Department of Fisheries and Oceans
Canadian Stock Assessment Secretariat
Research Document 97/83

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Ministère des pêches et océans
Secrétariat canadien pour l'évaluation des stocks
Document de recherche 97/83

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Preliminary results on groundfish catches in the 1996 *Calanus II* survey of the Magdalen Islands

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Abstract

Groundfish catches were monitored during a trawling survey aboard the CSS *Calanus II* in shallow waters off the Magdalen Islands (southern Gulf of St. Lawrence) from September 6-10, 1996. A Nephrops trawl was towed at 24 fixed stations, with a replicate tow made at each station. The annual groundfish survey of the southern Gulf with the research vessel *Alfred Needler* was conducted concurrently to the *Calanus II* survey. Flatfish species (yellowtail flounder, winter flounder, windowpane) dominated catches in the *Calanus II* survey, appearing at all sampled stations. White hake appeared at 21 of the 24 sampled stations. Catches of yellowtail and winter flounder were more abundant on a unit area basis and were composed of smaller fish in the *Calanus II* survey than in the nearest stratum sampled by the *Alfred Needler*. The 1996 *Needler* survey did not capture white hake and windowpane in the nearby stratum. For species distributed in the shallow waters of the Magdalen Islands, an area not sampled by the annual groundfish survey, the *Calanus II* survey may provide additional information on local abundance and biological characteristics.

Résumé

Du 6 au 10 septembre 1996, une évaluation des prises de poisson de fond a été faite pendant un relevé au chalut à bord du NSC *Calanus II* dans les eaux peu profondes au large des Îles de la Madeleine (sud du golfe Saint-Laurent). Des traits de chalut à langoustine ont été effectués à 24 stations fixes, un échantillonnage répété étant fait à chacune des stations. Le relevé annuel des stocks de poisson de fond dans le sud du golfe avec le navire de recherche *Alfred Needler* a été réalisé en même temps que le relevé effectué par le *Calanus II*. Les espèces de poisson plat (limande à queue jaune, plie rouge, turbot de sable) étaient les plus abondantes dans les prises du *Calanus II*, apparaissant à toutes les stations d'échantillonnage. La merluche blanche a été retrouvée dans 21 des 24 stations d'échantillonnage. Les prises de limande à queue jaune et de plie rouge étaient plus abondantes par superficie unitaire et la proportion de petits poissons dans l'échantillonnage du *Calanus II* était plus grande que dans la plus proche strate échantillonnée par le *Alfred Needler*. Le relevé effectué en 1996 par le *Needler* n'a pas capturé de merluche blanche et de turbot de sable dans la strate la plus proche. Quant aux espèces des eaux peu profondes entourant les Îles de la Madeleine, zone exclue du relevé annuel des stocks de poisson de fond, le relevé au chalut effectué par le *Calanus II* pourra fournir des renseignements supplémentaires sur l'abondance locale et les caractéristiques biologiques de ces stocks.

Background

In many sectors of the southern Gulf of St. Lawrence, flatfish are exploited for bait in lobster fisheries. The regional office of DFO on the Magdalen issued between 75 and 150 bait fishing licenses annually, resulting in approximately 250-350 tons of flatfish landed (information provided in 1995). The preferred gear for the Magdalen Islands flatfish bait fishery was a small otter trawl, operated within 1 km of the coastline, at depths of 9-15 m. The local industry described the species composition of these catches as roughly 60% yellowtail flounder, 20% winter flounder and 20% windowpane.

Since the closure of the southern Gulf cod fishery in 1993, DFO has undertaken measures to restrict bait fisheries. Bait fisheries were viewed as a potential cause for continued exploitation of moratorium species (including white hake since 1995) and a means for redirecting effort onto less exploited groundfish stocks such as winter flounder. Several requests have been addressed to the Science Branch to evaluate the consequences of this fishery with respect to bycatch and the status of the local flatfish resources.

Current scientific advice on flatfish near the Magdalen Islands is based on catches in the annual southern Gulf groundfish survey. However, this survey samples to a minimum depth of 20 m, whereas southern Gulf stocks of winter flounder, yellowtail and windowpane have a littoral distribution. Analyses of the relation of catch rates of winter flounder with depth indicate that the southern Gulf survey samples at the outer edge of their depth distribution. The catch-depth relation for winter flounder has varied over time, so that it is not possible to provide an annual depth-corrected index of winter flounder abundance (Morin et al. 1994). For shallow-water species with complex stock structure, such as winter flounder, it is important to confirm the adequacy of the annual groundfish survey as an index of local stock abundance.

An inshore lobster survey of the Magdalen Islands has been conducted annually since 1994. The main objective of this survey is to provide an index of the abundance of pre-recruitment stages of lobster, two to three years before they are exploited by the local fishery. Other activities are undertaken during the survey: lobster are tagged and released for information on growth, molting cycle and movements; detailed mapping of substrate is made in the survey area using hydroacoustic and sediment sampling. The survey is headed by Louise Gendron, lobster biologist in the DFO Laurentian Region.

The Magdalen Islands juvenile lobster survey catches groundfish species; however, the sampling requirements for lobster have made it impossible for the scientific staff to sort and record fish catches. I was invited to participate in the 1996 survey. My main objectives were to: 1) evaluate whether significant catches of flatfish were made; 2) determine if this survey augments the information obtained during the annual 4T groundfish survey.

Methods

The survey was conducted aboard the CSS *Calanus II* from September 5-21. The first nine days of the survey (to September 13) were used for the trawling survey, with the remainder of the survey reserved for sediment sampling and hydroacoustic mapping of bottom types. I participated over a five-day period, September 6-10.

The trawling survey was conducted off the southern shore of the Magdalen Islands, between Pointe Basse and Old Harry. Forty-three fixed stations have been designated in this sector (Figure 1), based on an initial grid design, modified by the availability of trawlable bottom. Each station was replicated with a nearby tow, not more than 500 m separating the two sets. The sampling design for this survey is based on a geostatistical analysis of lobster catch abundance. The distance separating the stations, as well as the distance between the replicate sets, were determined to maximize the model fit of the variogram of lobster catches.

The sets consisted of standard tows with a Nephrops trawl, with mesh size of 50 mm in the codend and 60 mm in the lengthening piece (Conan et al. 1994). The trawl was towed at a vessel speed of 3 knots for an average duration of 8 minutes on the bottom. The width of the trawl opening was determined by two Scanmar probes located at the ends of the trawl wings.

