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

by

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Introduction

American plaice, *Hippoglossoides platessoides*, also known as long rough dab in North American waters, is an arcto-boreal right eyed flounder (*Pleuronectidae*) inhabiting the continental shelf on both sides of the North Atlantic. Its distribution approximates the range of cod, *Gadus morhua*. In the western side of the North Atlantic, where it is the most abundant flatfish, it ranges (42° - 74° N) northeast from the Gulf of Maine and Georges Bank area along the Scotian Shelf, into the Gulf of St. Lawrence, St. Pierre Bank, the Grand Bank and Flemish Cap and northward along the Northeast Newfoundland and Labrador shelf to Baffin Island and West Greenland (Bigelow & Schroeder, 1953; Scott & Scott, 1988).

In the North Atlantic there has been a major fishery for this species, as early as the 1940's, occurring mainly on the Grand Bank, southern Gulf of St. Lawrence and Georges Bank and has expanded during the 1970-80's to include the Flemish Cap, St. Pierre Bank and Nova Scotian Shelf as other traditional demersal stocks declined. (Walsh, 1994a). In the last decade stocks on St. Pierre Bank, Grand Bank, Flemish Cap (Bowering & Brodie, 1991), southern Gulf of St. Lawrence (R. Morin, 1993. Dept. Fisheries and Oceans, Moncton New Brunswick: unpubl. data) and the Gulf of Maine/Georges Bank (O'Brien et al., 1992) have been heavily exploited at levels which have reduced stock size considerably. Other stocks in the area are considered moderately exploited.

Walsh (1991) identified three possible oceanic nursery areas for American plaice on the Grand Bank and these areas are also the same areas where the commercial fishery, by both Canadian and non-Canadian vessels, takes place.

This paper will report on the results of the 1989-93 surveys and compare distribution of juvenile plaice with earlier surveys conducted since 1985. I will focus mainly on the time period 1989-93 for which the overall coverage of the population on the Grand Bank is the most extensive. No age data was available for the 1993 period.

Materials and Methods

Survey design

Annual juvenile flatfish surveys of the Grand Bank were started in 1985. The main purpose of the surveys 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); in 1989, it was extended to the 183-m isobath and in 1992 it was further extended to the 274 m isobath to investigate distribution of juvenile plaice in deep water. In 1993 the stratified-random trawl survey for juveniles consisted of 50 strata on the Grand Bank, designated by 1° X 1° squares (Fig. 1). This stratification scheme has also been used in the annual spring Canadian groundfish surveys of the Grand Bank since 1971. The number of fishing hauls were proportioned according to the area of each stratum, and stations were randomly derived prior to each cruise. Since data on gear efficiency were not available, only relative abundance estimates were derived using a swept area model. Expanding symbol plots, using ACON software (Black 1993), were used to show distribution of standard catch per tow of plaice on the Grand Bank.

Survey gear and time

The survey gear used was a two-bridle Yankee 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-minutes 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. Bottom depth was recorded from sounder records. The surveys were generally conducted from mid- August to mid-September 1985-86, 1988-93 and November 1-13 in 1987 aboard the r.v. WILFRED TEMPLEMAN, a 50-m stern trawler. Fourteen hundred and eighty-five (1485) successful fishing hauls were made during the combined period of 1985-93.

All of the catch was sorted by species and weighed. All plaice were measured to the nearest centimetre (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.

Results and Discussion

Distribution

Catches

The surveys from 1989 to 1993 cover the area of the Grand Bank out to a maximum of 274 meters (150 fath.). Figure 2 shows the distribution of catch per standard tow (kg). In Division 3L, it catches were distributed across the bank in a depth range of 62 to 250 m and a temperature range of -1.6 to 1.7° C. The population was concentrated on the northern and northeastern section of the bank in a mean depth range of 115 to 135 m and a mean temperature range of -1.1° to -0.6° C (Table 1).

In Division 3N, the population was distributed over most of this area of the bank in a depth range of 42 to 223 m and a temperature range of -1.6 to 7.5° C (Fig. 2; Table 1). Concentrations were found mainly on the "Tail of the Bank", in the Regulatory Area in a mean depth range of 64 to 71 m and a mean temperature range of 0.1 to 1.7° C.

In Division 3O, the population was distributed over the bank in a depth range of 63 to 218 m and a temperature range of -1.5 to 8.0° C (Fig. 2; Table 1). Concentrations were located in the Whale Deep Area (Fig. 1), a deepwater basin on the western side, along the southwest slope and near the "Tail of the Bank" in the Regulatory Area of this Division. Here concentrations were found in a mean depth range of 84 to 94 m and a mean temperature range of 0.6 to 1.3° C.

In the summary, the northern population (Div. 3L) was concentrated in colder and deeper waters than the southeastern (Div. 3N) and southwestern populations (Div. 3O) which were concentrated in shallower and slightly warmer waters (above 0° C). This species appears to have a wide temperature and depth range. Milinsky (1944) described this species as both eurybathic and eurythermal. In the North Atlantic it occurs in depths of 20-1300 meters in a temperature range of -1.5° C to 13.0° C (Walsh, 1994a). Morgan (1992) demonstrated that plaice in tanks can survive in water as cold as -1.4 to -1.5° C. Perry et al. 1988 classified plaice on the Scotian Shelf as a temperature seeker and would change depths when

it found itself in unfavourable temperatures. Generally, average depth preference of this species in the North Atlantic seems to be in the 100-300 meter range (Milinsky, 1944; Isaksen, 1977; Scott and Scott, 1988; Bowering and Brodie, 1991). American plaice are considered to be relatively sedentary, with limited migrations associated with spawning and feeding (Milinsky, 1944; Pitt, 1969; Simacheva & Glukhov, 1986). Movements have also been documented in response to changes in temperature (Powles, 1965; Morgan & Brodie 1991).

Juveniles and Adults

Walsh (1991), using juvenile flatfish surveys of the Grand Bank, NAFO Divisions 3LNO from 1985-1989, showed that the distribution of juveniles (ages 1 to 4 yrs) and adults overlapped extensively. He identified three oceanic nursery areas on the Grand Bank: one the northern slope of the bank, Div. 3L; one on the southern end of the bank (NAFO Regulatory Area) of Div. 3N and 3O, and Whale Deep area of Div. 3O. Since that time surveys have continued and coverage has been extended into deepwater along the edge of the Bank. Figures 3 to 5 shows new information from these surveys and presents individual distribution plots of juveniles ages 0 to 4 and adults ages 5+ for the period of 1989-92. Catches of 0-group were incidental and will not be mentioned further.

In the northern Grand Bank, juveniles (1000 + fish per standard tow) were found, in each year, concentrated on the northern and northeastern slope of this area of the bank (Figs.3-6). In the southern Grand Bank juveniles were concentrated in the Regulatory Area of Division 3NO. In the western and southwestern area of Division 3O concentrations were found in the Whale Deep Area (bounded by 45 to 45.8° N by 52.25 to 53°W; stratum 339 of Fig. 1). Smaller patches were also found along the southwest slope and east of Whale Deep in some years. The adult population in each year was more widely distributed, however, concentrations of 1000+ plaice were found occupying the same areas as the juveniles and confirms previous descriptions. (Walsh, 1991).

