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Groundfish by-catch within the inshore vessel (<500 ton; <100') shrimp fishery off the east coast of Newfoundland and Labrador during 2000

by

D.C. Orr, D.W. Kulka, P.J. Veitch and J. Firth

Science Branch, Northwest Atlantic Fisheries Centre
St. John's, Newfoundland A1C 5X1

Abstract

This paper quantifies the by-catch of Atlantic cod (*Gadus morhua*), American plaice (*Hippoglossoides platessoides*), redfish (*Sebastes* spp.) and Greenland halibut (*Reinhardtius hippoglossoides*) within the 2GHJ3KL inshore vessel (<500 ton; <100') northern shrimp (*Pandalus borealis*) fishery which occurred during April – November, 2000. Northern shrimp catches were overlain upon contours of Atlantic cod (TL <= 19 cm), American plaice (TL <=16 cm), redfish (TL <=18 cm) and Greenland halibut (TL <= 24 cm) abundances. The plots indicated that northern shrimp are distributed along shelf edges, but are mainly in channels and at depths between 200 and 500m. However, Atlantic cod were mainly along the southeastern coast of Labrador, inshore along the Newfoundland coast and upon the Grand Banks. American plaice were common in low abundances throughout the northern shrimp distribution. These factors resulted in relatively small amounts of cod and plaice by-catch. Conversely redfish and Greenland halibut were abundant wherever shrimp were present. Redfish and Greenland halibut length frequencies were available, therefore, it was possible to estimate percent loss at age, and loss of yield estimates for these species.

Introduction

The commercial shrimp fishery (*Pandalus borealis* and *P. Montagui*) began off Labrador in Hopedale (56°N), Cartwright (54.5°N) and Hawke (53°N) Channels (Figure 1) during the mid 1970's. Since then it has expanded both northward to the continental slope off northern Labrador and southward to deep areas along the northern edge of the Grand Banks. Cumulative catches within NAFO 2GHJ3KL increased from approximately 17,000 tons during 1988 to 22,500 during 1993 – 1994 and finally 99,000 tons in 2000. Until 1997 the fishery was prosecuted by 12 large (=>500 ton) offshore vessels. However, the Total Allowable Catch (TAC) within Hawke Channel + 3K increased by 500% over the period 1996 – 2000 (11,050 tons – 60,908 tons) leading to the development of an "inshore" component of the shrimp fishing fleet (<500 tons; <100'). Since 1997, over 350 inshore licences have been issued. This component fishes from the spring until early fall (Table 1, Figures 2 and 3). The inshore shrimp fleet covers vast areas using modified small mesh otter trawl, resulting in incidental by-catches of economically important groundfish species such as Atlantic cod (*Gadus morhua*), American plaice (*Hippoglossoides platessoides*), redfish (*Sebastes* spp.) and Greenland halibut (*Reinhardtius hippoglossoides*). Wherever possible it is important to reduce by-catches since they are of no commercial value to the shrimp industry and require effort in separating them from directed species. In some cases, by-catch may be a significant source of the fishing mortality. Additionally, some stocks are currently under moratoria and, therefore, it is important to minimize incidental mortalities of these species. In an attempt to resolve this problem, licences stipulate that nets must be fitted 71.12 cm toggle chains and Nordmore Grates (maximum opening <22 mm). These devices reduce by-catch, however, where high concentrations of very small fish (generally <20 cm) are mixed with the shrimp, some by-catch passes through the grate and enters the codend. This paper makes use of Canadian multi-species survey, log book and observer program data to quantify the by-catch of Atlantic cod, American plaice, redfish and Greenland halibut within inshore vessel catches. Percent

removal and theoretical loss of yield due to the 2000 shrimp fishery were determined for redfish and Greenland halibut.

Methods and Materials

A target of 10% observer coverage (practical coverage) has been established to monitor regulation compliance and conduct biological sampling of the inshore shrimp fishery.
Observer deployments:

This was the first year in which an allocation plan had been developed for scientific purposes. Assuming that the 2000 fishery would be similar to that in 1999, a table of percent landings by port and month was created for the year 1999 (Table 1). There were approximately 3000 trips during 1999, therefore, each cell within Table 1 was multiplied by 3 to give the number of deployments by month, and port. If more than one shrimp fishing vessel was in port then a random numbers table was used in conjunction with the last two digits of the vessels' CFV numbers to select a vessel.

Wherever possible, sexed length frequencies (1 cm precision) were taken from randomly selected samples of commercial groundfish species. There were so few Atlantic cod and American Plaice within the by-catch that only total by-catch weights were available from the observer datasets. Therefore, any length/ age based analyses described below pertain to redfish and Greenland halibut only. Using a ratio of weight of fish measured to by-catch weight, the length frequencies were corrected on a set-by-set basis. Length frequencies were added together on a species by species basis. Similarly, total by-catch weights from which frequencies were derived were added together by species. Each frequency was then divided by the total by-catch weight to produce an average frequency per kg for each 1cm length bin. These average length frequencies were then merged with the catch records. The frequencies were multiplied by the by-catch weights in an effort to produce length frequency data on a set-by-set basis. The length frequencies were aggregrated to obtain total removals by length and species. Species specific population adjusted age length keys were applied to these data when estimating removals by age. The population adjusted age length keys were produced as part of stratified analyses (Cochran 1977) from Canadian fall multi-species research survey data. Redfish have not been aged since 1995, therefore, the redfish population adjusted age length key assumed 1995 growth patterns were maintained. The Greenland halibut population adjusted age length key made use of 1999 data obtained from fish caught during autumn 1999 in 2GHJ3KLMNO. The 1999 research survey population-at-age estimates were used as the benchmark from which the 2000 by-catch was taken. Therefore, the 1999 research adjusted age length key was applied to the 2000 observer data. The total removals at age, and total by-catch weights were determined by multiplying observed values by a ratio of quota report landings/ observed landings.

Canadian multi-species research data

The autumn multi-species research surveys were conducted onboard the Canadian research vessels **Wilfred Templeman** and **Teleost**. Fishing sets of 15 minute duration and a towing speed of 3 knots were randomly allocated within strata to a depth of 1500m. Both vessels used a Campelen 1800 trawl with a codend mesh size of 40 mm and a 12.7mm liner. SCANMAR sensors estimated that the mean wingspread was 16.8m. Details of the survey and fishing protocols are provided by Brodie (1996). The 1999 survey extended from 2G – 3L, but did not extend into inshore strata within 3KL.

Yield per recruit - redfish: Redfish yield per recruit estimate assumed a reference natural mortality of 0.1, a lifespan of 19+ years, as well as, the average commercial weight at age and partial recruitment values for 3M beaked redfish as found in Ávila de Melo *et al.* (1999) (Table 2). The yield per recruit model was created using an EXCEL spreadsheet routine produced by Mr. D. B. Atkinson (NWAFC, unpublished macro). The total number of by-caught fish was multiplied by the yield per recruit estimate with $F_{0.1}$ to obtain the theoretical loss of yield.

