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Distribution and Abundance of Juvenile and Adult American Plaice
on the Grand Bank, NAFO Divisions 3LNO

by

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INTRODUCTION

The greatest abundance of American plaice in the Northwest Atlantic occurs on the Grand Bank off Newfoundland, NAFO Div. 3LNO. The fishery, which has yielded an average 32,000 t during the last 2 years, occurs mainly on the northern part of the Bank (Div. 3L) in depths of 75 to 185 m, along the eastern edge (Div. 3N) in depths of 70-275 m, and to a lesser extent on the southwestern part of the Bank (Div. 3O) in depths of 70-185 m (Pitt, 1975; Walsh, 1982) (Fig. 1).

Walsh (1982) concluded that both juvenile and adult plaice, in catches from the Canadian spring groundfish surveys, were concentrated in the same areas of the Grand Bank. Since 1985, directed juvenile flatfish surveys on the shallow plateau of the Grand Banks inside of the 91-m (50 fath.) depth contour have identified a proposed nursery site for the southern Grand Bank population in the area known as the "Tail" of the Bank, in NAFO Div. 3N (Walsh and Brodie, 1988; Walsh, 1989, 1990). Since 1989, the juvenile flatfish survey has been expanded to include the slope waters of the Bank, out to a depth of 183 m (100 fath.). This expansion was made in order to investigate the distributional range of juveniles in the southern area and to look for other possible nursery areas. As a result of these extended surveys, three distinct areas of concentrations of juvenile plaice have been identified: the northern slope of Div. 3L, located in an average depth range of 130-140 m ($x = -1.2^{\circ}\text{C}$); the Tail of the Bank of Div. 3N, located in average depth range of 70-72 m ($x = 2.5^{\circ}\text{C}$); and Whale Deep, a deepwater basin located on the western side of Div. 3O, in an average bottom depth range of 105-115 m ($x = -0.3^{\circ}\text{C}$) (Walsh, 1991a,b). This paper will report the results of the 1991 survey and compare distribution of juveniles with earlier surveys since 1985.

Materials and Methods

Survey design

Annual juvenile flatfish surveys of the Grand Bank were started in 1985. The main purpose of the survey was to determine year-class strength of juvenile American plaice and yellowtail flounder as early as possible for the management of the resource. From 1985 to 1988, the survey area incorporated the entire Grand Bank inside the 91-m isobath, NAFO Div. 3L, 3N, and 3O (Fig. 1). Since 1989, the survey was extended to the 183-m isobath. The stratified-random trawl survey for juveniles the same depth stratification scheme which has also been in place for annual spring Canadian groundfish surveys of the Grand Bank since 1971 (Fig. 1). However, the juvenile survey is further stratified by densities based on historical information (see Walsh, 1986 for details). The number of fishing hauls was proportioned according to the area of each stratum, and stations were randomly derived prior to each cruise. Since data on gear efficiency was not available, only relative abundance estimates were derived using a swept area model.

Survey gear and time

The survey gear used was a two-bridle Yankoe 41 (80/104) shrimp trawl with a mesh size of 38 mm throughout and equipped with a 12-mm stretched mesh liner in the codend. The groundgear was rigged with 30-cm rubber rollers in the bosom, 30-cm rubber bunts in the quarters, and 11-cm rubber discs in the wing ends. The standard towing speed used, measured

by Doppler speed log, was 2.5 knots with each haul being 30-minute duration (on-bottom time), covering an average distance of 1.25 miles as calculated from Loran C navigation. At each fishing station, a surface-to-bottom temperature profile was taken with an XBT (Expendable Bathythermograph) from 1985 to 1988 and a trawl mounted CTD system since 1989 and bottom depth was recorded from sounder records. The surveys were carried out during the last week in August and the first 2 weeks in September 1985, 1986, 1988, 1989, 1990, and 1991 and November 1-13 in 1987 aboard the R.V. WILFRED TEMPLEMAN, a 50-m stern trawler. Seven hundred seventy-one (771) successful fishing hauls were made during the combined period of 1985-90. In the 1991 survey, 206 successful sets were completed in Div. 3LNO out to the 183 m depth contour.

All of the catch was sorted by species and weighed. All plaice were measured to the nearest centimeter (total length). Otoliths were removed for ageing. Fish were classified as juveniles based on the age they began to mature and for this species this was approximately age 5. All analyses of the data were done on a 1-cm size category using SAS software (SAS Institute Inc. 1985).

RESULTS

CATCHES DIV. 3L

Table 1. shows the average catch (numbers and weights), abundance and biomass estimates of American plaice catches in Div. 3L, derived from the 1985-91 juvenile surveys. In Div. 3L, the 1991 survey results showed plaice (juveniles and adults) were concentrated on the north and northeast slope, in an average bottom depth of 143.6 m and an average temperature of -1.2°C (Table 4). Both depth and temperatures are consistent for the three year period. Highest catch rates were found in strata 365, 348, 364, 385, and 390, similar to 1989 and 1990 surveys, where the average numbers per tow exceeded 1000 fish and average weight per tow was greater than 80 kg.

CATCHES DIV. 3N

Table 2. shows the average catch, abundance and biomass estimates in Div. 3N for 1989-91. Plaice in 1991 were concentrated on the Tail of the Bank, in the Regulatory Area, in an average bottom depth of 74.7 m and an average bottom temperature of 0°C (Table 4). Although average depth distribution was consistent, the average bottom temperature in 1991 was colder than the previous two years. On the Tail of the Bank, in strata 359 and 360, the average numbers per tow exceeded 1000 fish and the average weight per tow exceeded 78 kg. Both of these strata had the highest catches since the extended survey began in 1989 and strata 360 consistently showed the highest catches in Div. 3N since 1986.

CATCHES DIV. 3Ø

Table 3. shows the average catch, abundance and biomass estimates in Div. 3Ø. The highest average numbers and weights per tow were found in Whale Deep, a deepwater basin on the western side of the Bank (stratum 339) consistent with the 1989 and 1990 surveys. Concentrations of plaice were found in an average depth of 98.4 m and an average bottom temperature of 0.4°C in 1991, comparable to 1990, but colder than 1989 (Table 4).

