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Aspects of American Plaice Distribution in NAFO Divisions 3L, 3N and 3O

by

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Introduction

This paper examines the following features relating to the distribution of American plaice (Hippoglossoides platessoides) in the Grand Bank area:

1) Juvenile flatfish surveys:

A Canadian research survey on the Grand Banks in 1986, using a small mesh shrimp trawl, landed several large catches of 1-4 year old plaice in the southern area of the Grand Bank. This prompted a re-examination of distribution of juvenile American plaice in the southeast area of the Grand Bank. The results are presented in this paper.

2) Distribution by depth in the 1981-86 period:

At the recommendation of STACFIS in 1986 (NAFO Redbook, 1986), analysis of research vessel survey data was conducted to determine if changes in distribution of A. plaice by depth had occurred in recent years. To augment this analysis, trends in CPUE from the commercial fishery were also examined.

3) Occurrence of high CPUE levels in research vessel surveys:

In April, 1987, several large catches of A. plaice were taken on the northeast slope of the Grand Bank by the research vessel W. TEMPLEMAN, fishing in depths of about 520 m. The magnitude of the catches as well as the depth at which they were obtained were considered unusual and prompted further investigation and comparison with historical values in the research vessel and commercial catch rate series. These results are examined in this paper.

Materials and Methods

1) Juvenile flatfish surveys:

Stratified-random surveys were conducted by the Canadian research vessel W. TEMPLEMAN in 1985 and 1986 in NAFO Div. 3LNO. The surveys concentrated on strata inside the 100 m depth contour. The fishing gear used was a Yankee 41 (80/104) shrimp trawl. Each 30 minute set was made at a towing speed of 2.5 knots. Estimates of numbers at age were generated using STRAP Program (Smith and Somerton, 1981).

2) Distribution by depth:

Stratified-random research vessel surveys, conducted by the Canadian research vessel W. TEMPLEMAN at various times in 1984-86 in NAFO Div. 3L were examined. Biomass estimates were obtained in the usual fashion (Smith and Somerton, 1981) by combining all strata in similar depth ranges (Fig. 1). Further information on the distribution of sets by stratum in each of these surveys may be obtained in the 1987 assessment of A. plaice in Divs. 3LNO (Brodie, 1987).

Catch rate data from Canadian (Newfoundland) offshore trawlers directing for A. plaice in Div. 3L was examined for the 1981-86 period. Catch and effort were summed over virtually the same depth ranges used to calculate the biomass estimates from the r.v. surveys.

3) Occurrence of large catches, CPUE value:

A total of 11,861 catches of A. plaice from Canadian r.v. surveys over the 1948-87 period in Divs. 3LNO were examined. These sets were conducted by many different vessel-gear combinations throughout the period. Analysis of these catches was conducted to determine the number of catches greater than 1000 kg per 30 minute tow and to see if any trends existed in the location, time, depth, bottom temperature, etc. of these particular sets. Because many of the sets from the r.v. surveys are not from a stratified-random design, the unit area grid shown in Fig. 2 was used to analyze the location of these sets.

Commercial CPUE data, Divs. 3LNO, 1956-86, from the source described previously, were analyzed to determine areas and times of high catch rates of A. plaice. To permit a further breakdown of area beyond NAFO division, the statistical reporting areas shown in Fig. 3 were used in the analysis.

Results and discussion

1) Juvenile flatfish surveys:

Figure 4 shows the distribution of juvenile plaice ages 1-4 year old in comparison with the adult population on the plateau of the Grand Bank, NAFO Divs. 3LNO. Abundance estimates of juveniles were low in most areas sampled in 1985 and 1986. In 1985 only Stratum 384 in Div. 3L and Stratum 360 in Div. 3N showed any amount of concentrations of juveniles. In 1986, the survey was more extensive in its coverage and high concentrations of juvenile and young adults were found in Stratum 353 (Div. 3Ø) and Stratum 360 (Div. 3N) (Table 1, Fig. 4).

The stratified mean number per tow for Stratum 353 was 794 fish while for Stratum 360 it was 1823 fish (Table 2). In 1986 the overall average number per set was over twice that of 1985 mainly due to more extensive coverage in the survey. Table 3 compares the abundance estimates derived from Strata 353 and 360. Stratum 360 accounts for 59% and Stratum 353 accounts for 11% of the total abundance estimate of 942 million fish. Most of these abundance estimates are made up of ages 1-4 year old juvenile plaice (Tables 3 and 4).

Walsh (1982) reported on the distribution of juvenile and adult American plaice on the Grand Banks. He found catches of 1 and 2 year old plaice were extremely low and 3 and 4-year olds only slightly better due to the inefficiency of the bottom trawl used in the Candian surveys from 1971 to 1980. These large concentrations of juvenile plaice, mixed with the adult population, on the southern Grand Bank may be a nursery area supplying the southern Grand Bank population. This mixing of two age groups may result in juveniles being more vulnerable to exploitation by the commercial fishery.

