SCALLOP FISHERY AREA/TIME CLOSURE TO REDUCE YELLOWTAIL FLOUNDER BYCATCH ON GEORGES BANK IN 2007

Context

Managing bycatch is an emerging concern of Ecosystem Based Management. Additionally, the bilateral sharing arrangement between Canada and the USA for the transboundary resources of cod, haddock and yellowtail flounder on Georges Bank stipulates that the bycatches of these species are to be accounted for against their respective quotas.

The Canadian scallop fishery on Georges Bank captures yellowtail flounder as bycatch which is discarded. The scallop fishery has not been permitted to land yellowtail since 1996. Yellowtail bycatch is highest during the months of April through June, which is the period of peak spawning activity for yellowtail flounder (O'Brien et al., 1993). While yellowtail biomass increased during 1997-2006 compared to 1986-1996, the most recent stock assessment for yellowtail flounder on Georges Bank (5Zhjmn; Figure 1) indicated that adult biomass had declined from 11,300 mt in 2003 to 5,450 mt in 2006 and that recruitment, which averaged 23.5 million fish at age 1 during 1998-2001, had declined to 9.2 million fish in 2005 (TRAC, 2006). The recommended TAC for 2007 was 1,250 mt with a Canadian TAC allocation of 350 mt. Bycatch of yellowtail flounder in the Canadian scallop fishery has, in the past, exceeded this amount.

Given the recent poor status of the Georges Bank yellowtail stock, fishery managers need to consider opportunities for reducing yellowtail bycatch to improve rebuilding prospects for this stock in time for application in the 2007 scallop fishery. Area/time closure during cod spawning was implemented in 2006 and was considered an effective approach for managing cod bycatch in the scallop fishery. This approach may also be a useful strategy for reducing the bycatch of yellowtail flounder on Georges Bank. The request fishery managers put to Science is:

Some time/area combinations fished by the scallop fleet on the Canadian side of Georges Bank yield higher bycatches of yellowtail flounder than others. Identify opportunities for scallop fishery area/time closures that may reduce bycatch of yellowtail flounder.

Contributors

The response below was reviewed in a meeting on 23 January 2007 by DFO Science staff R. O'Boyle (Chair), P. Boudreau, A. Chisholm, S. Gavaris, P. Hurley, H. Stone (co-author, absent), L. Van Eeckhaute (co-author), and Consultant G. Robert

Response

Yellowtail flounder (*Limanda ferruginea*) is generally an offshore species with a preference for sandy substrates and is found most often at depths of 37-73 m (Collette and Klein-MacPhee,

2002). Yellowtail flounder on Georges Bank comprise a relatively discrete stock (Stone et al., 2004). They are batch spawners (eggs are released in batches over a period of one month) and the spawning season extends from April to August with peak spawning on Georges Bank in May and June (O'Brien et al., 1993). About 50% of males are mature at 21 cm (age 1.3) while 50% of females are mature at 26 cm (age 1.8) (O'Brien et al., 1993). Little published information is available on their seasonal movement patterns on northeastern Georges Bank. Recent tagging experiments (Stone and Nelson, 2003; Stone unpublished data) indicate that yellowtail flounder are capable of extensive movements (i.e. > 100 km) within the 5Zhjmn management unit. Further interpretation of tagging results is compromised by biased tag returns and limited effort distribution.

Information from February DFO and spring and fall NMFS bottom trawl surveys, was used to identify areas of high aggregations of adult (> 30 cm TL) yellowtail flounder during periods of high (1997-2006) and low (1987-1996) population abundance (Appendix A). The survey information showed that yellowtail flounder undergo an expansion of their spatial distribution from winter to spring and become more abundant in 5Zj during March-April. This seasonal pattern was consistent for both decades despite differences in population abundance and would tend to increase their availability to the scallop fishery in 5Zj, particularly during the second quarter. The NMFS spring survey indicated that the northeast portion of 5Zj may have lower relative abundance of yellowtail during March-April and could potentially yield lower bycatch. The DFO survey series showed widespread distribution of adult yellowtail in 5Zm during February-March with high relative abundance in the central portion during both decades. This region in 5Zm encompasses the "Yellowtail Hole" where a Canadian directed fishery for yellowtail occurred from 1994-2004.

Yellowtail flounder temporal bycatch trends were examined from observed scallop (2001, 2002 and 2004-2006) and groundfish (2005-2006) trips on Georges Bank (Appendix B and C). Both sources indicated that the bycatch rates of yellowtail were highest during the second quarter, particularly in May and June, and declined to low levels through summer, fall and early winter. The seasonal pattern of yellowtail flounder landings per trip for 1986-1995, a period when the scallop fishery was allowed to land their groundfish bycatch (Appendix D), showed general correspondence with seasonal trends in bycatch rates from the observed scallop and groundfish trips on Georges Bank and confirmed that the higher bycatch rate of yellowtail flounder in the second quarter for these fleets is a persistent feature and not just a recent phenomenon.

For the observed scallop trips, there were several cells (5' longitude x3.3' latitude rectangles) in north central 5Zj with higher density for yellowtail, particularly from April through to July (Appendix B). Observer data for the groundfish fleet was more extensive than the scallop fleet, especially for the month of June, and confirmed that the central portion of 5Zj yields higher yellowtail bycatch (Appendix C) and that the northeast part of Georges Bank in 5Zj may be an area of low yellowtail density at this time of year. This area of lower density was also apparent in the NMFS spring survey series for the March-April period. While there were few observed scallop trips in 5Zm, observed groundfish trips in 5Zm showed high bycatches in the central region in June near the international boundary.

The second quarter is the time of peak spawning (May-June) of yellowtail flounder on Georges Bank (O'Brien et al., 1993). Evidence for the onset of spawning was apparent in the maturity stages of yellowtail flounder determined during NMFS spring surveys over the past decade (1997-2006) and indicated that spawning was imminent during the March-April period (Appendix A). Because the fish are gravid at this time of year, their catchability may be higher. Also, stomachs of spawning fish contain only small quantities of food (Langton, 1983) which may contribute to lower energy levels and consequently reduced escape responses. The expansion

of spatial range into 5Zj during the second quarter, coupled with the onset of spawning condition may explain the higher bycatch rates at this time of year.

Conclusions

Historical areas of high yellowtail density from bottom trawl surveys and observed groundfish and scallop trips were considered to identify opportunities for reducing yellowtail bycatch in the scallop fishery. Information on spatial and temporal bycatch patterns in 5Zm is very limited, however, shifting effort to 5Zm will likely result in increased yellowtail bycatch since yellowtail abundance tends to be higher here than in 5Zj. Interpretation of the bottom trawl surveys was limited because they do not occur during the period of highest bycatch rates.

Yellowtail bycatch rates were highest during the second quarter, particularly May and June (Figure 2). The eastern part of 5Zj appeared to have lower densities of yellowtail during this time period (Figure 3). A reduction of effort in 5Zj during April-June or a shift to the eastern portion of 5Zj during these months might reduce yellowtail bycatch.

Approved by

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Sources of Information

Collette, B.B., and G. Klein-MacPhee. 2002. Bigelow and Schroeder's Fishes of the Gulf of Maine. Smithsonian Press, Washington D.C., 748 pp.

Langton, R.W. 1983. Food habits of yellowtail flounder, *Limanda ferruginea* (Storer), from off the northeastern United States. Fis. Bull., U.S. 81: 15-22.

O'Brien, L., J. Burnett, and R.K. Mayo. 1993. Maturation of nineteen species of finfish off the northeast coast of the United States, 1985-1990. NOAA Technical Report NMFS 113. 66p.

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Stone, H.H., S. Gavaris, C.M. Legault, J.D. Neilson, and S.X. Cadrin. 2004. Collapse and recovery of the yellowtail flounder (*Limanda ferruginea*) fishery on Georges Bank. Journal of Sea Research. 51(3-4): 261-270.

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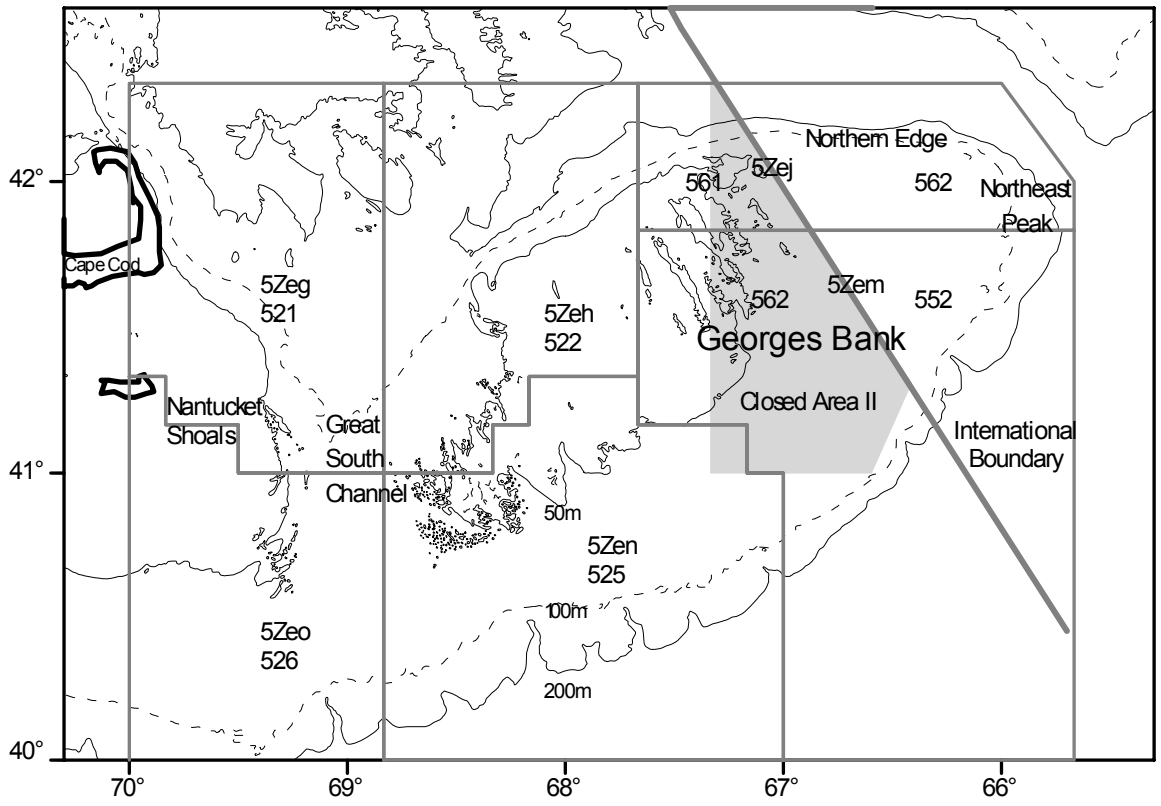

Figure 1. Fisheries statistical unit areas in NAFO Subdivision 5Ze. Alpha-numeric codes, e.g. 5Zej, are DFO designations and numeric codes, e.g. 561, are NMFS designations.