Between 6 and 14 sets were made daily over the five days that I sampled fish catches. On average, 33 minutes elapsed between successive sets (62% of the sets were made at less than 30-minute intervals). Under these time constraints, it was not possible to sample catches for individual lengths, weights, maturity and otoliths. Only at two sets were such data recorded for winter flounder. With the assistance of one other person, I was able to sort, count and weigh all catches. Length frequencies were made at the first set of each station; on the second set (replicate), the number and total weight of each species caught were determined. Sexed length frequencies were made on catches of winter flounder, yellowtail and windowpane. The second set at station 43 was not sampled. In all, fish catches were sampled at 24 stations, for a total of 47 sets. The sampled stations in Figure 1 are indicated by the designated number of the first set.

The *Calanus II* survey was conducted over depths ranging from 11 to 32 m. The sampled fish catches were made at depths of 11-21 m. The survey was conducted at the same time as the annual 4T groundfish survey aboard the CSS *Alfred Needler*. The 4T groundfish survey has been conducted annually since 1971 with a random stratified sampling design. This survey uses a Western IIA trawl with a 40-mm liner in the codend and lengthening piece. The net is towed at 3.5 knots for 30 minutes. Catch rates from this survey are standardized to a tow distance of 1.75 NM or a swept area of 0.041 km^2. NAFO Division 4T has been divided into 35 depth-related strata. The stratum that is closest to the *Calanus II* survey (stratum 435) was sampled at six locations on September 18. Depths sampled in stratum 435 ranged between 26 and 37 m.

Results

Fourteen fish species were recorded during the survey (Table 1). Most of these were species associated with warm waters (e.g. butterfish, cunner, longhorn sculpin) or tolerant of a wide range of temperatures. The three flatfish species, winter flounder, yellowtail and windowpane, appeared in all sets. White hake was the next most frequently encountered species, appearing at 21 of the 24 sampled stations (34 of the 47 sets). Atlantic cod appeared in only 3 sets.

The effect of replicating the survey trawls was first tested by paired t-tests on the catch rates of the first and second sets, then by graphic display of the data and regression analysis. The analyses were performed on the three flatfish species and white hake. In each of the four comparisons, there was no significant difference between catch rates of the first and second set by paired t-tests ($P>0.05$). Figure 2 shows the plotted catches. The regressions were strongly significant in all cases ($P<0.0001$ for winter flounder, yellowtail and white hake; $P=0.001$ for windowpane; *df*: 1, 22). Although the regression line for winter flounder appears above the 1:1 reference line and, for yellowtail flounder, crosses over the reference line, neither regression was significantly different from the predicted slope of one and intercept of zero ($P>0.05$ for all comparisons). The regression for white hake was strongly influenced by a single observation and in the case of windowpane, accounted for only 39% of the total variation in catches on the first set. For both of these species, the slope was significantly different from unity (windowpane: slope 0.58, $t = 2.60$, $P = 0.017$; white hake: slope 0.52, $t = 17.45$, $P< 0.001$). It remains to be determined with additional sampling whether at higher densities these species tend to disperse from the immediate site following the first tow.

Mapping of the catches of the four main species (flatfishes and white hake) was based on the average catch at each station, expressed as the number of fish caught per 100 m^2, grouped at five levels of abundance. The first three levels of abundance (0.1-0.5, 0.5-1.0, 1-2 fish /100 m^2) corresponded to the first three quartiles of abundance of winter flounder and yellowtail. Figures 3 and 4 illustrate the distribution of catches for the four main species in the *Calanus II* survey, in

comparison with comparable units of catch in stratum 435 of the 1996 groundfish survey. Catches of the flatfish species were similarly distributed, with highest concentration in the eastern sector of the *Calanus II* survey at stations with depths of 18-21 m. Catches of white hake were abundant at two locations in the western part of the survey, at depths of 12 and 15 m.

The *Calanus II* survey resulted in catch levels of winter flounder and yellowtail that were considerably higher than catches registered in stratum 435 by the groundfish survey. Windowpane and white hake were not captured in stratum 435 during 1996. Hake have appeared in stratum 435 catches in four years since 1986, at catches of less than 5 hake per standard tow. Windowpane have only been caught in one set in stratum 435 since 1971. This occurred in 1993 when 45 windowpane were caught at a depth of 27 m.

The average length frequencies of winter flounder caught in the *Calanus II* survey were dominated by a single mode at 12 cm (Figure 5). In contrast, yellowtail lengths indicated modal sizes of 8, 14 and 23-26 cm. Comparable data from catches in stratum 435 were unimodal (modal sizes: 32 cm for winter flounder, 28 cm for yellowtail; Figure 6). Length frequencies of white hake in the Calanus II survey were dominated by a single group of 15-20 cm and windowpane sizes peaked at 20-24 cm (Figure 5).

Discussion

The *Calanus II* survey extends groundfish sampling significantly shoreward to the Magdalen Islands. Few sampling programs have been conducted in the southern Gulf that extended the annual 4T groundfish survey to the littoral zone and none have been conducted near the Magdalen Islands. The juvenile cod survey, which sampled the Miramichi region with a stratified random design from 1990 to 1995, did not extend sampling further inshore than the stratum boundaries established for the annual 4T groundfish survey.

The *Calanus II* survey provides an alternate view of groundfish community structure from that of the annual 4T survey (Table 2). The annual surveys of stratum 435 have catches that are typically dominated by cod and yellowtail. More fish species are found in stratum 435 samples, including almost yearly catches of American plaice and dogfish, along with several cottid and eelpout species (Table 2 shows catch composition in 1996). Longhorn sculpin, thorny skate, winter skate and sea raven were common to both surveys, but the inshore sampling of the *Calanus II* survey yielded species that were absent or rare in stratum 435, such as white hake, windowpane, cunner and butterfish.

Groundfish catches in the *Calanus II* survey were dominated by yellowtail flounder, winter flounder and windowpane, appearing in all sampled sets. Catch rates of these species were greater than those in stratum 435 of the 4T groundfish survey for all years. The frequent appearance of white hake nearshore (in 34 of the 47 sampled sets) and catch rates reaching 11 hake/100 m^2 indicate that the coastal areas of the Magdalen Islands provide nursery habitat for hake.

