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An update on winter flounder and yellowtail flounder in NAFO Division 4T, 1995

by

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Abstract

Provisional landings of winter flounder in NAFO Division 4T totalled 609 t in 1995. Winter flounder landings have declined in 4T since 1991, with the sharpest declines occurring in 1993 and 1995. Annual landings have averaged 1916 t since 1960, with wide year-to-year fluctuations. Misreporting and unreported catches of winter flounder occur frequently in the 4T fishery, where the resource has been widely used as lobster bait. Otter trawls were the dominant gear, landing 344 t of winter flounder in 1995. The number of days that otter trawls fished for winter flounder, a measure of nominal fishing effort, has declined since 1991, from approximately 2000 days of directed effort to 453 days in 1995. Research survey data for 4T indicate that the resource is at an intermediate level of abundance relative to abundance indices since 1971. The abundance of winter flounder varies regionally within 4T, suggesting the existence of numerous stock units in this management unit.

Provisional landings of 4T yellowtail flounder reached 342 t in 1995. Landings have averaged 78 t since 1960, with wide year-to-year variation. Yellowtail flounder are landed mainly by the mobile fleet of otter trawls and seiners. The catch rates of yellowtail flounder in the 4T groundfish survey have fluctuated widely, but indicate an increasing trend since the late 1970s.

Résumé

Les débarquements provisoires de plie rouge dans la division 4T de l'OPANO ont atteint 609 t en 1995. Les débarquements de plie rouge sont en déclin dans la division 4T depuis 1991, avec les plus forts déclins enregistés en 1993 et 1995. Depuis 1960, les débarquements annuels de plie rouge ont été en moyenne de 1916 t, avec de grandes fluctuations d'une année à l'autre. Les prises de la plie rouge sont souvent faussement identifiées ou non-déclarées dans la pêcherie de 4T où la plie rouge est pêchée pour l'appât d'hommard. Les chaluts à panneaux sont l'engin le plus largement utilisé, contribuant 344 t des débarquements de plie rouge en 1995. Le nombre de jours de pêche à la plie rouge par les chaluts, une mesure de l'effort nominal de pêche, a diminué depuis 1991, alors qu'environ 2000 jours de pêche dirigée ont été enregistrés, à 453 jours de pêche en 1995. Les relevés scientifiques de 4T indiquent que la plie rouge de 4T est à un niveau d'abondance intermédiaire par rapport aux indices d'abondance depuis 1971. L'abondance de la plie rouge varie par secteur de 4T, ce qui indique que plusieurs unités de stocks habitent 4T.

Les débarquements de la limande à queue jaune de 4T ont atteint 342 t en 1995. Les débarquements de la limande à queue jaune ont été en moyenne de 78 t depuis 1960, avec de grandes fluctuations interannuelles. Les débarquements de la limande proviennent surtout des engins mobiles, soit des chaluts à panneaux et des sennes. Les taux de capture de la limande de 4T lors des relevés scientifiques ont fluctué largement; cependant, on observe une tendance vers l'augmentation de l'abondance depuis la fin des années 1970.

Introduction

Winter flounder and yellowtail flounder are limited in their distribution to the western North Atlantic. Yellowtail may be found from the southern limit of Labrador southward to Chesapeake Bay. The distribution of winter flounder is somewhat broader, extending from southern Labrador to the coast of Georgia (Scott and Scott 1988). Winter flounder is a coastal flatfish, whereas yellowtail is an offshore species that makes seasonal inshore-offshore movements. In the southern Gulf of St. Lawrence, winter flounder is a common coastal flatfish (NAFO Division 4T, Figure 1). The recent closure of the cod and hake fisheries and reductions in the quota allocations for other groundfish have generated concern for the future of secondary groundfish resources, such as winter flounder and yellowtail.

Aside from an analysis of flatfish catch rates by Clay and Nielsen (1983), no assessment of winter flounder was undertaken until 1994 (Morin et al. 1994). That assessment described the fishery, provided information on the catch-at-age from the commercial fishery and research surveys, and indices of abundance based on survey data (Morin et al. 1994). It was noted that over 80% of winter flounder landings since 1990 originated from a directed fishery. Data on the age composition of commercial and survey catches were also provided. The assessment of winter flounder in 1995 (Morin et al. 1995) revealed problems in age determination that caused a suspension of age-based analyses of the resource. The assessment focused on trends in effort data for otter trawls, the main gear exploiting 4T winter flounder, as well as trends in the length composition of winter flounder in annual groundfish surveys.

This assessment updates landings statistics and abundance indices for this resource. Summary data are provided for the first time on yellowtail flounder in 4T.

Winter flounder

Description of the fishery

The landings of 4T winter flounder have declined annually since 1991 (Table 1, Figure 2) with the exception of 1994. The sharpest declines occurred in 1993 and 1995. Landings in 1995 totalled 609 t, in contrast to 1183 t reported in 1994. Recent revisions to provisional landing statistics for 1993 have resulted in significantly less landings than reported in past assessments (30% reduction). NAFO data for 1992 landings became available, resulting in a 4% increase from the provisional landings reported previously. Trawls continued to contribute most of the landings and their combined landings of 344 t were less than half their level in 1994 (732 t). Gillnets reported relatively stable landings from 1986-1994, ranging between 307 and 588 t, but in 1995, gillnets landed only 242 t of winter flounder. The most prominent change in the gear composition of winter flounder landings has been the decline in landings by seines.

The wide fluctuations in winter flounder landings reflect problems in the reporting of catch statistics from this fishery. The most recent assessment of 4T American plaice (Morin et al. 1996) reports in detail how the category of "unspecified flounder" was designated in landing statistics in the past and how catches from bait fisheries have been estimated. The winter flounder fishery in 4T has been an important bait fishery, providing bait for lobster traps. Catches of winter flounder were frequently captured for personal use or sale by fishers. Plant purchasers have frequently indicated mixed flounder catches as "flounder" and these landings were in turn coded in official statistics as American plaice. When 16 fixed gear fishers with American plaice landings in 1994 were contacted by telephone, 13 of them confirmed that their catches were miscoded as plaice and should have been identified as winter flounder (Morin et al. 1996). Dockside monitoring of flounder catches for personal use or sale has been inconsistent from year-to-year and between regions of 4T (Morin et al. 1996). We conclude that misreporting and unreported catches of winter flounder in 4T have significantly influenced landing statistics for this resource.

The winter flounder fishery by mobile gears in 1995 was disrupted by the late opening of the fishing season in some sectors and by closures due to high bycatches of cod in areas of 4T. Mobile gear landings of winter flounder before July totalled less than five tons in 1994 and 1995 (Morin et al. 1995, Table 2), whereas in the same months of 1993, close to 200 t were landed (Morin et al. 1994). Mobile gear landings of winter flounder peaked in September, similar to the pattern recorded in 1993 and 1994. The winter flounder fishery is typically an open-water fishery with landings reported mainly from May to October (Table 2).

In 1995, the landings of winter flounder declined in most unit areas of 4T, with the exception of Northumberland Strait (unit area 4Th) where an upward trend has occurred since 1993 (Figure 3). Landed catches from the upper Chaleur Bay (4Tm) were similar to their level recorded in 1994. The strongest declines were registered east of PEI (4Tg), the Shediac Valley (4Tl) and off the Gaspé coast (4Tn). Figure 4 shows the distribution of winter flounder catches, grouped in 10-minute blocks. Catches in Northumberland Strait were concentrated at the eastern extremity, near 4Tg. The range of winter flounder catches, particularly in western parts, has diminished considerably since 1992. Catches reported from the Magdalen Shallows and along the Laurentian Channel at the 200-m depth contour (dotted line in Figure 4), are outside the normal depth distribution of winter flounder and are probably misreported catches of American plaice.

Winter flounder has become a mainly directed fishery in 4T in recent years. In 1995, 545 t of the winter flounder landings, 89% of the total, were attributed to the directed winter flounder fishery. Directed fisheries for American plaice and witch flounder contributed approximately 8% of all the winter flounder landings in 1994.

The effort by otter trawls landing 4T winter flounder appears to have declined since 1991 (Figure 5). These data, recorded in vessel logbooks, indicate the number of days spent fishing. The number of fishing days by all trawling vessels reporting winter flounder catches declined from over 12000 days in 1991 to fewer than 1000 days in 1995. Otter trawls directing for winter flounder registered approximately 2000 days in 1991, for 1690 t landed, and 453 days in 1995, for 305 t landed. In 1993, otter trawls directing for winter flounder registered 585 days at sea, for 429 t of winter flounder. Data from logbooks before 1991 were insufficient to evaluate effort in the fishery. Since not all vessels recorded effort in their logbooks, less than 10% of annual winter flounder landings from 1985 to 1990 were recorded with the number of days spent fishing. Since 1991, effort has been indicated for 47-90% of the annual landings of winter flounder by otter trawls.

Winter flounder in 4T are not under quota regulation. The approved mesh size for winter flounder remained 130 mm square for Northumberland Strait and the Magdalen Islands. In Chaleur Bay and Miscou Bank, the approved mesh size was 135 mm square. The opening date of the fishery in eastern Northumberland Strait was set at July 15, a measure to protect cod and spawning white hake. The minimum size for winter flounder was 25 cm, although vessels were allowed to return live winter flounder to the water. No closures were caused by captures of small winter flounder; however, 10 closures resulted from bycatches of cod or white hake by mobile and fixed gear.

Views of the fishing industry

Several consultations were held with the fishing industry, between July and December of 1995, concerning the status of 4T groundfish stocks. Assemblies were held in fishing communities throughout the southern Gulf (Gaspé, Grande Rivière and Cap-aux-Meules (Magdalen Islands), Québec; Caraquet, New Brunswick; Charletown, PEI; Port Hawkesbury, Nova Scotia). The meetings were conducted with brief presentations by DFO personnel on recent trends in the fishery and preliminary results of the latest research survey data, followed by general discussions on each stock. The purpose of the meetings was to receive the views of the fishing industry concerning the state of groundfish stocks and information that the industry would recommend in assessing stock status.