2) Distribution by depth:

Table 5 contains the results of the 1984-86 surveys in Div. 3L. These surveys were chosen because, with the exception of 1986 spring, coverage extends beyond the 200 fath (366 m) range. Although there are deviations from the averages, it is difficult to discern trends in the distribution of biomass by depth over seasons. On average, the shallower strata (31-100 fath; 55-183 m) contained about 80% of the A. plaice biomass, with less than 4% found in water deeper than 151 fath. The 1986 winter value of 15% for biomass deeper than 150 fath is anomalous in that the total for this survey was only 49,000 t, compared to 226,000 and 174,000 in the adjacent surveys. The 1985 spring survey did show a substantially higher biomass beyond 200 fath (366 m) than did any other survey. Unfortunately, the series of stratified-random surveys conducted on the Grand Bank by Canada from 1971 to 1987 did not cover depths greater than 200 fath (366 m) in any year other than 1985, thus precluding comparisons of the spring 1985 value for deep strata. Overall, the 8 surveys examined here indicate that there was no noticeable movement of A. plaice to deeper water in the 1984-86 period.

Table 6, which shows the commercial CPUE patterns from 1981-86 by depth, also indicates that there has been no shift of effort for A. plaice into deeper water in recent years. In fact, there has been virtually no effort in waters deeper than 150 fath (274 m) in Div. 3L since 1982. In the 1983-86 years, which are comparable in terms of total directed catch, the catch has come primarily from the shallowest depth zone, and was approximately equal to the catch from the next two depth ranges. There are no apparent trends in the CPUE values by depth, with the high 1985 value for the 0-50 fath (0-91 m) range affected significantly by a CPUE value in March of about 2800 t/650 hrs.

3) Occurrence of large catch, CPUE values:

From the 11,861 r.v. catches of A. plaice examined, only 33 (0.28%) had more than 1000.0 kg per 30 minutes towed; 16 were in Div. 3L and 17 in Div. 3N, with 3 of the catches in Div. 3L being taken in a survey in April 1987. One of these contained 3752 kg, the second largest catch of A. plaice in the data set (3756 was the largest). These 3 catches in April 1987, plus one of 947 kg in the same survey, were taken at separate locations in unit T25 (Fig. 3), at average depths between 514 and 520 m, and bottom temperatures around 3.1-3.6°C. Prior to these observations, the deepest catch with more than 1000 kg/30 min. was taken in 278 m in Unit U32, Div. 3N, 1960, and consisted of 2197 kg of A. plaice. Of the 30 catches prior to 1987 greater than 1000 kg/30 min., only 5 were in temperatures greater than 1.0°C (max. 2.7°C) with 15 being less than 0.0°C (min. -1.5°C). On only one other occasion did a survey locate 3 or more catches of A. plaice in excess of 1000 kg/30 min., that being in 1968, Unit U32, Div. 3N, in depths between 148 and 223 m, average catch 1384 kg.

For further comparison, all sets from the 11,861 - set database which occurred in Unit T25 were selected. A total of 42 sets, ranging in depths from 216-630 m were found, and excluding the catches in 1987 survey, the largest catch of A. plaice was 69 kg. As well, the largest catch from all (44) sets in Divs. 3LNO beyond 500 m was only 41 kg, with the largest catch from depths greater than 400 m (112 sets) being only 83 kg/30 min. tow prior to the April 1987 catches.

Some biological information was collected from the April, 1987 large catches. The A. plaice in these sets were about 80% female, mostly in the 32-45 cm size range. Fish were found in the immature, early pre-spawning, and post-spawning maturity stages in the same catches, and few if any in a ready-to-spawn condition, indicating that the concentration was unlikely of a pre-spawning or spawning nature. Furthermore, a random sample of about 30 fish from one set showed all fish with empty stomachs, meaning that the concentration was not likely to be feeding oriented.

Examination of the commercial CPUE data from 1956 to 1986 also revealed that concentrations of A. plaice permitting consistent catch rates of 2 t/hr were not common. In fact, only one year-unit-month combination which met this criterion was found, that being 1985, Unit 3Lr, March (Fig. 2), with 2800 t caught in 650 hrs fishing for a CPUE of 4.3 t/hr. Most of this unit area is in the 31-50 fath range, and it is interesting to note that a r.v. survey in January 1985 recorded two large catches in an adjacent area, averaging 2100 kg/30 min. (4.2 t/hr). While other instances of high CPUE did exist, most were of short duration, with total catches rarely exceeding 300 t in areas/times when CPUE values were greater than 2 t/hr. While the 1987 CPUE data are not yet available, it is known that several commercial vessels proceeded to the area of concentration observed in April and obtained high catch rates of A. plaice as well as other groundfish species.

