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Results of surveys directed at yellowtail flounder in NAFO Divisions 3NO, conducted on a Canadian commercial trawler.

by

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Introduction

The Department of Fisheries and Oceans (DFO) in St. John's, Newfoundland, and Fishery Products International Limited (FPI), a Canadian company also based in St. John's, are conducting cooperative trawl surveys directed at yellowtail flounder on the Grand Bank, NAFO Divisions 3NO. Given the moratorium on fishing this stock of yellowtail in Divisions 3LNO, which has existed since 1994, the primary objective of the surveys is to provide commercial indices of catch rate and distribution for yellowtail flounder in this area. FPI provides the vessel, crew, fishing gear, operating expenses, and contributes toward the scientific and technical support necessary to conduct the surveys, which is the responsibility of DFO. The first cooperative survey was completed in July, 1996, with the second and third being done in March and May, 1997 respectively. Additional surveys are tentatively planned for the summer and autumn of 1997. This paper examines the results from the first three surveys and compares the information collected with results from research vessel surveys of the area done by DFO, and with data from the FPI fishery for yellowtail in the same area from the 1970's through to the early 1990's.

Methods and Materials

The surveys are designed to cover an area of approximately 9500 square nautical miles (Fig. 1), corresponding to the area where the yellowtail stock is mainly distributed, and where the FPI fishery operated in most years prior to the current NAFO-imposed moratorium on fishing. The survey area is divided into 100 equal-sized blocks, and the same pre-selected position is fished in each block in every survey. These positions were selected at the start of the first survey by FPI, based on their understanding of yellowtail abundance and distribution, and their knowledge of the fishing grounds. All aspects of the fishing operation, including vessel, skipper, trawl gear, and tow speed and duration were kept standard within and between surveys, and aspects such as tow direction and time of day have been kept constant for a given tow between surveys where possible.

The vessel used is the Atlantic Lindsey, which is a commercial stern trawler, 44 m total length, 665 G.R.T., 1500 HP. The fishing gear used is an Engel 145 high lift otter trawl, with rockhopper footgear, and is reflective of trawls historically used by FPI in the yellowtail fishery. Table 1 shows a comparison of the Engel 145 Hi-Lift otter trawl used onboard the FPI trawler Atlantic Lindsey with the old standard survey gear, Engel 145 Hi-Lift otter trawl, and the new standard survey gear, Campelen 1800 shrimp trawl, as used by the DFO institute, Northwest Atlantic Fisheries Center (NAFC). There are several similarities and differences in the Engel trawl used by FPI and DFO. There are major differences are the footgear, sweep/bridle lengths and mesh size. Rockhopper footgear is used on the FPI Engel trawl and the NAFC Campelen trawl, instead of bobbin gear as used on the NAFC trawls. The other major difference in both Engels and the Campelen is the cable (sweeps+lower bridle) distance from the attachment of the lower wing to the trawl doors. The long cable length used on the FPI trawl is 1.7 times longer than the NAFC Engel trawl and 2.5 times longer than that used with the Campelen trawl. These long cable lengths should increase catch rates of flatfish, in particular adult fish, because long cables herd flatfish more efficiently than shorter cables in the fish capture zone. Unlike trawls used in research vessel (r.v.) surveys, no small mesh liner was used in the codend. All trawl components were measured prior to use, to ensure consistency within and between trips. Trawl performance was monitored with SCANMAR during each fishing set, which is one-hour in duration at a speed of 3.0 knots.

Catch numbers and weights of all yellowtail in the catch of each set were recorded. By-catch data on other species such as American plaice and cod were also collected, along with biological sampling (size and maturity) data for yellowtail. Temperature data were collected on about 55% of the tows on each survey via XBT. To facilitate comparisons, the catch data were grouped into quadrants of 5 x 5 blocks, with Q1 corresponding to the northwest quadrant, Q2 the northeast, Q3 the southeast, and Q4 the southwest. Results from the first 2 surveys are compared with data from spring and fall stratified random surveys done by DFO (Walsh et al. 1997), and with analysis of yellowtail CPUE data in the NAFO database for 1970-91 (Brodie et al. 1993). In addition, over 40,000 set-by set records from a sample of 15 FPI trawlers fishing in Div. 3NO between 1985 and 1991 (Brodie 1996) was examined for comparison with the 1996 and 1997 surveys. These vessels were very similar to the one which is conducting the surveys, and were engaged in groundfish (primarily flatfish) fisheries on the Grand Bank for most months in the period 1985-91.

Stratified random trawl surveys were conducted by DFO in Divisions 3NO during autumn 1995, and spring and autumn 1996, as part of ongoing time series measuring abundance and distribution of various groundfish species. The standard survey gear, adopted in mid-1995, was a Campelen 1800 shrimp trawl, with a 12.7 mm liner in the codend (for more information on the specifications of this trawl, see McCallum and Walsh 1996). Tows were 15 minutes in duration at a speed of 3.0 knots, and trawl gear was monitored with SCANMAR throughout each tow. Data from these surveys in 1995-96, including biomass estimates calculated with the usual swept-area methodology (Smith and Somerton 1981), were compared with the results from the FPI surveys in 1996-97.

Results and Discussion

Catches from first three surveys: Totals of 83, 68, and 82 successful sets were completed in July, 1996; March, 1997; and May, 1997 respectively. Coverage was reduced in March due to poor weather. For all species examined, catch weights per tow in March were significantly lower than those in July, 1996, as seen in the following table (all values in kg. per hr.):

Species	Survey	Median	Mean	Std. Error
Yellowtail	Jul 96	642.2	693.5	51.6
	Mar 97	25.6	124.0	65.3
A plaice	Jul 96	74.5	106.7	13.8
	Mar 97	4.5	20.4	5.4
Cod	Jul 96	41.0	105.6	31.1
	Mar 97	0.0	0.8	0.2
Th. Skate	Jul 96	40.0	62.5	8.1
	Mar 97	8.0	28.0	6.2

Set by set catches for yellowtail flounder from the first three surveys can be seen in Table 2. Of the 65 blocks covered in the first two surveys, only 1 block (G04) had a larger catch of yellowtail in the second survey. In the other 64 comparable blocks, the mean catch of yellowtail in March was only 7.4% of the mean value in the previous July. The quadrant comparisons show higher catch rates in July relative to March in all 4 zones (Fig. 2). In both surveys, yellowtail catch rates were higher in Div. 3N than in Div. 3O. The results of the third survey (only yellowtail was examined from the third survey), were very similar to the first, suggesting that the March survey was anomalous (Table 2). The largest catch in the May survey was 4607 kg., similar to the large catch in the March trip. Overall mean catch per tow was slightly lower in the third survey relative to the first, with the largest difference occurring in Q3. CPUE was slightly higher in the latter survey in Q2 and Q4.

The catch of 4972 kg. of yellowtail in Block G04 in March constituted 59% of the total yellowtail catch in this survey, and was about 40 times higher than the mean catch per tow. In comparison, the yellowtail catch in Block G04 in July, 1996 of 869 kg. was only 25% higher than the average catch per tow during July. The catch in this block in May, 1997 was 610 kg, which was also the average value for the whole grid. The largest catch of yellowtail in the July survey (2504 kg. in Block E04) made up only 4.4% of the total catch of this species during that survey, and was just under 4 times higher than the mean value. The largest catch in the May survey (4607 kg. in Block E01) comprised about 9.2 % of the total, and was 7.6 times higher than the mean. Various measures of the varibility in the yellowtail catches can be seen in Table 2. Mean bottom temperature was 1.98 °C in July compared to 1.26 °C in March.

Distribution of yellowtail: ACON plots (Black 1993) of yellowtail catch weights clearly show the difference in abundance and distribution of yellowtail flounder during the 3 surveys (Figs. 3 to 5). In March, 1997, the only large catches of yellowtail were taken near the center of the grid, around blocks G04 and F04. This area also contained relatively large catches in July, 1996, although several other areas also produced large catches in July, as well as in May, 1997. Of particular interest in the July survey were 5 catches, each greater than 1000 kg., which occurred in the northwest corner of the grid (Fig. 3). This was somewhat surprising, as this area was not known as a prime location for yellowtail when the commercial fishery was operating, and DFO surveys of this area in spring and fall do not usually produce large catches of yellowtail. Catches in May were somewhat lower in this area, although Block B01 did have one catch greater than 1000 kg. (Table 2). All catches greater than 1000 kg in May occurred in the northern part of the grid (first 3 rows). Catches in all 3 surveys were low in the southwest corner of the grid, as well in most tows in the eastern part (column J) of the grid.

To examine geographic distribution of yellowtail caught in the July survey, by size groups, the numbers of fish <= 30 cm. and the number > 40 cm. were plotted on a set by set basis. The highest densities of small fish occurred in quadrant 3 (Fig. 6a), in the nursery area for this species. There was a wider distribution of fish greater than 40 cm., with the largest catches occurring in the central portion of the grid (Fig. 6b). The overall length frequency of yellowtail caught during July is shown in Fig. 7a, and consists mainly of fish in the 30 to 45 cm. length range. Length frequency data from the 1997 surveys were not available for comparison at the time this paper was written, and will be analyzed subsequently. The age composition was obtained by applying the yellowtail age-length key from the spring 1996 stratified random survey to the numbers at length in the July, 1996 survey. Fig. 7b indicates that most fish caught were aged 6-8 years, which is typical of the Canadian commercial fishery in previous years (Brodie et al. 1993). The age compositions in Divs. 3N and 3O were similar, although there were more small fish in Div. 3N, consistent with the location of some fishing sets in the nursery areas on the Tail of the Bank.

Comparison of results with commercial fishery data: In many assessments of the yellowtail stock in Div. 3LNO, a multiplicative model has been used in the analysis of CPUE data reported by Canadian vessels in the period after 1964 (eg. Brodie et al. 1993). In these analyses, the effects on CPUE of vessel size, gear type, Division, month, and year were considered. To compare these results with the grid surveys, data from the same class of vessel as the Atlantic Lindsey were examined for Div. 3N, for the years 1970-91. For months with more than 100 tons of directed yellowtail catch, data from July of year n were compared with March of year n+1. Fig 8 shows, for the 6 comparisons available, that no marked declines from July to March were observed, to the extent seen from the first to the second FPI survey. This comparison also indicates that the July survey CPUE for yellowtail was similar to the maximum July CPUE , which occurred in the 1985 fishery. On the other hand, the March survey CPUE was much lower than any March CPUE value observed in the fishery. Fig. 9 shows the monthly trend in CPUE (aggregated over all years), compared with the monthly pattern indicated by the multiplicative model. These indices show that the March CPUE was intermediate between the low values in May-July, and the high values in September-October. The May value of the month coefficient was higher than the July value, but the mean July CPUE was slightly higher than the May CPUE.

