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Yellowtail flounder in Divisions 3LN0 - an assessment update

by

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INTRODUCTION

TAC regulation

This stock has been under quota regulation since 1973, when a precautionary TAC of 50,000 t was set. In 1976, the TAC was set at 9000 t following a drop in stock biomass when anticipated recruitment did not materialize. The TAC since then increased gradually to 23,000 t in 1982 and has declined to 17,000 t for 1984 (Table 1).

Catch trends

The nominal catch peaked in 1972 at 39,259 t and catches have averaged about 14,000 t since 1978 (Table 1). Catches have declined gradually since 1981 and the 1983 catch of 9,279 t is the second lowest since 1968. Since 1975, the fishery has been conducted almost exclusively by Canadian trawlers, with the USSR taking significant catches between 1966 and 1975 (Table 1). In virtually all years, the majority of the catch has been taken in Div. 3N (Table 2).

Catch/effort

Catch rates of yellowtail by Can(N) TC 5 otter trawlers (Table 3) declined from an average level of approximately 0.6 t/hr in the 1969-72 period to an average level of approximately 0.4 t/hr in the 1974-77 period and have increased to a level between 0.53 and 0.64 t/hr in the period 1980-83 (Fig. 1). Total fishing effort has shown a decreasing trend in recent years with the 1983 value being the lowest in the series (Table 3).

ASSESSMENT PARAMETERS

Sampling: The length measurements and otolith samples used (Table 4) were collected by the Canadian Commercial Groundfish Sampling Section in St. John's.

Numbers at age: These were obtained in the usual way by applying quarterly age-length keys (sexes separate) to monthly length frequencies for each NAFO division. Total catch at age for 1983 (Table 5) was obtained by combining male and female numbers at age from all three divisions (3L, 3N, and 3Ø). Table 6 contains the catch matrix for the years 1968-83, and Table 7 shows the corresponding percent numbers at age.

Weights at age: Average weights at age for 1983 were obtained by applying a length-weight equation to monthly average lengths at age (weighted by numbers caught at age). The 1983 weights are shown in Table 5 while Table 8 contains the average weights at age for 1968-83. Table 9 shows the calculated catch biomass (numbers at age X weights at age) and all yearly totals are within  $\pm 1\%$  of the corresponding nominal catch.

Natural mortality: Since there is no evidence to suggest anything to the contrary, the value of 0.3 used in previous assessments was used for all ages.

Research vessel survey data: Tables 11-13 give the results of surveys conducted by Canadian research vessels in selected strata in Div. 3LN (Fig. 2) over the period 1971-84. Survey coverage of Div. 3Ø was incomplete in many years and is not presented. Also, there was no spring survey conducted in Div. 3LN in 1983. The 1971-82 surveys were conducted by the A. T. Cameron while the 1984 survey was carried out by the A. Needler.

Table 11 shows the results on a stratum by stratum basis. Overall, the numbers and weights per tow remained relatively stable over the period 1980-82, given that stratum 361, which historically has had a high abundance of yellowtail, was not surveyed in 1981. The values for 1984 must be regarded with caution as preliminary analysis has shown that the fishing gear used by the A. Needler may be 1.5 to 1.8 times as efficient in catching yellowtail than the gear used by the A. T. Cameron.

Table 12 shows the average number per set at age for the same surveys (except 1984) and Table 13 shows the corresponding total abundance values. From these tables it can be seen that the surveys apparently do not adequately sample young yellowtail and thus cannot be used to estimate recruitment. Also, noticeable from Table 13 is the apparent increase in the abundance of fish aged 7 and older in the period 1979-82 (average  $61 \times 10^6$ ) over the level observed in the 1972-76 period (average  $38 \times 10^6$ ). Again, however, these results must be interpreted with some caution as the surveys were somewhat incomplete in 1975, 76, and 81.

Partial recruitment: The PR used to estimate population size in 1983 in the cohort analysis was calculated from average 1968-83 selectivity coefficients from a preliminary cohort run. The averages were normalized at age 8 and the resulting PR vector, as well as the PR used in the 1983 assessment (Brodie and Pitt, 1983) is shown in Table 10.

Terminal fishing mortality in 1983: Several methods were used in attempting to calibrate the cohort analysis. A summary of the results from several of these methods is given in Table 14.

- 1) Regressions of 5+ mid year population biomass from cohort vs CPUE (Table 3) over a range of  $F_T$  from 0.30 to 0.50 were barely significant at  $\alpha = 0.05$ . The correlation coefficient ( $r$ ) reached a peak of 0.587 at  $F_T = 0.35$ , although there was only a slight change in  $r$  over the range of  $F_T$ . The 1983 point came closest to the line at  $F_T = 0.45$  while the line best fit both the 1982 and 1983 points at a value for  $F_T$  of 0.40 (Fig. 3).
- 2) Regressions of 4+ mid year population biomass from cohort vs CPUE (Table 3) were performed at values of  $F_T = 0.35$ , 0.40, and 0.45. For these calculations, the population size at age 4 in 1983 was adjusted (by changing the PR) to equal approximately the geometric mean of the population size at age 4 in the cohort analysis from 1968-83. These results show  $r$  to be decreasing as  $F_T$  increases from 0.35 and that the 1983 point is closest to the line at  $F_T = 0.40$ . As well, the best fit of the regression line to both the 1982 and 1983 points is at  $F_T = 0.40$  (Fig. 4).
- 3) Regressions of 4+ fishing mortality weighted by population numbers from cohort against fishing effort (Table 3) were carried out under the same conditions described in 2) above. These results also show  $r$  to be decreasing over the range of  $F_T$  used and although the 1983 residual is relatively large for all three levels of  $F_T$ , the line from the run at  $F_T = 0.45$  best fits both the 1982 and 1983 points combined (Fig. 5). It is also interesting to note that the intercept of the calculated line is very close to zero for the run at  $F_T = 0.35$ .
- 4) Regressions of 4+ midyear population biomass from cohort versus average weight per tow from Canadian research vessel surveys, 1971-82 only (Table 11), were performed for a range of  $F_T$  from 0.35 to 0.50. The correlation coefficient increased from 0.815 to 0.883 over this range, and both the 1982 and the 1981-82 combined residuals were minimized at a level of  $F_T$  between 0.45 and 0.50 (Fig. 6). However, these results should be interpreted with caution as a) the surveys were not complete in all years, and b) the regressions are essentially "two-point regressions", driven mainly by a cluster of points near the origin and the high 1971 and 1972 values.

