Northwest Atlantic Fisheries Organization

Serial No. N1207

NAFO SCR Doc. 86/85

SCIENTIFIC COUNCIL MEETING - JUNE 1986

Standardization of 4VWX Silver Hake Catch Rates from the Scotian Shelf Small Meshed Fishery

by

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INTRODUCTION

A catch rate series was presented in Waldron and Fanning (1986). This series was from NAFO (1970-1984) and observed (1977-1985) catch rates. NAFO catch rates 1970-1976 were classed as "old" fishing regime. The observed catch rates from 1977 to 1979 were allocated to two categories, "old" and "new" fishing regimes. These observed catch and effort were subtracted from those reported. The remaining catch rates were classed as "new" fishing regime. NAFO and observed catch rates since 1979 were classed as "new" fishing regime. The observed catch rates from 1977-1979 were further subdivided into seaward and landward of the small meshed gear line (SMGL).

MATERIALS AND METHODS

Directed monthly catch and associated effort data for the Soviet silver hake fishery from 1977 to 1985 were obtained from NAFO and the Canadian International Observer Program (IOP)(Table 1). In 1977 and again in 1978 the Soviet Union reported monthly catch and effort from mixed fisheries. In these cases directed catch was defined when silver hake constituted greater than 50% of the monthly reported catch. Since 1979 the Soviet Union has reported monthly directed silver hake catch. Observed catch data were classed as directed when greater than 50% of the observed daily catch for the IOP data.

Observed data for 1977-1979 was separated by vessel by trip. Licensing information was obtained from the Foreign Licensing Unit of the Scotia Fundy Region, Department of Fisheries and Oceans. Licence amendments specified the time period that each Soviet vessel was engaged in the experimental fishery (ie. if the vessel was permitted to fish landward of the SMGL). Each trip was then classed as belonging to the "old" or "new" fishing regimes. These individual vessel data were then aggregated to month and area. For 1977-1979, observed data were subtracted from reported data. The difference in catch and associated effort was classed as belonging to the "new" fishing regime. Reported catch rates from 1980-1984 were also classified as "new" fishing regime. Observed data were used for 1985 and were also classified as new.

A multiplicative model (Gavaris, 1980) using the following categories and standards (in parenthesis):

Type 1	Data source, NAFO or IOP, (NAFO)
Type 2	Month (May)
Type 3	Year (1970)
Type 4	Area (4W, coded as 460) and
Type 5	Fishing regime ("old", coded as 1)

The model was run on data where catch was greater than 10 tons. In the first run of the model a large negative residual was isolated as being a month where small observed catches (16 t) and high effort (72 hrs) were observed during the month of August, 1977 in 4W. Perusal of the original data showed that these data were from two sets. The associated squid catches constituted 40% and 42% of the catch. Although the silver hake catches represent more than 50% of the catch, the low number of sets coupled with a high bycatch of squid justified the removal of these data from future runs of the model.

Using the remaining data another run was completed (Table 2 and 3). The model and only Type 3 (year) was significant at the 5% level. Categories 1,2,4 and 5 were grouped and removed from the model. The results of the model are given in Tables 4 and 5.

RESULTS AND DISCUSSION

The final model (Table 4) is significant at the 5% level. The coefficients of the model (Table 5) show that the 1973, 1982, 1984 and 1985 data points are above average with 1982 being the largest in the model. The residual plot (Figure 1) shows the yearly affect. There is good agreement between the expected normal values and the residuals (Figure 2).

The Predicted Catch Rates from the model are presented in Table 6. Catch rates in the early 1980's are the highest for the series (Figure 3). The 1982 catch rate is much higher than that of the previously high catch rate reported for the large 1973 fishery.

The catch rate has been increasing since 1983. The 1983 catch rate compared to that in 1977-1981 suggests that the 1982 point is anomalous. However, there is no obvious reason for such a high catch rate in 1982. The increasing trend in catch rates in the early to mid 1980's suggests that this stock is in excellent condition.

The assumption that the observed catch rates in 1977 to 1979 are typical for the 4VWX silver hake fishery is open for debate. Papers presented by Clay (1979), Waldron (1978, 1979, 1980) and Waldron and Sinclair (1984) suggest that for those vessels fishing landward (similar to what is referred to as the "old" regime) compared to those fishing seaward (similar to the "new" regime) there was very little difference in the observed catch rates. Although NAFO had requested a review of this subject and papers were presented at several meetings in the late 1970's, unfortunately the conclusions were not adequately recorded in the Red Books.