A summary of the set-by-set data from 15 FPI trawlers fishing for various species in Div. 3NO from 1985-91 is shown in Fig. 10. About 40 % of the sets occurred within the boundaries of the survey grid. Table 3 gives a breakdown, by quadrant and year, of the yellowtail catch and CPUE in this sample, arranged by total effort, and effort directed at yellowtail flounder. Most of the yellowtail catch from this fleet occurred in quadrants 2 and 3, with quadrant 3 usually showing the highest CPUE values. The blocks in the central parts of columns G and H had the highest overall catches of yellowtail (Fig. 11). This area also had CPUE values among the highest in the grid (Fig. 12), although the best catch rates in the July, 1996 survey were generally to the west, in columns A, E, and F (Table 2, Fig. 3b), and the best CPUE in the May survey (Table 2, Fig. 5b) was north of the peak values in the fishery. Figs 11 and 12 also indicate that the northwest corner of the grid, which produced several good catches in the July survey and one good one in the May survey, was not a primary fishing area for yellowtail. It is also interesting that block E04, which yielded the largest catch in the July survey, and a near-average catch in May, had only one set out of 16,000 in the commercial sample (Fig. 10). Block E01, with the largest catch in May 1997, was also a lightly fished block historically, with only 44 sets in the period 1985-91. However, Block G04, which had the highest catch in the March survey, was the fifth most heavily fished block in the grid from 1985 to 1991.

Seasonal trends in catch by this fleet show a peak in August-September for all years combined (Fig. 13), although there was some variability among years. The same general pattern observed in Fig. 9 can be seen in the monthly CPUE sample from this fleet (Fig. 14), ie. higher CPUE early in the year, a decrease in summer, and an increase in the autumn. It should be noted, however, that substantial catches in the first quarter in this sample occurred only in one month - February, 1985 (Fig. 13).

It must be stated that the direct comparability of the catch rates in the grid surveys with those from the previous commercial fishery is not known. Tow duration during the commercial fishery was generally around three hours, compared to one hour in the grid surveys. Also, the catch rates in the commercial fishery were obtained by several vessels over longer periods of time. Nonetheless, results from 2 of the 3 grid surveys in 1996 and 1997 suggest widespread distribution of yellowtail CPUE's considered to be quite high.

Comparison of results with research vessel data: The distribution of yellowtail from the 2 stratified random surveys in 1996, and the autumn survey in 1995, is shown in Fig. 10. The grid, which is not part of the design of the r.v. surveys, is superimposed on these plots, indicating that most of the yellowtail caught in the r.v. surveys is located within the boundaries of the grid. In fact, 87% of the yellowtail caught in spring 1996 were within the grid, compared with 89% in the autumn 1996 survey. Within the grid, r.v. survey catch rates of yellowtail were similar in spring and fall 1996, although there were differences between Divs. 3N and 3O in the 2 surveys (Fig. 16). From Div. 3NO overall, the swept-area biomass estimate of yellowtail from the r.v surveys was 174,000 t in spring 1996, and 132,000 t in the fall survey, with the latter figure being almost identical to the value from the fall, 1995 survey. In these past three surveys, the biomass in Div 3N has been relatively stable between 103, 000 and 113,000 t, while Div. 3O has ranged from 19,000 to 71,000 t. The largest catches of yellowtail during the 1996 spring and fall r.v. surveys were 257 and 307 kg. per 15 min. tow respectively. The length frequency of yellowtail from the spring r.v. survey (Fig. 7) differs substantially from the July FPI survey, due mainly to the differences in trawl gear used in both surveys. With the use of a fine mesh liner in the survey trawl, considerably more small yellowtail are taken relative to the commercial trawl. For the age compositions of yellowtail in these surveys, see Walsh et al. 1997.

Conclusions: Cooperative surveys in Divisions 3NO between DFO and FPI indicate drastic changes in catch rate and distribution of yellowtail and other species in March, 1997 compared with July, 1996, and May, 1997. The high CPUE observed in July, and the low CPUE observed in March are both extreme when compared to historic CPUE data from the fishery, and make interpretation of the results as an index of abundance virtually impossible. The similarity of the first and third grid surveys suggest that the second survey was anomalous. Research vessel surveys conducted in autumn 1995, spring 1996, autumn 1996, and spring 1997 show a relatively stable picture of yellowtail abundance and distribution (Walsh et al. 1997), although distribution appears to be more extensive than in the surveys of the early 1990's. There are no r.v. survey data from March in Div. 3NO in any year to compare with the March 1997 FPI survey. Given the moratorium on fishing yellowtail which existed during the time of the surveys, and the life history of the species, it can be assumed reasonably that the abundance of yellowtail did not change in proportion to the change in CPUE over the short time span of the grid surveys. Possible reasons for the differences between the second grid survey and the other two include changes in availability or catchability of fish relative to the trawl, and/or changes in distribution and concentration of yellowtail, both within the survey grid, and between the areas inside and outside the grid. Comparison of all three surveys suggests seasonal difference in distribution.

Future analyses will examine data for other species, as well as length frequency data for yellowtail from the second and third surveys. Further work is planned in 1997, including additional research vessel and FPI surveys, and will be important in evaluating the differences observed thus far.

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Table 1. Comparison of the FPI commercial trawl with the NAFC old standard Engel trawl and the new Campelen trawl.

Parameter	Engel 145 Hi-Lift Otter trawl		Engel 145 Hi-Lift Otter Trawl	Campelen 1800 Shrimp trawl
	Gadus Atlantica	Wilfred Templeman	Atl. Lindsey FPI	Wilfred Templeman
Doors	$5.6m^2$/1400kg	$3.8m^2$/1250kg	$6.7m^2$/2800kg	$4.3m^2$/1400kg
Sweeps (m)	17	15	90	6.1
Bridles (m)	50	50	24	40
Buoyancy (kg)	300	283		227
Headline (m)	29	29	29	29
Fishing Line (m)	31	31	31	20
<u>Footgear</u> Length (m)	44	44	44	37
Material	27 Steel Bobbins	25 Steel Bobbins & 4 Rubber Rollers	Rubber Disks (Rockhopper)	102 Rubber Disks (Rockhopper)
Weight Air (kg)	3169	2350	- -	501
Size (dia./cm)	61/53/46/36	53/46/36	46/41/36	35
<u>Mesh Size (mm)</u> Wings/Square	180	180	180	80/60
Bellies	160	150/130	160	60/44
Extension	none	none	148	none
Codend	160	130	140	44
Liner	30	30	None	12.7
Material	Nylon	Polyethelyene Nylon Codend	Polyethelyene Nylon Codend	Polyethylene

Table 2. Comparison of yellowtail catches (kg.) in July, 1996 and March and May, 1997 surveys. Largest catch in each survey is underlined. All tows are one hour (or standardized to 1 hour). Blocks fished in all 3 surveys are in italics.

Block	Jul 96	Mar 97	May 97
Quad 1			
A01	1315.9	7.0	234.9
A02	1828.3		646.0
A03	1086.9	23.7	204.0
A05	1410.5	35.5	421.8
B01	1075.2		1014.6
B02	321.0	0.0	210.0
B03	683.7		587.3
B04	492.9	41.0	498.2
C01	758.3	1.0	231.4
C02	352.5		389.8
C03	224.5	18.0	287.6
C04	324.0		702.0
C05	942.6	23.0	401.0
D01	720.9		1524.6
D02	280.0	3.5	241.6
D03	234.0	4.5	245.0
D04	668.1	35.0	400.0
D05	739.8		458.3
E01	713.9		4607.0
E02	937.3	18.5	2529.3
E04	2503.6	27.5	582.4
E05	1340.9	60.0	633.0
Mean	861.6	21.3	775.0
Standard Error	120.7	3.7	214.5
Median	730.4	20.8	440.1
Minimum	224.5	0.0	204.0
Maximum	2503.6	60.0	4607.0
Sum	18954.8	298.2	17049.8
Count	22	14	22

Block	Jul 96	Mar 97	May 97
Quad 2			
F02	1037.0	52.0	1145.0
F03	879.5	20.0	444.8
F04	1032.3	677.9	833.2
F05	1818.1	498.3	935.6
G01	664.8	5.5	635.4
G03	344.7	81.0	322.0
G04	868.7	4972.4	610.2
G05	502.5	67.5	469.3
H02	600.8	20.5	1911.0
H03		40.5	
H04	357.6	205.0	457.0
H05	322.9	52.5	256.5
I01	278.5	0.0	949.5
I03	441.9	0.5	1263.8
I05	440.2	7.0	404.1
J02	103.5	0.0	28.5
J04	34.0	0.0	32.0
Mean	607.9	394.2	668.6
Standard Error	107.5	289.9	119.1
Median	472.2	40.5	539.8
Minimum	34.0	0.0	28.5
Maximum	1818.1	4972.4	1911.0
Sum	9727.0	6700.6	10697.9
Count	16	17	16

Block	Jul 96	Mar 97	May 97
Quad 4			
A07	576.7		599.0
A08	326.0	67.5	585.0
A09	123.6	27.5	49.0
A10	114.5	7.0	32.5
B06	756.0	27.5	629.9
B07	106.5	65.5	
B08	642.2		778.0
B09	254.2	36.0	142.0
B10	79.5	68.0	84.0
B10	67.0		
C07	526.8	40.5	778.0
C08	115.4		495.0
C09	471.9	21.5	638.0
C10	1430.9	88.0	716.5
D06	1560.3	47.0	976.6
D07	698.1	4.6	956.8
D08	471.9		525.2
D09	684.8	71.5	868.6
D10	445.7		687.0
E06		29.5	584.5
E07	890.6	14.5	336.0
E08	1167.9	11.0	714.0
E09	609.6	5.0	640.0
E10	557.1		764.0
Mean	551.2	37.2	571.8
Standard Error	82.7	5.3	55.9
Median	526.8	29.5	634.0
Minimum	67.0	4.6	32.5
Maximum	1560.3	88.0	976.6
Sum	12677.2	632.1	12579.6
Count	23	17	22

Block	Jul 96	Mar 97	May 97
Quad 3			
F06	955.9	87.0	703.2
F07	1921.1	126.5	751.5
F08	1755.3	21.0	705.3
F09	836.8		587.0
F10	491.6		492.0
G06		31.0	
G07	721.7	28.5	638.9
G08	873.1		690.5
G09	813.0	51.0	798.5
G10	658.5	148.0	272.4
H06	436.4	33.0	302.9
H07	443.0	67.5	850.0
H08	736.7	7.5	697.4
H09	485.1	7.5	150.5
H10	934.3	102.8	299.0
I07	1084.3	19.0	378.0
I08	255.5	6.5	497.0
I09	806.7	15.5	200.3
I10	740.2	15.0	321.0
J06	82.0	2.0	24.5
J08	507.6	12.0	47.5
J09	127.5	2.5	43.0
J10	536.4	16.5	89.0
Mean	736.5	40.0	433.6
Standard Error	92.3	9.1	56.9
Median	729.2	20.0	435.0
Minimum	82.0	2.0	24.5
Maximum	1921.1	148.0	850.0
Sum	16202.7	800.3	9539.4
Count	22	20	22