The meetings failed to produce a clear view on the condition of winter flounder stocks and the fishery from the perspective of the active fishers. In several meetings, it was not clear whether the major participants in the fishery (i.e., those who direct for winter flounder) were in attendance. This is surprising, given the significant landings and directed effort that are attributed to winter flounder in 4T. In the meetings at Caraquet and Port Hawkesbury, no comments were made following the presentations on winter flounder. In Grande Rivière, it was noted that the winter flounder stock in Chaleur Bay appears to be at a stable level of abundance, whereas in the area near Grande Rivière, the abundance had declined in recent years. Fishers attending the meeting in Charlottetown could not comment on the abundance of winter flounder to the west of PEI because there was no fishing activity in that sector in 1995. Provincial samplers from PEI attending the meeting noted that substantial catches of large winter flounder were made in tangle net fisheries on herring spawning grounds. In their view, fishing effort by tangle nets set for winter flounder has increased in recent years. At Cap-aux-Meules, fishermen noted a decline in winter flounder abundance near the Magdalen Islands and low fishing effort in 1995. They also remarked that winter flounder is a coastal species, not found more than 12 NM from the shores of the Magdalen Islands.

Telephone questionnaire

A telephone survey was conducted of fishers who were active in the groundfish fishery in the southern Gulf of St. Lawrence during 1995. In October 1995, a list of 232 vessels was drawn from CFV numbers identified on purchase slips up to that time. From December 12, 1995 to January 9, 1996, 138 participants were interviewed for their views on the groundfish fishery. The respondents were distributed throughout the southern Gulf, from New Brunswick, Prince Edward Island and Nova Scotia (Figure 6). The questionnaires included 25 questions on diverse topics. The duration of the interviews averaged 16 minutes (ranged 8 to 30 minutes) and were conducted in English or French. Of the vessels that were identified and whose owners did not participate in the survey, five refused to participate, 28 did not fish groundfish in 1995, and the remaining fishers could not be reached by telephone.

Of the 138 respondents in the survey, 68 directed their fishing effort on winter flounder during 1995 and, of these, 48 respondents identified winter flounder as their primary choice of directed species. The main group of vessels was composed of 35 otter trawls, 25 gillnetters and 8 seines.

Most respondents reported using the same or less amount of fishing gear in 1995. Of the 68 vessels directing for winter flounder, 49 deployed the same amount of fishing gear in 1995 as in previous years, 11 deployed less gear, and only 5 reported using more gear. Compared to 1994, 32 respondents fished fewer days, 21 fished the same, and 10 reported more days of fishing (5 respondents had not fished in 1994 or expressed no opinion).

Twenty-two fishermen were able to provide the exact number of fishing days, averaging 21 days in 1995 (range 3 to 60 days). When asked to estimate the number of fishing days, 44 fishermen responded. Their estimated fishing days spanned a mode of 10 to 39 days (Figure 7). The most common reason cited for changes in fishing effort was fishery management regulations. Only four respondents reported shifting their effort to snow crab or tuna as a reason for reducing their fishing effort on winter flounder. Most reported that weather conditions were similar to previous years (37 respondents). Twenty-two fishermen reported fewer days of bad weather in 1995 than in previous years and nine reported more bad-weather days in 1995.

When fishermen were asked to judge the abundance of winter flounder in 4T on the basis of their experience, 24 of the 68 fishermen who directed for winter flounder considered the resource to be at its average level. More respondents considered winter flounder to be less-than-average (22) than above-average (18, Figure 7). Figure 7 illustrates how fishermen who directed for winter flouder responded to questions relating the state of the fishery to their experience over the past year, the past five years, and all of their years of fishing experience. Most of the respondents considered the fishery to be better than in 1994. Only 16 respondents considered the fishery to be worse, whereas 29 considered it to be better or much better than in 1994. However, when compared to longer periods in the past, the 1995 fishery was viewed as worse. Compared to the fishery during 1990-1994, 25 respondents considered it to be worse or much worse and 17 considered it to be better or much better. When judged on the basis of all of their years of experience, 32 felt that the 1995 fishery was worse or much worse and 9 considered it to be better or much better.

Research data

Abundance Indices

Abundance indices were calculated using catch rates in the September and July bottom trawl surveys. The September survey has been conducted each year since 1971, following a stratified random design, with strata defined mainly by depth (Figure 8). The survey has undergone some changes since 1971, most notably changes in vessels and trawling gear. The vessel *E.E. Prince* with a Yankee 36 trawl was used until 1984, when it was replaced with the *Lady Hammond* and a Western IIA trawl. Since 1991, the *Alfred Needler* and the Western IIA have been used. Comparative surveys conducted in 1985 and in 1991indicated that winter flounder catch rates of the *Prince* and the *Hammond* differed significantly, whereas there was no significant difference between catch rates of the *Hammond* and the *Needler* (Nielsen 1994). Winter flounder catches were standardized to a common distance towed of 1.75 NM, with catches of the *Prince* divided by 0.433 for equivalence with catch rates of the *Hammond* and *Needler*. Strata 401-403 have been fished only since 1984 and are not included in the analyses reported here.

Nearly all (99.8%) of the winter flounder caught in the 1971-1993 surveys were caught in 10 strata (Morin et al. 1994). Consequently, we restricted our analyses to these ten strata (418-422, 428, 429, 432, 433 and 435). The yearly stratified mean catch of winter flounder was calculated for the ten strata. To assess the significance of annual and regional variations in winter flounder abundance, we used multiplicative analyses of catch rates. Winter flounder catches were standardized to a *Hammond-Needler* equivalent, then transformed as ln(catch+0.5) and weighted by the stratum area divided by the number of tows in the stratum. Models with year and stratum effects and their interaction were fitted with the GLM procedure of SAS (SAS Institute 1990). The ten strata were broken down into four subareas of the Gulf: Chaleur Bay (strata 418 and 419); the Miramichi area (strata 420 and 421); the Magdalen Islands (strata 428 and 435); the area southeast of PEI (strata 432 and 433). The stratified mean catch in each subarea was calculated and separate multiplicative analyses were performed on each subarea to interpret trends in abundance.

The July survey has been conducted annually in the region of the Miramichi Bay-Shediac Valley, originally as an index of the abundance of juvenile cod. Since 1990, this survey has used the same stratified design, with four depth-related strata (Sinclair et al. 1995, p. 13). Four vessels have been used for the survey, but unlike the September survey, comparative surveys were not conducted to evaluate the relative efficiencies of the different vessels. The July survey has maintained the same trawling gear, including the net, doors and bridle (Sinclair et al. 1995). We used the stratified mean catches of winter flounder (number per standard 1.75-NM tow) from the two surveys as indices of relative abundance.

In the September survey, mean catch rates of winter flounder in the ten strata where winter flounder occur tended to be relatively low in the early to mid-1970s (except for 1974 and 1976) and have fluctuated between 52 and 200 per tow since then (Figure 9). Winter flounder catches in the 1995 survey averaged 165 per tow. The abundance index from the July survey, followed a similar trend with abundance high in 1992, declining to low levels in 1993 and 1994, followed by a large increase in 1995 (Figure 10). The multiplicative analysis of September catch data revealed a significant year effect (F=1.65; df=24, 999; P=0.03), as well as a significant year*stratum interaction (F=1.56; df=213, 999; P=0.0001).

Examining the abundance trends by sector of 4T, there was no apparent trend over time in the Chaleur Bay area up to 1994 (strata 418 and 419, Figure 11). Large catches in Chaleur Bay in 1995 caused a strong increase in the stratified mean, along with high variance. The multiplicative model of catches in the Chaleur Bay was not significant (F=1.03; df=25, 163; P=0.43). In the Miramichi subarea (strata 420 and 421), catch rates were relatively low throughout most of the 1970s and 1980s, with isolated peaks in 1976 and 1983. Catch rates increased through the 1980s to peak values in 1990-1992, and have declined to intermediate levels since 1993 (Figure 11). The main effects in the model for the Miramichi subarea (year and stratum) were highly significant ($P<0.0004$), as well as their interaction (F=2.03; df=22, 140; P=0.008). These results indicate more localized variation in the abundance trends of winter flounder within this subarea. The high catch rates in the Miramichi area in 1976 and 1989-1992 were due to catches in stratum

421, whereas stratum 420 contributed to the peak catches in 1983 (Figure 12). Since 1992, catch rates in stratum 421 have since declined to levels less than in stratum 420. Catch rates of winter flounder in the Magdalen Islands tended to be high from the mid-1970s to the early 1980s, but declined to low levels in recent years (Figure 11). The 1994 and 1995 catch rates, although higher than the very low 1989-1993 values, remained low relative to the high values of the mid-1970s to early 1980s. Annual variation in Magdalen Island catches were significant (F=2.21; df=24, 115; P=0.003) after dropping the non-significant interaction term (F=1.12; df=23, 115; P=0.34). In the area southeast of PEI, catch rates tended to be highest in the mid-1970s, and have declined to relatively low values in recent years (Figure 11). The catch rate in this area increased sharply in 1995. In catch analyses of this sector, dropping the non-significant interaction term (F=0.65; df=24, 178; P=0.89) resulted in a significant annual effect (F=1.89; df=24, 178; P=0.01).

Winter flounder inhabit inshore areas and appear to move into estuaries to overwinter (Hanson and Courtenay 1996). It is possible that winter flounder in the southern Gulf comprise a number of local stocks with localized movements, as has been observed elsewhere (McCracken 1963, Phelan 1992). The significant differences between regions in abundance trends is consistent with this possibility.

Catch rate time series for winter flounder show considerable annual fluctuation in the southern Gulf (Figures 9-11). Winter flounder are distributed in shallow water along the inshore edge of the September survey. Annual variation in the depth distribution of winter flounder and of sampling in the September survey (Morin et al. 1994) could contribute to these fluctuations. This variation in depth distribution suggests that the proportion of winter flounder occurring outside of the survey area has varied from year to year. Unfortunately, we are unable to correct this source of error in our estimates of relative winter flounder abundance.