It is not possible to account for the importance of gear selectivity in determining the species and size composition of catches in the two surveys. Although the trawls used in both surveys had similar small codend mesh size, there were some important differences in the trawls and their deployment. The Nephrops trawl has smaller footgear that may limit the escapement of small groundfish more effectively than the larger rollers used on the Western IIA. The Nephrops trawl was towed at a slower speed and used a greater warp ratio (up to 6:1 on the *Calanus II*; typically, 3:1 on *Needler* surveys). The Western IIA has a larger net opening and was towed over a greater distance than the Nephrops. Stratum 435 covers a larger area, and possibly more diverse habitats, than the area covered by the *Calanus II* survey.

In spite of possible differences in selectivity and sampling efficiency, many of the patterns observed in the two surveys are consistent with the known distribution of these species. For

example, the depth distribution of winter flounder may be related to size and maturity stage, with small, immature winter flounder in the shallowest waters and medium sized, maturing fish in deeper offshore areas (McCracken 1963). In Passamaquoddy Bay, New Brunswick, a similar pattern was noted for juvenile white hake up to 15 cm, which occupied sandy and muddy beaches during summer (Macdonald et al. 1984). The preponderance of small winter flounder and white hake in the shallow waters of the Magdalen Islands is consistent with these reported patterns. Seasonal sampling with a small flounder trawl at 10 fixed stations in St. George's Bay in southeastern Gulf of St. Lawrence yielded highest catches during summer at the warmest, most shallow locations, at depths of approximately 15 m (Kenchington 1980). Modal size for yellowtail in that study was at 30 cm and few yellowtail were found at less than 20 cm. Data from the two surveys of the Magdalen Islands indicate similar modes at 26-28 cm, but with length modes of 8 and 14 cm appearing in the *Calanus II* survey. This pattern could be consistent with a shoreward distribution of juvenile yellowtail, although this could not be confirmed with published descriptions of the yellowtail distribution.

In conclusion, the *Calanus II* survey provides an opportunity to examine the local abundance and biological characteristics of several fish stocks with coastal distributions. For species such as winter flounder and yellowtail, and for comparable size ranges, the survey may provide a test of abundance indices based on nearby strata sampled in the annual 4T groundfish survey. The survey can provide intensive sampling on biological and population parameters for species with isolated stock units or early life stages near the Magdalen Islands. The *Calanus II* survey, with its emphasis on detailed mapping of substrates used by lobster, can also provide an opportunity to examine the habitat preferences and interactions of groundfish species.

Acknowledgments

I thank Louise Gendron, Tom Hurlbut, Doug Swain and Linda Currie for comments on this manuscript. Isabelle Forest-Gallant assisted with logistics on the *Calanus II* survey and John Lubar kindly accepted to sample the catches at sea.

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Table 1. Catch by species in *Calanus II* survey (upper panel) and the 1996 4T groundfish survey (stratum 435, lower panel). Set information includes coordinates at the start of the tow, mean depth, and distance towed (dtow). Catches are in absolute numbers (#) and weights. Stations numbered >200 of the *Calanus II* survey are replicate sets.