BIOMASS TRENDS

Figure 2 shows the biomass by Division and total biomass of Div. 3LNO for the 1989-91 surveys which covers the majority of the stock distribution area on the Grand Banks. Stock biomass in Div. 3L and 3Ø has shown a decline since 1989 (using 1989-91 data only). In Div. 3N, the stock biomass has been variable since 1989 with the 1991 estimate showing a decrease of 38%. It is noteworthy that the 1991 estimate is about one-half of the stock size estimate in 1985 and 1986 when coverage was not as extensive. Total biomass of Div. 3LNO in 1991 decreased by 25% since 1990 (Tables 1-3).

AGE COMPOSITION

Tables 5-8 and Figures 3-5 show the age-by-age composition of the 1989, 1990, and 1991 surveys. In Div. 3L, the 1985 year class (age 6 in 1991) and the 1986 year class (age 5 in 1991) contributed significantly to a stable total abundance, as seen in all three years (Table 5; Fig 3). Older fish at age 7+ has been decreasing in abundance since 1989 while juvenile abundance (1-5 years) has been increasing due to the strength of incoming year classes being recruited to the survey gear. The 1985, 1986, and 1987 (age 4) year-classes comprised 70% of the 1991 total abundance. In Div. 3N, the total abundance in 1991 varied little from the 1990 estimate, but, both were approximately 40% below the 1989 estimate (Table 6; Fig.4) The 1985, 1986, and 1987 year classes comprised 38% of the 1991 total abundance in 1991. Juvenile abundance showed a modest increase from 1991 to 1990. Age 7+ estimate of abundance dropped by 54% from 1990 to 1991.

Table 7. shows the population structure of plaice caught in stratum 360, in the Regulatory Area of Div. 3N. During past assessments, this stratum has been selected to monitor changes in abundance on the "Tail of the Bank." Total population and the juvenile abundance remained stable between 1990 and 1991. Greater than 90% of the total abundance in this stratum, in any one year from 1985-1991, was comprised of juveniles 1 to 5 years of age. In 1991 the 1985 year class was the strongest at age 6 and the 1986 year-class at age 5 was the second largest next to 1990 estimate of the 1985 year-class (Fig.5). As reflected in all of Division 3N, 40% of total abundance of plaice in stratum 360 was comprised of the 1985, 1986, and 1987 year-classes.

In Div. 3Ø, approximately 72% of the total abundance of plaice in the 1989-91 surveys was comprised of juveniles (Table 8). Total population size, juveniles, and age 7+ abundances showed moderate fluctuations during 1989, 1990, and 1991, although, all showed a general increase from 1990 to 1991. The 1985 and 1986 year classes still appear strong in 1991 estimates and together with the 1987 year class comprise approximately 44% of total stock size in Div. 3Ø (Fig.6).

Tables 9 and 10 contain information on abundance estimates at age of plaice catches for nursery strata found on the northern slope of Div. 3L, in the Regulatory Area in Div. 3N, and Whale Deep area in Div. 3Ø for the 1989, 1990, and 1991 surveys. In Div. 3L (Table 9), the majority of catches of juveniles ages 1 to 5 were found in the deepwater strata (93-183 m) on the north and northeast slope of the Bank during 1989-91. In Div. 3Ø (Table 10), strata 329 and 339 of the Whale Deep area and strata 353 and 354 on the Tail of the Bank in the Regulatory Area account for 50%-60% of juveniles during 1989-91 surveys. In Div. 3N (Table 10), the majority of juveniles were found in the Regulatory Area, strata 359 and 360 in all three surveys.

Table 11. shows a breakdown of the distribution of the 1985 to 1990 year classes distributed in the Regulatory Area of Div. 3N and 3Ø, estimated from the 1991 survey. In Div. 3N, 66% to 85% of plaice ages 1 to 6 years were located in the Regulatory Area with stratum 360 containing the majority of the abundance estimates. In Div. 3Ø, 21%-31% of the 1985 to 1989 year-classes straddle the Regulatory Area, with the majority found in startum 353. These results agree with other years and support again the hypothesis (Walsh 1991a, 1991b) of a separate southern Grand Bank nursery area located primarily in the Regulatory Area.

CONCLUSIONS

DIVISION 3L:

Juvenile and adult American plaice were found concentrated on the northern slopes in an average depth range of 130 to 144m and average bottom temperatures below 0 C during the 1989-91 surveys. Biomass has shown a decrease since 1989, although total abundance and juvenile has remained stable due to strength of the 1985-87 year classes. However older plaice abundance (age 7+) decreased during the same time period.

DIVISION 3N:

Juvenile plaice were found mainly in the Regulatory Area while adults were dispersed throughout the area. Average bottom temperatures associated with concentrations of plaice ranged from -0.1 to 3 C and depth distribution was shallower than concentrations on the northern slope of Div. 3L. The 1991 biomass showed a decline from 1990, however, abundance remained stable. The strong 1985-87 yearclasses (ages 4,3 and 2) in the 1989 survey have been declining in strength in the 1990-91 survey estimates. In 1990 and 1991, fishery statistics for the Regulatory Area showed the 1985 and 1986 year classes comprised 46% of the catch composition in 1990 and the 1985-87 year classes comprised 60% of the 1991 catch composition.

DIVISION 3Ø:

Juveniles were concentrated in the Whale Deep area (strata 329 and 339), while adults were concentrated also in this area and dispersed in smaller amounts across the Division. Average temperature of concentrations of plaice were just above 0 C in all three years and average bottom depths showed little variation, being shallower than Div. 3L and deeper than Div. 3Ø. Biomass has shown a decline since 1989, while total abundance has remained stable over the three years due to strength of the 1985-87 year classes. An average of 72% of the total abundance in the 1989-91 surveys was comprised of juveniles ages 1 to 5. Older plaice abundance appear stable during 1990-91 surveys due to incoming recruitment but both estimates are lower than in 1989.

