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Cooperative Surveys of Yellowtail Flounder in NAFO Divisions 3LNO, 1996-2004

by

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Abstract

Results from cooperative grid surveys conducted in July showed that catch rates of yellowtail flounder were consistently high in July surveys (580-915 kg/hr) from 1996 through 2004. In the original grid, the 2004 CPUE for yellowtail flounder was the highest in the series. Catches of American plaice, cod and thorny skate also varied but were relatively stable at a lower level (less than 240 kg/hr) in those same surveys. In the 2004 survey of the expanded grid area catches of thorny skate increased, while yellowtail flounder, cod and American plaice catches declined.

Introduction

Cooperative trawl surveys directed for yellowtail flounder have been conducted in NAFO Div. 3NO by the Canadian Department of Fisheries and Oceans (DFO) Newfoundland Region and a Newfoundland based fishing company, Fisheries Products International (FPI) Ltd. since July 1996. While the scientific and technical support for the surveys is the responsibility of DFO, FPI provides the vessel, crew, fishing gear, and related operating expenses for the surveys. These surveys are designed to provide data on the spatial distribution and abundance of yellowtail flounder in the survey area. The surveys also provide information on species such as American plaice, cod and thorny skate, which are taken as by-catches in the commercial fishery for yellowtail flounder. This paper summarizes the results from the surveys completed in 1996 to 2004. No further cooperative surveys are planned using this design.

Methods and Materials

Originally, the surveys were designed to cover an area of approximately 9 500 square nautical miles (bolded grid, Fig. 1), corresponding to the area where the yellowtail flounder stock is mainly distributed, and where the FPI fishery operated in most years prior to the 1994 NAFO-imposed moratorium on fishing. The original survey area grid is divided into l00 equal-sized blocks, and the same pre-selected position is fished, if possible, 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 flounder abundance and distribution, and their knowledge of the fishing grounds. Some of the areas in the grid represent well-known fishing grounds for yellowtail, while other areas were not traditionally fished. 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. A July survey has been conducted each year since 1996, with seasonal surveys also carried out from 1997-1999.

In 2000, the grid area was expanded to cover an additional 100 blocks, an area equal in size and adjacent to the original grid (Fig. 1). Additional coverage was added in each of Div. 3L, 3N, and 3O. This expansion was necessary so that the survey would cover a larger portion of the yellowtail flounder stock, which has expanded its

range since the start of the grid survey series in 1996. Blocks in the expanded grid area are also identified by row and column, with the exception of the labelled blocks. This expanded grid has been surveyed immediately following the July survey of the original grid, using the same vessel and fishing protocols. The start and end dates of the summer surveys (original and expanded grid areas) are given in Table 2. The 2004 surveys were the earliest in the summer series by about 1-2 weeks.

The vessel used in all surveys to date was the *Atlantic Lindsey*, a 44 m total length, 665 G.R.T., 1500 HP commercial stern trawler in FPI's Newfoundland fleet up to 2004. The fishing gear used is an Engel (96) 145 Hi-Lift otter trawl, with rockhopper footgear, and is reflective of trawls historically used by FPI in the yellowtail flounder fishery (see Walsh and McCallum, 1999, for details). Brodie *et al*. (1997) give an in-depth comparison of this trawl used onboard the *Atlantic Lindsey* with the standard survey gears (Enge1 145 Hi-Lift otter trawl, and Campelen 1800 shrimp trawl) used by the DFO institute, Northwest Atlantic Fisheries Center (NAFC). There are major differences in the footgear, sweep/bridle lengths and mesh size. Unlike trawls used in research vessel (r.v.) surveys, no small mesh liner was used in the 156 mm codend of this commercial trawl. 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 (see Walsh and McCallum, 1999).

Catch numbers and weights of all yellowtail flounder in the catch of each set were recorded. Similar catch data on other species such as American plaice, cod and thorny skate were also collected, along with biological sampling (size and maturity) data for yellowtail flounder. Some temperature data have been collected using XBT's. Results from the original grid surveys are also compared with data from spring and fall stratified random surveys done by DFO (Walsh *et al*., 2000). Results from the expanded grid area are reported separately in this paper.

Results and Discussion

Seventeen surveys covering the original grid area were conducted, 1 in 1996, 4 each in 1997 and 1998, 3 in 1999 and 1 each in 2000 to 2004. In the last five years an expanded grid area was surveyed adjacent to the original grid, covering a further area equal in size to the original grid. Results are presented for both survey series, separately and combined.

Catch trends: Between 50 and 92 fishing sets were conducted during each survey (Table 1). For yellowtail flounder, plaice, cod and thorny skate, catch weights per tow in every March survey were lower than in other surveys of the original grid area (Table 1, Fig. 2). Considering just the July surveys (Fig. 3) yellowtail has shown a slight increasing trend, from just under 700 kg/hr in 1996-97 to about 900 kg/hr in 2003-04. Following an increase from 1996 to 1998, A. plaice CPUE has been relatively stable since then, with 5 of the past 7 values between 218 and 236 kg/hr. Between years, changes in CPUE for yellowtail and A. plaice follow the same direction, with the exception of 1997 and 2004. NAFO Div. 3N shows mostly higher catches of yellowtail flounder and plaice than Div. 3O in the July surveys, but lower catch rates of cod (Fig. 4). Overall, yellowtail flounder mean CPUE was highest in July of 2004 and lowest in May-June of 1999 (excluding March data) while American plaice catch rates peaked in 2003 (Table 1, Fig. 2).

Catch data from the expanded grid area, surveyed for the first time in August 2000, are also included in Table 1 and in Fig. 5. Average CPUE of yellowtail flounder in the expanded grid area has increased by about 5-10% each year from 2000-2003 and decreased in 2004. American plaice CPUE in the expanded grid area was stable from 2000-2002 at a much lower level than yellowtail flounder and decreased in 2003 and 2004. Catches of the main species were lower in the expanded grid compared to the original grid, with the exception of cod in 2001. Mean catch weight of yellowtail was higher than that for cod and American plaice in both grid areas (Table 1). Catch rates for both areas combined (Table 1, Fig. 3) are lower than those for the original grid only for both yellowtail flounder and American plaice and show no obvious trends over the time series. In the original grid, cod CPUE in 2003 and 2004 was about half the level of 2000-02, and has dropped sharply in the expanded grid from 2001 to 2004.

Distributions of the catches from the 2004 surveys are shown in Fig. 6. High yellowtail flounder catch rates were most common in the original grid area with lower catch rates in the expanded grid area. American plaice catches were much lower and occurred mostly in the lower 2 quadrants of the original grid. Cod and thorny skate catches were quite low over the whole area surveyed. Figures 7-10 give the distributions for the 4 main species

considered for the complete time series of July and August surveys. No changes in distribution are apparent over the time series for any of the species.

American plaice by-catch: Overall, 10 common blocks were fished in the 17 trips following the original grid design. To investigate the by-catch of American plaice, the ratio of American plaice to yellowtail flounder was calculated in the common blocks fished in all seventeen surveys (Table 3a). Several sets produced by-catch ratios less than 5% (highlighted), but no block consistently produced by-catch ratio of less than 5%, the current by-catch limit in the Canadian fishery for yellowtail flounder. None of the common blocks surveyed in 2004 had by-catch less than 5%. Furthermore, the overall mean by-catch for all blocks exceeded the 5% by-catch ratio. Excluding the ratios from the March 1999 survey, the majority of catches with a by-catch less than 5% occurred in the central portion of the grid (bounded by F4-H7). Largest by-catches of plaice are found in the southwest corner of the grid in Div 30. In the survey of the expanded grid area in 2004, the ratio of American plaice to yellowtail catch was less than 5% in several blocks (Table 3b).

The July surveys (conducted from 1996 through 2004) had 33 common blocks. Tables 4 and 5 give catch rates for yellowtail flounder and American plaice in these common blocks. In previous years, by-catch ratios of less than 5% were most frequently found in the central portion of the grid (Table 6). In 2004, none of the 33 common blocks had a plaice to yellowtail ratio of less than 5% and when averaged over the time series, only 1 block had an American plaice by-catch ratio equal to or less than 5%. Another eight blocks had plaice to yellowtail flounder ratios between 5 and 10% on average.

The distribution plots for yellowtail flounder (Figure 7) also contain information about American plaice by-catch. Greyed symbols indicate catch rates over 700 kg/hr and by-catch ratios less than 5% are marked with a centre dot. The July survey in 2000 had the fewest sets with by-catch of American plaice less than 5%. Many of the sets with high yellowtail flounder catch rates and low A. plaice by-catch were in the central portion of the original grid.

Length Composition: In all surveys, less than 2% of fish captured were smaller than 26 cm in length and less than 11% of the catch was composed of individuals less than 30cm in length (Table 7). Typically, yellowtail flounder 26-46 cm in length make up the bulk of the length frequencies of the catches and furthermore, female frequencies tended toward larger sizes than male frequencies in all surveys. The percentage of yellowtail above 40 cm in length has been at the lowest levels in the most recent surveys. Length compositions of male and female yellowtail flounder caught during the 9 July (original grid) surveys and 5 expanded grid surveys are shown in Fig. 11. Otoliths were not collected during the grid surveys and therefore age compositions have not been calculated at this time.

The male portion of the catch is given on each of the length frequency plots and is summarized in Fig. 12. March surveys in the original grid area showed a higher percentage of males in the catch than surveys at other times, and a slight decline in male composition is apparent over the time series. Expanded grid surveys showed a higher male composition than the original grid area survey in the same year (2000-2004).

Comparison of results with research vessel data: The distribution of yellowtail from the 13 stratified random research vessel surveys conducted by DFO with the Campelen trawl in Div. 3LNO from 1995-2001 (7 fall surveys and 6 spring) was shown in Maddock et al. (2000, 2001, 2002). Results from the 2004 surveys are shown in Fig. 13 and compared with the mean numbers per tow from 2003. The grid, which is not part of the design of the DFO R.V. surveys, is superimposed on these plots, and in most surveys, the majority of the yellowtail is caught within the boundaries of the grid. There was a steady decline in the percentage of yellowtail found in the original grid from 1996 to 2000 in the spring, and from 1995-2001 in the fall (Table 8, Fig 14). In the first four surveys (fall 95 to spring 97), between 80 and 90% of yellowtail were located within the grid. Since then, less than 81% of yellowtail in any survey was located in the grid area. The lowest values occurred in the fall surveys during 2000 and 2001, when only 40 - 47% of yellowtail in the surveys were found within the original grid. Spring 2004 percentages were lower than those in 2001-03, while fall 2004 percentages were lower than 2002-03, but above the 2000-01 levels.

Data from the 2000-2004 spring and fall DFO surveys were also compared to the results from the expanded grid, used for the first time in the grid surveys in 2000. For the spring surveys, about 80-90% of yellowtail was contained within the total (original + expanded) grid boundaries, with the 2002 and 2003 percentages being very similar, around 80% (Table 9, Fig. 13 and 14). In 2004, the percentages dropped to 63-74%. With the exception of 2002, the

percentage of weight in the expanded grid was higher in the spring than the fall of each year. Most yellowtail outside the expanded grid, both in spring and fall, were located just to the south of the grid boundary.

Overall, these observations are consistent with observed increases in the area of distribution of yellowtail flounder in recent years, as seen in both the survey and commercial fishery data. These increases in the range of distribution are also consistent with increases in stock size since 1995, following reductions in stock size and distribution range in the early to mid-1990s (Brodie *et al*., 1998).