These juveniles also showed fidelity to their nursery areas. For example you can follow the distribution of the 1988 year class at age 1 in the 1989 survey and track its location at each age up to age 4 in the 1992 survey and find little change in distribution.

This discontinuity in the distribution of juveniles and as well in adults may suggest that, at least for the northern Grand Bank and the "Tail of the Bank", there are two distinct stocks which recruit from separate nursery areas. Further evidence to support this separation is that there is no synchrony in year class strength when you correlate estimates of age 4 recruits from the standard Canadian groundfish indices from the spring period, 1971 to 1992 (Walsh, 1994b). Lack of synchrony means that strong year classes in one stock do not always show up in another adjacent stock. Interestingly enough is that synchrony in year-class strength was found between Div 3O and Div. 3L but not 3N. Different oceanographic regimes in these areas may play the key role in the dynamics of populations on the Grand Bank. Further investigation is required because if there is more than one stock on the Grand Bank than new strategies may be necessary to manage this resource.

Abundance and Biomass 1993

DIV. 3L

Table 2 shows average catch (numbers and weights) abundance and biomass of American plaice catches in Division 3L derived from the 1985-93 juvenile surveys. In the 1993 survey, plaice (juveniles and adults) were concentrated mainly on the north and northeast slope (Fig.2). Highest average catches in numbers, generally around 1000 fish, were found in strata 328, 347, 384, 385, and 370. Average weights per tow in most strata showed a decline from 1992.

Table 2 and Figure 7 shows that although stock abundance decreased by 9% , stock biomass in Div. 3L showed a 25% decline from 1992 to 1993 continuing a downward trend which began in 1990. This decline in biomass in Div 3L was also evident in the biomass estimates derived from the spring time groundfish surveys during this period (Brodie et al 1992). The decreasing trend in average weight per tow and hence biomass indicates that fewer adult fish are in the population, on the other hand the corresponding downward trends in abundance is buffered by juvenile fish recruiting to the survey gear.

DIV. 3N

In 1993 two new strata were surveyed, for the first time, one in the 51-100 fath. range (stratum 377) and one in the 101-150 fath. range (stratum 381).

Table 3 shows average catch in numbers and weights, in 1993, were concentrated in the Regulatory Area, mainly in strata 359 and 360, similar to results in the 1989-92 surveys and in (new) stratum 377 on the southeastern edge (Fig. 2). Noteworthy, is the large average catch in stratum 360, in the Regulatory Area, which is 3.5 times higher in 1993 when compared to 1992, but comparable to the earlier 1986-91 estimates. The low average catch in 1992, in this stratum, was due to insufficient sampling as a result of expanding the overall survey and survey design (see Walsh, 1993 for details).

Table 3 and Figure 7 shows the 1993 biomass estimate has increased to 118.9 thousand tons. This increase was also evident in the biomass estimates derived from the standard groundfish surveys in the spring of 1993 (Brodie et al 1992). The two new strata (377 & 381) contributed only 10.2 thousand metric tons to the overall total.

DIV. 30

In 1993 two new strata were surveyed, for the first time, both in the 101-150 fath. range (strata 333 & 336) on the southwest slope.

Table 4 shows that in Div. 30, the highest average numbers and weight per tow were found in Whale Deep, a deepwater basin, on the western side of the Bank (stratum 339) consistent with the 1989 to 1992 surveys and strata 353 and 354, in the Regulatory Area (Fig 2). Average catches in numbers showed an increase in several strata from 1992, most noticeable in stratum 329. The overall average catch in numbers in 1992 showed a 38% increase from the stable catches during the 1989-91 period, and the average catch in weight also showed a corresponding 21% increase from 1991.

Table 4 and Figure 7 shows that the abundance and biomass estimates in 1993 were quite similar to the 1992 estimates. This trend was not seen in the 1993 spring or fall Canadian groundfish surveys, which showed a declining trend since 1990 (Brodie et al 1994). The two new strata added 300 tons to the overall estimate of 123.8 thousand metric tons.

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Table 1. Average bottom depth (m) and temperature (°C) of catches of American plaice (juveniles and adults) from the 1989-93 surveys. (standard deviation around the mean is in brackets).

Year	Division	Depth (m)		Temperature (°C)	
		Mean (SD)	Range	Mean (SD)	Range
1989	3L	114.8(33.9)	67-178	-0.7(0.7)	-1.5-1.0
	3N	64.1(13.9)	42-129	1.7(2.0)	-1.5-7.5
	3Ø	83.8(15.8)	65-145	1.5(2.3)	-1.5-8.0
1990	3L	112.9(34.4)	66-178	-0.6(1.0)	-1.5-1.5
	3N	67.4(22.5)	43-163	0.9(1.6)	-1.4-4.2
	3Ø	80.5(17.1)	63-148	1.1(1.1)	-1.1-3.8
1991	3L	120.0(37.5)	64-179	-1.1(0.4)	-1.6-0.4
	3N	66.9(19.0)	43-142	0.7(2.2)	-1.6-5.6
	3Ø	88.7(26.6)	64-188	0.9(1.9)	-1.4-4.6
1992	3L	134.1(45.7)	64-244	-0.7(0.8)	-1.5-1.7
	3N	68.3(28.7)	42-203	1.0(1.6)	-1.5-6.3
	3Ø	89.9(24.1)	66-215	0.6(2.0)	-1.5-7.6
1993	3L	132.8(48.3)	62-250	-1.1(0.5)	-1.6-1.4
	3N	71.1(31.9)	43-223	0.1(1.3)	-1.6-3.0
	3Ø	94.0(34.0)	66-218	1.3(2.5)	-1.5-8.0

Table 2. Mean numbers and weight (kg) of American plaice per tow, by stratum from juvenile 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	1992	1993
51-100	328	Av.No./set	-	-	-	-	159.85(3)	-	238.15(5)	166.67(3)	1033.20(3)
		Av.wt./set	-	-	-	-	15.00	-	29.52	14.13	35.96
51-100	341	Av.No./set	-	-	-	-	1194.50(4)	202.80(5)	735.93(4)	320.78(5)	275.99(5)
		Av.wt./set	-	-	-	-	220.88	41.20	69.32	32.23	17.44
51-100	342	Av.No./set	-	-	-	-	223.00(2)	-	-	51.46(2)	35.97(2)
		Av.wt./set	-	-	-	-	51.25	-	-	6.36	4.07
51-100	343	Av.No./set	-	-	-	-	59.00(2)	-	109.92(2)	154.38(2)	14.99(2)
		Av.wt./set	-	-	-	-	7.50	-	22.68	18.43	1.62
101-150	344	Av.No./set	-	-	-	-	-	-	-	484.25(2)	137.89(3)
		Av.wt./set	-	-	-	-	-	-	-	42.27	13.26
101-150	347	Av.No./set	-	-	-	-	-	-	-	366.17(2)	1192.75(3)
		Av.wt./set	-	-	-	-	-	-	-	75.97	133.88
51-100	348	Av.No./set	-	-	-	-	1562.50(7)	773.90(4)	2165.33(7)	745.51(12)	483.99(11)
		Av.wt./set	-	-	-	-	146.84	104.21	127.65	35.07	28.73
51-100	349	Av.No./set	-	-	-	-	1341.40(5)	492.57(7)	803.12(7)	238.07(8)	370.9(7)
		Av.wt./set	-	-	-	-	199.62	93.57	66.64	27.99	19.18
31-50	350	Av.No./set	43.60(5)	106.67(6)	-	273.99(5)	71.63(8)	27.50(4)	76.07(8)	109.96(6)	513.46(7)
		Av.wt./set	39.80	93.92	-	69.25	51.44	33.30	47.12	22.93	42.84
31-50	363	Av.No./set	161.00(5)	119.40(5)	-	53.79(6)	315.43(7)	549.50(4)	220.08(4)	288.40(5)	133.10(5)
		Av.wt./set	56.30	42.61	-	27.65	88.70	77.86	58.68	58.54	16.59
51-100	364	Av.No./set	-	-	-	-	1406.53(11)	2361.60(5)	1370.61(6)	1852.77(17)	1024.75(16)
		Av.wt./set	-	-	-	-	113.02	292.07	122.29	130.16	55.59
51-100	365	Av.No./set	-	-	-	-	1854.75(4)	912.67(3)	2501.57(4)	1601.89(6)	752.42(6)
		Av.wt./set	-	-	-	-	95.08	89.76	125.65	74.05	48.62
101-150	366	Av.No./set	-	-	-	-	-	-	-	386.39(3)	120.41(2)
		Av.wt./set	-	-	-	-	-	-	-	97.58	29.40
101-150	369	Av.No./set	-	-	-	-	-	-	-	376.64(3)	771.74(3)
		Av.wt./set	-	-	-	-	-	-	-	68.47	96.78

