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American Plaice in NAFO Divisions 3L, 3N, and 3Ø - a Stock Assessment Update

by

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INTRODUCTION

This stock has been under quota regulation since 1973. Nominal catches by country, 1966-81 and TAC's, 1973-82 are listed in Table 1, nominal catches by division, 1965-81 are in Table 2, and catch and effort data, 1965-81 are in Table 3.

STOCK ASSESSMENT

Sampling: The Canadian Commercial Groundfish Sampling Section in St. John's provided the length measurements and the otolith samples listed in Table 4.

Numbers at age: The catch matrix (Table 5) contains data from 1960-81. The catch at age for 1981 was calculated in the usual manner by applying quarterly age-length keys (sexes separate) to monthly frequencies for each NAFO division. Male and female numbers were combined for all divisions to give total numbers caught at age.

The decline in catch at age for ages 6-10 in 1981 can be attributed mainly to the fact that a higher proportion of the catch in 1981 was taken in Div. 3L (76% in 1981 compared to 65% in 1980 and 59% in 1979). Because the fish in 3L have a slower growth rate, more discarding of young (6-9 yr old) fish occurred in 1981 (32% by numbers vs. 20% by numbers in 1980) (Stevenson pers. comm.).

Weight at age: Average weights at age for 1981 were calculated from average length at age for each month, weighted by the number caught at age and converted to weights by a length-weight relationship. Table 6 is the weight at age matrix for 1960-81. Again, the general decline in average weight at age in 1981 was due to the higher proportion of the smaller-at-age fish from Div. 3L.

Partial recruitment: Attempts to derive partial recruitment rates from a) average F's from a cohort run using the 1978-81 catch matrix and b) ratio of number per 1000 in the commercial catch to number per 1000 in the research catch, proved unsuccessful, the reason being the considerable reduction in the 1981 catch at age for ages 6-9. Therefore, a modified version of the partial recruitment vector used in the 1981 assessment was calculated (Table 7). The changes affected ages 6-10 and were based on the ratio of the 1981 catch at these ages to the 1980 catch at the same ages.

Terminal fishing mortality: An estimate of F_T was obtained using the following three methods:

a) Regression of catch per hour on 8+ biomass from cohort analysis. Table 8 shows the results of these regressions, using 8+ biomass from cohort analyses at five values of F_T between 0.25 and 0.35. The plot for the values at $F_T = 0.35$ is shown in Fig. 1. The value of 0.35 for F_T gives the highest r value and also produces the best predicted value for observed biomass in 1981. A comparison of the 1981 8+ biomass and CPUE with the average 1968-70 8+ biomass and CPUE shows little difference (230,000 t biomass and 0.570 t/hr in 1981 compared with 235,000 t, 0.564 t/hr, average 1968-70).

b) Regression of weighted F (ages 8-18) from cohort analyses on directed fishing effort. Table 9 shows the calculations for the same five values of F_T between 0.25 and 0.35. Once again, the values for r increase as F_T increases, although the rise is not as noticeable as it was for biomass on CPUE. Judging by predicted values for 1981 weighted F, F_T lies in the range 0.275-0.30. The plot for the values at $F_T = 0.30$ is given in Fig. 2.

c) Regression of population numbers (ages 8-18) from cohort analyses on research vessel abundance estimates (ages 8-18). Table 10 shows the calculations for the same five values of F_T discussed above. There is very little difference in the values of r over the range of terminal F's. The best predicted value comes from the cohort run initiated with $F_T = 0.325$ and Fig. 3 shows the plot of the values from this run. Abundance estimates for American plaice in NAFO Divs. 3L and 3N from research vessel surveys are shown in Table 11.

$F_{0.1}$: Long-term (1960-80) average weights and partial recruitment were used in the yield per recruit calculation (Table 12). The resulting value for $F_{0.1}$ was 0.262. These are the same values used in the 1981 assessment (Pitt and Brodie 1981).

Recruitment: The geometric mean (1976-80) of age six numbers from the cohort analysis at $F_T = 0.325$ was used to estimate recruitment for projections to 1983. This value was 236.5 X 10^6 fish, slightly lower than the 268.0 X 10^6 used in last year's assessment.

DISCUSSION

Abundance indices: Catch per unit effort from Can(N) otter trawlers, tonnage class 5 has shown an upward trend since 1977, with a very slight drop in 1981 to a level of 0.570 t/hr (Table 3). Research vessel surveys indicate that the population size has been relatively stable since 1977, with a decrease in 1981 possibly being due to some strata in Div. 3N having been missed in the survey (Table 11). Table 13a shows that population numbers from cohort analysis have remained steady at a level above 900 X 10^6 fish since 1976. The relative strength of incoming year-class is difficult to estimate because the younger age groups do not appear to be fully recruited to the research vessel gear.

Cohort analysis: Because of uncertainties in the catch at age and weight at age data prior to 1965, only the 1965-81 values from cohort were used in tuning the analysis. Depending on the criterion used, the analysis showed that terminal F in 1981 was in the range 0.28-0.35. The cohort run at FT = 0.325 is presented in Tables 13a, 13b, and 13c.

Catch projections: Tables 14a-14e show the projection to 1983, using the population in 1981 from the cohort run at FT = 0.325. Average weights, 1980-81 and average PR, 1977-80 were used to give a projected catch in 1983 of approximately 49,000 t at $F_{0.1} = 0.262$, assuming that 48,000 t will be taken in 1982. It should be noted that this estimate is for Divs. 3LN only and that a total TAC would have to include a portion for Div. 3Ø, where catches since 1977 have averaged 4000 t.

REFERENCES

Pitt, T. K., and W. B. Brodie. 1981. A stock assessment update of American plaice in NAFO Divisions 3L, 3N, and 3Ø. NAFO SCR Doc. 81/VI/61, Ser. No. N345.

Table 1. Nominal catches of American plaice for ICNAF Divisions 3LNO 1966-81 and TAC's from 1973-82.