					White hake		Yellowtail		Winter flounder		Window-pane		Cod		Herring	
Set	Latitude	Longitude	Depth (m)	Dtow (NM)	#	kg	#	kg	#	kg	#	kg	#	kg	#	kg
3	4731.43	6133.76	11	0.41	37	1.84	27	1.18	115	3.56	25	2.90	0	0.00	0	0.00
4	4731.31	6125.61	21	0.39	1	0.02	273	17.80	125	8.72	12	0.92	0	0.00	0	0.00
7	4731.11	6134.16	12	0.41	71	4.04	46	2.16	84	2.14	32	3.10	0	0.00	43	0.56
8	4730.89	6134.91	12	0.41	20	1.38	81	4.78	195	6.18	23	2.56	0	0.00	7	0.36
9	4729.80	6138.34	12	0.40	2	0.14	15	1.12	32	2.34	18	2.00	0	0.00	0	0.00
11	4730.70	6134.54	12	0.43	247	13.10	59	5.04	62	2.22	10	1.30	0	0.00	0	0.00
12	4730.30	6138.70	12	0.41	1	0.01	5	0.42	8	0.20	16	1.76	0	0.00	0	0.00
13	4730.44	6138.26	11	0.40	8	0.18	18	0.88	24	1.44	20	2.36	0	0.00	0	0.00
14	4729.59	6125.49	20	0.40	0	0.00	293	20.00	105	6.30	20	2.08	0	0.00	0	0.00
15	4729.79	6129.50	15	0.40	3	0.14	109	7.74	58	4.64	16	2.02	0	0.00	0	0.00
16	4729.94	6131.90	14	0.40	2	0.12	53	3.82	59	5.26	24	2.98	0	0.00	0	0.00
17	4729.69	6133.94	13	0.41	1	0.02	58	6.58	87	4.28	13	1.32	0	0.00	0	0.00
18	4729.79	6136.92	12	0.40	9	0.16	35	2.66	27	2.44	12	1.16	0	0.00	2	0.02
21	4728.44	6129.69	14	0.40	0	0.00	83	7.58	23	2.54	34	4.88	0	0.00	0	0.00
22	4728.24	6133.20	15	0.41	28	1.60	47	5.46	33	0.78	18	2.46	0	0.00	0	0.00
25	4728.69	6137.29	15	0.40	562	23.90	86	7.60	160	6.82	32	3.46	0	0.00	0	0.00
27	4727.61	6128.79	16	0.41	0	0.00	58	5.80	31	5.50	29	4.36	0	0.00	0	0.00
28	4727.23	6133.10	16	0.40	0	0.00	57	5.72	12	1.60	15	2.14	0	0.00	0	0.00
30	4726.98	6137.30	16	0.40	25	0.40	82	3.90	59	6.78	40	5.70	0	0.00	0	0.00
36	4725.29	6138.60	18	0.40	6	0.10	177	8.32	89	4.52	9	1.54	0	0.00	0	0.00
42	4733.20	6124.90	18	0.40	0	0.00	564	54.00	54	5.06	56	4.14	0	0.00	0	0.00
43	4731.96	6125.10	20	0.40	34	2.04	493	35.90	183	12.70	69	3.64	0	0.00	1	0.01
44	4731.16	6123.70	18	0.40	2	0.08	300	21.20	87	17.00	35	5.36	0	0.00	0	0.00
45	4730.13	6123.36	20	0.41	1	0.01	159	10.70	121	19.10	34	3.26	0	0.00	0	0.00
203	4731.40	6133.92	11	0.41	24	1.10	41	2.78	149	4.84	16	2.26	0	0.00	14	0.10
204	4731.30	6125.50	21	0.41	54	3.06	346	22.60	176	9.90	36	1.50	0	0.00	0	0.00
207	4731.17	6133.82	11	0.41	16	0.86	55	2.54	135	3.60	28	3.20	0	0.00	119	1.40
208	4730.91	6135.31	12	0.41	0	0.00	86	4.02	127	4.38	21	2.12	0	0.00	4	0.04
209	4730.19	6138.20	12	0.40	0	0.00	12	1.12	26	1.52	18	2.10	0	0.00	0	0.00
211	4730.74	6134.61	12	0.41	167	8.80	63	4.56	56	2.98	27	3.20	0	0.00	0	0.00
212	4730.74	6138.80	12	0.40	2	0.08	8	0.18	12	0.92	2	0.20	0	0.00	0	0.00
213	4730.96	6138.40	11	0.41	10	0.24	19	1.02	16	0.70	30	3.30	1	0.01	0	0.00
214	4729.62	6125.60	20	0.40	2	0.04	455	31.10	170	6.40	24	2.38	0	0.00	0	0.00
215	4729.35	6129.60	15	0.42	1	0.01	130	14.30	52	5.60	23	2.64	0	0.00	0	0.00
216	4729.92	6131.80	14	0.40	0	0.00	58	5.40	43	3.58	26	3.06	0	0.00	0	0.00
217	4729.66	6133.77	13	0.39	0	0.00	49	5.86	59	3.74	22	2.88	0	0.00	0	0.00
218	4729.37	6137.07	12	0.41	6	0.28	47	3.70	41	6.08	15	1.52	1	0.01	0	0.00
221	4728.45	6129.79	14	0.41	0	0.00	66	6.78	33	6.22	54	8.08	0	0.00	0	0.00
222	4728.31	6133.09	15	0.41	7	0.40	47	6.04	31	1.08	15	1.96	0	0.00	0	0.00
225	4728.73	6137.39	15	0.40	281	12.60	69	5.72	157	5.62	20	2.04	0	0.00	0	0.00
227	4727.65	6128.74	16	0.41	0	0.00	51	4.26	42	6.74	29	4.34	0	0.00	0	0.00
228	4727.24	6133.00	16	0.40	3	0.06	50	5.98	24	3.02	31	4.68	0	0.00	0	0.00
230	4726.98	6137.41	16	0.40	16	0.24	86	4.04	70	4.86	26	3.28	0	0.00	0	0.00
236	4725.33	6138.70	18	0.40	18	0.36	294	12.90	204	8.80	5	0.80	13	0.44	0	0.00
242	4733.11	6125.03	18	0.40	0	0.00	343	39.10	58	6.90	53	4.62	0	0.00	0	0.00
244	4731.10	6123.80	18	0.40	2	0.08	306	20.00	96	15.50	40	4.38	0	0.00	0	0.00
245	4730.15	6123.30	20	0.41	0	0.00	160	10.60	129	15.90	26	2.74	0	0.00	0	0.00
164	4746.60	6109.60	26	1.70	0	0.00	174	23.30	7	2.26	0	0.00	8	4.47	0	0.00
165	4740.42	6110.72	28	1.75	0	0.00	190	27.60	11	3.17	0	0.00	14	13.10	207	70.90
166	4738.60	6100.77	37	1.75	0	0.00	44	6.01	0	0.00	0	0.00	35	26.70	0	0.00
167	4722.73	6121.53	32	1.78	0	0.00	435	75.90	71	30.90	0	0.00	33	28.90	0	0.00
168	4708.77	6129.07	32	1.81	0	0.00	221	33.00	0	0.00	0	0.00	193	353.00	13	3.48
169	4706.53	6138.53	29	1.74	0	0.00	379	49.20	204	99.10	0	0.00	202	179.00	149	38.90

Table 1, continued.