In summary, it can be said that the concentration of A. plaice observed in the deep water in 1987 is most unusual. There has been no published information to suggest that A. plaice occupy these depths in significant numbers, nor is there any evidence from the survey or commercial databases to suggest this has occurred previously. Although large concentrations are occasionally located, the Canadian data do not show any in depths of 500 m or more, where both depth and temperature were thought previously to be well outside the preferred range for A. plaice (Pitt, 1966). From the limited biological sampling of the large catches, no conclusions can be reached on the reason for the fish to be concentrating, i.e. feeding or spawning, often observed for other species, but not believed to occur in the Grand Bank A. plaice stock (Pitt, 1966).

References

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Table 1. Mean catch per tow of juvenile and adult American plaice from juvenile surveys of the Grand Bank, 1985 and 1986.

Division	Stratum	1 Year	2 Year	3 Year	4 Year	>4 Year
			1985			
3Ø	351	4.09	4.20	3.39	2.32	52.00
3L	350	0.09	0.21	0.24	0.32	42.74
	363	2.53	8.44	5.13	3.85	141.05
	371	5.13	9.49	5.33	4.84	227.23
	372	0.37	0.51	0.42	0.74	96.23
	384	20.81	50.49	22.71	8.47	180.02
3N	360	24.79	66.08	32.64	11.07	53.41
	361	0.76	2.57	2.25	0.91	25.18
	362	1.28	3.84	3.19	2.56	52.91
	373	3.47	12.23	9.87	7.23	360.58
	374	10.45	23.82	12.67	6.84	93.46
	375	0.0	0.05	0.11	0.07	57.49
	376	2.05	2.02	0.63	0.28	55.02
	383	10.78	26.03	17.71	11.26	169.98
			1986			
3Ø	338	1.35	5.73	4.55	1.17	21.20
	351	10.93	9.04	6.96	5.08	49.12
	352	11.00	10.28	12.00	7.21	48.35
	353	280.19	191.35	132.70	54.65	131.56
3L	350	0.71	0.27	0.17	0.57	104.96
	363	5.34	5.05	5.19	6.42	96.41
	372	2.46	1.82	1.49	1.82	100.92
3N	360	483.81	486.80	396.98	173.58	205.92
	361	3.44	1.93	2.92	2.09	20.26
	362	0.83	3.41	4.39	4.49	49.30
	373	1.83	2.57	3.76	4.88	169.90
	374	8.29	57.09	57.61	37.88	247.74
	375	0.28	0.33	0.17	0.14	22.72
	376	7.62	17.64	20.00	10.24	166.00

Table 2. Comparison of average number and average weight per stratum of American plaice from juvenile surveys in 1985 and 1986.

		1985			1986	
Division	Stratum	No. of sets	Ave. no./set	Av. wt./set	No. of sets	Av. no./set	Av. wt./set
	338	-	-	-	3	33.00	15.50
	350	5	43.60	39.80	6	106.67	93.92
	351	3	66.00	35.00	9	81.33	36.28
	352	-	-		13	88.62	37.30
	353	-	-		5	794.00	51.33
	360	3	189.67	29.00	14	1823.93	86.67
	361	6	31.50	24.17	8	29.88	19.69
	362	9	63.78	37.72	7	62.57	34.71
	363	5	161.00	56.30	5	119.40	42.61
	371	4	252.00	102.13	-	-	-
	372	9	98.28	72.09	8	108.50	90.38
	373	10	399.80	313.34	7	182.93	139.68
	374	4	147.25	62.63	4	408.50	218.25
	375	7	57.71	67.43	5	24.38	31.98
	376	2	60.00	45.00	4	221.75	284.31
	383	4	236.00	75.63	-	-	-
	384	4	282.25	105.45	-	-	-
	Total	75	142.50	77.73	98	319.21	76.88

Table 3. A comparison of numbers at age and abundance estimates (nos. x 10^{-3}) of American plaice for Stratum 353 and 360 with all strata: Juvenile survey inside 100 m depth contour 1986.

Age	Stratum 353 - Div. 3O	Stratum 360 - Div. 3N	All Strata - Divs. 3LNO
1	38,182	153,870	203,554
2	26,075	154,823	199,285
3	18,083	126,257	163,494
4	7,447	55,206	76,370
5	3,023	20,013	34,011
6	4,833	22,691	49,697
7	4,157	11,993	44,088
8	2,108	4,882	39,134
9	1,250	2,208	34,633
10	941	1,141	30,719
11	624	773	19,398
12	412	638	15,695
13	294	512	12,141
14	108	255	7,810
15	66	232	6,610
16	54	106	2,981
17	24	15	1,461
18	27	22	709
19	0	5	266
Unknown	0	0	0
Total	107,715	555,650	942,063

Table 4. Distribution of numbers caught at age of plaice on a set by set basis in Stratum 353 and 360 during the 1986 survey.