Year	Canada	France	Poland	USSR	Other	Total	TAC
1966	51,225	1,246	860	11,484	196	65,011	-
1967	54,190	1,326	3,234	35,139	524	94,413	
1968	48,674	406	203	23,751	133	73,167	-
1969	64,815	43	34	14,493	52	79,437	-
1970	54,929	389	40	10,232	1,055	66,645	-
1971	49,394	323	370	17,173	628	67,888	-
1972	41,605	322	2,515	14,164	755	59,361	-
1973	38,586	310	1,116	12,516	319	52,843	60,000
1974	35,101	418	615	10,074	89	46,297	60,000
1975	34,015	442	537	7,682	545	43,221	60,000
1976	47,806	305	5	3,280	429	51,825	47,000
1977	42,579	31	0	1,023	349	43,982	47,000
1978	48,634	168	0	1,048	178	50,028	47,000
1979	47,131	131	0	1,190	138	48,572	47,000
1980	48,282	183	0	336	284	49,085	47,000
1981	48,157	349	-	847	-	49,353	55,000
1982[a]	-	-	-	-	-	-	55,000

[a]Provisional.

Table 2. Breakdown of plaice nominal catches in Divisions 3LNO by Division (metric tons).

Year	Division 3L	Division 3N	Division 3O	Total
1965	25,034	26,270	1,957	53,279
1966	18,575	34,698	11,741	65,011
1967	38,511	24,364	31,534	94,413
1968	39,126	20,038	14,003	73,167
1969	52,880	14,442	12,115	79,437
1970	39,347	21,032	6,266	66,645
1971	37,851	22,873	7,164	67,888
1972	33,330	17,378	8,644	59,361
1973	20,103	20,883	11,857	52,843
1974	16,609	21,118	8,561	46,297
1975	15,171	21,308	6,742	43,221
1976	25,112	18,623	8,080	51,825
1977	23,763	16,543	3,675	43,981
1978	30,145	13,443	6,440	50,028
1979	28,708	14,712	5,149	48,569
1980	31,728	15,107	2,250	49,085
1981[a]	37,256	9,579	2,518	49,353

[a]Provisional.

Table 3. Catch and effort data for American plaice for NAFO Divisions 3L and 3N. Directed catch (Column 2) refers to catch directed for plaice by Canada (N) otter trawls tonnage class 5.

Year	Directed catch (tons)	CPUE (tons/hr)	Total catch (tons)	Total effort (hours)
1965	18,082	0.905	51,304	56,836
1966	29,536	0.876	53,270	60,810
1967	34,416	0.818	62,879	76,869
1968	31,344	0.629	59,164	94,060
1969	39,251	0.548	67,322	122,850
1970	24,020	0.516	60,379	117,013
1971	24,439	0.479	60,724	126,772
1972	23,137	0.481	50,717	105,440
1973	20,027	0.517	40,986	79,276
1974	20,957	0.434	37,727	86,929
1975	27,111	0.416	36,479	87,689
1976	35,710	0.430	43,735	101,709
1977	32,117	0.406	40,306	99,275
1978	33,290	0.460	43,588	94,756
1979	30,763	0.495	43,420	87,717
1980	34,982	0.597	46,835	78,451
1981	34,199	0.570	46,831	82,160

Table 4. List of commercial sampling by quarter and division available for 1981, American plaice 3LNO provided by the St. John's Commercial Sampling Section.

Quarter	Measurements			Otoliths			Catch			No. samples		
	3L	3N	3O	3L	3N	3O	3L	3N	3O	3L	3N	3O
1	4,104	1,287	-	660	287	-	2,573 5(1)	447	96	10	3	-
2	22,648 4,074(1)	3,818	-	795 546(1)	769	-	17,694 2,825(1)	4,024	211	46 7(1)	9	-
3	5,462 2,341(1)	5,898	785	692 510(1)	876	182	6,282 1,801(1)	5,106	617	14 7(1)	13	2
4	10,508 2,516(1)	1,684	4,586	693 512(1)	496	531	4,834 32(1)	1,454	787	21 5(1)	4	7

(1)Inshore fishery -fixed gear.

Table 5.

AMERICAN PLAICE DIVISIONS 3LN CATCH MATRIX(NUMBERS X10^-3)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
6	309	189	428	960	1788	3041	5139	2228	1894	2079	1968	1565	2199	837	5222	2945	3400	6537	3538	6069	2924	538
7	816	501	632	1740	4662	6969	8224	7216	3347	6674	2314	7524	2023	4909	7305	6693	7388	8065	7874	12560	9110	2038
8	1324	1161	1054	1337	3035	8964	9122	5093	7913	12023	9066	9354	6576	8158	8070	8266	15963	10827	9238	16872	11601	4330
9	1685	2324	1139	1442	5760	6789	7798	6330	9065	15409	12264	13868	9656	10096	6675	7802	15166	12653	11583	13242	13571	7134
10	2210	2994	1605	2086	8180	7285	5954	9133	9405	10830	10225	12670	10907	7789	7741	6445	10772	10303	12370	11329	13735	10761
11	2462	2327	2339	2894	6493	5521	5823	9106	6255	10793	10128	9833	10866	7741	5901	4524	6867	5954	8859	8075	10796	13178
12	3367	2143	2594	3892	5737	5578	4644	9700	11193	8811	7473	8074	9147	5245	3839	3880	4273	3750	5825	3406	7696	11622
13	2668	3673	2317	3633	3028	5023	4696	6324	7098	5978	5034	4647	5796	5111	2940	3110	2415	2014	2977	1640	3385	8553
14	2486	2433	3151	3591	2830	4174	4105	4377	5126	4496	4223	3328	3720	2896	1642	2175	1984	1311	1738	594	1460	5527
15	1601	1746	2217	2308	2124	1773	2959	3615	2558	2955	3851	2920	2151	1560	866	1091	1176	872	1161	294	619	2903
16	1387	1408	1320	1296	1350	2054	1626	2501	2075	1586	2176	1753	1806	1828	595	595	448	308	469	148	244	1099
17	931	581	942	623	607	1270	1037	1314	1230	1051	1236	898	1239	802	187	393	193	161	152	57	79	383
18	293	775	771	620	563	556	933	1110	615	609	834	447	527	913	65	190	45	93	53	13	25	231
19	236	303	480	395	536	618	390	283	330	296	315	360	286	337	20	80	20	25	18	5	2	101

Table 6.