Assessment results

The nominal landings of winter flounder in 4T have averaged 1916 t since 1960, varying widely from one year to the next. The landings of 4T winter flounder in 1995 (609 t) were the lowest on record in over a decade. Recent revisions to landing statistics indicate that in addition to a decreasing trend since 1991, landings dropped sharply in 1993 and 1995. Landings by otter trawls, the main gear component in this fishery, have declined since 1991. The fishing effort by otter trawls also appears to have declined, even though the winter flounder fishery has become subject to increasing directed effort.

Current indices of stock abundance, based on research surveys, indicate that 4T winter flounder are at an intermediate level of abundance relative to data since 1971. An increase in the abundance of winter flounder was noted in 1995 from the September survey of 4T and from July surveys of the Miramichi Bay-Shediac Valley area. Winter flounder in 4T probably comprise numerous stocks that vary regionally in abundance. September surveys indicate that abundance is intermediate in the Miramichi area and low in the Magdalen Islands. Increases were noted in 1995 in Chaleur Bay and southeast of PEI, areas that had recorded low catch rates in recent years.

Ecological considerations

Size at maturity

Several flatfish species, such as winter flounder, are late-winter or spring spawners. Research surveys conducted in September provide the best discrete sampling of groundfish stocks throughout the southern Gulf; however, for early spawning fishes it is usually difficult to visually assess maturity stages in autumn. For winter flounder, information on the age of first reproduction is necessary to provide advice on appropriate target size for commercial fisheries. One of the recommendations of the last assessment (Science Branch 1995) was to examine maturity data for winter flounder from July surveys, as a basis for determining the size at maturity of male and female winter flounder.

The data were collected at sea during the July groundfish surveys conducted annually since 1990. Biological data were collected at a rate of one specimen per centimeter, per sex, per set. In addition to length, weight, sex and otoliths (age data not available), the reproductive condition of each specimen was evaluated visually. The maturity codes were on a scale of 1 to 8, based on the system outlined by Hurlbut and Clay (1990, page 3-9) for gadoid fishes.

Over the six surveys, maturity staging was determined on 712 male and 909 female winter flounder. For both sexes, the sampling comprised two main maturity stages. Stage-1 maturity, describing immature or virgin fish with no reproductive development, contributed 19% of the sampled males and 14% of the sampled females. Stage-8 describes non-ripe or resting fish. This stage shows some signs of reproductive development, indicated by larger or colored gonads; however, it permits no interpretation of whether the fish has recently spawned or will spawn in the coming spring. Stage-8 winter flounder were 79% of the sampled males and 85% of the sampled females. The remaining stages, indicating ripening, ripe, or spent fish (stages 2, 4 and 6) contributed less than 2% of the males or females sampled. One reason for undertaking this analysis was that spawning or post-spawning winter flounder would be more easily detected in July. This appears not to be the case. Figure 13 shows the frequency of maturity stages-1 and 8. For both males and females, stage-1 maturities become insignificant at lengths of 19-24 cm, replaced by stage-8.

Yellowtail flounder

Recently, interest has been expressed concerning the condition of the yellowtail fishery in 4T. This section is a brief summary of information on a flatfish stock that has not yet been the subject of any assessment. Yellowtail landings have exhibited wide annual variations in 4T since 1960 (Table 3, Figure 14). It is difficult to detect any period when significant and consistent landings have been observed. Landings have averaged 78 t annually since 1960 and the landings of 342 t in 1995 are clearly at the uppermost range of reported landings. In 1986, 1987 and 1995, landings exceeded 300 t, most of which were landed by seines. In most other years with significant landings, otter trawls have been the main contributing gear type. Fixed gear, including gillnets, land an insignificant portion of the annual yellowtail landings.

Most of the yellowtail landings in 1995 originated from 4Tf (Table 4, Figure 1) and may have originated from fishing activity near the Magdalen Islands where yellowtail are fished for lobster bait. The Shediac Valley (4Tl) and Chaleur Bay (4Tm) have been the other unit areas with significant landings of yellowtail flounder.

The index of 4T yellowtail abundance was obtained from the September groundfish survey. The data series was corrected for a significant difference between catch rates of the E.E. Prince and the Lady Hammond (Nielsen 1994). There was no significant difference between catch rates of the Hammond and the Alfred Needler; however, recent analyses have revealed a significant day-night effect in catch rates for yellowtail flounder, with more yellowtail captured at night than during daytime. All catches were standardized to a 1.75 NM tow and conversion factors were applied for equivalent Hammond-Needler daytime catches.

The catch rates of yellowtail flounder in the September survey of 4T (Figure 15) indicate an increasing trend over time. Mean catch per tow was lowest in the early 1970s. Catches since 1977 have fluctuated widely, but show an increasing trend. Coefficients of variation for these estimates have averaged 31% (range: 17-56%).

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Table 1. Yearly landings of winter flounder in NAFO division 4T by major gear types. gear codes: OTB=otter trawls (unspecified), OTB1=otter trawls side. OTB2=otter trawls stern, SNU=seines, GNS=gillnets, LLS=longlines.

	GEAR							
YEAR	OTB	OTB1	OTB2	SNU	GNS	LLS	OTHER	TOTAL
1960	730	0	0	137	0	17	16	900
1961	1043	0	0	452	1	2	98	1596
1962	1407	0	0	642	115	8	140	2312
1963	2324	0	0	697	66	15	46	3148
1964	2247	0	0	546	0	0	209	3002
1965	4026	0	0	217	12	89	68	4412
1966	0	2639	1	300	53	0	63	3056
1967	0	1853	17	464	58	33	19	2444
1968	0	423	1	107	16	2	1	550
1969	0	1251	12	51	0	12	368	1694
1970	0	1724	85	576	142	21	136	2684
1971	0	1708	61	572	79	23	378	2821
1972	0	1191	2	533	36	44	16	1822
1973	0	1470	336	390	29	42	33	2300
1974	0	1323	6	388	23	4	176	1920
1975	0	1559	18	254	35	3	141	2010
1976	4	1738	400	96	24	3	142	2407
1977	0	709	194	48	24	6	254	1235
1978	0	571	173	104	77	13	183	1121
1979	0	944	336	52	64	10	179	1585
1980	1247	17	0	80	274	147	211	1976
1981	1563	42	0	30	215	16	75	1941
1982	1652	0	0	32	579	1	41	2305
1983	1405	0	8	131	231	7	17	1799
1984	0	6	37	32	13	4	57	149
1985	2	71	862	56	97	38	54	1180
1986	0	66	1101	243	538	6	90	2044
1987	0	20	804	307	526	85	69	1811
1988	0	24	759	280	321	20	10	1414
1989	0	109	1082	392	469	37	0	2089
1990	0	4	1167	274	588	32	12	2077
1991	1	49	1825	181	344	15	120	2535
1992	0	38	1204	141	324	5	235	1973
1993*	0	16	440	61	307	2	41	869
1994*	0	45	687	32	411	2	7	1183
1995*	0	5	339	10	242	0	13	609
MEAN	490	545	332	247	176	21	103	1916

* Provisional data

Table 2. Preliminary landings (t) of 4T Winter flounder in 1995 by gear and month. Gear types: OTB1=otter trawls side. OTB2=otter trawls stern, PTB=pair trawls, TXS=shrimp trawls, SDN=Danish seines, SSC=Scottish seines, GNS=gillnets, BXN= box net, LHB=handlines, FIX=traps, UNK=unknown.

	MONTH											
GEAR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Total
OTB1	0.0	0.0	0.0	0.0	0.0	0.0	3.7	1.6	0.0	0.0	0.0	5.3
OTB2	0.0	0.0	0.0	0.0	1.1	3.7	54.9	61.5	146.1	71.2	0.5	339.0
PTB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.7	0.6	0.0	2.4
TXS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5
SDN	0.0	0.0	0.0	0.0	0.0	0.0	0.2	2.0	5.0	2.7	0.0	9.8
SSC	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
GNS	0.0	0.0	0.0	0.0	3.6	67.2	110.5	60.6	0.0	0.0	0.0	243.3
BXN	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
LHB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2
FIX	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
UNK	0.0	0.0	0.0	0.0	1.9	6.5	0.7	0.0	0.0	0.0	0.0	9.1
Total	0.6	0.1	0.0	0.0	6.5	77.4	170.0	126.6	152.8	74.5	0.5	609.0

Table 3. Yearly landings of yellowtail flounder in NAFO division 4T by major gear types. Gear codes: OTB= bottom otter trawl, OTB1= side otter trawl, OTB2= stern otter trawl, PTB= bottom pair trawl, SDN= Danish seine, SSC= Scottish seine, SPR= pair seine, GNS= gillnets, LLS= longlines, LHB= handlines, MIS= miscellaneous, NK= unspecified.

	GEAR													
YEAR	OTB	OTB1	OTB2	OTM	PTB	SDN	SSC	SPR	GNS	LLS	LHB	MIS	NK	TOTAL
1960	2	0	0	0	0	0	0	0	0	0	0	0	0	2
1961	5	0	0	0	0	1	0	0	0	0	1	0	0	7
1962	2	0	0	0	0	0	0	0	0	0	0	0	0	2
1963	33	0	0	0	0	18	0	0	0	0	0	0	0	51
1964	26	0	0	0	0	8	0	0	0	0	0	5	0	39
1965	26	0	0	0	0	21	0	0	0	3	0	0	1	51
1966	0	98	1	0	0	22	0	0	1	0	0	0	3	125
1967	0	31	0	0	0	0	0	0	24	0	0	0	0	55
1968	0	6	0	0	0	0	0	0	0	0	0	0	0	6
1969	0	243	0	0	0	0	0	0	0	0	0	0	0	243
1970	0	38	0	0	0	6	0	0	0	0	0	0	0	44
1971	0	2	0	1	0	2	0	0	0	0	0	0	0	5
1972	0	2	0	0	0	1	0	0	0	0	0	0	0	3
1973	1	0	0	0	0	0	0	0	0	0	0	0	0	1
1974	0	5	0	0	0	5	11	0	0	0	0	0	0	21
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	13	15	0	0	1	0	0	0	0	0	0	0	29
1977	0	1	0	0	0	18	0	0	0	0	0	6	0	25
1978	0	1	0	0	0	2	0	0	0	0	0	0	0	3
1979	0	43	2	0	0	6	1	0	0	0	0	0	0	52
1980	7	0	33	0	0	0	0	1	0	0	0	0	0	41
1981	0	6	0	0	0	4	0	0	0	0	0	0	0	10
1982	0	0	0	0	0	6	0	0	0	0	0	0	0	6
1983	12	0	0	0	0	0	2	12	0	0	0	0	0	26
1984	0	9	53	0	0	5	0	0	14	1	0	0	0	82
1985	0	0	66	0	73	72	1	3	0	0	0	0	0	215
1986	1	3	60	0	36	248	11	37	0	0	0	0	0	396
1987	0	1	70	0	21	260	0	34	16	1	1	0	0	404
1988	0	0	145	0	0	25	14	11	3	0	0	0	0	198
1989	0	0	31	0	0	9	2	0	1	0	0	0	0	43
1990	0	0	13	0	0	0	0	2	0	0	0	0	0	15
1991	0	0	6	0	0	11	36	0	1	0	0	0	0	54
1992	0	7	99	0	0	0	10	0	1	0	0	0	0	117
1993*	0	0	19	0	0	13	4	0	0	0	0	0	0	36
1994*	0	2	22	0	0	31	7	0	1	0	0	0	0	62
1995*	0	0	85	0	0	1	117	0	2	0	0	0	136	342
MEAN	3	14	20	0	4	22	6	3	2	0	0	0	4	78

* Provisional data

Table 4. Yearly landings of yellowtail flounder in NAFO division 4T by unit area.