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Table 1. Mean numbers and weight (kg) of Am. plaice per tow, by stratum from r.v. surveys in Division 3L. Numbers in parentheses are the number of successful 30-minute tows in each stratum. The stratified mean number and weight per tow (kg/30 min.), abundance (millions), and biomass ($t \times 10^3$).

Depth (fm)	Stratum	Category	Year						
			1985	1986	1987	1988	1989	1990	1991
51-100	328	Av.No./set	-	-	-	-	159.85(3)	-	238.15(5)
		Av.wt./set	-	-	-	-	15.00	-	29.52
51-100	341	Av.No./set	-	-	-	-	1194.50(4)	202.80(5)	735.93(4)
		Av.wt./set	-	-	-	-	220.86	41.20	69.32
51-100	342	Av.No./set	-	-	-	-	223.00(2)	-	-
		Av.wt./set	-	-	-	-	51.25	-	-
51-100	343	Av.No./set	-	-	-	-	59.00(2)	-	109.92(2)
		Av.wt./set	-	-	-	-	7.50	-	22.68
51-100	348	Av.No./set	-	-	-	-	1562.50(7)	773.90(4)	2165.33(7)
		Av.wt./set	-	-	-	-	146.84	104.21	127.65
51-100	349	Av.No./set	-	-	-	-	1341.40(5)	492.57(7)	803.12(7)
		Av.wt./set	-	-	-	-	199.62	93.57	66.64
31-50	350	Av.No./set	43.60(5)	106.67(6)	-	273.99(5)	71.63(8)	27.50(4)	76.07(8)
		Av.wt./set	39.80	93.92	-	69.25	51.44	33.30	47.12
31-50	363	Av.No./set	161.00(5)	119.40(5)	-	53.79(6)	315.43(7)	549.50(4)	220.08(4)
		Av.wt./set	56.30	42.61	-	27.65	88.70	77.86	58.68
51-100	364	Av.No./set	-	-	-	-	1406.53(11)	2361.60(5)	1370.61(6)
		Av.wt./set	-	-	-	-	113.02	292.07	122.29
51-100	365	Av.No./set	-	-	-	-	1854.75(4)	912.67(3)	2501.57(4)
		Av.wt./set	-	-	-	-	95.08	89.76	125.65
51-100	370	Av.No./set	-	-	-	-	1703.83(6)	1119.33(3)	627.85(3)
		Av.wt./set	-	-	-	-	87.53	145.37	60.17
31-50	371	Av.No./set	252.00(4)	-	-	74.34(5)	67.00(4)	96.67(3)	-
		Av.wt./set	102.13	-	-	41.45	33.50	40.97	-
31-50	372	Av.No./set	98.28(9)	108.50(8)	-	97.80(8)	97.88(8)	73.00(4)	62.95(4)
		Av.wt./set	72.09	90.38	-	55.02	38.43	45.23	36.25
11-50	384	Av.No./set	282.25(4)	-	-	191.45(5)	172.25(4)	246.90(2)	628.18(1)
		Av.wt./set	105.45	-	-	88.33	72.41	105.15	146.21
51-100	385	Av.No./set	-	-	-	-	1085.80(5)	2084.00(4)	1354.46(6)
		Av.wt./set	-	-	-	-	69.33	87.62	80.72
51-100	390	Av.No./set	-	-	-	-	284.00(4)	234.33(3)	1228.00(4)
		Av.wt./set	-	-	-	-	50.91	41.27	87.72
Mean No./set (# sets)			142.23(27)	110.89(19)	- (0)	140.50(29)	806.79(84)	809.53(51)	888.77(67)
Abundance (Nos x 10 ³)			129.4	74.4	-	127.8	2231.8	2013.0	2295.5
Mean wt./set			69.24	78.00	-	55.35	91.72	100.10	78.55
Biomass (t)			63.0	52.4	-	50.4	253.7	248.9	202.9

Table 2 . Mean numbers and weight (kg) of Am. plaice per tow, by stratum from r.v. surveys in Division 3N. Numbers in parentheses are the number of successful 30-minute tows in each stratum. The stratified mean number and weight per tow (kg/30 min.), abundance (millions), and biomass ($t \times 10^{-3}$).

Depth (fm)	Stratum	Category	Year						
			1985	1986	1987	1988	1989	1990	1991
51-100	359	Av.No./set Av.wt./set	-	-	-	-	2395.50(2) 99.55	898.18(3) 51.08	1703.94(4) 78.19
31-50	360	Av.No./set Av.wt./set	189.67(3) 29.00	1823.93(14) 86.67	1043.14(19) 47.28	1271.32(20) 83.37	3015.54(19) 165.56	1427.81(21) 113.05	1509.73(18) 104.44
31-50	361	Av.No./set Av.wt./set	31.50(6) 24.17	29.88(8) 19.69	59.08(8) 41.80	64.12(6) 24.90	53.78(9) 188.50	71.36(10) 38.18	76.07(8) 33.63
31-50	362	Av.No./set Av.wt./set	63.78(9) 37.72	62.57(7) 34.71	201.84(2) 84.19	135.76(6) 45.55	177.50(8) 38.44	162.14(9) 90.19	357.12(7) 61.44
31-50	373	Av.No./set Av.wt./set	399.80(10) 313.34	182.93(7) 139.68	-	51.59(8) 35.93	95.25(8) 54.13	198.00(9) 123.16	64.27(7) 14.51
31-50	374	Av.No./set Av.wt./set	147.25(4) 62.63	408.50(4) 218.25	-	166.12(4) 53.98	173.33(3) 37.00	93.25(4) 36.31	42.85(2) 27.09
≤ 30	375	Av.No./set Av.wt./set	57.71(7) 67.43	24.38(5) 31.98	48.96(7) 69.54	23.54(9) 17.45	21.63(8) 17.06	50.50(11) 50.58	24.98(7) 27.04
≤ 30	376	Av.No./set Av.wt./set	60.00(2) 45.50	221.75(4) 284.31	347.63(10) 18.75	674.98(12) 52.81	71.89(9) 18.89	110.36(11) 23.01	210.04(10) 36.19
51-100	382	Av.No./set Av.wt./set	-	-	-	-	48.00(2) 5.25	584.00(3) 46.51	56.77(3) 4.44
31-50	383	Av.No./set Av.wt./set	236.00(4) 75.63	-	-	106.42(4) 42.59	268.33(3) 52.50	396.33(3) 65.49	350.66(4) 18.43
Mean No./set (# sets)			155.70(45)	494.50(49)	414.87(46)	388.86(69)	723.63(71)	425.72(84)	453.48(70)
Abundance (Nos x 10 ⁻⁶)			241.5	731.6	461.5	663.2	1204.7	708.7	754.4
Mean wt./set			89.11	101.70	54.50	47.10	59.89	76.06	47.12
Biomass (t)			138.2	150.5	60.6	73.1	99.7	126.6	78.4