AMERICAN PLAICE DIVISIONS 3LNO WEIGHT MATRIX (KG)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
6	0.193	0.189	0.177	0.227	0.285	0.289	0.277	0.287	0.276	0.290	0.275	0.259	0.278	0.244	0.252	0.248	0.261	0.264	0.266	0.320	0.328	0.381
7	0.274	0.279	0.276	0.297	0.378	0.365	0.369	0.383	0.348	0.332	0.330	0.331	0.372	0.292	0.339	0.347	0.345	0.359	0.363	0.374	0.410	0.408
8	0.363	0.373	0.380	0.384	0.491	0.498	0.499	0.469	0.450	0.412	0.397	0.404	0.484	0.380	0.416	0.418	0.403	0.431	0.414	0.448	0.483	0.453
9	0.487	0.493	0.522	0.525	0.547	0.625	0.640	0.610	0.602	0.564	0.536	0.494	0.527	0.519	0.568	0.578	0.548	0.623	0.515	0.546	0.537	0.480
10	0.594	0.596	0.611	0.621	0.639	0.703	0.788	0.788	0.697	0.670	0.680	0.612	0.629	0.629	0.694	0.706	0.658	0.676	0.618	0.594	0.570	0.523
11	0.695	0.741	0.738	0.731	0.760	0.827	0.976	0.847	0.851	0.785	0.795	0.772	0.753	0.816	0.917	0.922	0.841	0.884	0.773	0.683	0.653	0.542
12	0.857	0.865	0.885	0.845	0.851	0.869	0.988	1.030	0.991	0.982	0.841	0.909	0.867	1.041	1.108	1.099	1.029	1.013	0.928	0.906	0.742	0.670
13	0.903	0.888	0.905	0.867	0.920	0.932	0.984	1.064	1.075	1.050	1.043	1.034	0.935	1.243	1.360	1.339	1.152	1.199	1.199	1.188	0.989	0.786
14	1.193	1.199	1.206	1.152	1.208	1.258	1.287	1.369	1.397	1.401	1.166	1.132	1.175	1.334	1.567	1.536	1.327	1.389	1.389	1.659	1.352	1.000
15	1.262	1.264	1.272	1.255	1.289	1.377	1.413	1.631	1.597	1.602	1.311	1.279	1.380	1.524	1.922	1.813	1.658	1.768	1.768	1.886	1.739	1.300
16	1.308	1.324	1.330	1.541	1.596	1.614	1.656	1.890	1.881	1.870	1.673	1.600	1.654	1.816	2.387	2.319	2.137	2.196	2.196	2.118	1.770	1.762
17	1.411	1.423	1.423	1.872	1.921	1.905	1.922	2.166	2.197	2.240	1.854	1.911	1.854	1.939	2.458	2.578	2.318	2.324	2.324	2.302	2.140	2.099
18	1.516	1.516	1.525	1.891	1.934	1.943	1.917	2.305	2.297	2.348	2.073	2.117	1.915	2.104	2.871	2.880	2.716	2.546	2.546	3.199	2.700	2.368
19	1.562	1.558	1.572	1.962	1.997	1.957	2.025	2.527	2.488	2.595	2.283	2.285	2.129	2.294	3.004	2.942	2.864	3.072	3.072	3.243	3.000	2.558

Table 7. Partial recruitment vectors, 1981 and 1982 versions, for American plaice in NAFO Divisions 3LN.

Age	Partial recruitment used in 1981 assessment	Partial recruitment used in 1982 assessment
6	.040	.008
7	.150	.037
8	.300	.123
9	.400	.231
10	.600	.515
11	.750	.750
12	.800	.800
13	1.000	1.000
14	1.000	1.000
15	1.000	1.000
16	1.000	1.000
17	1.000	1.000
18	1.000	1.000
19	1.000	1.000

Table 8. Regression of 8+ biomass from cohort on commercial CPUE. Cohort runs are at the indicated levels of F_T.

Year	CPUE (t/hr)	Terminal F .25	.275	.30	.325	.35
		8+ Biomass (t X 10^{-3})				
1965	.905	302.7				
1966	.876	315.1				
1967	.818	296.0				
1968	.629	270.3				
1969	.548	237.3				
1970	.516	198.3	198.1	198.0	198.0	197.8
1971	.479	166.6	166.2	165.9	165.6	165.4
1972[a]	.481	146.3	145.5	144.8	144.2	143.7
1973	.517	131.0	129.5	128.2	127.2	126.2
1974	.434	159.4	155.8	152.8	150.3	148.2
1975	.416	199.1	192.4	186.9	182.3	178.3
1976	.430	232.1	222.1	213.8	206.8	200.8
1977	.406	303.9	287.8	274.4	263.1	253.4
1978	.460	317.4	297.9	281.6	267.9	256.1
1979	.495	353.0	328.5	308.2	291.0	276.3
1980	.597	363.3	334.6	310.7	290.5	273.2
1981	.570	322.1	292.8	268.4	247.8	230.1
	1965-78 r	.558	.634	.695	.742	.780
	intercept	130.0	115.1	102.0	91.0	81.6
	slope	195.9	215.1	231.6	245.5	257.4
	predicted 1981	241.7	237.7	234.0	231.0	228.3
	1965-81 r	.420	.515	.600	.670	.727
	intercept	157.4	137.5	120.3	105.9	93.4
	slope	183.1	203.5	221.0	235.7	248.3
	predicted 1981	261.8	253.5	246.3	240.2	235.0

[a]Point not used.

Table 9. Regression of F, ages 8-18, weighted by population numbers on effort for American plaice in Divisions 3LN. Cohort runs are at the indicated terminal F values.

Year	Effort (hr X 10^{-3})	Terminal F .25	.275	.30	.325	.35
		Weighted F				
1966	60.8	.127				
1967	76.9	.164				
1968	94.1	.182				
1969	122.9	.232				
1970	117.0	.234				
1971	126.8	.273	.274	.274	.275	.276
1972[a]	105.4	.301	.303	.305	.306	.308
1973[a]	79.3	.271	.275	.279	.282	.284
1974	86.9	.158	.163	.167	.170	.173
1975	87.7	.124	.129	.133	.137	.141
1976	101.7	.149	.156	.162	.168	.173
1977	99.3	.100	.106	.111	.116	.121
1978	94.8	.103	.110	.116	.122	.128
1979	87.7	.100	.107	.114	.121	.128
1980	78.5	.112	.121	.131	.140	.149
1981	82.2	.122	.135	.148	.160	.173
	1966-78 r	.713	.734	.753	.772	.791
	intercept	-0.032	-0.029	-0.025	-0.022	-0.020
	slope	0.002	0.002	0.002	0.002	0.002
	predicted 1981	.137	.140	.142	.145	.147
	1966-81 r	.739	.754	.764	.773	.777
	intercept	-0.054	-0.044	-0.033	-0.023	-0.014
	slope	0.002	0.002	0.002	0.002	0.002
	predicted 1981	.129	.134	.139	.144	.148

[a]Points not used.

