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An Assessment of the Yellowtail Stock in Divisions 3LNO

by

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INTRODUCTION

This stock has been under quota regulation since 1973 with nominal catches and TAC's as follows:

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Catch ('000 t)	13.3	15.7	26.4	37.3	39.3	32.8	24.3	22.9	8.1	11.6	15.5	18.9	12.2*
TAC ('000 t)						50.0	40.0	35.0	9.0	12.0	15.0	18.0	18.0

*Preliminary

The TAC for 1981 was set at 21,000 t. Since 1972 the major portion of the catches have been by Canadian (N) stern otter trawlers.

Catch per hour showed a sharp decrease over the period 1973-76 but this was followed by a marked increase in the period 1976-80 (Table 1; Fig. 1). The TAC in 1980 was not taken due to the significant reduction in directed effort for yellowtail (Table 1).

STOCK ASSESSMENT

Sampling: The Canadian Commercial Groundfish Sampling Section at St. John's provided the length measurements and otolith samples listed in Table 2.

Numbers at Age: These were calculated in the usual manner by applying quarterly age-length keys (sexes separate) to monthly frequencies for each NAFO division. The males and females were combined from all divisions to give total numbers at age (Table 4).

Weights at Age: This matrix (Table 5) was calculated by applying the length-weight relationship to the monthly length at age data which is weighted by the numbers caught.

Partial Recruitment: The following vector was calculated from average F's in a cohort run using the 1976-79 catch matrix:

Age	5	6	7	8	9	10
P.R.	0.15	0.53	1.00	1.00	1.00	1.00

Terminal F: F_T was determined by two methods. The first was the regression of VPA 7+ numbers on research vessel 7+ numbers. Correlations (r^2) were significant and showed little variation over a range of F_T 's from 0.2 to 0.35 (Table 9). The regression at $F_T = 0.30$ predicted a 1980 value for 7+ numbers which was extremely close to the figure for 7+ numbers in the VPA. This relationship is shown in Fig. 3. The second method used the regression of F on effort (Table 8). Correlations were highest at values of F_T close to 0.30. The relationship at $F_T = 0.30$ is shown in Fig. 4. Regression of biomass from VPA on CPUE did not produce significant correlation (Fig. 2). Because of this poor relationship, it does not seem appropriate to use the effort data. Hence, the only acceptable method for deriving F_T is the research vessel data.

$F_{0.1}$: Average weights at age (1968-74) and a partial recruitment vector based on average F's (1968-76) from cohort were used in the Thompson-Bell yield per recruit model. The resulting value calculated for $F_{0.1}$ was 0.518 (Table 7).

Research Vessel Surveys: Table 3 shows numbers at age from A. T. Cameron surveys in Div. 3LN, 1971-80.

Recruitment: The geometric mean of age 5 VPA numbers, 1968-79, was used to estimate recruitment for projections to 1983. Because of some uncertainty, due to discarding, regarding the population at age 5 in 1980, the GM was also used as the best estimate for age 5 population in 1980.

Stock Projections: Table 11 shows projections to 1983 using a population in 1980 generated by terminal F = 0.30. Assuming that the 1981 TAC of 21,000 t will be taken and that recruitment will be at the estimated level, the projected removal for 1982 at $F_{0.1} = 0.518$ is 23,000 t.

DISCUSSION

Based on the recent increases in directed CPUE for yellowtail, there is evidence that the stock is in relatively good condition. However, attempts to correlate stock biomass with CPUE were not successful (Fig. 2). There is also some evidence from the research surveys (Table 3) to suggest that the number of younger fish (ages 4 and 5) has increased between 1979 and 1980. Estimating age 1 to age 3 abundance from the surveys is virtually impossible and thus, estimates of recruitment must come from ages 4 and 5 which are the ages that the fish start entering the commercial fishery. Therefore, caution must be expressed when making projections for this stock based on average recruitment at age 5 as the projected catch in 1982 is largely dependent on the estimate of the age 5 population in 1980. Basing our estimates of age 5 recruitment on the long-term geometric mean (1968-79) of the age 5 population in the VPA run at $F_T = 0.30$, the yield in 1982 at $F_{0.1}$ would be approximately 23,000 t.