Observations on sexual maturity of yellowtail: In all surveys thus far, with the exception of November 1998, observations on sexual maturity of yellowtail have been collected. These were generally obtained at sea by sampling 300-400 fish from each of 2 fishing sets per day, although the March 1998 data were collected from port samples immediately following the survey. Figure 15 indicates that overall, about 80% of the female yellowtail caught was mature, and that there was a slight increasing seasonal trend in the 4 surveys in 1997 and the 3 in 1999. The July 2004 survey had the highest percentage of mature females in the July surveys, continuing an increasing trend from 2000. The August surveys (extended grid) had a higher percentage of mature females than the July surveys in all 5 years (2000-2004) – over 96% were mature in the last 3 extended grid surveys.

A closer look at the data from the 9 July surveys (Fig. 16) showed that most mature females had spawned prior to the surveys in 1997-2000. The July 1997 survey had the highest percentage of females judged to be maturing following a recent spawning (Sp. P Mat AN), and the lowest percentage of females with hydrated eggs (Mat B and Mat C stages). This suggests that spawning may have been earliest in 1997, although mean bottom temperature in depths <100 m on the Grand Bank during spring 1997 was the second lowest (next to 2003) in the years covered by the grid surveys (Colbourne and Bowering 2001). The high percentage of spent females in 1999 corresponds with the highest mean temperature (<100 m bottom depth) in spring surveys of this area since 1983. In 1996, and 2001 to 2004, it appears that spawning had not been completed in the grid area by July, as evidenced by the higher number of females either with hydrated eggs or eggs in pre-spawning condition (Mat A stage - highest in 2004). The percentage of spent females in 2004 was the lowest in the series, and combined with the high percentage of pre-spawning females (Mat A), suggests that much of the spawning was later than the survey in 2004. However, the 2004 survey was about 2 weeks earlier than most others in the series (Table 2). Mean temperatures at <100 m bottom depth in spring surveys of 2004 were higher than recent years. Overall, there was no apparent correlation between the proportion of spent females in the summer grid surveys and spring bottom temperature (Fig 17).

Conclusions

Cooperative surveys between DFO and FPI in Div. 3LNO indicate that CPUE for yellowtail flounder in the July surveys of the original grid have been around 600-920 kg/hr, and have averaged about 850 kg/hr in the last 5 surveys (2000-04). American plaice CPUE ranged from 100 to 236 kg/hr in the July surveys, averaging about 220 kg/hr in the last 5 surveys. Overall catch rates in the expanded grid surveys are generally lower for all species considered when compared to the original grid. Mean catch rates of yellowtail flounder and thorny skate in the original grid area were higher in 2004 than in 2002 and 2003, while American plaice and cod catch rates declined in 2004.

References

Brodie, W.B., S.J. Walsh and D.B. Atkinson 1998. The effect of stock abundance on range contraction of yellowtail flounder on the Grand Bank of Newfoundland in the Northwest Atlantic from 1975 to 1995. J. Sea Res. 39: 139-152

Brodie, W.B., S.J.Walsh, , and D.Orr. 1997. Results of surveys directed at yellowtail flounder in NAFO Divisions 3NO, conducted on a Canadian commercial trawler. NAFO SCR Doc. 97/31, Ser. No. N2863, 23 p.

Colbourne, E.B. and W.R. Bowering. 2001. Recent Trends in Bottom Temperatures and Distribution and Abundance of Yellowtail Flounder (*Limanda ferruginea*) in NAFO Divisions 3LNO During the Spring and Fall. NAFO SCR Doc. 01/32, Ser. No. 4409.

Maddock Parsons, D., W.B. Brodie and K. Dwyer. 2002. Update on Cooperative Surveys of Yellowtail flounder in NAFO Divisions 3NO, 1996-2001, Including an Expanded Survey in Divisions 3LNO in 2000 and 2001. NAFO SCR Doc. 02/44, Ser. No. 4655.

Maddock Parsons, D., W.B. Brodie and M. Simpson. 2001. Update on Cooperative Surveys of Yellowtail flounder in NAFO Divisions 3NO, 1996-2000, Including an Expanded Survey in Divisions 3LNO in 2000. NAFO SCR Doc. 01/70, Ser. No. 4448.

Maddock Parsons, D., W.B. Brodie, D. Power and S.J. Walsh. 2000. Update on Cooperative Surveys of Yellowtail Flounder in NAFO Divisions 3NO, 1996-1999. NAFO SCR Doc. 00/42, Ser. No. 4272.

Walsh S. J., M.J. Veitch, M.J. Morgan W.R. Bowering and B. Brodie. 2000. Distribution and Abundance of Yellowtail Flounder (*Limanda ferruginea*) on the Grand Bank, NAFO Divisions 3LNO, as Derived from Annual Canadian Bottom Trawl Surveys. NAFO SCR Doc. 00/35, Ser. No. N4264.

Walsh, S.J. and B.R. McCallum. 1999. The efficiency of the Engel 145 high lift otter trawl used in the DFO/FPI grid surveys for yellowtail flounder on the Grand Bank. NAFO SCR Doc 99/63, Ser. No. N4122

Table 1. Catches (kg/hr) by species and trip from FPI/DFO cooperative grid surveys (original grid area only, expanded grid area only and both areas combined).

Yellowtail Flounder	Trip	Trip #	N	Mean	StdDev	Max	Min
Original Grid	Jul96	1	83	693.51	478.81	2503.57	34.00
	Mar97	2	68	123.99	605.47	4972.44	0.00
	May/Jun97	3	82	608.03	602.88	4607.00	24.50
	Jul97	4	85	666.41	478.62	3369.10	17.50
	Nov97	5	50	627.37	926.85	5931.00	3.50
	Mar98	6	84	74.99	91.65	427.74	0.00
	May/Jun98	7	73	653.62	504.02	2872.62	67.00
	Jul98	8	78	803.78	533.24	2678.27	0.00
	Nov98	9	63	553.61	776.78	5726.06	1.00
	Mar99	10	73	145.21	136.96	536.40	0.30
	May/Jun99	12	80	506.49	400.74	2289.83	57.60
	Jul99	13	64	583.61	341.74	1488.97	8.00
	Jul00	14	65	802.74	521.12	3319.19	62.00
	Jul01	16	72	752.24	416.05	1979.66	6.36
	Jul02	21	78	835.31	421.28	2065.76	20.00
	Jul03	23	63	898.27	472.07	2702.15	12.50
	Jul04	26	61	917.51	490.87	2321.09	19.08
Expanded Grid	Aug00	15	83	419.32	346.50	1519.49	10.00
	Aug01	17	80	451.42	374.19	1704.48	14.50
	Aug02	22	89	506.04	417.49	2536.59	11.00
	Aug03	24	92	532.91	385.47	1898.40	17.00
	Aug04	27	80	461.23	366.22	1924.80	10.00
Original Grid & Expanded Grid	2000	14,15	148	587.71	470.81	3319.19	10.00
	2001	16,17	152	593.33	421.28	1979.66	6.36
	2002	21,22	167	659.83	449.30	2536.59	11.00
	2003	23,24	155	681.41	458.18	2702.15	12.50
	2004	26,27	141	658.63	480.02	2321.09	10.00

Cod	Trip	Trip #	N	Mean	StdDev	Max	Min
Original Grid	Jul96	1	83	105.64	282.99	2509.09	0.00
	Mar97	2	68	0.76	1.95	10.00	0.00
	May/Jun97	3	82	43.82	65.66	308.00	0.00
	Jul97	4	85	71.38	110.58	644.00	0.00
	Nov97	5	50	72.08	103.38	411.50	0.00
	Mar98	6	84	3.09	10.46	55.00	0.00
	May/Jun98	7	73	55.47	95.07	400.00	0.00
	Jul98	8	78	106.47	248.92	1273.80	0.00
	Nov98	9	63	41.18	121.01	917.70	0.00
	Mar99	10	73	1.94	10.24	86.00	0.00
	May/Jun99	12	80	70.91	139.40	1005.87	0.00
	Jul99	13	64	192.85	773.21	6067.20	0.00
	Jul00	14	65	69.71	126.80	877.80	0.00
	Jul01	16	72	74.28	109.88	739.20	0.00
	Jul02	21	78	76.52	144.17	849.60	0.00
	Jul03	23	63	39.36	58.33	349.20	0.00
	Jul04	26	61	35.56	69.14	340.80	0.00
Expanded Grid	Aug00	15	83	51.96	58.05	340.80	0.00
	Aug01	17	80	88.30	199.69	1674.40	0.00
	Aug02	22	89	74.02	102.34	714.00	0.00
	Aug03	24	92	58.04	81.44	437.40	0.00
	Aug04	27	80	16.74	28.67	151.40	0.00
Original Grid & Expanded Grid	2000	14,15	148	59.76	94.65	877.80	0.00
	2001	16,17	152	81.66	163.06	1674.40	0.00
	2002	21,22	167	75.19	123.27	849.60	0.00
	2003	23,24	155	50.45	73.31	437.40	0.00
	2004	26,27	141	24.89	50.99	340.80	0.00

American plaice	Trip	Trip #	N	Mean	StdDev	Max	Min
Original Grid	Jul96	1	83	106.73	125.89	942.94	3.00
	Mar97	2	68	20.44	44.23	234.50	0.00
	May/Jun97	3	82	168.57	133.70	759.80	3.50
	Jul97	4	85	180.92	265.55	1654.40	0.00
	Nov97	5	50	131.78	94.88	492.90	23.30
	Mar98	6	84	19.49	40.31	246.74	0.00
	May/Jun98	7	73	173.18	111.74	785.46	33.02
	Jul98	8	78	229.29	361.15	2197.82	12.72
	Nov98	9	63	136.74	106.51	471.60	13.78
	Mar99	10	73	17.53	47.55	330.00	0.00
	May/Jun99	12	80	176.22	158.31	890.08	21.20
	Jul99	13	64	151.72	175.80	975.20	8.48
	Jul00	14	65	219.43	203.19	1117.24	30.18
	Jul01	16	72	187.95	269.04	1534.35	22.79
	Jul02	21	78	224.90	388.24	3180.00	12.72
	Jul03	23	63	236.09	358.25	1895.81	22.26
	Jul04	26	61	217.66	198.30	889.81	14.84
Expanded Grid	Aug00	15	83	132.05	173.57	934.51	6.00
	Aug01	17	80	129.90	205.68	1159.46	5.30
	Aug02	22	89	125.68	160.01	1040.42	2.65
	Aug03	24	92	94.33	91.94	462.91	7.42
	Aug04	27	80	88.75	95.18	633.52	4.24
Original Grid & Expanded Grid	2000	14,15	148	170.43	191.51	1117.24	6.00
	2001	16,17	152	157.40	238.77	1534.35	5.30
	2002	21,22	167	172.02	293.18	3180.00	2.65
	2003	23,24	155	151.95	248.08	1895.81	7.42
	2004	26,27	141	144.52	161.47	889.81	4.24

Thorny skate	Trip	Trip #	N	Mean	StdDev	Max	Min
Original Grid	Jul96	1	83	62.48	74.05	435.50	0.00
	Mar97	2	68	28.00	50.74	281.00	0.00
	May/Jun97	3	82	33.61	36.77	135.00	0.00
	Jul97	4	85	96.99	174.70	922.50	0.00
	Nov97	5	50	166.27	239.29	1216.00	0.00
	Mar98	6	84	43.48	88.55	502.74	0.00
	May/Jun98	7	73	25.04	60.55	450.00	0.00
	Jul98	8	78	113.97	160.28	975.00	0.00
	Nov98	9	63	102.82	108.36	440.00	0.00
	Mar99	10	73	45.28	106.55	595.00	0.00
	May/Jun99	12	80	54.10	47.81	258.67	5.40
	Jul99	13	64	72.27	68.38	429.00	0.00
	Jul00	14	65	114.68	142.23	743.75	3.00
	Jul01	16	72	70.43	74.85	318.00	0.00
	Jul02	21	78	70.70	83.90	424.80	2.00
	Jul03	23	63	82.76	131.15	1011.50	2.00
	Jul04	26	61	103.26	92.98	523.43	0.00
Expanded Grid	Aug00	15	83	12.47	30.64	227.50	0.00
	Aug01	17	80	14.51	37.39	224.00	0.00
	Aug02	22	89	17.27	26.26	146.00	0.00
	Aug03	24	92	8.92	18.11	96.00	0.00
	Aug04	27	80	14.01	22.17	122.00	0.00
Original Grid & Expanded Grid	2000	14,15	148	57.36	109.19	743.75	0.00
	2001	16,17	152	41.00	64.42	318.00	0.00
	2002	21,22	167	42.23	65.92	424.80	0.00
	2003	23,24	155	38.93	91.88	1011.50	0.00
	2004	26,27	141	52.62	77.15	523.43	0.00

Table 2. Start and finish dates of the summer grid surveys, 1996-2004.