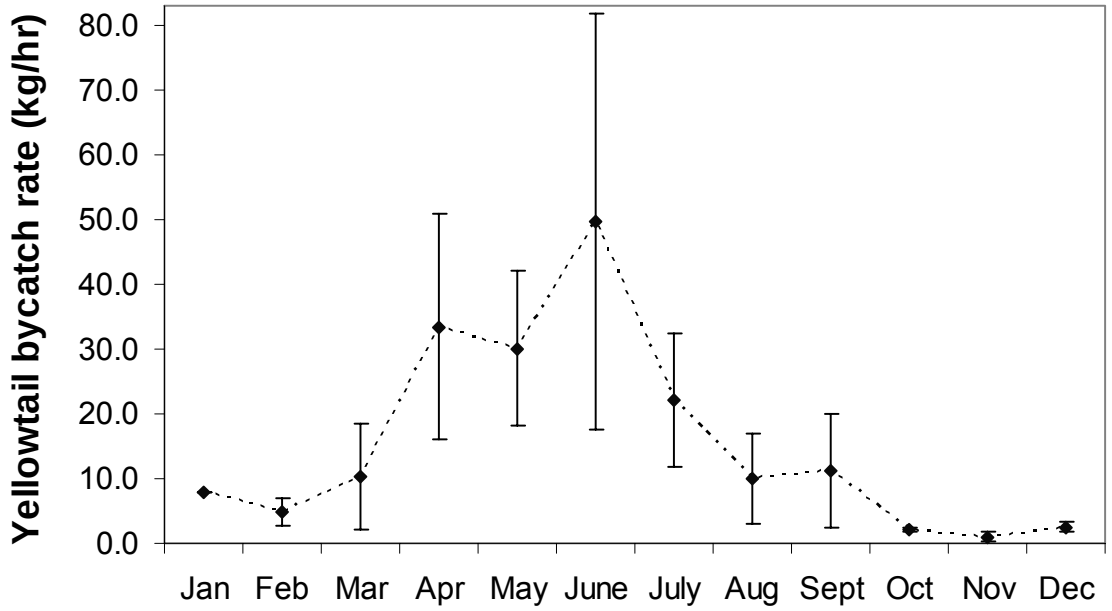

Figure 2. Yellowtail flounder bycatch rate (kg/hr) estimated by month for observed Georges Bank scallop trips in 2001, 2002 and 2004-2006. Error bars indicate ± 1 standard deviation.

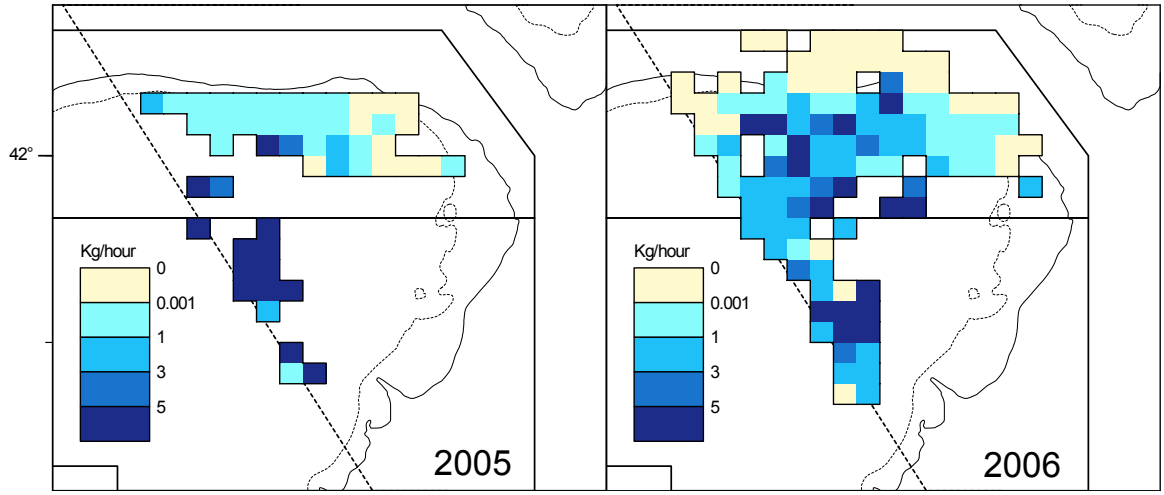

Figure 3. Average yellowtail flounder catch rates (kg/hour) in the month of June in 2005 and 2006 for otter trawlers on eastern Georges Bank. Data are from at-sea observed fishing sets.

Appendix A: Distribution, Relative Abundance and Maturity Stages of Yellowtail Flounder from Bottom Trawl Surveys.

Survey Data

Information on the distribution and relative abundance of adult yellowtail (≥ 30cm total length, TL) was obtained from annual bottom trawl surveys conducted by the Canadian Department of Fisheries and Oceans (DFO) in late winter (February-March) and by the USA National Marine Fisheries Service (NMFS) in spring (March-April) and fall (October). At 30 cm TL, over 90% of females and 95% of males have reached maturity (O'Brien et al., 1993), and are considered to be adult fish for the purpose of this study. Adult distribution and relative abundance was plotted as the average number/tow in cells of 5-minutes longitude and 3.33-minutes latitude (area = 17 nautical miles^2 or approximately 55 km^2) for composite data from two ten-year periods: 1997-2006, a period of relatively good recruitment and abundance, and 1987-1996, a period of low recruitment and abundance. Since yellowtail catchability is higher in the DFO survey, for plotting purposes, all catches were divided by a factor of 6.0 before plotting to provide comparability with the NMFS spring and fall series.

Yellowtail flounder maturity stage data based on a standardized classification scheme (Burnett et al., 1989) was examined from the NMFS spring survey series from 1997-2006 to provide an indication of the percentage of immature, ripening and spawning fish for the March-April period. The timing of this survey overlaps with the period of high yellowtail bycatch in the Georges Bank scallop fishery (April-June) (Appendix B).

Results and Discussion

During the period of higher population abundance and recruitment (1997-2006), the DFO survey series showed widespread distribution of adult yellowtail in 5Zm during February-March with several cells in the central region averaging more than 50 fish/tow (Fig. A1). This region in 5Zm encompasses the "Yellowtail Hole" where a Canadian directed fishery for yellowtail occurred from 1994-2004. The NMFS spring series showed an expansion in the distribution of yellowtail in March-April to the north and east in 5Zj. Within 5Zj there were several rectangles with catches greater than 50 fish/tow that were not present during the February-March period. The NMFS fall series also showed a broad distribution of yellowtail in 5Zjm during October with several areas of higher density persisting in the north and south central regions of northeastern George Bank.

For the period of low population abundance and recruitment (1987-1996), the overall distribution of adult yellowtail was similar to the more recent period for each of the survey series, although there were fewer areas with catches > 50 fish/tow (Fig. A2). The seasonal distribution pattern exhibited the same expansion to the north and east in 5Zj from the winter to spring survey periods with several cells having catches > 50 fish/tow in 5Zj in the NMFS spring series. The fall distribution was similar to spring, but the density was lower.

Evidence for the onset of spawning was apparent in the maturity stages of yellowtail flounder determined during NMFS spring surveys over the past decade (1997-2006) (Fig. A3). Fish with developing ovaries and testes were predominant in sample collections (mean = 63% for 1997-2006), followed by spawning (mean = 23%) and immature (mean = 15%) fish. Taken together, yellowtail in the developing and spawning stages represented most of the fish sampled and indicated that the onset of spawning was imminent during the March-April period.

The implication here is that yellowtail flounder undergo an expansion of their spatial distribution in spring, and become more abundant in 5Zj. This seasonal movement pattern, coincident with the onset of the spawning season, would tend to increase their catchability in the scallop fishery which occurs throughout 5Zj for much of the year (Appendix B).

References

Burnett, J., L. O'Brien, R. Mayo, J. Darde, and M. Bohan. 1989. Finfish maturity sampling and classification schemes used during Northeast Fisheries Center bottom trawl surveys, 1963-89. NOAA Technical Memorandum NMFS-F/NEC-76. 14p.

O'Brien, L., J. Burnett, and R.K. Mayo. 1993. Maturation of nineteen species of finfish off the northeast coast of the United States, 1985-1990. NOAA Technical Report NMFS 113. 66p.

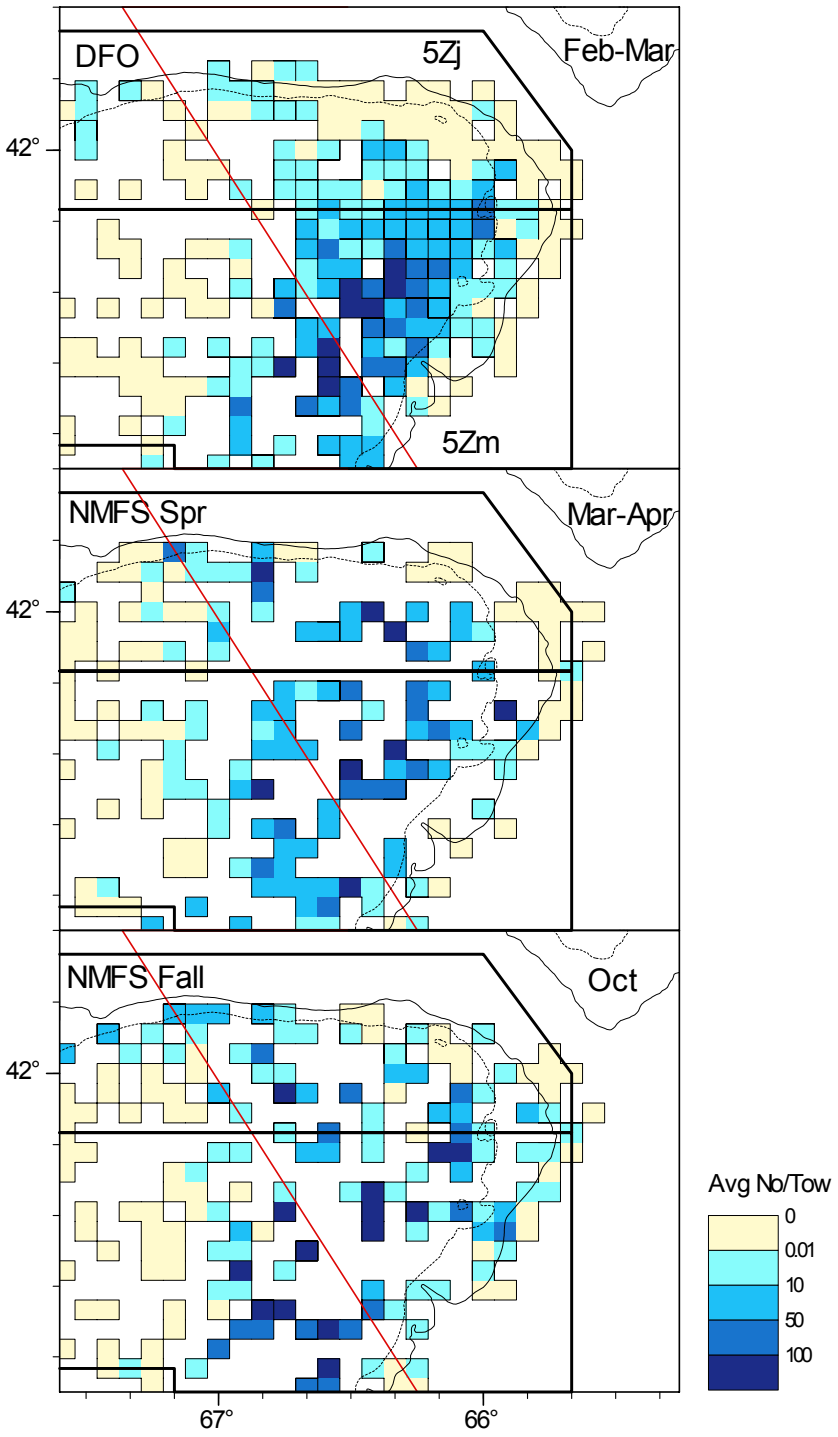

Fig. A1. Relative abundance of Georges Bank yellowtail flounder ≥ 30 cm TL (avg. number/tow per 5 x 3.3 minute square) for composite data (1997-2006) from annual bottom trawl surveys conducted in late winter by the Canadian Department of Fisheries and Oceans (DFO)) and in spring and fall by the National Marine Fisheries Service (NMFS Spr; NMFS Fall). The DFO survey has been adjusted for higher catchability.