YEAR	UNIT AREA											TOTAL
	4T	4TF	4TG	4TH	4TJ	4TK	4TL	4TM	4TN	4TO	4TP	
1990	15.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	15.6
1991	6.2	36.0	5.3	0.2	3.9	0.0	1.3	0.0	0.7	0.0	0.0	53.6
1992	0.5	81.6	0.0	0.0	2.5	0.0	2.4	27.9	4.1	0.0	0.0	118.9
1993*	11.0	3.5	0.3	1.6	1.6	0.0	9.9	8.3	0.1	0.0	0.3	36.5
1994*	0.9	7.3	1.0	0.0	0.0	2.5	46.6	3.2	0.3	0.0	0.8	62.5
1995*	0.0	285.0	2.0	0.0	0.0	0.0	47.9	6.7	0.2	0.0	0.3	342.1
MEAN	5.7	68.9	1.4	0.3	1.3	0.4	18.0	7.7	0.9	0.0	0.2	112.8

*Provisional data

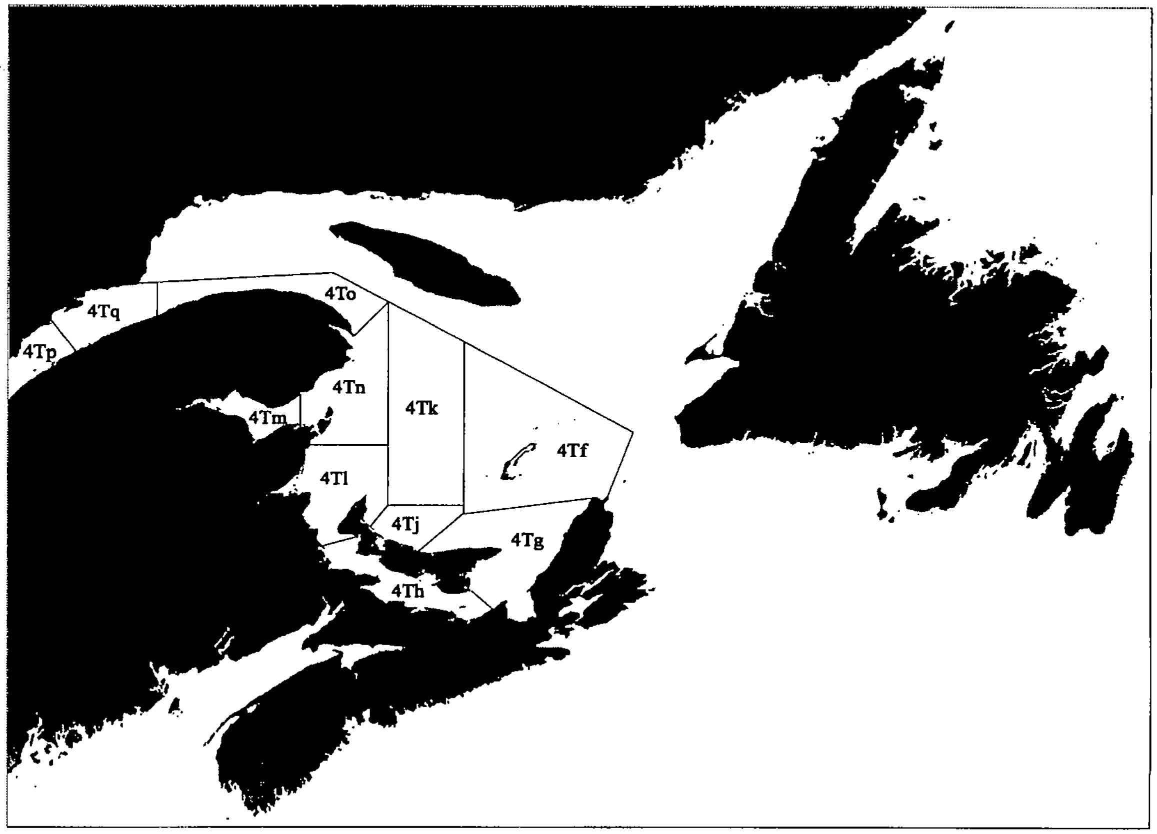

Figure 1. Gulf of St. Lawrence showing unit areas of NAFO Division 4T.

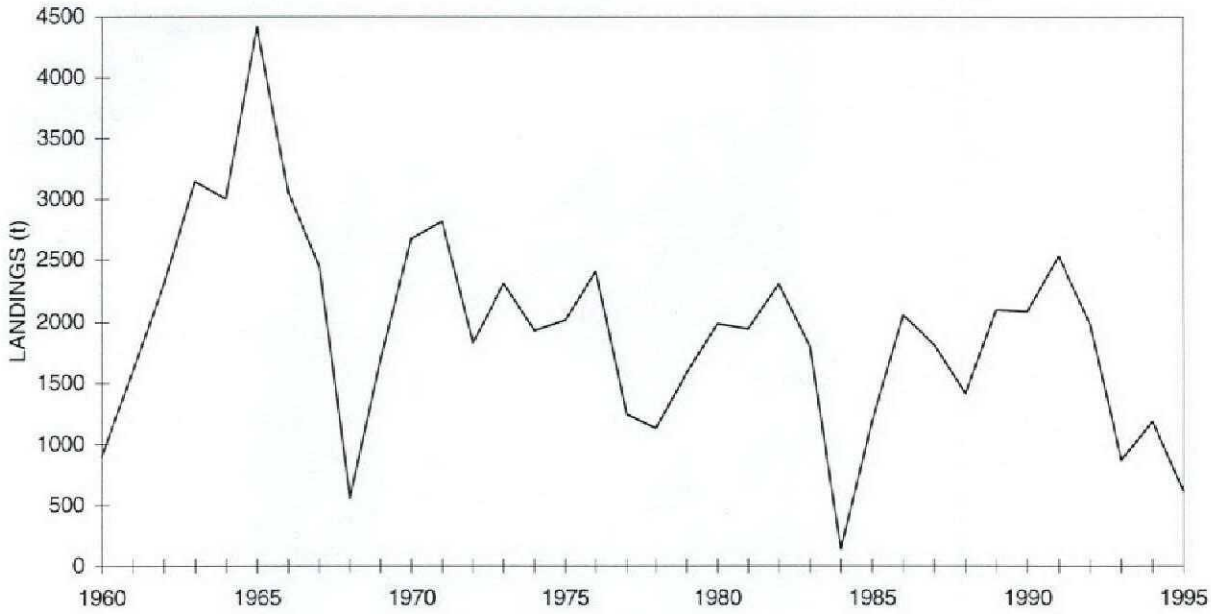

Figure 2. Annual nominal landings of winter flounder in NAFO Division 4T.

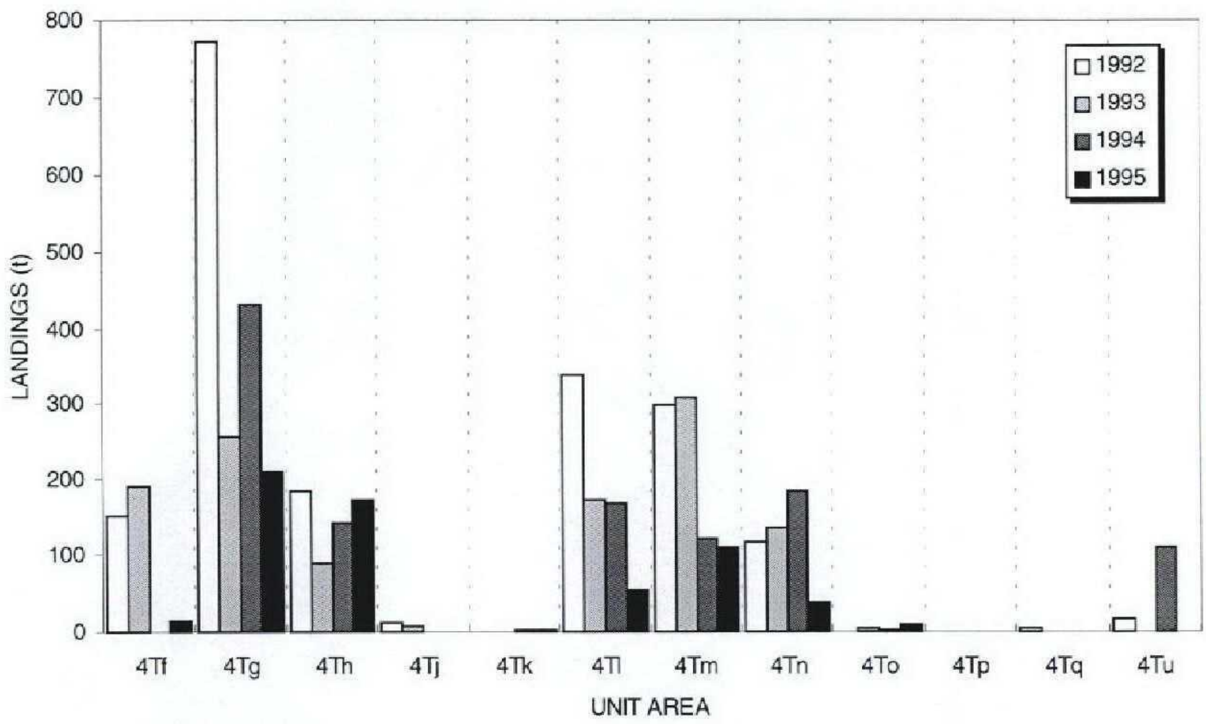

Figure 3. Nominal landings of winter flounder by unit area of 4T since 1992.