It is not inconceivable that captains fishing under a new set of Canadian regulations would be cautious in their fishing practices. The Fleet commanders on the other hand would be more concerned with demonstrating higher catch rates with subsequently lower by-catches while fishing to the landward side of the SMGL. In this regard the fishing habits could have been altered. If fishing was better on the seaward side of the SMGL there would have been a reluctance to send vessels to the landward side of the line. The converse is also true. Therefore there would be incentives to keep vessels fishing under situations where by-catch would be minimal and catch rates high.

During the 1977-1979 experiments to evaluate the placement of the SMGL no restrictions on the amount of bycatch each vessel could take were imposed by Canada. However, Cuban scientists

expressed concern that the by-catch restrictions imposed on the fleets fishing seaward of the SMGL would influence the behavior of Captains who fished to the landward side of the line. In order to investigate this potential bias, Cuba and Canada conducted a joint experiment. A vessel was given the normal experimental permit which provided exemptions from all Foreign Fishery Regulations. Further, Canada met with the fishing Captain and Cuban fishing representative again giving complete assurances that all Canadian regulations pertaining to Foreign Fisheries were revoked for the duration of the experiment. In a further attempt to ensure that the Captains would fish in a relatively uninhibited fashion both Cuban and Canadian scientists were present for the duration of the experiment. During this same experiment Soviet vessels were given the usual permit without the extra effort to reassure the Captain.

By-catch and catch rates are reported in Waldron and Sinclair (1980). Catch rates were found to be higher landward after July and by-catches remained at comparable levels to other vessels (Soviet) fishing in the same area under the usual amendment. The silver hake catch rates between Cuban and Soviet were similar (approximately 2.0 t/hr). Canadian managers and scientists held informal discussions with Soviet and Cuban fishing officials and Captains after the experiments. There was no evidence that vessels were fishing in a manner contrary to normal practices before 1977. Indeed there were incentives to prove that the line did impede the normal fishery catch rates, particularly in the late Summer and early Fall.

REFERENCES

Clay, D. 1979. A preliminary review of silver hake (Merluccius bilinearis) stock distribution and differentiation on the Scotian Shelf. ICNAF RES. Doc. 79/II/15 15p.

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

Waldron, D. E. and P. Fanning. 1986. Assessment of the Scotian Shelf silver hake population in 1985. NAFO SCR Doc. 86/62. 29p.

Waldron, D.E. and A. Sinclair. 1980. Observations on the squid (Illex illecebrosus) and silver hake (Merluccius bilinearis) fisheries on the Scotian Shelf in 1979. NAFO SCR Doc. 80/II/18. 21p.

Waldron, D. E. and A.F. Sinclair. 1984. Analysis of by-catches observed in the Scotian Shelf foreign fishery and their impact on domestic fisheries. CAFSAC Res. Doc. 84/101. 52p.

Table 1: 4VWX silver hake catch and effort used used as input to the multiplicative model.