	Mackerel		Longhorn sculpin		Shorthorn sculpin		Cunner		Thorny skate		Winter skate		Sea raven		Butterfish	
SET	#	kg	#	kg	#	kg	#	kg	#	kg	#	kg	#	kg	#	kg
3	2	0.60	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.24	0	0.00
4	0	0.00	0	0.00	0	0.00	1	0.02	0	0.00	0	0.00	2	1.06	0	0.00
7	1	0.30	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
8	3	0.98	1	0.12	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
9	3	1.02	1	0.01	1	0.50	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
11	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
12	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
13	1	0.34	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
14	1	0.20	1	0.18	0	0.00	1	0.22	1	0.14	0	0.00	2	1.36	0	0.00
15	1	0.34	1	0.26	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
16	0	0.00	1	0.14	0	0.00	0	0.00	1	0.20	0	0.00	0	0.00	0	0.00
17	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
18	1	0.38	0	0.00	0	0.00	0	0.00	0	0.00	1	1.80	0	0.00	1	0.04
21	1	0.40	5	0.78	0	0.00	0	0.00	1	0.66	1	1.74	1	0.56	0	0.00
22	3	0.80	2	0.44	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
25	3	1.08	4	0.58	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
27	1	0.34	2	0.32	0	0.00	0	0.00	8	2.46	0	0.00	1	0.32	0	0.00
28	0	0.00	2	0.32	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
30	0	0.00	9	1.78	0	0.00	0	0.00	0	0.00	1	1.88	2	0.76	0	0.00
36	0	0.00	8	0.86	0	0.00	0	0.00	0	0.00	0	0.00	2	0.50	0	0.00
42	1	0.30	0	0.00	0	0.00	8	0.46	3	2.66	0	0.00	0	0.00	0	0.00
43	0	0.00	1	0.14	0	0.00	0	0.00	0	0.00	3	3.88	3	0.72	43	1.66
44	0	0.00	1	0.10	0	0.00	1	0.64	3	0.64	3	5.70	1	0.50	17	0.64
45	0	0.00	0	0.00	0	0.00	2	0.70	0	0.00	0	0.00	0	0.00	1	0.02
203	3	0.66	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	37	1.48
204	0	0.00	3	0.52	0	0.00	2	0.22	0	0.00	3	4.30	2	1.40	0	0.00
207	3	0.34	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
208	1	0.04	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
209	1	0.36	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
211	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
212	7	2.64	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
213	3	1.06	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.04
214	0	0.00	2	0.12	0	0.00	0	0.00	1	0.16	1	1.18	3	1.70	0	0.00
215	0	0.00	3	0.52	0	0.00	0	0.00	0	0.00	0	0.00	1	0.54	0	0.00
216	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.96	0	0.00
217	5	2.12	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
218	1	0.06	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.12	2	0.08
221	0	0.00	2	0.22	0	0.00	0	0.00	1	0.20	3	3.60	0	0.00	0	0.00
222	2	0.62	2	0.50	0	0.00	0	0.00	0	0.00	1	1.76	0	0.00	0	0.00
225	0	0.00	0	0.00	0	0.00	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00
227	1	0.18	0	0.00	0	0.00	0	0.00	6	1.92	1	1.46	0	0.00	0	0.00
228	0	0.00	4	1.02	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
230	0	0.00	4	0.50	0	0.00	0	0.00	0	0.00	1	1.86	1	0.26	0	0.00
236	0	0.00	6	0.74	1	0.26	0	0.00	0	0.00	0	0.00	1	0.01	0	0.00
242	0	0.00	0	0.00	0	0.00	1	0.29	1	0.12	0	0.00	0	0.00	0	0.00
244	0	0.00	1	0.28	0	0.00	2	0.38	8	5.22	2	4.48	0	0.00	0	0.00
245	0	0.00	0	0.00	0	0.00	0	0.00	6	3.64	0	0.00	2	1.82	9	0.36
164	0	0.00	5	0.74	0	0.00	0	0.00	1	2.32	1	1.98	1	0.63	0	0.00
165	0	0.00	6	0.92	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
166	0	0.00	1	0.58	0	0.00	0	0.00	4	1.05	0	0.00	1	0.98	0	0.00
167	0	0.00	3	0.30	0	0.00	0	0.00	2	0.45	0	0.00	4	4.29	0	0.00
168	0	0.00	99	15.50	0	0.00	0	0.00	8	3.20	0	0.00	1	0.03	0	0.00
169	0	0.00	190	24.10	0	0.00	0	0.00	0	0.00	8	9.41	1	0.27	0	0.00

Table 2. Percent species composition of fish catches in the *Calanus II* survey and in stratum 435 of the *Alfred Needler* survey, based on numbers caught per standard distance towed.

	Calanus	*Needler*
Yellowtail	45.9	48.2
Winter flounder	28.4	9.8
White hake	12.6	
Windowpane	9.1	
Herring	1.4	12.4
Butterfish	0.8	
Longhorn sculpin	0.5	10.1
Mackerel	0.4	
Thorny skate	0.3	0.5
Sea raven	0.2	0.3
Winter skate	0.2	0.3
Cunner	0.1	
Cod	0.1	16.1
Shorthorn sculpin	0.0	
Haddock		0.0
Halibut		0.1
Plaice		1.1
Greenland cod		0.0
Dogfish		0.9

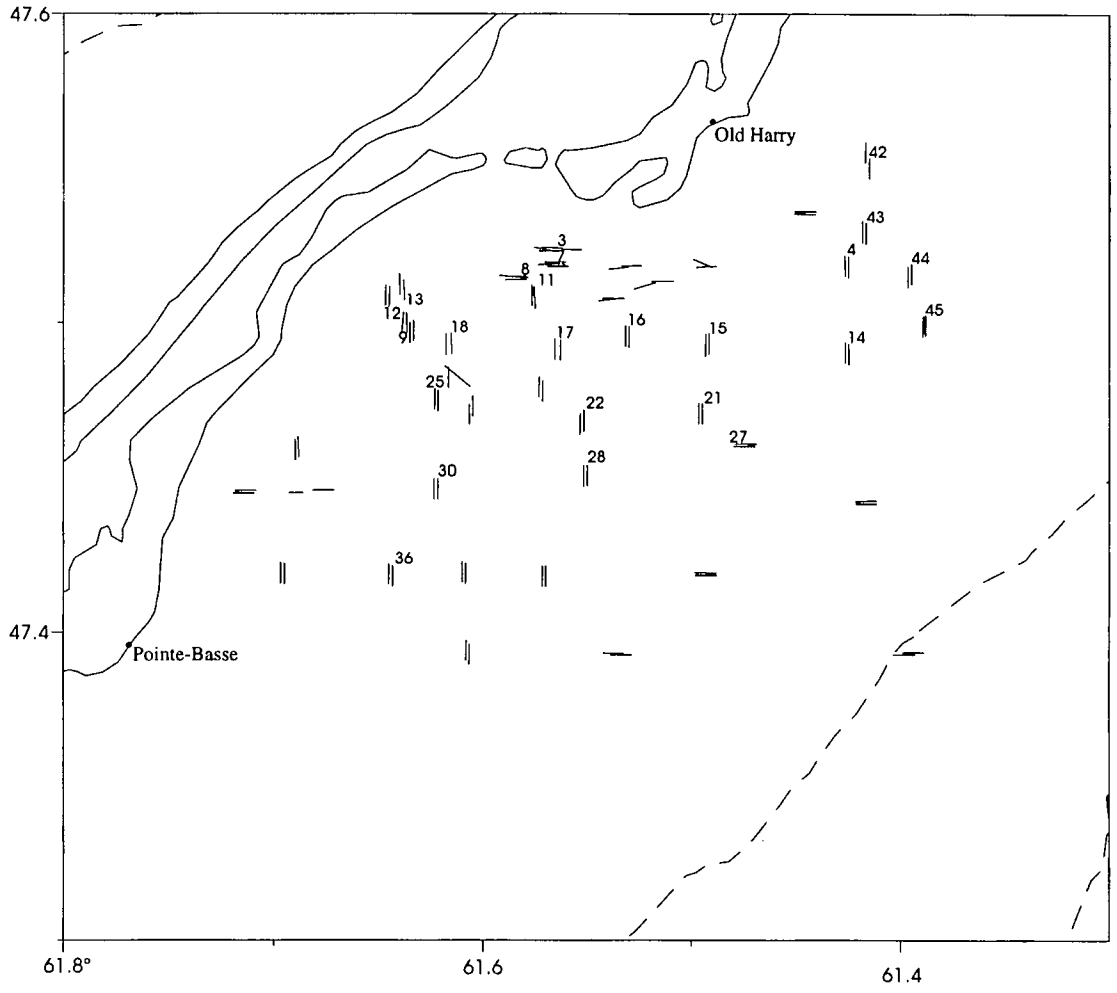

Figure 1. Set tracks of the 1996 *Calanus II* survey off the Magdalen Islands. Labelled sets were sampled for fish catches. Dashed lines indicate nearest stratum boundaries of the annual 4T groundfish survey.