	Original grid	Expanded grid
1996	July 14-24	
1997	July 22-31	
1998	July 21-30	
1999	July 20-29	
2000	July 19-27	August 1-10
2001	July 17-26	July 31- August 9
2002	July 18-27	August 2-11
2003	July 15-24	July 31- August 10
2004	July 6-14	July 20-29

Table 3a. Ratio of American plaice to yellowtail flounder catch, by block, from common blocks fished in sixteen surveys of the original grid area.

Block	Jul96	Mar97	May97	Jul97	Nov97	Mar98	May/ Jun98	Jul98	Nov98	Mar99	May/ Jun99	Jul99	Jul00	Jul01	Jul02	Jul03	Jul04	Ratio Mean
G04	0.04	0.04	0.14	0.07	0.08	0.05	0.18	0.05	0.03	0.16	0.12	0.02	0.04	0.05	0.05	0.05	0.08	0.07
F05	0.01	0.34	0.05	0.02	0.02	0.26	0.03	0.01	0.06	0.07	0.12	0.15	0.08	0.06	0.01	0.03	0.07	0.08
G03	0.14	0.22	0.28	0.08	0.83	0.03	0.20	0.05	0.11	0.03	0.32	0.02	0.11	0.11	0.09	0.05	0.08	0.17
A01	0.18	0.50	0.44	0.11	0.09	0.02	0.36	0.10	0.25	0.02	0.06	0.14	0.17	0.20	0.28	0.13	0.30	0.19
A05	0.08	0.10	0.38	0.21	0.32	0.12	0.39	0.36	0.32	0.01	0.49	0.14	0.12	0.07	0.13	0.10	0.13	0.21
A03	0.08	0.33	0.91	0.06	0.65	0.33	0.45	0.26	0.38	0.00	0.38	0.11	0.05	0.19	0.24	0.21	0.24	0.29
G07	0.11	0.11	0.29	0.12	0.13	0.06	0.21	0.37	0.12	0.04	0.48	0.45	1.57	0.28	0.27	0.10	0.30	0.29
B02	0.14		0.39	0.33	1.15		0.51	0.20	1.28	0.24	0.43	0.45	0.32	0.19	0.14	0.26	0.12	0.43
C10	0.20	0.97	0.51	0.34	6.52	0.28	0.27	0.61	3.57	0.38	0.28	0.16	0.19	0.15	0.58	0.40	0.40	0.96
B09	1.65	1.25	3.66	0.56	19.57	4.18	0.36	7.70	28.15	11.17	1.47	2.73	0.34	0.49	1.28	0.47	1.33	5.31

Table 3b. Blocks from the expanded grid surveys, August 2000 to 2004, in which the ratio of plaice to yellowtail catch was under 5 percent.

Trip	Block	Yellowtail (kg/hr)	American Plaice (kg/hr)	Cod (kg/hr)	Thorny Skate (kg/hr)	Ratio (Plaice/Ytail)
Aug00	151	305.04	9.54	55.20	34.00	0.03
Aug00	505	688.37	28.62	16.80	0.00	0.04
Aug00	604	659.21	26.50	13.80	9.00	0.04
Aug01	162	196.98	5.30	410.40	224.00	0.03
Aug02	151	538.94	10.60	273.60	35.00	0.02
Aug02	601	64.00	2.65	52.80	0.00	0.04
Aug03	506	760.52	32.38	51.23	1.15	0.04
Aug04	151	415.41	16.45	86.90	20.69	0.04
Aug04	162	312.10	13.12	103.20	36.00	0.04
Aug04	310	1165.15	40.58	0.00	34.00	0.03
Aug04	506	1100.50	37.10	0.00	10.00	0.03
Aug04	701	1891.79	72.38	145.20	58.00	0.04
Aug04	902	102.00	4.24	31.20	0.00	0.04
Aug04	802	152.00	5.30	48.00	86.00	0.03

Table 4. Catches of yellowtail (kg/hr) in the common blocks fished in July surveys (original grid).

	Yellowtail									
Block	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**Mean**
A01	1315.86	997.64	2236.80	1488.97	1132.44	1979.66	934.82	1237.90	905.04	1415.51
A03	1086.85	690.78	835.10	520.21	3319.19	797.39	711.33	606.18	538.29	1070.88
A05	1410.51	167.00	418.65	720.18	398.90	403.37	899.73	474.50	982.71	611.61
A07	576.73	845.50	572.27	516.58	438.24	779.90	907.66	1380.76	1271.25	752.21
A08	325.95	637.30	270.55	554.12	301.90	651.60	681.18	636.91	402.33	507.44
B02	321.00	482.30	379.29	124.50	165.74	163.06	295.56	208.88	397.72	267.54
B04	492.90	90.00	219.58	178.76	384.38	304.06	630.75	496.80	1021.24	349.65
B06	756.00	612.00	666.10	665.60	489.45	1074.30	1289.32	979.64	2024.82	816.55
B08	642.20	857.00	506.90	649.10	340.29	563.70	740.67	736.29	907.58	629.52
B09	254.20	582.34	26.00	101.00	486.75	302.58	141.00	334.29	249.62	278.52
B10	146.50	17.50	0.00	8.00	62.00	34.45	63.00	239.90	43.00	71.42
C07	526.79	1240.50	2383.01	747.90	928.84	620.79	646.76	1264.76	547.15	1044.92
C08	115.38	720.50	333.14	1438.47	174.90	337.20	368.36	1247.40	1417.28	591.92
C10	1430.89	1014.13	503.63	528.18	722.29	556.38	503.86	1062.78	941.48	790.27
D04	668.14	567.38	593.45	465.55	632.81	1328.60	923.26	812.36	615.12	748.94
D08	471.87	481.50	698.63	752.12	586.63	1083.22	888.16	1394.13	1079.18	794.53
D09	684.76	513.20	903.64	682.98	965.14	1360.21	1136.24	1165.38	882.18	926.44
E01	713.85	3369.10	2678.27	710.46	851.43	751.58	666.08	1010.35	1166.02	1343.89
E10	557.09	483.38	694.02	632.36	805.87	1096.10	1063.59	1308.05	1896.54	830.06
F02	1037.00	653.25	858.87	671.33	607.61	1275.68	744.62	1475.20	785.88	915.45
F04	1032.34	704.00	1869.00	529.45	1471.18	1606.27	1875.01	1031.36	875.35	1264.83
F05	1818.10	1396.97	2284.75	170.50	959.57	959.32	1906.62	1938.94	1185.04	1429.35
F06	955.94	728.30	1385.96	1087.21	1478.99	886.68	2065.76	2702.15	743.64	1411.37
F08	1755.34	639.19	1469.34	830.30	1401.36	1063.85	1689.75	1034.75	2321.09	1235.49
F09	836.83	354.25	704.09	913.36	1095.84	675.05	910.60	1145.15	1068.86	829.40
G01	664.77	538.50	301.76	296.04	453.21	373.86	433.74	558.36	739.93	452.53
G03	344.68	518.50	1039.25	667.28	642.23	742.41	462.76	573.10	1302.48	623.78
G04	868.66	451.13	899.02	538.87	1096.56	837.70	1098.37	1106.36	1213.49	862.08
G07	721.72	711.25	1042.11	589.41	246.13	655.72	887.16	882.10	928.90	716.95
H02	600.77	977.44	1198.47	853.26	1417.99	944.28	761.41	1052.88	1001.37	975.81
I01	278.50	483.15	824.50	807.22	488.63	391.93	515.95	485.74	632.78	534.45
I03	441.88	857.50	567.89	163.00	870.36	496.83	855.15	764.60	790.60	627.15
J08	507.58	439.67	477.88	196.20	296.26	484.86	442.50	588.04	438.72	429.12
Mean	738.23	721.88	904.30	599.95	779.19	775.23	852.75	967.76	948.99	

Table 5. Catches of plaice (kg/hr) in the common blocks fished in July surveys (original grid).

	American Plaice									
Block	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**Mean**
A01	232.80	114.27	218.90	204.56	187.90	388.49	261.50	162.79	270.85	221.40
A03	84.50	40.95	213.38	56.53	176.89	149.46	168.54	126.08	128.84	127.04
A05	110.00	35.00	152.64	104.41	47.70	26.50	119.78	45.46	132.24	80.19
A07	29.50	220.50	76.32	27.32	63.60	29.68	68.90	50.04	263.22	70.73
A08	220.50	111.10	100.70	138.48	142.60	49.70	90.60	163.50	197.86	127.15
B02	45.00	158.70	77.23	56.00	53.00	30.74	42.40	55.12	49.14	64.77
B04	111.50	15.50	42.40	12.72	30.18	26.50	24.38	22.26	251.00	35.68
B06	34.00	37.03	56.71	68.04	72.08	97.52	93.50	59.80	136.52	64.84
B08	158.00	173.90	47.70	120.58	225.12	137.20	84.80	163.05	346.42	138.79
B09	420.23	326.93	200.10	276.16	166.10	149.10	180.00	155.82	332.82	234.31
B10	270.00	146.75	253.49	140.50	209.27	116.60	237.14	241.28	335.24	201.88
C07	151.00	231.20	431.42	73.60	110.74	113.42	136.30	251.84	181.00	187.44
C08	53.08	88.05	179.62	714.75	403.78	148.86	142.06	258.45	123.32	248.58
C10	293.00	349.50	309.68	85.10	138.07	81.84	292.76	428.57	378.93	247.32
D04	41.00	66.50	49.82	21.52	48.58	71.55	34.80	71.60	70.60	50.67
D08	124.00	96.00	389.90	385.90	496.72	218.56	169.60	159.00	262.02	254.96
D09	163.50	232.78	330.46	190.37	479.48	272.14	232.14	275.57	206.38	272.06
E01	80.00	130.40	120.66	15.90	208.14	87.98	58.30	39.57	119.48	92.62
E10	147.50	265.25	189.21	263.73	352.92	306.09	248.64	247.96	424.75	252.66
F02	47.50	35.63	34.98	47.40	75.79	118.19	45.58	60.12	47.04	58.15
F04	8.00	38.09	33.92	8.48	36.57	42.40	40.81	22.26	60.30	28.82
F05	20.00	22.25	15.90	26.00	74.61	54.06	12.72	64.66	78.70	36.28
F06	23.00	0.00	56.18	55.12	95.84	83.74	73.96	133.56	143.88	65.18
F08	91.00	73.92	326.75	171.92	424.94	146.28	149.34	87.26	357.52	183.93
F09	67.50	85.12	302.10	311.11	438.84	158.26	123.78	125.24	174.06	201.49
G01	42.00	49.90	72.08	31.80	81.62	28.62	34.98	54.59	54.51	49.45
G03	47.50	39.15	54.06	15.90	70.78	80.56	41.34	29.68	105.76	47.37
G04	39.00	30.57	44.52	8.48	41.87	42.40	51.94	58.30	101.40	39.64
G07	80.00	86.80	382.66	265.27	386.47	184.97	242.09	90.10	282.84	214.80
H02	67.00	92.81	80.56	122.96	367.56	237.44	258.38	139.80	269.00	170.81
I01	86.50	214.60	114.48	57.71	121.90	142.04	168.54	129.79	106.94	129.45
I03	81.00	274.38	216.24	9.00	79.50	106.53	193.98	106.00	52.38	133.33
J08	387.00	1654.40	2197.82	975.20	403.86	1534.35	3180.00	1895.81	889.81	1528.56
Mean	116.85	167.82	223.41	153.41	191.30	165.51	221.32	181.06	210.14	

Table 6. Ratio of American plaice to yellowtail flounder catch from common blocks fished in July surveys (original grid).