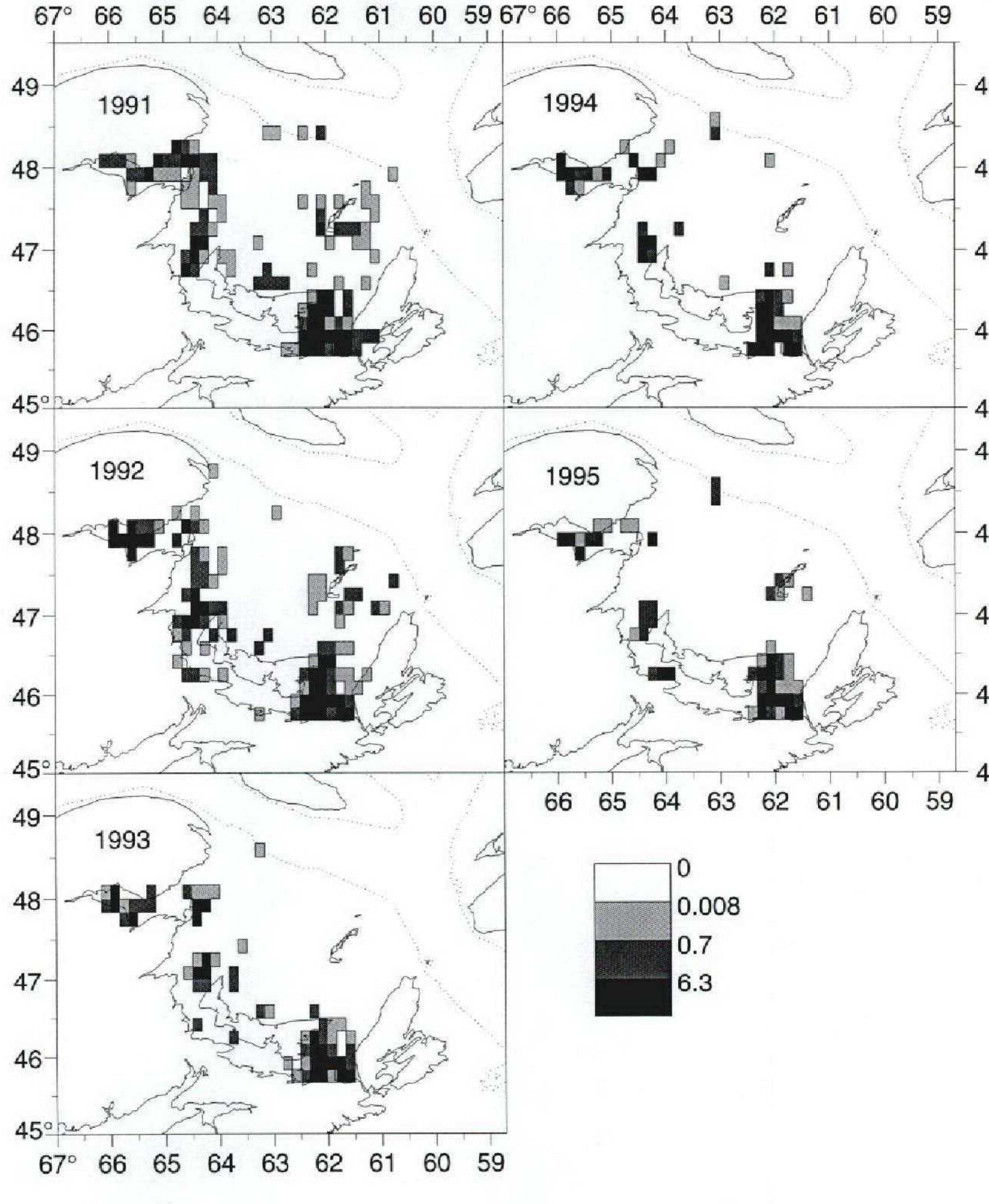

Figure 4. Distribution of commercial catches (tons) of winter flounder in 4T. Upper two contour levels correspond to average 33% and 67% quantiles of catch in 10-minute blocks.

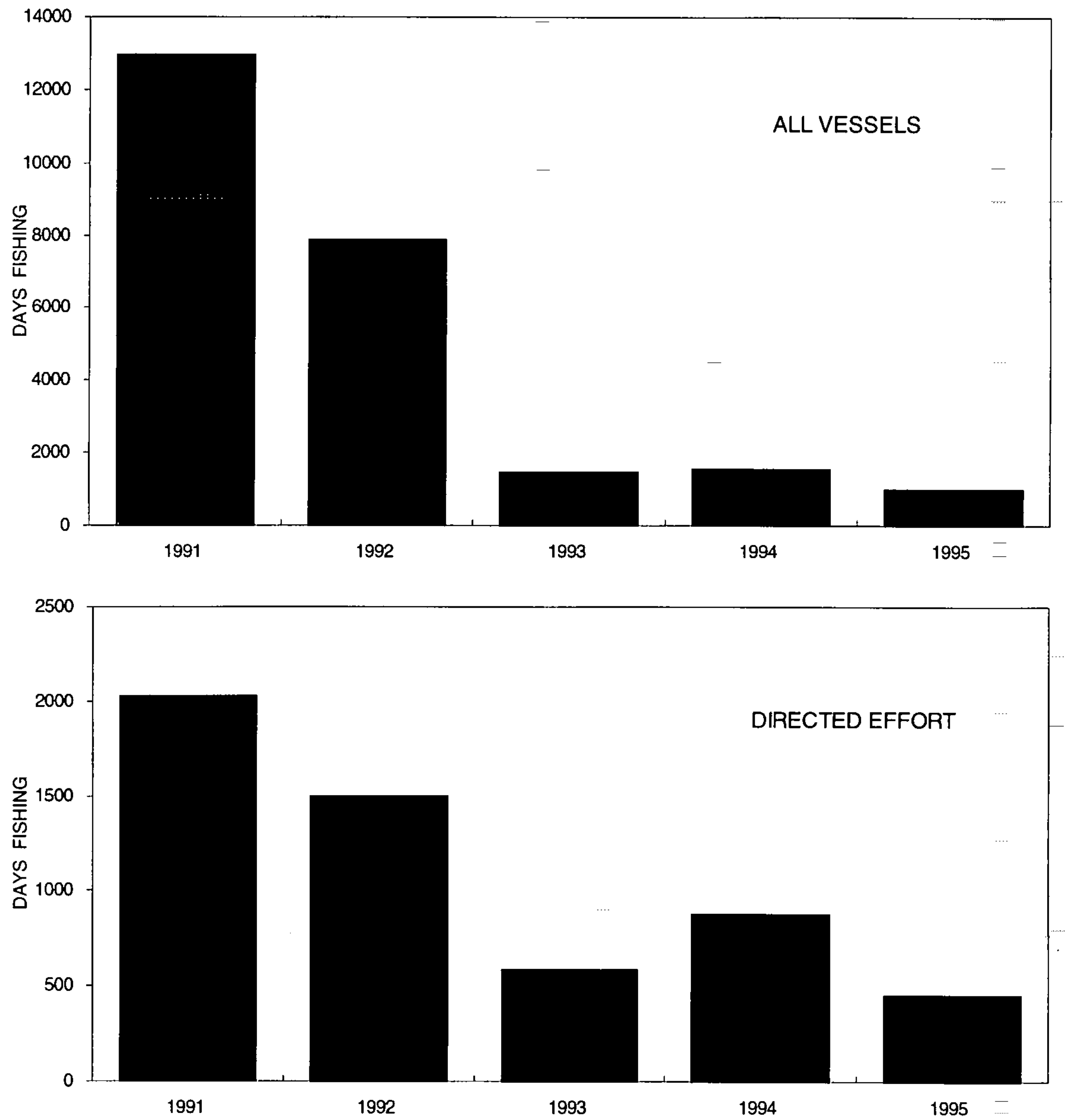

Figure 5. The number of fishing days by all otter trawls landing 4T winter flounder (upper panel) and by otter trawls directing for winter flounder.