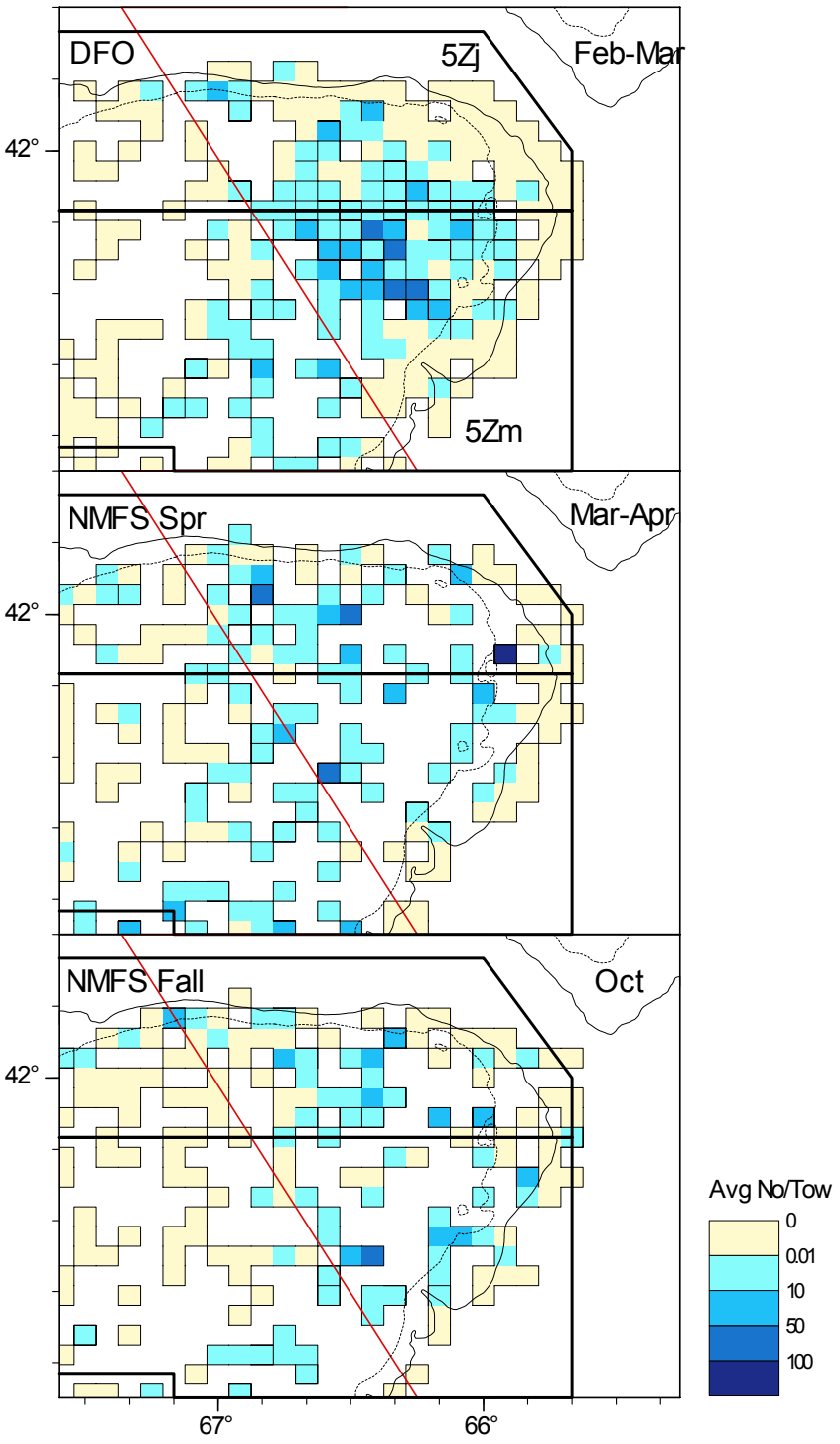

Fig. A2. Relative abundance of Georges Bank yellowtail flounder ≥ 30 cm TL (avg number/tow per 5 x 3.3 minute square) for composite data (1987-1996) from annual bottom trawl surveys conducted in late winter by the Canadian Department of Fisheries and Oceans (DFO) and in spring and fall by the National Marine Fisheries Service (NMFS Spr; NMFS Fal). The DFO survey has been adjusted for higher catchability.

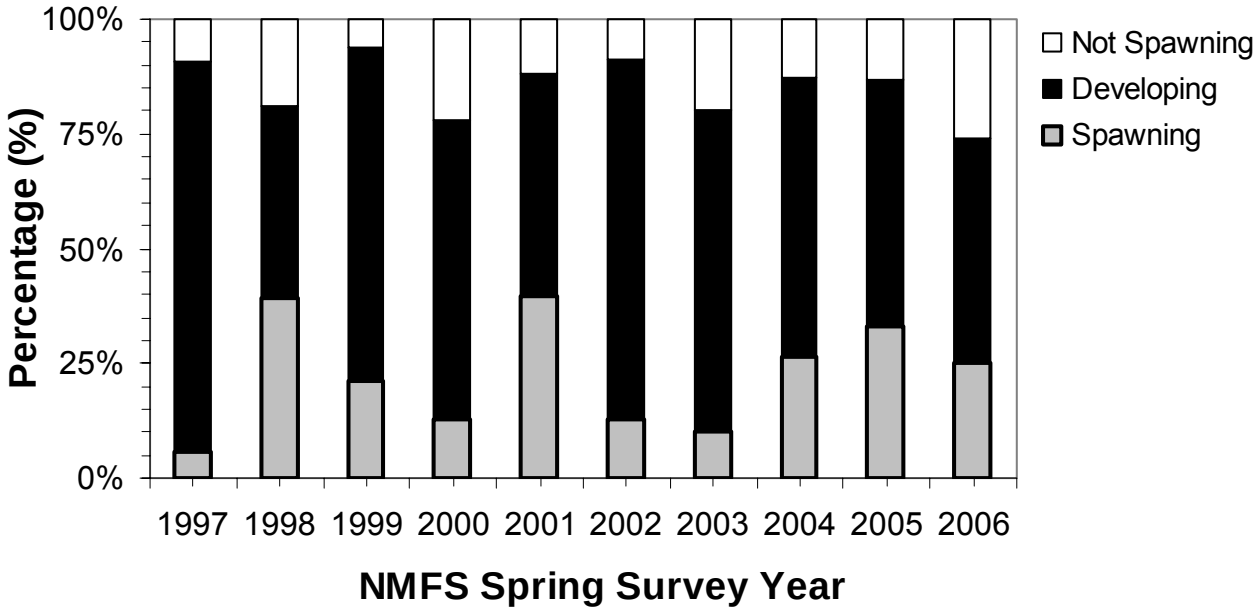

Fig. A3. Maturity stages of Georges Bank yellowtail flounder sampled during NMFS spring surveys from 1997-2006. Stages were grouped into three categories: Not spawning (immature + resting), Developing and Spawning (ripe + ripe and running + spent.).

Appendix B: Catch Rates, Size Composition, Geographic Distribution and Relative Abundance of Yellowtail Flounder Bycatch from the Georges Bank Scallop Fishery

Observer Data

Data on yellowtail flounder bycatch rate (kg/hr), distribution, relative abundance and size composition was examined from 39 observed scallop trips on Georges Bank conducted in 2001, 2002, 2004, 2005 and 2006. Although data was available for 5Zj, there was very low coverage in 5Zm. Catch rates for individual trips were grouped by month and averaged across years for 5Zjm for sets which observers actually monitored. (Note: Observers could not monitor all sets during a trip). At-sea length measurements (TL, cm) of yellowtail bycatch were grouped by quarter across years to examine seasonal changes in length composition. For plots of distribution and relative abundance, the yellowtail bycatch (kg) from observed sets was grouped by month after standardizing for the number of dredges deployed per set (range: 2-28 dredges per set). (Note: Observers combined the yellowtail bycatch weight estimates from individual tows into "sets" which generally represented 3 hour periods, therefore it was necessary to account for the variable number of dredges deployed per set by dividing catch/set by the number of dredges/set). Bycatch distribution and relative abundance was plotted for each month as the average weight (kg)/dredge in cells of 5-minutes longitude and 3.33-minutes latitude (area = 17 nautical miles^2 or approximately 55 km^2).

Results and Discussion

Bycatch rates of yellowtail flounder generally followed an increasing trend from February to June, declining rapidly in July and August before falling off again to low levels in October and November (Fig. B1). The highest bycatch rates occurred in the second quarter (April-June) peaking in June, although variability was high for the mean values during this period. The second quarter is also the time of peak spawning (May-June) of yellowtail flounder on Georges Bank (O'Brien et al., 1993) and because the fish are gravid at this time of year their catchability may be higher. Stomachs of spawning fish contain only small quantities of food (Langton, 1983) which may contribute to lower energy levels and consequently reduced escape responses. Water temperature may also be a factor, since at lower temperatures, escape responses to scallop gear may be slower.

Quarterly size frequencies of yellowtail bycatch support the hypotheses that fish in spawning condition may have higher catchability or that larger fish move into 5Zj where scallop fishing activity occurs. Proportionally more adult fish (> 35 cm TL) were captured in quarters 1 and 2 (mean size = 36.5 cm and 36.0 cm TL, respectively) compared to quarters 3 and 4 (mean size = 34.7 cm and 32.9 cm TL, respectively) (Fig. B2). The presence of larger yellowtail in the bycatch during quarters 1 and 2 may reflect their gravid condition and higher catchability or greater abundance in the area of the scallop fishery (5Zj) during winter and spring.

