Northwest Atlantic Fisheries Organization

Serial No. N999

NAFO SCR Doc. 85/50

SCIENTIFIC COUNCIL MEETING - JUNE 1985

An Assessment of the Yellowtail Flounder Stock in NAFO Div. 3L, 3N, and 3O

by

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INTRODUCTION

TAC regulation: This stock has been under TAC regulation since 1973, when a precautionary TAC of 50,000 t was set. The TAC was set at 9,000 t for 1976, following a decline in stock biomass, increased gradually to 23,000 t in 1982 and declined to 15,000 t for 1985 (Table 1). The TAC for this stock has not been caught since 1979 (Fig. 1).

Catch trends: The nominal catch of this stock increased steadily from the mid 1960s to a high of 39,000 t in 1972 (Table 1), 12,000 t of which was caught by USSR vessels. Since 1975 the fishery has been conducted almost exclusively by Canadian vessels, with the nominal catch averaging just under 13,000 t from 1976 to 1984. The reduced catches in 1983 and 1984 are due in part to financial and labor problems in the offshore trawler fleet.

The majority of the nominal catches of this stock have come from Div. 3N (Table 2). The catch in Div. 3L increased to over 5,000 t in 1984, which is the highest catch from this Division since 1972. Catches from Div. 3O have been relatively low in recent years.

The fishery for yellowtail is carried out mainly by stern otter trawlers (TC5), usually in conjunction with the American plaice fishery, and landings in most recent years have been spread over all 12 months (Table 3). Catches are usually higher in the fall months, although the pattern was different in 1984 due to a trawler strike in the latter half of the year.

Catch/effort: Catch rates of yellowtail by Can(N) TC 4 and 5 otter trawlers declined from a level of 0.6 t/hr in the 1969-72 period to approximately 0.4 t/hr in the 1974-77 period (Table 4, Fig. 2). Catch rates increased from 1976 until 1980, declined slightly to 1982 and have been between 0.53 and 0.56 t/hr in each of the last 3 years. Total fishing effort has been between 16,000 and 24,000 hours in each year since 1979. It should be noted that since 1981, about 50% of the total catch has been from the directed fishery, with the remainder being taken as by-catch, primarily in the American plaice fishery.

ASSESSMENT

Sampling: The length frequency and otolith samples used to calculate numbers and weights at age from the commercial fishery in 1984 are shown in Table 5.

Numbers caught at age: These were determined in the usual manner by applying quarterly age-length keys (sexes separate) to monthly length frequencies for each NAFO Div. separately. Total catch at age was then obtained by combining male and female numbers at age for Div. 3LNO. Table 6 contains the catch at age and associated statistics for 1984. Table 7 shows the catch at age for 1968-84 and Table 8 gives the corresponding proportions at age.

Table 8 shows that the catch at ages 4 and 5 has declined sharply since 1981. Also, in 1984 the catch at ages 6 and 7 represented almost 83% of the catch in numbers and approximately 78% of the catch in weight. Although there are no discarding estimates available by age for this stock, Stevenson (1983) noted a significant increase in the discard rate of small plaice from 1980 to 1982. Given the overlap of the plaice and yellowtail fisheries and the similarity of the products, it is quite likely that the discard rate for yellowtail aged 4 and 5 has increased as well. Because there are no actual estimates of discarding, the catch at age in Table 7 represents only the numbers landed, rather than the numbers actually caught.

Weights at age: These were determined for the 1984 catch in the usual manner by applying a length-weight equation (log weight = 3.4498 log length -5.768) to monthly average lengths at age. The average weights, presented in Table 6, were obtained by taking the mean of the monthly average weights at age, weighted by the numbers caught at age each month. The 1984 weights are similar to those calculated in recent years (Table 9). Table 10 contains the calculated catch biomass (numbers X weights) at age and the totals in virtually all years compare favorably with the nominal catches in Div. 3LNO.

Natural mortality: The value of 0.3, used in recent assessments, was retained.

Research vessel surveys: Stratified random surveys have been conducted by Canadian research vessels on the Grand Banks in the spring since 1971. The results from these surveys, in the form of mean weight per tow per stratum, is shown for Div. 3L, 3N, and 3O in Tables 12, 13, and 14 respectively. When considering the survey data for this stock, the following points should be taken into account:

1) The 1971-82 surveys were conducted by the research vessel A.T. Cameron.
2) There were no surveys in any of the 3 divisions in the spring of 1983.
3) The 1984 survey was conducted by the R.V. A. Needler and the 1985 survey was conducted by both the R.V. A. Needler and the R.V. W. Templeman.

Because of the limited spatial distribution and suspected sedentary nature of yellowtail on the Grand Banks, as well as the existance of significant gaps in survey coverage (Tables 12-14), a series of strata from Div. 3LN was selected to try and obtain an index of abundance which would be comparable across most years. The strata selected were those which showed consistently high yellowtail abundance and which were present in most surveys, with the exception of 1975, 1976, and 1981. The resulting series is shown in Table 15 and the strata selected can be seen in Fig. 3. It should be noted that comparisons of the yellowtail biomass from these strata with the stock biomass, in years where survey coverage is relatively complete, reveal that the selected strata biomass comprises about 70% of the total for Div. 3LN and about 40-60% of the total for Div. 3LNO. It should also be noted that the values for 1984 in Tables 12-15 and for 1985 in Table 13 were from vessel-gear combinations shown to be more efficient in catching yellowtail than the vessel-gear combination used in previous surveys (Gavaris and Brodie 1984).

Table 15 suggests a relatively stable biomass from 1978-82, with an increase in 1984. However, this increase may be due in part to the different vessel-gear used in 1984, as mentioned above. Also, survey data for Div. 3N in 1985 (Table 13) indicate a biomass level close to what was observed in the 1978-82 period. Because the survey data for 1985 from Div. 3L was not available at the time of writing, the comparable 1985 point could not be added to Table 15. However, all the mean weights per tow from the selected strata in Div. 3N declined from 1984 to 1985.

In an attempt to standardize the series with respect to vessel-gear combination, the age by age values for the Div. 3LN selected strata data from the R.V. A.T. Cameron were multiplied by 1.4 (Gavaris and Brodie 1984). Tables 16 and 17 show the mean number per set at age in actual and converted forms respectively. Tables 18 and 19 show the corresponding population estimates at age in actual and converted forms respectively. From these tables it can be seen that these surveys apparently do not adequately sample young (possibly up to age 6) yellowtail and thus cannot be used to estimate recruitment. As was noted in the previous assessment of this stock (Brodie and Pitt 1984), the abundance of yellowtail aged 7+ is significantly higher, on average, in the 1979-84 period compared to the 1972-76 period. Overall, the population estimates remained relatively stable (between 107 million and 145 million fish) in the 1978-82 period, and increased to 191 million in 1984 (Table 19). Unfortunately, no surveys exist for 1983 to corroborate this increase. However with the decline in biomass observed in 1985 in Div. 3N, it appears that the 1984 estimate may have been anomalously high.

Partial recruitment (PR): The significant change in the distribution of commercial catch at age in 1984, which was not present in the research vessel catch at age, suggested a change in the partial recruitment pattern in 1984. Therefore, calculation of PR by traditional methods such as long-term or short-term average F's did not seem appropriate. Additionally calculation of PR based on the ratio of commercial catch at age to research catch at age has never yielded realistic results for this stock, as was the case again this year. Finally, attempts to correlate numbers at age from previous cohort analyses with research vessel survey numbers at age to determine year-class strength was not sucessful, probably due to the effects of discarding on the commercial catch at age and the inability of the research vessel gear to adequately sample younger fish.

Given the relatively small number of ages which contribute significantly to the commercial catch, it was decided to examine the proportion at age matrix (Table 8) to see if a pattern similar to the 1984 catch at age distribution was present. It was felt that the 1969-71 proportions at age closely resembled those of 1984, with ages 4 and 5 contributing

less than 10% and ages 6 and 7 approximately 80% to the catch in numbers. Consequently, the average F's for 1969-71 from a preliminary cohort analysis were determined and the PR vector was calculated from these in the usual manner. This and various other PR vectors for this stock are shown in Table 11.

Calculation of the PR by the method described above has the obvious disadvantage of assuming that the removals at age in 1969-71 are reflective of the same population structure as the removals at age in 1984. Even if research vessel survey data existed for this period, it is unlikely, given the amount of fluctuation present in estimated year-class strengths from successive surveys, that accurate comparisons of population structure could be made.

A comparison of the current PR with the 1968-76 average PR (Table 11) shows the current value at age 5 to be significantly lower and the current value at age 6 to be marginally higher. Given the commercial catch at these ages in 1984, the absence of contradictory evidence from research vessel surveys and the failure of traditional methods to produce what could be considered as realistic values, PR 4 in Table 11 was felt to be the best available estimate of partial recruitment in 1984.

Terminal fishing mortality (F_T) in 1984

The pattern of very high mortalities at ages 7+ in previous years continues to emerge from cohort analysis on this stock. With the apparent increase in stock size since the mid 1970's, it was considered that such high values of F were unlikely and that significant declines in population numbers after age 7 could be due to reasons other than fishing mortality. In any event, it remains possible to calibrate the cohort analysis, over values of F in 1984 close to the $F_{0.1}$ value, using the output from cohort analysis regressed against commercial and research vessel survey abundance indices. Several methods were attempted in the calibration of the cohort analysis. Among those which produced non-significant linear regressions over a range of F_T values were exploitable biomass (ages 5+) from cohort vs CPUE and average 5+ exploitable biomass (calculated with an average selectivity vector, 1968-84) vs CPUE. The relationships which were used are presented in Table 20 and summarized below. In all 4 relationships, age 4 values were omitted from the calculations because of the sensitivity of the 1984 population value from cohort analysis to a slight change in partial recruitment. The first two regressions use all points from 1968 to 1984 and the last 2 regressions use the 1971-82 and 1984 points.