Yield per recruit - Greenland halibut: The yield per recruit estimate assumed a reference natural mortality of 0.2, a lifespan of 17+ years and the average commercial weight at age and partial recruitment values found in Mahe and Darby (2000) for the ages 1-14 and Bowering and Brodie (1987) for ages 15-17 (Table 3). Brodie *et al.* (1998) verified that the commercial weights per age from the mid 1980's were similar to present commercial weights at age. Brodie *et al.* (1998) made use of the 1987 partial recruitment values and weights at age for a Greenland halibut yield per recruit

analysis. The yield of 17+ fish was considered to be negligible. The above spreadsheet routine was used in estimating the theoretical loss of Greenland halibut yield.

Qualitative analyses: Juvenile groundfish distributions were inferred from abundance contour plots created using the autumn 1999 multi-species survey data. Northern shrimp distributions were then plotted upon these groundfish distributions to obtain a visual presentation of overlap between species. The term juvenile refers to the median length of a species (L_c50) passing through a 22 mm Nordmore Grate. Where possible, median lengths were obtained from cumulative percent frequencies (CPF) using observer length frequency data (Figures 4 and 5). These values are dependent upon year class strength and therefore vary greatly between years and areas. For this reason, the (L_c50) values were compared with the literature. The highest species specific L_c50 values were used as conservative estimates of sizes that were susceptible to the fishing gear. Respective L_c50 values for Atlantic cod, American plaice, redfish and Greenland halibut were 19 cm (Hickey *et al*. 1993), 16 cm (Hickey *et al*. 1993), 18 cm (Kulka and Power, 1996) and 24 cm (Nicolajsen, 1997). All distribution maps were produced using the ACON data visualization software (Black, 2000).

Results and Discussion

The 2000 inshore shrimp fishery mainly occurred during April – September. Between April and July, the fishery occurred along the edge of 2J3KL, as well as, in Hawke Channel, St. Anthony Basin, and Funk Island Deep. Between August and November the fishery extended from northern 2G to southeastern 3K (Figures 2 and 3). Figures 2 and 3 present fishing positions from log book and observer data respectively. Both exhibit similar fishing patterns throughout space and time. Likewise, Table 2 indicates similarities in percent landings by port and month for both types of data. Thus observer coverage was not biased toward any port, fishing area or season. Discussions with Observers indicated, however, that there was a tendency to select larger vessels because they did not feel safe going 200 Nmi offshore on certain small vessels.

The comparisons below provide are used to estimate the relative observer coverage.

Observer data	**Log book data**
8,022.1 hours fished	95,568.06 hours fished
3,523.217 tons of shrimp landed	38,898.104 tons of shrimp landed

Approximately 8.4% of the fishing hours and 9.1% of the landed shrimp were observed. The average, 8.7% was used in estimating the total weight and, where possible, the total number of fish removed by the inshore shrimp fishery.

Species	Weight Observed (kg)	Estimated removals (kg)	Removals kg/ton
Atlantic cod	104	1,195	0.031
American plaice	486	5,586	0.144
Redfish	2,402	27,609	0.710
Greenland halibut	6,894	79,241	2.037

By-catch weights were recorded to a one kg precision. If a set contained a single 0.1 kg cod, it would be recorded as 1 kg. Thus values in this table may be overestimated.

Low numbers of juvenile Atlantic cod were found present in the study area. Cod were generally found in areas that were shallower and inshore from the main shrimp fishing areas (Figures 2, 3 and 6). Juvenile American plaice were common in low numbers throughout the range of the inshore shrimp fishery (Figures 2, 3 and 8). Consequently, there were relatively low by-catches of either Atlantic cod or American plaice. Both species were taken from Hawke Channel, Funk Island Deep and west of St. Anthony Basin (Figures 7 and 9).

Northern shrimp and juvenile redfish distributions overlapped extensively (Figure 10). Redfish were taken throughout the April – September in Hawke Channel, St. Anthony Basin and Funk Island Deep. Between April and July 2000, redfish were taken near Tobin's point and close to the 200 Nmi limit along the edge of the northeastern edge of the Grand Banks (Figure 11). This is in agreement with Orr *et al*. (2000) who note that most of the 3L inshore fishery occurred near the 200 Nmi limit, at 200 – 500 m depths, during April - July.

Figure 4 indicates that the redfish length frequency had two modes: one at 9 cm and another at 13 cm. Respectively, they probably correspond to two and four year old fish (Figure 12). The median length of redfish was 13 cm. This is much lower than the L_c50 obtained by Kulka and Power (1996) for redfish bycaught in the 3M shrimp fishery and demonstrates that L_c50 values are dependent upon the size of fish present during the shrimp fishery.

An estimated 1.2 million redfish were removed as part the 2000 inshore northern shrimp catches. This equated to a loss of approximately 31 redfish per ton of shrimp. Less than 1.5% of any year class of redfish was removed as by-catch (Figure 13). Theoretically, the inshore fleet activities would have resulted in a 151 ton loss of redfish yield over a 19+ year period if fishing mortality at $F_{0.1}$ was 0.194 and natural mortality was 0.1 (Figure 14).

Juvenile Greenland halibut abundances were proportionate to northern shrimp catches in all locations along the east coast of Newfoundland and Labrador. The largest concentrations of both were in Hopedale, Cartwright and Hawke Channels, St. Anthony Basin and Funk Island Deep (Figure 15). Greenland halibut were taken from almost every shrimp fishing location (Figures 2, 3 and 16). A few sets taken from St. Anthony Basin held over 25 kg of Greenland halibut. Relatively large amounts of by-catch were also taken from Hawke Channel, and from the edge east of Hawke Channel (Figure 16).

The Greenland halibut length frequency (Figure 5) was bimodal with peaks at 13 cm and 23 cm. The median length was 14 cm. As with redfish, this value is much lower than the maximum L_c50 value quoted in the literature.

An estimated 1.7 million Greenland halibut were removed by the inshore shrimp fishing fleet during 2000. Most of the fish were one year old (Figure 17). However, a comparison with the stratified abundances at age from the research survey indicated that less than 1% of any year class of Greenland halibut was removed as by-catch (Figure 18). Theoretically, the inshore fleet activities would have resulted in a 275 ton loss of yield over a 17+ year period if fishing mortality at $F_{0.1}$ was 0.370 and natural mortality was 0.2 (Figure 15). Orr *et al*. (1999) noted similar percent removals and loss of Greenland halibut yield due to shrimp fishing by the offshore fleet.

It is important to note that the 1999 multi-species survey did not include inshore areas within 3KL, therefore, stratified population estimates at age for redfish and Greenland halibut were probably conservative. Percent removals at age did not take into account natural mortality that would have occurred over the fishing season. These factors mean that the percent removals at age and loss of yield were possibly overestimated.

Conclusions

The inshore shrimp fleet observer deployment strategy provided a means of collecting data in proportion to month, port and fishing area. There may have been a slight bias toward larger shrimp fishing vessels, however, we can not ask people to work in unsafe conditions. Approximately 9% of the catches were observed. This is close to the mandated 10% coverage.