CATCH	EFFORT	NAFO/IOP	MONTH	YEAR	AREA	OLD/NEW	CPUE
708	296	1	5	70	450	1	2.39
789	847	1	6	70	450	1	.93
1476	602	1	8	70	450	1	2.45
1533	924	1	9	70	450	1	1.66
16546	6764	1	4	70	460	1	2.45
17112	10216	1	5	70	460	1	1.68
16526	8729	1	6	70	460	1	1.89
34550	14534	1	7	70	460	1	2.38
41689	16713	1	8	70	460	1	2.49
17222	11395	1	9	70	460	1	1.51
136	30	1	4	70	470	1	4.53
2060	510	1	5	70	470	1	4.04
1638	794	1	6	70	470	1	2.06
197	77	1	7	70	470	1	2.56
631	323	1	8	70	470	1	1.95
241	113	1	9	70	470	1	2.13
1435	623	1	4	71	450	1	2.30
17949	11037	1	4	71	460	1	1.63
22118	15915	1	7	71	460	1	1.39
21101	14635	1	8	71	460	1	1.44
4994	3702	1	5	71	470	1	1.35
227	111	1	6	71	470	1	2.05
520	322	1	8	71	470	1	1.61
11078	4912	1	4	72	460	1	2.24
19675	12254	1	4	72	460	1	1.90
16336	6522	1	5	72	460	1	1.84
24043	16754	1	6	72	460	1	2.33
14610	9392	1	7	72	460	1	1.40
11481	5310	1	8	72	460	1	1.79
596	421	1	9	72	460	1	1.92
2382	1359	1	7	72	470	1	2.02
69254	13843	1	4	73	460	1	2.01
71540	24498	1	5	73	460	1	3.92
40103	24643	1	6	73	460	1	1.42
38789	18263	1	7	73	460	1	2.24
12991	9393	1	8	73	460	1	1.80
6732	2797	1	9	73	460	1	2.88
22111	5776	1	4	73	470	1	2.01
187	107	1	5	73	470	1	1.50
1368	610	1	6	73	470	1	1.25
3779	1830	1	7	73	470	1	2.13
8332	7512	1	4	74	460	1	2.26
12617	7672	1	6	74	460	1	1.61
2072	898	1	9	74	460	1	2.50
11751	10067	1	4	75	460	1	1.44
11181	9819	1	5	75	460	1	1.56
22520	12334	1	7	75	460	1	2.16
17383	10807	1	8	75	460	1	1.42
15447	12093	1	9	75	460	1	1.75
2067	1502	1	5	75	470	1	5.00
2095	1495	1	7	75	470	1	2.92
4029	2548	1	8	75	470	1	1.63
3629	1959	1	4	76	450	1	1.61
4787	2966	1	5	76	450	1	1.46
4268	3289	1	7	76	450	1	1.08
3934	1733	1	8	76	450	1	1.19
3747	1260	1	9	76	450	1	1.39
5950	2284	1	4	76	460	1	2.06
8409	3753	1	7	76	460	1	1.34
1276	673	1	8	76	460	1	1.51
1223	665	1	9	76	460	1	1.64
4020	1722	1	7	76	470	1	.71
14	10	1	8	77	450	2	2.12
3295	1841	1	4	77	460	2	1.38
3721	1933	1	5	77	460	2	2.41
1796	889	1	6	77	460	2	3.83
8261	4117	1	7	77	460	2	1.75
1704	435	1	8	77	460	2	2.24

Table 1: 4VWX silver hake catch and effort used used as input to the multiplicative model.

470	332	1	9	77	460	2	2.07
2423	1083	1	4	77	470	2	1.11
1576	875	1	5	77	470	2	1.64
236	82	1	6	77	470	2	2.31
1051	524	1	7	77	470	2	1.17
24	16	1	8	77	470	2	1.14
232	186	1	4	78	450	2	1.83
2995	1406	1	5	78	450	2	1.61
326	203	1	6	78	450	2	1.28
1591	1087	1	4	78	460	2	1.38
5219	4812	1	5	78	460	2	1.40
6169	5196	1	6	78	460	2	1.58
7847	5626	1	7	78	460	2	1.85
4183	2031	1	8	78	460	2	1.61
330	247	1	4	78	470	2	1.30
133	88	1	5	78	470	2	2.27
1064	649	1	6	78	470	2	2.97
27	38	1	7	78	470	2	2.61
22	5	1	4	79	450	2	4.40
13	10	1	8	79	450	2	1.30
2103	1244	1	4	79	460	2	1.69
8847	4874	1	5	79	460	2	1.82
8390	4985	1	6	79	460	2	1.68
7470	3948	1	7	79	460	2	1.89
2014	1338	1	8	79	460	2	1.51
713	411	1	9	79	460	2	1.73
65	31	1	4	79	470	2	2.10
739	436	1	5	79	470	2	1.69
98	65	1	6	79	470	2	1.51
1531	1176	1	4	80	460	2	1.30
9033	7902	1	5	80	460	2	1.14
11333	9056	1	6	80	460	2	1.25
9018	7083	1	7	80	460	2	1.27
3665	5683	1	8	80	460	2	.64
168	118	1	5	80	470	2	1.42
1639	906	1	6	80	470	2	1.81
4494	2725	1	7	80	470	2	1.65
66	113	1	8	80	470	2	.58
117	80	1	6	81	450	2	1.46
363	275	1	7	81	450	2	1.32
7	6	1	8	81	450	2	1.17
601	490	1	4	81	460	2	1.23
13317	6091	1	5	81	460	2	2.19
11804	8717	1	6	81	460	2	1.35
9940	7100	1	7	81	460	2	1.40
763	543	1	8	81	460	2	1.41
220	192	1	6	81	470	2	1.15
17	14	1	8	81	470	2	1.21
2165	386	1	4	82	460	2	5.61
16644	3895	1	5	82	460	2	4.27
20985	5441	1	6	82	460	2	3.86
6653	2348	1	7	82	460	2	2.83
5134	1726	1	4	83	460	2	2.97
13127	6030	1	5	83	460	2	2.18
7110	4935	1	6	83	460	2	1.44
15732	3794	1	5	84	460	2	4.15
17276	7077	1	6	84	460	2	2.44
21453	8735	1	7	84	460	2	2.46
2838	904	1	8	84	460	2	3.14
21	8	2	6	77	460	1	2.63
5	9	2	6	77	460	2	.56
435	184	2	7	77	460	1	2.36
50	41	2	7	77	460	2	1.22
771	712	2	8	77	460	1	1.08
16	72	2	8	77	460	2	.22
18	16	2	8	77	470	1	1.13
225	128	2	9	77	460	1	1.76
527	408	2	4	78	460	1	1.29
5	6	2	5	78	450	1	.83
1233	776	2	5	78	460	1	1.59
17	17	2	5	78	470	1	1
16	19	2	5	78	470	2	.84