Table 3 . Mean numbers and weight (kg) of Am. plaice per tow, by stratum from r.v. surveys in Division 3N. Numbers in parentheses are the number of successful 30-minute tows in each stratum. The stratified mean number and weight per tow (kg/30 min.), abundance (millions), and biomass ($t \times 10^{-3}$).

Depth (fm)	Stratum	Category	Year						
			1985	1986	1987	1988	1989	1990	1991
51-100	329	Av.No./set Av.wt./set	-	-	-	-	803.63(4) 132.21	-	640.01(6) 41.15
31-50	330	Av.No./set Av.wt./set	-	-	-	24.48(2) 40.47	355.06(7) 80.35	244.86(7) 186.71	182.36(6) 58.35
31-50	331	Av.No./set Av.wt./set	-	-	-	6.99(2) 2.50	305.00(2) 113.75	749.00(2) 123.06	295.77(3) 43.58
51-100	332	Av.No./set Av.wt./set	-	-	-	-	592.25(4) 80.53	515.00(2) 42.67	435.17(4) 24.82
51-100	337	Av.No./set Av.wt./set	-	-	-	-	357.00(2) 45.38	501.33(3) 37.58	444.66(4) 43.76
31-50	338	Av.No./set Av.wt./set	-	33.00(3) 15.50	-	89.60(6) 14.49	289.00(6) 36.87	99.25(4) 17.87	329.58(6) 40.41
51-100	339	Av.No./set Av.wt./set	-	-	-	-	2960.50(2) 449.60	2666.33(3) 253.35	1908.28(4) 178.36
31-50	340	Av.No./set Av.wt./set	-	-	-	19.79(3) 6.09	60.17(6) 36.87	38.14(7) 19.16	244.21(5) 39.37
31-50	351	Av.No./set Av.wt./set	66.00(3) 35.00	81.33(9) 36.28	-	48.11(7) 39.47	334.25(8) 54.54	390.99(9) 70.23	70.83(7) 29.64
31-50	352	Av.No./set Av.wt./set	-	88.62(13) 37.30	-	120.09(11) 28.22	150.14(14) 39.06	106.46(16) 35.94	112.40(16) 31.21
31-50	353	Av.No./set Av.wt./set	-	794.00(5) 51.33	-	700.71(4) 145.90	770.33(3) 108.07	1306.00(4) 113.06	992.44(5) 132.53
51-100	354	Av.No./set Av.wt./set	-	-	-	-	472.50(2) 80.53	692.00(3) 82.46	1334.97(3) 103.79
Mean No./set (# sets)			65.95(3)	182.73(30)	-	126.60(35)	464.37(60)	444.89(60)	406.23(69)
Abundance (Nos x 10 ⁻⁶)			17.7	160.9	-	168.9	855.4	738.1	747.7
Mean wt./set			34.97	34.14	-	38.51	79.94	76.58	52.19
Biomass (t)			9.4	30.1	-	51.4	147.2	127.0	96.1

Table 4. Weighted average bottom depth (m) and temperature (°C) of catches of American plaice (juveniles and adults) from the 1989-91 surveys.

Year	Division	Depth (m)	Temperature (°C)
1989	3L	139.7	-1.1
	3N	71.2	3.3
	3Ø	97.1	1.1
1990	3L	130.2	-1.1
	3N	76.2	-0.1
	3Ø	90.8	0.3
1991	3L	143.6	-1.2
	3N	74.7	0.0
	3Ø	98.4	0.4

Table 5. Division 3L abundance at age (Nos. $\times 10^{-6}$) of plaice in the 1989, 1990, and 1991 surveys.

Age	1989	1990	1991
1	4.1	2.2	4.1
2	84.0	28.6	63.2
3	456.9	171.4	177.5
4	486.7	476.3	405.4
5	199.7	474.9	751.0
6	223.5	198.1	450.3
7	220.2	194.3	216.5
8	238.9	180.8	103.0
9	196.2	142.1	50.9
10	70.1	77.8	42.6
11	30.2	41.9	10.9
12	13.8	19.1	6.0
13	4.1	5.7	4.7
14	1.4	1.4	2.0
15	0.5	0.6	1.8
16			0.3
Unknown	0.1	0.2	
Total			
1+	2230.6	2015.4	2290.5
5+	1198.7	1336.7	1640.0
7+	775.4	663.7	438.7
1 to 5	1231.5	1153.3	1401.2

Table 6. Division 3N abundance at age (Nos. $\times 10^{-6}$) of plaice in the 1989, 1990, and 1991 surveys.

Age	1989	1990	1991
1	52.5	35.2	42.5
2	254.1	78.5	215.2
3	405.6	129.5	172.1
4	332.5	192.0	104.4
5	94.5	143.8	124.2
6	35.4	39.0	61.9
7	13.4	20.0	13.3
8	9.7	13.9	4.1
9	5.8	14.0	5.5
10	6.7	12.0	4.2
11	5.6	9.9	4.1
12	2.9	7.3	2.7
13	2.1	5.0	1.7
14	0.8	3.9	0.9
15	0.2	1.5	2.0
16	0	0.6	1.3
17	0	0.2	0.4
18			0.2
Unknown	0.1	0	0
Total			
1+	1221.9	706.3	760.6
5+	177.1	271.0	226.5
7+	47.2	88.1	40.4
1 to 5	1139.1	579.0	658.4

Table 7 . Abundance at age (Nos. x 10⁻⁶) for Stratum 360 from surveys in 1985-91.