Table 2. (Cont'd.)

Depth (fm)	Stratum	Category	Year									
			1985	1986	1987	1988	1989	1990	1991	1992	1993	
51-100	370	Av.No./set Av.wt./set	-	-	-	-	1703.83(6) 87.53	1119.33(3) 145.37	627.85(3) 60.17	1305.96(8) 77.81	1245.33(7) 58.46	
31-50	371	Av.No./set Av.wt./set	252.00(4) 102.13	-	-	74.34(5) 41.45	67.00(4) 33.50	96.67(3) 40.97	-	1064.19(3) 145.37	369.38(3) 17.28	
31-50	372	Av.No./set Av.wt./set	98.28(9) 72.09	108.50(8) 90.38	-	97.80(8) 55.02	97.88(8) 38.43	73.00(4) 45.23	62.95(4) 36.25	222.00(6) 45.11	306.16(10) 43.01	
31-50	384	Av.No./set Av.wt./set	282.25(4) 105.45	-	-	191.45(5) 88.33	372.25(4) 72.41	246.50(2) 105.15	629.18(3) 146.21	549.25(4) 76.50	1065.93(4) 122.54	
51-100	385	Av.No./set Av.wt./set	-	-	-	-	1085.80(5) 69.33	2084.00(4) 87.62	1354.46(6) 80.72	1994.67(13) 70.31	1688.45(12) 83.13	
101-150	386	Av.No./set Av.wt./set	-	-	-	-	-	-	-	409.50(3) 96.73	387.70(3) 50.80	
101-150	389	Av.No./set Av.wt./set	-	-	-	-	-	-	-	249.17(3) 35.98	144.30(3) 19.42	
51-100	390	Av.No./set Av.wt./set	-	-	-	-	284.00(4) 50.91	234.33(3) 41.27	1228.00(4) 87.72	417.08(4) 55.23	653.25(4) 68.61	
101-150	391	Av.No./set Av.wt./set	-	-	-	-	-	-	-	460.96(2) 57.44	327.75(2) 27.18	
Mean No./set (# sets)			142.23(27)	110.89(19)	- (0)	140.50(29)	806.79(84)	809.53(51)	888.77(67)	689.42(122)	627.04(123)	
Abundance (Nos x 10 ⁴)			129.4	74.4		127.8	2231.8	2013.0	2295.5	2412.7(2124.9)*	2196.0(1889.8)*	
Mean wt./set			69.24	78.00		55.35	91.72	100.10	78.55	60.89	45.81	
Biomass (t)			63.0	52.4		50.4	253.7	248.9	202.9	213.1(166.6)*	160.5(122.4)*	

* Revised estimates with the catches of the 7 new deepwater strata removed for comparison with survey results in 1989-91.

Table 3. Mean numbers and weight (kg) of American plaice per tow, by stratum from juvenile 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	1992	1993						
101-150	358	Av.No./set Av.wt./set	-	-	-	-	-	-	-	-	-	-	-	-	-	247.50(2) 30.28	-
51-100	359	Av.No./set Av.wt./set	-	-	-	-	2395.50(2) 99.55	898.18(3) 51.08	1703.94(4) 78.19	-	-	-	-	284.33(3) 25.24	1299.00(3) 160.23		
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(2) 113.05	1509.73(18) 104.44	-	-	-	550.69(16) 55.96	1498.10(14) 195.57			
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	-	-	-	33.00(8) 12.65	138.89(8) 43.82			
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	-	-	-	144.50(6) 26.89	111.47(8) 31.50			
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	-	-	-	88.00(5) 37.70	112.79(8) 15.92			
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	-	-	-	175.67(3) 25.61	201.35(4) 14.45			
≤ 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	-	-	-	29.64(11) 27.44	112.59(10) 45.68			
≤ 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	-	-	-	399.13(8) 57.12	208.17(9) 55.93			
51-100	377*	Av.No./set Av.wt./set	-	-	-	-	-	-	-	-	-	-	-	-	968.25(2) 128.15		
101-150	381*	Av.No./set Av.wt./set	-	-	-	-	-	-	-	-	-	-	-	-	477.13(2) 33.46		
51-100	382	Av.No./set Av.wt./set	-	-	-	-	48.00(2) 5.25	584.00(3) 46.51	56.77(3) 4.44	-	-	-	104.00(2) 10.80	571.06(2) 92.77			
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	-	-	-	450.00(2) 41.60	90.93(2) 18.59			
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)				229.90(66)	448.47(72)			
Abundance (Nos x 10 ³)			241.5	731.6	461.5	663.2	1204.7	708.7	754.4				388.0	760.1(740.6)*			
Mean wt./set			89.11	101.70	54.50	47.10	59.89	76.06	47.12				35.23	70.17			
Biomass (t)			138.2	150.5	60.6	73.1	99.7	126.6	78.4				59.4	118.9(116.9)*			

* New strata in 1993.

† Revised estimates with catches of the 2 new deepwater strata removed for comparison with survey results, 1989-92.