Table 1: 4VWX silver hake catch and effort used used as input to the multiplicative model.

1375	493	2	6	78	450	1	2.79
2136	1557	2	6	78	460	1	1.37
116	63	2	6	78	460	2	1.84
72	40	2	6	78	470	1	1.80
774	310	2	7	78	450	1	2.50
2745	1645	2	7	78	460	1	1.67
47	32	2	7	78	470	1	1.47
74	29	2	8	78	450	1	2.55
3195	1316	2	8	78	460	1	2.43
2	6	2	8	78	470	1	.33
7	10	2	9	78	450	1	.70
110	102	2	9	78	460	1	1.08
1	1	2	9	78	460	2	1
0	3	2	10	78	450	1	0
1	3	2	10	78	460	1	.33
1510	690	2	5	79	460	1	2.19
1684	847	2	5	79	460	2	1.99
105	81	2	5	79	470	1	1.30
11	15	2	5	79	470	2	.73
3174	1604	2	6	79	460	1	1.98
2097	1188	2	6	79	460	2	1.77
41	46	2	6	79	470	1	.89
83	87	2	6	79	470	2	.95
2239	899	2	7	79	460	1	2.49
1017	455	2	7	79	460	2	2.24
3	1	2	7	79	470	2	3
392	259	2	8	79	460	2	1.51
4083	1641	2	5	85	460	2	2.49
1153	455	2	5	85	460	2	2.53
7818	2322	2	6	85	460	2	3.37
960	414	2	6	85	460	2	2.32
4894	1638	2	7	85	460	2	2.99
2184	450	2	8	85	460	2	4.85
59	15	2	7	85	470	2	3.93

TABLE 2. REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... .634
MULTIPLE R SQUARED..... .402

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	6.153E0001	6.153E0001	
REGRESSION	24	1.039E0001	4.330E-001	3.862
TYPE 1	1	1.918E-001	1.918E-001	1.710
TYPE 2	5	5.397E-001	1.079E-001	0.963
TYPE 3	15	9.474E0000	6.316E-001	5.632
TYPE 4	2	1.392E-001	6.959E-002	0.621
TYPE 5	1	2.763E-001	2.763E-001	2.464
RESIDUALS	138	1.547E0001	1.121E-001	
TOTAL	163	8.739E0001		