	Stratum 353					Stratum 360													
Age/set no.	103	104	105	106	107	87	88	89	90	91	93	94	96	97	98	99	100	101	102
1	21.07	650.87	51.32	36.26	641.42	721.51	34.61	954.01	951.89	1981.80	22.55	30.90	355.83	184.62	449.77	4.86	870.83	189.34	20.80
2	37.96	529.81	63.69	53.56	271.70	798.03	36.31	419.87	750.03	1337.11	40.14	41.71	466.67	713.53	1032.52	39.63	873.16	247.47	19.07
3	48.44	384.94	57.07	66.56	106.50	369.52	38.67	197.43	559.19	1194.85	74.54	69.88	458.76	704.16	864.34	56.26	732.32	213.88	24.00
4	29.67	126.51	29.27	43.45	44.38	113.43	50.96	103.23	275.86	559.37	49.24	61.51	215.69	287.10	270.67	32.46	312.80	84.67	13.14
5	14.14	18.18	10.42	24.10	44.09	30.34	50.03	50.09	118.78	118.57	21.92	42.06	76.09	125.27	66.19	10.69	138.98	26.80	5.18
6	21.67	13.72	14.80	41.70	85.47	34.44	98.42	62.40	106.39	108.23	29.32	63.25	67.42	133.97	84.05	12.90	165.97	25.20	6.92
7	17.45	3.96	12.47	31.00	87.66	18.67	93.98	57.13	64.87	54.89	22.22	39.03	19.71	63.08	25.73	7.34	45.14	8.11	8.04
8	10.11	3.80	10.33	11.23	41.87	4.68	34.16	30.26	45.93	16.01	7.78	12.82	6.44	26.87	5.76	2.60	12.49	4.25	4.86
9	6.87	2.42	10.98	5.50	20.12	0.91	8.87	14.21	30.69	6.37	1.86	2.82	3.69	15.00	0.88	1.71	5.69	1.40	3.11
10	6.39	0.85	11.42	5.60	10.29	0.66	0.93	6.26	18.84	4.51	1.79	2.27	0.90	4.25	1.99	0.91	1.97	0.22	4.76
11	5.46	1.79	5.42	1.78	8.46	0.29	0.04	6.45	10.21	1.23	0.71	3.13	1.31	2.52	2.77	0.60	0.82	0.02	3.95
12	1.79	0.48	4.21	0.46	8.19	0.73	0.0	9.64	4.53	2.24	0.87	2.67	0.79	1.07	1.23	0.77	1.74	0.0	1.85
13	0.00	0.0	1.41	0.0	9.40	0.0	0.0	5.68	4.28	1.42	2.12	0.96	0.34	1.04	0.74	0.95	2.46	0.0	2.57
14	0.00	0.21	0.80	0.0	2.97	0.0	0.0	2.97	3.28	0.4	0.21	0.49	0.0	1.05	0.09	0.94	1.12	0.0	0.69
15	0.00	0.94	0.40	0.22	0.88	0.0	0.0	1.40	4.47	0.0	0.64	0.67	0.0	0.60	0.27	0.38	1.33	0.0	0.44
16	0.00	0.40	0.0	0.33	1.25	0.0	0.0	0.29	2.11	0.0	0.14	0.45	0.0	0.43	0.45	0.0	0.18	0.0	0.63
17	0.00	0.44	0.0	0.44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.09	0.0	0.50	0.09	0.0	0.0	0.0	0.0
18	0.00	0.0	0.0	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0	0.0	0.0
19	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.25	0.0	0.0	0.0	0.0	0.0
Unknown	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	221.00	1739.33	284.00	323.19	1384.68	2093.21	447.00	1921.33	2951.35	5386.98	276.04	374.73	1673.66	2265.30	2807.53	174.00	3166.99	801.37	120.00

Table 5. A. plaice, Division 3L, biomass estimates ('000 t) from r.v. surveys, 1984-86, summed by depth zone. Numbers in parenthesis in the column headings indicate the percentage of the stratified area of Division 3L found in each depth zone.