The spatial distribution and relative abundance of yellowtail flounder bycatch from observed scallop trips is presented by month in Figures B3-B6. In general, observer coverage of the scallop fishery was low during the first quarter, as indicated by the low number and limited distribution of observed sets (Fig. B3). An area of high yellowtail bycatch in 5Zj with > 25kg/dredge occurred on the northern edge of the bank in March.

An increase in the number of observed sets was apparent during the second quarter (Fig. B4). Several cells with high bycatch (> 25kg/dredge) were present along the northern edge of the

bank in 5Zj in May and June and along the eastern edge of the bank in 5Zm during April and June. Overall, many of the areas fished during the observed trips in the second quarter appeared to have higher bycatch rate for yellowtail.

In the third quarter, there were good numbers of observed sets for each month (Fig. B5). High bycatches (> 25kg/dredge) in 5Zj were apparent in July for cells along the northern and eastern edges of the bank. There were also some high bycatch cells in August and September in 5Zj along the northern edge of the bank close to the international boundary, but generally, bycatch density appeared to be declining, which is consistent with bycatch rates (Fig. B1).

In the fourth quarter, the number of observed sets was lower in October, compared to November and December (Fig. B6). Consistent with bycatch rates (Fig. B1), the relative abundance of yellowtail in observed sets showed a decline in October and November, and increased very slightly in December. The increase is due to the higher abundance encountered in 5Zm in December, as indicated by the large number of cells with up to 10 kg/dredge. During the fourth quarter, there were no rectangles with catches > 25 kg/dredge.

In summary, the spatial analyses indicate that there were several rectangles in 5Zj which appear to be areas of higher bycatch rate for yellowtail particularly from April through to July. This period coincides with the spawning season for yellowtail flounder on Georges Bank. Seasonal movements into 5Zj coupled with the onset of spawning condition may lead to higher catchabilities at this time of year. Although there are no observed sets in the extreme northeasten portion of 5Zj during the second quarter, the NMFS spring survey indicates that this area may have lower relative abundance of yellowtail (Appendix A) and could yield lower bycatch.

References

Langton, R.W. 1983. Food habits of yellowtail flounder, *Limanda ferruginea* (Storer), from off the northeastern United States. Fis. Bull., U.S. 81: 15-22.

O'Brien, L., J. Burnett, and R.K. Mayo. 1993. Maturation of nineteen species of finfish off the northeast coast of the United States, 1985-1990. NOAA Technical Report NMFS 113. 66p.

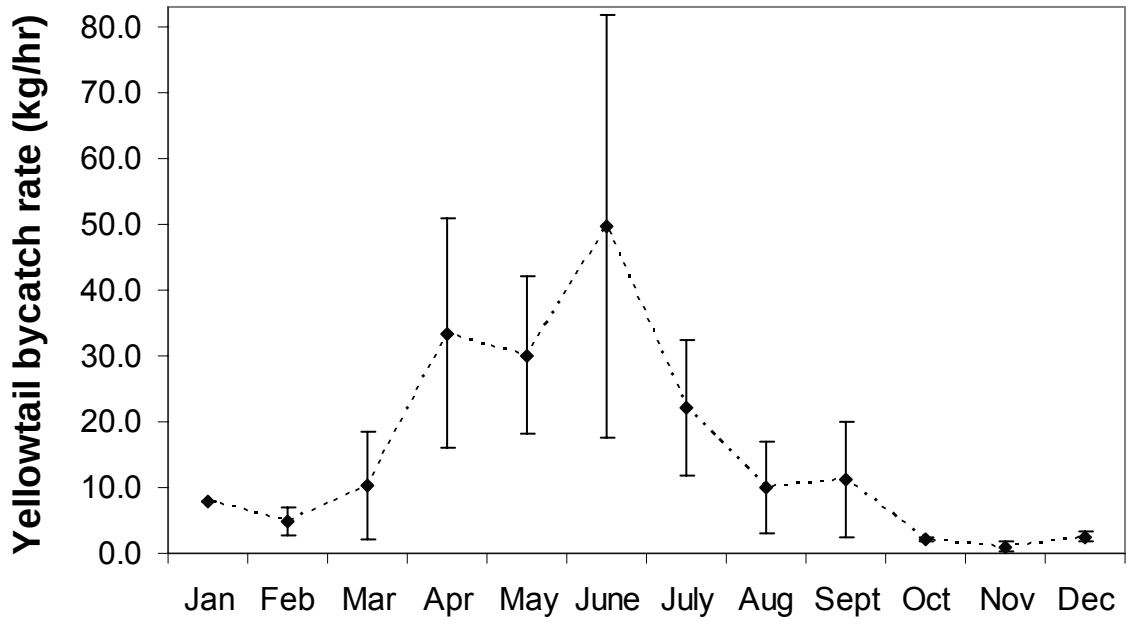

Fig. B1. Yellowtail flounder bycatch rate (kg/hr) estimated by month for observed Georges Bank scallop trips in 2001, 2002 and 2004-2006. Error bars indicate ± 1 standard deviation.

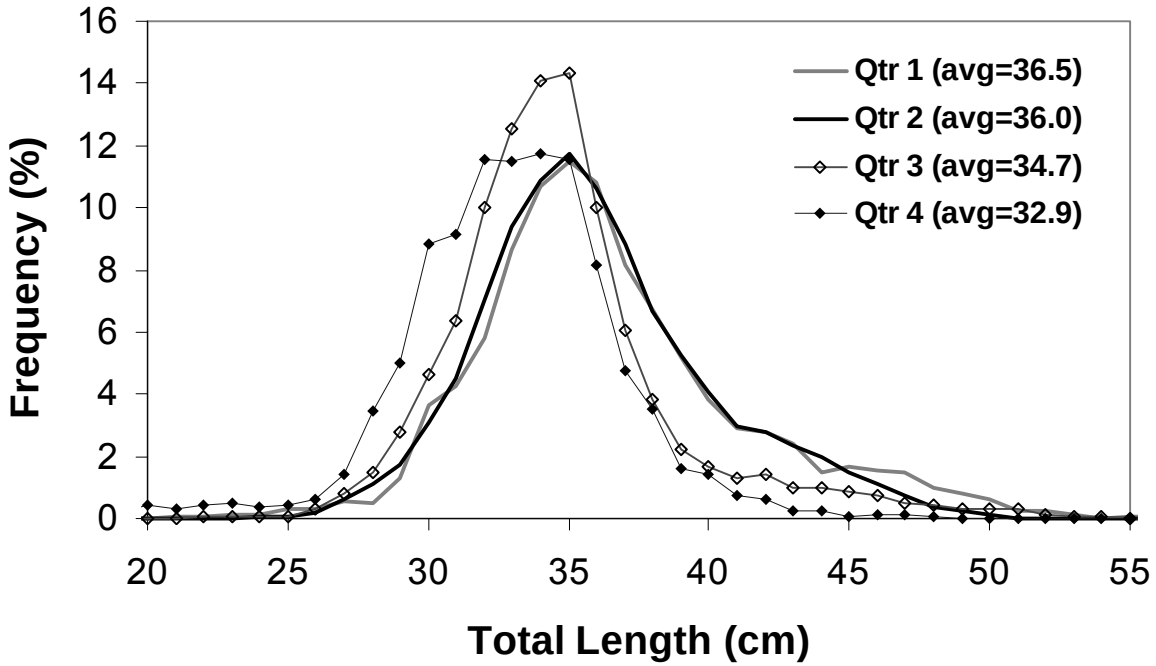

Fig. B2. Quarterly size frequencies (Total Length, cm) of yellowtail flounder bycatch from observed scallop trips on Georges Bank in 2001, 2002, 2004, 2005 and 2006. The average size for each quarter is shown.

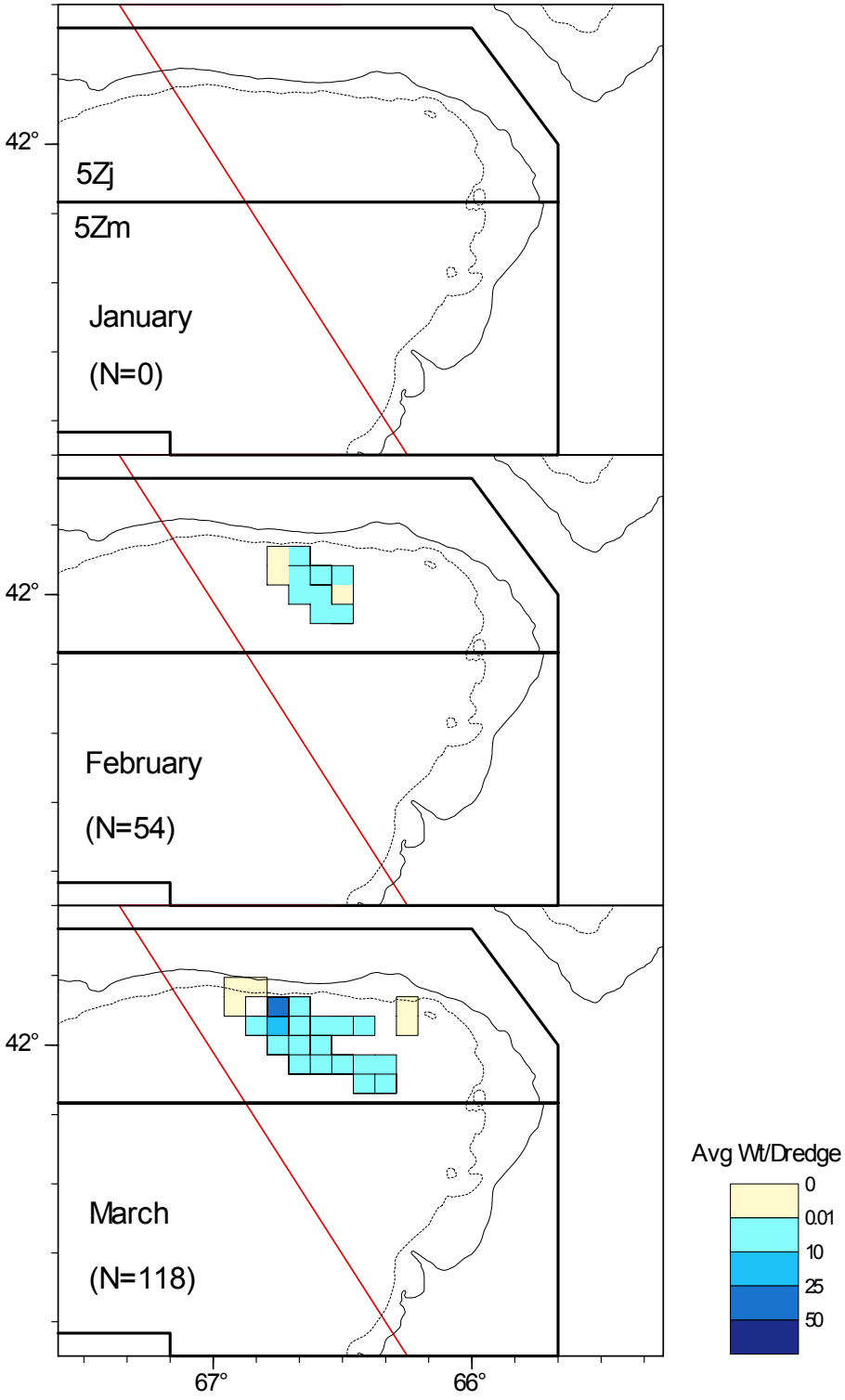

Fig. B3. Relative abundance of yellowtail flounder bycatch (average weight (kg)/dredge per 5 x 3.3 minute square) from observed Georges Bank scallop trips in 2001, 2002 and 2004-2006 for January, February and March. (N= number of observed sets in each month).