Regressions of exploitable biomass from cohort (calculated from yearly selectivity coefficients) on CPUE (Fig. 7) as well as average exploitable biomass (calculated from average selectivity coefficients at age) on CPUE (Fig. 8) over a range of  $F_T$  were not significant.

From the calibrations, it was determined that a value of  $F_T$  for 1983 = 0.40 was appropriate. The cohort run at this level of  $F_T$  is shown in Table 15.

Recruitment for stock projections: The geometric mean (1978-82) of age 4 numbers from the cohort run at  $F_T = 0.40$  was used to estimate recruitment at age 4 for 1982-84. This value was  $90 \times 10^6$  fish, slightly lower than the 1968-82 geometric mean ( $99 \times 10^6$ ) and 19% lower than the value used in the 1983 assessment ( $111 \times 10^6$ ).

$F_{0.1}$ : The value of 0.52 calculated by Brodie and Pitt, 1981, and used in the last three assessments is retained.

Catch projections: Projections were carried out to 1985, using the population size in 1983 from the cohort run at  $F_T = 0.40$  (age 4 replaced by geometric mean), the PR used to calculate the 1983 population, and the long-term (1968-83) average weights. Table 16 shows that assuming the catch in 1984 equals the TAC of 17,000 t, the projected  $F_{0,1}$  catch in 1985 would be 15,000 t. It should be pointed out that over 25% of this projected catch is comprised of fish from year-classes for whose size the geometric mean was used as an estimate.

#### REFERENCES

Brodie, W. B., and T. K. Pitt. 1981. An assessment of the yellowtail stock in Div. 3LN0. NAFO SCR Doc. 81/VI/54, Ser. No. N338.

Brodie, W. B., and T. K. Pitt. 1983. A stock assessment for yellowtail flounder in NAFO Div. 3L, 3N, and 30. NAFO SCR Doc. 83/VI/57, Ser. No. N715.

Table 1. Nominal catches by country and TACs (tons) of yellowtail-NAFO Divisions 3LN0.

Year	Canada	France	USSR	Other	Total	TAC
1966	4,185	0	2,834	7	7,026	
1967	2,122		6,736	20	8,878	
1968	4,180	14	9,146	0	13,340	
1969	10,494	1	5,207	6	15,708	
1970	22,814	17	3,426	169	26,426	
1971	24,206	49	13,087	0	37,342	
1972	26,939	358	11,929	33	39,259	
1973	28,492	368	3,545	410	32,815	50,000
1974	17,053	60	6,952	248	24,313	40,000
1975	18,458	15	4,076	345	22,894	35,000
1976	7,910	31	57	59	8,057	9,000
1977	11,295	245	97	1	11,638	12,000
1978	15,091	375	-	-	15,466	15,000
1979	18,116	202	-	33	18,351	18,000
1980	12,011	366	-	-	12,377	18,000
1981	14,122	558	-	-	14,680	21,000
1982 <sup>a</sup>	11,479	110	-	657	12,246	23,000
1983 <sup>a</sup>	9,084	184	11	-	9,279	19,000
1984						17,000

<sup>a</sup>:preliminary

Table 2. Breakdown of nominal catches (tons) of yellowtail by NAFO Division 3L, N and 0.

Year	3L	3N	30	Total
1965	117	2,958	55	3,130
1966	62	6,442	522	7,026
1967	453	6,117	2,308	8,878
1968	2,815	8,459	2,066	13,340
1969	5,287	7,215	3,206	15,708
1970	7,419	18,668	339	26,426
1971	6,632	25,174	5,536	37,342
1972	9,292	25,788	4,179	39,259
1973	4,856	23,693	4,266	32,815
1974	1,544	19,329	3,440	24,313
1975	2,638	16,156	4,100	22,894
1976	516	5,023	2,518	8,057
1977	2,651	7,381	1,606	11,638
1978	2,547	11,079	1,840	15,466
1979	2,595	14,556	1,200	18,351
1980	1,898	9,805	674	12,377
1981	2,345	11,733	602	14,680
1982 <sup>a</sup>	2,510	7,890	1,846	12,246
1983 <sup>a</sup>	2,672	5,875	732	9,279

<sup>a</sup>: preliminary

Table 3. Nominal catch and effort data for yellowtail in NAFO Divisions 3LN0. Column 2 refers to reported "directed" catch by Canada (N) Tonnage Class 5 Otter trawlers.

Year	Directed catch (tons)	CPUE (tons/hr)	Total catch (tons)	Total calculated effort (hours)
1968	2,216	0.705	13,340	18,922
1969	3,165	0.610	15,708	25,751
1970	12,444	0.598	26,426	44,191
1971	14,094	0.600	37,342	62,237
1972	14,544	0.607	39,259	64,677
1973	21,225	0.645	32,815	50,876
1974	14,025	0.421	24,313	57,751
1975	13,345	0.402	22,894	56,950
1976	4,889	0.332	8,057	24,268
1977	5,029	0.423	11,638	27,513
1978	9,289	0.496	15,466	31,181
1979	13,273	0.517	18,351	35,495
1980	7,855	0.640	12,377	19,339
1981	10,400	0.614	14,680	23,909
1982 <sup>a</sup>	5,530	0.525	12,246	23,326
1983 <sup>a</sup>	4,605	0.556	9,279	16,689

<sup>a</sup>: preliminary

Table 4. List of commercial samples available, by quarter and division, available for 1983 yellowtail, Division 3LN0, as provided by the St. John's Commercial Sampling Section.

Div.	Can(N)		Quarter				Total
			1	2	3	4	
3L	Can(N)	Catch (t)	2	692	1,395	431	2,520 (t)
		Samples	-	5	7	3	15
		Measured	-	2,131	3,078	1,212	6,421
		Otoliths	-	227	342	175	744
3N	Can(N)	Catch (t)	717	1,178	2,305	1,340	5,540 (t)
		Samples	-	6	9	11	26
		Measured	-	2,488	4,024	4,057	10,569
		Otoliths	-	264	449	439	1,152
30	Can(N)	Catch (t)	43	298	87	262	690 (t)
		Samples	-	3	-	2	5
		Measured	-	964	-	648	1,612
		Otoliths	-	153	-	129	282

- Table 5. Average lengths, weights, and numbers at age, 3LNO yellowtail, 1983.  
 Table 6. Catch matrix (nos. at age) for 1968-83.  
 Table 7. Percent numbers at age, 1968-83.  
 Table 8. Average weights, 1968-83.  
 Table 9. Catch biomass (numbers x weights), 1968-83.