Table 1. Catches and directed effort, 3LNO yellowtail.

Year	Catch (t)	Directed	CPUE (t/hr)	Calculated effort (hr)
1968	13,340		0.705	18,921
1969	15,708		0.609	25,793
1970	26,426		0.598	44,191
1971	37,141		0.600	61,901
1972	39,259		0.607	64,677
1973	32,815		0.645	50,876
1974	24,313		0.421	57,751
1975	22,894		0.402	56,950
1976	8,057		0.332	24,268
1977	11,638		0.423	27,513
1978	15,466		0.496	31,181
1979	18,351		0.517	35,495
1980*	12,206		0.640	19,072

*Provisional

Table 2. List of commercial samples, 3LNO yellowtail, 1980.

Quarter	Measured			Otoliths			Samples		
	3L	3N	3Ø	3L	3N	3Ø	3L	3N	3Ø
1	-	377	-	-	121	-	-	1	-
2	6,262	845	-	401	113	-	18	2	-
3	796	3,983	-	151	521	-	2	10	-
4	-	16,807	236	-	574	36	-	24	1
Total	7,058	22,012	236	552	1,329	36	20	37	1

Table 3. Abundance of Yellowtail ($\times 10^{-3}$) from research vessel surveys for selected strata in Divisions 3L & 3N

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1				88						
2							76	24		15
3	1599	3965	264	895	174	1212	93	1180	287	1525
4	18797	29756	3844	7966	3015	5134	1383	4111	1889	3355
5	42304	58604	25409	25567	15104	22921	8383	15788	3957	11491
6	79562	67380	32789	43865	21794	31345	20425	29167	15737	29669
7	72076	36341	33541	22134	25186	28750	54476	30258	40589	42454
8	9691	11556	12804	2663	6174	5824	44686	15786	19334	13788
9	3090	1222	4355	391	688	120	12437	1640	2261	950
10	42	71	360		46	0	1889	17	269	30
11						16	143			
12							21			
TOTAL	227,161	208,895	113,366	103,569	72,181	95,322	143,936	98,023	84,347	103,277
AGE 7 & OLDER	84,667	49,190	51,060	25,188	32,094	34,710	113,652	47,701	62,453	57,222

Table 4.

YELLOWTAIL CATCH MATRIX 5+

2/ 6/81

I	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
5	6202	2993	2776	7534	10128	21280	19800	11240	2529	3211	3654	4783	5130
6	12483	15035	19839	30365	22502	23709	18100	20931	7650	6851	10979	13067	8383
7	9154	12076	20615	22117	19416	17053	11200	12737	5361	7331	11028	14284	7199
8	1421	3150	4557	5869	10553	4713	2400	2536	953	4078	3870	4940	1519
9	47	326	610	2152	4206	862	850	372	74	1433	310	773	224
10	1	40	68	245	1110	300	130	23	15	289	34	109	28

Table 5.

YELLOWTAIL WEIGHT MATRIX 5+

2/ 6/81

I	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
5	0.305	0.305	0.305	0.305	0.305	0.305	0.300	0.298	0.322	0.324	0.315	0.278	0.274
6	0.456	0.456	0.456	0.456	0.456	0.456	0.452	0.450	0.486	0.409	0.430	0.378	0.493
7	0.610	0.610	0.610	0.610	0.610	0.610	0.600	0.569	0.615	0.532	0.557	0.504	0.635
8	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.743	0.814	0.648	0.740	0.668	0.750
9	0.842	0.842	0.842	0.842	0.842	0.842	0.842	0.953	1.029	0.809	0.981	0.787	0.927
10	1.030	1.030	1.030	1.030	1.030	1.030	1.030	1.111	1.201	0.905	1.235	0.756	1.221

Table 6.