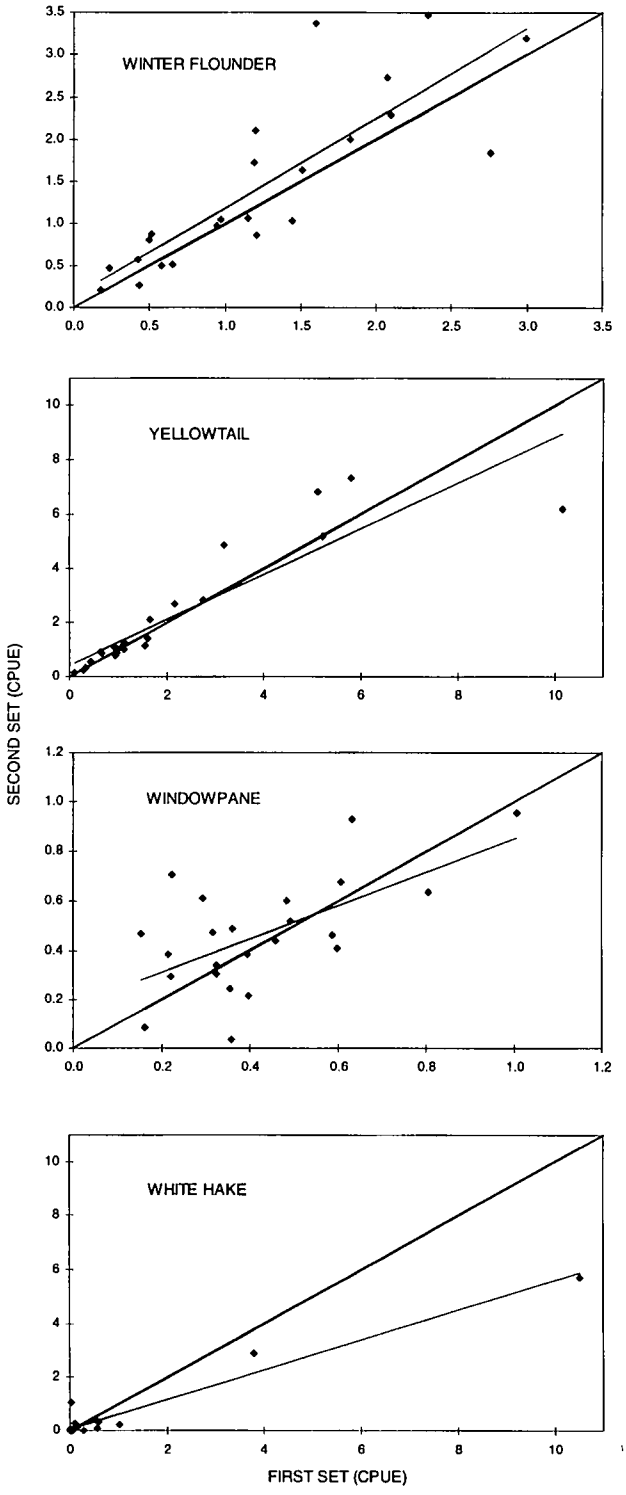

Figure 2. Comparison of replicated sets in the 1996 *Calanus II* survey. Catch per unit effort (CPUE) is numbers of fish caught per 100 m^2. Regression line (thin line) is compared with 1:1 relation (heavy line, diagonal).