	Ratio American plaice/yellowtail									MEAN	Total Plaice/Total Ytail
Block	96	97	98	99	00	01	02	03	04		
F04	0.01	0.05	0.02	0.02	0.02	0.03	0.02	0.02	0.07	0.03	0.03
F05	0.01	0.02	0.01	0.15	0.08	0.06	0.01	0.03	0.07	0.05	0.03
G04	0.04	0.07	0.05	0.02	0.04	0.05	0.05	0.05	0.08	0.05	0.05
F06	0.02	0.00	0.04	0.05	0.06	0.09	0.04	0.05	0.19	0.06	0.06
F02	0.05	0.05	0.04	0.07	0.12	0.09	0.06	0.04	0.06	0.07	0.06
D04	0.06	0.12	0.08	0.05	0.08	0.05	0.04	0.09	0.11	0.08	0.07
E01	0.11	0.04	0.05	0.02	0.24	0.12	0.09	0.04	0.10	0.09	0.07
B06	0.04	0.06	0.09	0.10	0.15	0.09	0.07	0.06	0.07	0.08	0.08
G03	0.14	0.08	0.05	0.02	0.11	0.11	0.09	0.05	0.08	0.08	0.08
G01	0.06	0.09	0.24	0.11	0.18	0.08	0.08	0.10	0.07	0.11	0.10
A07	0.05	0.26	0.13	0.05	0.15	0.04	0.08	0.04	0.21	0.11	0.11
A03	0.08	0.06	0.26	0.11	0.05	0.19	0.24	0.21	0.24	0.16	0.13
A05	0.08	0.21	0.36	0.14	0.12	0.07	0.13	0.10	0.13	0.15	0.13
B04	0.23	0.17	0.19	0.07	0.08	0.09	0.04	0.04	0.25	0.13	0.14
F08	0.05	0.12	0.22	0.21	0.30	0.14	0.09	0.08	0.15	0.15	0.15
A01	0.18	0.11	0.10	0.14	0.17	0.20	0.28	0.13	0.30	0.18	0.17
H02	0.11	0.09	0.07	0.14	0.26	0.25	0.34	0.13	0.27	0.19	0.19
C07	0.29	0.19	0.18	0.10	0.12	0.18	0.21	0.20	0.33	0.20	0.19
I03	0.18	0.32	0.38	0.06	0.09	0.21	0.23	0.14	0.07	0.19	0.19
B02	0.14	0.33	0.20	0.45	0.32	0.19	0.14	0.26	0.12	0.24	0.22
F09	0.08	0.24	0.43	0.34	0.40	0.23	0.14	0.11	0.16	0.24	0.23
I01	0.31	0.44	0.14	0.07	0.25	0.36	0.33	0.27	0.17	0.26	0.23
B08	0.25	0.20	0.09	0.19	0.66	0.24	0.11	0.22	0.38	0.26	0.25
A08	0.68	0.17	0.37	0.25	0.47	0.08	0.13	0.26	0.49	0.32	0.27
E10	0.26	0.55	0.27	0.42	0.44	0.28	0.23	0.19	0.22	0.32	0.29
D09	0.24	0.45	0.37	0.28	0.50	0.20	0.20	0.24	0.23	0.30	0.29
G07	0.11	0.12	0.37	0.45	1.57	0.28	0.27	0.10	0.30	0.40	0.30
D08	0.26	0.20	0.56	0.51	0.85	0.20	0.19	0.11	0.24	0.35	0.31
C10	0.20	0.34	0.61	0.16	0.19	0.15	0.58	0.40	0.40	0.34	0.32
C08	0.46	0.12	0.54	0.50	2.31	0.44	0.39	0.21	0.09	0.56	0.34
B09	1.65	0.56	7.70	2.73	0.34	0.49	1.28	0.47	1.33	1.84	0.89
B10	1.84	8.39		17.56	3.38	3.38	3.76	1.01	7.80	5.89	3.17
J08	0.76	3.76	4.60	4.97	1.36	3.16	7.19	3.22	2.03	3.45	3.39

Table 7. Length compostion of Yellowtail flounder (sexes combined). Asterisk indicates expanded grid area.

		Percentage of Yellowtail		
Trip	Trip #	<26cm	<30cm	>=40cm
Jul96	1	1.90	6.31	26.41
Mar97	2	1.62	6.72	21.05
May/Jun97	3	1.11	5.80	26.88
Jul97	4	1.19	7.70	24.81
Nov97	5	0.16	2.73	31.49
Mar98	6	1.56	8.97	25.36
May/Jun98	7	0.88	6.05	24.81
Jul98	8	1.74	10.28	21.61
Nov98	9	0.79	5.81	24.56
Mar99	10	0.55	6.63	22.37
May/Jun99	12	0.62	5.99	24.90
Jul99	13	0.34	3.67	28.41
Jul00	14	0.64	4.45	21.88
Aug00 *	15	0.15	2.65	18.12
Jul01	16	0.63	4.84	20.05
Aug01 *	17	0.15	2.72	18.01
Jul02	21	0.80	5.76	16.64
Aug02*	22	0.18	2.96	17.92
Jul03	23	0.58	4.64	16.95
Aug03*	24	0.19	2.80	17.01
Jul04	23	0.75	2.40	14.99
Aug04*	24	0.15	1.13	16.07

Table 8. Numbers and weights (kg) of yellowtail caught in original grid area during DFO stratified random surveys in Div. 3LNO.

Yr/season	**Yellowtail in original grid area**		**Yellowtail in survey**		**Pct of total catch in original grid**	
	Numbers	Weight	Numbers	Weight	% nos	%wt
95F	19842	4528	22276	4997	89.1%	90.6%
96S	14695	3878	16937	4619	86.8%	84.0%
96F	7038	1899	8640	2141	81.5%	88.7%
97S	12059	2807	15010	3882	80.3%	72.3%
97F	10640	2928	17349	5037	61.3%	58.1%
98S	14617	3950	20827	5734	70.2%	68.9%
98F	8987	2507	12512	3696	71.8%	67.8%
99S	21054	4976	34082	9600	61.8%	51.8%
99F	12778	2946	18570	4978	68.8%	59.2%
00S	14183	3924	23131	7263	61.3%	54.0%
00F	9091	2784	22438	6507	40.5%	42.8%
01S	26003	6900	32446	8939	80.1%	77.2%
01F	15396	4365	32783	9475	47.0%	46.1%
02S	12781	3523	16444	4734	77.7%	74.4%
02F	16487	4265	23282	6757	70.8%	63.1%
03S	23540	7106	34548	10511	68.1%	67.6%
03F	16019	4464	25191	7359	63.6%	60.7%
04S	15252	4341	23126	7354	66.0%	59.0%
04F	16730	3880	28305	7491	59.1%	51.8%

Table 9. Numbers and weights (kg) of yellowtail flounder caught in the total (original + expanded) grid area during DFO surveys in Div. 3LNO.

Yr/Season	**Yellowtail in expanded grid area**		**Yellowtail in survey**		**Pct of total catch in expanded grid**	
	Numbers	Weight	Numbers	Weight	% nos	% wt
00S	20798	6453	23131	7263	89.9%	88.8%
00F	12574	3759	22438	6507	56.0%	57.8%
01S	29295	8000	32446	8939	90.3%	89.5%
01F	21456	6338	32783	9475	65.4%	66.9%
02S	13153	3613	16444	4734	80.0%	76.3%
02F	19208	5198	23282	6757	82.5%	76.9%
03S	27412	8473	34548	10511	79.3%	80.6%
03F	20457	5813	25191	7359	81.2%	79.0%
04S	17144	5057	23126	7354	74.1%	68.8%
04F	19265	4722	28305	7491	68.1%	63.0%

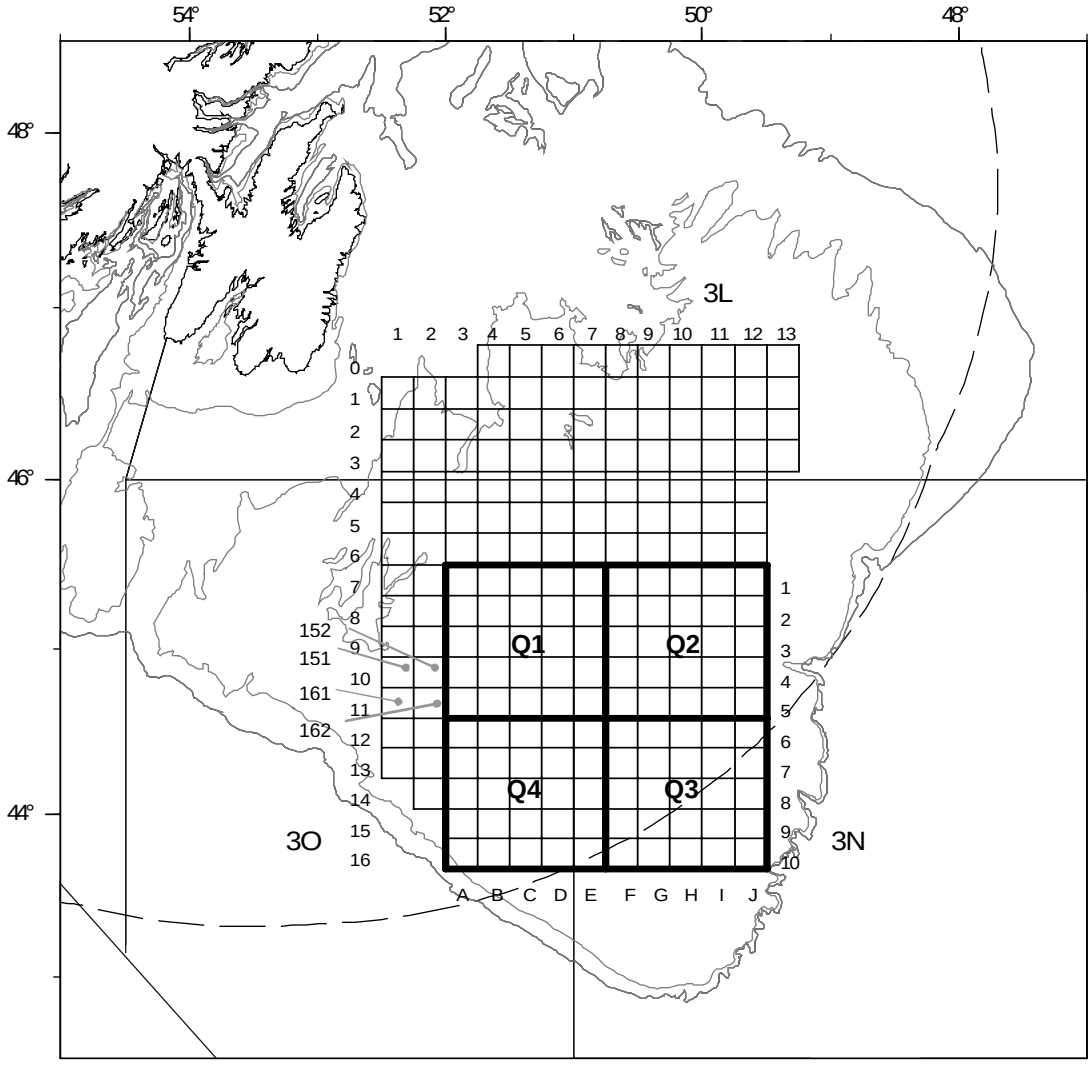


Figure 1. Location of grid used in cooperative surveys directed at yellowtail flounder. Original grid bolded with 5x5 blocks per quadrant. Expanded grid surveyed in 2000-2004.