Table 4. Mean numbers and weight (kg) of American plaice per tow, by stratum from juvenile surveys in Division 3Ø. 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	1992	1993	
51-100	329	Av.No./set Av.wt./set	-	-	-	-	803.63(4) 132.21	-	640.01(6) 41.15	531.30(6) 41.26	1074.17(5) 60.53	
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	198.20(5) 61.46	177.06(5) 25.21	
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	291.50(2) 36.70	95.43(2) 19.56	
51-100	332	Av.No./set Av.wt./set	-	-	-	-	592.25(4) 80.53	515.00(2) 42.67	435.17(4) 24.82	963.75(4) 80.49	1145.62(4) 115.17	
101-150	333*	Av.No./set Av.wt./set	-	-	-	-	-	-	-	-	50.96(2) 10.64	
101-150	336*	Av.No./set Av.wt./set	-	-	-	-	-	-	-	-	57.96(2) 16.91	
51-100	337	Av.No./set Av.wt./set	-	-	-	-	357.00(2) 45.38	501.33(3) 37.58	444.66(4) 43.76	874.25(4) 71.29	505.86(4) 63.40	
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	647.0(4) 70.03	460.90(4) 57.84	
51-100	339	Av.No./set Av.wt./set	-	-	-	-	2960.50(2) 449.60	2666.33(3) 253.35	1908.28(4) 178.36	1892.00(4) 179.79	2907.76(4) 210.69	
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	844.75(4) 64.53	71.94(3) 14.23	
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	481.27(7) 49.43	297.77(8) 50.42	
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	392.08(13) 53.01	418.14(13) 71.10	
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	889.50(4) 85.47	985.99(4) 133.12	
51-100	354	Av.No./set Av.wt./set	-	-	-	-	472.50(2) 80.53	692.00(3) 82.46	1334.97(3) 103.79	1760.25(4) 115.41	1511.50(3) 158.24	
Mean No./set (# sets)				182.73(30)		126.60(35)	464.37(60)	444.89(60)	406.23(69)	651.57(62)	594.99(63)	
Abundance (Nos $\times 10^6$)				160.9		168.9	855.4	738.1	747.7	1199.3	1113.2(111.6)*	
Mean wt./set				34.14		38.51	79.94	76.58	52.19	65.97	66.16	
Biomass (t)				30.1		51.4	147.2	127.0	96.1	121.4	123.8(123.4)*	

* New strata in 1993.

† Revised estimates with catches of the 2 new strata removed for comparison with survey results in 1989-92.

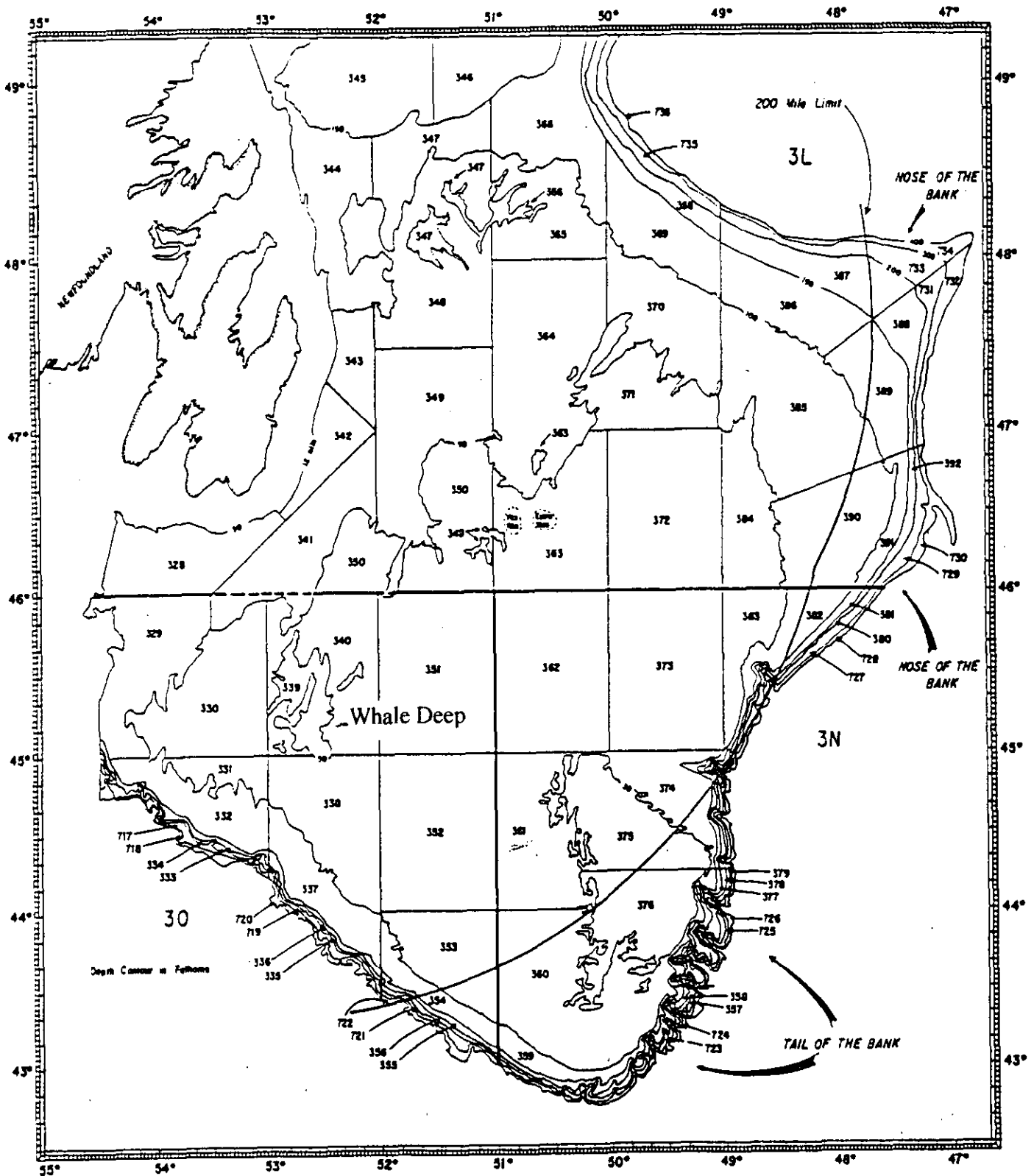


Fig. 1. Grand Banks, NAFO Div. 3LNO, showing the Canadian 200 mile limit in relation to the Nose and Tail of the Bank as well as the stratification scheme used in Canadian groundfish surveys.