Table 5.

AGE	AVERAGE			CATCH		
	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.	
4	0.210	29.820	22	5.38	0.24	
5	0.338	34.170	1843	129.24	0.07	
6	0.420	36.413	6016	215.08	0.04	
7	0.530	38.916	6964	219.96	0.03	
8	0.680	41.842	3483	146.73	0.04	
9	0.944	46.089	484	37.07	0.08	
10	1.303	50.675	22	6.71	0.30	

Table 6.

AGE	CATCH MATRIX( $\times 10^{-3}$ )															
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
4	573	80	141	169	1943	3734	1375	955	409	1391	691	1061	1142	3245	97	22
5	6202	2993	2776	7534	10128	21280	19800	11240	2529	3211	3654	4783	5130	5077	1311	1843
6	12483	15035	19839	30365	22502	23709	18100	20931	7650	6851	10979	13047	8383	8191	4580	6016
7	9154	12074	20615	22117	19416	17053	11200	12737	5361	7331	11028	14284	7199	9991	7774	6964
8	1421	3150	4557	5869	10553	4713	2400	2536	953	4078	3870	4940	1519	4361	6630	3483
9	47	326	610	2152	4206	862	850	372	74	1433	310	773	224	356	1907	484
10	1	40	68	245	1110	300	130	23	15	289	34	109	28	29	268	22
4+	29881	33700	48606	68451	69858	71651	53855	48794	16991	24584	30566	39017	23625	31250	22567	18834

Table 7.

PERCENT AT AGE

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
4	0.019	0.002	0.003	0.002	0.028	0.052	0.026	0.020	0.024	0.057	0.023	0.027	0.048	0.104	0.004	0.001
5	0.208	0.089	0.057	0.110	0.145	0.297	0.368	0.230	0.149	0.131	0.120	0.123	0.217	0.162	0.058	0.098
6	0.418	0.446	0.408	0.444	0.322	0.331	0.336	0.429	0.450	0.279	0.359	0.335	0.355	0.282	0.203	0.319
7	0.306	0.358	0.424	0.323	0.278	0.238	0.208	0.261	0.316	0.298	0.361	0.366	0.305	0.320	0.344	0.370
8	0.048	0.093	0.094	0.086	0.151	0.066	0.045	0.052	0.056	0.166	0.127	0.127	0.064	0.140	0.294	0.185
9	0.002	0.010	0.013	0.031	0.060	0.012	0.016	0.008	0.004	0.058	0.010	0.020	0.009	0.011	0.085	0.026
10	0.000	0.001	0.001	0.004	0.016	0.004	0.002	0.000	0.001	0.012	0.001	0.003	0.001	0.001	0.012	0.001

Table 8.

AVERAGE WEIGHTS(KG)

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	
4	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.200	0.184	0.200	0.214	0.249	0.178	0.271	0.228	0.238	0.210
5	0.305	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	0.308	0.292	0.338
6	0.456	0.456	0.456	0.456	0.456	0.456	0.456	0.456	0.450	0.486	0.409	0.430	0.378	0.493	0.349	0.346	0.420
7	0.610	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	0.496	0.486	0.530
8	0.725	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	0.661	0.675	0.680
9	0.842	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	0.909	0.933	0.944
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	1.186	1.304	1.303	

Table 9.

CATCH BIOMASS(t)

I	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
4	142	20	35	42	480	922	275	176	82	298	172	189	309	740	23	5
5	1892	913	847	2298	3089	6490	5940	3350	814	1040	1151	1330	1406	1564	383	623
6	5692	6858	9047	13846	10281	10811	8181	9419	3718	2802	4721	4939	4133	2859	1585	2527
7	5584	7366	12575	13491	11844	10402	6720	7247	3297	3900	6143	7199	4571	4956	3778	3691
8	1030	2284	3304	4255	7651	3417	1740	1884	776	2643	2864	3300	1139	2883	4475	2368
9	40	274	514	1812	3541	726	716	355	76	1159	304	608	208	324	1779	457
10	1	41	70	252	1143	309	134	26	18	262	42	82	34	34	349	29
4+	14380	17754	26391	35997	38009	33078	23706	22456	8781	12104	15397	17648	11800	13358	12373	9699

Table 10. Partial recruitment vectors, Div. 3LN0 yellowtail,  
used in 1983 and 1984 assessments.

Age	PR in 1983 assessment	PR in 1984 assessment
4	.003	.010
5	.068	.090
6	.222	.290
7	.628	.780
8	1.000	1.000
9	1.000	1.000
10	1.000	1.000

Table 11. Average numbers and weights of yellowtail per 30 minute set for selected strata in Divisions 3LN. Surveys from 1971-82 were conducted by the research vessel A. T. Cameron and the 1984 survey was conducted by the R.V. A. Needler.