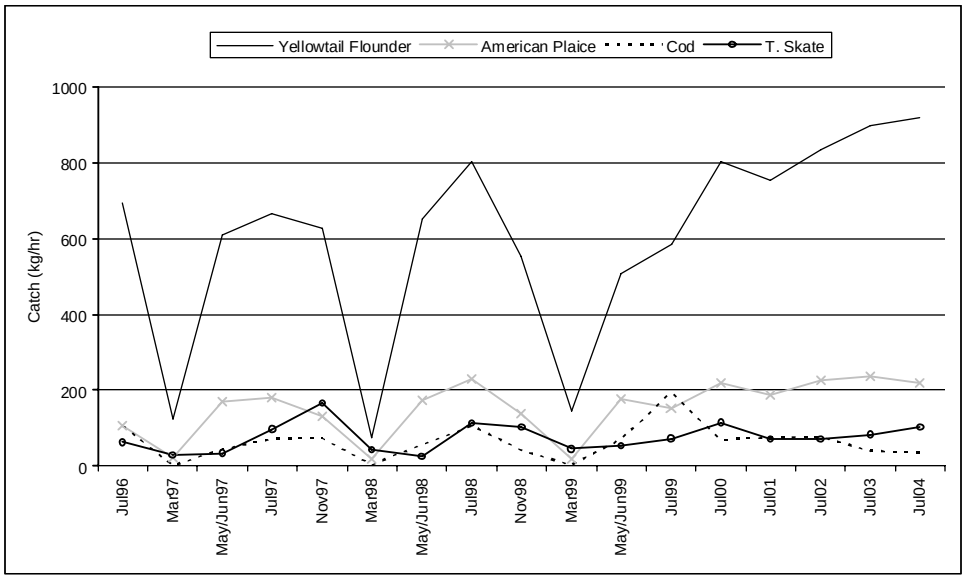
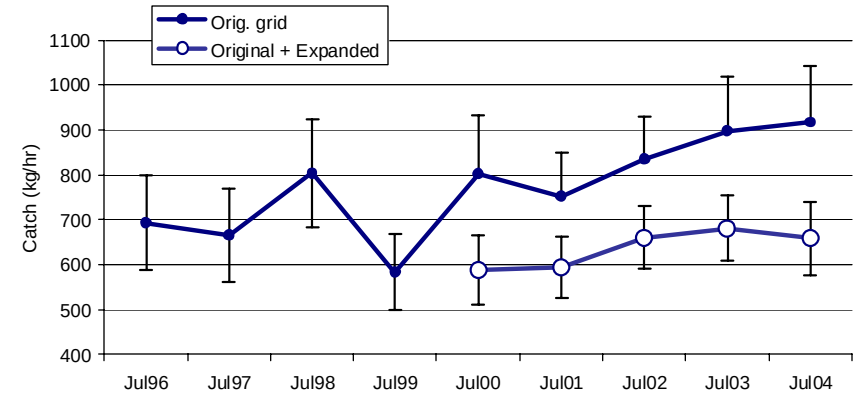
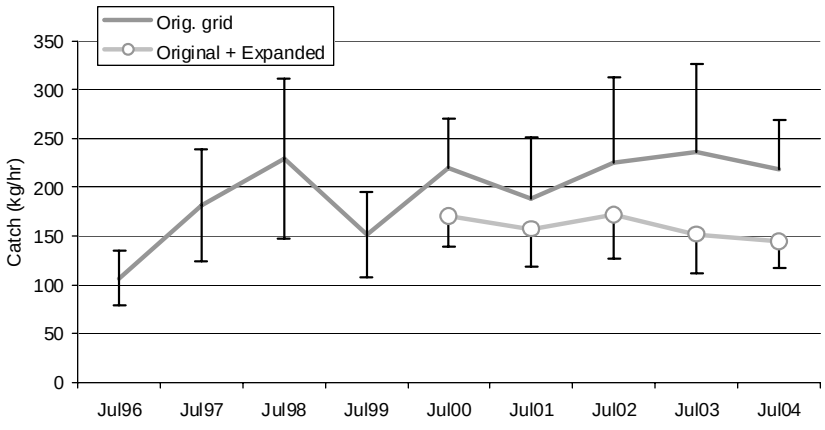


Figure 2. Mean catch (kg/hr) of yellowtail, American plaice, cod and thorny skate caught in original grid surveys from 1996-2004.



a.



b.

Figure 3. Average catches for yellowtail flounder (a) and American plaice (b) for original grid surveys (1996-1999) and July/August surveys combined (2000-2004). Error bars are 2 SE.

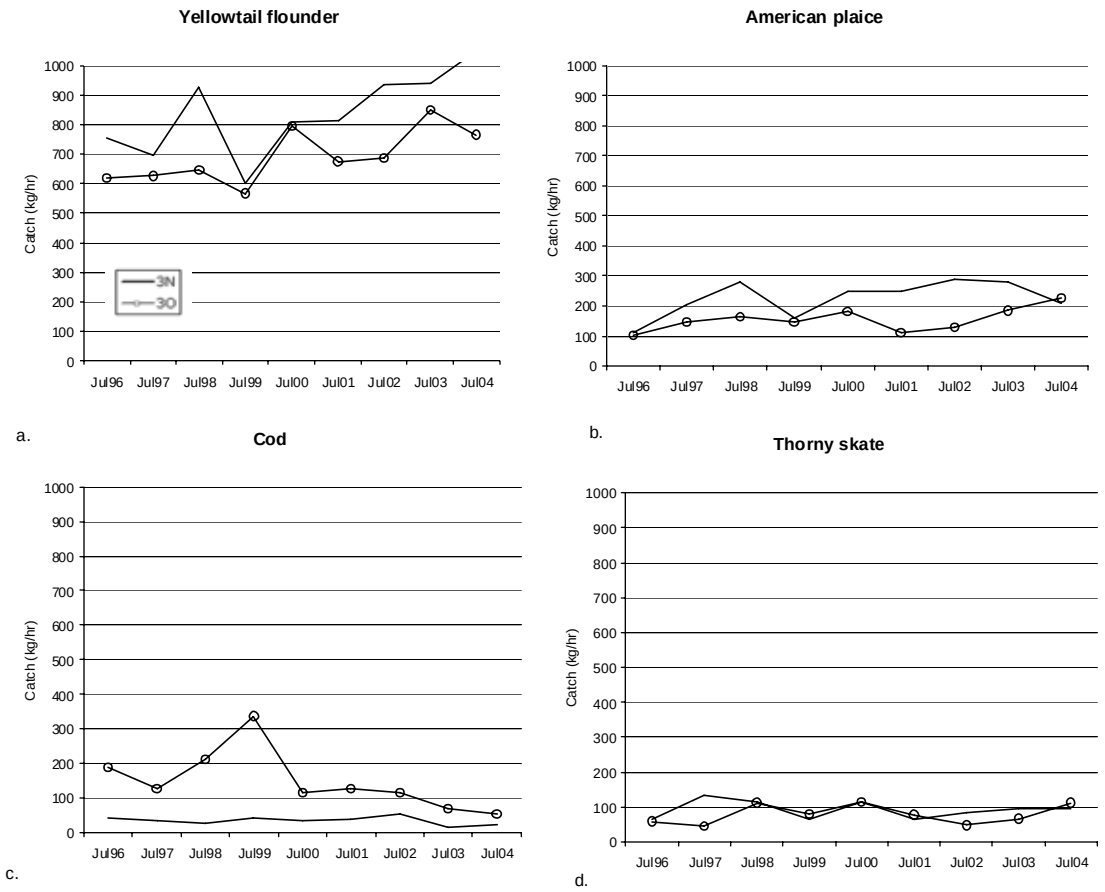


Figure 4. Catch (kg/hr) of yellowtail, American plaice, cod and thorny skate by NAFO Division, caught in cooperative surveys (original grid) from 1996-2004.

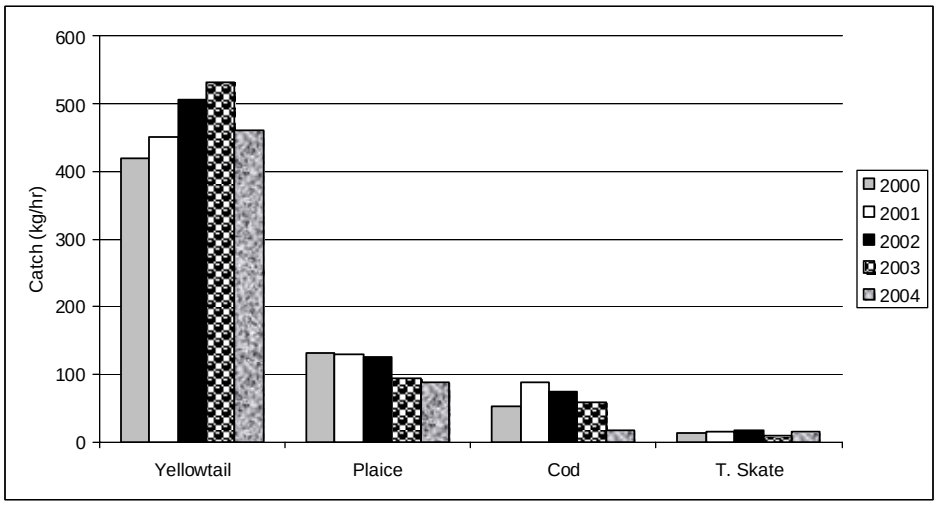


Figure 5. Catch (kg/hr) of yellowtail, American plaice, cod and thorny skate caught in surveys covering the expanded grid area.