Div. 3O (cols A - D)	Jul 96	Mar 97	May 97
Mean	619.2	31.8	521.1
Standard Error	73.2	4.1	51.9
Median	526.8	27.5	498.2
Minimum	67.0	0.0	32.5
Maximum	1828.3	88.0	1524.6
Sum	22911.1	764.3	18239.2
Count	37	24	35
Div. 3N (cols E - J)			
Mean	753.3	174.2	672.9
Standard Error	71.0	107.2	106.4
Median	689.4	20.8	584.5
Minimum	34.0	0.0	24.5
Maximum	2503.6	4972.4	4607.0
Sum	34650.6	7666.9	31627.5
Count	46	44	47
Total (all blocks)			
Mean	693.5	124.0	608.1
Standard Error	51.6	65.3	65.0
Median	642.2	25.6	553.8
Minimum	34.0	0.0	24.5
Maximum	2503.6	4972.4	4607.0
Sum	57561.7	8431.2	49866.7
Count	83	68	82
Comparable blocks (July 96, May 97)			
Mean	708.5		608.4
Standard Error	52.8		67.4
Median	658.5		525.2
Minimum	34.0		24.5
Maximum	2503.6		4607.0
Sum	57388.2		49282.2
Count	81		81
Comparable blocks (all 3 surveys)			
Mean	717.8	129.1	527.1
Standard Error	62.5	78.0	54.2
Median	661.7	22.3	450.9
Minimum	34.0	0.0	24.5
Maximum	2503.6	4972.4	2529.3
Sum	45939.4	8264.7	33734.9
Count	64	64	64

Table 3. Catch and CPUE data for yellowtail from a sample of 15 FPI trawlers in the commercial fishery in198591. Catches are in kg., and CPUE is kg. Per hour trawling.

		All sets			Yellowtail directed sets		
Year	Quadrant	No. sets	Ytail Catch	Ytail CPUE	No. sets	Ytail Catch	Ytail CPUE
1985	Q1	183	92,374	193	51	32,250	239
	Q2	1026	1,005,888	368	414	539,821	483
	Q3	610	961,481	632	506	830,619	642
	Q4	161	6,713	13	1	454	151
1986	Q1	316	158,009	182	120	84,663	258
	Q2	2139	1,618,702	261	935	1,037,101	381
	Q3	901	1,303,751	568	716	1,114,739	608
	Q4	129	47,718	118	23	18,234	266
1987	Q1	155	126,634	281	82	78,789	326
	Q2	1885	2,152,661	395	1302	1,667,548	443
	Q3	1208	1,343,991	401	830	977,887	424
	Q4	600	516,401	288	292	327,592	390
1988	Q1	142	110,665	243	30	22,070	262
	Q2	971	891,780	280	348	393,483	378
	Q3	1128	1,278,220	398	745	947,830	438
	Q4	566	296,049	152	97	91,544	283
1989	Q1	314	228,767	242	57	64,659	411
	Q2	613	347,374	172	124	157,433	389
	Q3	420	343,825	306	161	180,668	394
	Q4	271	158,174	179	36	35,977	318
1990	Q1	173	75,818	157	17	10,160	199
	Q2	556	320,715	197	94	90,074	349
	Q3	118	190,736	619	66	113,435	646
	Q4	36	11,050	101	6	6,350	343
1991	Q1	458	249,563	182	21	14,560	203
	Q2	592	486,358	272	149	247,344	507
	Q3	188	169,264	324	70	107,184	496
	Q4	177	151,992	275	38	38,991	343
1985-91	Q1	1741	1,041,831	207	378	307,152	287
	Q2	7782	6,823,476	296	3366	4,132,804	422
	Q3	4573	5,591,268	453	3094	4,272,362	506
	Q4	1940	1,188,097	191	493	519,143	351

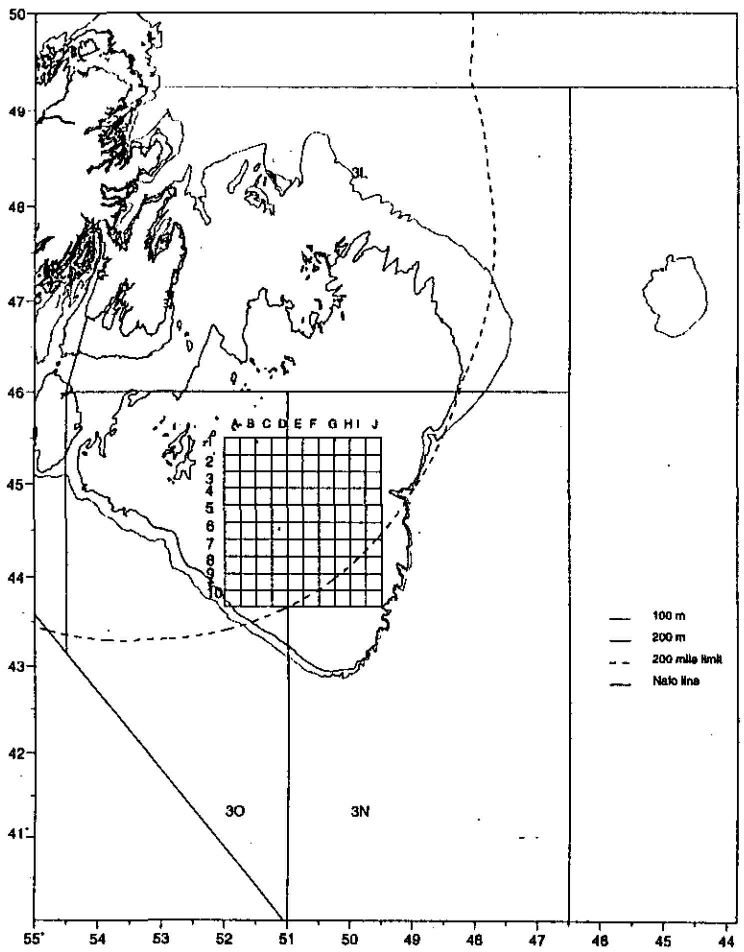

Fig. 1. Map of Grand Bank of Newfoundland, showing location of grid used in FPI surveys of 1996 and 1997.

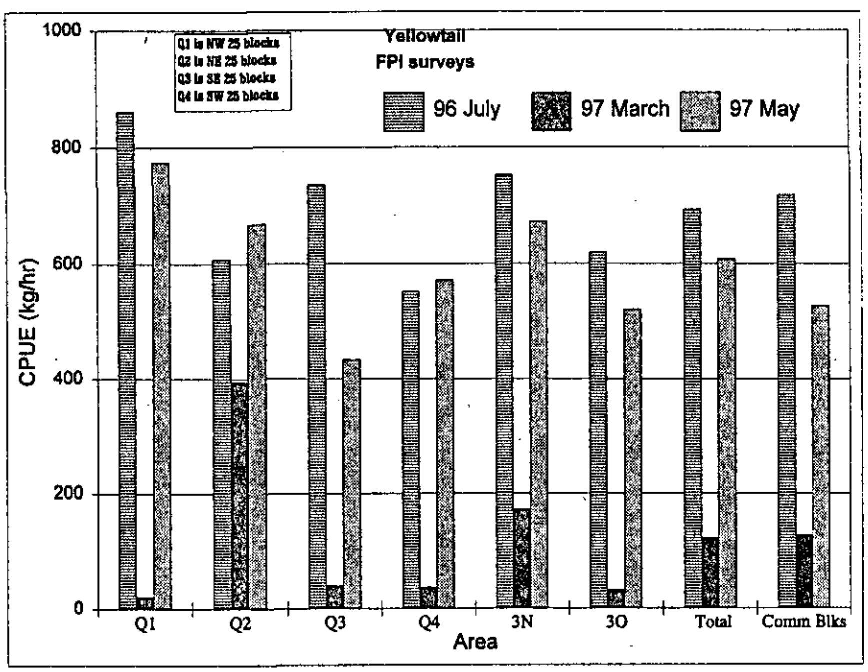

Fig. 2. CPUE (kg/hr) of yellowtail taken in various areas during FPI surveys in July, 1996, and March and May, 1997.

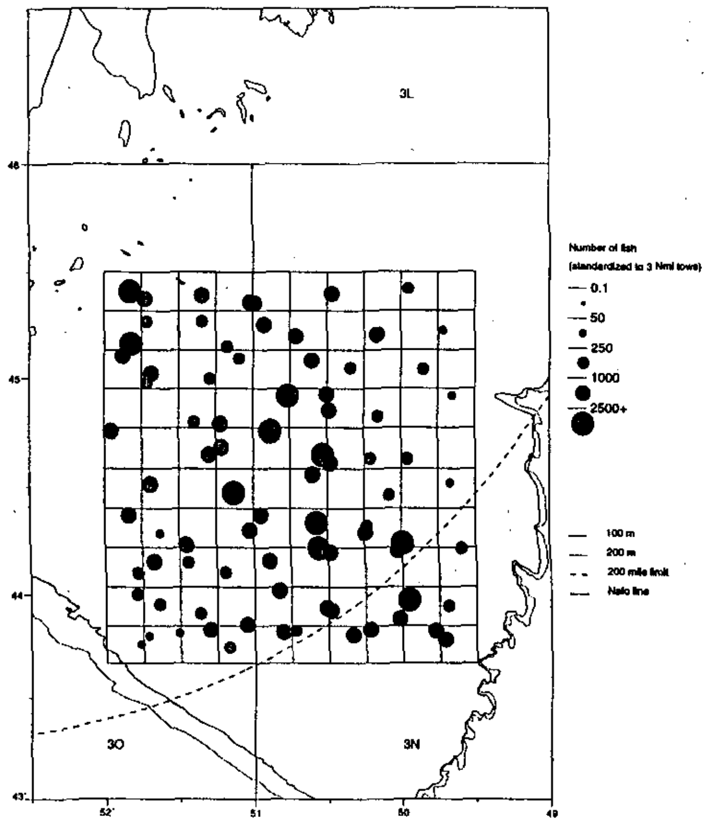

Fig. 3a). Distribution of Yellowtail Flounder catches from 1996 Atlantic Lindsey Trip 1