Table 10. Regression of population numbers (ages 8-18) from cohort on population numbers (ages 8-18) from research vessel surveys. Cohort runs are at the indicated levels of terminal F.

Year	Abundance (ages 8-18) from research vessel surveys in 3LN (no. X 10^{-6})	Terminal F .25	.275	.30	.325	.35
		Population (8-18) from cohort (X 10^{-6})				
1971	241.5	320.4	319.4	318.6	317.9	317.3
1972[b]	176.6	280.2	278.5	277.0	275.8	274.8
1973[b]	-	265.1	261.5	258.5	256.0	253.8
1974	153.6	302.1	294.5	288.1	282.7	278.1
1975[b]	169.9	386.5	372.9	361.6	352.0	343.9
1976[b]	-	487.4	467.0	450.0	435.6	423.3
1977[a]	408.5	570.3	540.6	515.9	495.1	477.2
1978	295.6	628.4	591.3	560.4	534.4	512.0
1979	339.8	648.5	605.6	570.0	539.8	514.0
1980	355.0	664.5	614.3	572.5	537.1	506.8
1981	321.7	644.0	588.9	542.9	504.0	470.7
	1971-80 r	.915	.918	.919	.920	.921
	intercept	-15.89	16.25	42.89	65.48	84.91
	slope	1.93	1.71	1.53	1.38	1.24
	predicted 1981	604.8	566.5	534.7	507.8	484.7
	1971-81 r	.924	.926	.927	.927	.925
	intercept	-24.87	11.13	41.01	66.34	88.12
	slope	1.98	1.74	1.54	1.37	1.22
	predicted 1981	613.2	571.3	536.5	507.0	481.7

[a]Point not used.

[b]Indicates inadequate coverage by research vessel.

Table 11. American plaice population numbers estimated from research vessel surveys in NAFO Division 3L and 3N ($X\ 10^{-5}$) for selected strata.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1		1.1						0.2	2.9		4.7
2		4.0			12.5	5.8	4.1	7.5	6.5	8.5	9.9
3	55.0	8.9		12.3	50.8	114.9	38.6	194.7	18.3	55.2	78.4
4	158.5	159.0		75.3	86.8	208.1	205.3	317.9	196.6	115.9	106.8
5	527.3	313.0		114.6	121.3	281.6	550.7	967.5	651.7	580.8	200.1
6	679.7	567.9		311.6	269.6	269.7	1010.9	963.2	1012.7	1009.8	547.3
7	905.5	570.9		368.6	428.8	615.5	1553.4	1189.7	1034.2	1070.1	823.5
8	381.6	456.0		376.0	541.2	1080.8	1473.2	1114.3	1188.4	1275.0	1136.6
9	658.2	300.9		322.1	407.4	816.6	927.5	754.4	838.2	989.9	905.8
10	327.9	344.0		323.8	334.3	691.5	844.2	570.8	710.7	628.9	587.1
11	297.7	212.7		176.2	169.6	415.6	374.3	214.4	359.3	284.3	312.2
12	266.7	206.7		149.6	116.8	255.2	249.9	148.6	154.1	184.6	136.7
13	187.9	104.3		94.6	61.1	125.5	108.2	69.9	57.0	94.5	64.9
14	130.3	83.4		48.6	34.5	39.9	46.0	44.6	32.6	38.9	22.5
15	67.5	58.1		31.3	17.0	34.4	31.6	22.9	22.4	23.3	25.1
16	49.9	40.2		11.0	13.3	16.9	18.4	9.4	10.7	18.7	14.6
17	26.4	12.8		2.3	3.5	11.3	8.0	5.9	4.0	8.8	7.8
18	20.8	4.5		0.4	1.3	3.1	4.4	1.2	0.9	3.2	3.2
19	5.6	2.4		0.8	0.7	0.9	0.8		0.2	0.8	
20	3.2	2.7						0.5			
21	1.1										
22	1.6										
2+	4752.4	3452.3		2419.1	2670.5	4987.3	7449.5	6597.4	6298.5	6391.2	4982.5
4+	4697.4	3439.4		2406.8	2607.2	4866.6	7406.8	6395.2	6273.7	6327.5	4894.2
6+	4011.6	2967.4		2216.9	2399.1	4376.9	6650.8	5109.8	5425.4	5630.8	4587.3
8+	2426.4	1828.6		1536.7	1700.7	3491.7	4086.5	2956.9	3378.5	3550.9	3216.5
12+	761.0	515.0		338.6	248.2	487.2	467.3	303.0	281.9	372.8	274.8

Table 12. Yield per recruit analysis for Divisions 3LN American plaice.

YIELD PER RECRUIT ANALYSIS

AGE	WEIGHT-AT-AGE	PARTIAL RECRUITMENT
5	0.209	0.005
6	0.261	0.025
7	0.341	0.100
8	0.428	0.220
9	0.552	0.300
10	0.625	0.470
11	0.700	0.580
12	0.880	0.730
13	1.020	1.000
14	1.250	1.000
15	1.524	1.000
16	1.803	1.000
17	2.022	1.000
18	2.233	1.000
19	2.401	1.000
20	2.428	1.000

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	0.1000	0.120	0.117	0.972	1.712
	0.2000	0.191	0.164	0.858	1.202
F0.1---	0.2615	0.222	0.178	0.803	1.000
	0.3000	0.238	0.184	0.773	0.901
	0.4000	0.272	0.194	0.711	0.710
	0.5000	0.299	0.199	0.664	0.583
	0.6000	0.321	0.202	0.628	0.493
	0.7000	0.339	0.204	0.600	0.427
	0.8000	0.355	0.205	0.576	0.377
	0.9000	0.369	0.206	0.559	0.337
	1.0000	0.382	0.207	0.543	0.305
	1.1000	0.393	0.208	0.530	0.278
	1.2000	0.403	0.209	0.518	0.256
	1.3000	0.413	0.210	0.508	0.237
	1.4000	0.421	0.210	0.499	0.221
	1.5000	0.429	0.211	0.491	0.206
FMAX---	3.1357	0.512	0.214	0.417	0.100