There were low levels of Atlantic cod and American plaice by-catch. Low cod by-catch was because juvenile cod abundances were low and generally distributed inshore of most shrimp fishing activity. There was considerable overlap in distribution between juvenile American plaice and northern shrimp, however, relatively low plaice abundances resulted in low by-catch.

Redfish and Greenland halibut were abundant in channels and along shelf edges where much of the inshore shrimp fishing effort was expended. However, percent removals of both species was less than 2% per year class. The respective loss of yield for these species was 151 and 275 tons.

This type of monitoring exercise should be continued on an annual basis to ensure that the shrimp fishing activities are conducted in a precautionary manner.

Acknowledgments

At this time the authors would like to thank the Conservation and Protection field staff officers who co-ordinated the deployments; the observers who collected data in often inclement conditions and staff within SeaWatch who maintained the observer databases and ensured a timely transfer of information. We would also like to thank Mr. D.B. Atkinson (Director of Science, Oceans and Environment Branch, NWAFC) for use of his EXCEL spreadsheet macro which models yield per recruit.

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Table 1 Percent landings by month and port using log book data for the 2000 inshore northern shrimp fishery (vessel <500 ton; <100').

Percent Shrimp landings by month and port

1999	Month									
Landing Port	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Rivere-Au-Renard (Que.)										
Blanc Sablon (Que.)										
St. Anthony		1.80	8.50	15.60	9.60	3.66	2.48	0.98		42.62
Main Brook - Roddickton		0.35	0.20	1.07	1.62	0.17	0.14	0.09		3.63
Wild Cove - Middle Arm		0.41	0.61	1.23	0.88	1.17	0.63			4.92
King's Cove - Triton										
Comfort Cove - Cobb's Arm			0.16	0.86	1.10	0.43	0.09			2.63
Fogo Island - Joe Batt's Arm			0.00	0.70	0.84	0.43	0.28			2.25
Carmanville - Clarenville		0.19	0.44	3.00	3.36	2.20	0.73	0.20		10.12
Eastport - Bonavista				0.70	2.06	1.03	0.39	0.05		4.23
Catalina - Clarenville			0.10	1.19	2.78	2.26	0.84	0.07		7.23
Little Heart's Ease - Old Perlican			0.09	0.65	0.78	0.68	0.12	0.04		2.35
Red Head Cove - Port de Grave		0.20	0.46	2.10	2.45	1.72	1.18	0.19		8.30
Barenead - Portugal Cove				0.10		0.01				0.11
St. John's				0.13	0.51	1.38	0.38	0.04		2.43
Petty Harbour - Cape Broyle		0.04	0.36							0.40
Calvert - St. Shott's										
Mall Bay - St. Bride's			0.09							0.09
Fortune										
Port Saunder's - L'Anse Au Loop		0.15	2.16	3.43	2.37	0.01	0.36	0.17		8.65
Mary's Harbour (Lab.) - Francis Harbour (Lab.)										
Charlottetown (Lab.) - Triangle Harbour (Lab.)										
Cartwright (Lab.)										
Smokey (Lab.)										
Hopedale (Lab.)										
Total		3.14	13.17	30.75	28.34	15.06	7.61	1.83		100.00

Table 2. Redfish yield per recruit parameters. (Ávila de Mdo *et al.* 1999).

Age	Mean stock wt. (kg)	Average Partial Recruitment Vector (95 – 98)
1	0.015	0.000
2	0.037	0.000
3	0.071	0.001
4	0.097	0.004
5	0.137	0.016
6	0.189	0.058
7	0.247	0.190
8	0.318	0.471
9	0.391	0.772
10	0.444	0.928
11	0.491	0.980
12	0.541	0.995
13	0.598	0.999
14	0.635	1.000
15	0.672	1.000
16	0.735	1.000
17	0.759	1.000
18	0.789	1.000
19+	0.944	1.000

Table 3. Greenland halibut yield per recruit parameters. (Mahe and Darby, 2000 for ages 1-14; Bowering and Brodie, 1987 for ages 15-17).

Age	Mean stock wt. (kg)	Average Partial Recruitment Vector
1	0.000	0.000
2	0.000	0.000
3	0.000	0.000
4	0.000	0.201
5	0.358	0.303
6	0.533	0.142
7	0.825	0.191
8	1.253	0.156
9	1.675	0.137
10	2.287	0.226
11	2.888	0.218
12	3.509	0.407
13	4.456	0.483
14	5.789	0.483
15	7.183	0.660
16	8.696	0.510
17+	10.714	0.350

Table 4. Percent landings by month and port from Logbook data sets compared with percent landings according to Observer data. Percent landings is used as a proxy for percent trips. The comparison illustrates that Observer deployments mirror percent landings according to logbook data.

Logbook data set

2000 Month Landing Port	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Rivere-Au-Renard (Que.)										
Blanc Sablon (Que.)										
St. Anthony	1.33	8.53	6.58	9.09	6.18	1.46	0.34	0.15	0.04	33.71
Main Brook - Roddickton	0.12	0.56		0.42	1.20	0.03				2.34
Wild Cove - Middle Arm	0.04	1.03	0.33	1.29	2.06	0.22				4.97
King's Cove - Triton										
Comfort Cove - Cobb's Arm	0.06	0.17	0.29	2.46	1.90	0.25				5.14
Fogo Island - Joe Batt's Arm	0.16	0.27	0.71	1.97	1.66	0.39				5.16
Carmanville - Clarenville	0.90	1.01	0.92	3.31	2.80	0.07				9.02
Eastport - Bonavista	0.09	0.28	0.16	1.27	0.65					2.44
Catalina - Clarenville	0.17	0.28	0.93	4.16	3.38	0.13				9.06
Little Heart's Ease - Old Perlican	0.02	0.05	0.29	0.60	0.99	0.04	0.08			2.07
Red Head Cove - Port de Grave	0.82	0.75	2.51	4.33	1.98					10.38
Barenead - Portugal Cove			0.13	0.77	0.41					1.31
St. John's	0.33	0.40	3.36	2.68	0.99					7.76
Petty Harbour - Cape Broyle			0.31	0.05	0.05					0.41
Calvert - St. Shott's			0.17		0.13					0.30
Mall Bay - St. Bride's										
Fortune										
Port Saunder's - L'Anse Au Loop		1.42	2.26	1.60	0.44		0.11			5.83
Mary's Harbour (Lab.) - Francis Harbour (Lab.)			0.00	0.05	0.03	0.04				0.12
Charlottetown (Lab.) - Triangle Harbour (Lab.)										
Cartwright (Lab.)										
Smokey (Lab.)										
Hopedale (Lab.)										
Total	4.04	14.75	18.95	34.04	24.86	2.62	0.53	0.15	0.04	100.00