Year/survey	B = Biomass Pct. = Percentage	Depth zone (fath) 31-50 (22.1)	51-100 (45.0)	101-150 (17.9)	151-200 (10.0)	201-400 (5.0)	Total
1984 summer/fall	B	69601	170923	59907	5664	51	306,146
	Pct.	22.7	55.8	19.6	1.9	<0.01	100.0
1985 winter	B	37964	132564	32198	8842	605	212,173
	Pct.	17.9	62.4	15.2	4.2	0.3	100.0
1985 spring	B	67297	73710	20262	6595	7263	175,125
	Pct.	38.4	42.1	11.6	3.8	4.1	100.0
1985 summer	B	45835	128779	43046	3506	271	221,440
	Pct.	20.7	58.2	19.4	1.6	0.1	100.0
1985 fall	B	50336	123344	48840	3611	231	226,362
	Pct.	22.2	54.5	21.6	1.6	0.1	100.0
1986 winter	B	19328	19235	3400	5672	1713	49,348
	Pct.	39.1	39.0	6.9	11.5	3.5	100.0
1986 spring[a]	B	62064	87508	19214	4821	-	173,607
	Pct.	35.7	50.4	11.1	2.8	-	100.0
1986 fall	B	24793	75079	26249	2588	486	129,195
	Pct.	19.2	58.1	20.3	2.0	0.4	100.0
Average	B	47152	101393	31640	5162	1517	186,864
	Pct.	25.2	54.3	16.9	2.8	0.8	100.0

[a]No sets in depths greater than 200 fath.

Table 6. Summary of American plaice directed CPUE data, by depth zone, for Division 3L, 1981-86.

Year	Catch (t) = C Effort (hrs) = E CPUE = C/E	Depth range (fath) 0-50	51-100	101-150	151-200	>200	Total
1981	C	9320.3	12685.7	2753.3	3074.0	222.8	28056
	E	19505	21474	3987	3424	329	48719
	CPUE	0.478	0.591	0.691	0.898	0.677	0.576
1982	C	6109.6	14001.5	2391.9	890.0	108.8	23502
	E	12235	23411	4198	920	101	40865
	CPUE	0.499	0.598	0.570	0.967	1.077	0.575
1983	C	5297.8	3716.1	3112.4	36.7	5.9	12169
	E	9400	6133	5049	85	10	20677
	CPUE	0.564	0.606	0.616	0.432	0.590	0.589
1984	C	5029.0	2308.2	2898.7	71.4	-	10307
	E	8070	4021	2997	92	-	15180
	CPUE	0.623	0.574	0.967	0.776	-	0.679
1985	E	8909.1	1393.8	4635.6	2.3	-	14941
	C	11346	3091	7155	6	-	21598
	CPUE	0.785	0.451	0.648	0.383	-	0.692
1986	C	6644.8	2364.3	3582.2	22.7	29.7	12644
	E	14528	4329	7082	79	43	26061
	CPUE	0.457	0.546	0.506	0.287	0.691	0.485
Average	C	6885.1	6078.3	3229.0	682.9	61.2	16937
	E	12514	10410	5095	768	81	28868
	CPUE	0.550	0.584	0.634	0.889	0.756	0.587