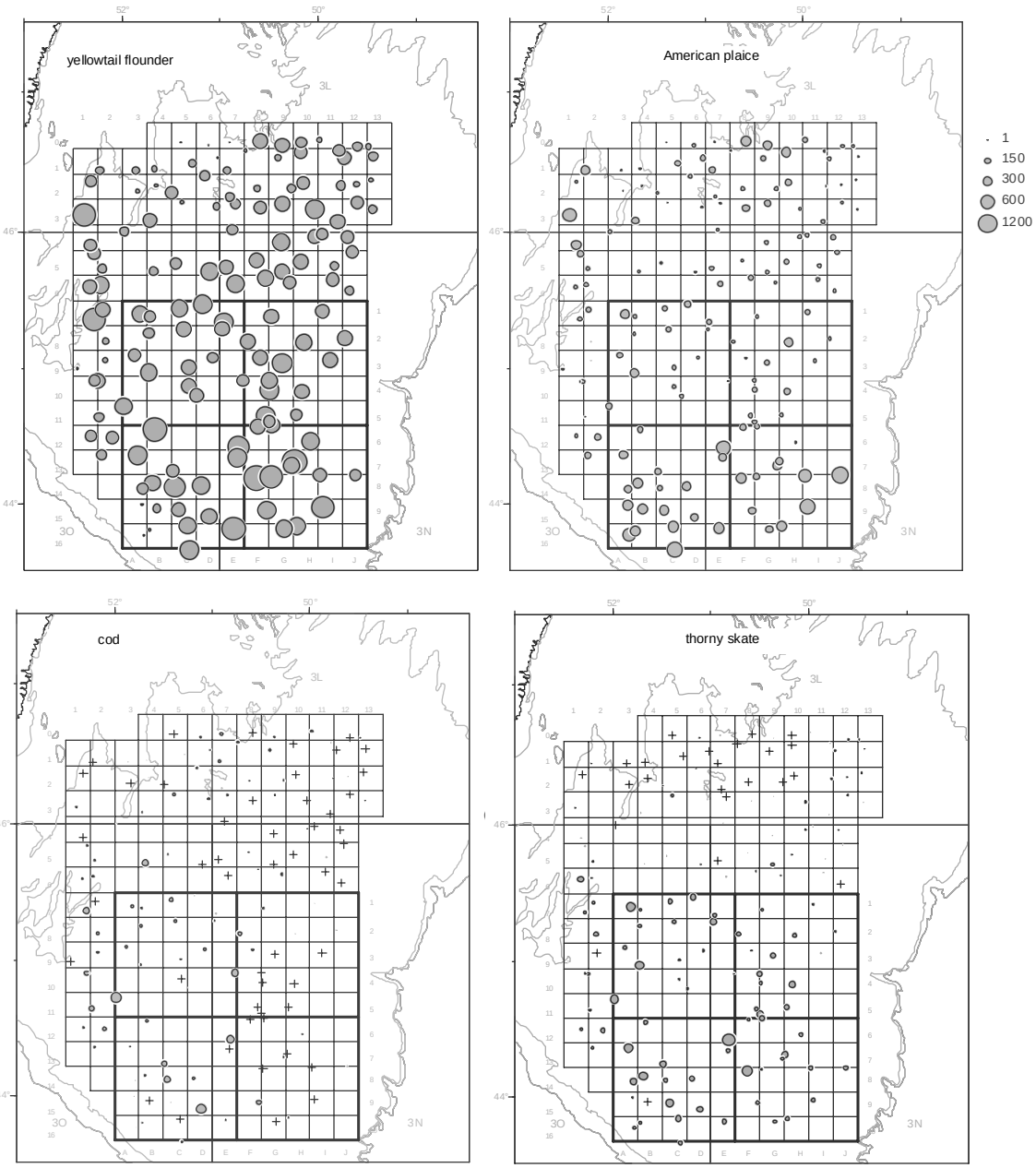


Figure 6. Distribution and catch (kg per standard 3Nm tow) for yellowtail flounder, American plaice, cod and thorny skate from industry surveys of original grid and expanded grid area in 2004.

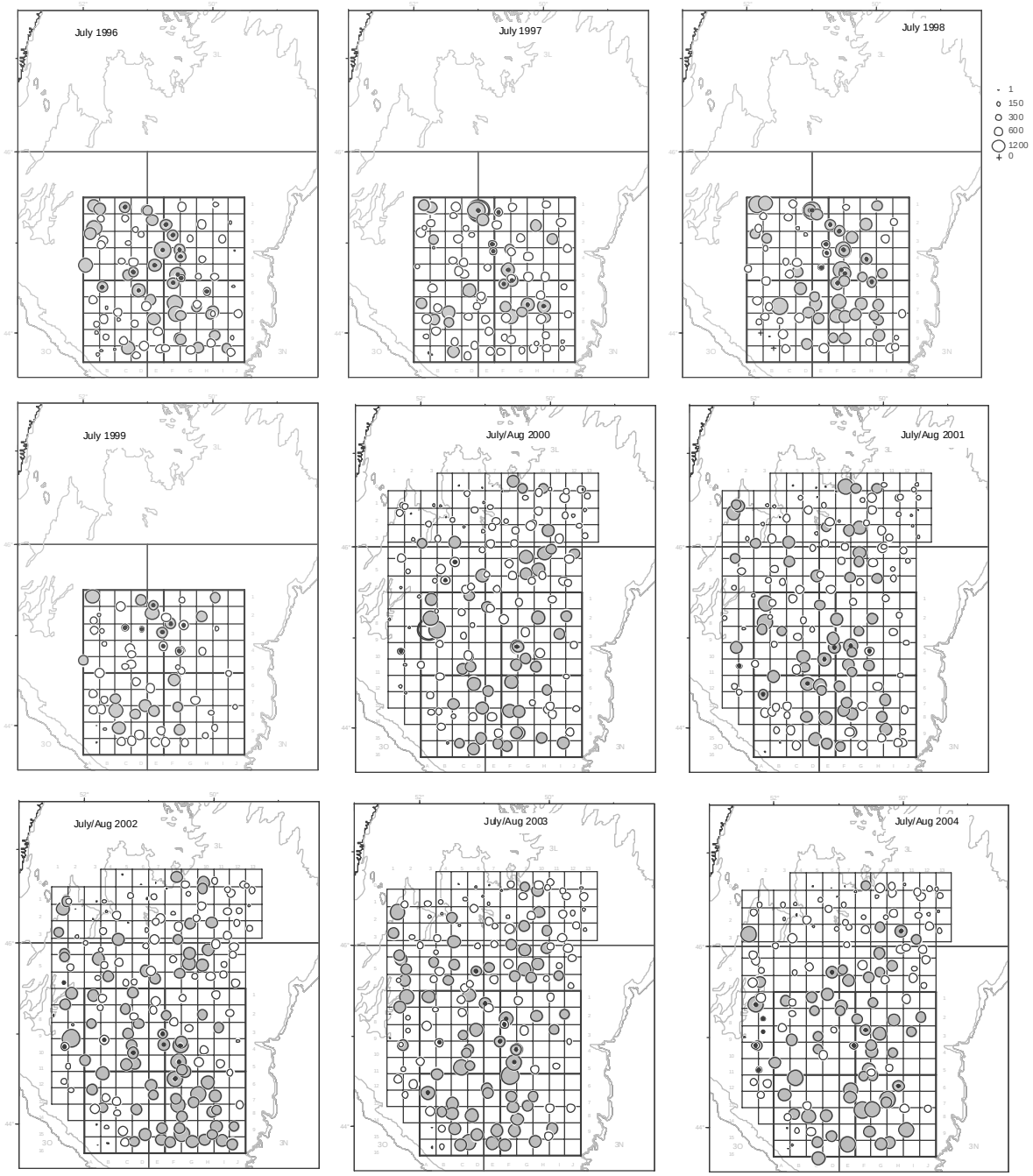


Figure 7. Distribution of yellowtail flounder (kg per standard 3Nm. Tow) from industry grid surveys conducted in NAFO Div. 3LNO in July and August 2002. Symbols are scaled to catch rate, grey indicates catch rate over 700 kg/tow and center dot shows sets with less than 5% bycatch of American plaice.

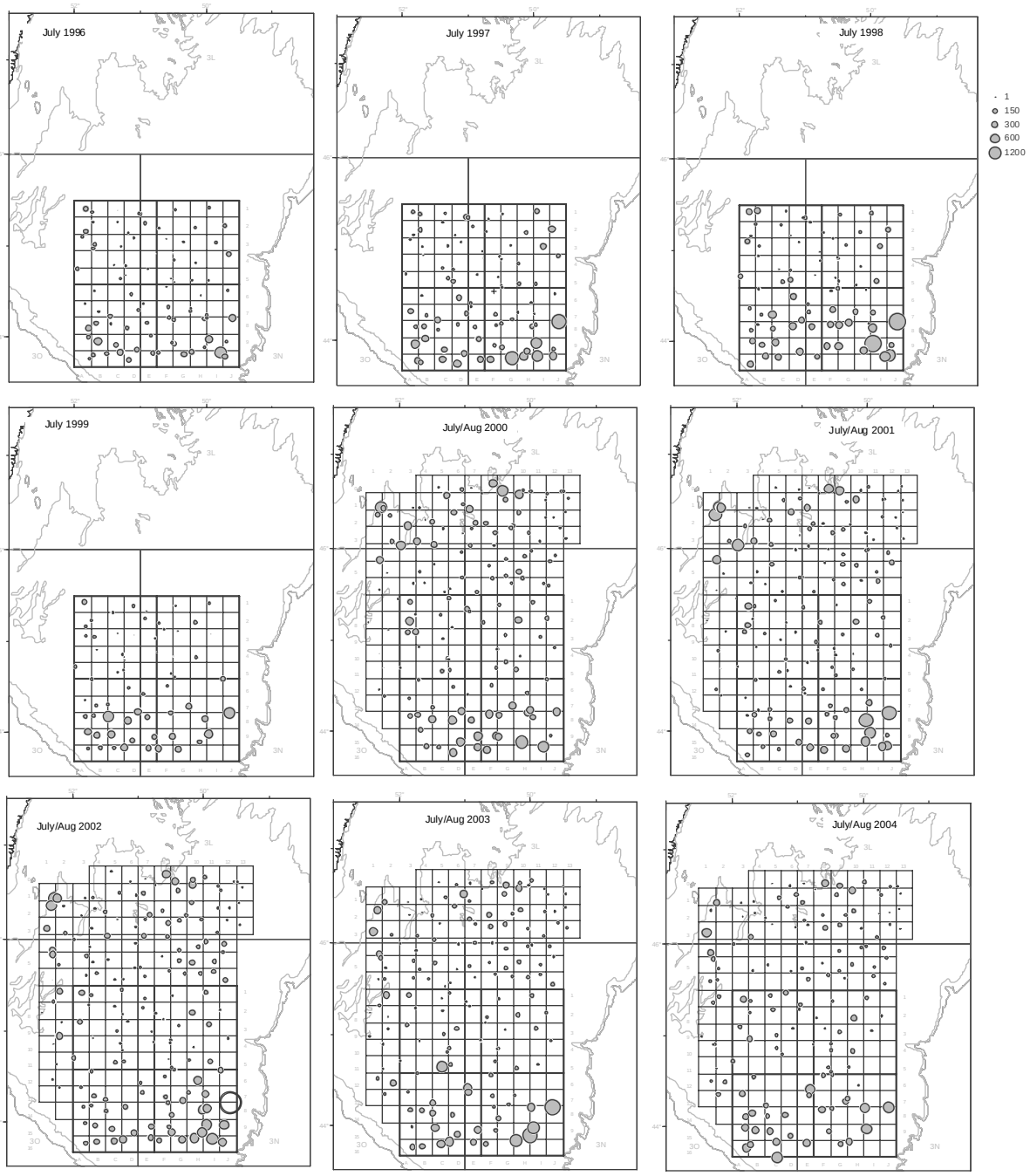


Figure 8. Distribution and catches of American plaice (kg per standard 3Nm tow) from industry surveys of original grid conducted in NAFO Div. 3LNO in July from 1996-1999 and expanded grid area surveyed in July/August from 2000-2004. Hollow circles indicate catches over 2800 kg/tow.