Observer data set

2000 Month Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Rivere-Au-Renard (Que.)									
Blanc Sablon (Que.)									
St. Anthony	7.16	10.58	3.96	6.55	4.45				32.70
Main Brook - Roddickton									
Wild Cove - Middle Arm	0.21			1.46	1.24				2.91
King's Cove - Triton									
Comfort Cove - Cobb's Arm	1.06		1.91	4.45	0.44				7.86
Fogo Island - Joe Batt's Arm	1.29	0.97	0.94	2.86	6.58	1.78			14.41
Carmanville - Clarenville	1.15	4.29		2.50	5.83	0.54			14.30
Eastport - Bonavista				0.67	1.65				2.32
Catalina - Clarenville		0.53		3.79	6.56				10.88
Little Heart's Ease - Old Perlican	0.01				0.16				0.18
Red Head Cove - Port de Grave		0.51	0.89	2.81	4.57				8.78
Barenead - Portugal Cove				0.52					0.52
St. John's			1.71	0.76	1.27				3.74
Petty Harbour - Cape Broyle									
Calvert - St. Shott's									
Mall Bay - St. Bride's									
Fortune									
Port Saunder's - L'Anse Au Loop		0.46	0.78		0.19				1.42
Mary's Harbour (Lab.) - Francis Harbour (Lab.)									
Charlottetown (Lab.) - Triangle Harbour (Lab.)									
Cartwright (Lab.)									
Smokey (Lab.)									
Hopedale (Lab.)									
Total	2.45	15.19	14.90	19.78	39.27	8.45			100.02

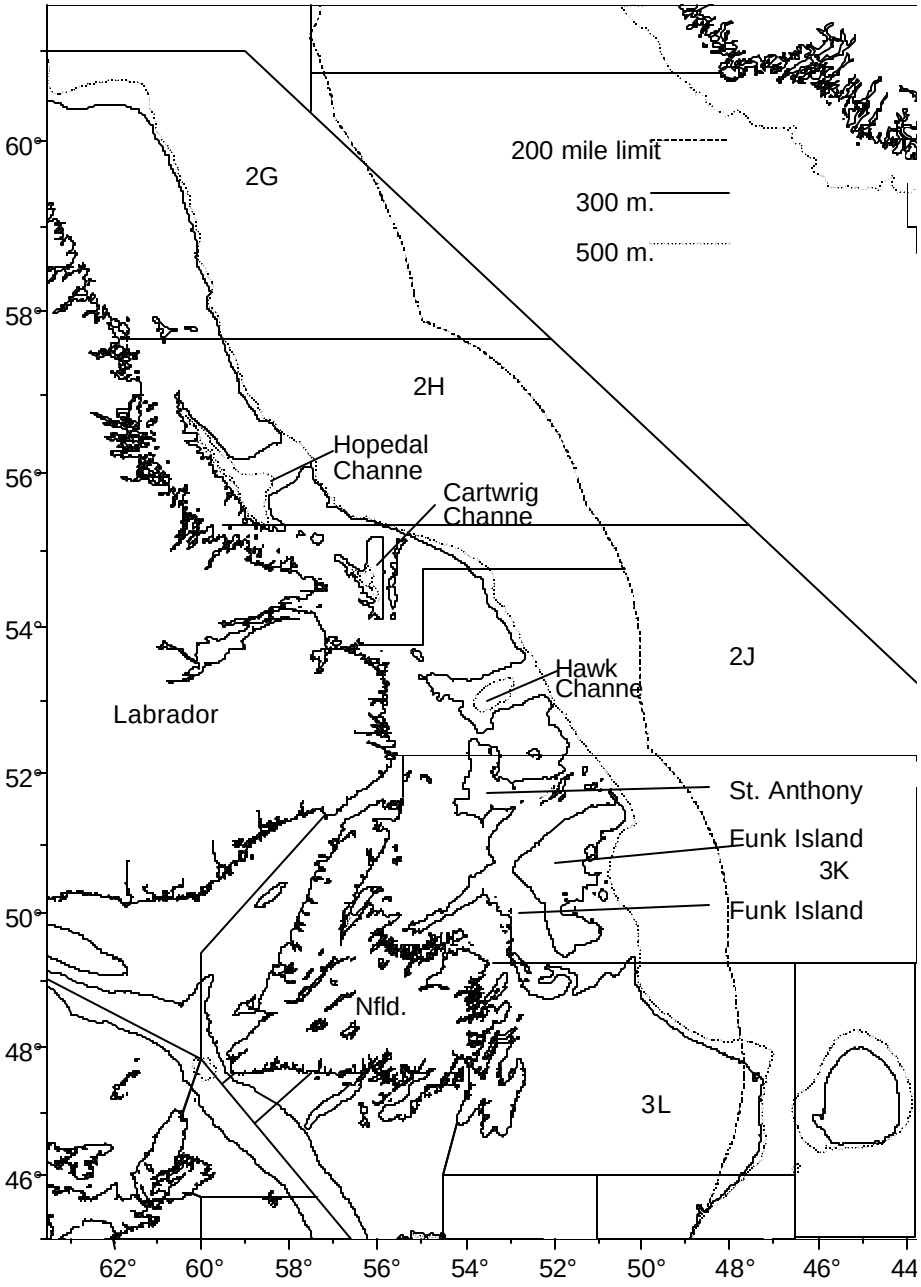


Fig. 1 Positions of channels and basins mentioned within this document.