1) 5+ population biomass vs CPUE.

   The biomass estimates are midyear from cohort analysis and the CPUE values are those in Table 4. This relationship produced a maximum value for the correlation coefficient (r) of only 0.510, although the regressions were significant. The 1984 residual was lowest at F_T = 0.475, while the 1983 + 1984 residuals combined would be minimized at a value of F_T slightly over 0.50.

2) Age 5+ fishing mortality, weighted by population numbers from cohort vs fishing effort.

   This relationship showed r to be decreasing slightly over the range of F_T tested. However, in all cases both the 1983 and 1984 points were below the regression line, indicating a higher value for F_T.

3) Age 5+ cohort numbers vs age 5+ survey numbers.

   The cohort numbers are beginning of the year estimates and the survey numbers are from the spring research vessel surveys, with 1971-82 adjusted to account for the difference in fishing power of the vessels, as discussed previously. The correlation coefficient changed marginally over the range of F_T, reaching a peak of 0.818 at F_T = 0.45. The 1984 residual was minimized at a level of F_T between 0.40 and 0.45. There was no 1983 residual to examine and the 1982 (which is affected to a lesser extent by F_T) + 1984 residuals combined was minimized at a level of F_T between 0.45 and 0.475.

4) Age 5+ cohort numbers (midyear) vs age 5+ survey numbers.

   This relationship used midyear population estimates from cohort analyses against the same research vessel data described in 3 above. The correlation coefficient increased from 0.867 at F_T = 0.45 to 0.877 at F_T = 0.50. The 1984 residual was lowest at F_T = 0.475 and the 1982 + 84 residuals combined would be minimized at a value of F_T slightly over 0.50.

Plots of these 4 relationships from the cohort run at F_T = 0.475 are shown in Fig. 4-7 and results of the cohort analysis are shown in Table 21.

Yield per recruit

Using long-term PR and average weight values, Brodie and Pitt (1981) performed a Thompson-Bell yield per recruit calculation for this stock. The resulting $F_{0.1}$ value was

0.518 with yield per recruit equal to 0.186 kg. Applying this value to the geometric mean recruitment at age 4 of 90 X 10^6, calculated in the most recent assessment of this stock, a long-term yield of 16,700 t is obtained.

CONCLUSIONS

The analysis indicated a relatively stable stock size from 1978-82, with a slight increase to 1984. Hence, the very high values of fishing mortality at ages 7-10 from cohort analyses could not be rationalized. Based on this it was concluded that the analysis was not reliable enough to form the basis for catch projections, but that the cohort analysis was useful in indicating trends in population size. With both commerical and research vessel abundance indices showing relative stock stability, continuation of the 1985 TAC of 15,000 t is recommended for 1986.

REFERENCES

Brodie, W. B., and T. K. Pitt. 1981. An assessment of the yellowtail stock in Divisions 3LNO. NAFO SCR Doc. 81/VI/54, Ser. No. N338. 9 p.

1984. Yellowtail flounder in Divisions 3LNO - an assessment update. NAFO SCR Doc. 84/VI/49, Ser. No. N835. 13 p.

Gavaris, S., and W. B. Brodie. 1984. Results of comparative fishing between the A.T. Cameron and the Wilfred Templeman during July-August 1983. CAFSAC Res. Doc. 84/41. 16 p.

Stevenson, S. C. 1980. Summary of discarding and estimates of the total removals by Canadian trawlers in the American plaice fishery of Divisions 3LNO during 1978 and 1979. NAFO SCR Doc. 80/VI/86, Ser. No. N140. 10 p.

1981. Summary of discarding and estimates of total removals by Canadian trawlers during the 1980 Divisions 3LNO American plaice fishery. NAFO SCR Doc. 81/VI/55., Ser. No. N339. 8 p.

1982. Summary of discarding and estimates of total removals by Canadian trawlers during the 1981 Divisions 3LNO American plaice fishery. CAFSAC Res. Doc. 82/19. 9 p.

1983. Summary of discarding and estimates of total removals by Canadian (Newfoundland) trawlers during the 1982 Divisions 3LNO American plaice fishery. NAFO SCR Doc. 83/VI/27, Ser. No. N678. 7 p.

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

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	11,479	110	-	657	12,246	23,000
1983[a]	9,085	184	-	-	9,269	19,000
1984[a]	12,438	-	-	168	12,606	17,000
1985	-	-	-	-	-	15,000

[a]Provisional.

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

Year	3L	3N	3O	UNK	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	2,305	8,299	1,642	-	12,246
1983[a]	2,552	5,737	796	184	9,269
1984[a]	5,266	6,848	324	168	12,606

[a]Provisional.

Table 3. Breakdown of yellowtail nominal catches (t) by Division and month, for the years 1977-84.

Month	1977	1978	1979	1980	1981	1982	1983[a]	1984[a]
				3L				
Jan	-	1	-	-	1	-	-	5
Feb	21	2	-	-	-	-	2	-
Mar	13	-	165	-	2	-	-	13
Apr	9	5	195	-	101	3	31	367
May	113	184	621	715	1,024	24	100	2,164
June	668	1,230	778	864	309	918	568	1,154
July	731	473	452	233	503	711	533	1,212
Aug	790	423	256	65	153	154	611	290
Sept	127	175	79	11	134	96	253	21
Oct	163	50	43	9	65	255	227	6
Nov	15	-	3	-	9	51	165	26
Dec	-	4	3	1	44	93	62	8
TOTAL	2,651	2,547	2,595	1,898	2,345	2,305	2,552	5,266
				3N				
Jan	-	219	11	-	66	70	364	366
Feb	14	55	27	-	16	400	349	120
Mar	66	106	109	180	30	144	4	316
Apr	52	519	1,007	17	189	16	423	2,508
May	876	384	1,044	431	614	371	556	1,897
June	853	788	1,557	896	765	402	248	626
July	1,270	750	917	594	2,351	1,202	547	670
Aug	1,099	1,047	1,229	325	3,582	1,965	1,074	182
Sept	520	1,265	2,203	374	1,765	1,346	718	16
Oct	320	3,136	4,417	2,675	1,972	1,464	521	18
Nov	1,730	2,259	1,828	3,389	372	739	447	54
Dec	581	551	207	924	11	180	486	75
TOTAL	7,381	11,079	14,556	9,805	11,733	8,299	5,737	6,848
				30				
Jan	-	6	2	-	-	-	24	10
Feb	13	7	-	-	-	-	13	24
Mar	4	23	-	-	7	-	6	45
Apr	45	157	97	-	-	1	37	7
May	309	922	233	165	38	768	264	56
Jun	416	123	229	226	158	662	73	38
July	331	108	54	36	206	31	27	63
Aug	228	91	58	2	30	1	31	5
Sept	97	49	70	14	34	40	54	1
Oct	34	105	253	93	39	23	59	27
Nov	107	160	120	104	23	96	191	38
Dec	22	89	84	34	67	20	17	10
TOTAL	1,606	1,840	1,200	674	602	1,642	796	324

[a]Provisional.

Table 4. Nominal catch and effort data for yellowtail in NAFO Div 3LNO. 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	5,530	0.525	12,246	23,326
1983[a]	4,605	0.556	9,269	16,671
1984[a]	6,813	0.551	12,606	22,878

[a]Provisional.

Table 5. List of commercial samples, by quarter and Division, available for yellowtail flounder in Divisions 3LNO, 1984, as provided by the St. John's Commercial Sampling Section.

Division	Quarter 1	2	3	4	Total
3L Can(N) catch(t)	18	3,593	1,405	28	5,044
Samples	-	11	6	-	17
Measured	-	4,492	2,329	-	6,821
Otoliths	-	374	207	-	581
3N Can(N) catch(t)	802	5,020	808	48	6,678
Samples	7	15	2	2	26
Measured	3,305	6,927	801	876	11,909
Otoliths	405	475	110	159	1,149
30 Can(N) catch(t)	79	95	60	47	281
Samples	1	-	-	1	2
Measured	309	-	-	399	708
Otoliths	64	-	-	85	149

Table 6. Average weights and lengths, and catch at age with associated statistics for yellowtail in Divisions 3LNO in 1984.