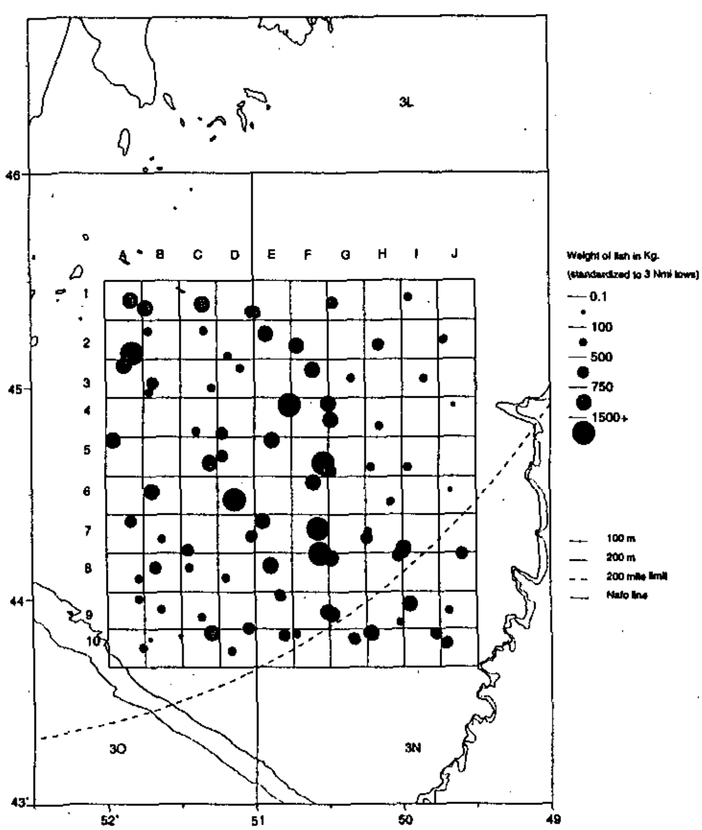

Fig. 3b). Distribution of Yellowtail Flounder catches from 1996 Atlantic Lindsey Trip 1

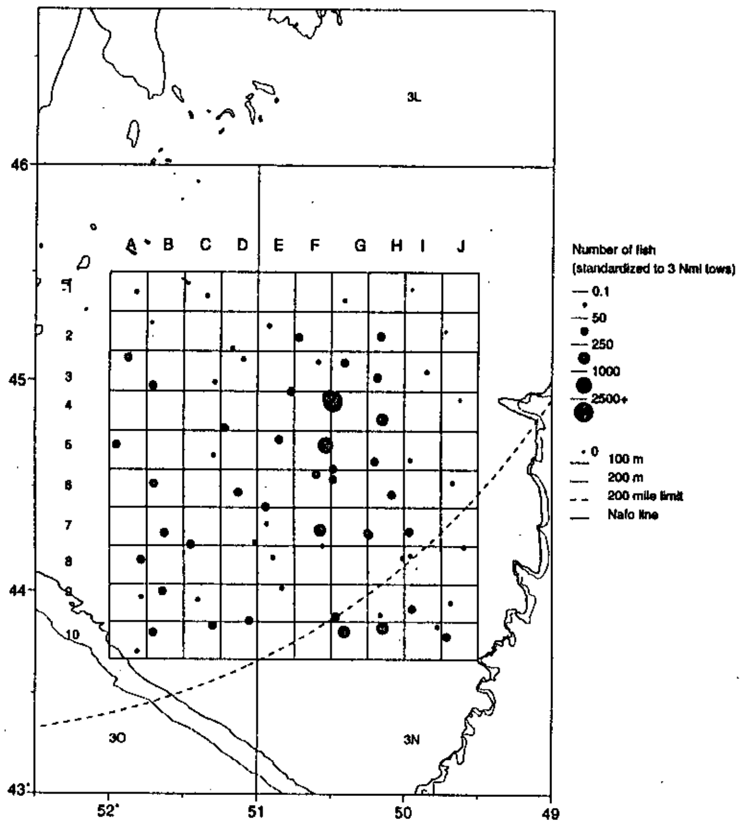

Fig. 4a). Distribution of Yellowtail Flounder catches from 1997 Atlantic Lindsey Trip 2

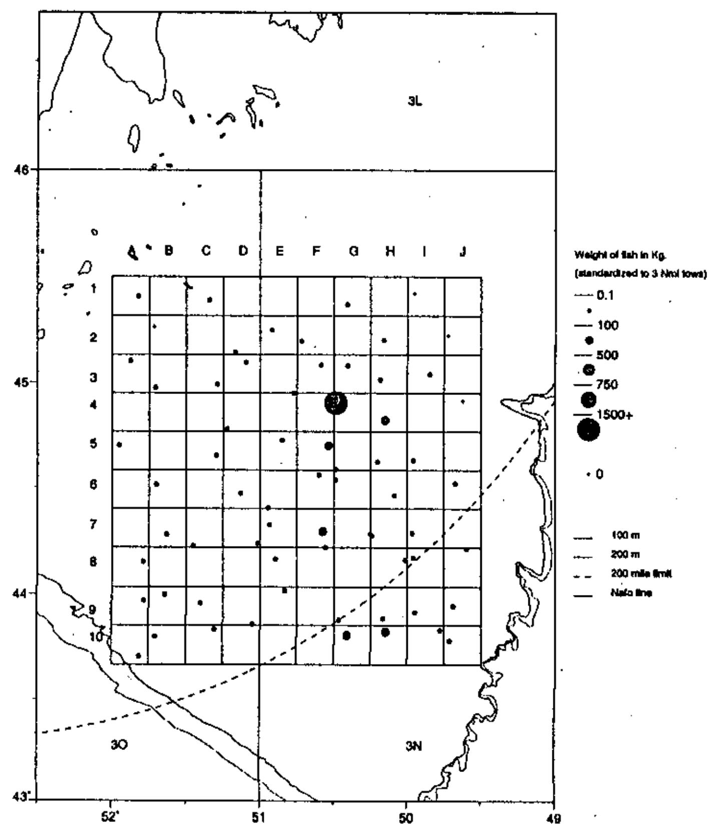

Fig. 4b). Distribution of Yellowtail Flounder catches from 1997 Atlantic Lindsey Trip 2

- 12 -

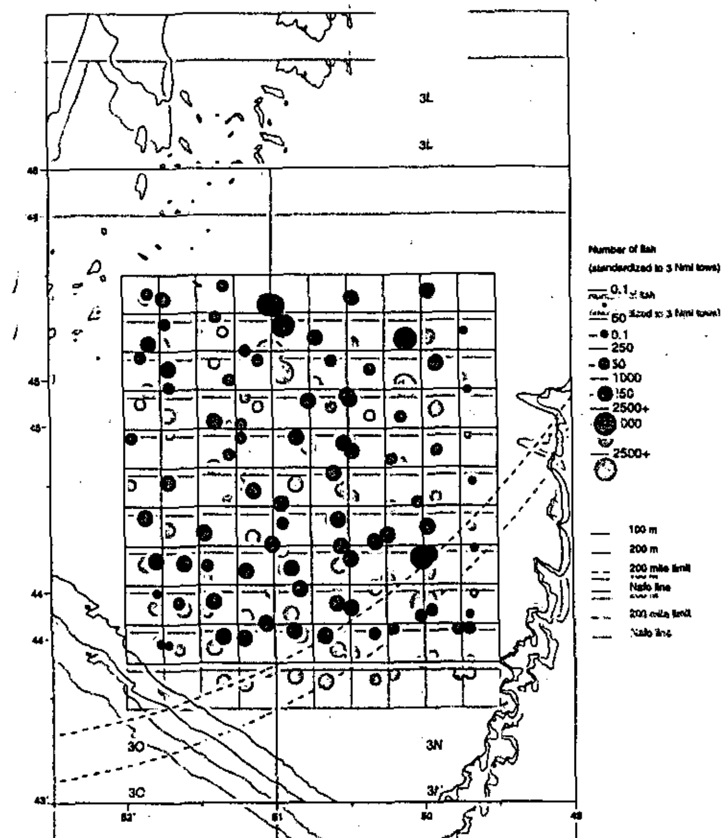

Fig. 5a. Distribution of yellowtail flounder catches from 1997 Atlantic Lindsey Trip 3.

Fig. 5a. Distribution of yellowtail flounder catches from 1997 Atlantic Lindsey Trip 3.

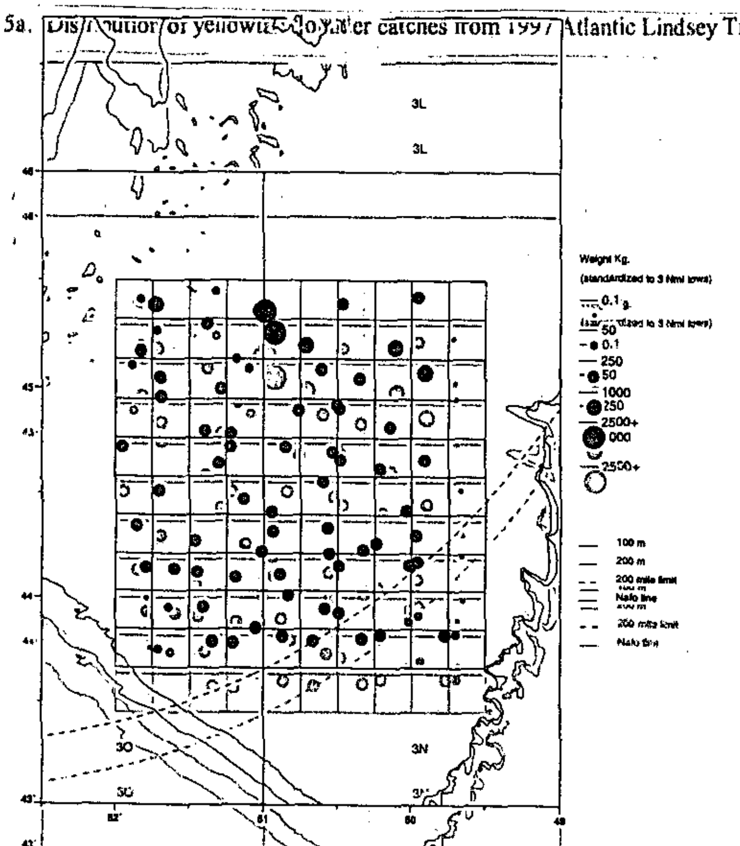

Fig. 5b. Distribution of yellowtail flounder catches from 1997 Atlantic Lindsey Trip 3.

Fig. 5b. Distribution of yellowtail flounder catches from 1997 Atlantic Lindsey Trip 3.