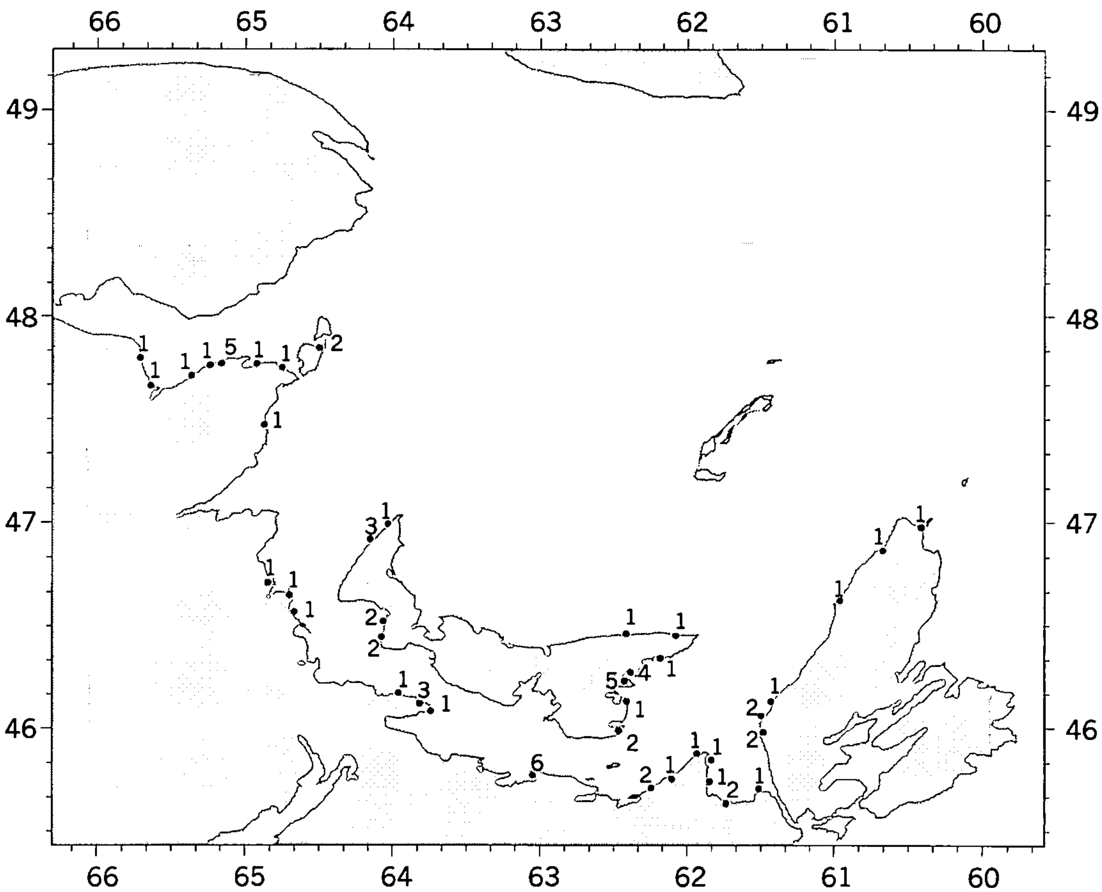

Figure 6. The number of fishers directing for winter flounder in 4T who participated in a telephone survey on the status of southern Gulf groundfish, by home port.

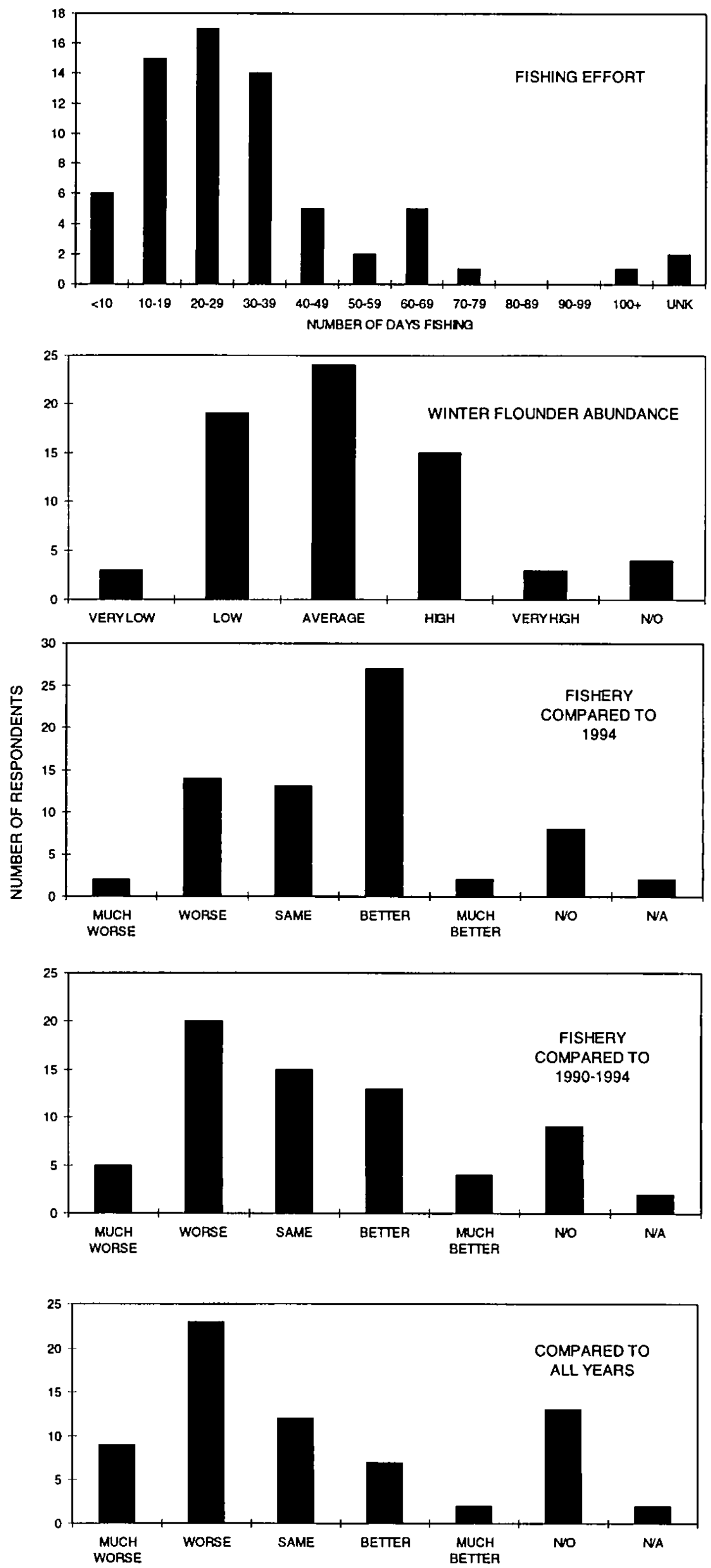

Figure 7. Responses of participants in telephone survey of directed 4T winter flounder fishery in 1995. N/O signifies "no opinion"; N/A signifies that respondents could not reply or that question was not appropriate.

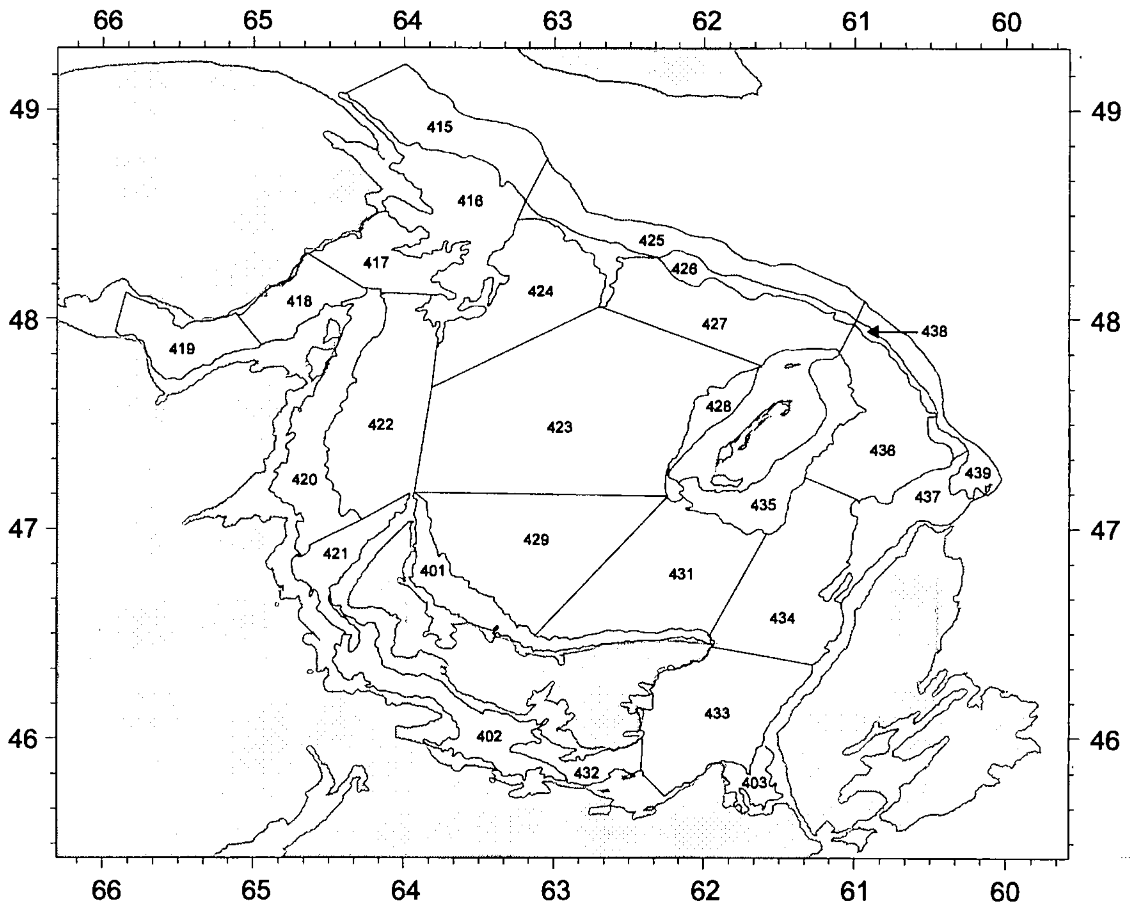

Figure 8. Stratification of the September groundfish abundance survey of the southern Gulf of St. Lawrence.