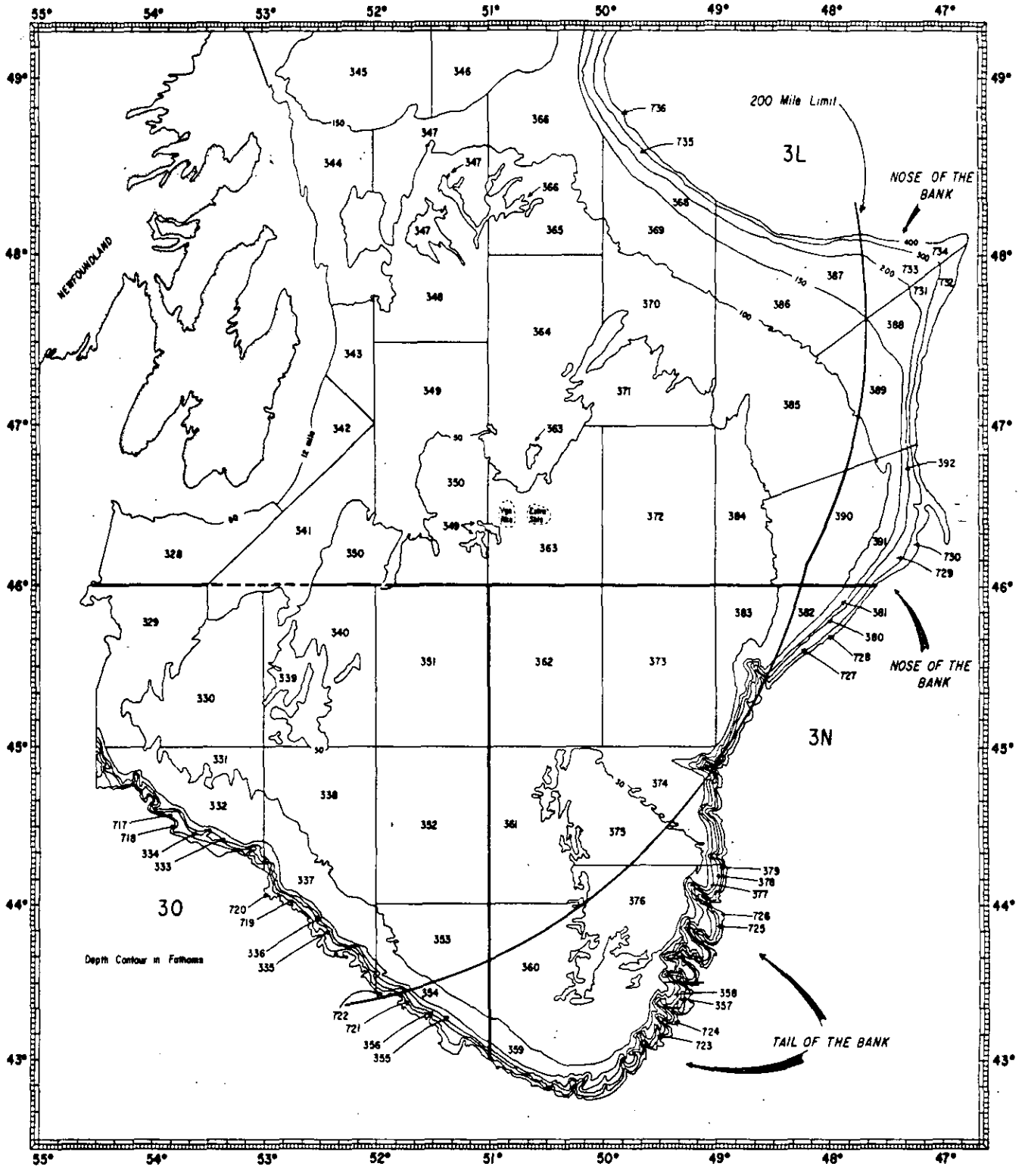

Fig. 1. NAFO Div. 3LNO, showing the Canadian 200 mile limit in relation to the Nose and Tail of the Bank, as well as the stratification scheme used in Canadian groundfish surveys.