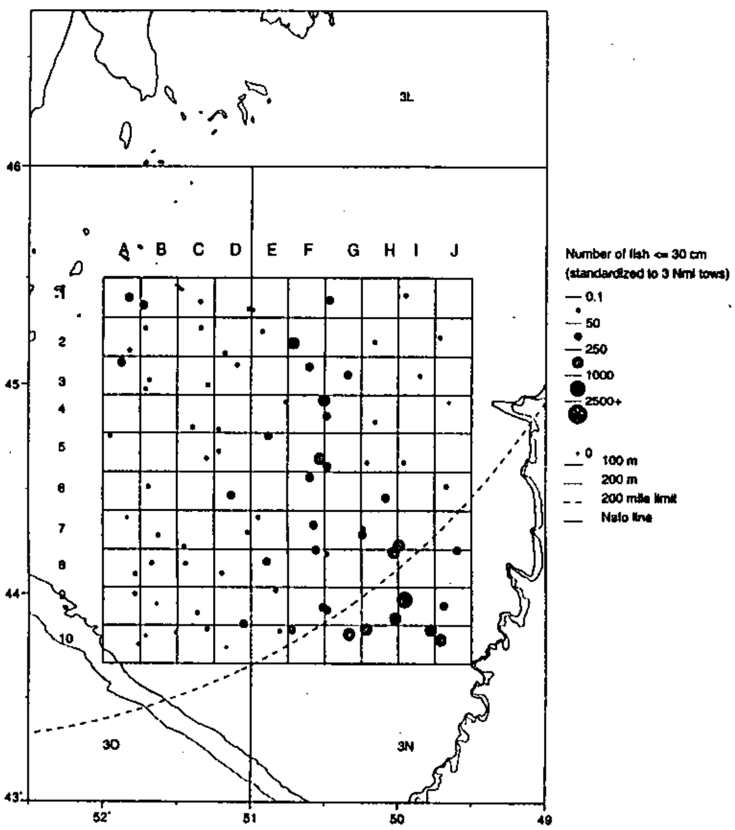

Fig. 6a. Distribution of yellowtail flounder catches (total length <= 30 cm) from 1997 Atlantic Lindsey Trip 2.

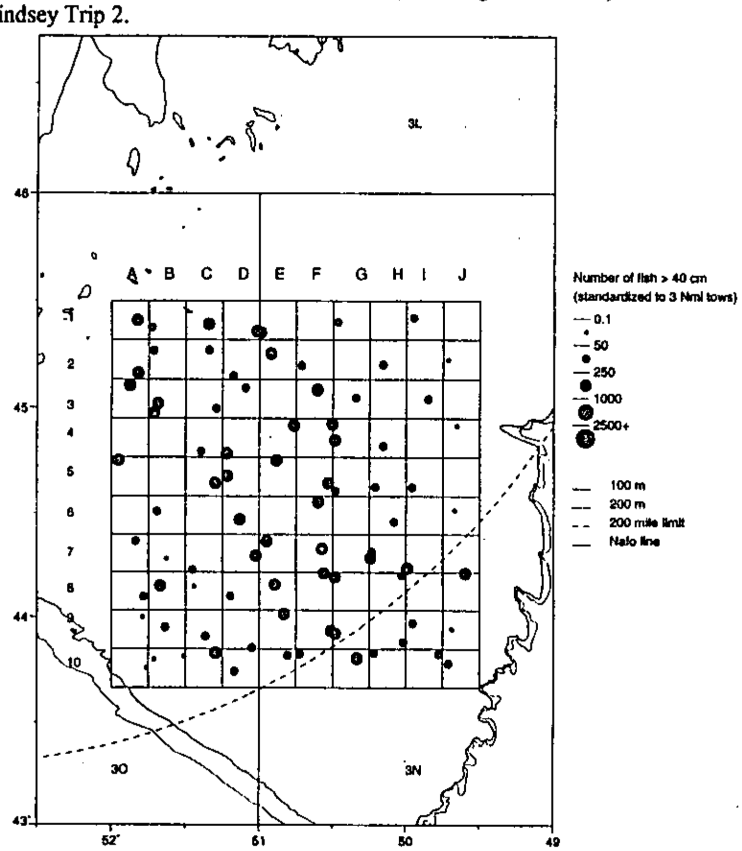

Fig. 6b. Distribution of yellowtail flounder catches (total length <= 40 cm) from 1997 Atlantic Lindsey Trip 2.

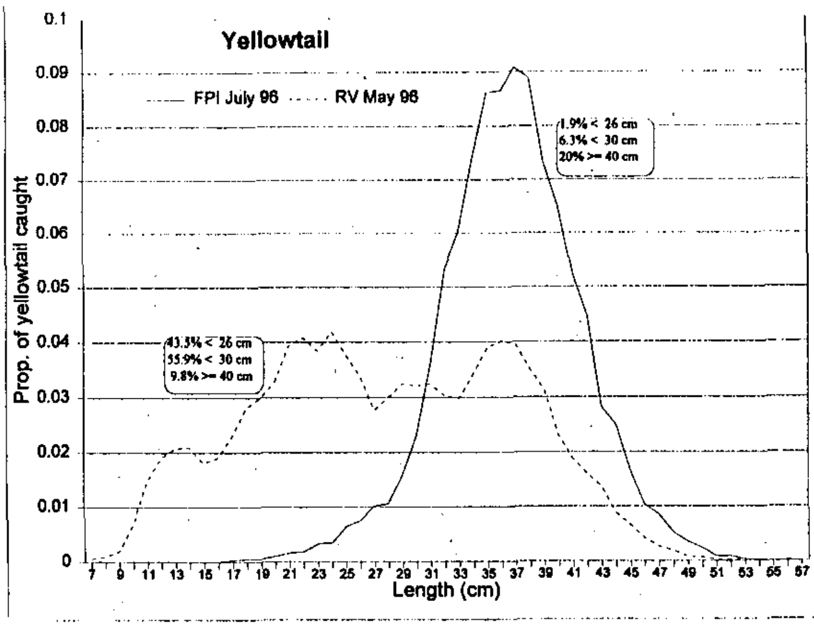

Fig. 7a). Length composition of yellowtail flounder caught in the July, 1996 FPI survey, and sets made in the grid area during the spring stratified random survey.

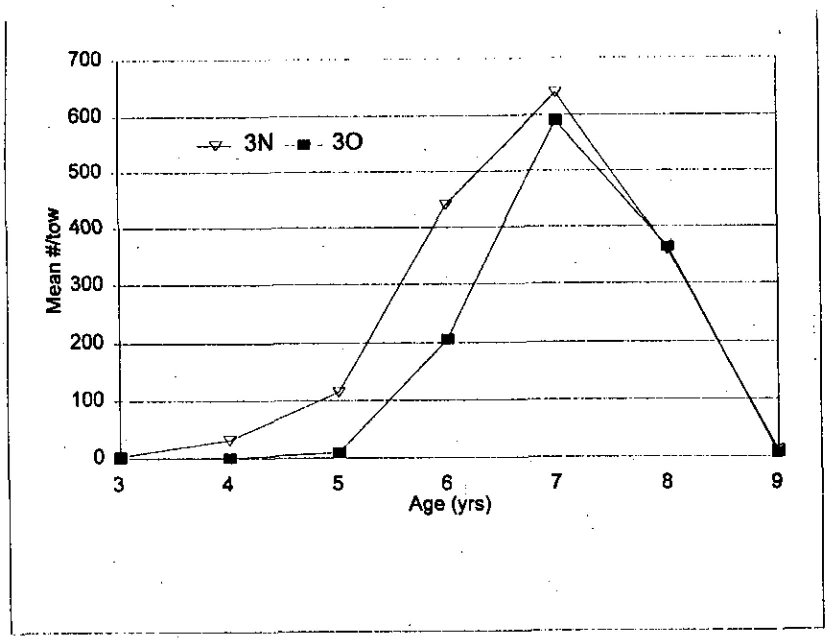

Fig. 7b). Age composition of yellowtail flounder caught in the July, 1996 FPI survey.

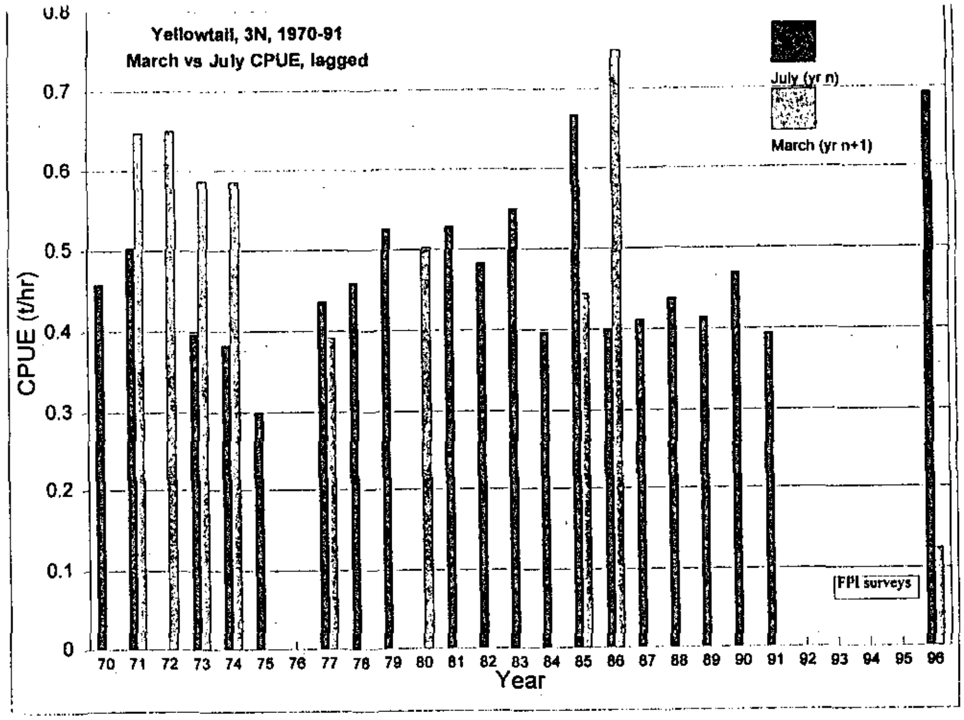

Fig. 8. Comparison of yellowtail CPUE in July of year n with CPUE in March of year n+1. Data from 1970-91 are from NAFO catch and effort statistics for Canadian trawlers.