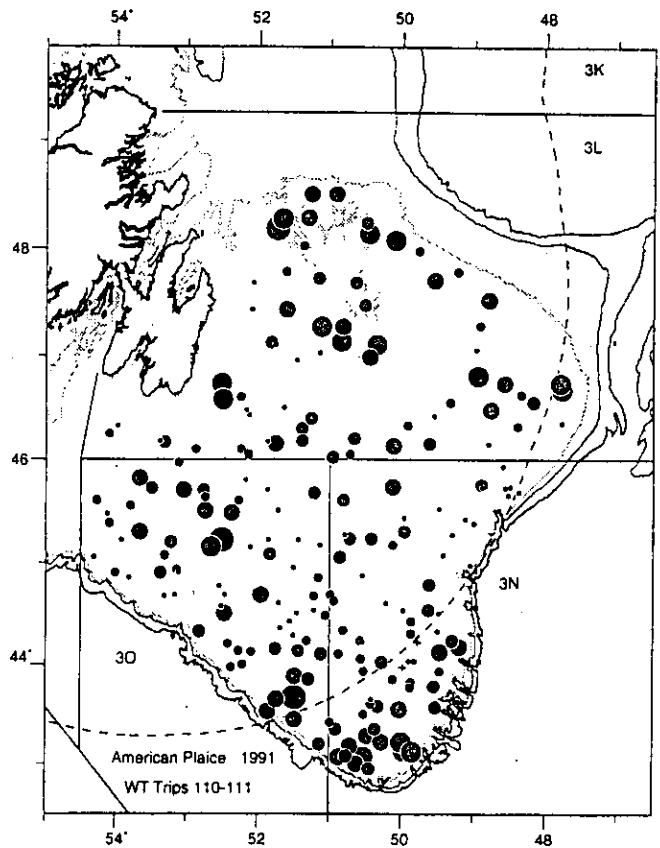
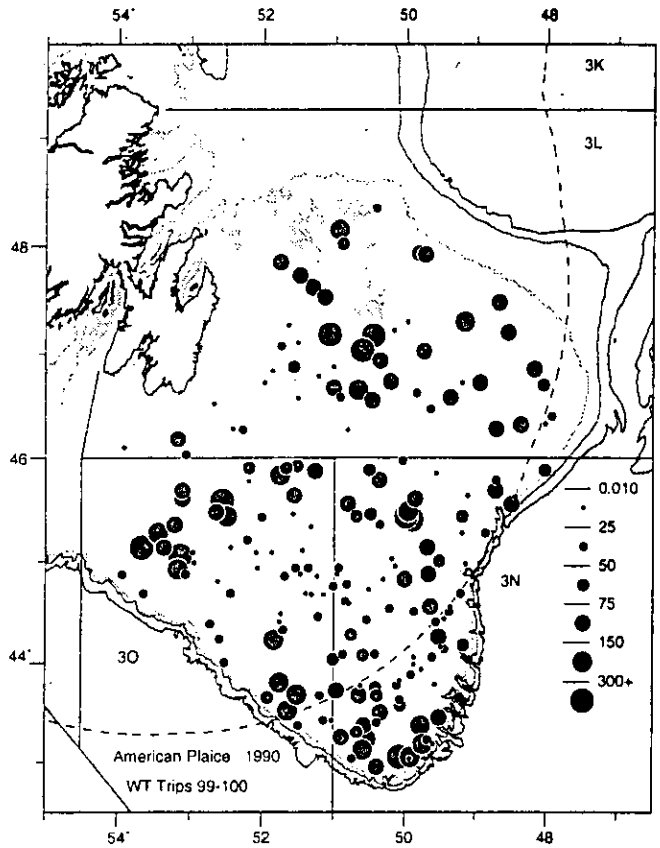
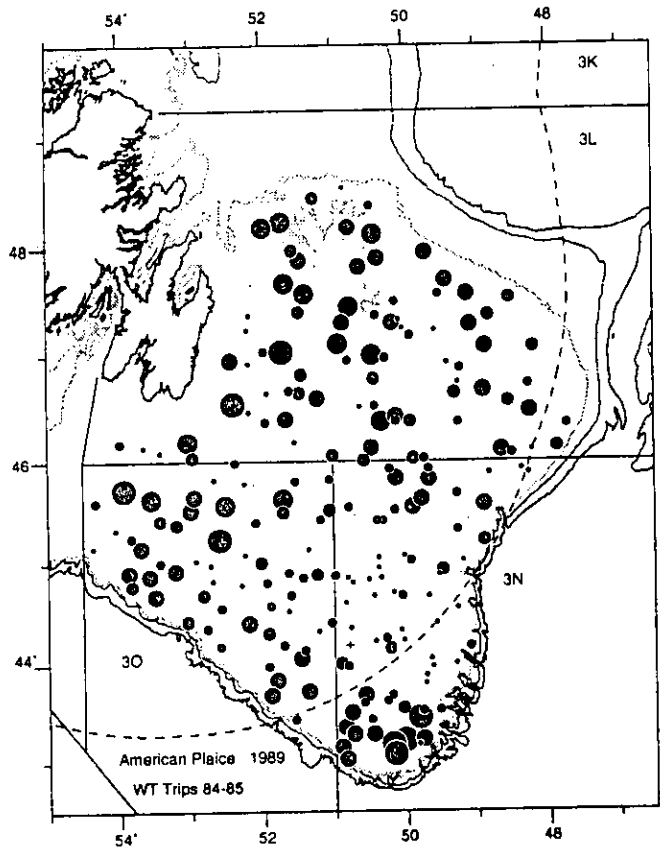


Fig.- 2 Distribution of American Plaice catches from 1989-1993 Canadian Juvenile Flatfish surveys to NAFO Divisions 3LNO by Canadian research vessel Wilfred Templeman. Plots are of the catch per standard tow (kg). All survey tows standardized to 1.3 nautical miles.

Depth (m)
..... 200
..... 400
..... 1000
- - - 200 mile limit

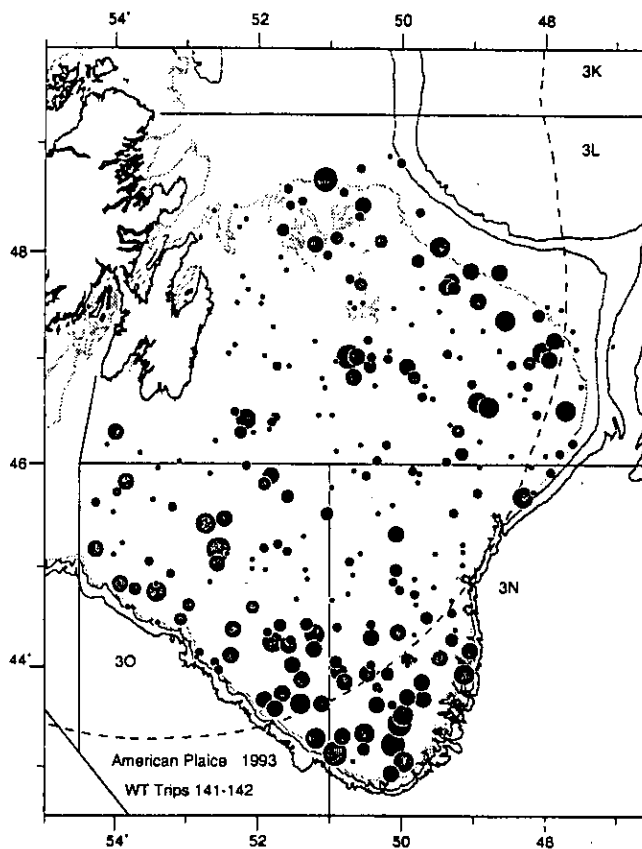
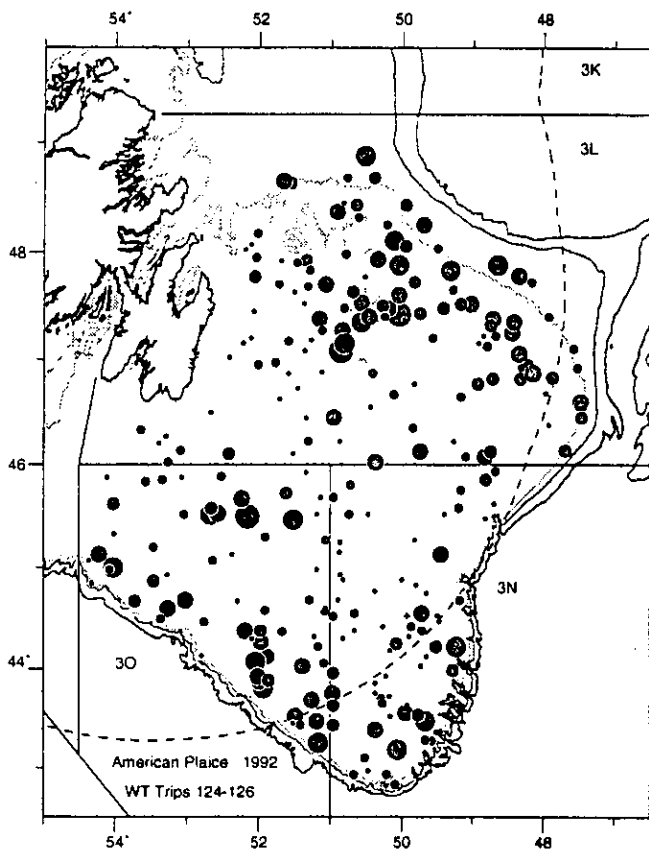


Fig. 2. (continued).