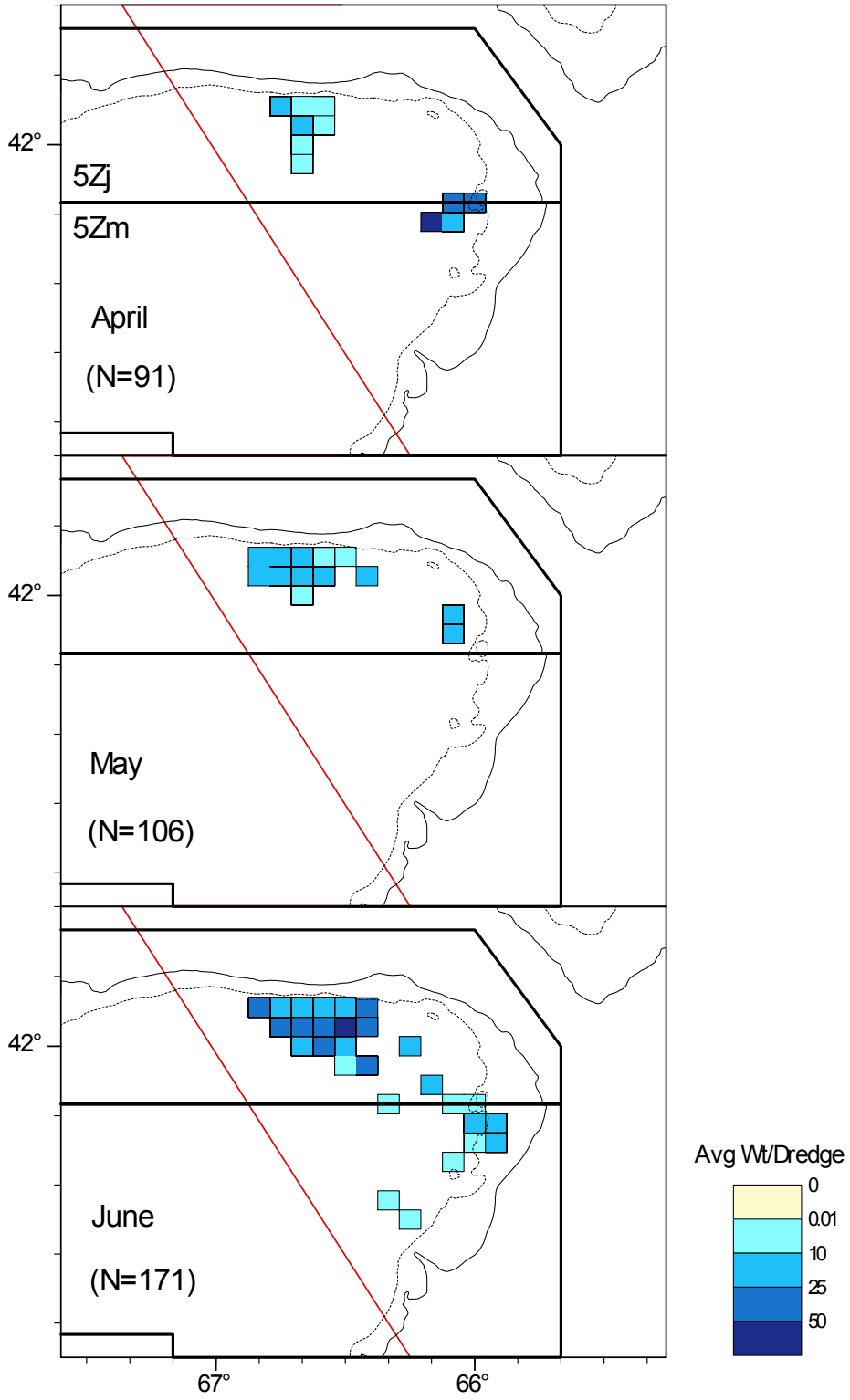

Fig. B4. Relative abundance of yellowtail flounder bycatch (average weight (kg)/dredge per 5 x 3.3 minute square) from observed Georges Bank scallop trips in 2001, 2002 and 2004-2006 for April, May and June. (N= number of observed sets in each month).

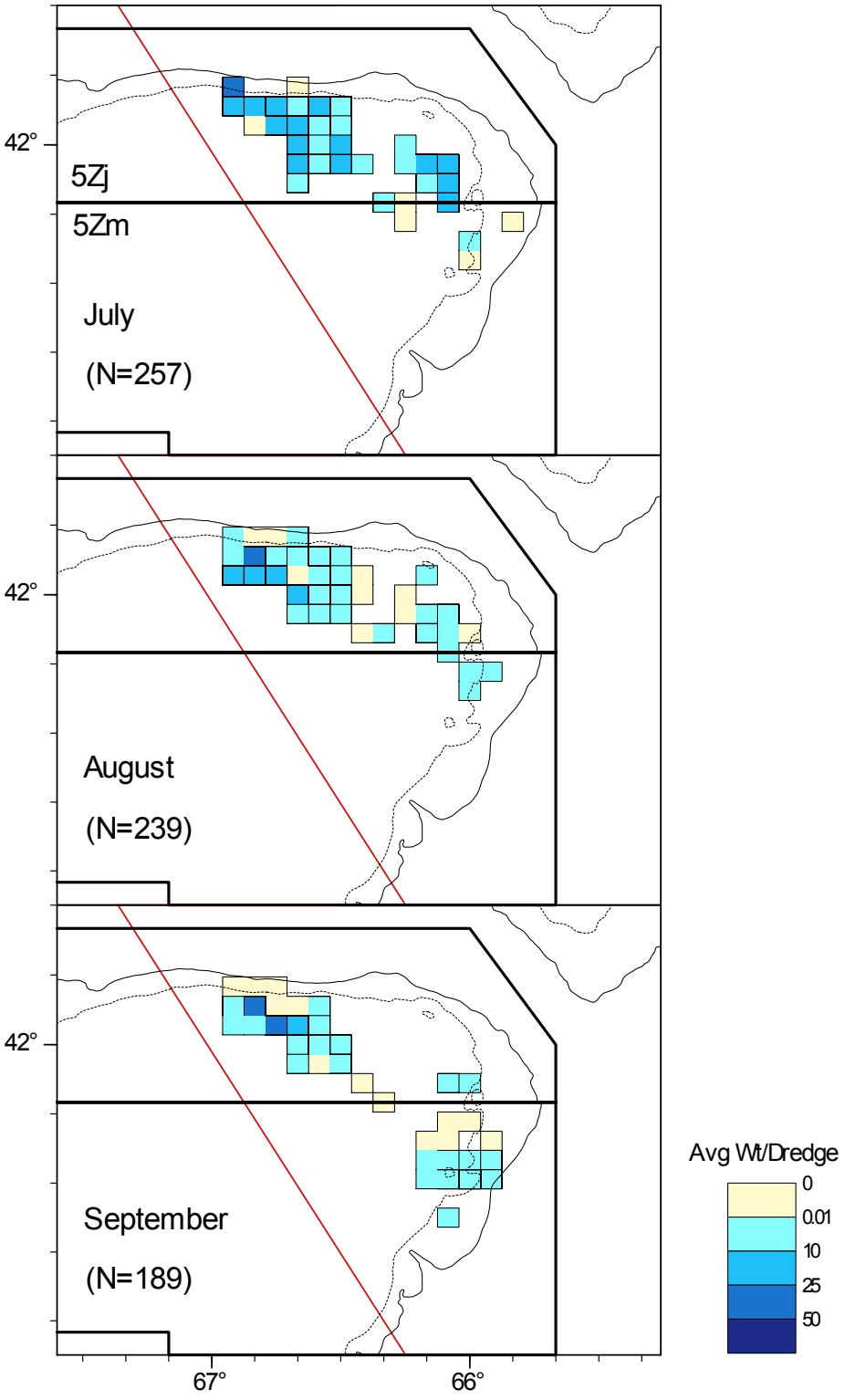

Fig. B5. Relative abundance of yellowtail flounder bycatch (average weight (kg)/dredge per 5 x 3.3 minute square) from observed Georges Bank scallop trips in 2001, 2002 and 2004-2006 for July, August and September. (N= number of observed sets in each month).