Stratum		Year												
		1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
350	No. sets	3	2	4	3	3	4	4	6	9	10	3	7	6
	Av. No./set	76.00	4.00	0.00	0.33	0.00	0.50	6.50	3.17	2.78	2.30	0.67	1.86	3.33
	Av. wt./set	32.21	2.26	0.00	0.15	0.00	0.23	3.80	1.51	1.07	1.05	0.33	0.61	1.47
361	No. sets	2	3	4	4	4	5	3	4	8	7	-	6	5
	Av. No./set	121.50	289.33	187.00	295.00	272.11	292.20	361.67	314.25	194.62	303.57	-	347.33	270.80
	Av. wt./set	45.81	115.82	93.44	151.50	105.27	113.04	141.52	122.78	92.28	128.38	-	118.92	108.20
362	No. sets	2	4	5	4	3	5	5	4	12	11	5	8	7
	Av. No./set	382.00	361.00	54.80	88.50	78.89	96.60	141.64	76.75	94.58	120.45	194.80	125.50	229.60
	Av. wt./set	140.16	132.79	22.05	38.89	33.30	44.09	62.44	28.75	40.33	53.59	104.20	47.19	95.00
363	No. sets	3	3	4	4	3	4	5	5	8	5	3	5	6
	Av. No./set	250.67	48.00	41.00	1.00	1.67	5.25	65.40	13.20	47.38	77.20	5.67	69.80	81.80
	Av. wt./set	119.75	21.32	12.47	0.45	0.98	2.52	27.40	6.27	22.33	39.30	3.00	30.40	40.10
372	No. sets	4	3	3	3	3	3	6	7	9	6	4	6	4
	Av. No./set	271.50	55.67	132.00	12.33	19.60	156.67	65.17	44.29	52.11	48.83	31.25	46.50	96.80
	Av. wt./set	135.28	28.12	39.61	7.10	7.59	44.15	32.13	20.52	24.31	25.00	13.25	19.75	47.30
373	No. sets	4	4	4	4	-	5	4	5	11	8	5	5	7
	Av. No./set	151.25	355.00	51.75	59.50	-	68.20	189.28	112.80	44.55	93.50	109.80	52.40	133.90
	Av. wt./set	73.60	135.06	26.65	24.21	-	23.31	74.51	50.46	22.08	48.13	58.40	23.70	63.50
375	No. sets	3	3	3	3	3	-	4	5	5	4	4	5	5
	Av. No./set	111.67	149.67	312.33	259.00	157.33	-	141.00	65.20	121.00	103.00	104.25	113.80	378.80
	Av. wt./set	60.03	68.95	121.87	94.50	80.27	-	62.65	30.64	66.14	57.75	69.25	61.10	176.10
Total	No. sets	21	22	27	25	19	26	31	36	62	51	24	42	40
	Av. No./set	203.98	189.87	102.07	92.25	81.85	102.43	136.44	88.05	75.84	103.27	78.96	102.43	163.00
	Av. wt./set	90.01	75.10	41.20	41.15	34.80	37.33	56.96	36.54	36.18	48.65	43.16	40.57	72.40

Table 12. Average number per set at age and average numbers for totals for yellowtail from Canadian research vessel surveys in NAFO Divisions 3L and 3N (see Fig. 1). A key stratum, number 361, was not fished in 1981, and in 1975 and 1976 strata 373 and 375 respectively were missed.

Age	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	1.44	3.57	0.24	0.81	0.19	1.09	0.08	1.06	0.26	1.37	0.32	1.88
4	16.92	26.79	3.46	7.17	3.27	4.62	1.24	3.70	1.70	3.02	0.57	6.41
5	38.09	52.76	22.88	23.02	16.39	20.64	7.55	14.21	3.56	10.35	2.54	13.16
6	71.63	60.66	29.52	39.49	23.65	28.22	18.39	26.26	14.17	26.71	10.93	19.10
7	64.89	32.72	30.20	19.93	27.33	25.88	49.05	27.24	36.54	38.22	27.96	29.74
8	8.73	10.40	11.53	2.40	6.70	5.24	40.23	14.21	17.41	12.41	29.43	19.31
9	2.78	1.10	3.92	0.35	0.75	0.11	1.20	1.48	2.04	0.86	5.64	4.74
10	0.04	0.06	0.32	-	0.05	-	1.70	0.02	0.24	0.03	1.52	0.70
11						0.04	0.13					0.09
Average number (3+)												
per set 204.52 188.06 102.07 93.27 78.33 85.84 119.57 88.18 75.92 92.97 78.91 95.13												

Table 13. Abundance of yellowtail ( $\times 10^{-3}$ ) from Canadian research vessel surveys for selected strata in Divisions 3L and 3N.

Age	1971	1972	1973	1974	1975 <sup>1</sup>	1976 <sup>1</sup>	1977	1978	1979	1980	1981 <sup>1</sup>	1982
1												12
2					88			76	24	15		537
3	1,599	3,965	264	895	174	1,212	93	1,180	287	1,525	314	2,090
4	18,797	29,756	3,844	7,966	3,015	5,134	1,383	4,111	1,889	3,355	556	7,116
5	42,304	58,604	25,409	25,576	15,104	22,921	8,383	15,788	3,957	11,491	2,471	14,614
6	79,562	67,380	32,789	43,865	21,794	31,345	20,425	29,167	15,737	29,669	10,623	21,217
7	72,076	36,341	33,541	22,134	25,186	28,750	54,476	30,258	40,589	42,454	27,166	33,033
8	9,691	11,556	12,804	2,663	6,174	5,824	44,686	15,786	19,334	13,788	28,951	21,448
9	3,090	1,222	4,355	391	688	120	12,437	1,640	2,261	950	5,455	5,268
10	42	71	360		46	0	1,889	17	269	30	1,479	773
11						16	143					100
12							21					
Total	227,161	208,895	113,366	103,578	72,181	95,322	143,936	98,023	84,347	103,277	77,015	106,208
Age 7 and older	84,899	49,190	51,060	25,188	32,094	34,710	113,652	47,701	62,453	57,222	63,051	60,622

<sup>1</sup>Survey coverage incomplete.

Table 14. Results of cohort calibration, 3LNO yellowtail.

Regression	Parameter	$F_T$				
		.30	.35	.40	.45	.50
5+ pop. biomass (midyr.) vs CPUE	r	.576	.587	.581	.567	.551
	intercept	2,333	2,286	2,266	2,220	2,195
	slope	87,347	84,889	83,037	81,619	80,479
	1983 resid.	+20,856	+12,019	+5,381	+235	-3,889
4+ pop. biomass (midyr.) vs CPUE (pop. size at age 4 in 1983 equal approx. to G.M.)	1982 resid.	+6,533	+1,382	-2,468	-5,492	-7,889
	r		.718	.696	.668	
	intercept		-6,364	-5,924	-5,583	
	slope		139,317	135,400	132,358	
4+ fishing mortality (wtd. by pop. nos.) vs effort (age 4 in 1983 equal approx. to G.M.)	1983 resid.		+10,715	+2,226	-4,377	
	1982 resid.		+548	-5,054	-9,413	
	r		.890	.881	.871	
	intercept		0.0013	0.0133	0.0246	
4+ pop. biomass (midyr.) vs Av. wt. per r.v. tow (1971-82)	slope		0.0067	0.0065	0.0063	
	1983 resid.		-0.0299	-0.0255	-0.0204	
	1982 resid.		-0.0063	+0.0085	+0.0233	
	r		.815	.859	.878	.883
4+ pop. biomass (midyr.) vs Av. wt. per r.v. tow (1971-82)	intercept		26,158	23,337	21,135	19,379
	slope		722	752	775	793
	1982 resid.		+11,841	+6,266	+1,904	-1,575
	1981 resid.		+7,977	+4,328	+1,456	-821

Table 15. Cohort analysis for 3LNO Yellowtail. Terminal F in 1983 = 0.40.