TABLE 3. REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	1	INTERCEPT	0.771	0.110	163
2	5				
3	70				
4	460				
5	1				
1	2	1	-0.165	0.126	38
2	4	2	0.153	0.094	24
	6	3	0.001	0.083	35
	7	4	-0.003	0.085	32
	8	5	-0.029	0.090	27
	9	6	-0.046	0.117	13
3	71	7	-0.297	0.154	7
	72	8	-0.159	0.148	8
	73	9	0.078	0.137	10
	74	10	-0.328	0.215	3
	75	11	-0.422	0.148	8
	76	12	-0.102	0.138	10
	77	13	0.050	0.172	18
	78	14	-0.178	0.167	26
	79	15	-0.025	0.188	22
	80	16	-0.101	0.195	8
	81	17	-0.282	0.192	9
	82	18	0.788	0.230	4
	83	19	0.156	0.250	3
	84	20	0.511	0.231	4
	85	21	0.743	0.282	7
4	450	22	0.066	0.090	21
	470	23	-0.040	0.064	46
5	2	24	-0.205	0.130	80

TABLE 4. REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... .603
MULTIPLE R SQUARED..... .363

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	6.153E0001	6.153E0001	
REGRESSION	15	9.399E0000	6.266E-001	5.593
TYPE 1	0	0.000E0000	1.000E0000	8.926
TYPE 2	0	0.000E0000	1.000E0000	8.926
TYPE 3	15	9.399E0000	6.266E-001	5.593
TYPE 4	0	0.000E0000	1.000E0000	8.926
TYPE 5	0	0.000E0000	1.000E0000	8.926
RESIDUALS	147	1.647E0001	1.120E-001	
TOTAL	163	8.739E0001		

TABLE 5. REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	1	INTERCEPT	0.778	0.084	163
2	4				
3	70				
4	450				
5	1				
3	71	1	-0.276	0.152	7
	72	2	-0.192	0.145	8
	73	3	0.078	0.135	10
	74	4	-0.299	0.211	3
	75	5	-0.438	0.145	8
	76	6	-0.065	0.135	10
	77	7	-0.165	0.115	18
	78	8	-0.363	0.106	26
	79	9	-0.264	0.110	22
	80	10	-0.312	0.145	8
	81	11	-0.477	0.139	9
	82	12	0.615	0.187	4
	83	13	-0.004	0.211	3
	84	14	0.293	0.187	4
	85	15	0.357	0.152	7

TABLE 6. PREDICTED CATCH RATE

STANDARDS USED VARIABLE NUMBERS: 1 4 450 1

YEAR	TOTAL CATCH	PROP.	CATCH RATE MEAN	S.E.	EFFORT
1970	169045	0.905	2.295	0.192	73666
1971	128653	0.531	1.733	0.219	74246
1972	114048	0.879	1.888	0.223	60418
1973	299530	0.891	2.476	0.262	120985
1974	95745	0.240	1.676	0.322	57113
1975	116394	0.743	1.476	0.175	78841
1976	97184	0.424	2.146	0.227	45295
1977	37095	0.703	1.946	0.154	19064
1978	48404	0.879	1.599	0.105	30272
1979	51751	0.828	1.764	0.126	29339
1980	44525	0.457	1.673	0.198	26607
1981	42927	0.488	1.420	0.158	30232
1982	60251	0.496	4.198	0.700	14352
1983	35839	0.497	2.251	0.432	15922
1984	74280	0.522	3.042	0.507	24414
1985	76120	0.278	3.263	0.413	23328