CATCH BIOMASS (KG)

2/ 6/81

I	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
5	1892	913	847	2298	3089	6490	5940	3350	814	1040	1151	1330	1406
6	5692	6856	9047	13846	10261	10811	8181	9419	3718	2802	4721	4939	4133
7	5584	7366	12575	13491	11844	10402	6720	7247	3297	3900	6143	7199	4571
8	1030	2284	3304	4255	7651	3417	1740	1884	776	2643	2864	3300	1139
9	40	274	514	1812	3541	726	716	355	76	1159	304	608	208
10	1	41	70	252	1143	309	134	26	18	262	42	82	34
5+1	14239	17735	26356	35955	37529	32156	23431	22280	8699	11806	15224	17459	11491

Table 7. SUMMARY OF YIELD PER RECRUIT CALCULATED FROM PARTIAL RECRUITMENT AND AVERAGE WEIGHT AT AGE OVER AGES 4 TO 11

F	Y/R (KG)	NATURAL MORTALITY = 0.30		
		NO. OF AGES = 8 FIRST AGE = 4		
0.001	0.0010	AGE	AVG. WT.	P. REC.
0.050	0.0424	4	247.	0.010
0.100	0.0757	5	305.	0.130
0.150	0.1019	6	456.	0.460
0.200	0.1226	7	610.	1.000
0.250	0.1391	8	725.	1.000
0.300	0.1523	9	842.	1.000
0.350	0.1628	10	1030.	1.000
0.400	0.1714	11	1103.	1.000
0.450	0.1783			
0.500	0.1839			
0.550	0.1886			
0.600	0.1924			
0.650	0.1956			
0.700	0.1983			
0.750	0.2006			
0.800	0.2025			
0.850	0.2042			
0.900	0.2056			
0.950	0.2068			
1.000	0.2079			
1.050	0.2088			
1.100	0.2096			
1.150	0.2103			
1.200	0.2109			
1.250	0.2115			
1.300	0.2120			
1.350	0.2124			
1.400	0.2128			
1.450	0.2131			
1.500	0.2135			
1.550	0.2137			
1.600	0.2140			
1.650	0.2142			
1.700	0.2144			
1.750	0.2146			
1.800	0.2147			
1.850	0.2148			
1.900	0.2150			
1.950	0.2151			
2.000	0.2152			

F_{0.1} IS 0.518 AND Y/R IS 0.1857
CURVE CONTINUES TO RISE. F_{MAX} IS GREATER THAN 2.0

Table 8. Regression of fishing mortality on directed effort.

Year	Directed effort (hr X 10 ⁻³)	F (ages 5-10) from VPA, weighted by pop'n. no.			
		F _T = 0.20	0.25	0.30	0.35
1968	18.9	0.231			
1969	25.8	0.215			
1970	44.2	0.298			
1971	61.9	0.472			
1972	64.7	0.668			
1973	50.9	0.702			
1974	57.8	0.575			
1975	57.0	0.694	0.695	0.696	0.696
1976	24.3	0.224	0.226	0.228	0.229
1977	27.5	0.291	0.303	0.312	0.318
1978	31.2	0.241	0.271	0.295	0.314
1979	35.5	0.232	0.285	0.335	0.381
1980	19.1*				
1968-79	r ²	0.744	0.751	0.751	0.744

*Provisional

Table 9. Regression of VPA 7+ numbers on research vessel 7+ numbers.

Year	Research vessel no. (7+, X 10 ⁻³)	VPA No. (7+, X 10 ⁻³)			
		F _T = 0.20	0.25	0.30	0.35
1971	84,667	62,408			
1972	49,190	50,910			
1973	51,060	31,673			
1974	25,188	22,405			
1975	32,094	23,257			
1976	34,710	17,413			
1977	113,652	23,657	23,567	23,506	23,462
1978	47,701	29,031	28,462	28,078	27,801
1979	62,453	37,936	35,113	33,224	31,870
1980	57,222	56,993	46,647	39,762	34,854
1971-79 (1977 excl.)	r ²	.748	.718	.695	.678
	predicted 1980	40,596	40,034	39,658	39,387

Table 10.