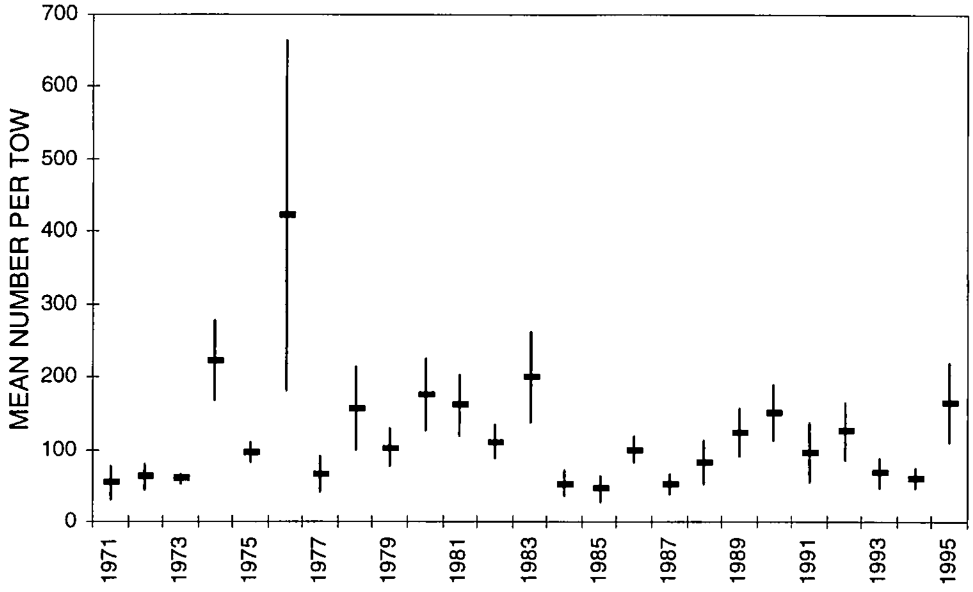

Figure 9. Mean catch per standard tow of winter flounder in selected strata of the September bottom trawl survey of the southern Gulf of St. Lawrence. Horizontal lines show the stratified mean and vertical lines are +/- one standard deviation.

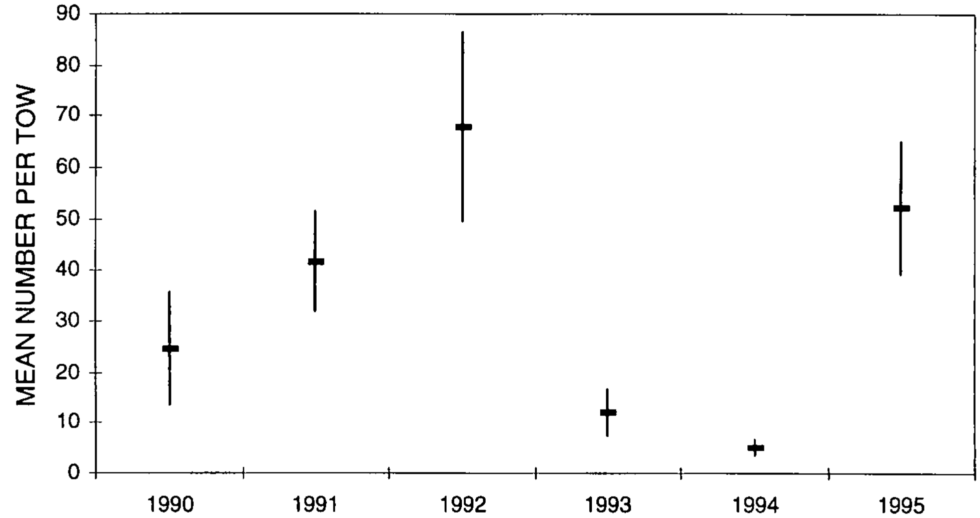

Figure 10. Mean catch per standard tow of winter flounder in the July juvenile cod survey. Horizontal lines show the stratified mean and vertical lines indicate +/- one standard deviation.

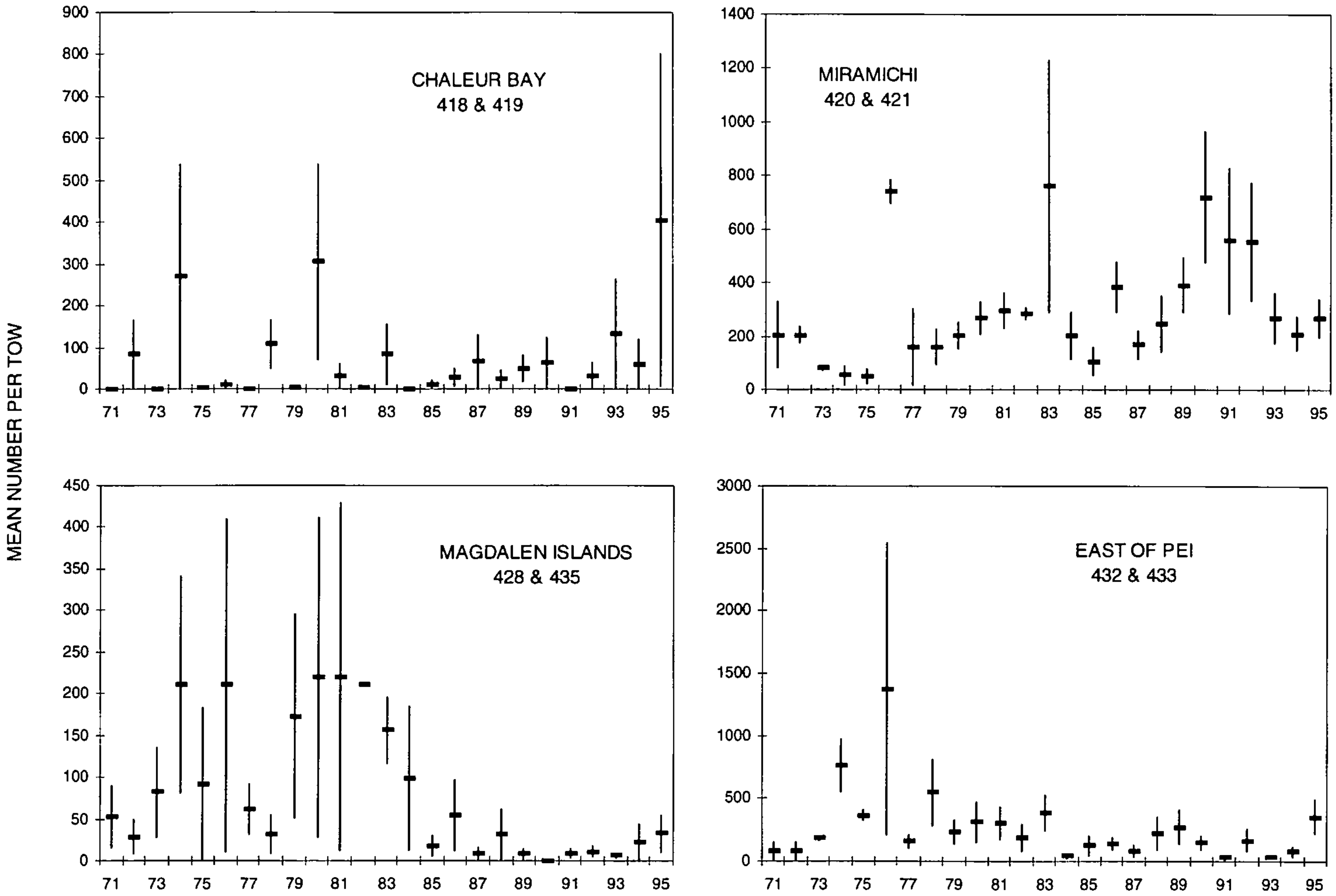

Figure 11. Catch rates of winter flounder in subareas of the southern Gulf of St. Lawrence, indicated by name and stratum numbers. Data are from the September bottom trawl surveys. Horizontal lines show the stratified mean catch per standard tow. Vertical lines are +/- one standard deviation.

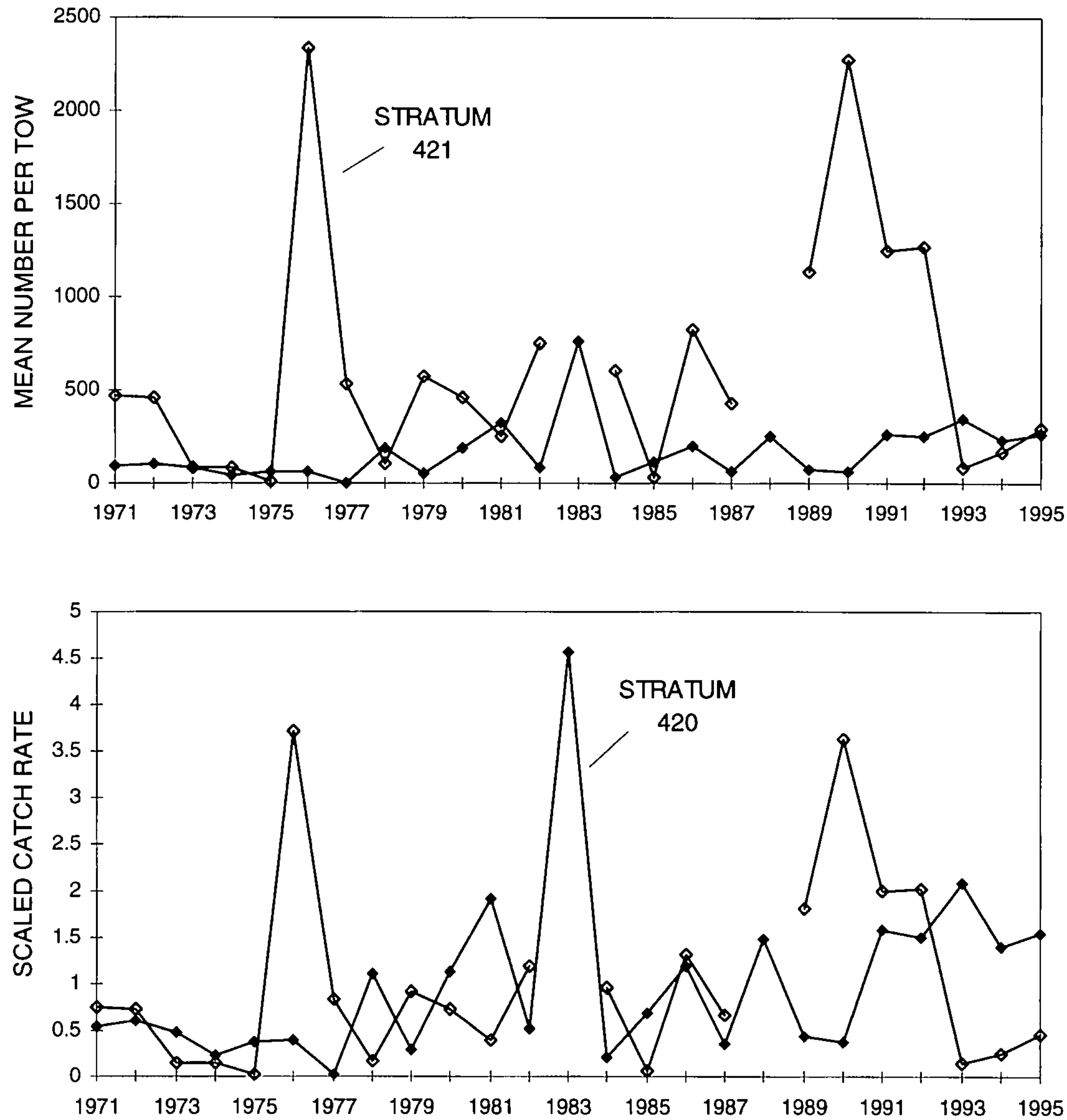

Figure 12. Catch rates of winter flounder in strata 420 (closed diamonds) and 421 (open diamonds) from September groundfish survey. Scaled catch rate is the mean number per tow divided by the stratum average over the time series. Stratum 421 was not sampled in 1983 and 1988.