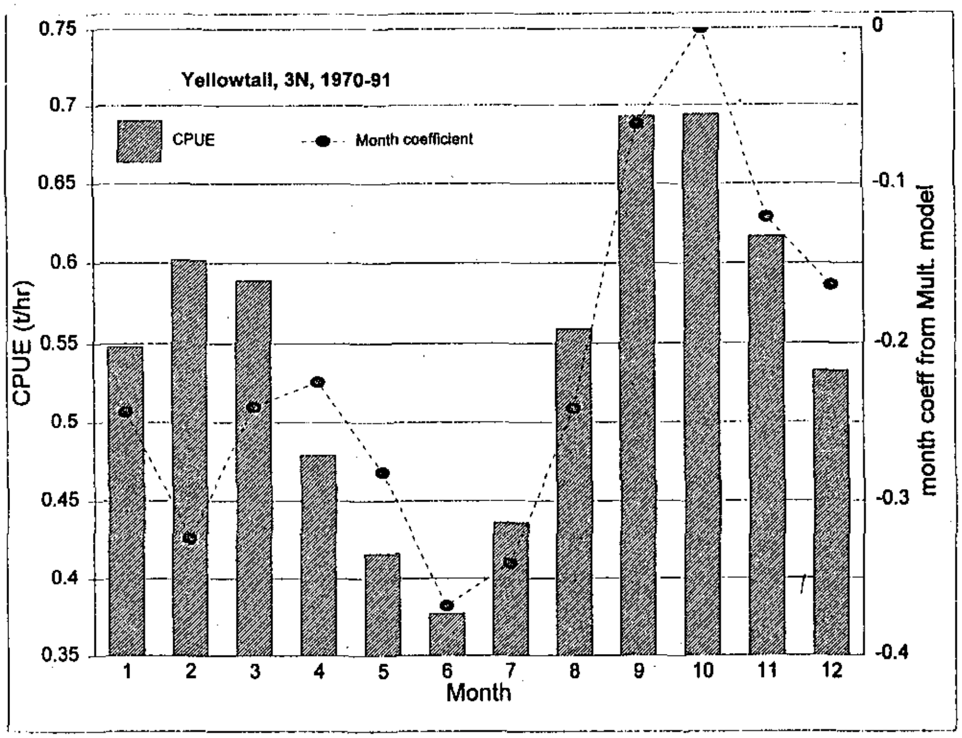

Fig. 9. Comparison of monthly CPUE of yellowtail for the years 1970-91 combined, and the relative measure of monthly CPUE determined from a multiplicative model of yellowtail catch rates.

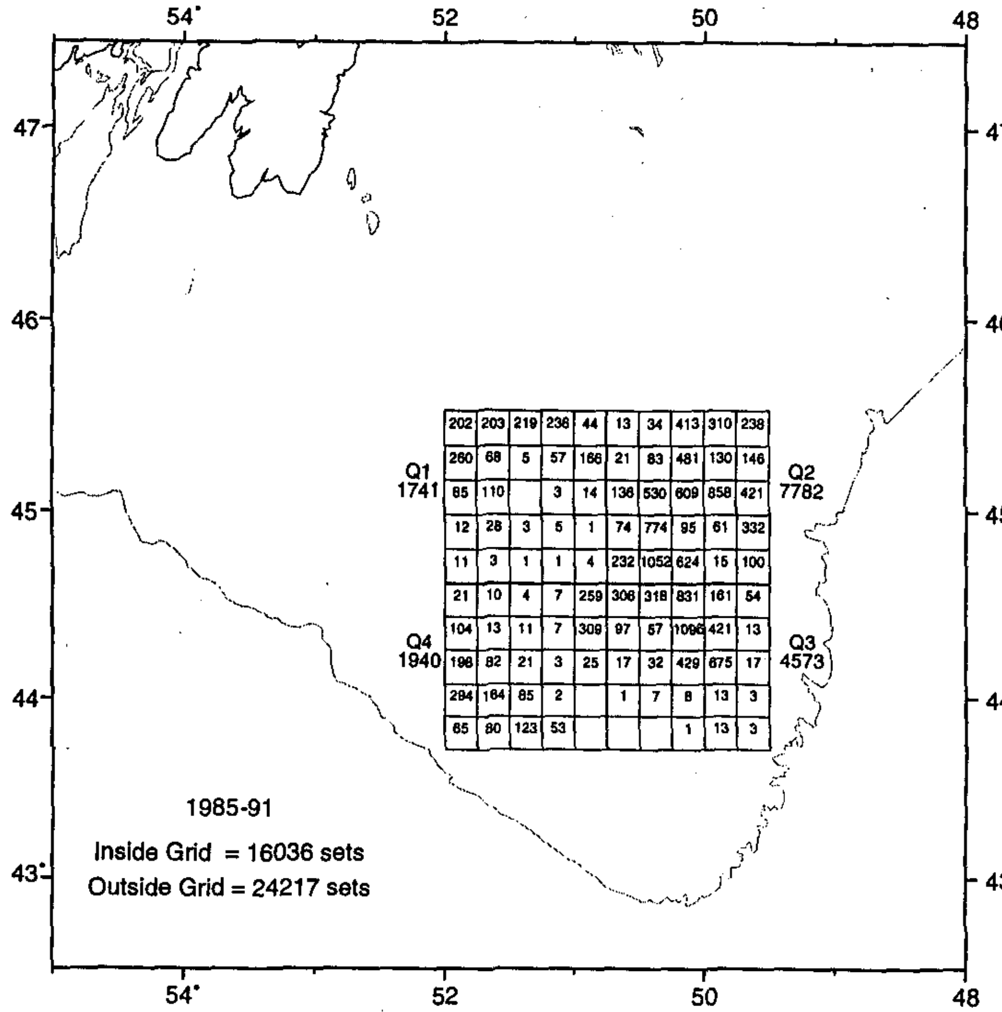

Fig. 10. Locations of sets, by block, from a sample of 15 FPI vessels fishing in Div. 3NO during 1985-91.

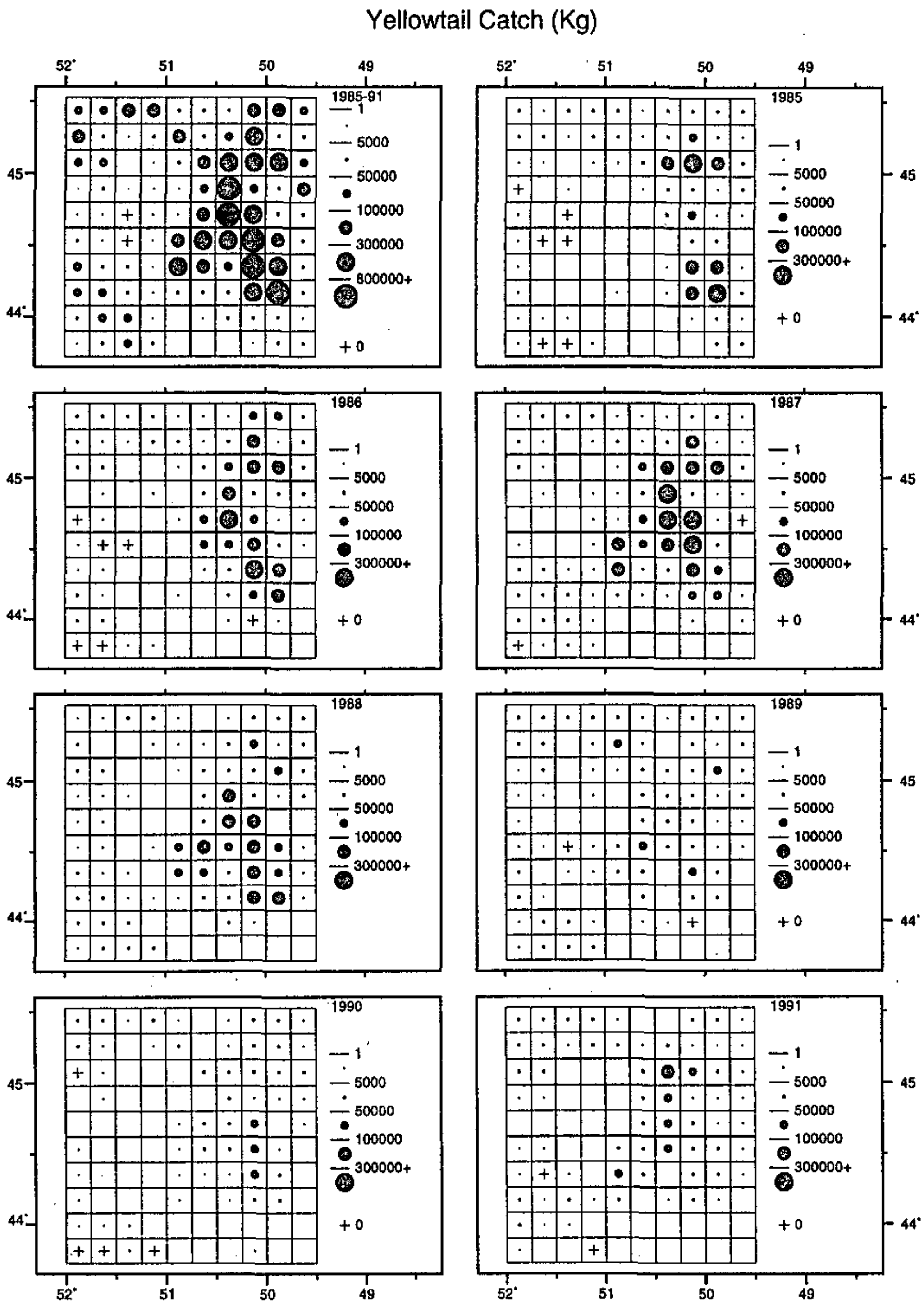

Fig. 11. Catches of yellowtail, by block, from a sample of 15 FPI vessels fishing in Div. 3NO during 1985-91. Data are from sets where yellowtail was the main species sought.