AGE	POPULATION NUMBERS															
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
4	156799	147013	119893	110606	121785	113143	75638	71447	79528	82796	87717	89033	92387	100096	81477	6376
5	109297	115666	108841	86697	81754	88548	80605	54851	52256	58564	60140	64388	65044	67459	71360	60276
6	53827	75631	83112	78242	39224	51877	47282	42671	30960	36535	40622	41408	43583	43771	45605	51737
7	18231	29132	43088	44495	31826	24507	18025	19449	13596	16351	21169	20643	19429	25072	25376	29643
8	2460	5627	11187	14177	13926	6867	3477	3713	3445	5458	5804	6191	2999	8137	9974	12108
9	142	599	1457	4366	5451	1234	1031	510	568	1732	534	968	334	914	2319	1683
10	2	70	163	555	1382	418	172	32	58	357	50	128	32	55	371	76
4+	340763	373738	367742	341138	315389	286594	226230	192874	180411	201794	216034	222759	223827	245563	236481	162100
5+	183965	226725	247849	230532	193605	173451	150592	121226	100683	116998	128317	133726	131441	145487	155005	155722
6+	74668	111058	139008	141834	111811	84903	69987	66376	48627	60434	66177	69339	66396	78008	83645	95446
7+	20841	35427	55896	63592	52587	33026	22705	23704	17667	23899	27556	27931	22814	34237	38040	43710

AGE	POPULATION BIOMASS (MID-YEAR)															
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
4	33392	31362	25566	23583	25758	23701	12938	11305	13702	15145	13788	13601	21482	19342	16742	1155
5	27687	30041	28274	22256	20040	20060	17892	12448	14145	15891	15811	14820	14716	17193	17819	17304
6	18342	26376	28183	23531	17941	14602	14162	11440	11122	11516	12691	10979	16505	11776	12860	17547
7	6540	11437	15865	16053	9928	6569	5435	5261	5484	5417	6786	4610	8264	8124	8715	11830
8	955	2238	5256	6619	3797	2231	1121	1245	2028	1372	1998	1340	1316	3077	3145	5921
9	88	282	787	2184	1650	454	242	198	468	383	279	247	143	547	613	1142
10	1	39	109	361	529	192	74	16	51	118	29	31	37	38	214	72
4+	87205	101775	104041	94586	79644	67811	51864	41913	46999	49863	56381	45629	62463	60116	60107	54970
5+	53613	70413	78473	71004	53865	44109	38926	30608	33296	34698	37594	32027	40981	40755	43365	53815
6+	25926	46372	50199	48747	33846	24049	21034	18159	19152	18807	21783	17207	26265	23562	25547	34512
7+	7584	13997	22016	25217	15904	9447	6872	6720	6030	7291	9092	6228	9760	11786	12686	18965

AGE	FISHING MORTALITY															
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
4	0.034	0.001	0.001	0.002	0.019	0.039	0.021	0.016	0.006	0.020	0.009	0.014	0.014	0.038	0.001	0.004
5	0.068	0.031	0.030	0.104	0.155	0.327	0.334	0.272	0.058	0.066	0.073	0.090	0.096	0.092	0.022	0.036
6	0.314	0.263	0.325	0.599	0.582	0.757	0.588	0.844	0.338	0.246	0.377	0.457	0.253	0.245	0.124	0.144
7	0.676	0.657	0.812	0.862	1.234	1.653	1.280	1.431	0.613	0.736	0.930	1.629	0.563	0.622	0.440	0.312
8	1.112	1.051	0.641	0.856	2.124	1.576	1.619	1.577	0.388	2.025	1.491	2.619	0.888	0.963	1.480	0.400
9	0.458	1.000	0.666	0.856	2.268	1.669	3.171	1.677	0.164	3.253	1.124	2.622	1.506	0.602	3.112	0.400
10	1.061	1.046	0.644	0.698	2.162	1.607	1.818	1.609	0.353	2.212	1.454	2.619	0.935	0.914	1.635	0.400

Table 16. Results of catch projections to 1985, assuming the TAC of 17,000t is taken in 1984.

CATCH NUMBERS			POPULATION NUMBERS			FISHING MORTALITY					
	1983	1984	1985		1983	1984	1985		1983	1984	1985
4	22	450	403	4	90000	90000	90000	4	0.000	0.006	0.005
5	1843	2935	2621	5	60276	66655	66288	5	0.036	0.052	0.047
6	6016	7055	6945	6	51737	43075	46865	6	0.144	0.209	0.187
7	6964	10559	7534	7	29843	33188	25893	7	0.312	0.453	0.406
8	3483	6246	5547	8	12108	16183	15633	8	0.400	0.581	0.520
9	484	2321	2381	9	1683	6013	6709	9	0.400	0.581	0.520
10	22	323	885	10	76	836	2493	10	0.403	0.581	0.520
4+	18834	29888	26316	4+	245723	255948	253880	4+	0.100	0.162	0.141
5+	18812	29438	25913	5+	155723	165948	163880				
6+	16969	26503	23291	6+	95447	99294	97593				
7+	10953	19448	16347	7+	43710	56219	50727				
CATCH BIOMASS			POPULATION BIOMASS (AVERAGE)								
	1983	1984	1985		1983	1984	1985		1983	1984	1985
4	5	103	92	4	17754.80	17708.32	17713.40				
5	562	895	799	5	15611.15	17131.52	17080.93				
6	2613	3064	3016	6	18144.79	14661.48	16111.95				
7	3997	6061	4325	7	12812.00	13385.27	10662.01				
8	2493	4471	3971	8	6233.60	7702.52	7636.93				
9	429	2055	2108	9	1071.68	3539.47	4053.45				
10	24	351	964	10	59.47	605.49	1853.27				
4+	10123	17000	15273	4+	71687.49	74734.08	75111.74				
5+	10118	16897	15183	5+	53932.69	57025.76	57398.54				
6+	9556	16002	14383	6+	38321.54	39894.24	40317.61				
7+	6943	12938	11367	7+	20176.75	25232.76	24205.66				

