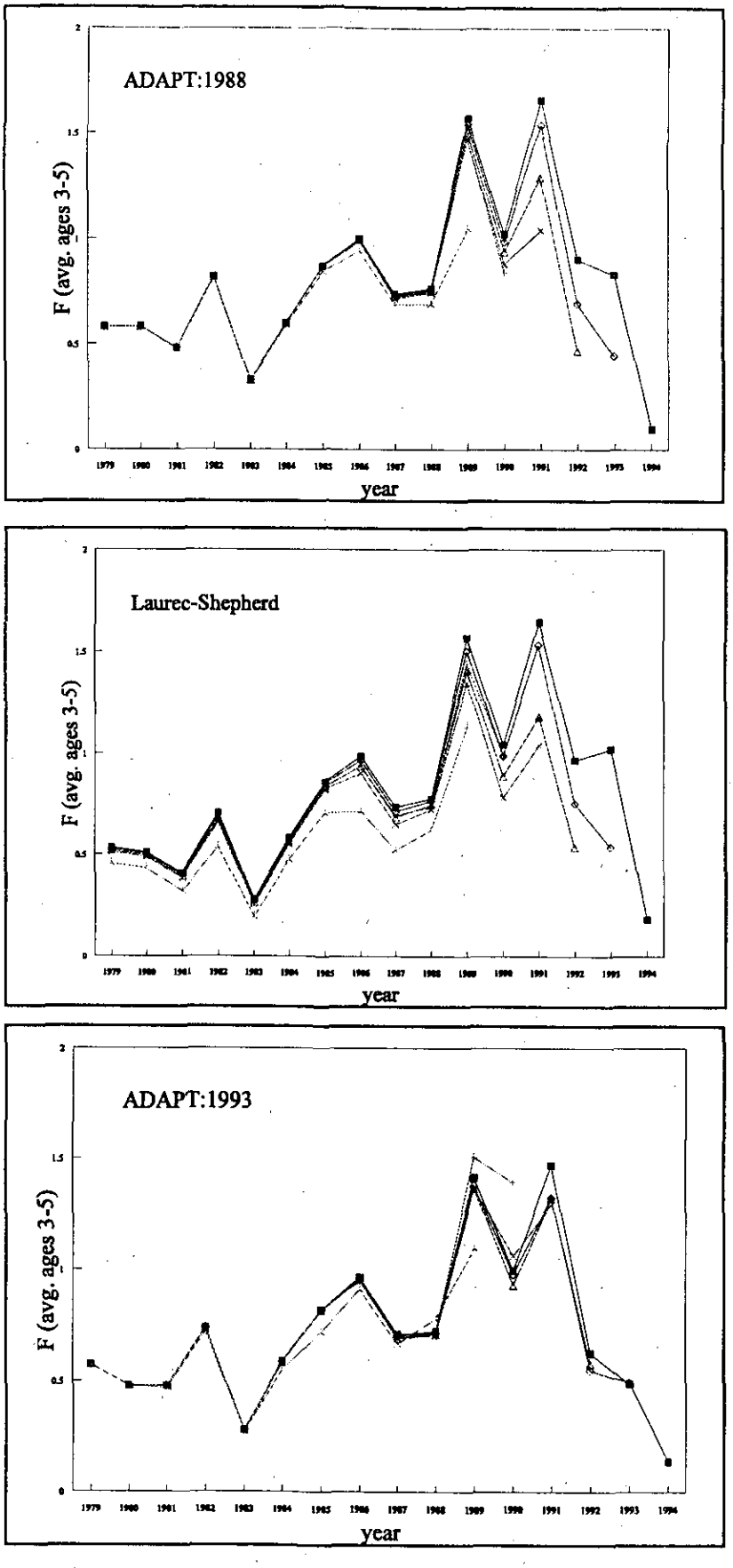


Figure 5: Comparison of retrospective analysisaverage for age 3-5 F derived from ADAPT, Laurec-Shepherd, and bias corrected ADAPT techniques.