Yellowtail Catch Rate (Kg/Hr) - Yellowtail Main Species Sought

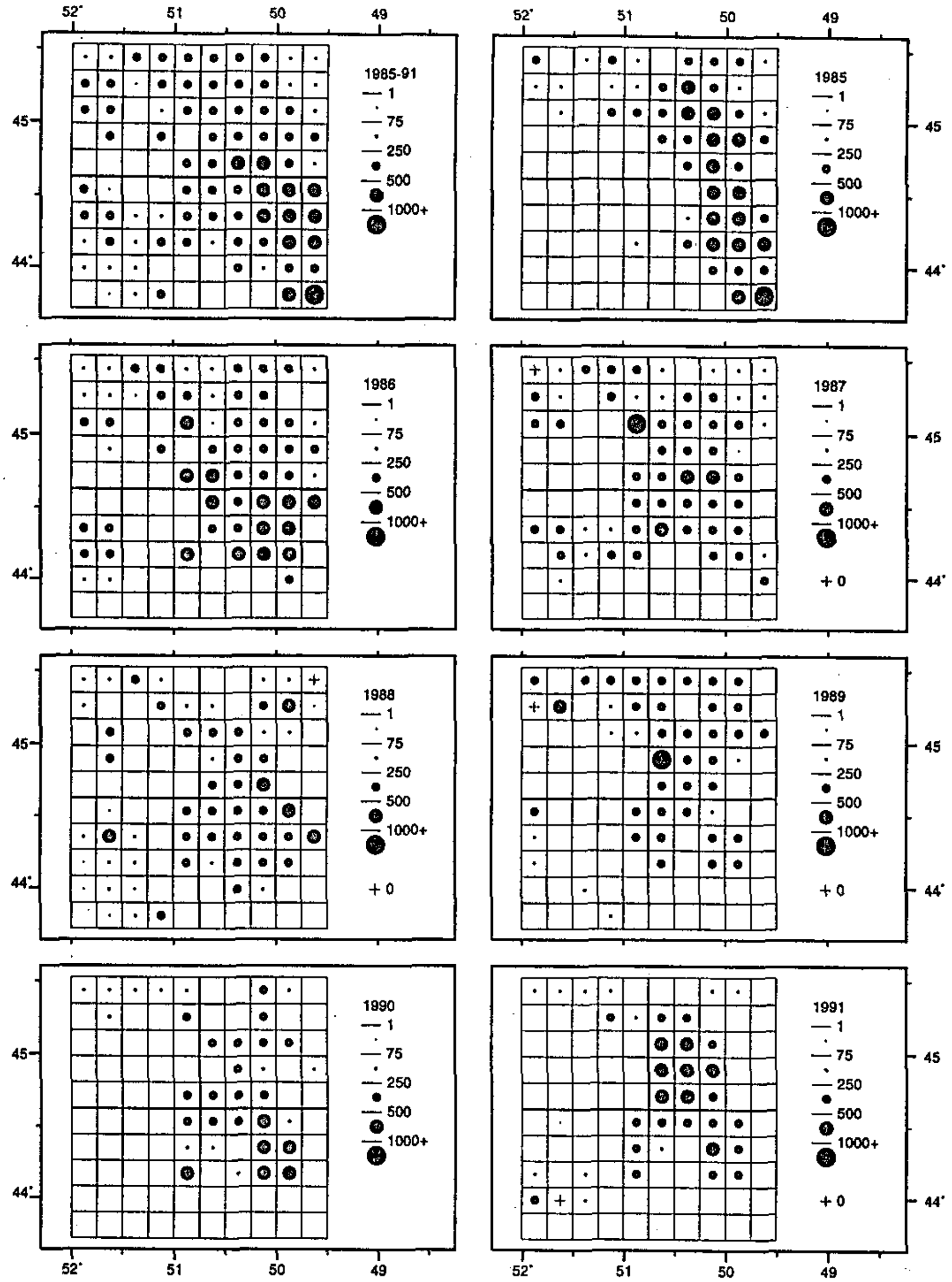

Fig. 12. Catch rates of yellowtail, by block, from a sample of 15 FPI vessels fishing in Div. 3NO during 1985-91. Data are from sets where yellowtail was the main species sought.

Yellowtail Main Species Sought

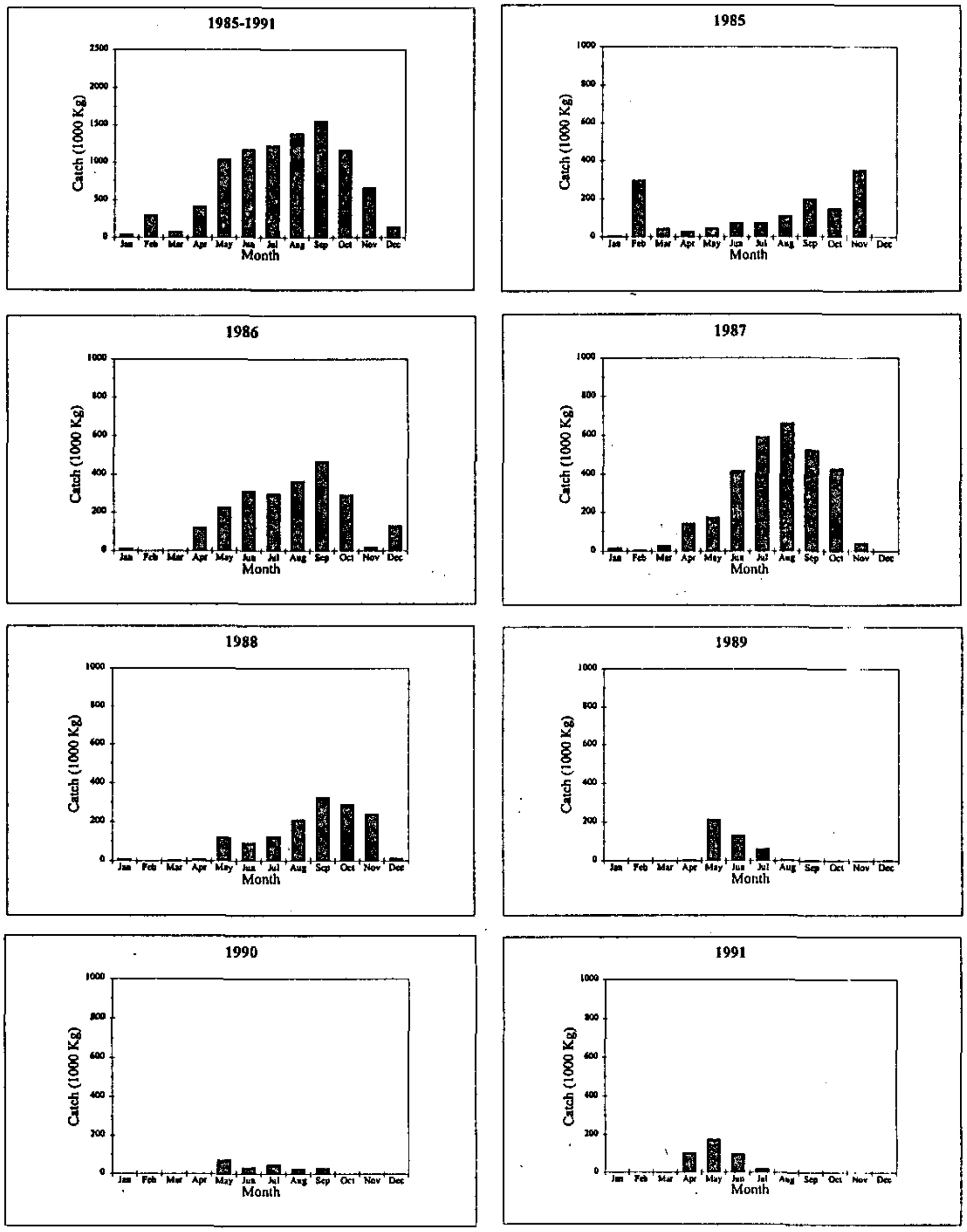

Fig. 13. Catches of yellowtail, by month, from a sample of 15 FPI vessels fishing in Div. 3NO during 1985-91. Data are from sets where yellowtail was the main species sought.

Yellowtail Main Species Sought

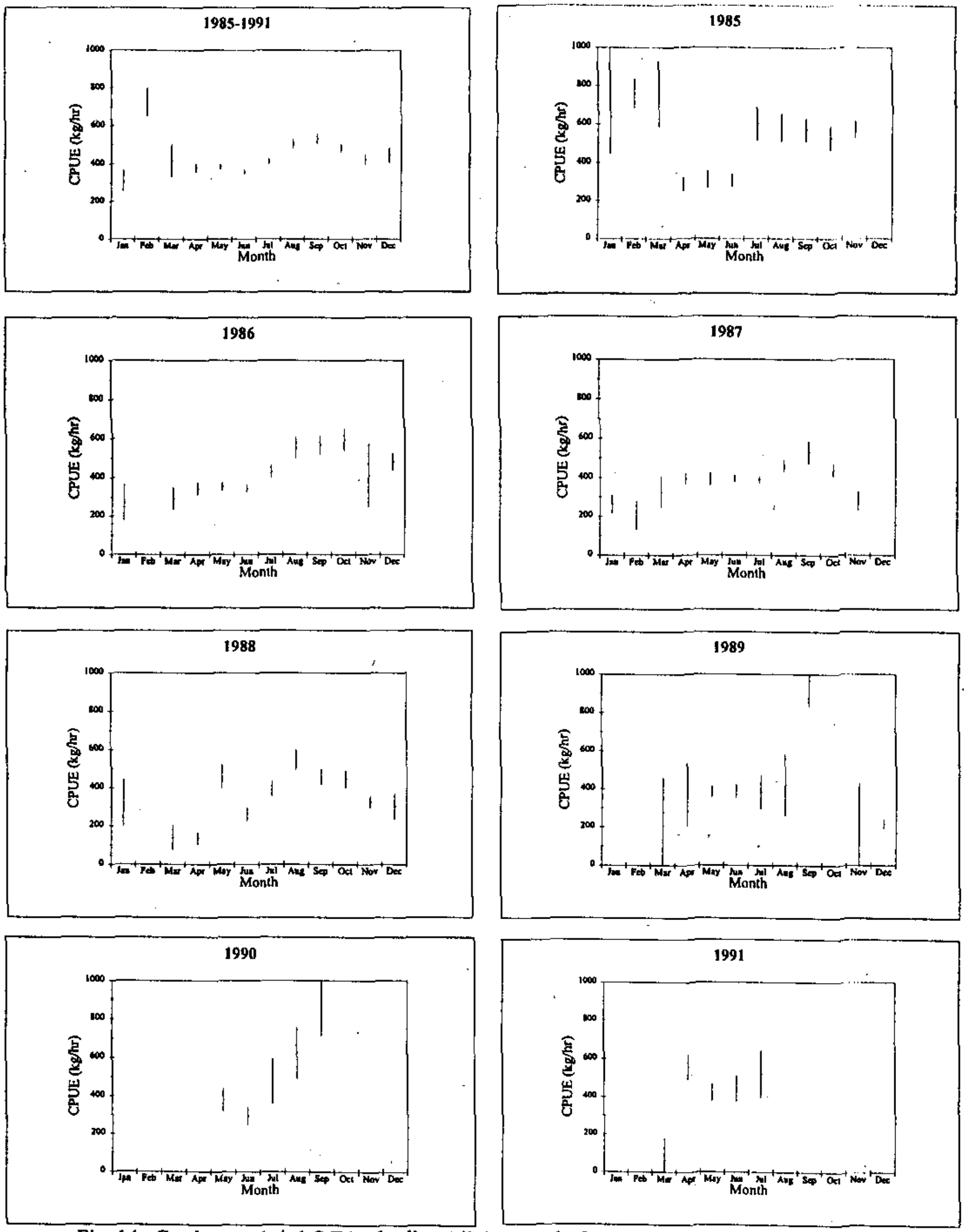

Fig. 14. Catch rates (+/- 1 S.E.) of yellowtail, by month, from a sample of 15 FPI vessels fishing in Div. 3NO during 1985-91. Data are from sets where yellowtail was the main species sought.