AVERAGE C.V. FOR THE MEAN: .122

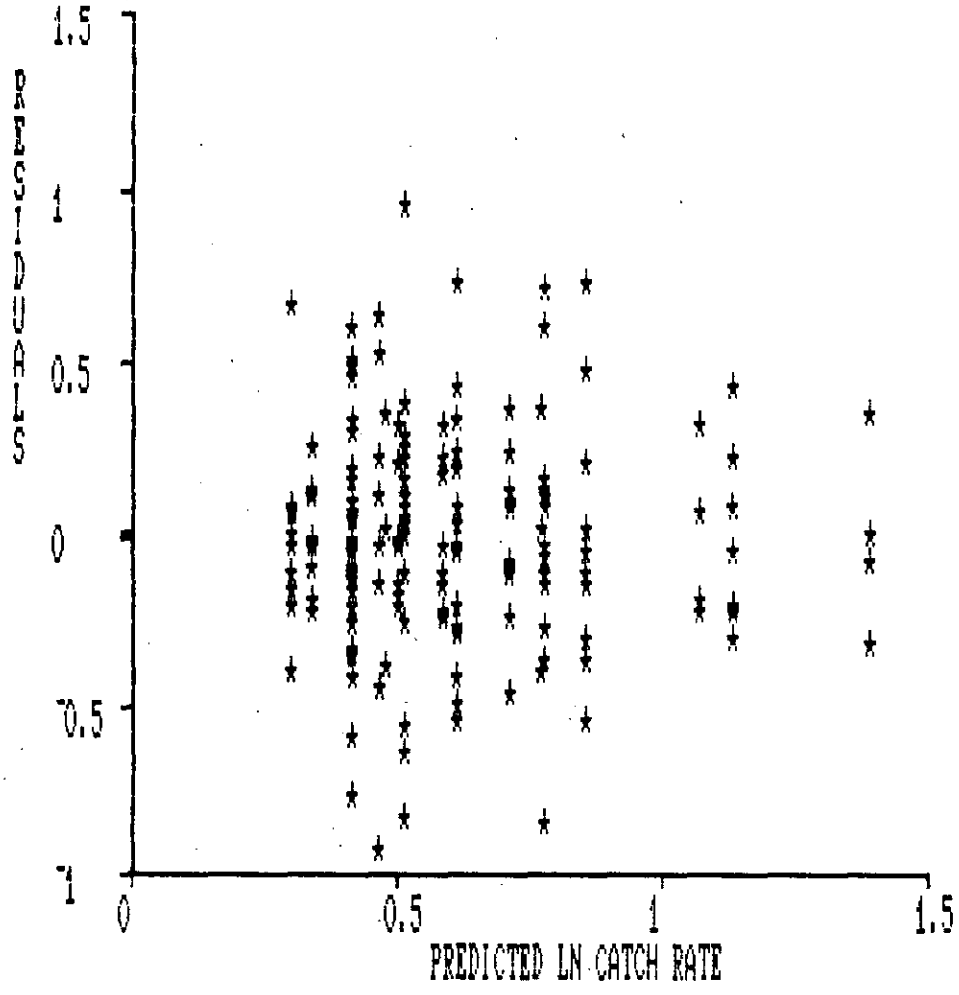

Figure 1. Residuals of multiplicative model (Table 4).