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C.V.
4	0.206	29.643	97	19.86	0.21
5	0.303	33.113	1206	176.40	0.15
6	0.386	35.537	11022	399.66	0.04
7	0.511	38.558	12011	402.29	0.03
8	0.702	42.289	3293	174.39	0.05
9	1.040	47.446	235	25.47	0.11
10	1.207	49.530	9	3.91	0.45

TABLE 7. YELLOWTAIL, DIV 3LNO CATCH MATRIX(NOS X10^-3)

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
4	573	80	141	169	1943	3734	1375	955	409	1391	691	1061	1142	3245	97	22	97
5	6202	2993	2776	7534	10128	21280	19800	11240	2529	3211	3654	4783	5130	5077	1311	1843	1206
6	12483	15035	19839	30365	22502	23709	18100	20931	7650	6851	10979	13067	8383	8191	4580	6016	11022
7	9154	12076	20615	22117	19416	17053	11200	12737	5361	7331	11028	14284	7199	9991	7774	6964	12011
8	1421	3150	4557	5869	10553	4713	2400	2536	953	4078	3870	4940	1519	4361	6630	3483	3293
9	47	326	610	2152	4206	862	850	372	74	1433	310	773	224	356	1907	484	235
10	1	40	68	245	1110	300	130	23	15	289	34	109	28	29	268	22	9
4+	29881	33700	48606	68451	69858	71651	53855	48794	16991	24584	30566	39017	23625	31250	22567	18834	27873

TABLE 8. YELLOWTAIL,DIV 3LNO,CATCH AT AGE AS PROPORTION OF TOTAL

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
4	0.0192	0.0024	0.0029	0.0025	0.0278	0.0521	0.0255	0.0196	0.0241	0.0566	0.0226	0.0272	0.0483	0.1038	0.0043	0.0012	0.0035
5	0.2076	0.0888	0.0571	0.1101	0.1450	0.2970	0.3677	0.2304	0.1488	0.1306	0.1195	0.1226	0.2171	0.1625	0.0581	0.0979	0.0433
6	0.4178	0.4461	0.4082	0.4436	0.3221	0.3309	0.3361	0.4290	0.4502	0.2787	0.3592	0.3349	0.3548	0.2621	0.2030	0.3194	0.3954
7	0.3063	0.3583	0.4241	0.3231	0.2779	0.2380	0.2080	0.2610	0.3155	0.2982	0.3608	0.3661	0.3047	0.3197	0.3445	0.3698	0.4309
8	0.0476	0.0935	0.0938	0.0857	0.1511	0.0658	0.0446	0.0520	0.0561	0.1659	0.1266	0.1266	0.0643	0.1396	0.2938	0.1849	0.1181
9	0.0016	0.0097	0.0125	0.0314	0.0602	0.0120	0.0158	0.0076	0.0044	0.0583	0.0101	0.0198	0.0095	0.0114	0.0845	0.0257	0.0084
10	0.0000	0.0012	0.0014	0.0036	0.0159	0.0042	0.0024	0.0005	0.0009	0.0118	0.0011	0.0028	0.0012	0.0009	0.0119	0.0012	0.0003

TABLE 9. YELLOWTAIL,DIV 3LNO,WEIGHT AT AGE MATRIX(KG)

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
4	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	0.206
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	0.308	0.292	0.338	0.303
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	0.349	0.346	0.420	0.386
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	0.496	0.486	0.530	0.511
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	0.661	0.675	0.680	0.702
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	0.909	0.933	0.944	1.040
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	1.207

TABLE 10. YELLOWTAIL,DIV 3LNO,CALCULATED CATCH BIOMASS AT AGE(T)

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
4	142	20	35	42	480	922	275	176	82	298	172	189	309	740	23	5	20
5	1892	913	847	2298	3089	6490	5940	3350	814	1040	1151	1330	1406	1564	383	623	365
6	5692	6856	9047	13846	10261	10811	8181	9419	3718	2802	4721	4939	4133	2859	1585	2527	4254
7	5584	7366	12575	13491	11844	10402	6720	7247	3297	3900	6143	7199	4571	4956	3778	3691	6138
8	1030	2284	3304	4255	7651	3417	1740	1884	776	2643	2864	3300	1139	2883	4475	2368	2312
9	40	274	514	1812	3541	726	716	355	76	1159	304	608	208	324	1779	457	244
10	1	41	70	252	1143	309	134	26	18	262	42	82	34	34	349	29	11
4+	14380	17754	26391	35997	38009	33078	23706	22456	8781	12104	15397	17648	11800	13358	12373	9699	13344

Table 11. Comparison of various partial recruitment vectors for yellowtail in Divisions 3LNØ.

Age	PR1	PR2	PR3	PR4
4	.010	.010	.018	.002
5	.090	.130	.077	.071
6	.360	.460	.331	.510
7	.780	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000

PR1 calculated from average F's, 1968-83. Used in 1984 assessment in cohort analysis as well as projections.

PR2 calculated from average F's, 1968-76. Calculated in 1981 (Brodie and Pitt 1981) and used in the calculation of $F_{0.1}$ = 0.518 for this stock.

PR3 calculated from average F's, 1981-84, in an iterative model.

PR4 calculated from average F's, 1969-71. Used in cohort analysis in this paper.

Table 12. Mean weight of yellowtail per tow, by stratum, from research vesel surveys in Div. 3L. Numbers in parentheses are the number of successful 30 minute tows in each stratum. The stratified mean weight per tow and the biomas estimates, along with their approximate 95% confidence limits are given at the bottom of the table.

		Year - Trip												
(FM) Depth	Stratum	1971 ATC 187	1972 ATC 199	1973 ATC 207-9	1974 ATC 222	1975 ATC 233	1976 ATC 245-6	1977 ATC 262-3	1978 ATC 276-7	1979 ATC 289-91	1980 ATC 303-5	1981 ATC 317-9	1982 ATC 327-9	1984 AN 27-28
51-100	328	-	-	-	-	-	-	0.0(3)	-	0.0(5)	-	0.0(2)	0.0(3)	0.0(2)
51-100	341	-	-	0.0(3)	-	-	-	0.1(4)	0.1(4)	0.0(6)	0.0(6)	0.0(2)	0.0(5)	0.0(4)
51-100	342	-	-	-	-	-	-	0.0(2)	0.0(2)	0.0(4)	0.0(4)	-	0.0(3)	0.0(4)
51-100	343	-	-	-	-	-	-	0.0(2)	0.0(3)	0.0(4)	0.0(4)	0.0(2)	0.0(4)	-
101-150	344	-	-	-	-	-	0.0(4)	0.0(4)	0.0(4)	0.0(2)	0.0(3)	0.0(5)	0.0(4)	-
151-200	345	-	-	-	-	-	0.0(4)	0.0(4)	0.0(2)	0.0(4)	0.0(5)	0.0(4)	0.0(4)	-
151-200	346	-	-	-	-	0.0(2)	0.0(2)	0.0(3)	-	0.0(4)	0.0(3)	0.0(3)	0.0(3)	-
101-150	347	0.0(2)	-	-	0.0(2)	0.0(2)	0.0(3)	0.0(3)	0.0(4)	0.0(4)	0.0(5)	0.0(4)	0.0(2)	-
51-100	348	0.0(3)	0.0(3)	-	0.0(6)	0.0(4)	0.0(6)	0.0(6)	0.0(6)	0.0(6)	0.0(7)	0.0(7)	0.0(4)	-
51-100	349	4.8(3)	0.0(4)	-	0.0(4)	0.0(2)	0.2(3)	0.0(6)	0.0(6)	0.0(7)	0.0(9)	0.0(4)	0.0(6)	0.1(6)
31-50	350	32.2(3)	2.3(2)	0.0(4)	0.2(3)	0.0(3)	0.2(4)	3.8(4)	1.5(6)	1.1(9)	1.1(10)	0.3(3)	0.6(7)	1.5(6)
31-50	363	119.8(3)	21.3(3)	12.5(4)	0.5(4)	1.0(3)	2.5(4)	27.4(5)	6.3(5)	22.3(8)	39.3(5)	3.0(3)	30.4(5)	28.2(5)
51-100	364	13.7(4)	0.0(3)	-	0.0(4)	0.0(2)	0.0(3)	0.2(7)	0.1(6)	0.1(8)	0.4(6)	0.0(3)	0.0(6)	0.6(5)
51-100	365	0.0(3)	0.0(2)	-	0.0(3)	0.0(2)	0.0(3)	0.0(3)	0.0(2)	0.0(4)	0.0(4)	0.0(2)	0.0(3)	-
101-150	366	0.0(3)	-	-	0.0(3)	0.0(4)	0.0(4)	0.0(4)	-	0.0(4)	0.0(4)	0.0(3)	0.0(5)	-
151-200	368	0.0(2)	-	-	0.0(2)	0.0(2)	0.0(3)	0.0(3)	-	0.0(4)	0.0(2)	0.0(2)	0.0(2)	-
101-150	369	0.0(3)	-	-	0.0(3)	0.0(3)	0.0(4)	0.0(3)	0.0(2)	0.0(4)	0.0(3)	0.0(2)	0.0(2)	-
51-100	370	1.4(2)	0.3(3)	-	0.0(3)	0.0(3)	0.0(3)	0.5(3)	0.2(3)	0.0(4)	0.0(3)	0.0(2)	0.0(2)	-
31-50	371	88.5(3)	6.4(2)	-	0.0(3)	-	-	1.4(3)	0.3(3)	0.5(3)	0.5(3)	0.0(2)	1.1(4)	-
31-50	372	135.3(4)	28.1(3)	39.6(3)	7.1(3)	7.6(3)	44.2(3)	32.1(6)	20.5(7)	24.3(9)	25.0(6)	13.3(4)	19.8(6)	59.4(5)
31-50	384	86.0(3)	3.0(2)	2.3(3)	0.6(3)	-	-	7.0(2)	0.0(3)	1.5(4)	0.0(2)	0.4(2)	10.3(2)	-
51-100	385	0.0(4)	0.0(4)	0.2(3)	0.0(2)	0.0(4)	0.0(2)	0.0(6)	0.0(6)	0.0(7)	0.0(4)	0.0(3)	0.0(3)	-
101-150	386	0.0(2)	-	-	0.0(3)	0.0(3)	0.0(2)	0.0(3)	0.0(3)	0.0(4)	0.0(3)	0.0(2)	0.0(3)	-
151-200	387	0.0(3)	-	-	0.0(3)	0.0(2)	0.0(3)	0.0(2)	0.0(3)	0.0(4)	0.0(2)	0.0(2)	0.0(3)	-
151-200	388	0.0(2)	-	0.0(2)	0.0(3)	0.0(2)	0.0(2)	0.0(2)	0.0(2)	0.0(3)	0.0(2)	0.0(2)	0.0(2)	-
101-150	389	0.0(3)	0.0(2)	0.0(2)	0.0(3)	0.0(2)	0.0(2)	0.0(3)	0.0(3)	0.0(4)	0.0(3)	0.0(2)	0.0(2)	-
51-100	390	0.3(3)	0.0(3)	0.0(3)	0.0(3)	0.0(3)	-	0.0(2)	0.0(4)	0.0(5)	0.0(3)	0.0(2)	0.8(4)	-
101-150	391	-	0.0(2)	0.0(2)	0.0(3)	0.0(2)	-	0.0(2)	0.0(2)	0.0(4)	0.0(2)	0.0(2)	0.0(2)	-
151-200	392	-	-	0.0(3)	0.0(4)	0.0(2)	-	0.0(2)	0.0(3)	0.0(2)	0.0(2)	0.0(2)	0.0(2)	-
201-300	729	-	-	-	-	-	-	-	-	-	-	-	-	-
301-400	730	-	-	-	-	-	-	-	-	-	-	-	-	-
201-300	731	-	-	-	-	-	-	-	-	-	-	-	-	-
301-400	732	-	-	-	-	-	-	-	-	-	-	-	-	-
201-300	733	-	-	-	-	-	-	-	-	-	-	-	-	-
301-400	734	-	-	-	-	-	-	-	-	-	-	-	-	-
201-300	735	-	-	-	-	-	-	-	-	-	-	0.0(2)	-	-
301-400	736	-	-	-	-	-	-	-	-	-	-	-	-	-
	Upper	43.3	10.9	13.7	1.7	2.4	10.4	7.4	4.1	4.6	6.1	2.6	5.4	23.4
Mean(no.sets)		30.3(58)	5.4(38)	8.5(32)	0.7(70)	0.7(55)	4.0(64)	4.0(102)	2.0(94)	2.8(140)	3.8(115)	1.1(80)	3.2(103)	13.5(37)
	Lower	17.3	-0.2	3.2	-0.4	-0.9	-2.4	0.5	-0.1	1.1	1.6	-0.4	1.0	3.5
	Upper	92.2	18.8	14.9	3.7	4.9	22.1	20.5	10.1	12.6	16.0	7.0	15.0	26.3
Biomass('000t)		64.5	9.2	9.2	1.4	1.5	8.5	11.0	4.9	7.8	10.2	2.9	8.8	15.1
	Lower	36.8	-0.4	3.5	-0.8	-1.9	-5.0	1.5	-0.2	3.0	4.3	-1.2	2.7	4.0