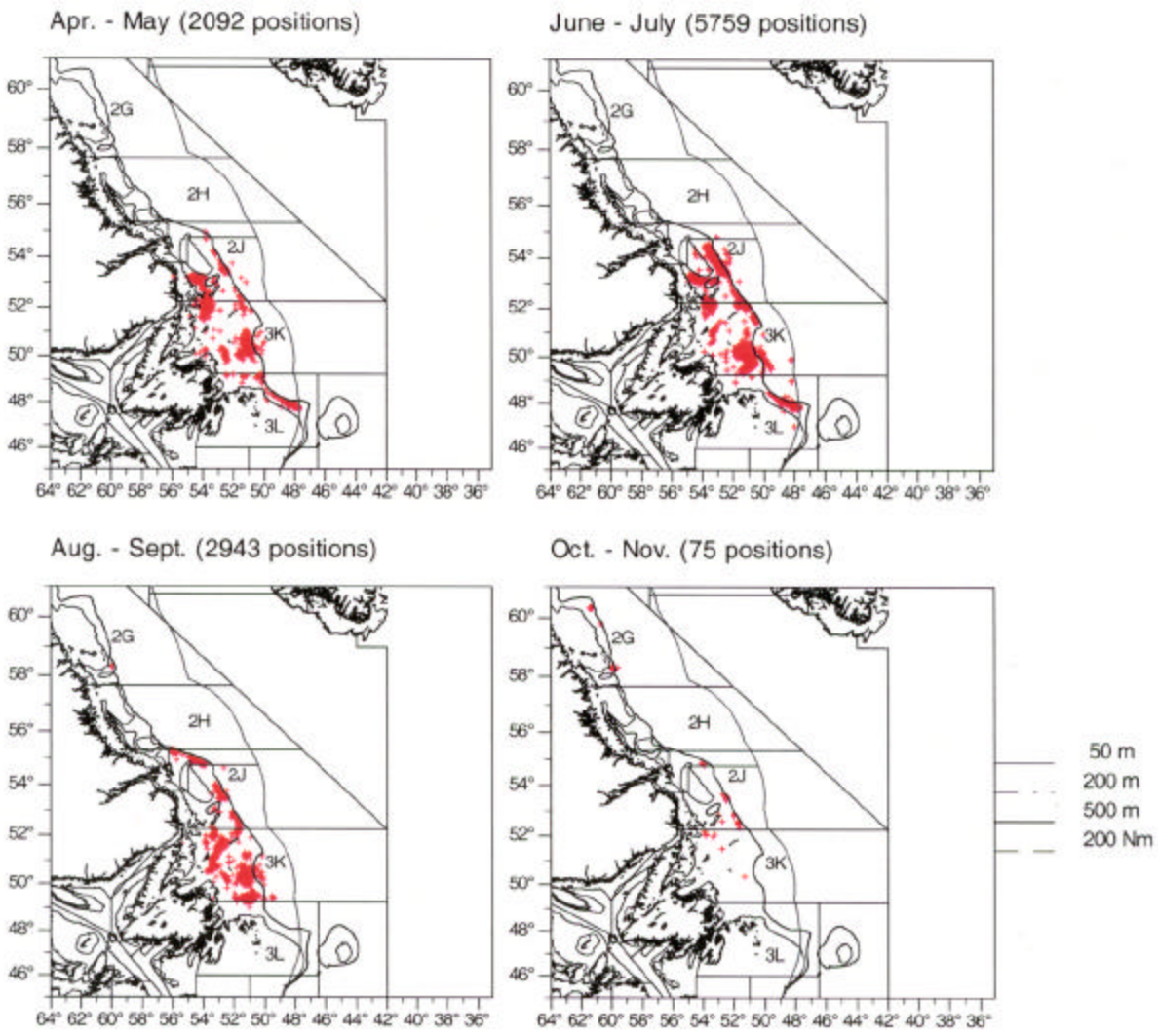


Fig. 2. Small vessel (<500 t; <100') logbook shrimp fishing positions during the 2000 April-November season.

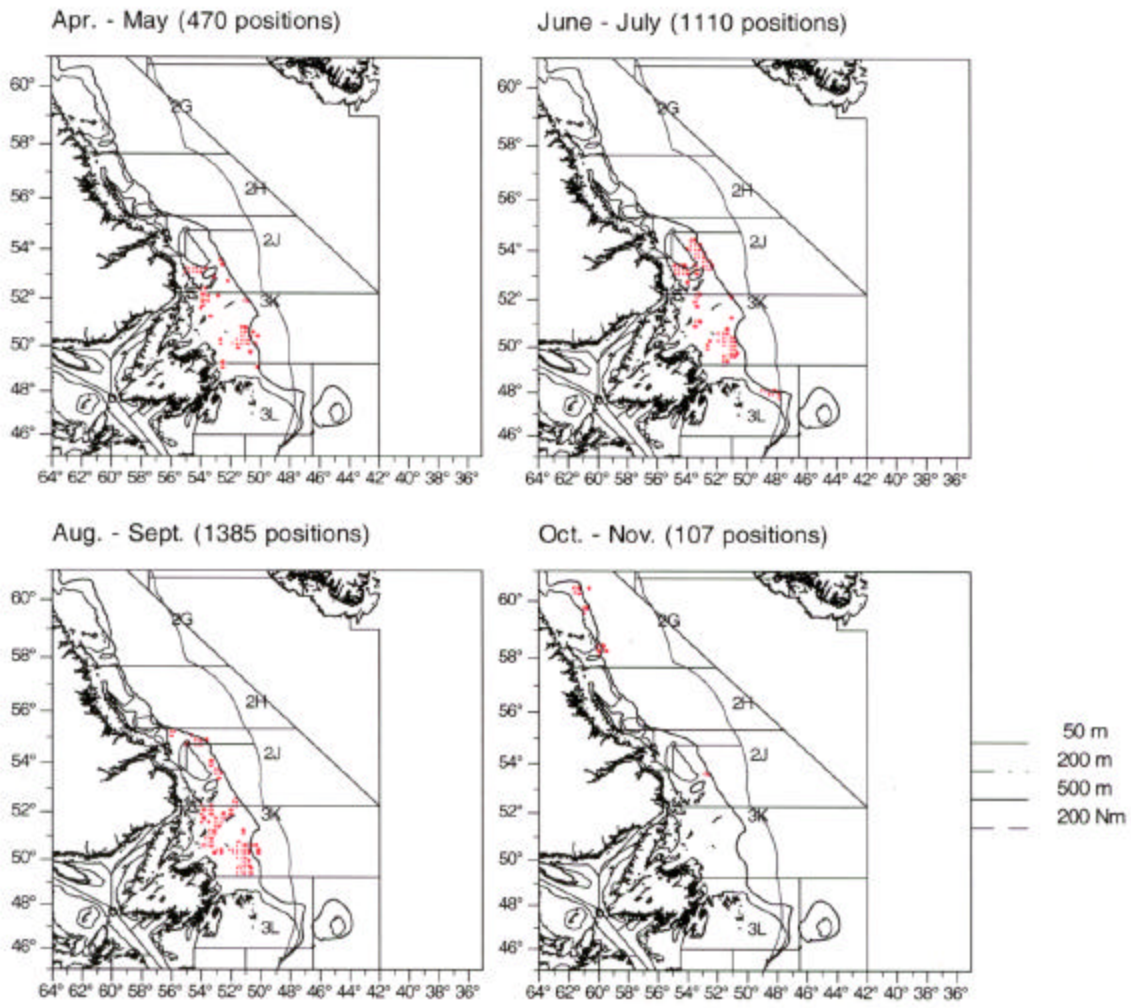


Fig. 3. Small vessel (<500 t; <100') observed shrimp fishing positions during the 2000 April-November season.