POPULATION NUMBERS													2/ 6/81
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
5	106726	112607	105806	86126	80674	86549	78770	54013	53169	66679	82635	94275	134794
6	54286	73756	80857	76004	57360	51114	46019	41519	30441	37223	46648	58089	65746
7	18637	29594	41833	43028	30656	23479	17907	18798	13179	16047	21736	25217	31911
8	2294	6113	11727	13665	13312	6553	3331	3940	3369	5236	5714	6842	6733
9	136	516	1885	4836	5173	1235	965	487	810	1686	539	1025	993
10	2	61	111	879	1769	405	202	33	56	537	90	140	124
5+	182081	222646	242218	224538	188945	169336	147194	118789	101023	127409	157361	185588	240301
6+	75355	110038	136412	138412	108271	82787	68424	64776	47854	60729	74726	91312	105507
7+	21069	36283	55555	62408	50910	31673	22405	23257	17413	23506	28078	33224	39762
8+	2432	6689	13722	19380	20255	8194	4498	4459	4234	7459	6342	8007	7850
MEAN POPULATION BIOMASS (KG)													2/ 6/81
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
5	27214	29237	27476	21585	19756	19570	17451	12250	14401	18166	21937	22005	31236
6	18559	25670	27345	22775	17296	14437	13743	11113	10926	11774	14981	16519	25993
7	6853	11774	15357	15451	9529	6293	5535	5107	5292	5324	7177	7055	15238
8	864	2605	5640	6338	3683	2115	1072	1470	1979	1338	2020	2024	3797
9	79	222	1110	2568	1577	480	232	189	683	441	290	336	692
10	1	31	60	655	936	179	105	16	49	279	74	42	114
5+	53570	69538	76988	69373	52778	43075	38137	30146	33330	37322	46480	47981	77070
6+	26355	40302	49512	47788	33022	23505	20686	17896	18929	19155	24542	25976	45834
7+	7797	14632	22167	25013	15725	9068	6943	6782	8003	7381	9561	9457	19842
8+	944	2858	6810	9562	6196	2774	1409	1676	2711	2058	2384	2402	4604
FISHING MORTALITY													2/ 6/81
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
5	0.070	0.031	0.031	0.106	0.156	0.332	0.340	0.273	0.057	0.057	0.052	0.060	0.045
6	0.307	0.267	0.331	0.608	0.593	0.749	0.595	0.848	0.340	0.238	0.315	0.299	0.159
7	0.815	0.626	0.819	0.873	1.243	1.653	1.214	1.419	0.623	0.733	0.856	1.020	0.300
8	1.193	0.877	0.586	0.671	2.077	1.616	1.622	1.282	0.392	1.974	1.418	1.630	0.300
9	0.502	1.239	0.463	0.706	2.246	1.511	3.090	1.872	0.111	2.631	1.048	1.811	0.300
10	1.115	1.327	1.175	0.385	1.221	1.728	1.281	1.556	0.371	0.939	0.565	1.977	0.300
5+	0.231	0.215	0.298	0.472	0.668	0.702	0.575	0.696	0.228	0.312	0.295	0.335	0.118

Table 11.