Table 13. Mean weight of yellowtail per tow, by stratum, from research vessel surveys in Division 3N. Numbers in parentheses are the number of successful 30 minute tows in each stratum. The stratified mean weight per tow and the biomass estimates, along with their approximate 95% confidence limits are given at the bottom of the table.

(FM) Depth	Stratum	Year - Trip 1971 ATC 187	1972 ATC 199	1973 ATC 207-9	1974 ATC 222	1975 ATC 233	1976 ATC 245-6	1977 ATC 262-3	1978 ATC 276-7	1979 ATC 289-91	1980 ATC 303-5	1981 ATC 317-9	1982 ATC 327-9	1984 AN 27-28	1985 AN 43 WT 29
151-200	357	-	-	0.0(2)	-	-	-	0.0(2)	-	0.0(3)	0.0(3)	0.0(2)	0.0(2)	0.0(2)	0.0(2)
101-150	358	-	0.0(4)	0.0(3)	-	-	-	0.0(2)	-	0.0(2)	0.0(3)	0.0(3)	0.0(2)	0.0(2)	0.0(2)
51-100	359	-	0.0(3)	0.0(3)	-	-	0.0(3)	0.0(2)	-	0.0(4)	0.0(4)	0.0(3)	0.0(2)	0.0(2)	0.0(2)
31-50	360	-	58.3(4)	-	-	12.1(4)	128.6(4)	55.9(4)	43.5(4)	27.6(9)	83.8(11)	78.4(6)	36.7(7)	124.1(7)	54.0(16)
31-50	361	45.8(2)	115.8(3)	93.4(4)	151.5(4)	105.3(4)	113.0(5)	141.5(3)	122.8(4)	92.3(8)	128.4(7)	-	118.9(6)	139.9(5)	67.1(7)
31-50	362	140.2(2)	132.8(4)	22.1(5)	38.9(4)	33.3(3)	44.1(5)	62.4(5)	28.8(4)	40.3(12)	53.6(11)	104.2(5)	47.2(8)	95.1(7)	36.6(11)
31-50	373	73.6(4)	135.1(4)	26.7(4)	24.2(4)	-	23.3(5)	74.5(4)	50.5(5)	22.1(11)	48.1(8)	58.4(5)	23.7(5)	63.5(7)	32.0(9)
31-50	374	67.8(2)	42.4(2)	115.4(4)	16.1(2)	62.1(2)	-	22.4(3)	22.0(3)	24.8(4)	39.0(3)	71.7(3)	19.1(4)	35.5(3)	25.3(4)
<30	375	60.0(3)	69.0(3)	121.9(3)	94.5(3)	80.3(3)	-	62.7(4)	30.6(5)	66.1(5)	57.8(4)	69.3(4)	61.1(5)	176.1(5)	97.8(8)
<30	376	-	45.4(2)	10.3(3)	-	82.1(2)	126.4(3)	78.3(3)	4.6(2)	86.4(4)	125.3(3)	74.3(4)	63.0(7)	32.5(4)	78.5(7)
51-100	377	-	0.0(2)	0.0(2)	0.0(3)	0.0(2)	-	0.0(2)	0.0(2)	0.0(3)	0.0(4)	0.0(3)	0.0(2)	0.0(2)	0.0(2)
101-150	378	0.0(2)	0.0(2)	0.0(2)	0.2(3)	-	-	0.0(2)	1.4(2)	0.0(3)	0.0(2)	0.0(2)	0.0(2)	0.0(2)	0.0(2)
151-200	379	-	-	0.0(2)	0.0(3)	-	-	0.0(2)	0.3(2)	0.0(3)	0.0(3)	0.0(3)	0.0(2)	0.0(2)	0.0(2)
151-200	380	-	0.0(2)	0.0(3)	0.0(2)	-	-	0.0(2)	-	0.0(2)	0.0(3)	0.0(3)	-	0.0(2)	0.0(2)
101-150	381	0.0(4)	0.5(4)	0.0(3)	0.0(4)	0.0(2)	-	0.0(2)	0.0(3)	0.0(3)	0.5(4)	0.0(3)	0.0(2)	0.0(2)	0.0(2)
51-100	382	0.0(3)	0.0(4)	0.0(3)	0.0(3)	-	0.0(2)	0.0(3)	0.0(3)	0.0(3)	0.0(4)	0.0(2)	0.0(2)	0.0(3)	0.0(4)
31-50	383	18.6(2)	7.3(2)	0.1(2)	0.0(2)	-	0.0(3)	2.7(3)	0.0(2)	0.0(3)	0.5(4)	1.3(3)	10.0(2)	1.8(3)	0.0(3)
201-300	723	-	-	-	-	-	-	-	-	-	-	-	-	-	-
301-400	724	-	-	-	-	-	-	-	-	-	-	-	-	-	-
201-300	725	-	-	-	-	-	-	-	-	-	-	-	-	-	-
301-400	726	-	-	-	-	-	-	-	-	-	-	-	-	-	-
201-300	727	-	-	-	-	-	-	-	-	-	-	-	-	-	-
301-400	728	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Upper	89.3	108.3	64.7	72.6	164.6	91.7	83.7	59.7	55.1	79.4	91.4	53.7	113.8	57.3
Mean (no. sets)		71.9(24)	78.4(45)	44.8(48)	53.2(37)	53.5(22)	72.7(30)	60.8(48)	40.2(41)	40.1(82)	63.6(81)	63.0(54)	43.8(60)	83.5(60)	45.3(85)
	Lower	54.5	48.4	24.9	33.8	-57.7	53.6	37.9	20.7	25.1	47.8	34.6	33.9	53.3	33.3
	Upper	74.1	133.4	66.5	62.2	144.2	90.3	104.8	70.6	69.0	99.5	101.7	66.7	142.5	71.7
Biomass ('000t)		59.7	96.6	46.0	45.4	46.8	71.6	76.2	47.6	50.2	79.7	70.1	54.4	104.6	56.7
	Lower	45.2	59.7	25.5	28.8	-50.5	52.8	47.5	24.5	31.4	59.9	38.5	42.1	66.8	41.7

Table 14. Mean weight of yellowtail per tow, by stratum, from research vessel surveys in Division 30. Numbers in parentheses are the number of successful 30 minute tows in each stratum. The stratified mean weight per tow and the biomass estimates, along with their approximate 95% confidence limits are given at the bottom of the table.