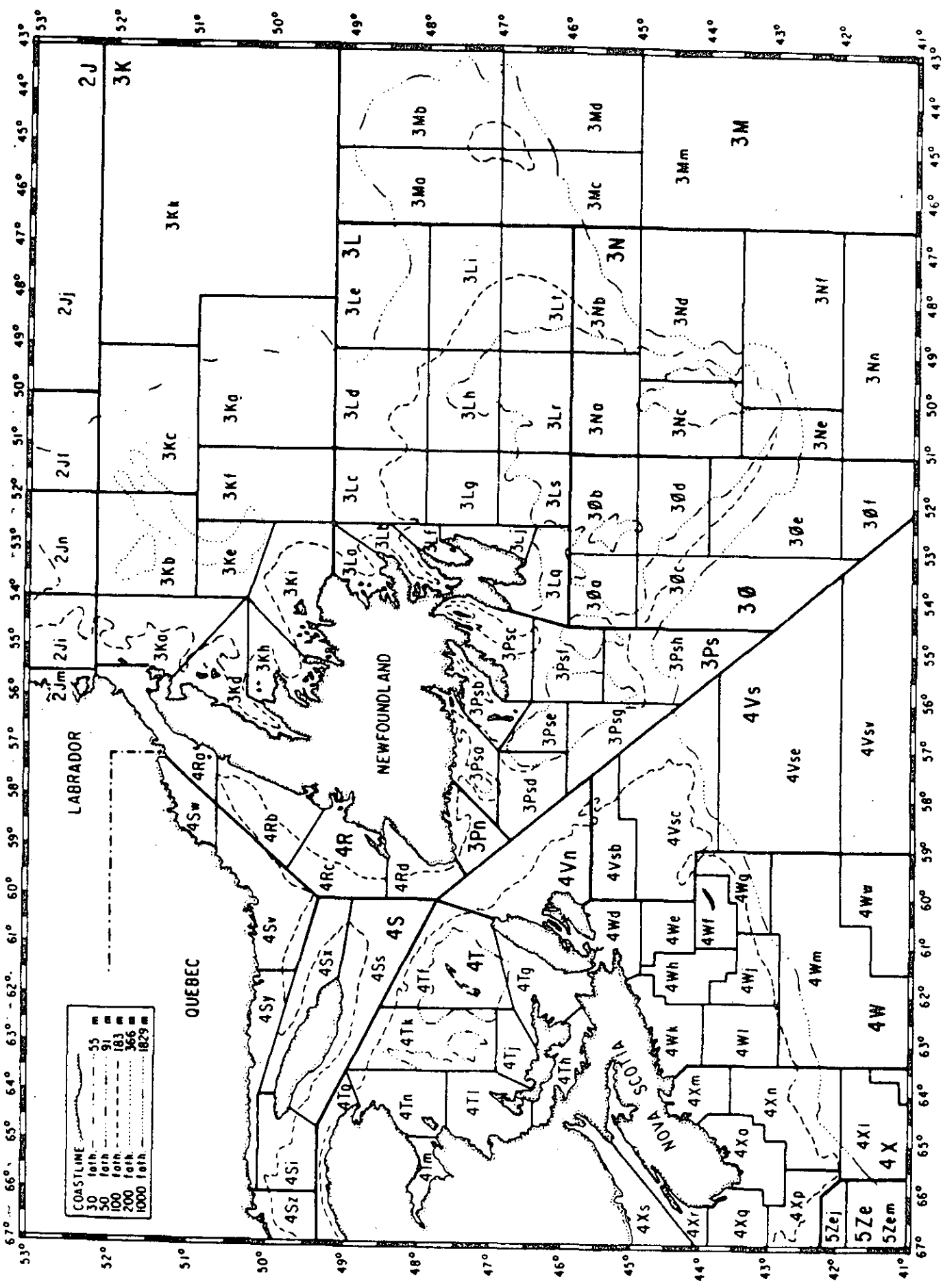

Fig. 2. Statistical unit areas used in reporting catch and effort data.

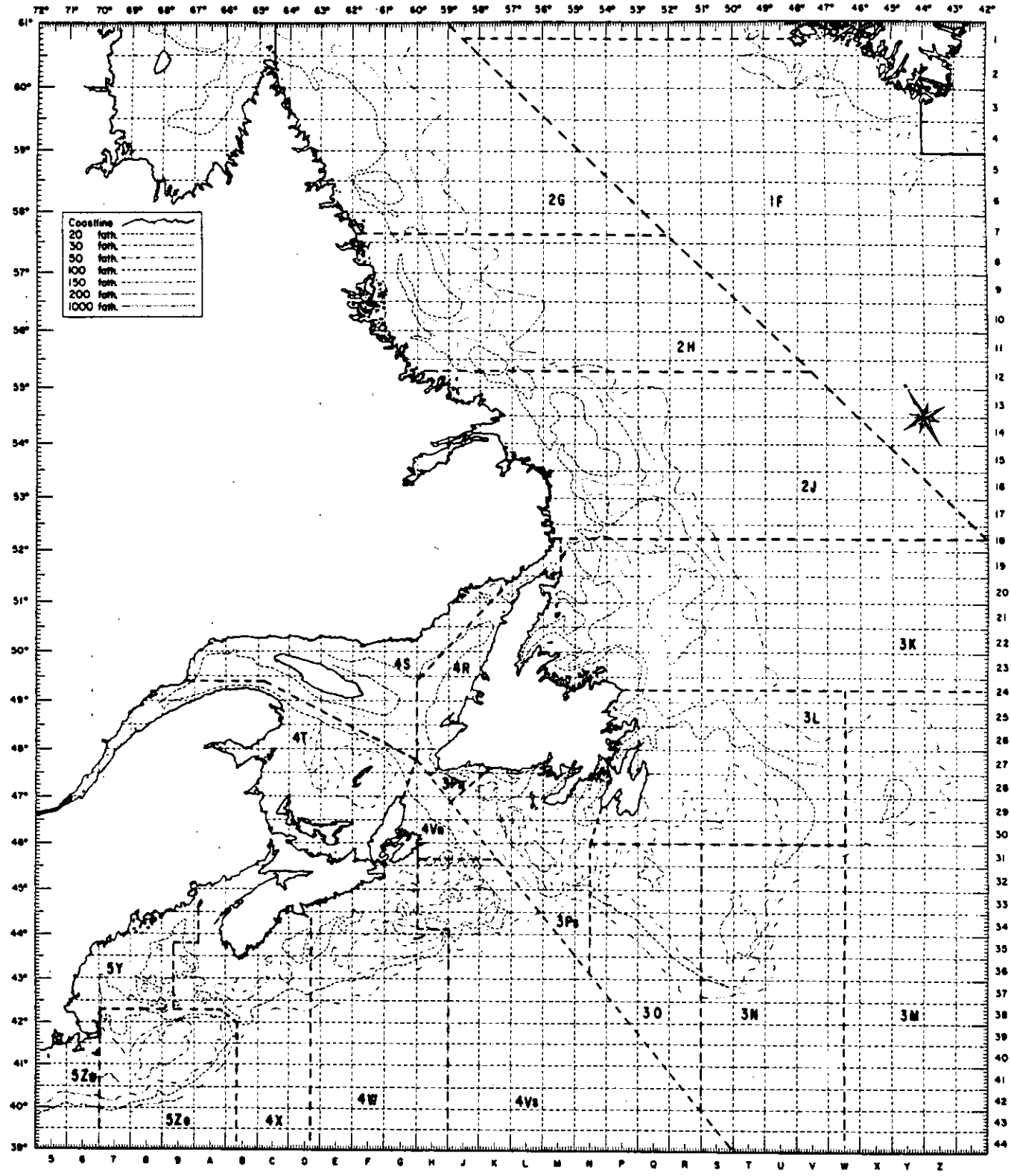

Fig. 3. Map showing unit areas used in analysis of r.v. survey data.