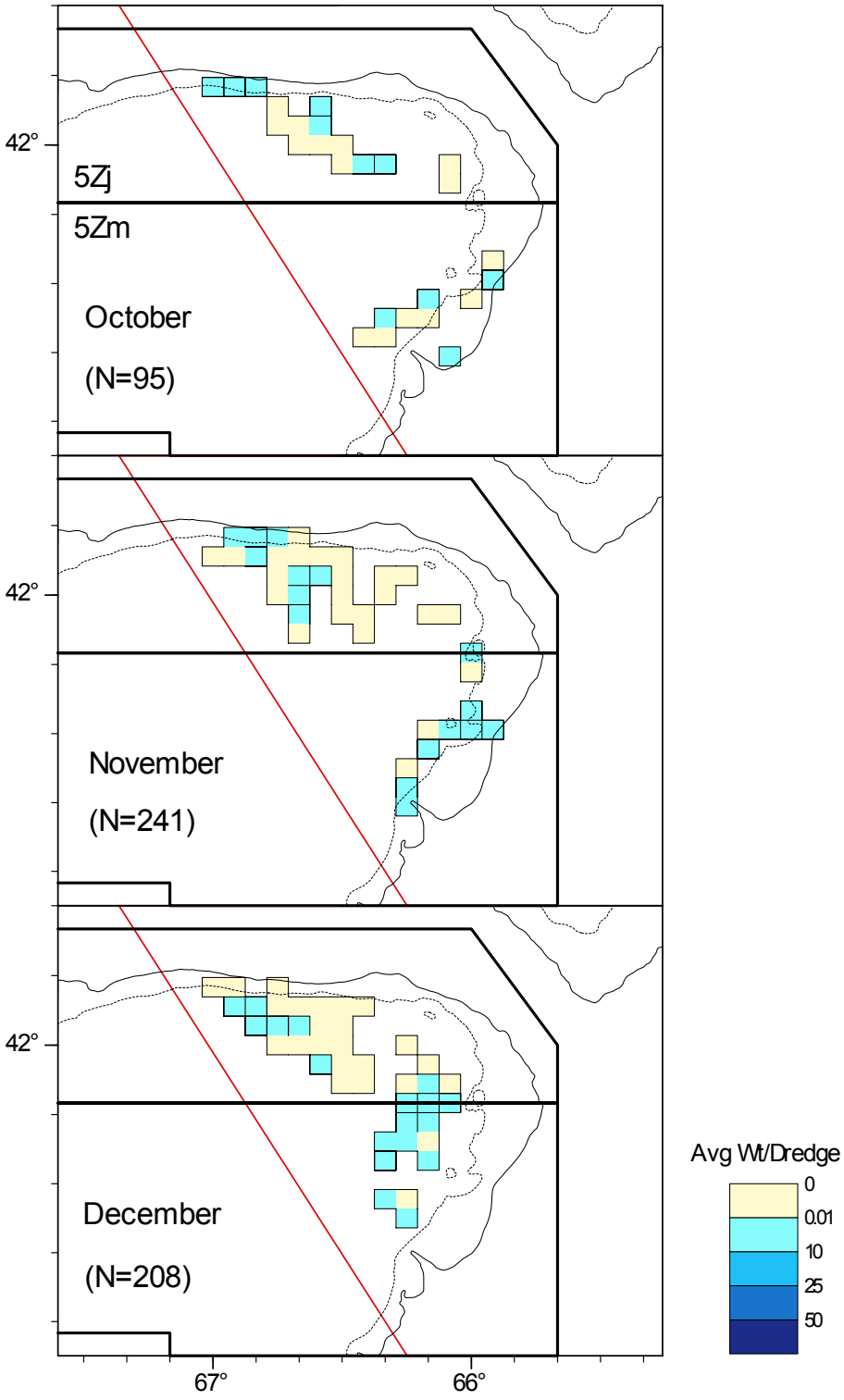

Fig. B6. Relative abundance of yellowtail flounder bycatch (average weight (kg)/dredge per 5 x 3.3 minute square) from observed Georges Bank scallop trips in 2001, 2002 and 2004-2006 for October, November and December. (N= number of observed sets in each month).

Appendix C. Yellowtail Flounder Catch Rates and Catch Density from Otter Trawlers in 5Zjm in 2005 and 2006 from Trips Observed at Sea

The observer coverage of the eastern Georges Bank groundfish fishery increased significantly in 2005 and 2006. Sufficient catch rate data for yellowtail flounder by otter trawlers was collected to allow examination of both temporal and spatial catchability rates.

Observer Data

A total of 1,140 sets in 2005 and 3,545 sets in 2006 were available for analysis (Table C1). Monthly catch rates for January, February and June-December were available for both years. Some additional data was available for May in 2005. The majority of observed sets were made in 5Zj. Since tow duration was available, the catch rate per set was standardized to catch per hour. Positional data was collected on a set by set basis and allowed the comparison of catch rates by month and by 5 x 3.3 minute squares.

The majority of sets caught no yellowtail flounder (78% in 2006 and 85% in 2005). Low catch rates for yellowtail flounder are expected since the groundfish fleet was not targeting this species. Most sets were made with a separator panel which would have released many flounders caught below the panel since this part of the cod end would be open. Also the foot gear in use would not be optimal for flounder. However, the data should give information on relative density and catchability of yellowtail.

Results and Discussion

Catch rates in 2006 were generally higher than in 2005 with a maximum of 133 kg/hr in 5Zj and 320 kg/hr in 5Zm in 2006 compared to 19 kg/hr in 5Zj and 53 kg/hr in 5Zm in 2005 (Table C2). Catch rates were much higher in 5Zm than in 5Zj but data were fewer for 5Zm. The highest maximum catch rate for both years was in June in both unit areas. The highest average catch rate in 5Zj in 2005 was in May but in June for 2006 (Figs. C1 and C2). In 5Zm, a high average catch rate was observed in June in 2006 compared to other months but there were few sets made in other months. Catch rates were very low in January and February and July to November. In 2005 the average catch rate dropped through June and July from the high in May to negligible rates in August to December.

Similar spatial and seasonal catch rate patterns were seen for both 2005 and 2006 (Figs C3 and C4). During most months, sets were usually confined to 5Zj and favoured the northern half of that unit area but effort increased in June into the western portion of 5Zm near the Canada/US boundary line during both years. In June, high catch rates were widespread on the bank throughout 5Zj and 5Zm. At other times of the year, catch rates were low where fishing occurred but there were occasional higher densities encountered, generally in the southern half of 5Zj. Some higher catch rates were observed in October 2006 in 5Zj near the boundary line.

Seasonal trends in bycatch rates of yellowtail from observed otter trawl sets and observed scallop sets (Appendix B) follow the same pattern, with peak catch rates in 5Zj during the second quarter. The monthly trends in spatial patterns in yellowtail bycatch density from observed otter trawl sets in 2005 and 2006 were similar to the patterns observed for the scallop fishery. Observer coverage of the groundfish fleet during the month of June was much more extensive than the scallop fleet, and provides an indication that the extreme northeastern part of Georges Bank in 5Zj may be an area of low yellowtail density at this time. This area of lower density was also apparent in the NMFS spring survey series for the March-April period (Appendix A).

Table C1. Number of otter trawl sets observed at sea in 2005 and 2006 in unit areas 5Zj and 5Zm.

2006	Unit Area			2005	Unit Area		
Month	5Zj	5Zm	Total	Month	5Zj	5Zm	Total
1	287	4	291	1	117		117
2	33		33	2	149	1	150
3				3			
4				4			
5				5	13	2	15
6	878	181	1059	6	280	27	307
7	567	4	571	7	304	14	318
8	560	11	571	8	124	2	126
9	386		386	9	34		34
10	192	1	193	10	20		20
11	300	1	301	11	47		47
12	140		140	12	6		6
Total	3343	202	3545		1094	46	1140

Table C2. Maximum yellowtail flounder catch rates by set in kg/hour by otter trawl gear observed at sea in 2005 and 2006 in unit areas 5Zj and 5Zm.

2006	Unit Area		2005	Unit Area	
Month	5Zj	5Zm	Month	5Zj	5Zm
1	3.33	1.68	1	0.00	
2	0.73		2	0.97	0
3			3		
4			4		
5			5	9.00	0
6	132.71	320.00	6	18.75	52.65
7	38.00	1.62	7	13.77	0
8	32.43	0.98	8	0.82	0
9	0.63		9	0.00	
10	25.00	0	10	0.92	
11	1.05	0	11	0.71	
12	0.88		12	0.00	

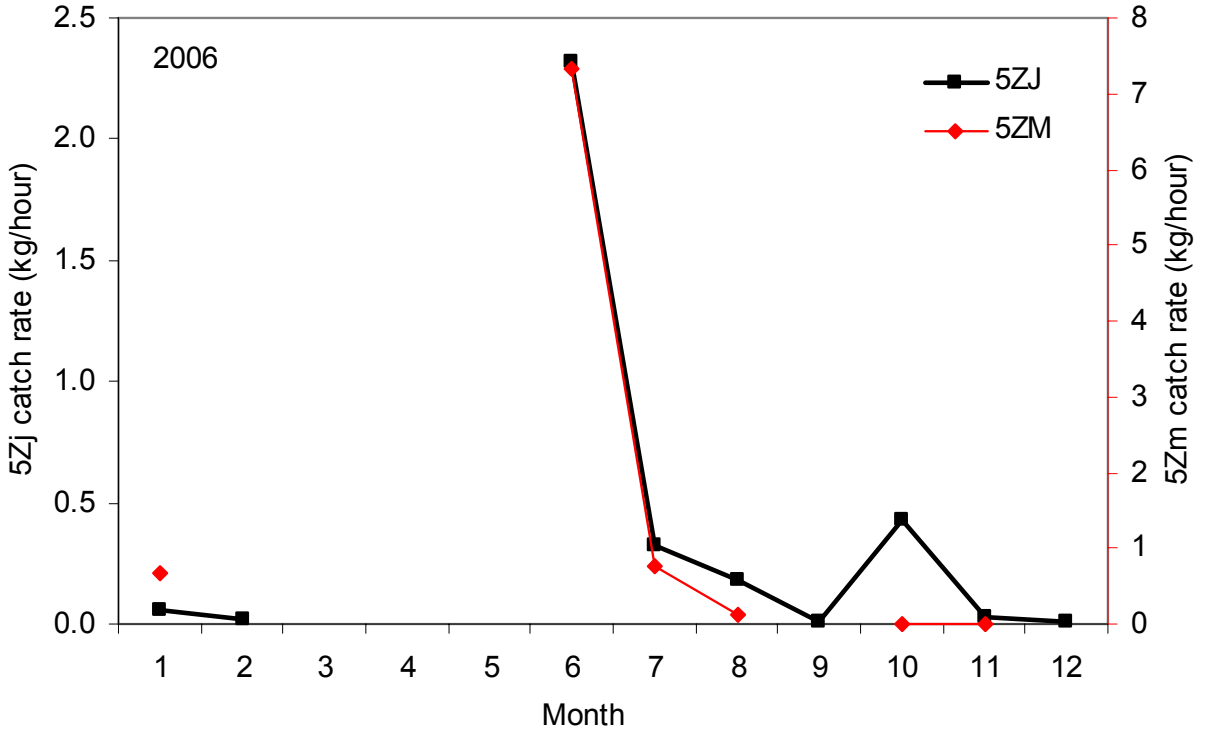

Figure C1. Yellowtail flounder catch rates (kg/hour) by month and unit area for otter trawl sets observed at sea in 2006.