		Year - Trip																					
		1973		1975		1976		1977		1978		1979		1980		1981		1982		1984		1985	
		207										289		303		317		327					
(fm)		208				245		262		276		290		304		318		328		27			
Depth	STRATUM	ATC	209	ATC	233	ATC	246	ATC	263	ATC	277	ATC	291	ATC	305	ATC	319	ATC	329	AN	28	AN	43
51-100	329	0.0	(2)	-		0.0	(2)	0.0	(3)	0.2	(5)	0.0	(6)	0.0	(2)	0.0	(2)	0.0	(6)	0.0	(5)	0.0	(8)
31-50	330	0.1	(6)	1.1	(3)	0.2	(3)	2.0	(3)	5.6	(6)	10.0	(7)	0.0	(2)	0.1	(4)	1.9	(7)	0.5	(4)	7.8	(10)
31-50	331	33.6	(2)	0.4	(2)	9.2	(2)	-		7.3	(2)	6.0	(3)	3.5	(2)	-		4.0	(4)	23.8	(3)	36.7	(3)
51-100	332	-		3.2	(2)	2.0	(3)	11.5	(3)	2.6	(3)	2.0	(4)	0.0	(2)	-		0.3	(4)	0.0	(2)	0.3	(5)
101-150	333	-		0.0	(2)	0.0	(2)	0.0	(2)	0.0	(3)	0.0	(2)	0.0	(2)	-		0.0	(4)	0.0	(2)	0.0	(2)
151-200	334	-		-		0.0	(2)	0.0	(2)	0.0	(3)	0.0	(3)	0.0	(2)	-		0.0	(4)	0.0	(2)	0.0	(2)
151-200	335	0.0	(2)	-		0.0	(3)	-		0.0	(2)	0.0	(2)	0.0	(3)	-		0.0	(2)	0.0	(2)	0.0	(2)
101-150	336	0.0	(3)	0.0	(2)	0.0	(2)	0.0	(2)	0.0	(2)	0.0	(4)	0.0	(2)	-		0.0	(2)	0.0	(2)	0.0	(2)
51-100	337	0.2	(3)	1.3	(3)	4.5	(2)	6.6	(2)	0.0	(2)	0.6	(4)	0.0	(3)	-		0.3	(3)	0.0	(2)	0.0	(5)
31-50	338	33.7	(5)	7.5	(2)	9.1	(3)	23.8	(4)	2.3	(5)	54.1	(7)	23.0	(5)	-		1.0	(5)	15.8	(5)	11.1	(9)
51-100	339	1.4	(2)	0.0	(2)	-		-		0.7	(2)	0.4	(3)	-		0.0	(2)	0.1	(4)	0.4	(2)	0.1	(3)
31-50	340	-		0.6	(3)	2.4	(6)	22.2	(3)	10.2	(3)	32.8	(7)	1.3	(2)	15.0	(3)	3.9	(6)	3.0	(4)	7.2	(9)
31-50	351	31.2	(5)	29.3	(4)	15.7	(4)	80.6	(5)	26.4	(6)	78.5	(11)	68.2	(10)	51.0	(4)	34.2	(9)	40.5	(6)	42.3	(9)
31-50	352	47.5	(5)	55.5	(4)	62.0	(4)	76.6	(5)	92.2	(4)	79.7	(12)	67.3	(11)	-		40.3	(7)	30.5	(7)	29.7	(11)
31-50	353	0.5	(3)	43.9	(3)	9.1	(2)	41.7	(3)	8.5	(3)	68.6	(5)	0.4	(4)	-		4.5	(3)	1.0	(2)	56.3	(6)
51-100	354	0.0	(3)	-		4.8	(3)	3.6	(2)	-		0.0	(4)	0.0	(3)	0.0	(2)	0.0	(2)	0.0	(2)	0.5	(3)
101-150	355	0.0	(2)	0.0	(2)	0.0	(2)	-		-		0.0	(4)	0.0	(2)	0.0	(2)	0.0	(2)	0.0	(2)	0.0	(2)
151-200	356	0.0	(2)	-		-		-		-		0.0	(2)	0.0	(2)	0.0	(2)	-		0.0	(2)	0.0	(2)
201-300	717	-		-		-		-		-		-		-		-		-		-		-	
301-400	718	-		-		-		-		-		-		-		-		-		-		-	
201-300	719	-		-		-		-		-		-		-		-		-		-		-	
301-400	720	-		-		-		-		-		-		-		-		-		-		-	
201-300	721	-		-		-		-		-		-		-		-		-		-		-	
301-400	722	-		-		-		-		-		-		-		-		-		-		-	
Upper		29.0		29.4		19.2		43.0		48.9		49.6		30.7		51.2		15.9		21.1		24.6	
Mean (no. sets)		19.0	(45)	19.1	(34)	14.2	(45)	33.8	(39)	20.6	(51)	37.8	(90)	22.7	(59)	16.7	(21)	11.8	(74)	12.8	(56)	18.0	(93)
Lower		8.9		8.7		9.3		24.5		-7.7		26.0		14.8		-17.9		7.7		4.5		11.4	
Upper		32.5		34.2		24.9		53.7		63.3		66.7		39.9		35.6		21.3		28.3		33.1	
Biomass ('000t)		21.2		22.2		18.4		42.1		26.7		50.8		29.5		11.6		15.8		17.2		24.2	
Lower		9.9		10.1		12.0		30.6		-10.0		34.9		19.2		-12.4		10.4		6.1		15.3	

Table 15. Average numbers and weights of yellowtail per 30 minute set for selected strata in Divisions 3LN. Abundance and biomass estimates, with their respective 95% confidence limits, are given at the bottom of the table. 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	1984
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		334.20
	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		139.90
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		229.57
	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		95.05
363	No. sets	3	3	4	4	3	4	5	5	8	5	3	5		5
	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		56.20
	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		28.20
372	No. sets	4	3	3	3	3	3	6	7	9	6	4	6		5
	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		119.20
	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		59.40
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		133.86
	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		379.20
	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		171.61
	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		76.95
Abundance (millions nos.)	Upper	293.2	324.5	150.6	138.4	97.6	153.4	214.9	150.5	112.7	146.4	124.9	146.8		251.1
		226.6	210.9	113.4	102.5	75.4	101.5	151.5	97.8	84.2	114.7	76.7	113.8		190.6
	Lower	159.9	97.3	76.1	66.5	53.3	49.6	88.1	45.1	55.7	83.0	28.5	80.7		130.1
Biomass ('000t)	Upper	126.8	119.5	60.6	62.0	43.0	49.5	85.7	60.3	55.3	69.4	67.8	55.8		111.7
		100.0	83.4	45.8	45.7	32.1	37.0	63.3	40.6	40.2	54.0	41.9	45.1		85.5
	Lower	73.1	47.3	30.9	29.4	21.1	24.4	40.8	20.9	25.1	38.6	16.1	34.4		59.2

Table 16. Average number per set at age and totals for yellowtail from Canadian research vessel surveys in Divisions 3LN (selected strata).

Age	Year												
	1971	1972	1973	1974	1975[a]	1976[a]	1977	1978	1979	1980	1981[a]	1982	1984
1	-	-	-	-	-	-	-	-	-	-	-	0.01	-
2	-	-	-	0.08	-	-	-	0.07	0.02	0.01	-	0.48	-
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	0.15
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	1.88
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	14.32
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	51.02
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	71.33
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	30.69
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	2.38
10	0.04	0.06	0.32	-	0.05	-	1.70	0.02	0.24	0.03	1.52	0.70	0.03
11	-	-	-	-	-	0.04	0.13	-	-	-	-	0.09	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-
UNK	-	-	-	-	-	-	-	-	0.02	0.04	0.03	-	-
Average number (1+) per set	204.52	188.06	102.07	93.25	78.33	85.84	119.57	88.25	75.96	93.02	78.94	95.62	171.80

[a]Survey coverage incomplete, see Table 15.

Table 17. Average number per set at age and totals for yellowtail from Canadian research vessel surveys in Divisions 3LN (selected strata). Estimates from the surveys conducted by the R.V. A. T. Cameron have been adjusted upward by a factor of 1.4.

	Year - Trip												
	1971	1972	1973	1974	1975[a]	1976[a]	1977	1978	1979	1980	1981[a]	1982	1984
Age (yrs)	ATC187	ATC199	208 ATC209	ATC222	ATC233	245 ATC246	262 ATC263	276 ATC277	289 ATC290	304 ATC305	317 318 ATC319	327 328 ATC329	27 AN 28
1	-	-	-	-	-	-	-	-	-	-	-	0.01	-
2	-	-	-	0.11	-	-	-	0.10	0.03	0.01	-	0.67	-
3	2.02	5.00	0.34	1.13	0.27	1.53	0.11	1.48	0.36	1.92	0.45	2.63	0.15
4	23.69	37.51	4.84	10.04	4.58	6.47	1.74	5.18	2.38	4.23	0.80	8.97	1.88
5	53.33	73.86	32.03	32.23	22.95	28.90	10.57	19.89	4.98	14.49	3.56	18.42	14.32
6	100.28	84.92	41.33	55.29	33.11	39.51	25.75	36.76	19.84	37.39	15.30	26.74	51.02
7	90.85	45.81	42.28	27.90	38.26	36.23	68.67	38.14	51.16	53.51	39.14	41.64	71.33
8	12.22	14.56	16.14	3.36	9.38	7.34	56.32	19.89	24.37	17.37	41.20	27.03	30.69
9	3.89	1.54	5.49	0.49	1.05	0.15	15.68	2.07	2.86	1.20	7.90	6.64	2.38
10	0.06	0.08	0.45	-	0.07	0.0	2.38	0.03	0.34	0.04	2.13	0.98	0.03
11	-	-	-	-	-	0.01	0.18	-	-	-	0.0	0.13	-
12	-	-	-	-	-	-	0.03	-	-	-	0.06	-	-
UNK	-	-	-	-	-	-	-	-	0.03	0.06	0.04	-	-
Totals	286.34	263.28	142.90	130.55	109.67	120.14	181.43	123.54	106.35	130.22	110.58	133.86	171.80

[a]Survey coverage incomplete, see Table 15.