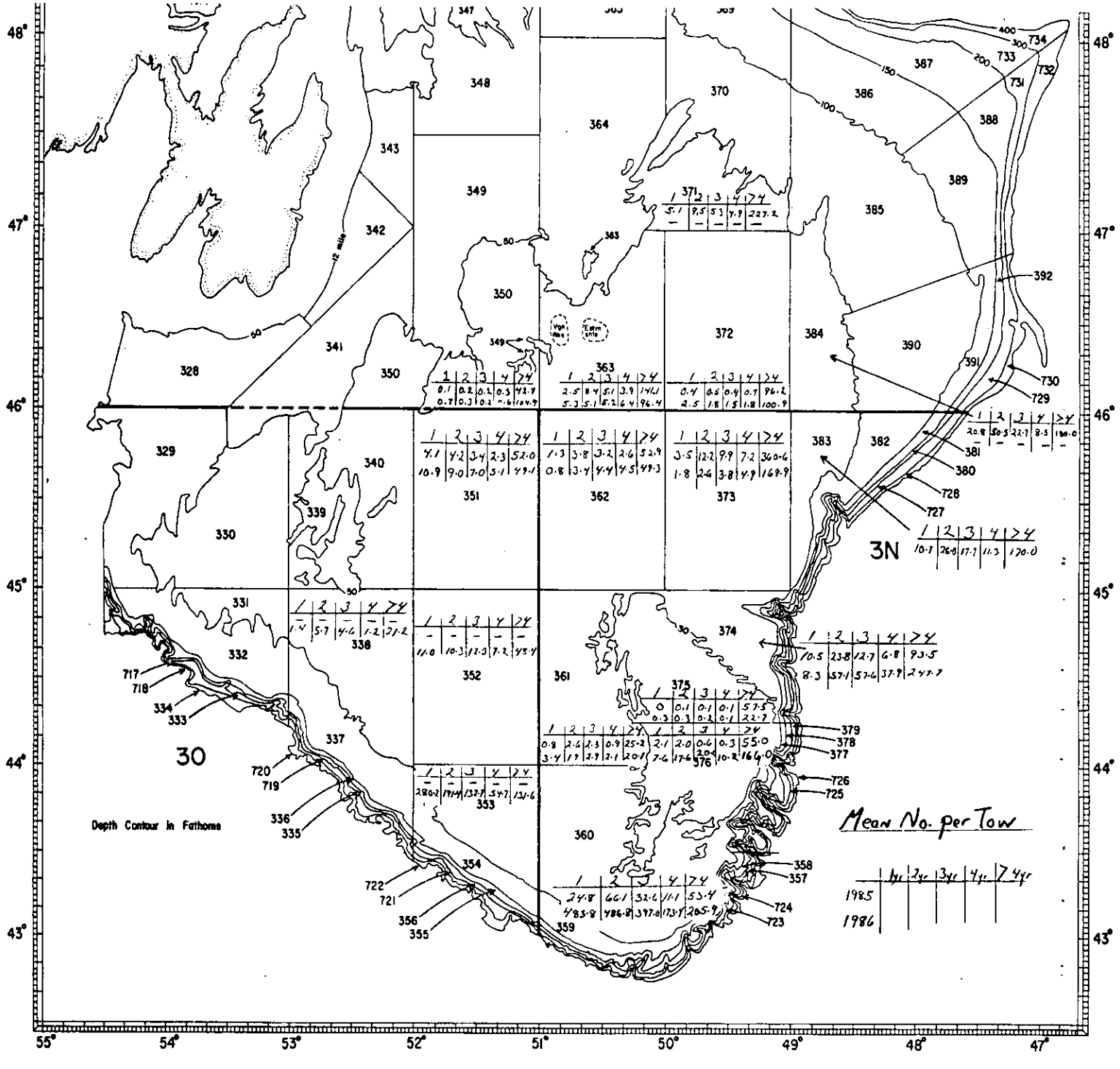

Fig. 4. Comparison of the distribution and relative abundance of juvenile and adult (>4 yr. olds) A. plaice from the 1985 and 1986 juvenile surveys: NAFO DIV 3LNO.