NATURAL MORTALITY RATE : 0.2
F0.1 COMPUTED AS 0.2615 AT Y/R OF 0.1781
FMAX COMPUTED AS 3.1357 AT Y/R OF 0.2135

Tables 13 a,b,c. Results of Cohort analysis at F_t=0.325

POPULATION NUMBERS $(x10^{-3})$

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
6	175492	206586	199424	186272	183811	183817	193217	172003	158854	129240	127982	134443	188628	242847	286702	299852	272294	243974	238043	200759	232955	228592
7	124123	143401	168967	162867	151638	148824	147745	153543	138809	126345	103931	103002	108656	152446	198069	230006	242834	219859	193834	191691	158876	138082
8	108079	100967	118953	137767	131787	119932	115582	113522	119181	110618	99041	82998	77823	87130	120370	155555	182257	192130	172708	151573	145579	121834
9	76869	87290	81614	94800	111584	105152	90081	86377	86336	90417	79680	72865	59489	57520	63954	91249	119878	134776	147506	133043	108831	108693
10	50868	61410	69364	65789	76311	86145	79948	66897	64992	64121	60085	54146	47125	39969	37959	46321	67649	84425	98896	110287	96944	76824
11	42330	39648	47569	55338	51976	55078	63938	60068	46343	44701	42698	39941	32867	28713	25676	24073	32093	45639	59799	69776	80045	66943
12	32613	32429	30355	36830	42688	36680	40097	47079	40940	32382	26832	25794	23804	17077	16504	15682	15616	20062	31979	40943	49822	55756
13	23425	23654	24612	22506	26632	29759	24983	28627	29768	23391	18458	15266	13813	11212	9236	10039	9329	8919	13032	20911	30440	33827
14	17036	14309	16043	18054	15139	19065	19820	16206	17715	17950	13742	10557	8245	6065	4555	4901	5405	5452	5480	7976	15637	21859
15	13486	11698	9513	10284	11532	9834	11832	12513	9308	9866	10628	7430	5632	3384	2345	2244	2045	2630	3278	2914	5993	11481
16	7628	9593	7998	5783	6331	7520	6447	7010	6974	5306	5404	5217	3441	2665	1359	1136	850	610	1364	1633	2120	4347
17	6127	4990	6580	5354	3562	3962	4298	3807	3476	3832	2909	2455	2685	1183	528	575	392	290	221	693	1203	1515
18	2676	4174	3560	4535	3820	2367	2095	2581	1928	1733	2186	1263	1198	1077	243	263	115	146	92	43	516	914
19	1661	1926	2716	2217	3152	2618	1435	871	1108	1022	868	1035	630	504	56	140	43	53	36	27	24	399
6+	679513	742075	785270	808415	819963	810801	801519	770903	727732	662824	594452	556373	573736	651792	767555	882038	950800	958968	966268	932272	928984	921075
7+	504021	535489	585845	622143	636152	626984	608302	598899	566877	533584	466470	421931	385107	408945	480853	582185	678506	714994	728226	731513	696028	692484
8+	379798	392088	416878	459256	484514	478110	460557	445356	430069	405239	362539	318928	276451	256499	282785	352179	435672	495134	534391	539821	537152	504402
9+	271719	291121	299925	321489	352727	358177	344975	331834	310888	294621	263497	235930	198928	169370	162414	196623	253415	303004	361683	388248	391573	382568
10+	194850	203832	218311	226689	241143	253026	254893	245458	222552	204204	183810	163045	139439	111849	98460	105375	133536	168228	214177	255205	282742	273875
11+	143982	142422	148947	160900	164832	166880	174945	178761	157560	140083	123725	108899	92314	71881	60502	59053	65888	83803	116281	144918	185798	197051
12+	101652	102774	101378	105562	112856	111804	111007	118693	111218	95382	81027	68958	59447	43167	34826	34980	33795	38164	55482	75141	105753	130108
13+	69039	70344	71022	68732	70168	75124	70910	71613	70278	63100	54195	43164	35643	26090	18322	19298	18178	18102	23503	34198	55932	74341

POPULATION BIOMASS (MID-YEAR) (t)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
6	30669	35371	31956	38218	47233	47721	47816	44431	39484	33677	31636	31363	47231	53606	64843	67045	63982	57537	56932	57281	68788	78838
7	30741	36194	42183	43596	51093	48007	47927	51949	43215	37536	30714	29678	36269	39647	59649	71207	74690	70126	62377	62675	57210	69148
8	35325	33923	40086	47699	57922	51939	50035	47089	46862	38855	33862	28519	32440	28479	43737	57242	63402	72769	62934	57803	60973	49068
9	33530	38446	38324	44741	53779	57484	49795	45858	45501	41861	35428	29181	25867	24426	31050	45582	55413	72213	65918	62267	49351	45612
10	26745	32300	37935	36398	41610	52367	54794	44052	37788	35299	33544	26086	23375	20315	21161	27374	36798	48270	51598	56050	46181	33625
11	25826	25783	30974	35629	33352	39027	53757	42261	33095	27482	26664	24071	18160	17991	18587	18017	21537	33950	38478	40461	43866	29302
12	23905	24515	23218	26580	30496	26468	33632	38898	31069	24284	17217	17438	14501	13280	14409	13442	12303	16507	24179	32102	30652	29949
13	15519	17407	19153	16108	20827	22791	19954	24191	25115	19048	14750	11759	8801	9187	9304	10022	8315	8466	12348	21558	25628	20685
14	16941	14086	15618	16762	14854	19074	20447	17030	18734	19573	11968	8873	6414	5222	5115	5019	5112	5936	5643	11509	18187	17006
15	14424	12300	9532	10226	12095	11046	13016	15453	11371	11874	9969	6628	5472	3383	3206	2603	1967	3419	4174	4707	8914	11612
16	8130	10582	8761	7063	8067	9296	8299	9522	9869	7458	6253	6099	3498	2397	2175	1621	1114	841	2176	2981	3187	5958
17	7180	6026	7818	8505	5617	5581	6471	5982	5502	6569	3658	3348	3264	1152	934	736	578	401	253	1381	2251	2474
18	3457	5144	4324	7189	6152	3618	2673	4016	3279	2937	3192	1927	1534	726	536	351	218	199	136	104	1229	1683
19	2168	2485	3493	3555	5171	4031	2231	1625	2079	2011	1421	1717	890	602	121	243	82	107	69	73	61	795
6+	274561	294563	313378	342270	388269	398452	410847	392358	352963	308465	260276	226687	227716	220413	274829	320504	345510	390732	387214	410950	416477	395755
7+	243892	259193	281422	304052	341036	350731	363031	347927	313479	274788	228640	195324	180485	166807	209986	253459	281527	333194	330282	353669	347689	316918
8+	213151	222998	239239	260455	289943	302724	315104	295978	270264	237252	197926	165647	144216	127160	150337	182252	206837	263069	267905	290995	290479	247770
9+	177826	189075	199153	212757	232021	250784	265069	248889	223402	198397	164064	137128	111776	98681	106599	125010	143435	190300	204971	233192	229506	198702
10+	144296	150629	160829	168016	178241	193300	215274	203030	177901	156536	128636	107946	85909	74255	75550	79428	88023	118087	139053	170924	180155	153090
11+	117551	118329	122894	131618	136631	140933	160481	158978	140113	121237	95092	81860	62534	53940	54389	52054	51225	69817	87455	114875	133974	119465
12+	91725	92545	91920	95989	103279	101906	106723	116717	107018	93754	68428	57789	44375	35949	35801	34038	29688	35867	48977	74414	90108	90162
13+	67820	68030	68702	69408	72783	75438	73091	77820	75949	69470	51212	40351	29874	22669	21392	20595	17385	19360	24799	42312	59456	60213