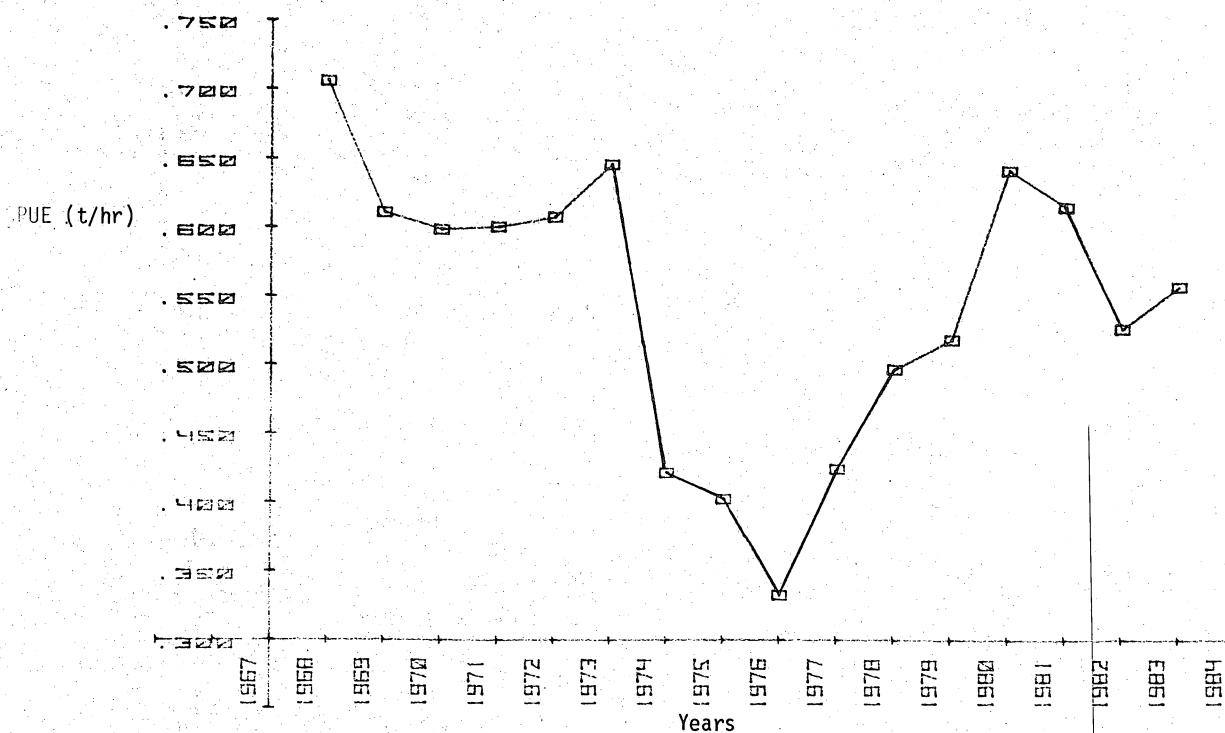


Fig. 1. Catch rate of yellowtail in Divisions 3LNO by Can(N) TC 5 otter trawls, 1968-83.

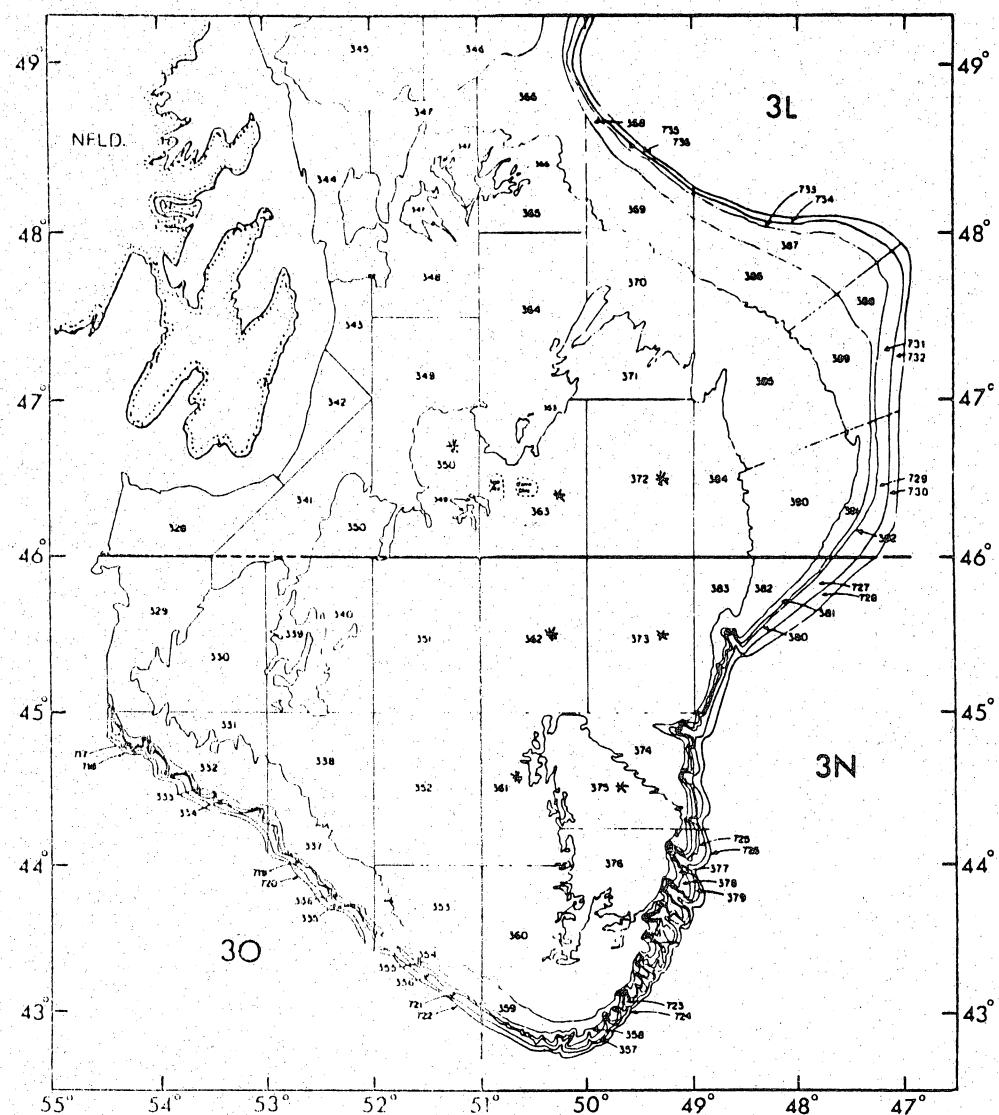


Fig. 2. Stratum map for NAFO Divisions 3LNO. Asterisks denote strata of prime importance in determining yellowtail abundance.