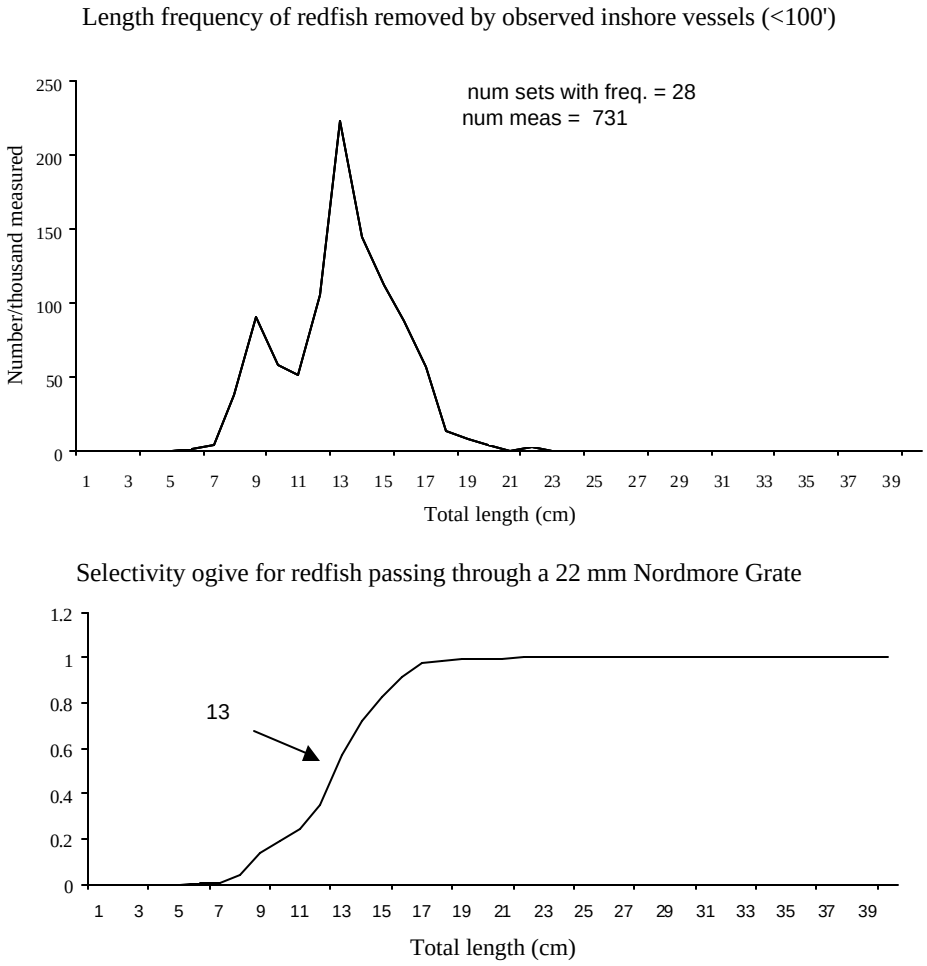
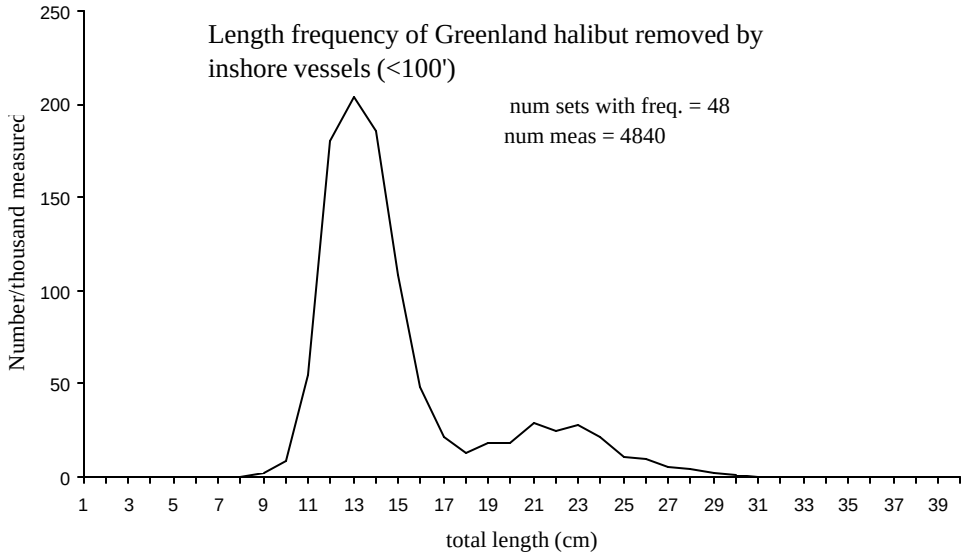


Fig. 4. Estimated number and size of redfish caught by inshore vessels (<100') fishing northern shrimp in 2GHJ3KL during 2000.



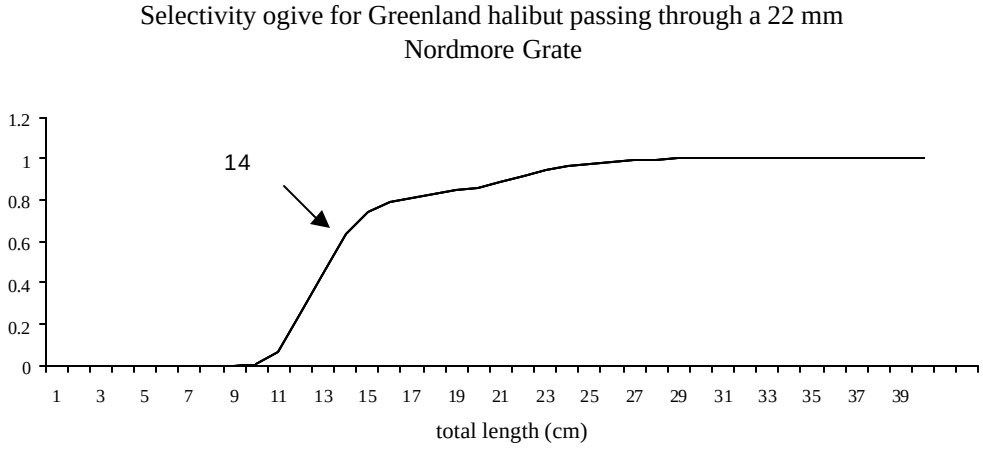


Fig. 5. Estimated number and size of Greenland halibut caught by inshore vessels (<100') fishing northern shrimp in 2GHJ3KL during 2000.