FISHING MORTALITY

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
6	0.002	0.001	0.002	0.006	0.011	0.018	0.030	0.014	0.013	0.018	0.017	0.013	0.013	0.004	0.020	0.011	0.014	0.030	0.017	0.034	0.014	0.003
7	0.007	0.004	0.004	0.012	0.035	0.053	0.063	0.053	0.027	0.059	0.025	0.084	0.021	0.036	0.042	0.033	0.034	0.041	0.046	0.075	0.065	0.012
8	0.014	0.013	0.010	0.011	0.026	0.086	0.091	0.051	0.076	0.128	0.107	0.133	0.098	0.109	0.077	0.061	0.102	0.064	0.061	0.131	0.092	0.040
9	0.025	0.030	0.016	0.017	0.059	0.074	0.101	0.084	0.120	0.209	0.186	0.236	0.198	0.216	0.123	0.099	0.151	0.110	0.091	0.117	0.148	0.075
10	0.049	0.055	0.026	0.036	0.126	0.098	0.086	0.164	0.174	0.207	0.208	0.299	0.295	0.243	0.255	0.167	0.194	0.145	0.149	0.121	0.170	0.167
11	0.066	0.067	0.056	0.060	0.149	0.117	0.106	0.183	0.162	0.310	0.304	0.318	0.455	0.354	0.293	0.233	0.270	0.156	0.179	0.137	0.161	0.244
12	0.121	0.076	0.099	0.124	0.161	0.184	0.137	0.258	0.360	0.359	0.368	0.425	0.553	0.415	0.297	0.319	0.360	0.231	0.225	0.096	0.187	0.260
13	0.156	0.188	0.110	0.197	0.134	0.206	0.233	0.280	0.306	0.332	0.359	0.412	0.623	0.701	0.434	0.419	0.337	0.287	0.291	0.091	0.131	0.325
14	0.176	0.208	0.245	0.248	0.231	0.277	0.260	0.355	0.385	0.324	0.415	0.428	0.690	0.750	0.508	0.674	0.520	0.309	0.432	0.086	0.109	0.325
15	0.141	0.180	0.298	0.285	0.228	0.222	0.323	0.385	0.362	0.402	0.512	0.570	0.548	0.712	0.525	0.771	1.010	0.456	0.497	0.118	0.121	0.325
16	0.224	0.177	0.201	0.285	0.269	0.359	0.327	0.501	0.399	0.401	0.589	0.464	0.868	1.419	0.661	0.865	0.874	0.816	0.478	0.106	0.136	0.325
17	0.184	0.138	0.172	0.138	0.209	0.437	0.310	0.480	0.496	0.361	0.634	0.518	0.713	1.383	0.497	1.410	0.786	0.948	1.431	0.095	0.075	0.325
18	0.129	0.230	0.274	0.164	0.178	0.301	0.678	0.645	0.435	0.492	0.547	0.496	0.666	2.760	0.351	1.602	0.567	1.214	1.009	0.404	0.055	0.325
19	0.170	0.190	0.216	0.218	0.207	0.300	0.354	0.440	0.395	0.382	0.506	0.479	0.684	1.284	0.498	0.968	0.699	0.716	0.802	0.223	0.098	0.325

Tables 14a-e. Results of projections to 1983 using 1981 population generated from cohort run at F_t=.325. Numbers are X 10^{-3} and biomass is in tons.

POPULATION NUMBERS

	1981	1982	1983
6	228592	236500	236500
7	188082	186669	191647
8	121834	152148	147044
9	108693	95840	115311
10	76824	82554	70791
11	66943	53204	57917
12	55766	42952	35913
13	33827	35204	28622
14	21859	20011	22282
15	11481	12931	12665
16	4347	6792	8184
17	1515	2572	4299
18	914	896	1628
19	399	541	567
6+	921076	928814	933370
7+	692484	692314	696870
8+	504402	505645	505224
9+	382568	353497	358180

POPULATION BIOMASS (AVERAGE)

	1981	1982	1983
6	73457.79	75717.17	75711.16
7	69317.53	67922.38	69712.76
8	50692.77	62187.72	60066.17
9	48367.76	42086.23	50596.98
10	35168.13	38021.73	32566.17
11	29897.06	24328.59	26445.57
12	31557.91	24924.48	20807.78
13	23369.57	25087.89	20358.61
14	19999.13	18885.36	20989.03
15	13576.74	15773.45	15420.39
16	5972.59	9625.43	11577.31
17	2498.82	4375.20	7299.60
18	1802.02	1822.64	3303.71
19	865.90	1210.81	1267.74
6+	406543.73	411969.10	416122.99
7+	333085.94	336251.93	340411.82
8+	263768.41	268329.56	270699.06
9+	213075.64	206141.83	210632.89

CATCH NUMBERS

	1981	1982	1983
6	538	2196	2231
7	2038	6412	6686
8	4330	10261	10069
9	7134	8513	10398
10	10761	10735	9341
11	13178	8493	9379
12	11622	7269	6166
13	8553	7272	5995
14	5527	4133	4667
15	2903	2671	2653
16	1099	1403	1714
17	383	531	900
18	231	185	341
19	101	112	119
6+	68398	70185	70659
7+	67860	67989	68428
8+	65822	61577	61742
9+	61492	51317	51674