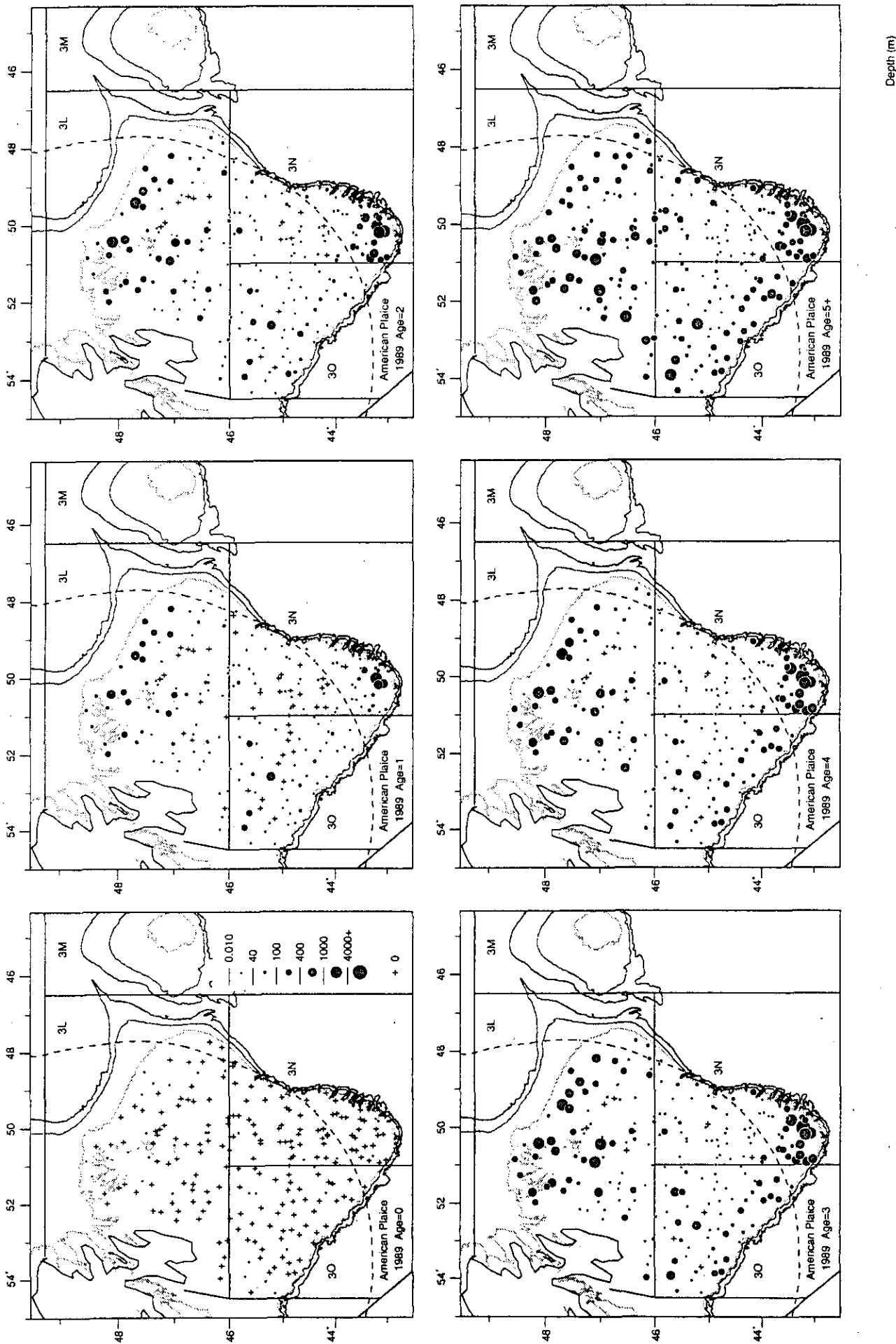
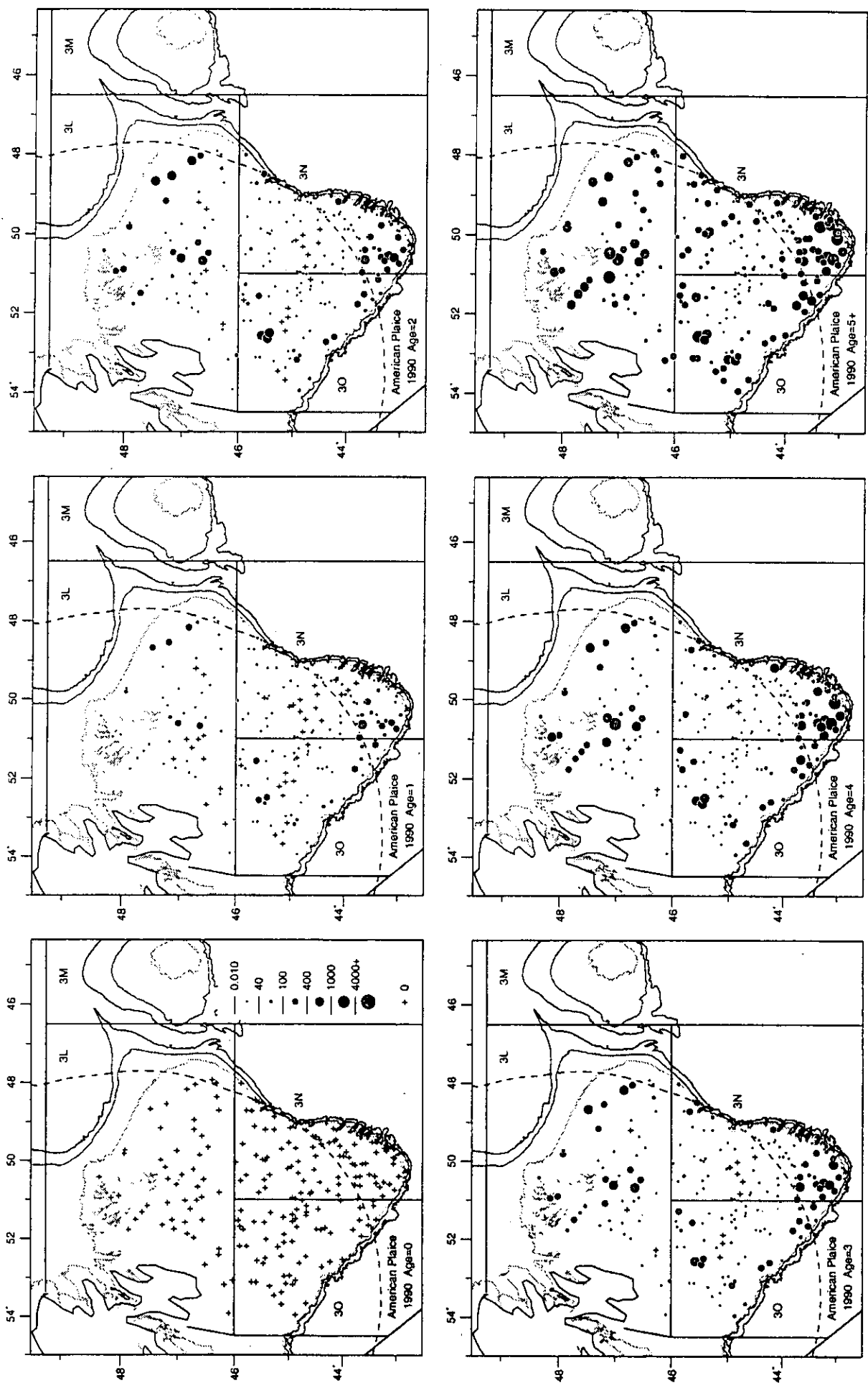