Age	1985 ^a	1986	1987	1988	1989	1990	1991
1	12.1	165.4	95.2	10.1	48.9	29.1	20.9
2	20.7	144.9	144.1	100.5	212.8	58.5	140.5
3	8.6	127.1	58.1	172.3	327.7	93.2	120.0
4	3.1	53.4	21.8	73.9	275.9	137.1	72.3
5	4.1	19.9	4.7	26.6	77.3	97.4	84.1
6	3.1	25.2	3.5	8.3	24.6	23.6	39.6
7	2.0	11.6	1.5	4.8	5.2	7.9	6.3
8	1.0	4.7	0.7	3.5	2.3	3.5	1.1
9	1.5	1.8	0.4	1.3	0.9	1.4	0.9
10	1.5	1.1	0.2	0.6	0.8	0.7	0.4
11	0.7	0.7	0.2	0.6	0.6	0.4	0.4
12	0.7	0.6	0.2	0.4	0.5	0.2	0.2
13	0.4	0.5	0.2	0.4	0.4	0.2	0.2
14	0.2	0.3	0.2	0.2	0.2	0.2	0
15	0	0.2	0	0	0	0	0.2
16	0	0	0	0	0	0	0.2
17	0	0	0	0	0	0	0
Total							
1+	59.8	557.7	331.7	403.5	978.3	453.6	487.4
5+	15.2	66.6	11.8	46.7	112.8	135.5	133.6
7+	8.0	21.5	3.6	11.8	10.9	14.5	9.9
1 to 5	48.6	510.7	323.9	383.4	942.6	415.3	437.80

^aPoor coverage in 1985 (three sets in the northern section only).

Table 8 . Division 38 abundance at age (Nos. x 10⁻⁶) of plaice in the 1989, 1990, and 1991 surveys.

Age	1989	1990	1991
1	83.7	41.2	2.8
2	110.5	138.3	163.0
3	200.7	80.5	140.3
4	141.3	159.9	91.3
5	72.7	107.8	151.2
6	57.2	44.5	83.2
7	57.7	32.5	32.5
8	36.5	24.0	36.2
9	34.2	17.1	11.4
10	22.3	15.7	11.6
11	18.8	12.8	6.6
12	10.0	9.4	3.7
13	3.9	5.5	3.1
14	3.3	2.6	1.6
15	1.8	1.1	2.2
16	0.7	0.5	1.7
17	0.2	0	1.4
18	0	0	0.2
19	0	0	0.3
Total			
1+	855.6	693.5	744.3
5+	319.4	273.5	346.9
7+	189.4	121.2	112.5
1 to 5	608.9	527.8	548.6

Table 9 . Abundance estimates at age (10⁻⁶) from deepwater strata (93-183 m) on the north and northeast slopes of Division 3L from 1989-91 juvenile surveys.

Age	Stratum 348			Stratum 349			Stratum 364			Stratum 365			Stratum 370			Stratum 385			Div. 3L abundance					
	1989	1990	1991	1989	1990	1991	1989	1990	1991	1989	1990	1991	1989	1990	1991	1989	1990	1991	1989	1990	1991			
1	0.2	0.1	0.6	0.1	0	0	0.3	0.4	0.4	0.1	0.3	0	0.5	0	0	2.0	0	0	4.1	81	2.2	87	4.1	49
2	9.5	0.6	8.0	3.9	0.2	2.2	14.2	7.1	14.3	14.3	0.7	2.7	14.5	2.2	1.4	19.3	0	3.0	84.0	90	28.6	94	63.2	59
3	53.8	6.8	31.6	31.0	1.2	10.0	109.0	46.2	28.1	58.8	5.8	66.1	79.0	11.0	5.3	84.4	0.4	26.0	456.9	91	171.4	93	177.5	77
4	63.4	25.7	85.7	40.6	6.4	28.6	117.1	169.1	71.6	53.8	21.3	289.0	79.4	29.0	13.5	70.9	0.8	71.1	486.7	87	476.3	92	405.4	83
5	42.1	35.2	177.4	19.5	15.5	57.9	40.2	197.1	136.0	21.7	27.9	519.8	21.7	33.3	28.0	23.4	0.5	134.2	199.8	84	474.8	91	751.0	84
6	51.5	24.0	120.0	32.5	12.7	40.2	36.5	70.8	70.4	21.2	14.8	44.3	15.5	16.9	20.5	23.8	0.2	69.7	223.5	81	198.1	90	450.3	81
7	51.6	28.1	44.5	44.9	19.5	23.9	24.5	66.2	40.8	15.8	13.5	4.0	9.2	19.8	10.2	17.3	0.1	20.7	220.2	76	194.3	90	216.5	71
8	45.1	25.8	14.1	66.9	25.1	9.8	34.1	61.9	24.5	11.5	8.2	1.1	7.4	19.8	4.9	12.8	0	7.2	239.0	75	180.8	87	103.0	66
9	24.2	18.5	3.8	49.1	19.5	2.8	27.6	48.3	12.7	5.5	5.2	0.5	7.1	14.7	2.2	10.3	0	3.6	196.2	63	142.1	81	50.9	56
10	5.8	6.5	2.1	9.1	7.2	1.6	9.0	29.0	9.1	1.5	2.7	0.3	3.1	6.6	1.6	4.9	0	2.8	70.1	48	77.8	71	42.6	45
11	1.7	2.2	0.3	2.2	2.6	0.3	2.7	15.4	1.2	0.9	0.6		1.3	2.5	0.3	1.7	0	0.6	30.2	35	41.9	58	11.0	25
12	0.7	0.9	0.1	1.2	0.7	0.2	0.9	6.7	0.6	0.2	0.5		0.4	0.7	0.1	0.8	0	0.4	13.8	30	19.1	53	6.0	22
13	0.2	0		0.4	0	0	0	1.5	0.4	0	0		0.1	0.2		0.2	0	0.2	4.1	24	5.7	33	4.7	15
14	0	0		0	0	0	0	0.3	0.2	0	0		0	0		0	0		1.4	13	1.4	22	2.0	15
15	0	0		0	0	0	0	0	0.2	0	0		0	0		0	0		0.5	4	0.6	9	1.8	11
16	0	0		0	0	0	0	0	0	0	0		0	0		0	0		0	0	0	0	0.3	0
Total	350.4	174.4	488.2	301.4	110.7	177.7	421.2	719.9	410.7	205.2	101.5	3123.0	239.3	156.6	88.2	271.9	2.0	339.5	2230.5	2015.4	2290.5			