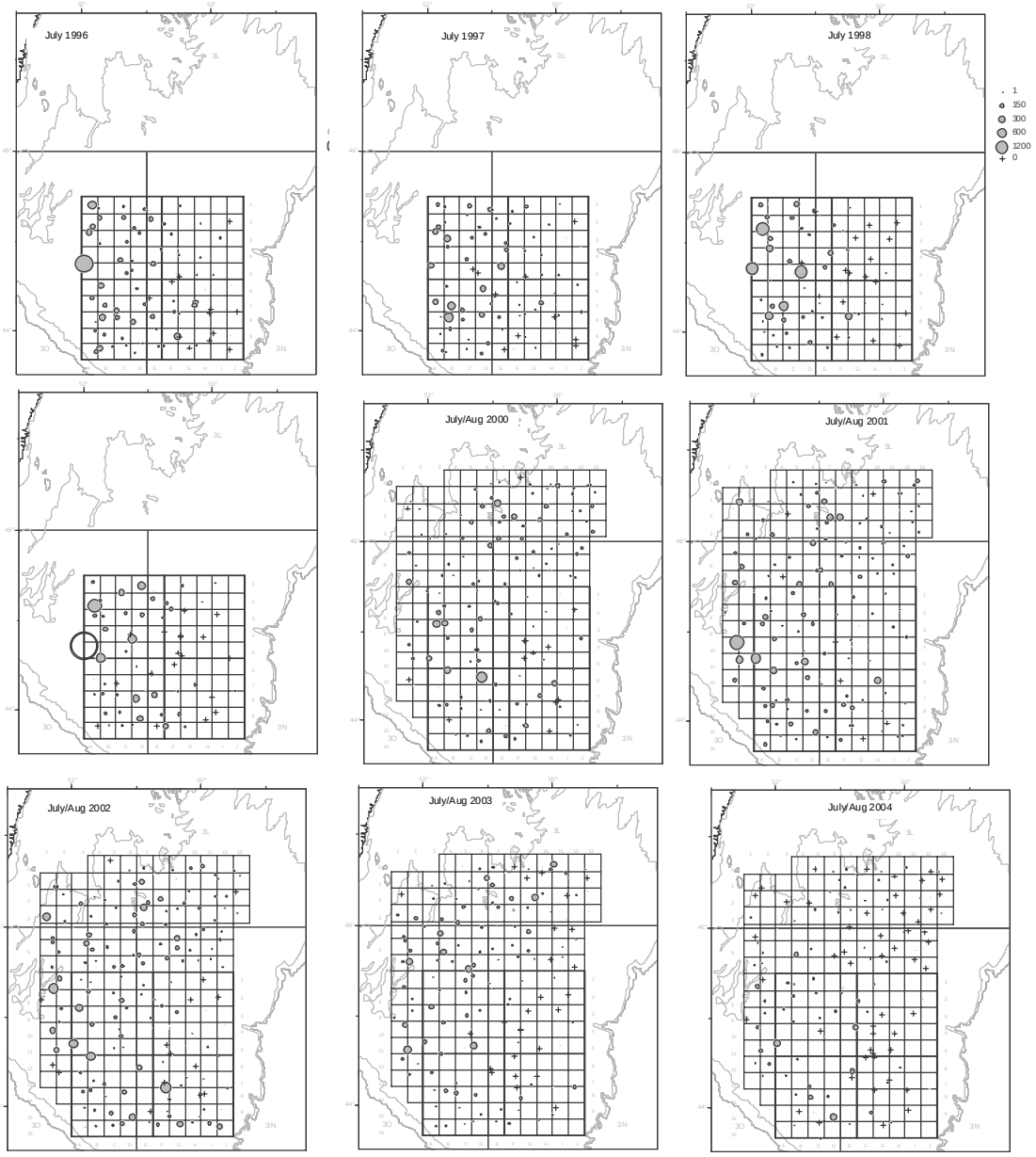


Figure 9. Distribution and catches of cod (kg per standard 3Nm tow) from industry surveys of original grid conducted in NAFO Div. 3LNO in July from 1996-1999 and expanded grid area surveyed in July/August from 2000-2004. Hollow circles indicate catches over 2800 kg/tow.

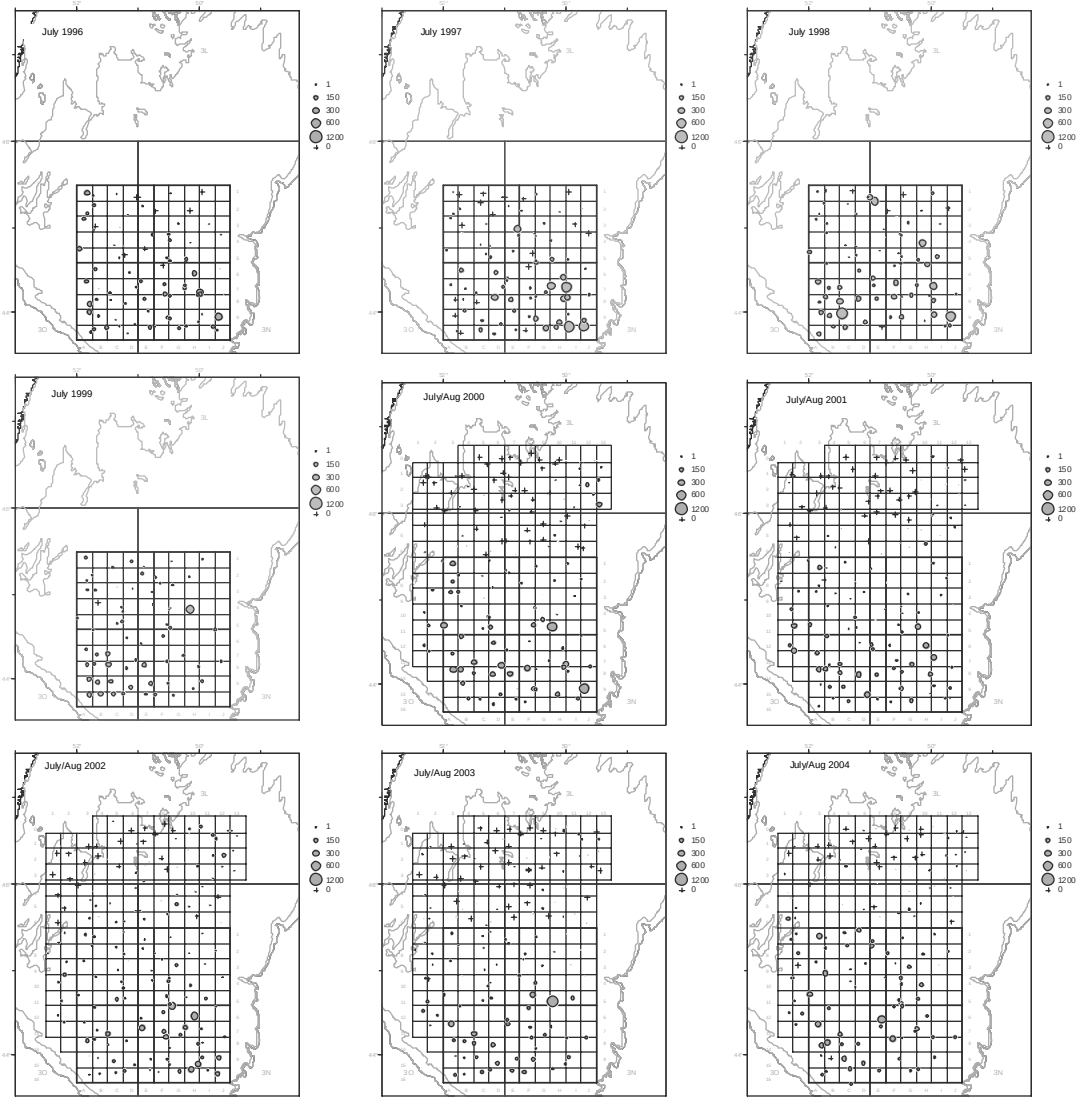


Figure 10. Distribution and catches of thorny skate (kg per standard 3Nm tow) from industry surveys of original grid conducted in NAFO Div. 3LNO in July from 1996-1999 and expanded grid area surveyed in July/August from 2000-2004.

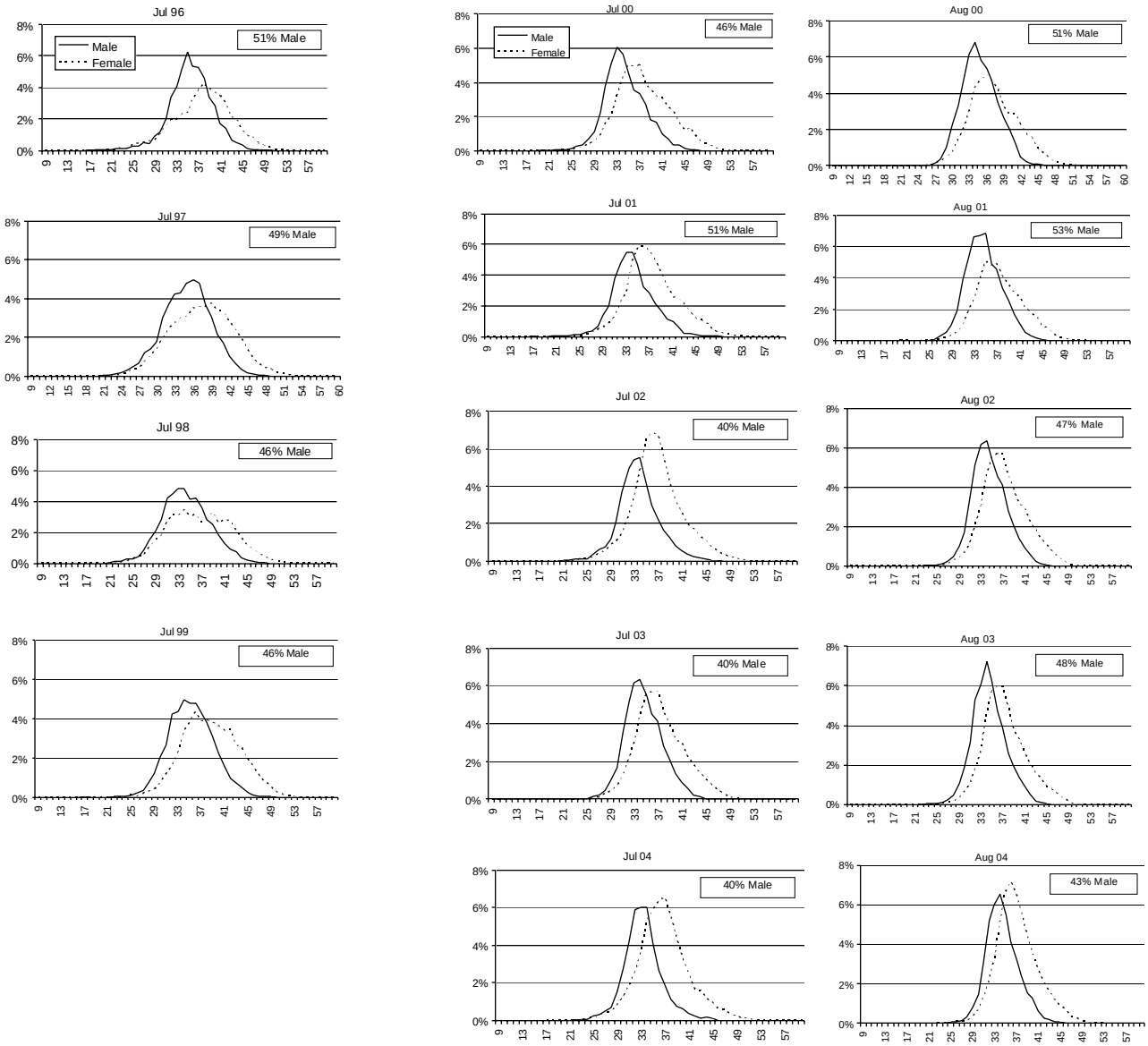


Figure 11. Length compostion of yellowtail flounder caught in the Atlantic Lindey July surveys (original grid) and expanded grid area (Aug plots).