POPULATION NUMBERS 3/ 6/81					CATCH NUMBERS 3/ 6/81				
	1980	1981	1982	1983		1980	1981	1982	1983
5	81808	81808	81808	81808	5	5130	4840	5294	5294
6	65746	56214	56462	56074	6	8383	10816	11791	11710
7	31911	41546	32427	31786	7	7199	13664	11472	11246
8	6733	17513	19198	14311	8	1519	5760	6792	5063
9	993	3695	8093	8472	9	224	1215	2863	2997
10	124	545	1707	3571	10	28	179	604	1264
5+	187315	201321	199695	196023	5+	22483	36474	38817	37574
6+	105507	119513	117887	114215	6+	17353	31634	33523	32280
7+	39761	63299	61425	58140	7+	8970	20818	21732	20569
8+	7850	21753	28998	26354	8+	1771	7154	10259	9324
POPULATION BIOMASS (AVERAGE) 3/ 6/81					CATCH BIOMASS 3/ 6/81				
	1980	1981	1982	1983		1980	1981	1982	1983
5	18690.28	18728.94	18668.45	18668.45	5	1406	1326	1451	1451
6	25992.71	21315.21	21174.00	21028.43	6	4133	5332	5813	5773
7	15237.73	18382.09	14063.76	13785.67	7	4571	8676	7285	7141
8	3797.29	9152.01	9833.91	7330.54	8	1139	4320	5094	3797
9	692.21	2386.70	5123.64	5364.04	9	208	1127	2654	2779
10	113.84	463.65	1423.89	2978.25	10	34	219	738	1543
5+	64524.06	70428.59	70287.66	69155.39	5+	11491	21000	23034	22483
6+	45833.77	51699.65	51619.21	50486.94	6+	10085	19674	21584	21033
7+	19841.06	30384.44	30445.20	29458.51	7+	5952	14342	15771	15260
8+	4603.34	12002.35	16381.44	15672.83	8+	1381	5665	8486	8119
FISHING MORTALITY									
	1980	1981	1982	1983					
5	0.075	0.071	0.078	0.078					
6	0.159	0.250	0.275	0.275					
7	0.300	0.472	0.518	0.518					
8	0.300	0.472	0.518	0.518					
9	0.300	0.472	0.518	0.518					
10	0.300	0.472	0.518	0.518					
5+	0.152	0.247	0.269	0.265					

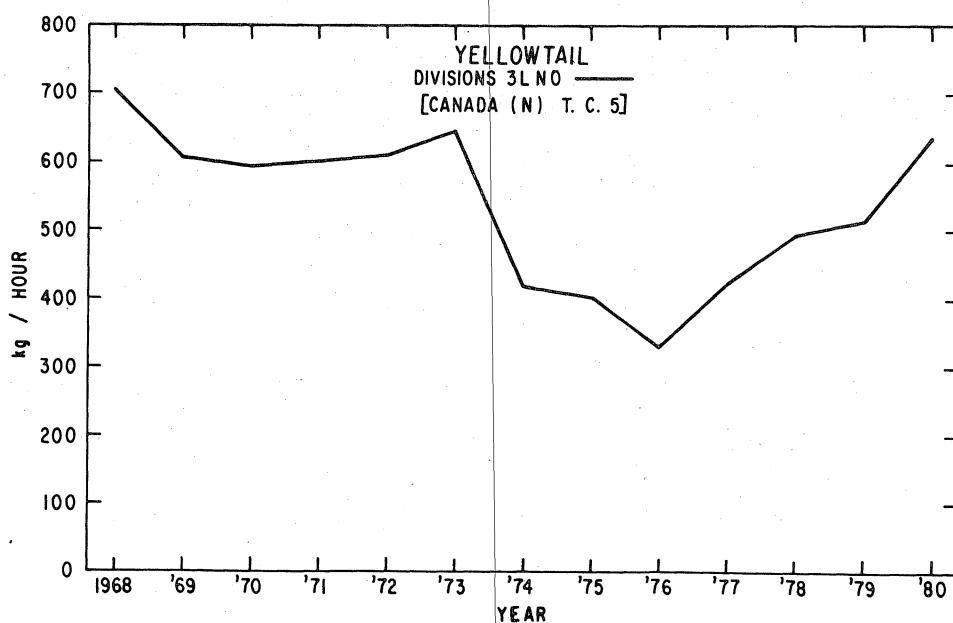


Fig. 1. Catch/hr of yellowtail in NAFO Divisions 3LNO.