Table 10 Abundance estimates at age (Nos x 10⁻⁶) from plaice catches on the "Tail of the Bank" (Strata 353, 354, 359, and 360) and Whale Deep and Whale Bank (Strata 339 and 329) during 1989, 1990, and 1991 juvenile surveys.

Age	Stratum 329			Stratum 339			Stratum 353			Stratum 354			Div. 38 total abundance				Stratum 360			Stratum 359				
	1989	1990	1991	1989	1990	1991	1989	1990	1991	1989	1990	1991	1989	%	1990	%	1991	%	1989	1990	1991	1989	1990	1991
1	10.6	0.4	39.2	6.8	0.3	4.0	11.4	0	0.5	0.9	0	83.7	63	41.3	46	2.8	32	49.0	29.0	20.9	0.6	3.5	5.1	
2	21.0	31.3	25.0	42.3	18.7	5.1	26.6	33.9	1.1	3.4	16.4	110.5	47	138.3	52	163.0	62	212.8	58.5	141.4	19.3	3.8	26.2	
3	31.4	26.3	34.0	23.4	28.6	25.9	16.1	20.2	6.1	3.0	9.9	200.7	49	80.5	53	140.3	61	327.8	93.2	120.0	47.2	9.1	18.4	
4	20.6	14.9	15.8	40.7	14.3	28.5	37.9	17.9	7.0	9.8	9.6	141.3	51	160.0	55	91.3	62	275.9	137.1	72.3	29.5	13.7	9.8	
5	10.6	22.7	12.2	21.9	24.4	14.8	29.4	29.8	3.1	9.5	16.5	72.7	56	107.8	56	151.2	62	77.3	97.4	84.1	5.9	8.4	12.4	
6	11.9	11.6	12.5	10.4	16.1	9.7	10.4	13.2	1.8	3.3	7.2	57.3	63	44.5	54	83.2	58	24.6	23.6	39.6	1.9	1.2	3.2	
7	13.5	3.5	14.2	7.7	5.5	8.3	6.7	5.7	1.9	2.1	3.1	57.8	66	32.5	51	32.5	55	5.2	7.9	6.3	0.5	0.3	0.4	
8	9.3	3.6	10.8	5.1	5.7	3.4	3.4	6.1	0.7	0.9	3.3	36.5	67	24.0	39	36.2	52	2.3	3.5	1.1	0.1	0.1	0	
9	9.2	1.1	10.4	2.7	1.8	2.3	1.8	1.3	0.6	0.4	0.6	34.2	66	17.1	29	11.4	42	0.9	1.4	0.9	0	0	0	
10	5.3	0.8	6.3	1.7	1.8	0.8	1.1	1.0	0.3	0.2	0.3	22.3	57	15.7	19	11.6	34	0.8	0.7	0.4	0	0	0	
11	2.8	0.3	3.6	0.8	0.9	0.4	0.7	0.5	0.2			18.8	37	12.8	12	6.6	26	0.6	0.4	0.4	0	0	0	
12	0.7		1.1	0.5	0.3	0.4	0.2	0.2	0.1			10.0	23	9.4	8	3.7	16	0.5	0.2	0.2	0	0	0	
13			0.3		0.1	0.3	0.4	0.2	0			3.9	21	5.5	7	3.1	13	0.4	0.2	0.2	0	0	0	
14			0.5		0.0	0.4	0.2	0.3	0			3.3	33	2.6	8	1.6	25	0.2	0.2	0	0	0	0	
15					0.1	0.5	0	0.8	0.1			1.8	39	1.1	9	2.2	41			0.2			0	
16						0.1	0	0.7	0			0.7	29	0.5	0	1.7	47			0.2			0	
17								0.7	0							1.4	57			0				
18								0	0							0.2	0			0				
Total	146.9	N.S. ^a	116.7	184.2	163.9	118.8	105.2	146.4	132.9	23.8	33.7	67.3	855.7	693.5	744.3	978.3	453.6	487.4	105.1	40.2	75.7			

Age	Div. 3M total abundance					
	1989	%	1990	%	1991	%
1	52.5	95	35.2	93	42.5	61
2	254.0	91	78.5	79	215.2	78
3	405.6	93	129.5	79	172.1	80
4	332.5	92	192.0	79	104.4	79
5	94.5	88	143.8	74	124.2	78
6	35.4	75	39.0	64	61.9	69
7	13.4	42	26.0	32	13.3	50
8	9.7	25	14.0	27	4.1	29
9	5.8	17	14.0	10	5.5	18
10	6.7	12	12.0	6	4.2	12
11	5.6	11	9.8	4	4.1	10
12	3.0	17	7.3	3	2.7	7
13	2.1	17	5.0	3	1.7	12
14	0.8	22	3.9	5	0.9	0
15	0.2	23	1.5	5	2.0	10
16			0.5	2	1.3	15
17					0.4	0
18					0.2	0
Total	1221.9		706.3		760.6	

Table 11 Percent abundance distribution of the 1985-90 year-classes of plaice in the Regulatory Area derived from the 1991 juvenile surveys.