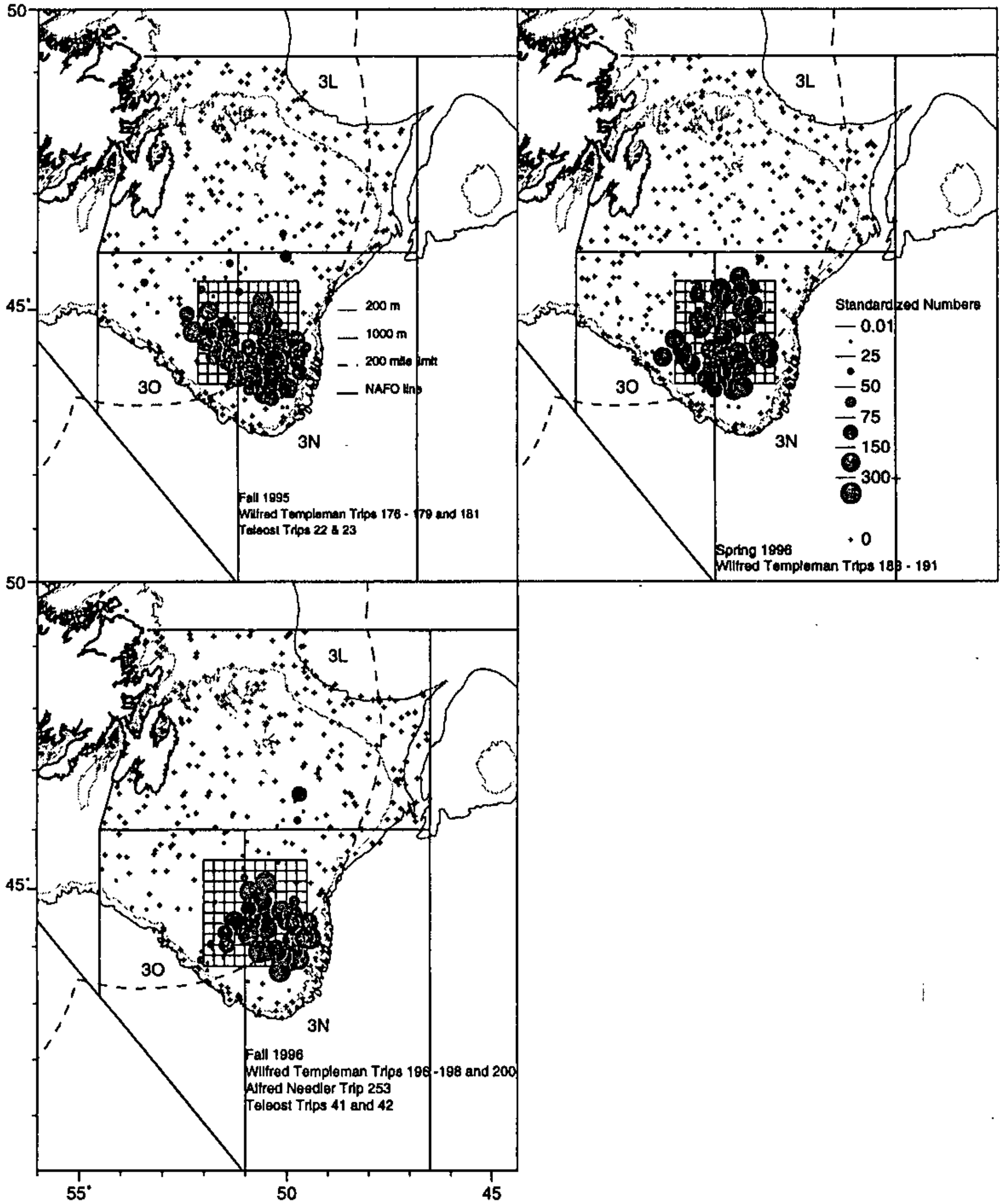

Fig. 15a). Distribution of yellowtail (number per set) from stratified random surveys in Div. 3LNO in 1995 and 1996. Grid used in FPI surveys is overlaid for illustration.

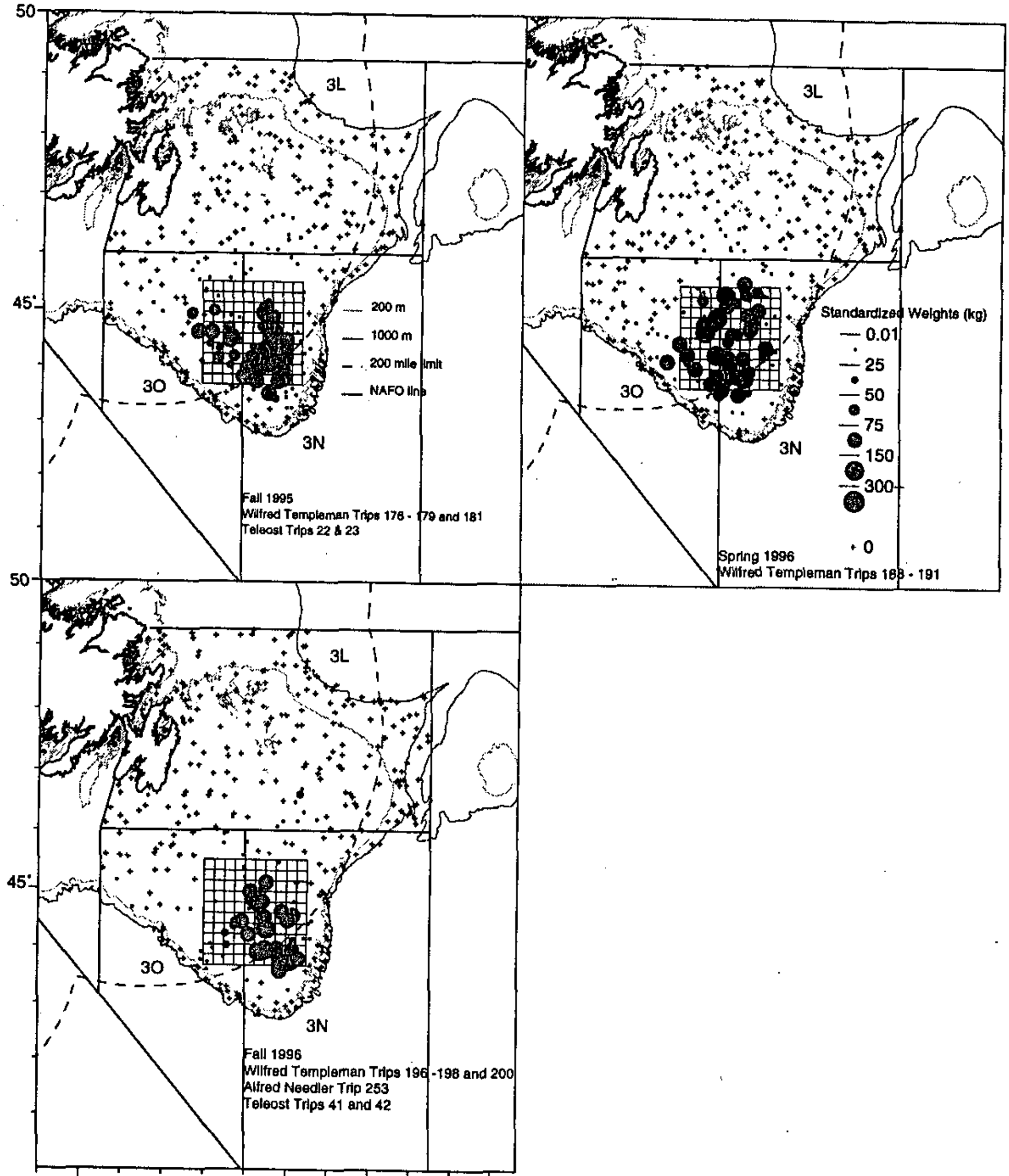

Fig. 15b). Distribution of yellowtail (kg. per set) from stratified random surveys in Div. 3LNO in 1995 and 1996. Grid used in FPI surveys is overlaid for illustration.

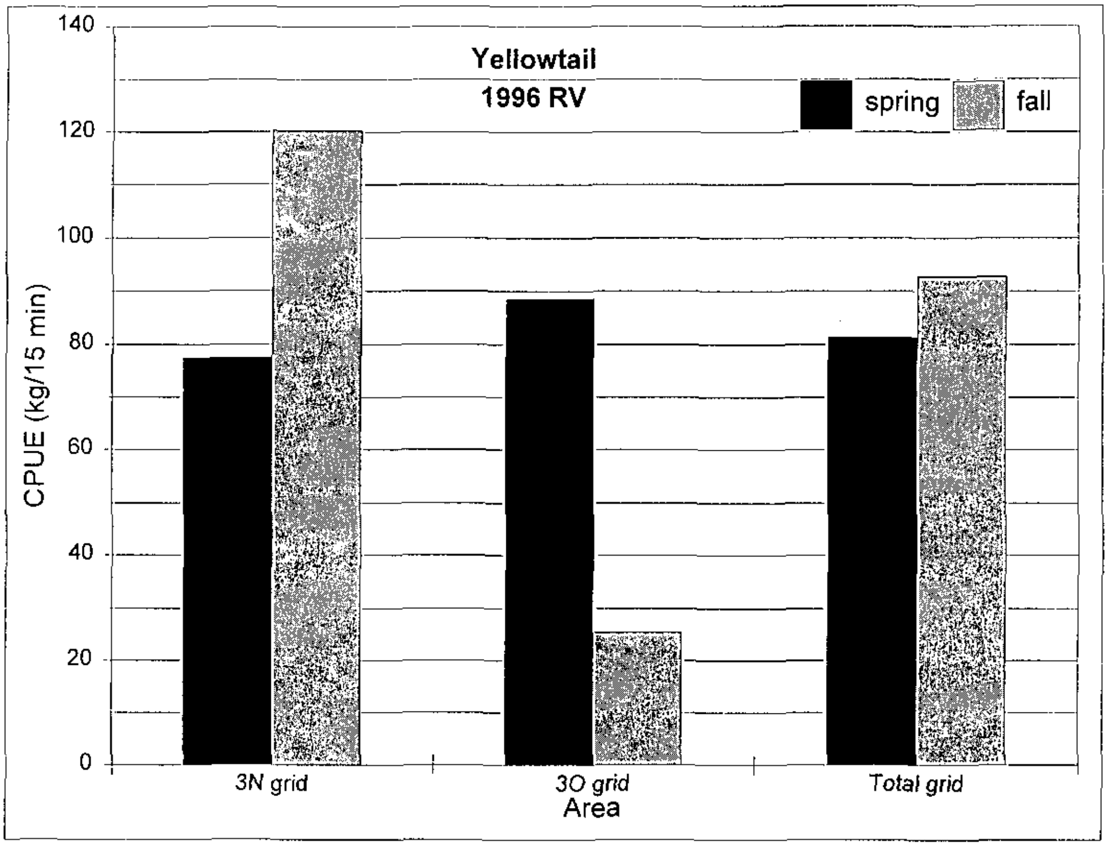

Fig. 16. Catches of yellowtail (kg. per set) from 1996 spring and fall stratified random surveys in Div. 3NO. Only the data located within the FPI grid is shown.