Table 18. Abundance (nos. x 10^{-3}) of yellowtail, by age from Canadian research vessel surveys in Divisions 3LN (selected strata).

Age	Year												
	1971	1972	1973	1974	1975[a]	1976[a]	1977	1978	1979	1980	1981[a]	1982	1984
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	169
4	18,797	29,756	3,844	7,966	3,015	5,134	1,383	4,111	1,889	3,355	556	7,116	2,087
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	15,901
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	56,668
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	79,224
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	34,093
9	3,090	1,222	4,355	391	688	120	12,437	1,640	2,261	950	5,455	5,268	2,647
10	42	71	360	-	46	0	1,889	17	269	30	1,479	773	32
11	-	-	-	-	-	16	143	-	-	-	-	100	-
12	-	-	-	-	-	-	21	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	24	56	42	-	-
Totals													
1+	227,161	208,895	113,366	103,578	72,181	95,322	143,936	98,023	84,371	103,333	77,057	106,208	190,821
4+	225,562	204,930	113,102	102,595	72,007	94,110	143,843	96,919	84,060	101,793	76,743	103,569	190,652
7+	84,899	49,190	51,060	25,188	32,094	34,710	113,652	47,701	62,453	57,222	63,051	60,622	115,996

[a]Survey coverage incomplete, see Table 15.

Table 19. Abundance (nos. x 10^{-3}) of yellowtail, by age, from Canadian research vessel surveys in Divisions 3LN (selected strata). Estimates from surveys conducted by the R.V. A. T. Cameron have been adjusted upward by a factor of 1.4.

	Year - Trip												
	1971	1972	1973	1974	1975[a]	1976[a]	1977	1978	1979	1980	1981[a]	1982	1984
Age (yrs)	ATC187	ATC199	208 ATC209	ATC222	ATC 233	245 ATC246	262 ATC263	276 ATC277	289 ATC290	304 ATC305	317 318 ATC319	327 328 ATC329	27 AN 28
1	-	-	-	-	-	-	-	-	-	-	-	16	-
2	-	-	-	124	-	-	-	106	34	22	-	752	-
3	2,239	5,551	369	1,252	243	1,697	130	1,651	402	2,135	439	2,926	169
4	26,316	41,658	5,381	11,153	4,221	7,188	1,936	5,755	2,645	4,697	778	9,962	2,087
5	59,225	82,045	35,573	35,794	21,145	32,089	11,737	22,103	5,540	16,087	3,460	20,460	15,901
6	111,386	94,332	45,905	61,410	30,512	43,882	28,595	40,834	22,032	41,536	14,874	29,704	56,668
7	100,907	50,878	46,958	30,988	35,261	40,250	76,267	42,361	56,825	59,436	38,033	46,246	79,224
8	13,568	16,179	17,925	3,728	8,643	8,154	62,561	22,100	27,068	19,303	40,029	30,028	34,093
9	4,326	1,711	6,098	547	963	168	17,411	2,297	3,165	1,330	7,668	7,375	2,647
10	58	99	504	-	64	-	2,645	24	377	42	2,072	1,083	32
11	-	-	-	-	-	23	200	-	-	-	0	141	-
12	-	-	-	-	-	-	30	-	-	-	48	-	-
Unknown	-	-	-	-	-	-	-	-	24	56	42	-	-
Totals													
1+	318,025	292,453	158,713	144,996	101,052	133,451	201,512	137,231	118,112	144,644	107,443	148,693	190,821
4+	315,886	286,902	158,344	143,620	100,809	131,754	201,382	135,474	117,676	142,487	107,004	144,999	190,652
7+	118,959	68,867	71,485	35,263	44,931	48,595	159,114	66,782	87,459	80,167	87,892	84,873	115,996

[a]Survey coverage incomplete, see Table 15.

Table 20. Results of cohort analysis calibration, Divisions 3LNO yellowtail.

Regression	parameter	F_t 0.400	0.450	0.475	0.500
Age 5+ population biomass (midyear) vs CPUE, 1968-84	r	0.507	0.510	0.509	0.506
	intercept	4706	4257	4069	3899
	slope	78006	77240	76917	76627
	1984 residual	+7797	+2502	+273	-1734
	1983 residual	+11812	+7350	+5473	+3785
Age 5+ fishing mortality (wtd. by pop. nos.) vs fishing effort, 1968-84	r	0.828	0.822	0.819	0.815
	intercept	0.069	0.082	0.089	0.095
	slope	0.009	0.009	0.009	0.009
	1984 residual	-0.067	-0.046	-0.036	-0.025
	1983 residual	-0.069	-0.061	-0.057	-0.053
Age 5+ population numbers (beg. of year)vs Age 5+ pop. nos. from r.v. surveys (1971-82, 1984)	r	0.812	0.818	0.815	0.811
	intercept	62489	60936	60283	59698
	slope	530	526	524	522
	1984 residual	+10132	-4796	-11076	-16725
	1982 residual	+17126	+10286	+7413	+4833
Age 5+ population numbers (mid-year) vs Age 5+ pop. nos from r.v. surveys (1971-82, 1984)	r		0.867	0.874	0.877
	intercept		45580	45016	44511
	slope		364	362	360
	1984 residual		+6180	+721	-4191
	1982 residual		+15113	+12628	+10396

Table 21. Results of cohort analysis for Divisions 3LNØ yellowtail at F_t = 0.475.

POPULATION NUMBERS (x10⁻3)

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
4	156799	147013	119893	110606	121784	113143	75629	71640	79211	82512	82861	65456	71963	107939	110405	56798	139095
5	109297	115666	108841	88697	81794	88548	80604	54844	52250	58329	59929	60790	47578	52328	77170	81707	42058
6	53827	75631	83112	78242	59224	51877	47282	42671	30955	36531	40447	41252	40918	30831	34396	56041	58944
7	18231	29132	43088	44495	31828	24507	18025	19448	13596	16348	21166	20514	19313	23097	15790	21539	36338
8	2460	5627	11187	14177	13926	6867	3477	3713	3445	5458	5801	6188	2903	8111	8512	5006	9963
9	149	599	1457	4366	5451	1234	1031	510	568	1732	533	966	333	843	2255	599	711
10	2	70	163	555	1382	418	172	32	58	357	50	128	51	54	318	30	27
4+	340763	373738	367742	341138	315389	286593	226220	192859	180083	201267	210788	195295	183058	223204	248847	221720	287136
5+	183965	226725	247849	230532	193605	173450	150591	121219	100872	118755	127927	129840	111095	115265	138441	164922	148040
6+	74668	111058	139008	141834	111811	84903	69987	66375	48622	60426	67997	69049	63517	62936	61271	83215	105982
7+	20841	35427	55896	63592	52587	33026	22705	23704	17667	23895	27550	27798	22599	32106	26875	27174	47039

MIDYEAR POPULATION NUMBERS(x10⁻3)

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
4	135191	126972	103513	95476	104285	95956	64681	61436	68238	70620	71257	56042	61625	91696	95337	49060	120124
5	91433	98494	92702	72971	65704	65771	59641	41767	43923	48844	50011	50200	38601	42737	66043	69707	35760
6	40224	57842	61806	51602	39345	32023	31331	25421	22879	28153	29362	28908	31163	22478	27468	45480	45498
7	10722	18750	26008	26316	16276	10769	9059	9246	8916	10179	12180	9007	12912	14611	9388	15014	25286
8	1317	3086	7249	9129	5237	3078	1546	1675	2491	2118	2697	2003	1666	4575	2982	2201	6933
9	104	335	934	2594	1960	539	288	208	454	473	284	310	153	539	513	185	495
10	1	38	106	351	513	187	72	14	43	131	23	41	28	31	106	13	19
4+	278992	305518	292317	258440	233320	208323	166617	139767	146945	160518	165814	146512	146149	176666	201837	181659	234115
5+	143801	178545	188804	162964	129035	112367	101936	78331	78707	89898	94557	90470	84524	84970	106499	132600	113991
6+	52368	80051	96103	89992	63331	46596	42296	36564	34784	41054	44547	40270	45923	42233	40456	62893	78231
7+	12144	22210	34297	38390	23986	14573	10964	11143	11904	12901	15185	11362	14760	19755	12989	17413	32733

POPULATION BIOMASS (MID-YEAR) (TONS)

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
4	33392	31362	25568	23583	25758	23701	12936	11304	13648	15113	17743	9975	16700	20907	22690	10303	24746
5	27887	30041	28274	22256	20040	20060	17892	12447	14143	15825	15753	13956	10577	13163	19285	23561	10835
6	18342	26376	28183	23531	17941	14602	14162	11439	11119	11515	12626	10927	15363	7845	9504	19102	17562
7	6540	11437	15865	16053	9928	6569	5435	5261	5484	5415	6784	4539	8199	7247	4563	7958	12921
8	955	2238	5256	6619	3797	2231	1121	1245	2028	1372	1996	1338	1250	3024	2013	1496	4867
9	88	282	787	2184	1650	454	242	198	468	383	279	244	142	490	479	175	515
10	1	39	109	361	529	192	74	16	51	118	29	31	35	36	138	16	23
4+	87205	101775	104041	94586	79644	67811	51862	41910	46940	49742	55210	41012	52266	52712	58671	62610	71469
5+	53813	70413	78473	71004	53885	44109	38926	30606	33292	34629	37467	31036	35565	31805	35980	52308	46723
6+	25926	40372	50199	48747	33846	24049	21034	18159	19149	18804	21714	17080	24989	18642	16696	28747	35888
7+	7584	13997	22016	25217	15904	9447	6872	6720	8030	7289	9088	6153	9625	10797	7192	9645	18325