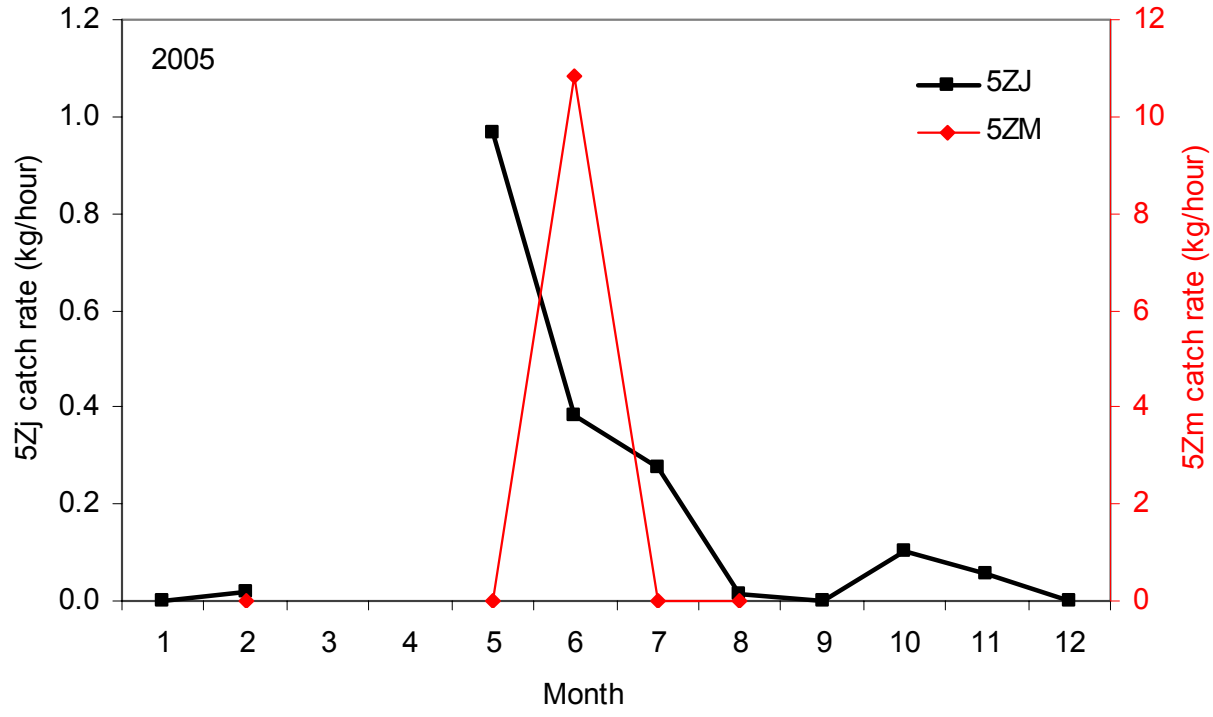

Figure C2. Yellowtail flounder catch rates (kg/hour) by month and unit area for otter trawl sets observed at sea in 2005.

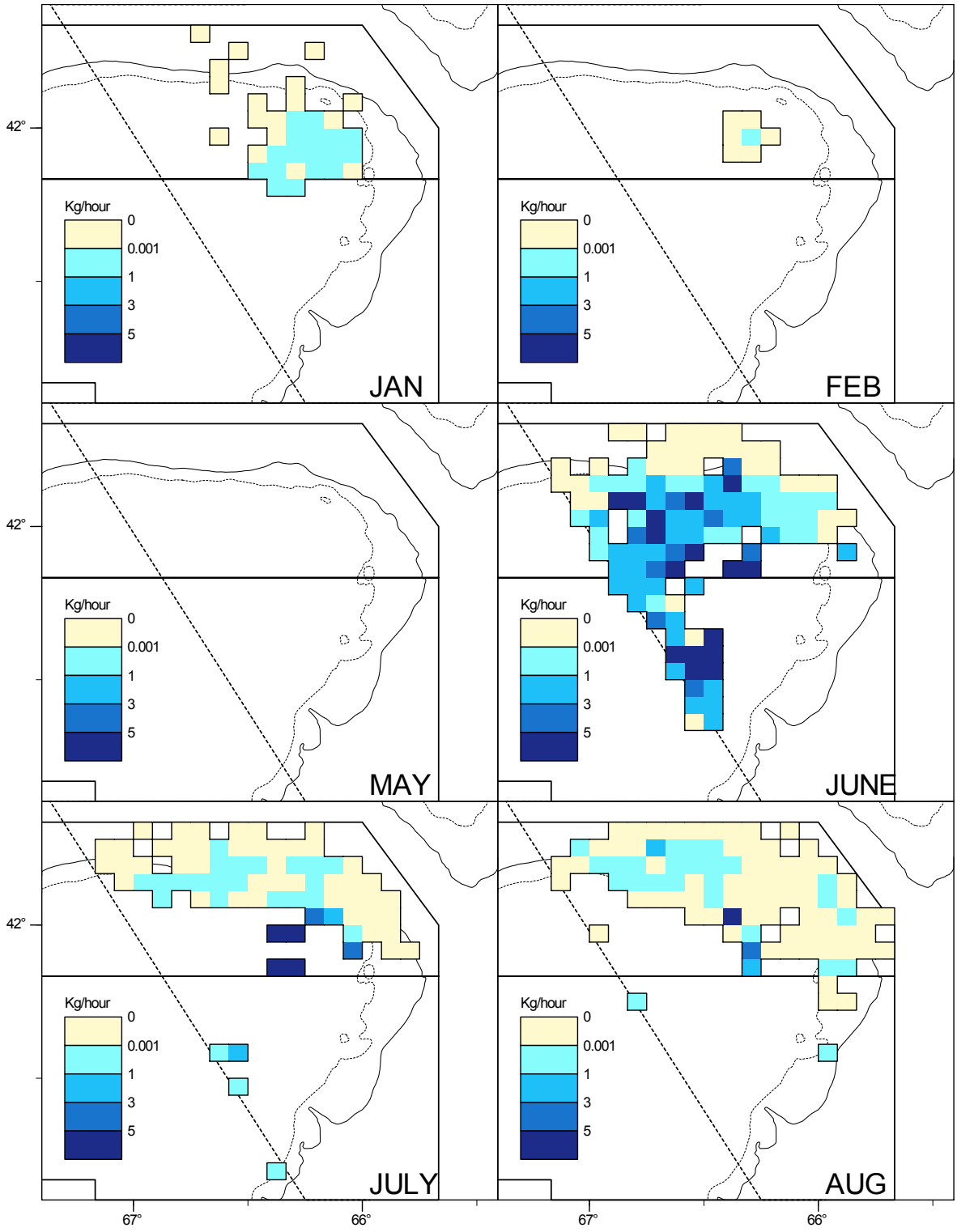

Figure C3. Average yellowtail flounder 2006 catch rates (kg/hour) for otter trawlers in 5Zjm. Data are from 3545 at-sea observer fishing sets.

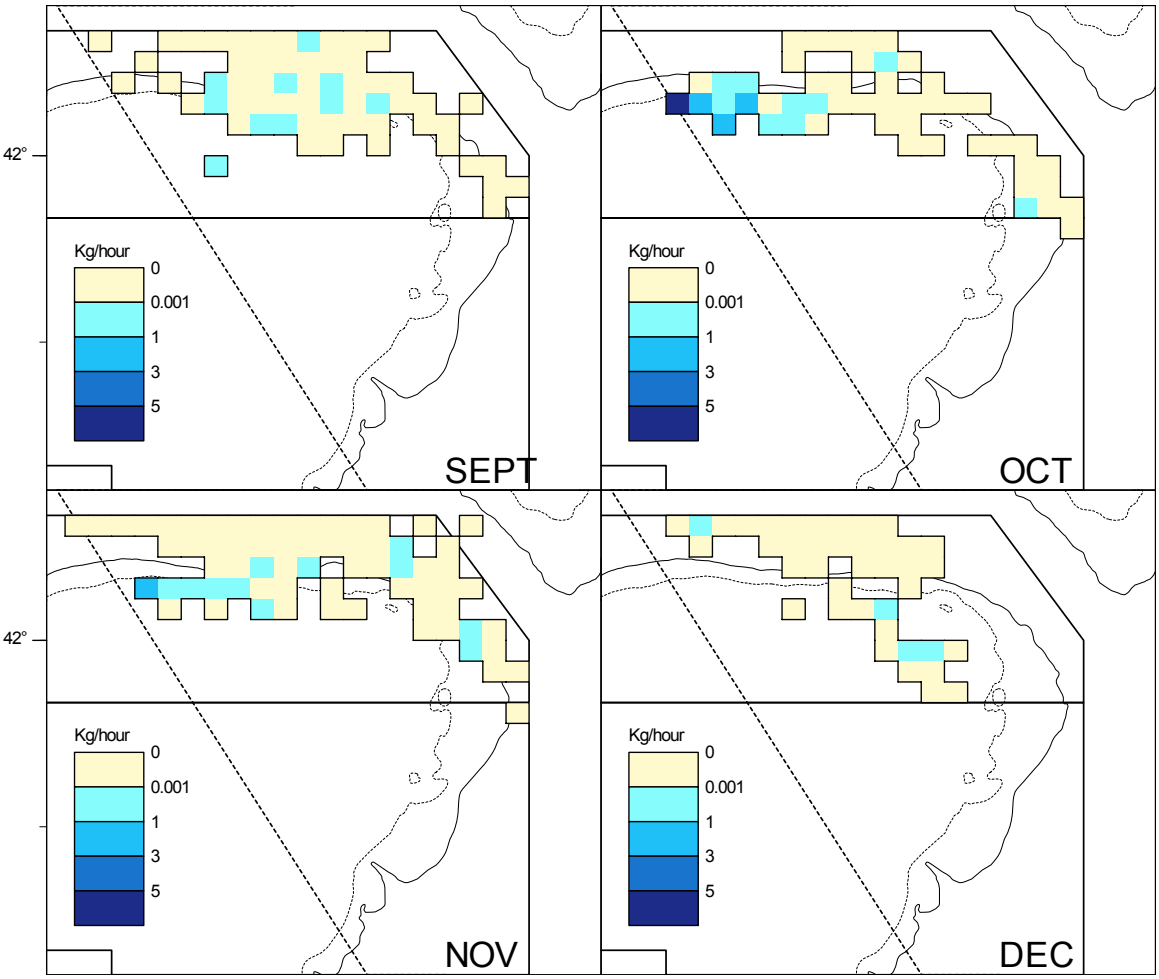

Figure C3. (continued).