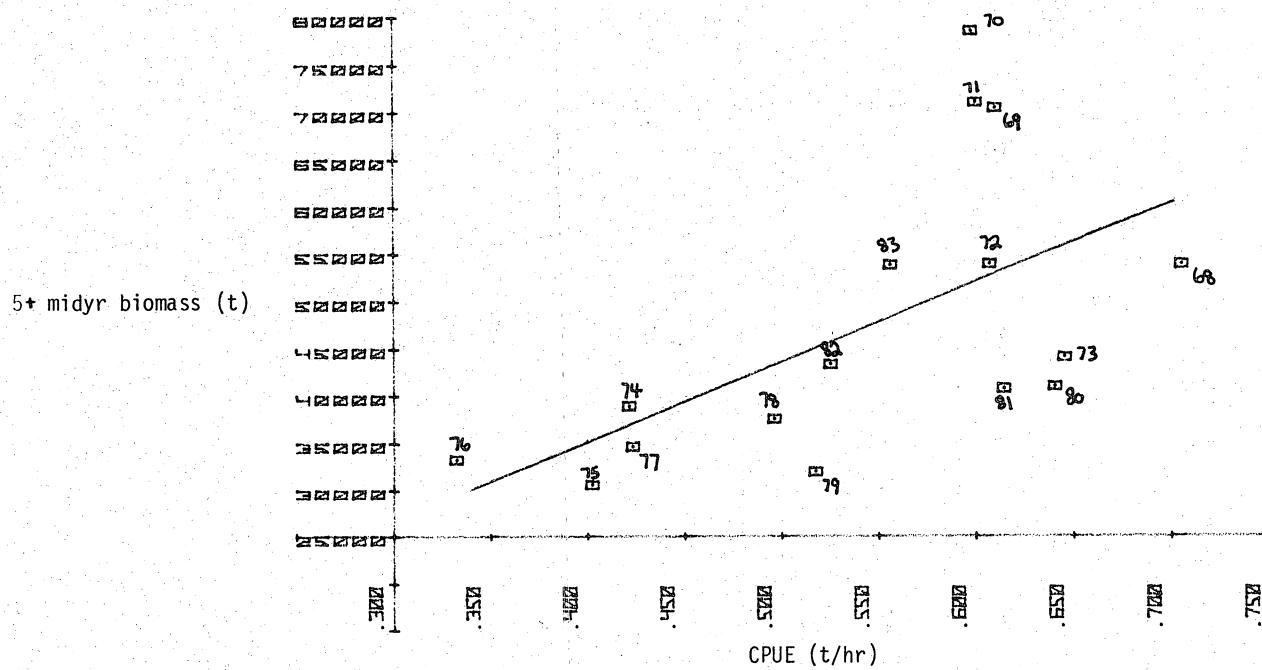


Fig. 3. Regression of 5+ midyear biomass from cohort ( $F_{T=4}$ ) on CPUE, 1968-83

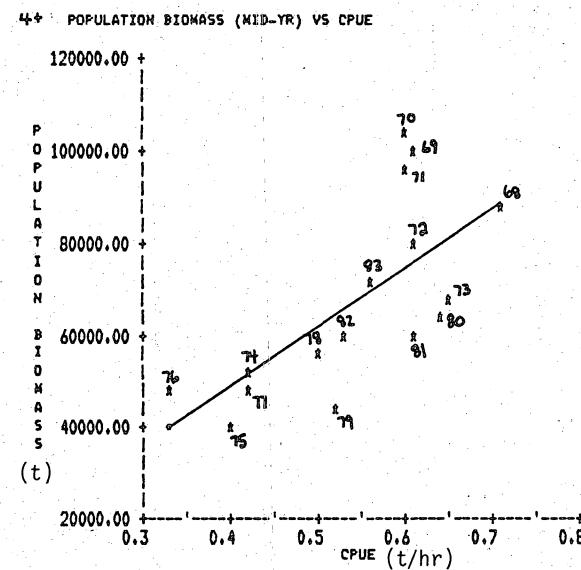


Fig. 4. Regression of 4+ midyear biomass from cohort ( $F_1 = 0.4$ ) on CPUE. Value for age 4 in 1983 is equal approximately to the geometric mean.

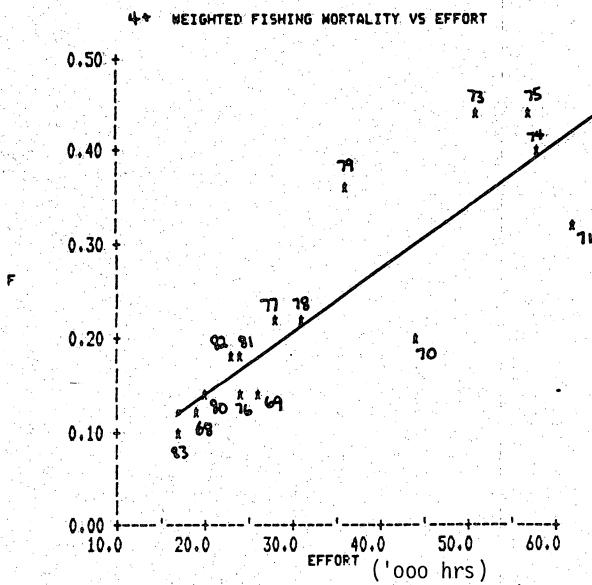


Fig. 5. Regression of 4+ weighted  $F$  from cohort ( $F_T = .4$ ) on fishing effort.  
Population size in 1983 is equal approximatley to the geometric mean.