Year-class	Age	Length (10 ⁻⁶)	Division 3N				Division 38					
			Abundance	Stratum	percent	Total	Abundance	Stratum	percent	Total		
			(10 ⁻⁶)	376 ^a	360 ^b	359 ^d	%	length (10 ⁻⁶)	353 ^c	354 ^e	%	
1990	1	7.3	42.5	5	49	12	66	6.0	2.8	0	0	0
1989	2	11.5	215.2	5	65	12	82	10.5	163.0	21	10	31
1988	3	17.7	172.1	4	70	11	85	15.7	140.3	14	7	21
1987	4	21.1	104.4	4	69	9	82	18.3	91.2	20	11	31
1986	5	24.6	124.2	3	68	10	81	22.3	151.2	20	11	31
1985	6	30.4	61.9	5	64	5	74	25.3	83.2	16	9	25

^a93% of area outside 200-mile limit.
^b89% of area outside 200-mile limit.
^c100% of area outside 200-mile limit.
^d21% of area outside 200-mile limit.
^e54% of area outside 200-mile limit.

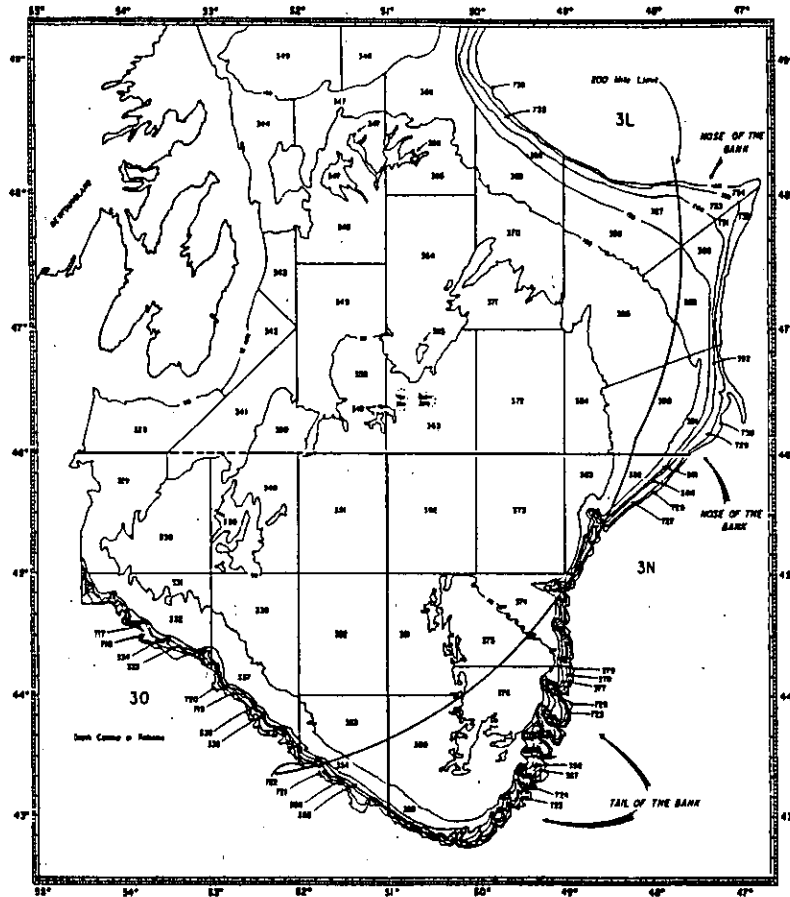


Fig.1. Depth stratification chart of the Grand Bank, NAFO Div. 3LNO

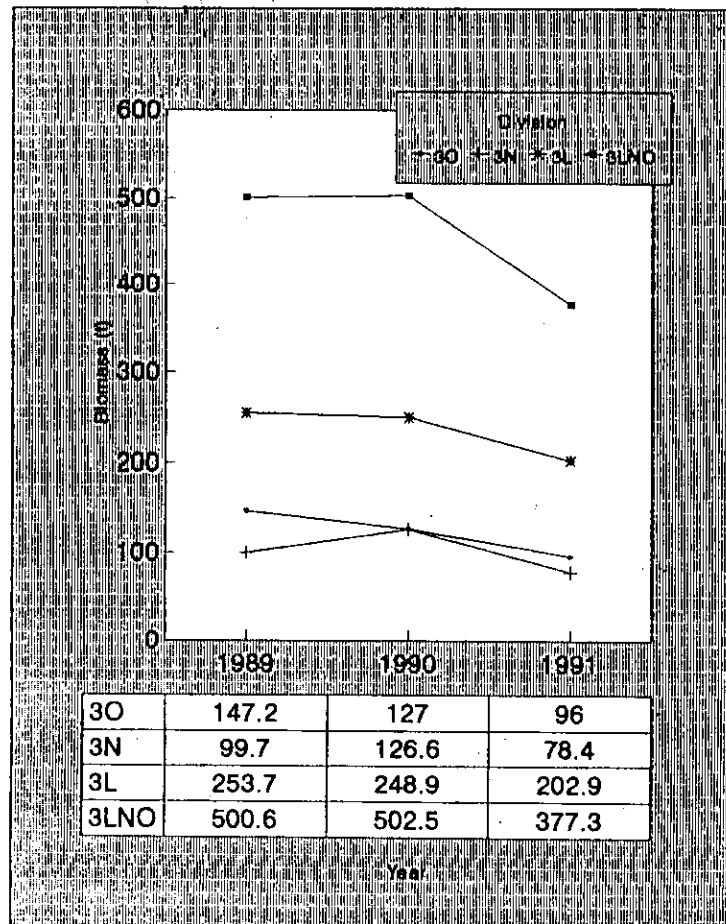


Fig. 2 Biomass of plaice derived from the 1989-91 juvenile flatfish surveys.