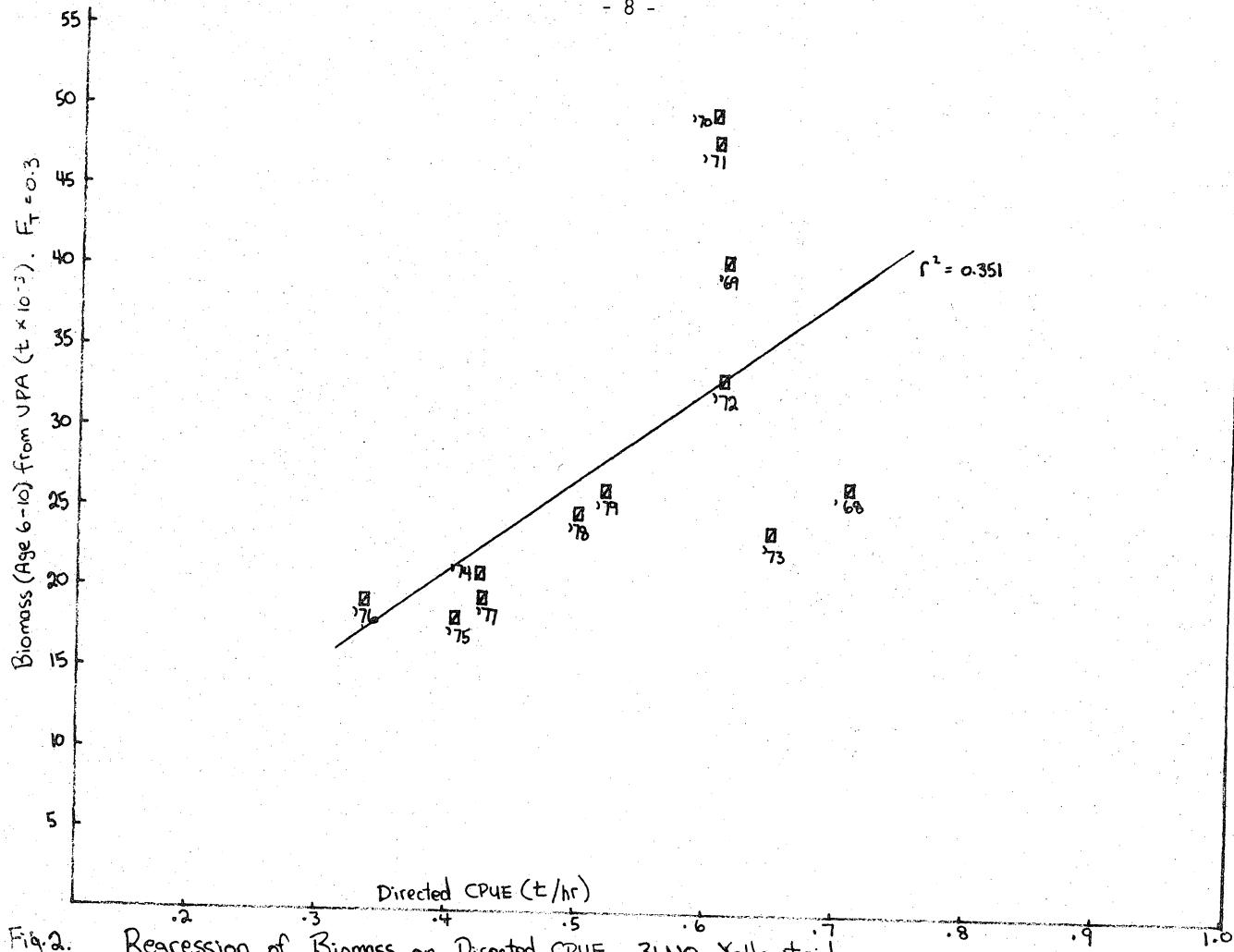


Fig. 2. Regression of Biomass on Directed CPUE, 3LNO Yellowtail