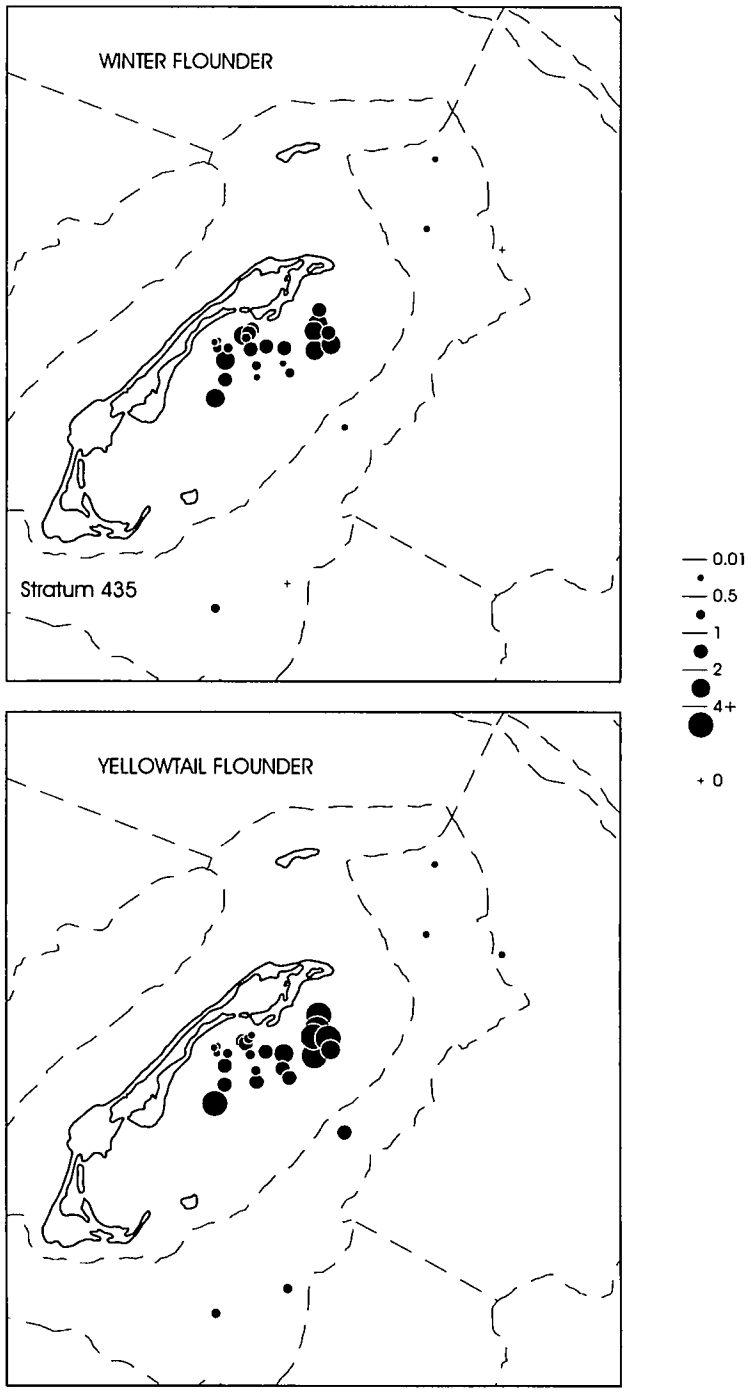

Figure 3. Mean catch abundance of winter flounder and yellowtail (number of fish per 100 m^2) at sampled stations of the *Calanus II* survey. Data points within the zone indicated by the dashed lines represent catches in stratum 435 of the 1996 4T groundfish survey.

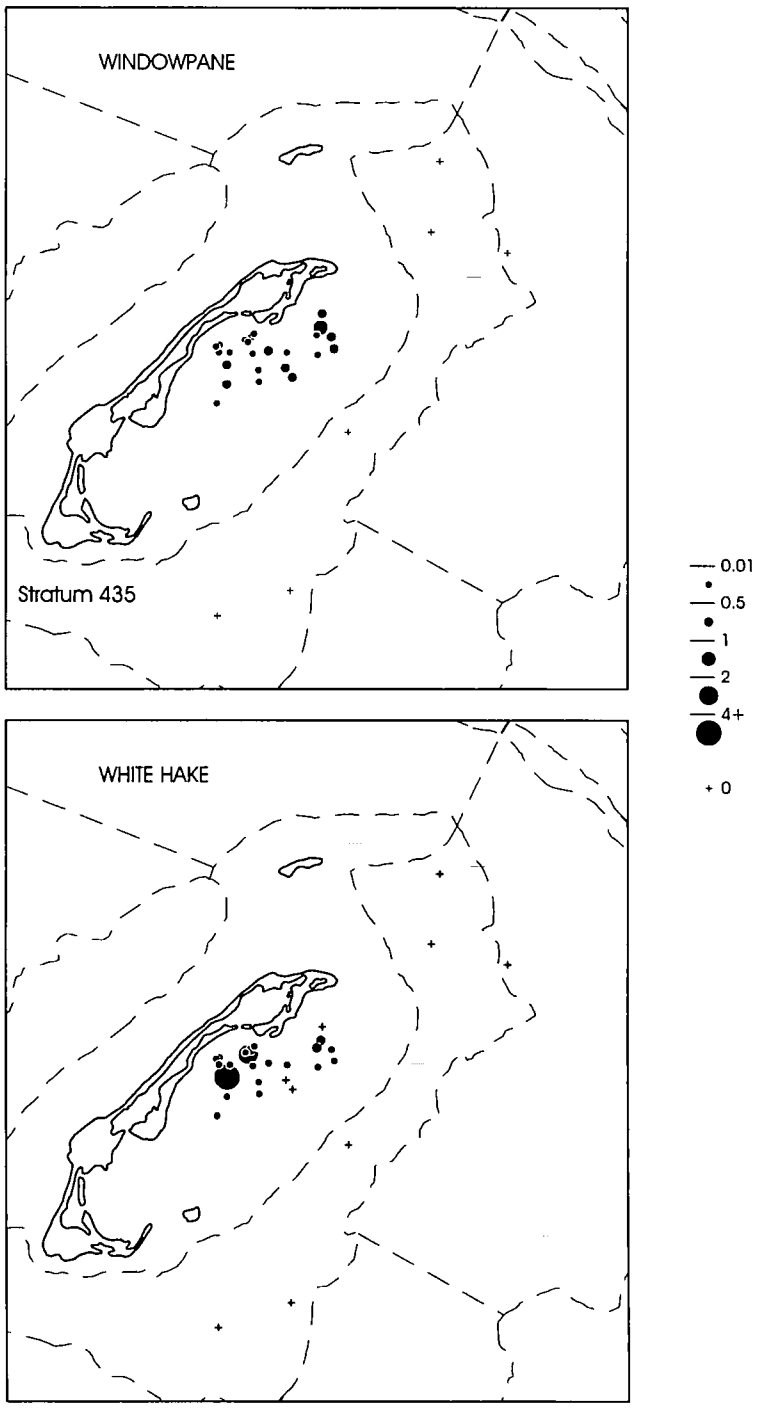

Figure 4. Mean catch abundance of windowpane and white hake (number of fish per 100 m^2) at sampled stations of the *Calanus II* survey. Data points within the zone indicated by the dashed lines represent catches in stratum 435 of the 1996 4T groundfish survey.