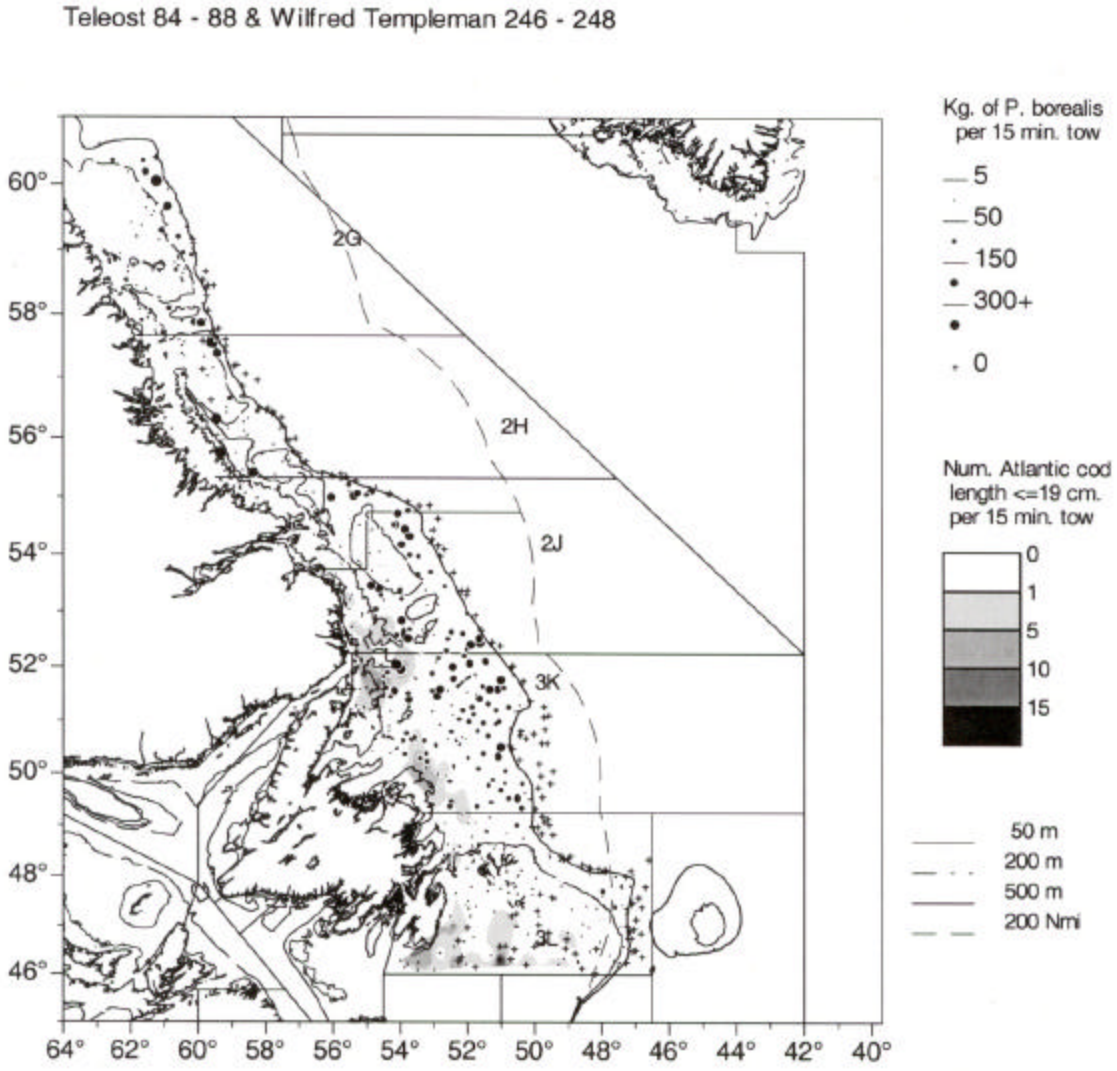


Fig. 6. Distribution of northern shrimp in relation to juvenile Atlantic cod with lengths ≤19 cm, collected during autumn 1999 Canadian multi-species research surveys. (Catches were made with a Campelen 1800 shrimp trawl, tows were standardized to 15 min.)

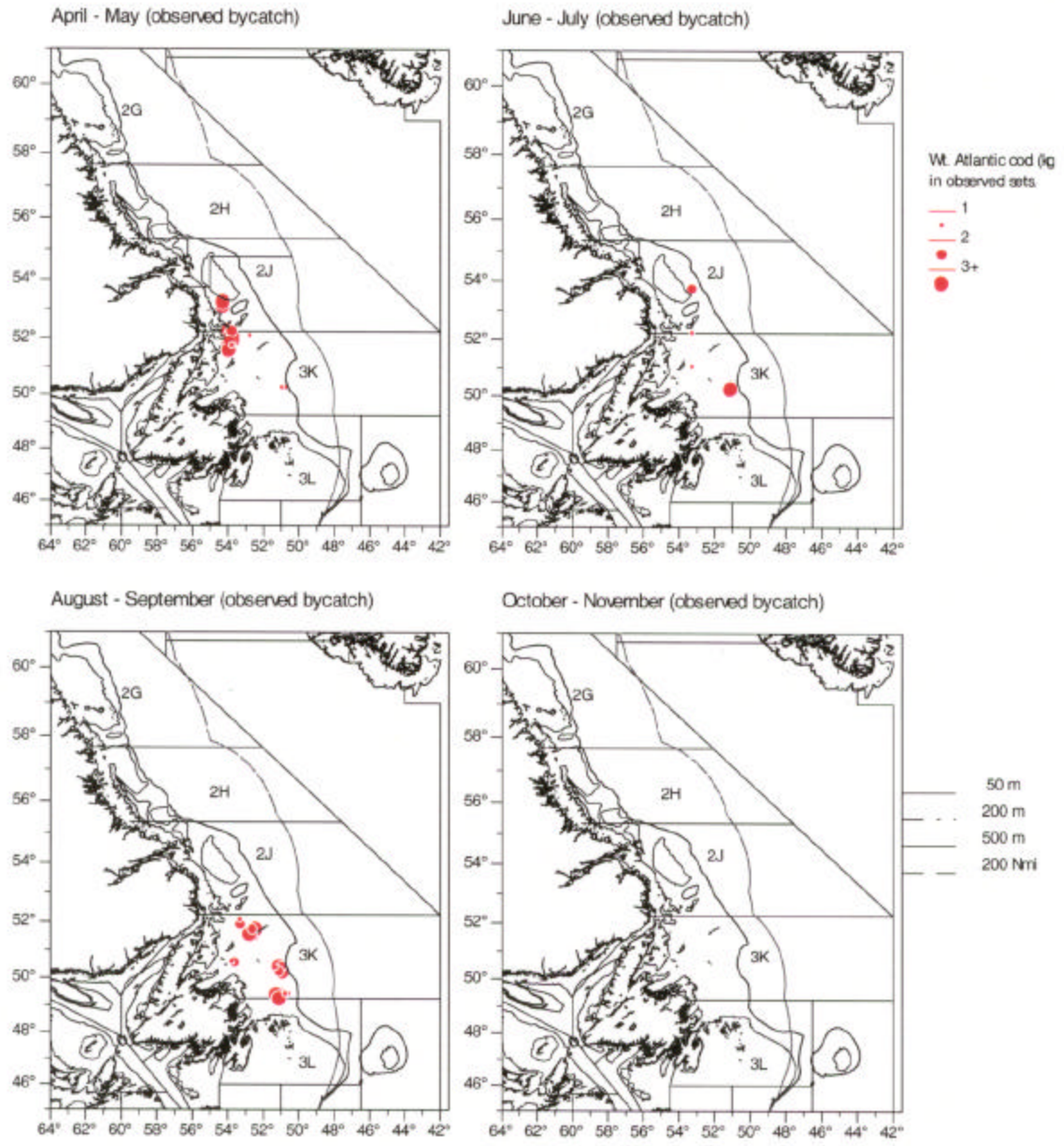


Fig. 7. Observed Atlantic cod by-catch during the April-November 2000 small vessel (<500 t; <100') shrimp fishery.