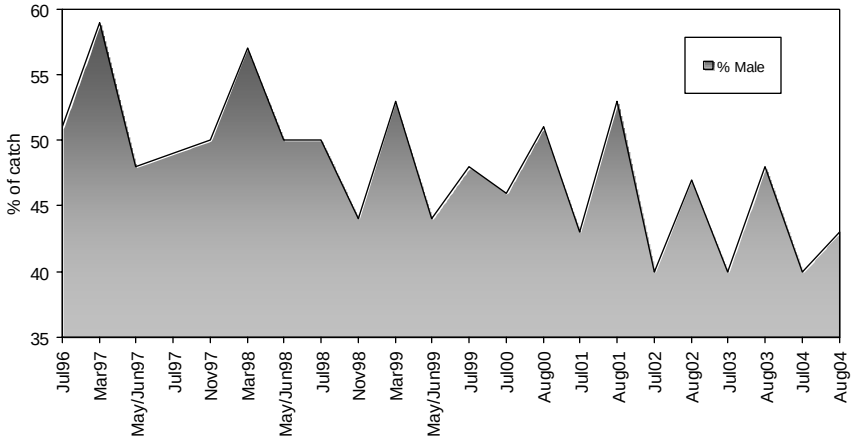


Figure 12. Sex ratio of yellowtail flounder catch for the Atlantic Lindsey surveys.

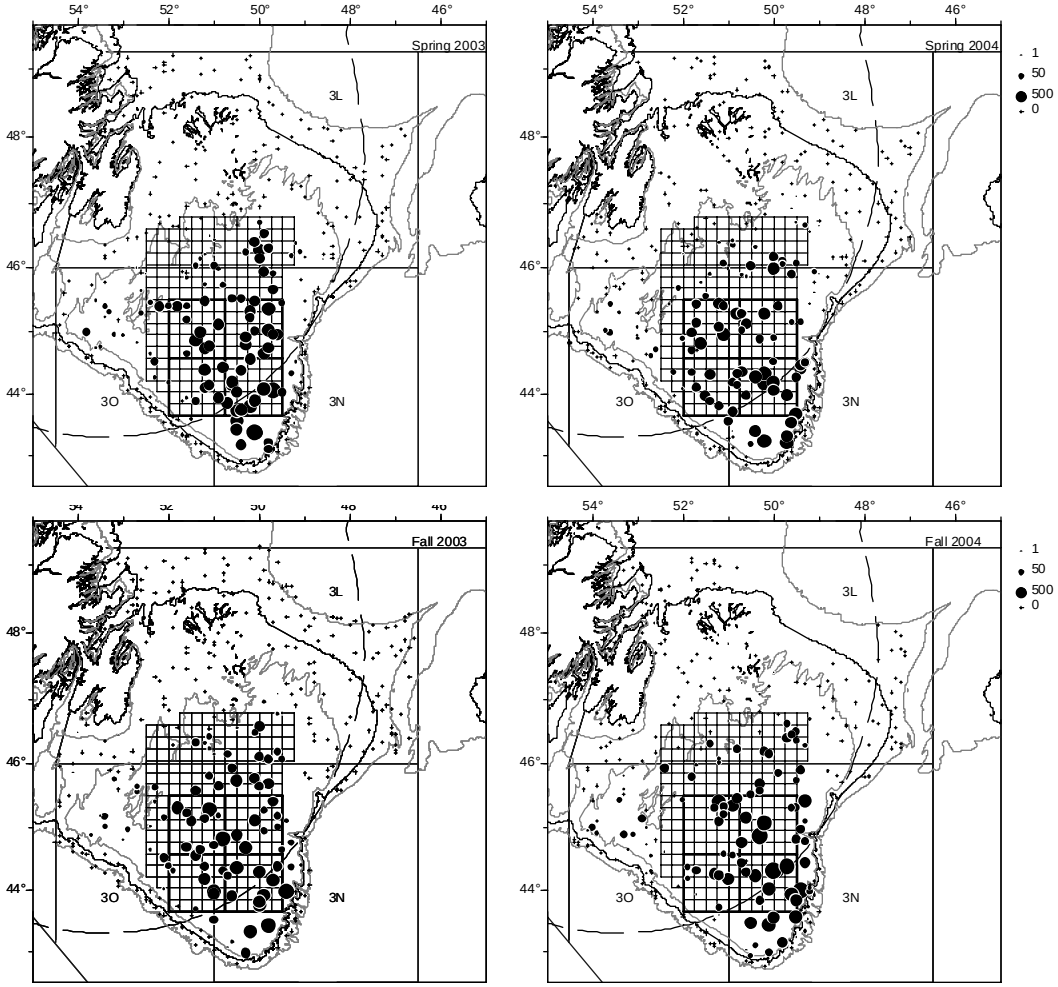


Figure 13. Distribution of yellowtail flounder catches (number per tow) from stratified random spring and fall surveys conducted in 2003 and 2004 with a Campelen 1800 trawl in Div. 3LNO. Grid used in the FPI-DFO surveys is depicted for illustration.

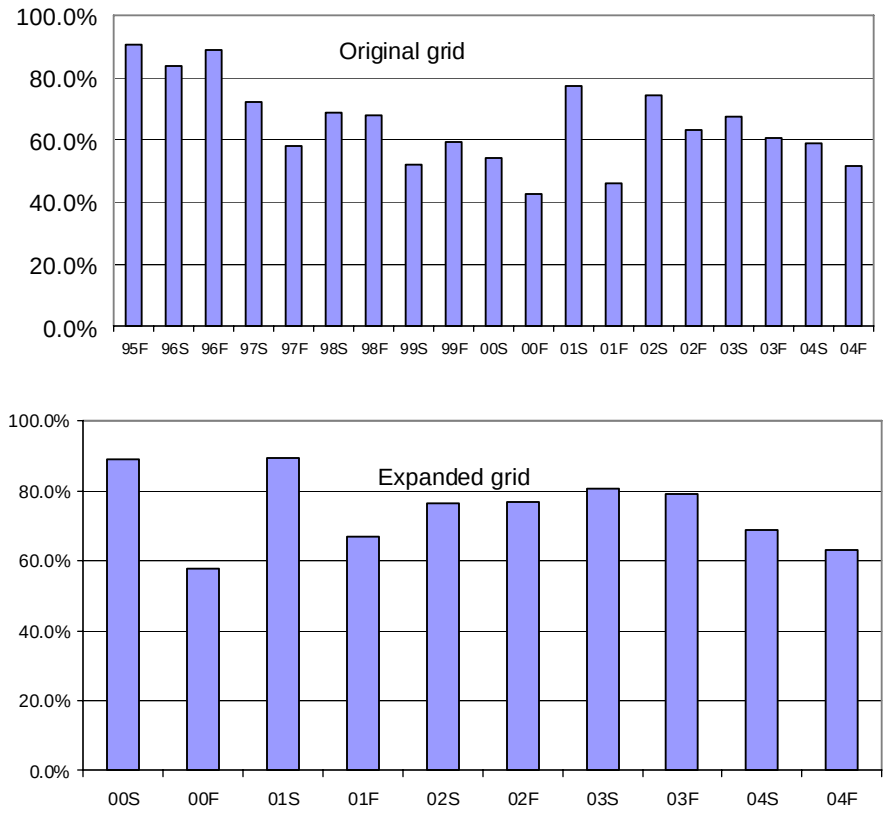


Fig. 14. DFO spring (S) and fall (F) surveys, 1995-2004 - proportion of total yellowtail flounder, by weight, caught within the original grid area (upper panel), and expanded grid (lower panel).

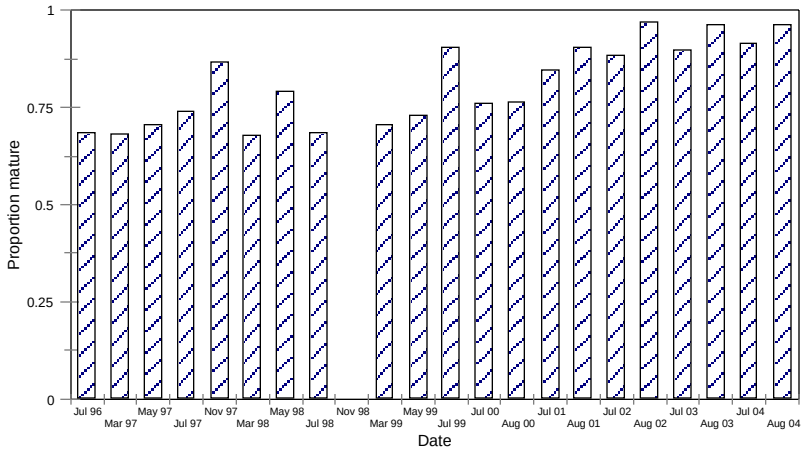


Fig. 15. Proportion of female yellowtail flounder considered to be sexually mature, from grid surveys in Div. 3NO

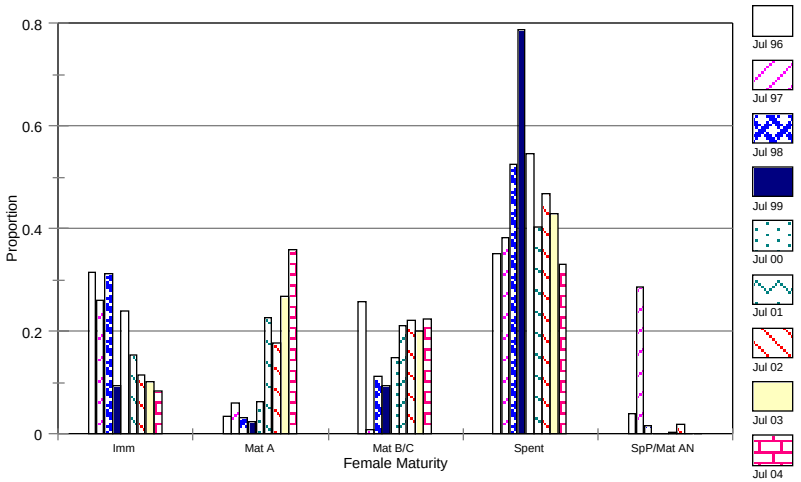


Fig 16. Maturity stages of female yellowtail flounder, from grid surveys conducted in July in Div. 3NO.

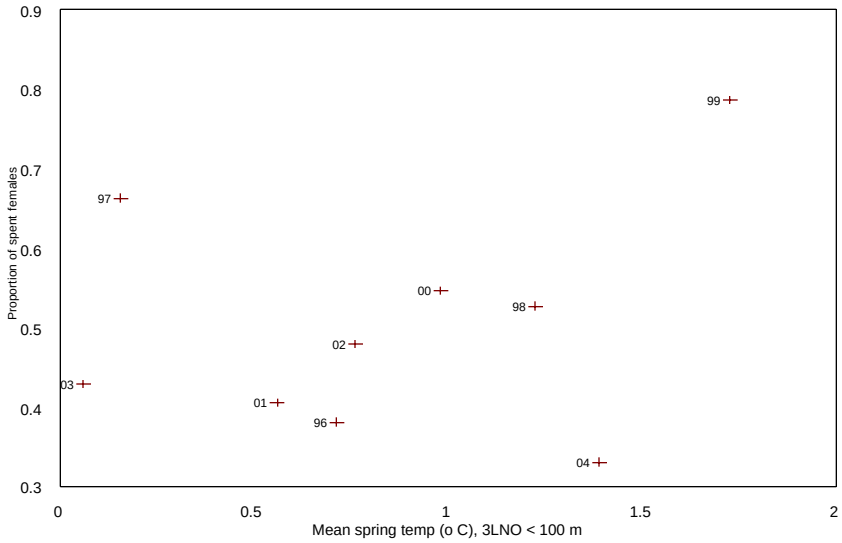


Fig. 17. Relationship between proportion of spent female yellowtail in the July grid surveys, and the mean spring bottom temperature, 3LNO <100 m.