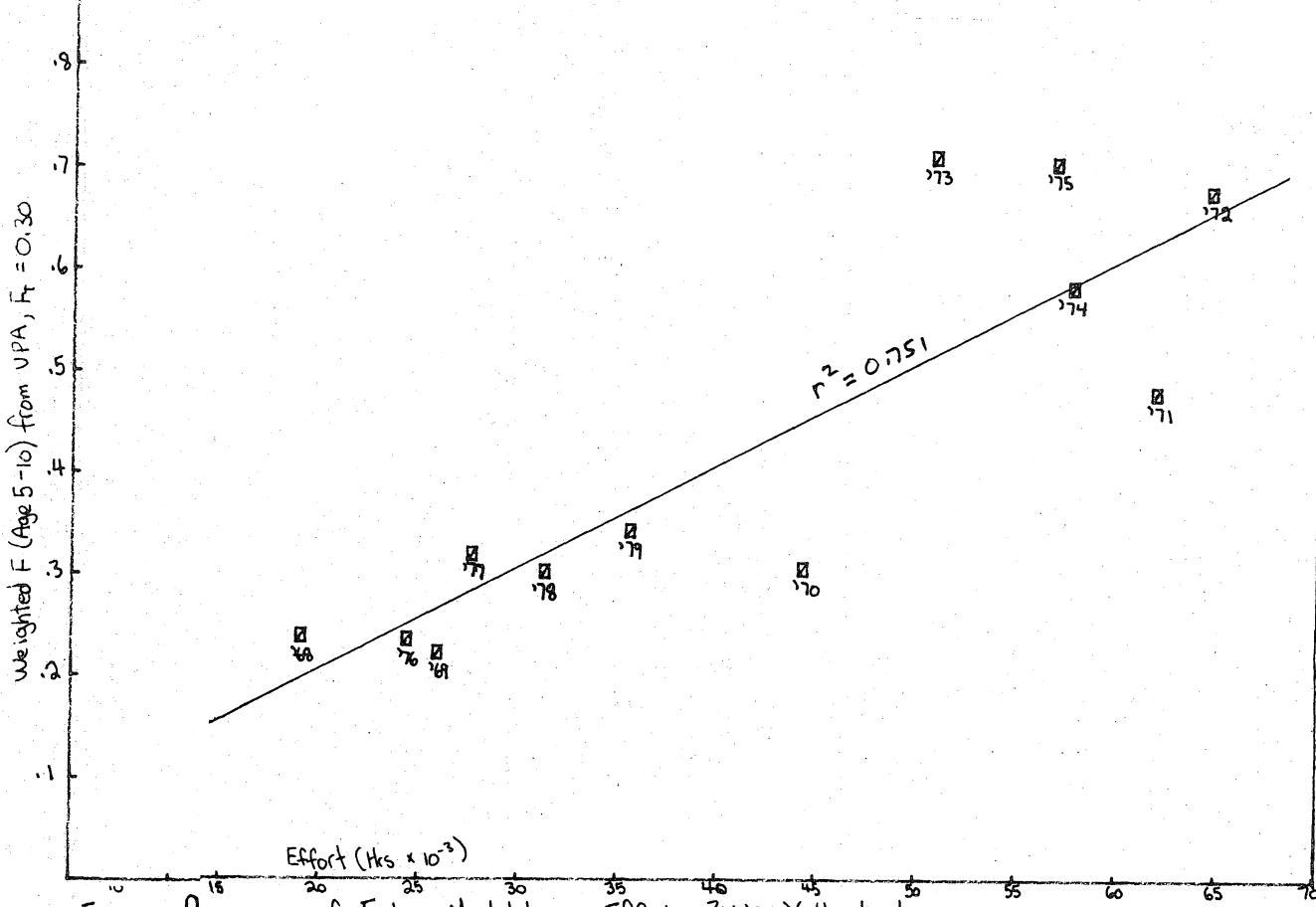


Fig. 3. Regression of Fishing Mortality on Effort, 3LNO Yellowtail