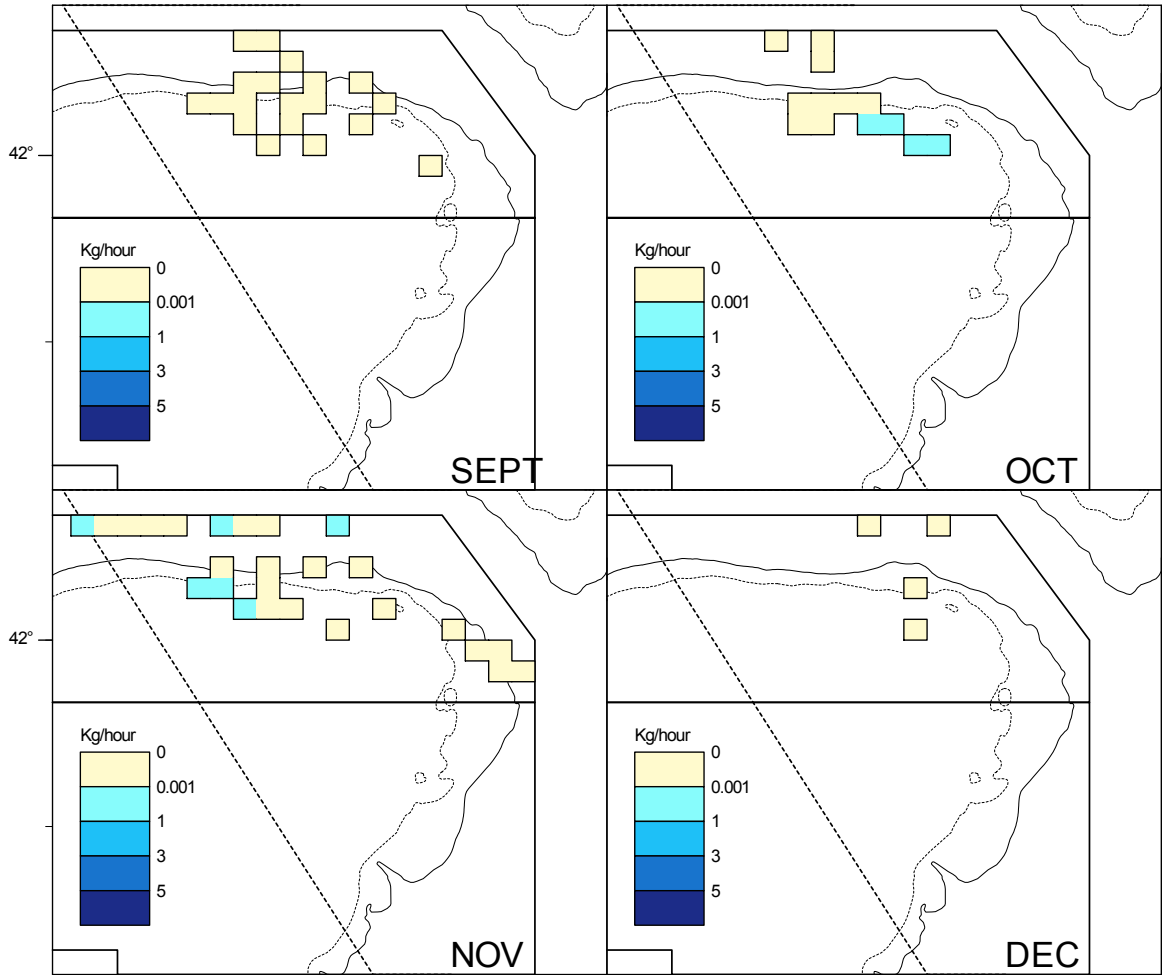

Figure C4. (continued).

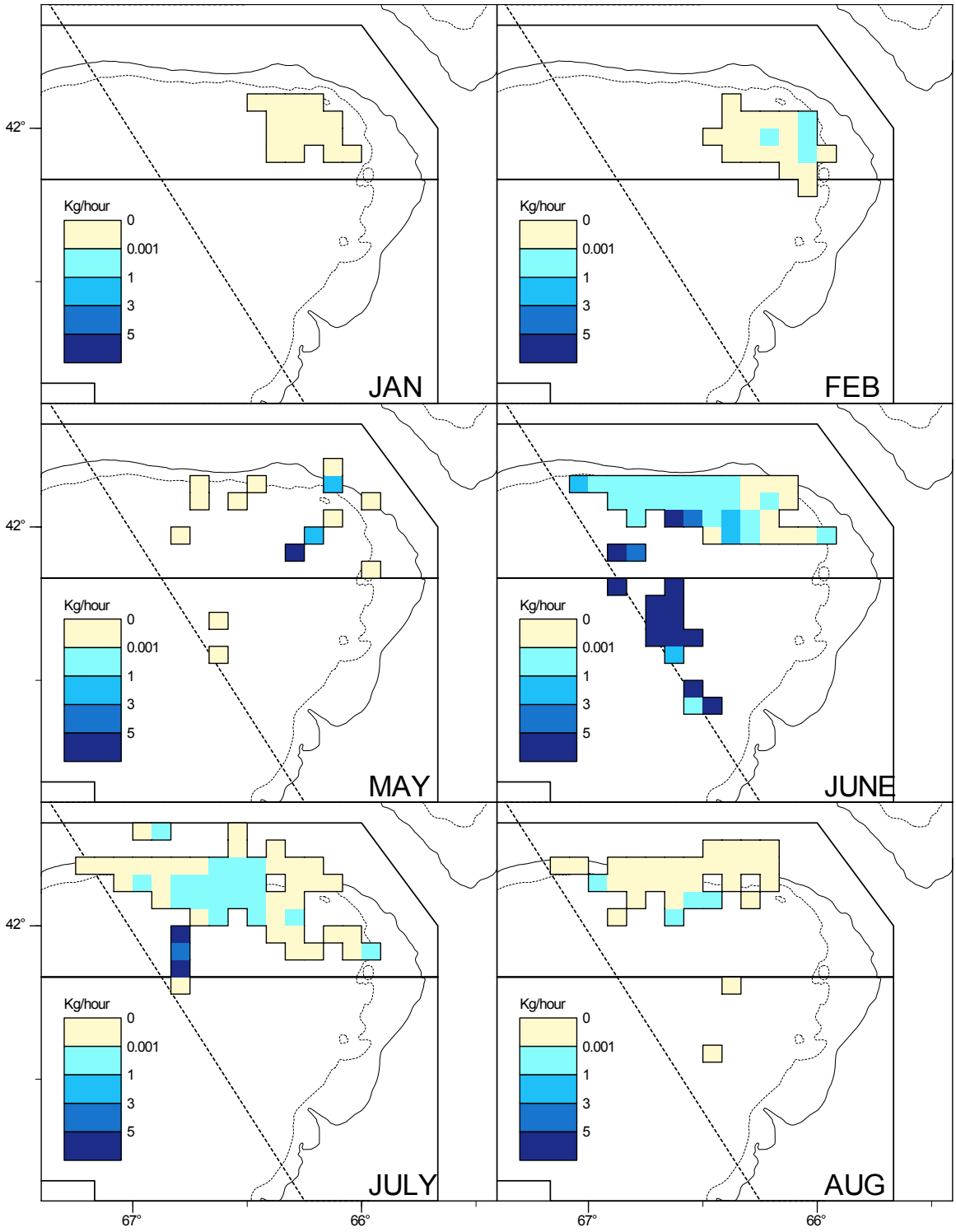

Figure C4. Average yellowtail flounder 2005 catch rates (kg/hour) for otter trawlers in 5Zjm. Data are from 1140 at-sea observer fishing sets.

Appendix D: Trends in Landings of Yellowtail Flounder from the Canadian Scallop Fishing Fleet from Eastern Georges Bank, 1986 to 1995

Before 1996, the scallop fishery was allowed to land their groundfish bycatch. Although yellowtail flounder were discarded, landings of this species were recorded. If it is assumed that landing of yellowtail flounder increased as catches increased, an analysis of the landings per trip may be useful in assessing seasonal catchability and/or availability of yellowtail flounder to scallop dredges during this earlier time period for which landings data were available.

Table D1 shows the number of trips which landed yellowtail flounder. Between 1986 and 1995, the highest landings were made in 1987 (52 mt) and the lowest in 1990 (8 mt). The average annual yellowtail landings/trip from 1986 to 1995 are shown in Figure D1. The pattern varies from year to year but overall the landings/trip increased from January to May after which they show a decreasing trend to December. Highest values were observed in April, May, June and July.

The seasonal pattern of landings/trip for 1986-1995 generally corresponds to seasonal trends in bycatch rates from recent observed scallop trips on Georges Bank (Fig. B1) and confirm that the higher bycatch rate of yellowtail flounder in the second quarter is a persistent feature and not just a recent phenomenon. The only notable difference is that the peak in landings/trip occurred in May while the highest bycatch rates in recent observed trips occurred in June.

Table D1. Number of scallop trips by Canadian vessels which landed yellowtail flounder during the years 1986 to 1995 on Eastern Georges Bank.

Year	Month												
	1	2	3	4	5	6	7	8	9	10	11	12	Totals
1986	0	0	4	14	3	1	10	14	4	5	0	0	55
1987	0	3	12	20	23	15	19	14	19	15	12	2	154
1988	2	4	11	9	19	25	26	20	0	1	5	6	128
1989	3	9	7	9	13	12	10	5	3	7	1	0	79
1990	0	6	10	8	6	5	12	6	6	10	5	0	74
1991	0	1	8	11	8	10	8	9	8	12	1	0	76
1992	0	3	13	7	7	9	8	12	8	7	0	0	76
1993	2	6	8	8	12	7	5	9	4	10	5	0	76
1994	0	9	8	11	14	11	5	10	9	11	5	1	94
1995	0	2	5	3	8	9	7	6	4	5	1	0	50
Totals	7	43	86	100	113	104	110	105	65	83	35	9	860

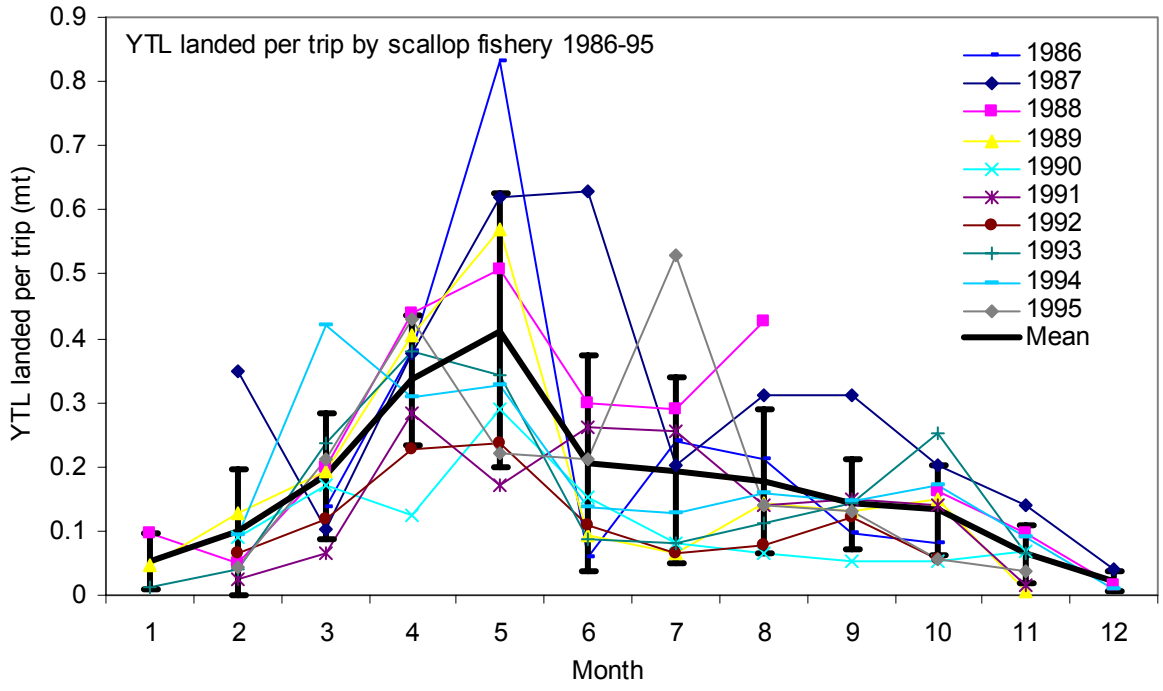

Figure D1. Average annual landings of yellowtail flounder per trip by Canadian scallop vessels from eastern Georges Bank from 1986 to 1995. The thicker line is the mean for 1986 to 1995 with standard error bars.

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