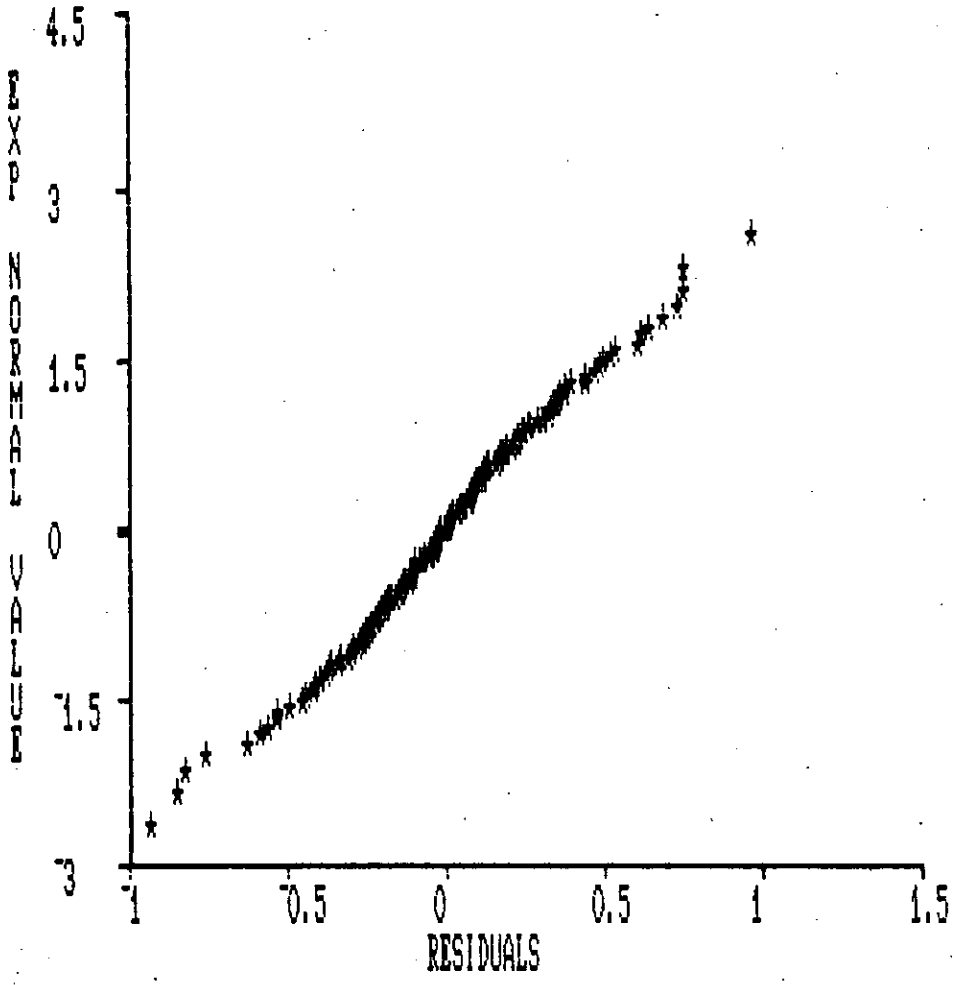

Figure 2. Residuals of multiplicative model (Table 4).

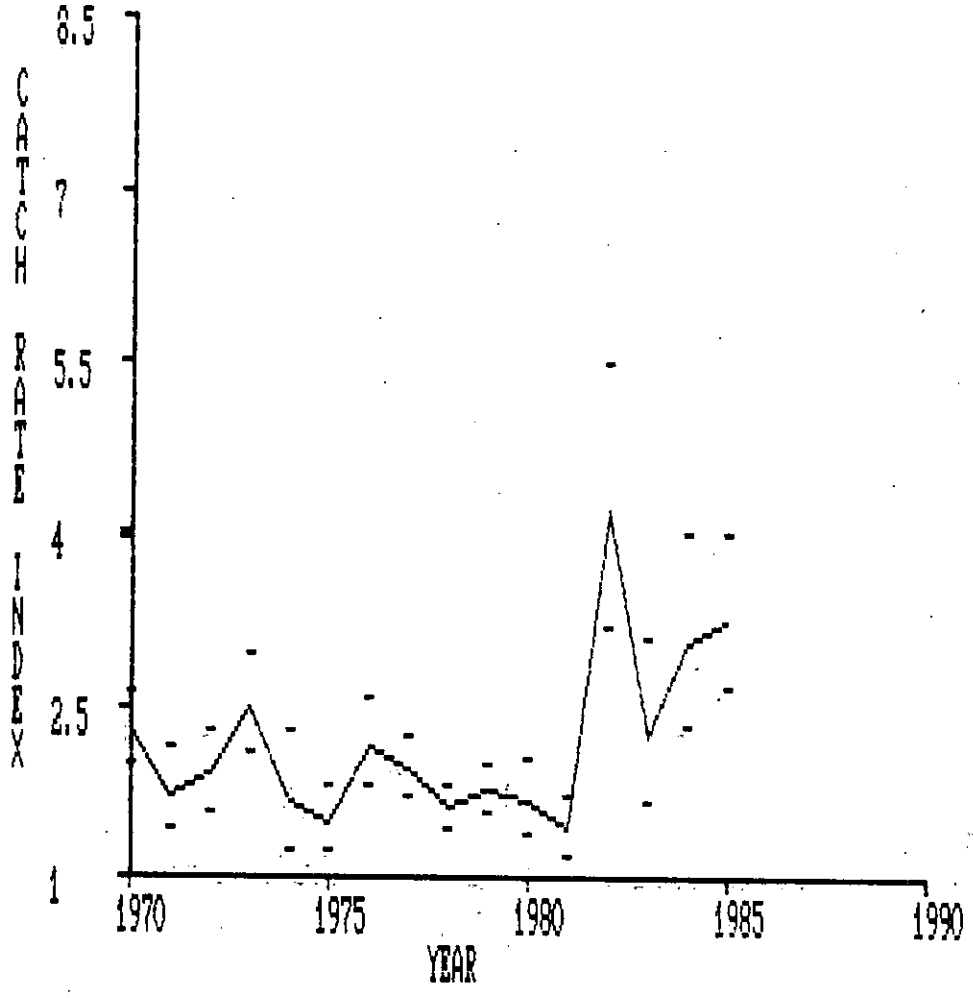

Figure 3. Catch rate index (t/hr) for 4VWX silver hake.