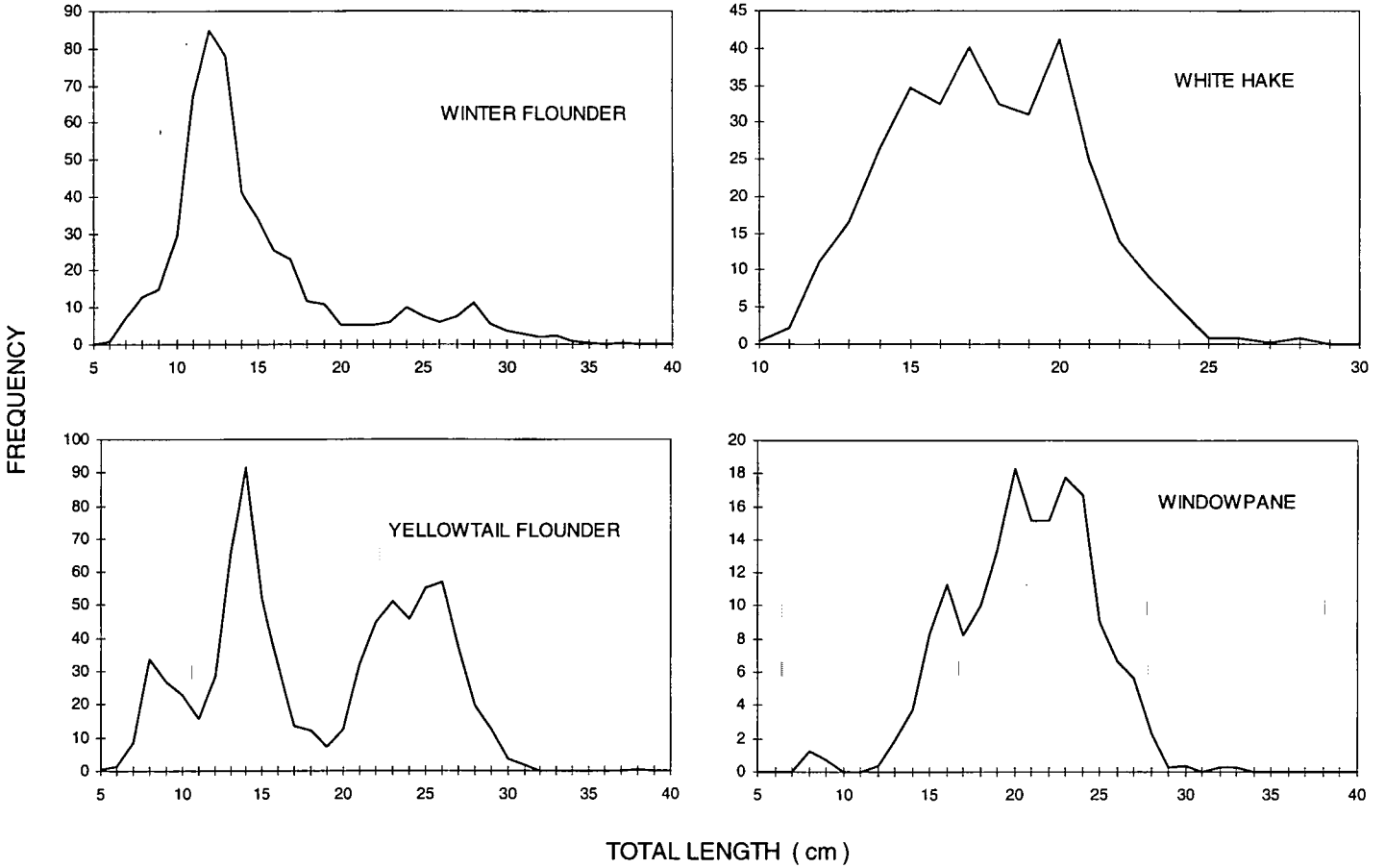

Figure 5. Length frequencies of main species captured in the *Calanus II* survey. Frequencies are expressed as the number of fish per standard groundfish survey trawl (trawl area of 0.041 km^2).

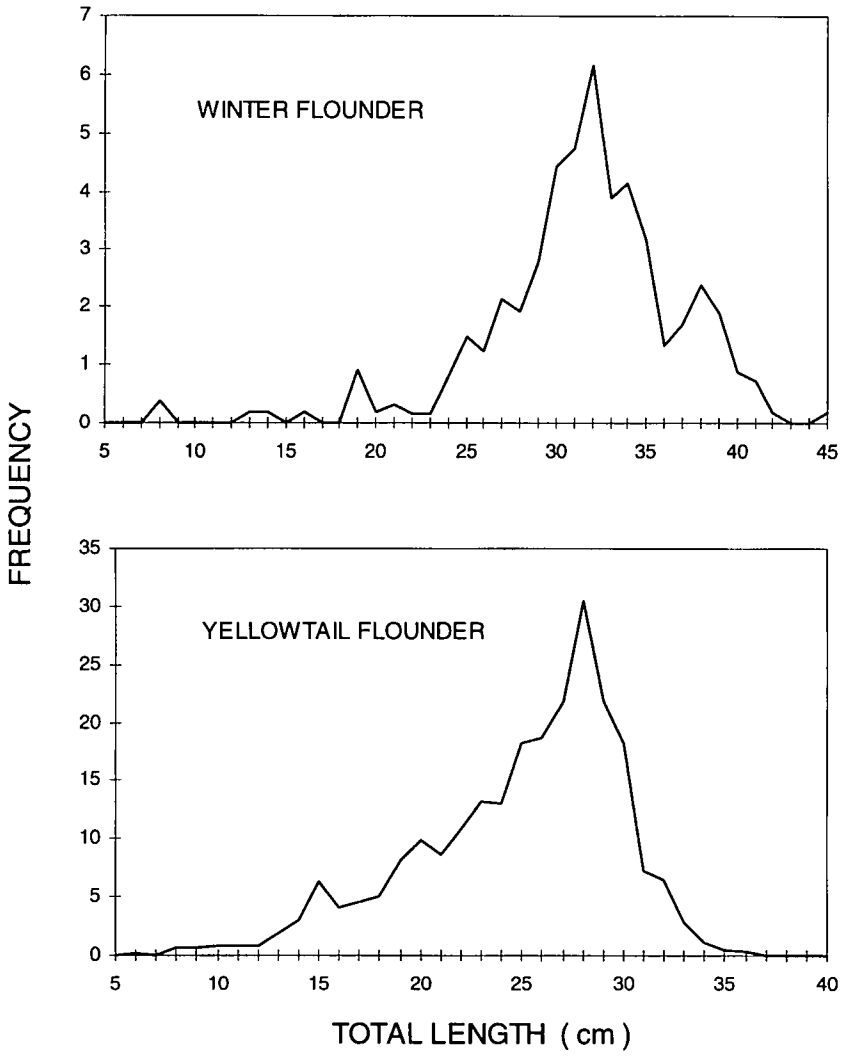

Figure 6. Length frequencies of main species in stratum 435 of the 1996 4T groundfish survey. Frequencies are expressed as the number of fish per standard groundfish survey trawl (trawl area of 0.041 km^2).