FISHING MORTALITY

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
4	0.004	0.001	0.001	0.002	0.019	0.039	0.021	0.016	0.006	0.020	0.010	0.019	0.019	0.036	0.001	0.000	0.001
5	0.068	0.031	0.030	0.104	0.155	0.327	0.336	0.272	0.058	0.066	0.073	0.096	0.134	0.120	0.020	0.027	0.034
6	0.314	0.263	0.325	0.599	0.582	0.757	0.588	0.844	0.338	0.246	0.379	0.459	0.272	0.369	0.168	0.133	0.242
7	0.876	0.657	0.812	0.862	1.234	1.653	1.280	1.431	0.613	0.736	0.930	1.655	0.568	0.698	0.849	0.471	0.475
8	1.112	1.051	0.641	0.656	2.124	1.596	1.619	1.577	0.388	2.026	1.492	2.624	0.936	0.980	2.354	1.652	0.475
9	0.458	1.000	0.666	0.850	2.268	1.669	3.171	1.877	0.164	3.253	1.125	2.650	1.526	0.674	4.036	2.791	0.475
10	1.061	1.046	0.644	0.698	2.162	1.607	1.818	1.609	0.353	2.212	1.455	2.627	0.983	0.947	2.538	1.758	0.475

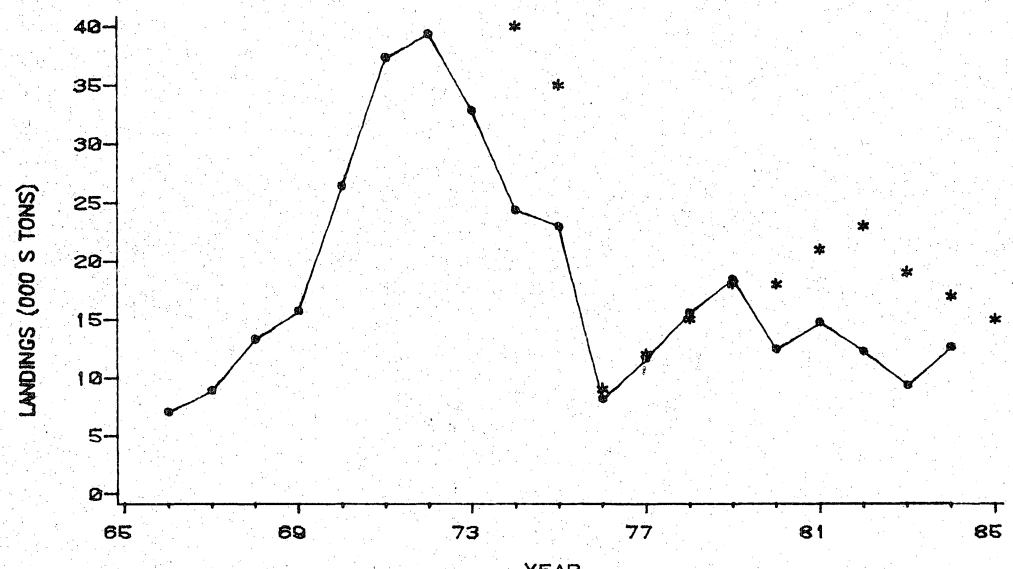

FIG. 1. LANDINGS OF YELLOWTAIL IN NAFO DIVISIONS 3LNO FOR THE YEARS 1966-84 AND TACS FOR 1973-85 (TACS DENOTED BY ASTERISKS).

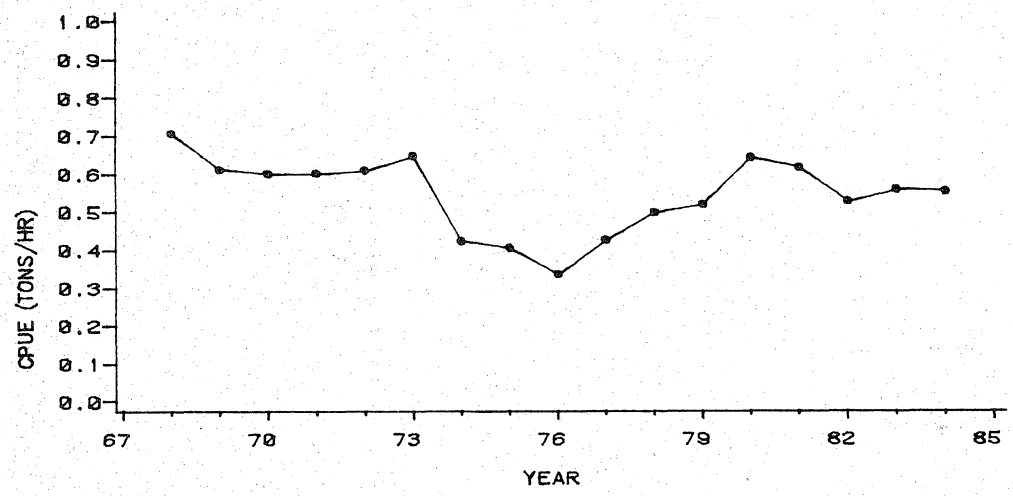

FIG. 2. CATCH RATES OF YELLOWTAIL BY CAN(N) TRAWLERS(TC4&5) IN NAFO DIVISIONS 3LNO FOR THE YEARS 1968-84.

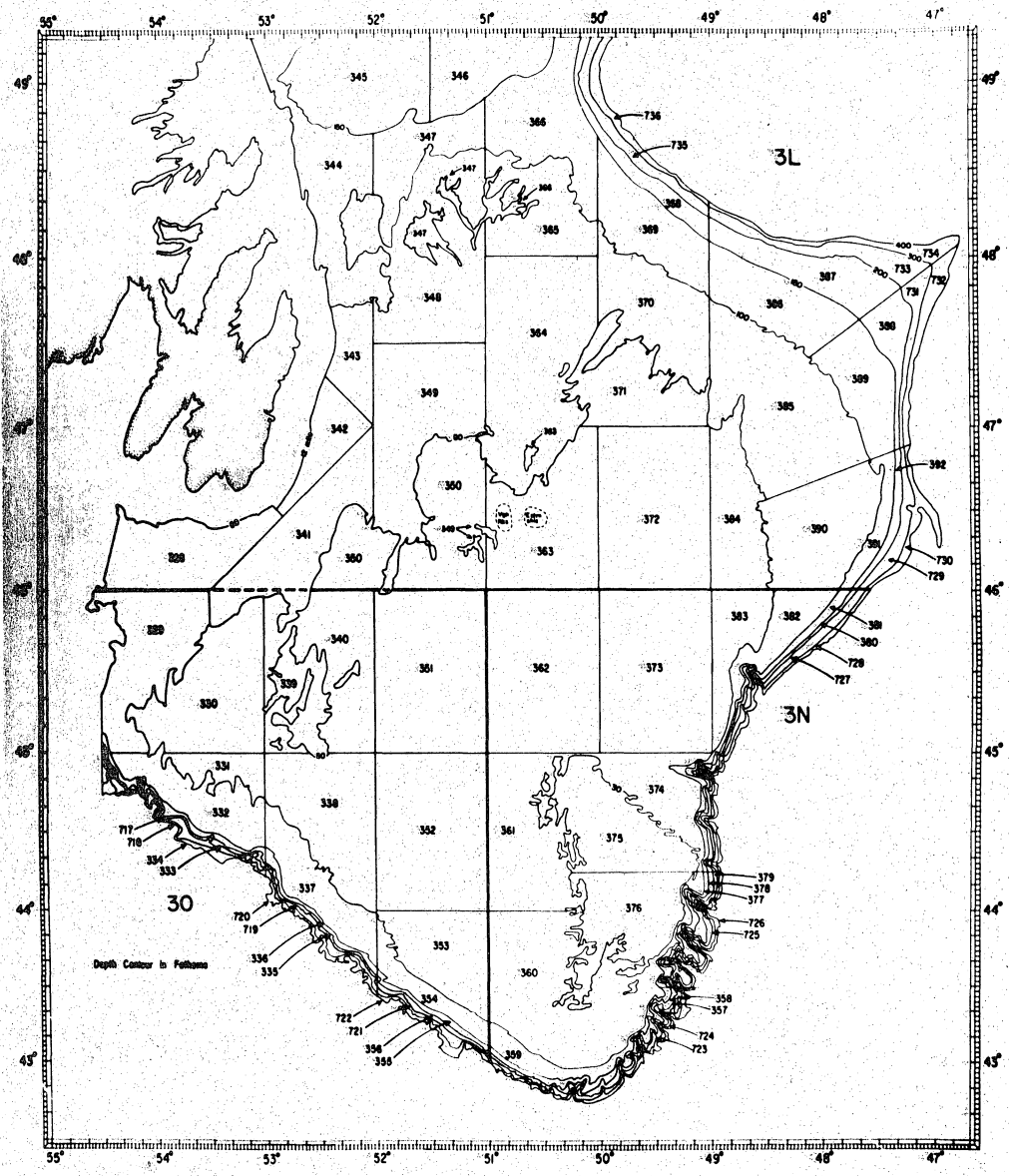

Fig. 3. Strata used in Canadian research vessel surveys in NAFO Divisions 3LNØ.