DIVISION 3L

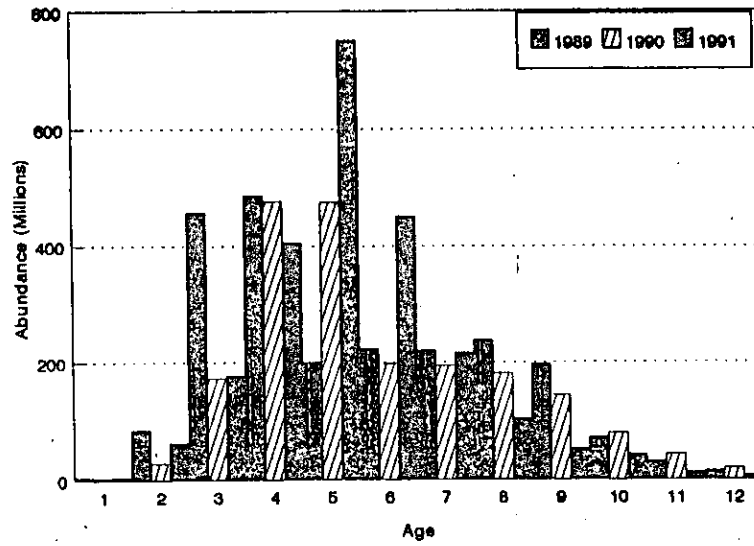


Fig 3. 1989-91 abundance at age of plaice in Div. 3L from the juvenile surveys.

DIVISION 3N

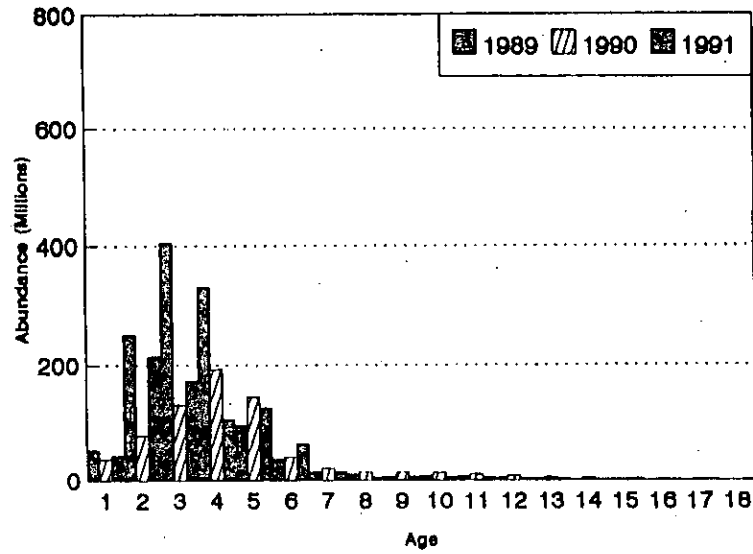


Fig.4. 1989-91 abundance at age of plaice from flatfish surveys in Division 3N.

DIVISION 3O

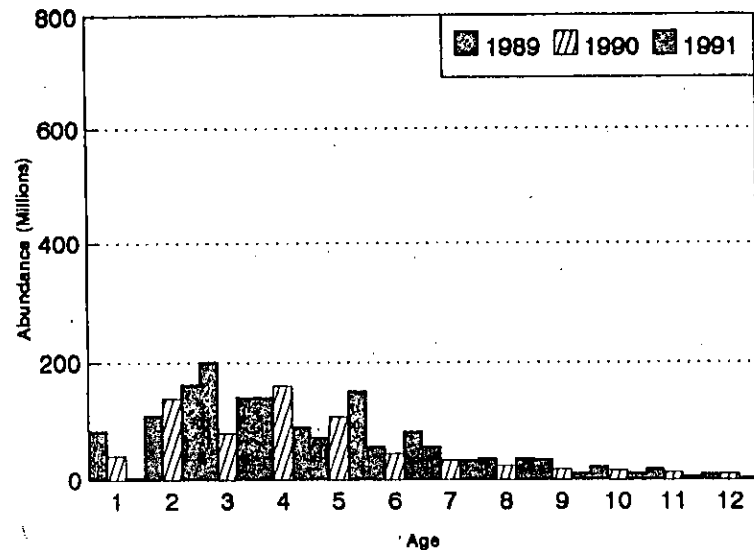


Fig.5. 1989-91 abundance at age of plaice from the flatfish surveys

STRATUM 360

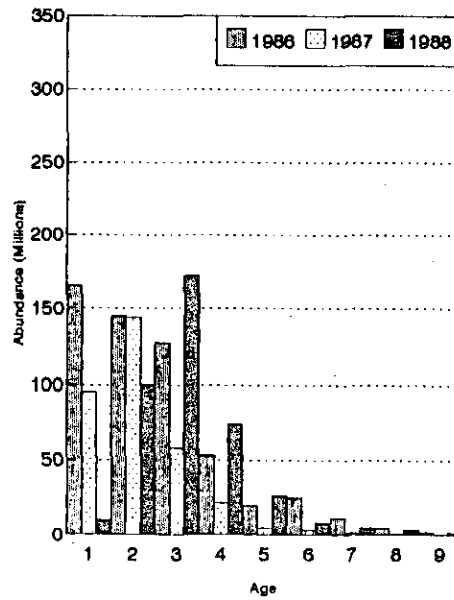
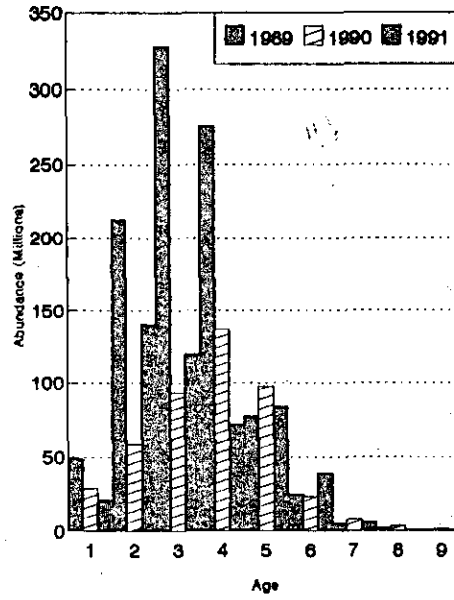


Fig. 6. 1986-91 abundance at age of plaice in Stratum 360 from juvenile flatfish surveys.