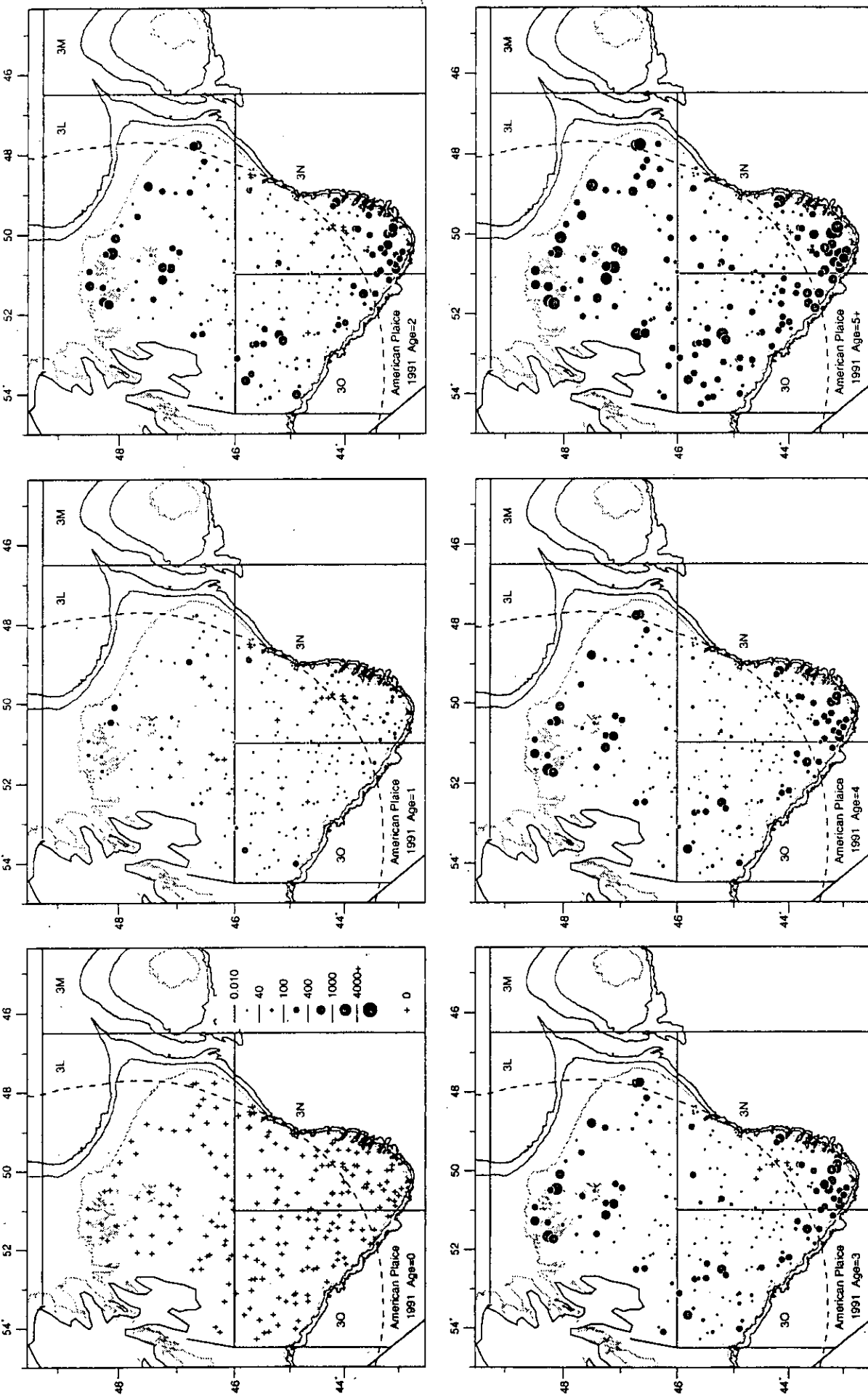