CATCH BIOMASS

	1981	1982	1983
6	191	780	792
7	834	2622	2734
8	2026	4802	4712
9	3631	4333	5292
10	5886	5872	5110
11	7287	4696	5187
12	8205	5132	4353
13	7595	6457	5324
14	6500	4861	5489
15	4413	4060	4032
16	1941	2477	3027
17	812	1126	1909
18	585	469	864
19	282	312	332
6+	50188	48000	49157
7+	49997	47220	48365
8+	49164	44598	45630
9+	47137	39796	40918

FISHING MORTALITY

	1981	1982	1983
6	0.003	0.010	0.010
7	0.012	0.039	0.039
8	0.040	0.077	0.078
9	0.075	0.103	0.105
10	0.167	0.154	0.157
11	0.244	0.193	0.196
12	0.260	0.206	0.209
13	0.325	0.257	0.262
14	0.325	0.257	0.262
15	0.325	0.257	0.262
16	0.325	0.257	0.262
17	0.325	0.257	0.262
18	0.325	0.257	0.262
19	0.325	0.257	0.262
6+	0.091	0.090	0.090

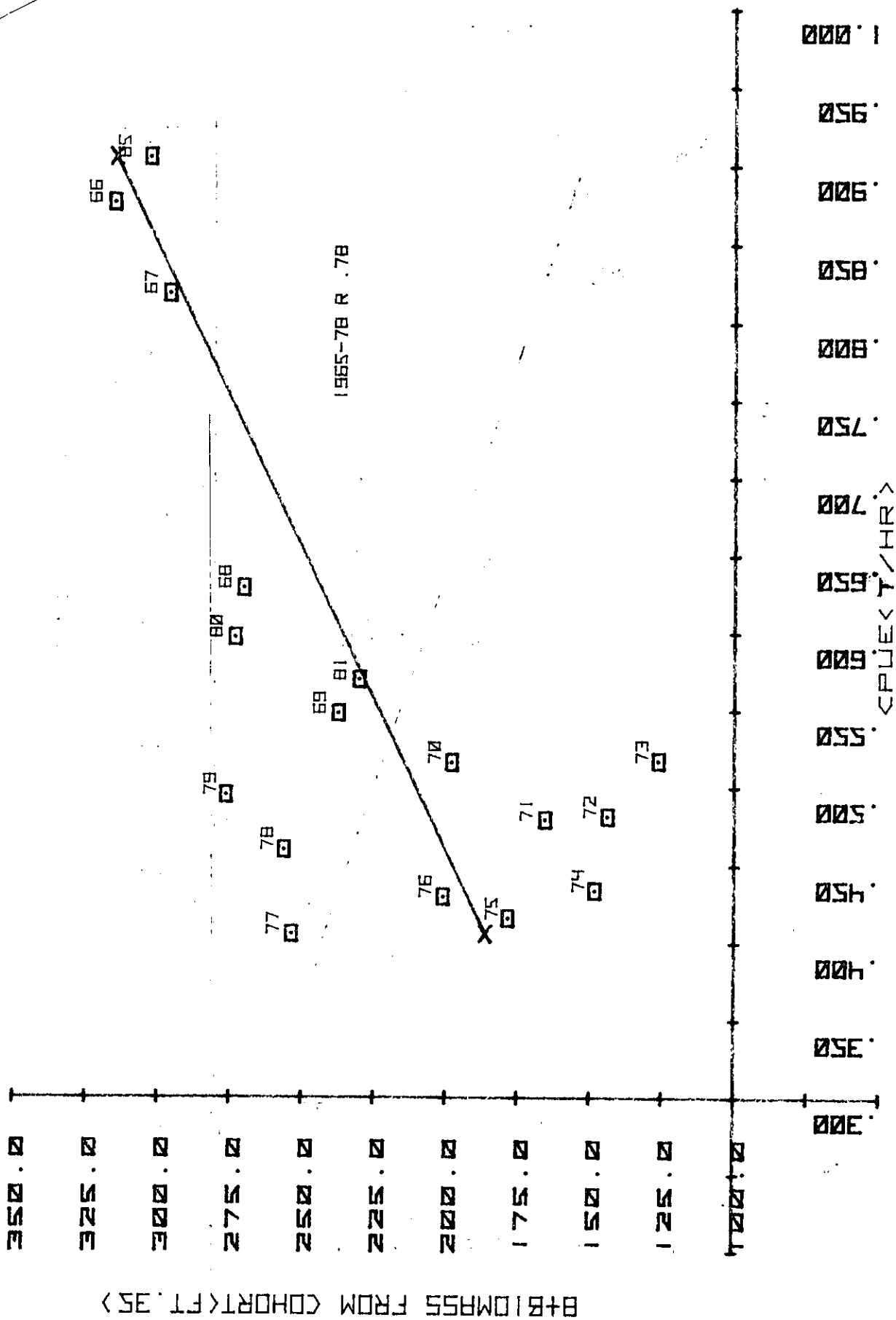

FIG.1, B+BIOMASS FROM COHORT ON CPUE.