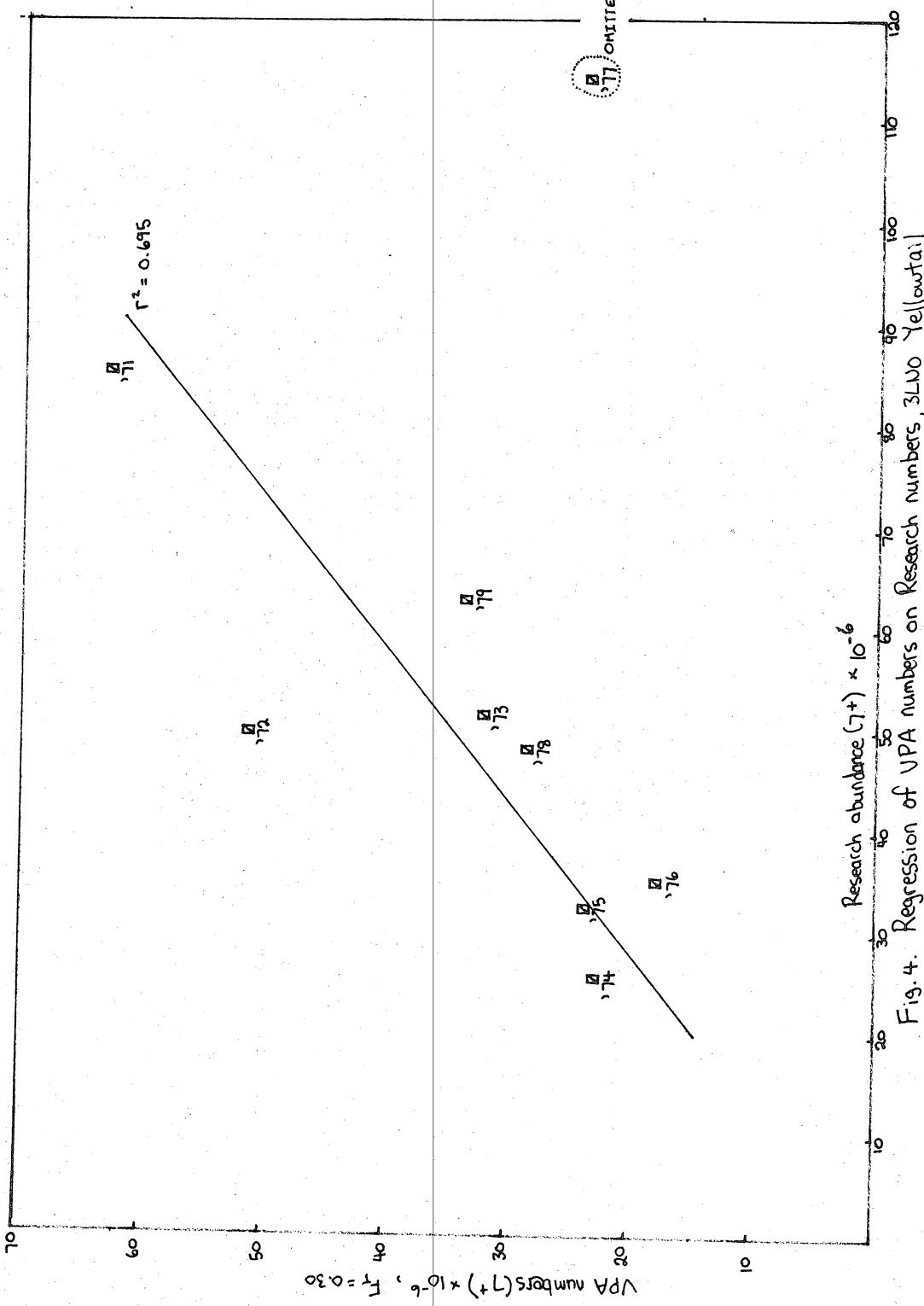


Fig. 4. Regression of VPA numbers on Research numbers, 3LNU Yellowtail