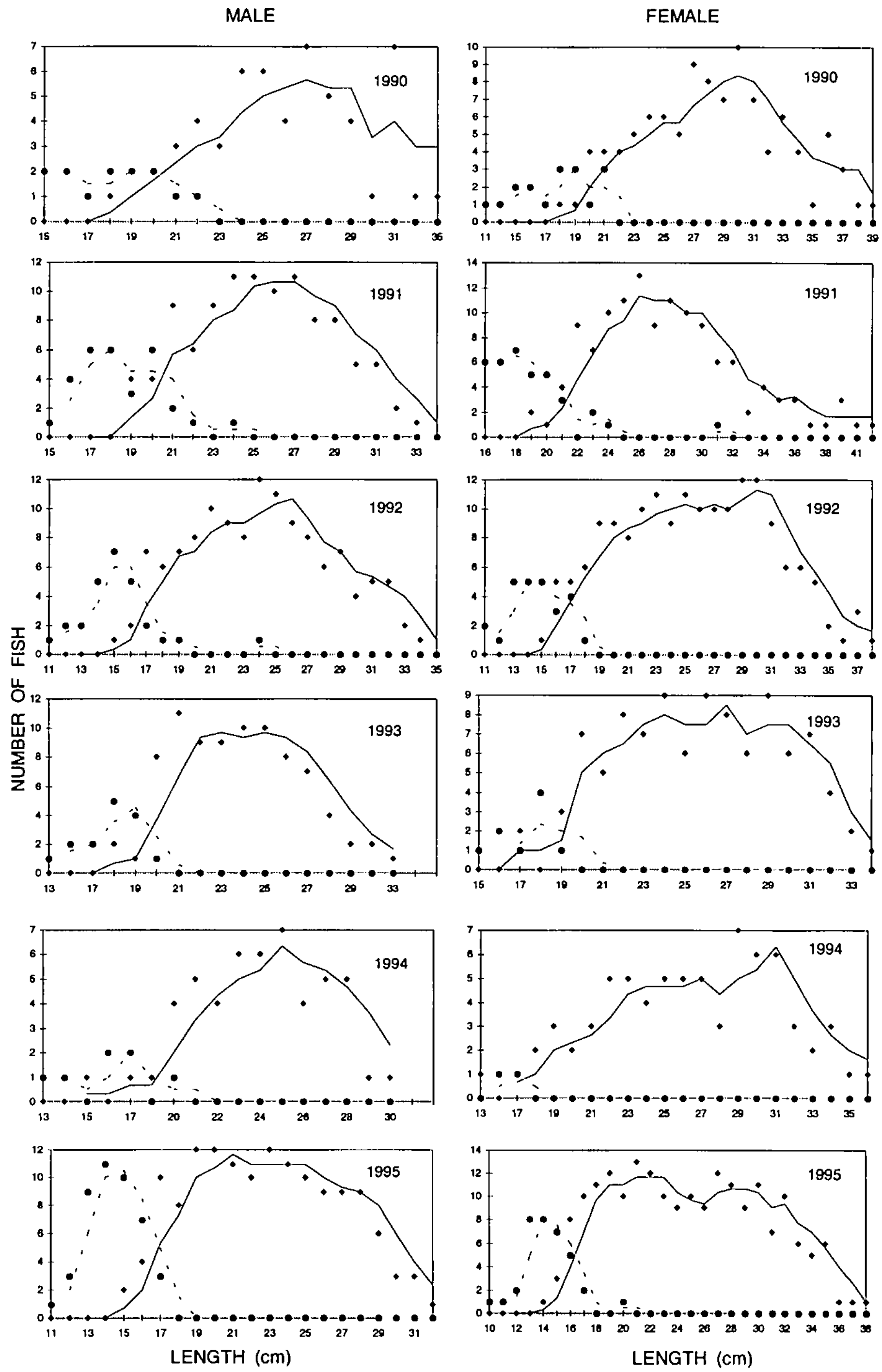

Figure 13. Annual patterns of maturity for winter flounder sampled in July surveys of southwestern Gulf of St. Lawrence. Dotted line was fitted to maturity stage-1 by moving average of 2. Solid line was fitted by same method to maturity stage-8 (non-ripe or resting stage).

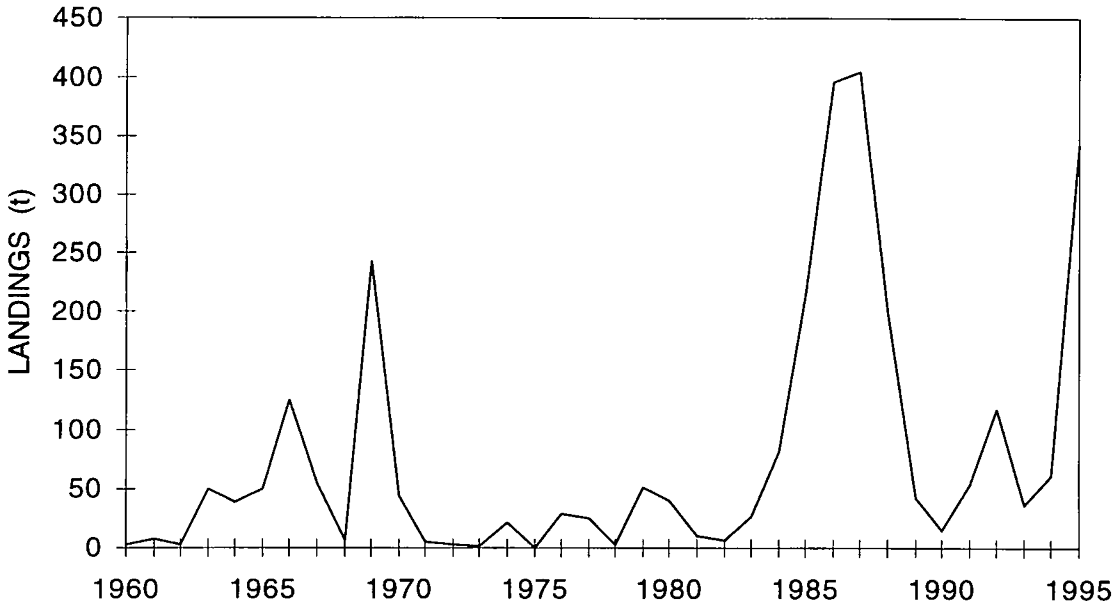

Figure 14. Annual nominal landings of yellowtail flounder in NAFO Division 4T.

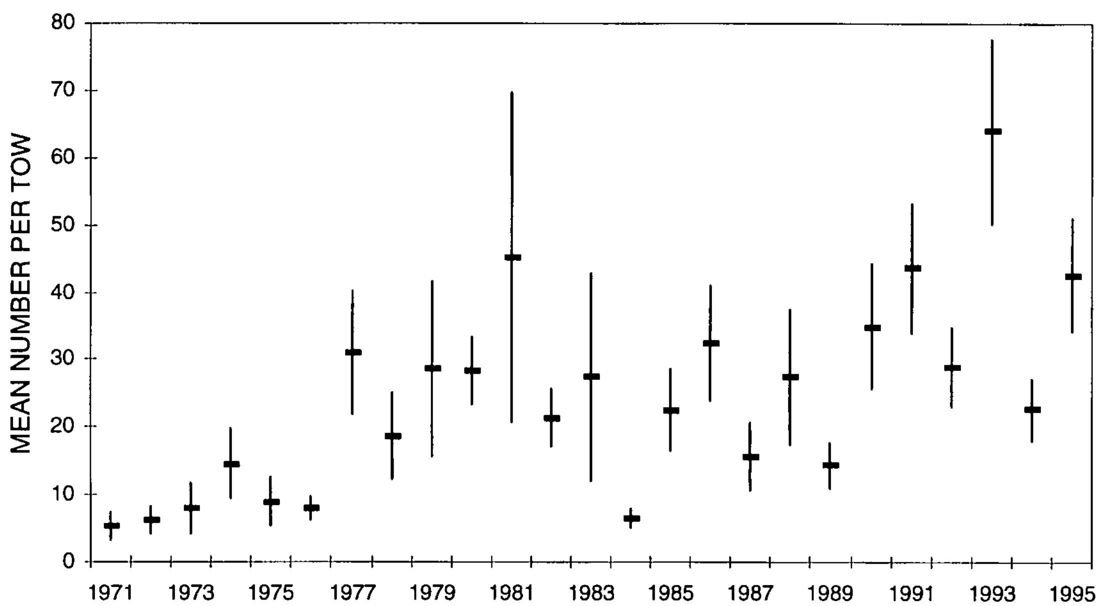

Figure 15. Mean catch per standard tow of yellowtail flounder in the September bottom trawl surveys of the southern Gulf of St. Lawrence. Horizontal lines show the stratified mean and vertical lines are +/- one standard deviation.