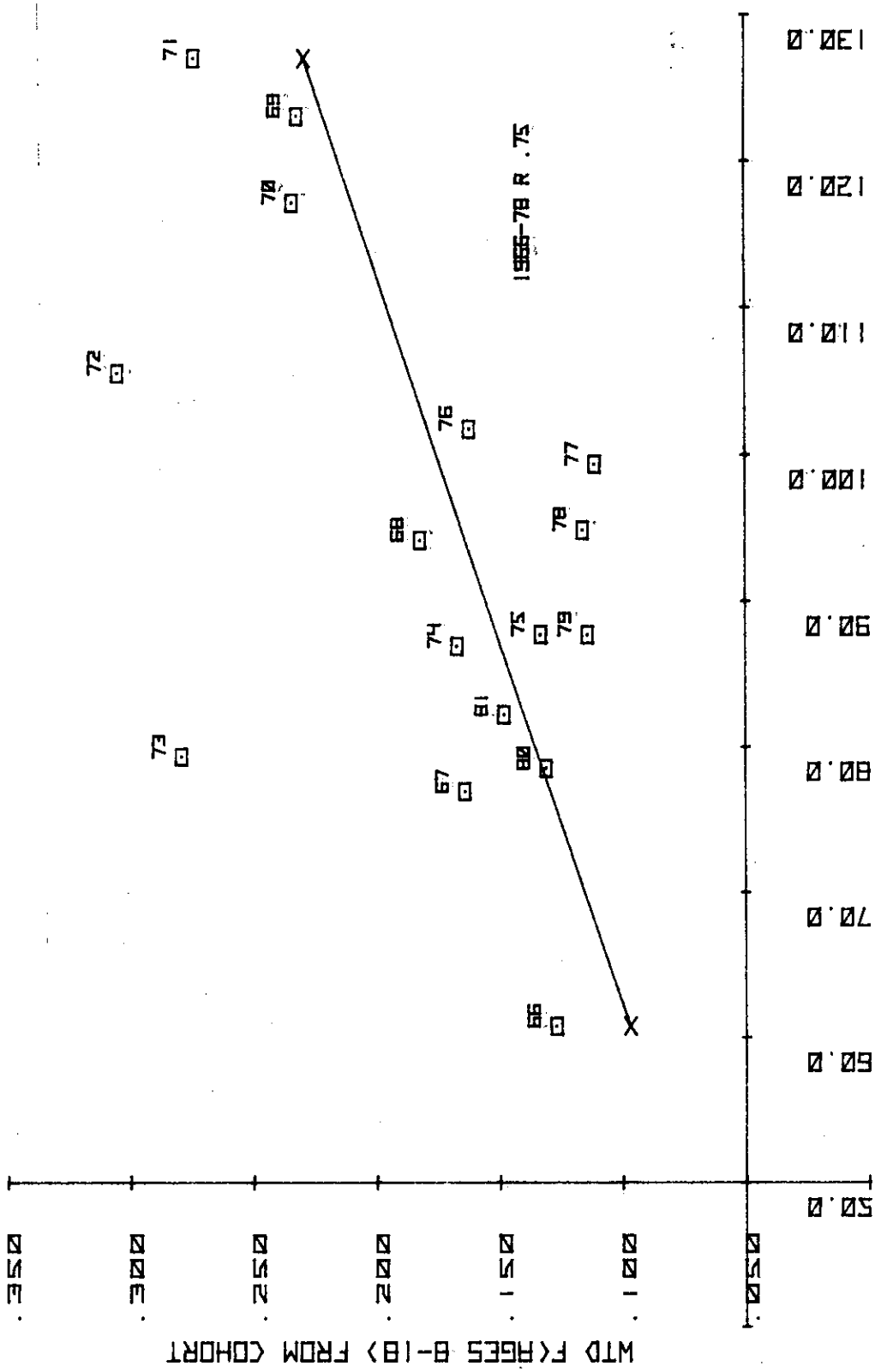

FIG.2. WEIGHTED F ON EFFORT

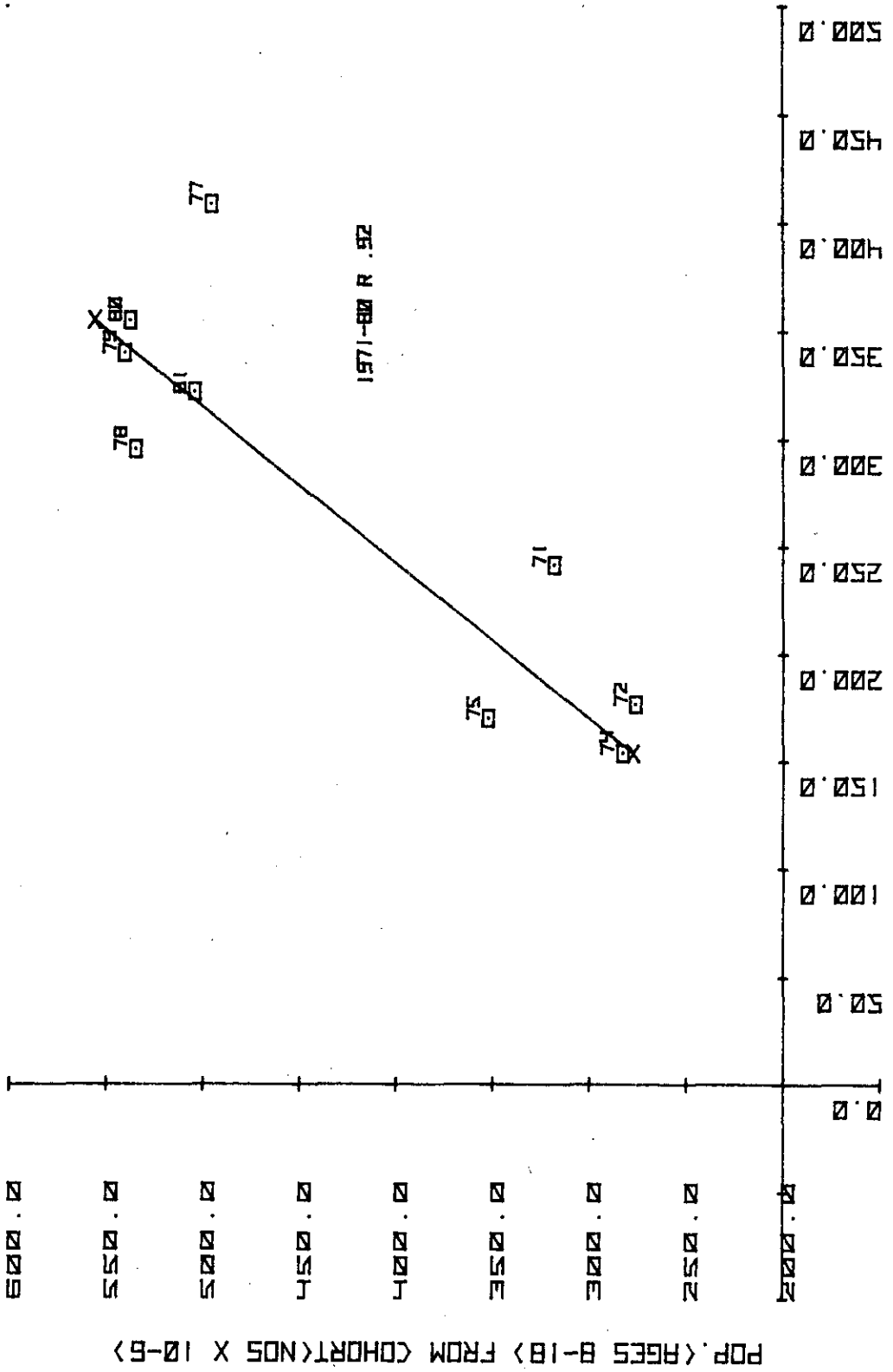

FIG.3. POP. FROM COHORT ON R.V. ABUNDANCE