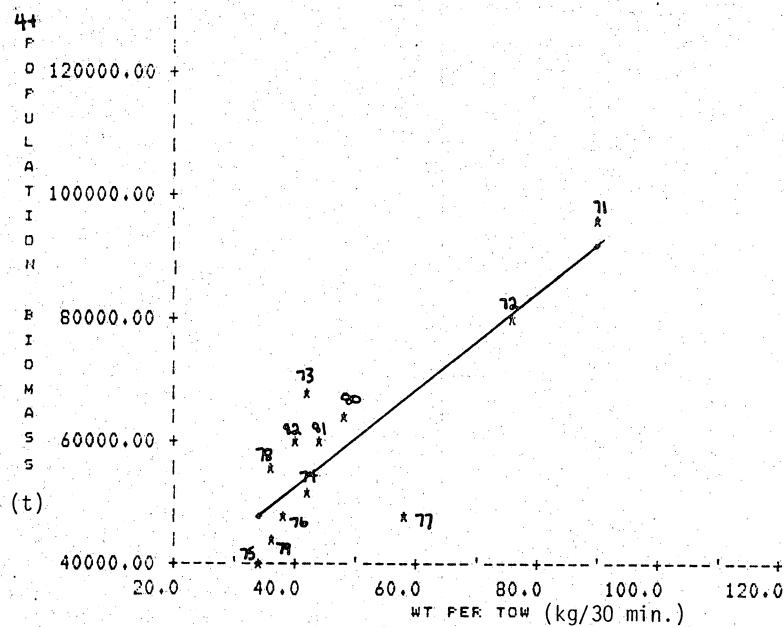


Fig. 6. Regression of 4+ midyear biomass from cohort ( $F_T = 0.4$ ) on mean weight per tow from selected strata in Divisions 3LN from Canadian research vessel surveys, 1971-82.

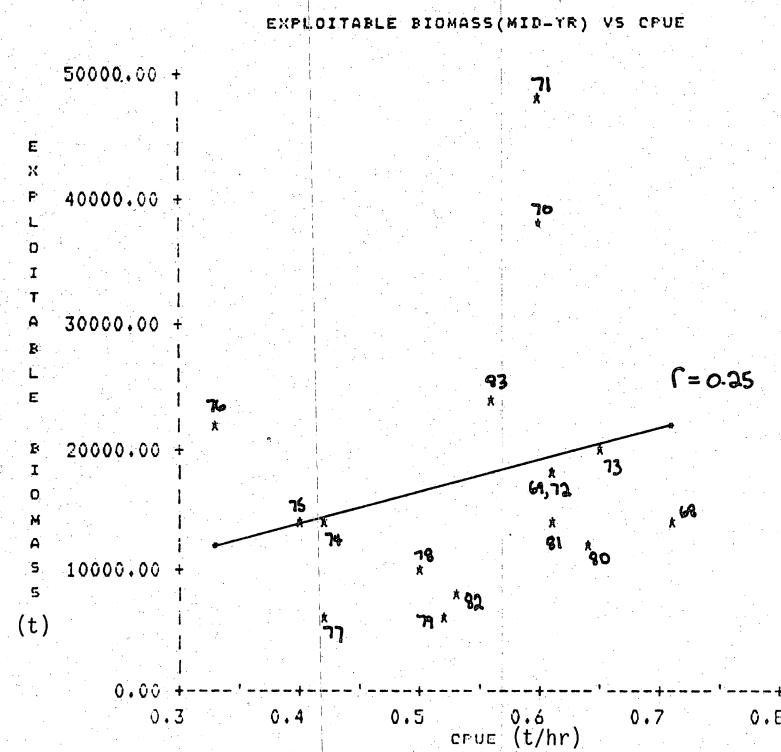


Fig. 7. Regression of midyear exploitable biomass from cohort analysis ( $F_T = 0.4$ ) on CPUE.

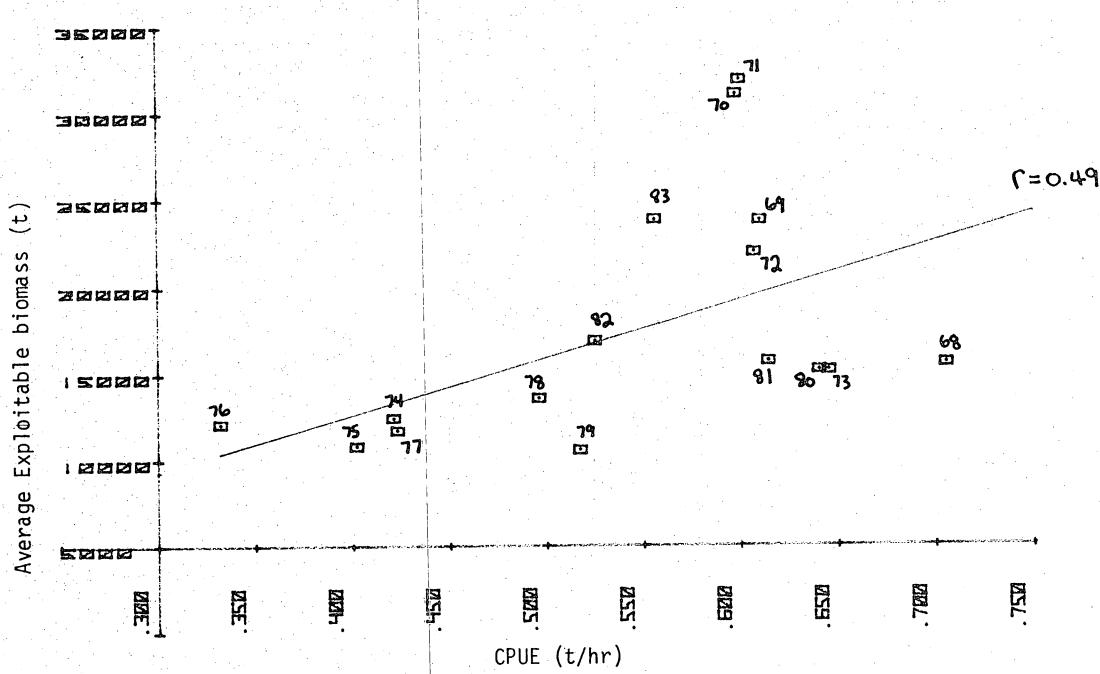


Fig. 8. Regression of midyear average exploitable biomass from cohort ( $F_T = 0.4$ ) on CPUE.