Fig. 3 Distribution of American Plaice catches from 1989 Canadian Juvenile Flatfish surveys to NAFO Divisions 3LNO by the Canadian research vessel Wilfred Templeman. Plots are of the # of fish for age=0, age=1, age=2, age=3, age=4, and age=5+. All survey tows standardized to 1.3 nautical miles.



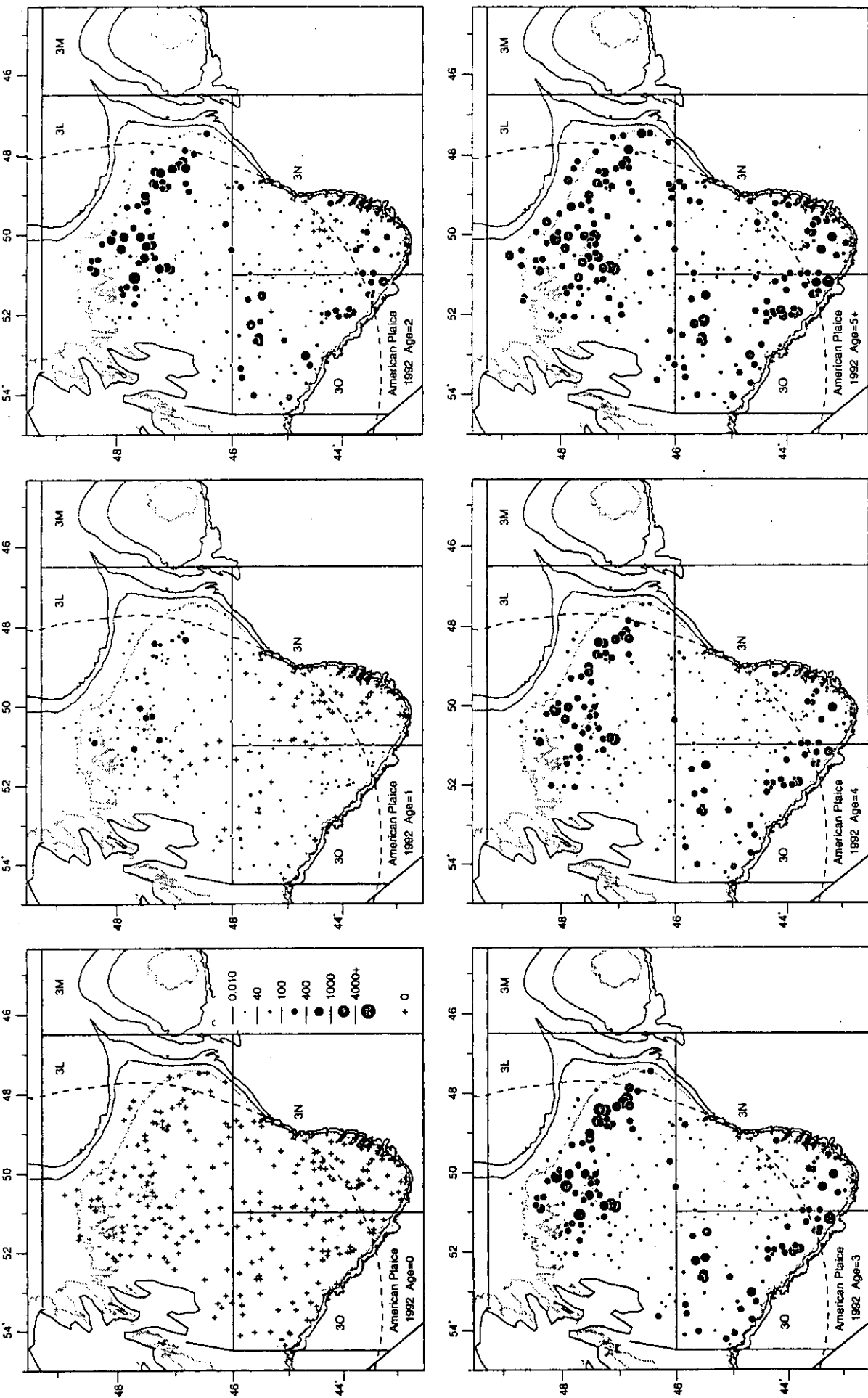
Depth (m)
 200
 400
 1000
 - - - 200 mile limit

Fig. 4 Distribution of American Plaice catches from 1990 Canadian Juvenile Flatfish surveys to NAFO Divisions 3LNO by the Canadian research vessel Wilfred Templeran. Plots are of the # of fish for age=0, age=1, age=2, age=3, age=4, and age=5+. All survey tows standardized to 1.3 nautical miles.



Depth (m)
 200
 400
 1000
 2000
 --- 200 mile limit

Fig. 5 Distribution of American Plaice catches from 1991 Canadian Juvenile Flatfish surveys to NAFO Divisions 3LNO by the Canadian research vessel Wilfred Templeman. Plots are of the # of fish for age=0, age=1, age=2, age=3, age=4, and age=5+. All survey tows standardized to 1.3 nautical miles.



Depth (m)
200
400
1000
2000
--- 200 mile limit

Fig. 6 - Distribution of American Plaice catches from 1992 Canadian Juvenile Flatfish surveys to NAFO Divisions 3LNO by the Canadian research vessel Wilfred Templer. Plots are of the # of fish for age=0, age=1, age=2, age=3, age=4, and age=5+. All survey tows standardized to 1.3 nautical miles.

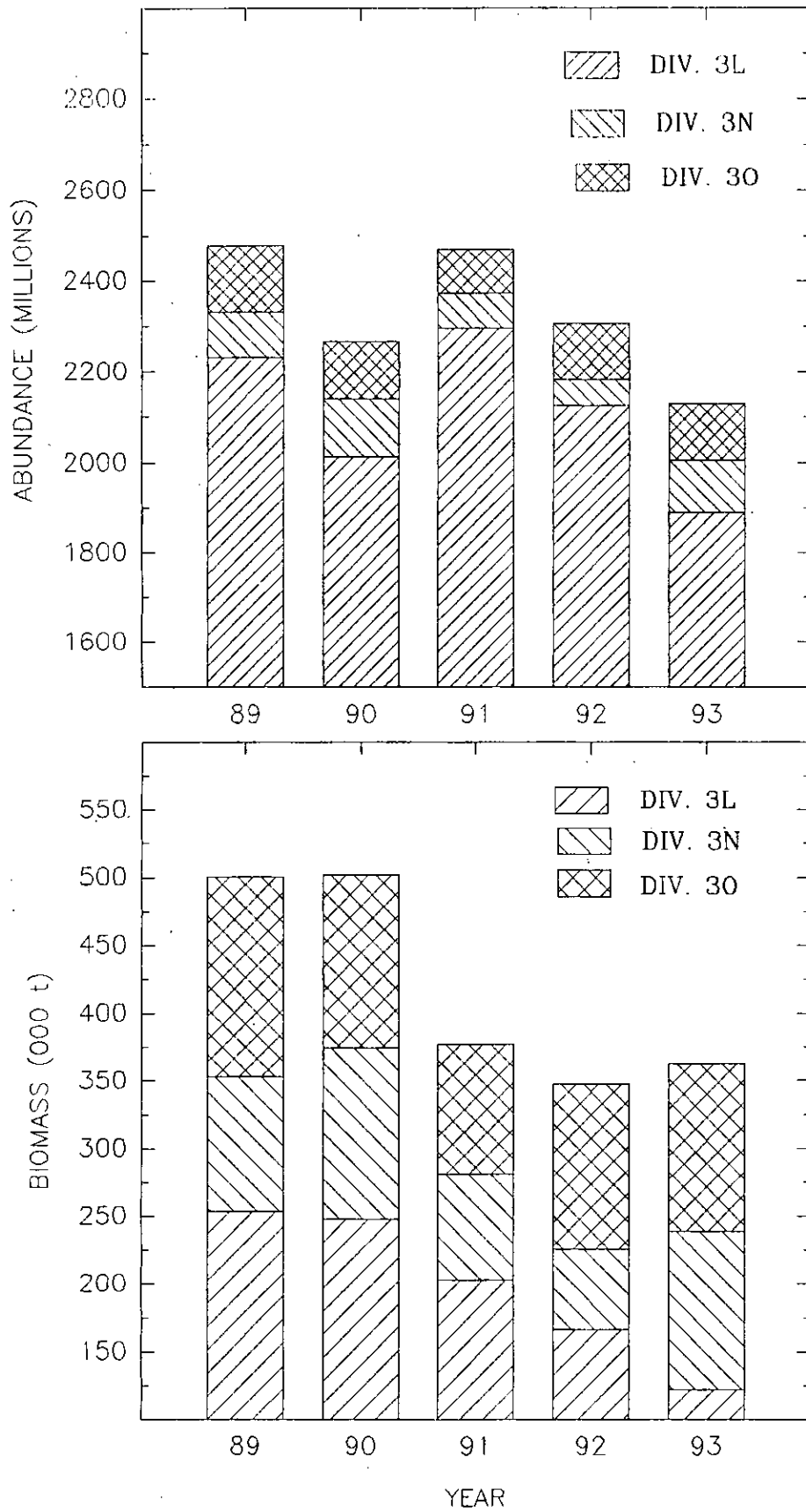


Fig. 7 Trends in abundance and biomass of American plaice on the Grand Bank, 1989-93.