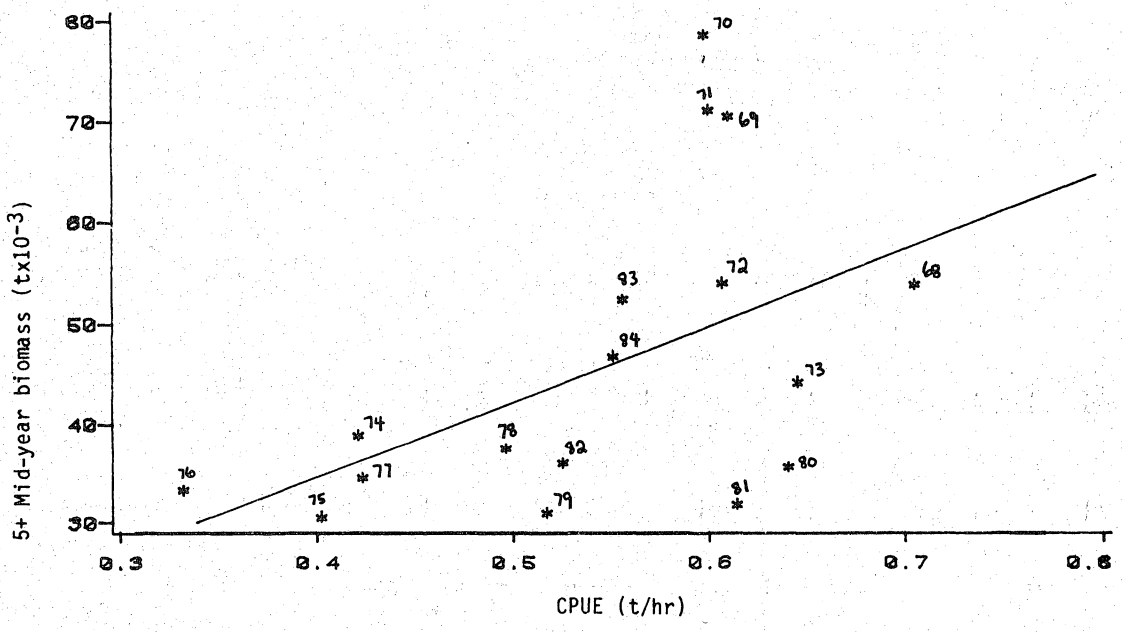

FIG. 4. MIDYEAR BIOMASS(AGE 5+) FROM COHORT(FT=.475) VS CPUE FOR YELLOWTAIL, NAFO DIV. 3LNO, FOR THE YEARS 1968-84.

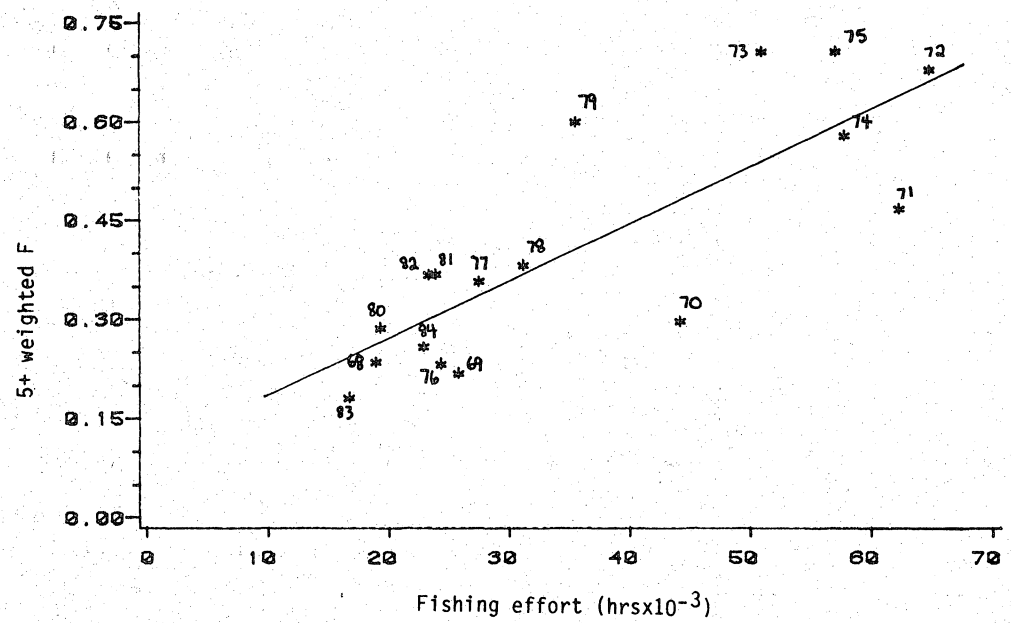

FIG. 5. AVG. 5+ FISHING MORTALITY FROM COHORT(FT=.475), WEIGHTED BY POPULATION NUMBERS VS FISHING EFFORT, FOR THE YEARS 1968-84.

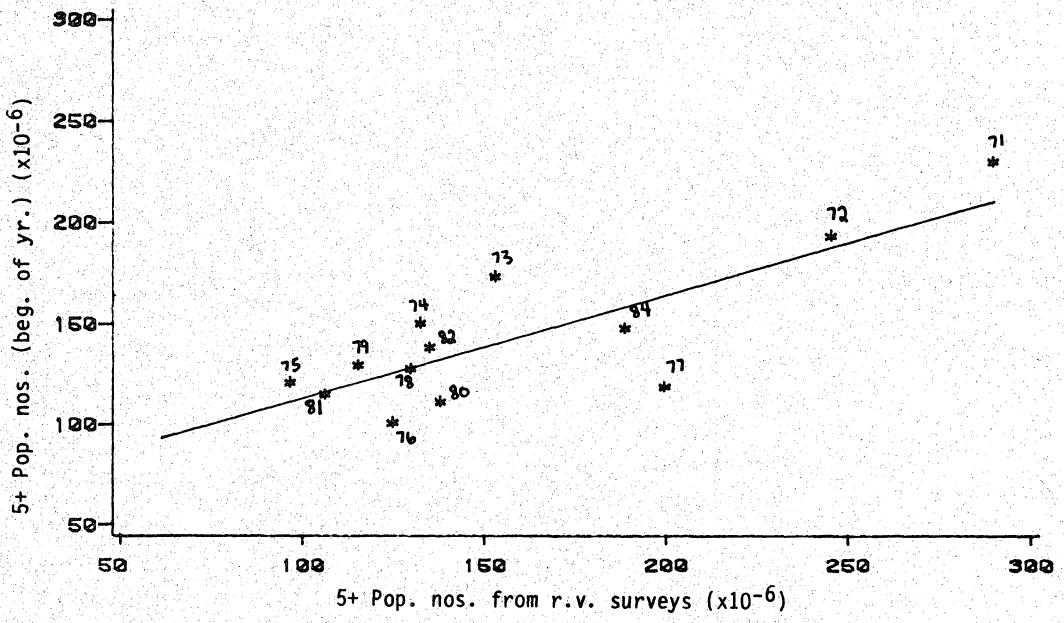

FIG. 6. 5+ POPULATION NOS(BEGINNING OF YR) FROM COHORT(FT.475) VS 5+ POPULATION NOS FROM R.V. SURVEYS, FOR THE YEARS 1971-84 (1971-82 R.V. DATA MULTIPLIED BY 1.4).

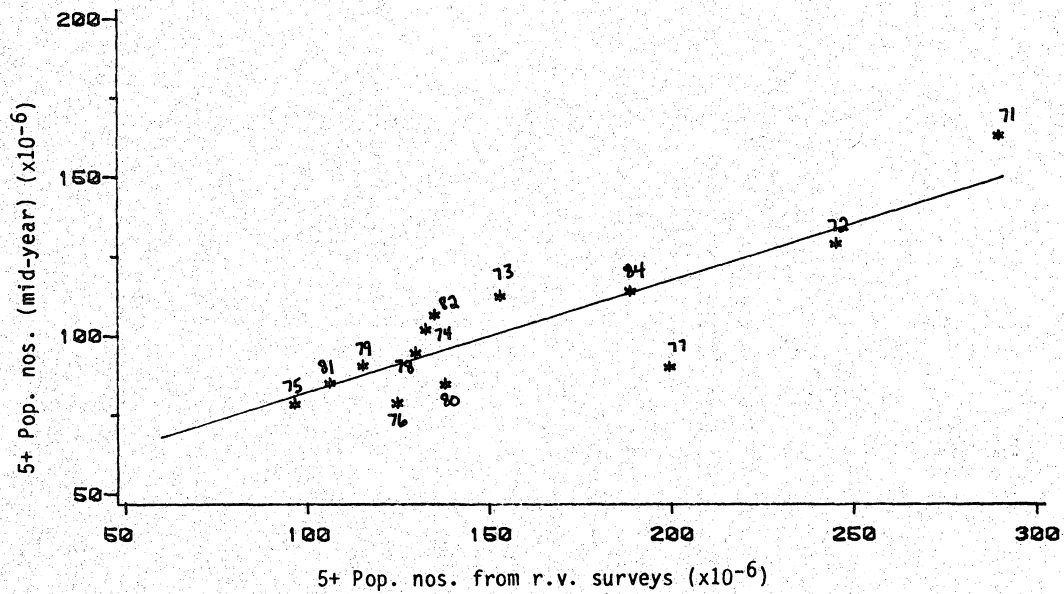

FIG. 7. 5+ POPULATION NOS(MID-YEAR) FROM COHORT(FT.475) VS 5+ POPULATION NOS FROM R.V. SURVEYS, FOR THE YEARS 1971-84 (1971-82 R.V. DATA MULTIPLIED BY 1.4).