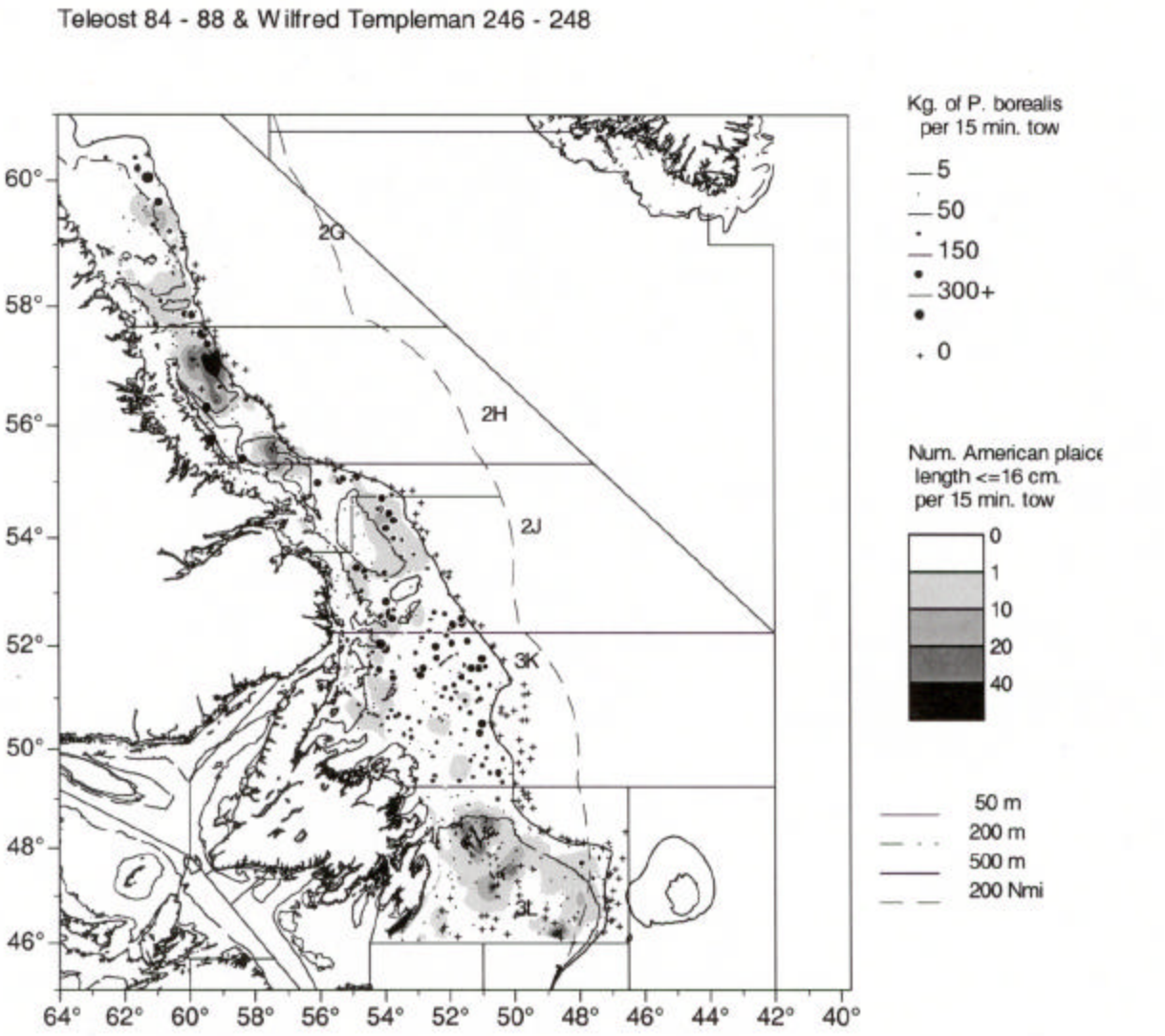


Fig. 8. Distribution of northern shrimp in relation to juvenile American plaice with lengths ≤16 cm, collected during autumn 1999 Canadian multi-species research surveys. (Catches were made with a Campelen 1800 shrimp trawl, tows were standardized to 15 min.)

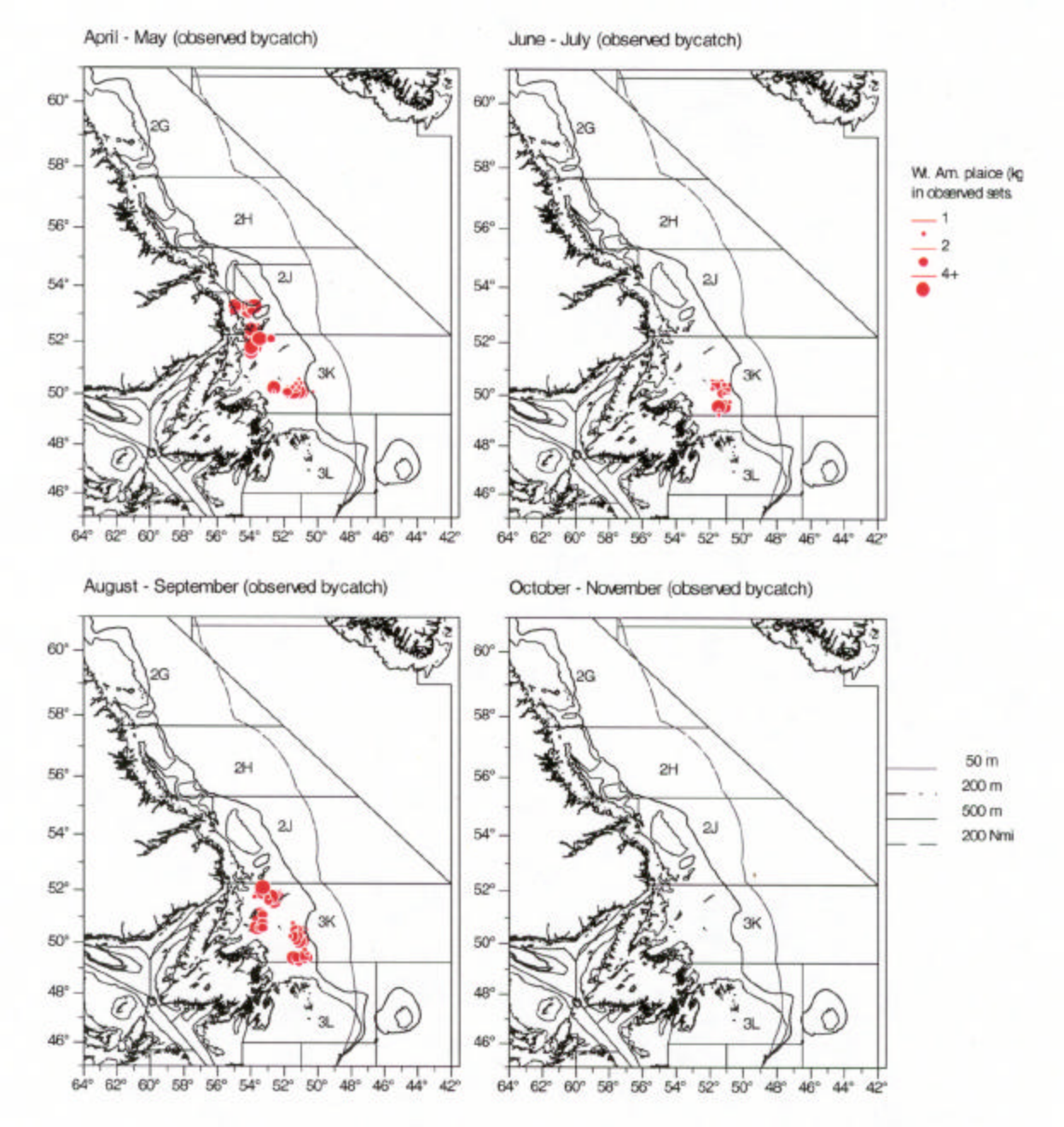


Fig. 9. Observed American plaice by-catch during the April-November 2000 small vessel (<500 t; <100') shrimp fishery.

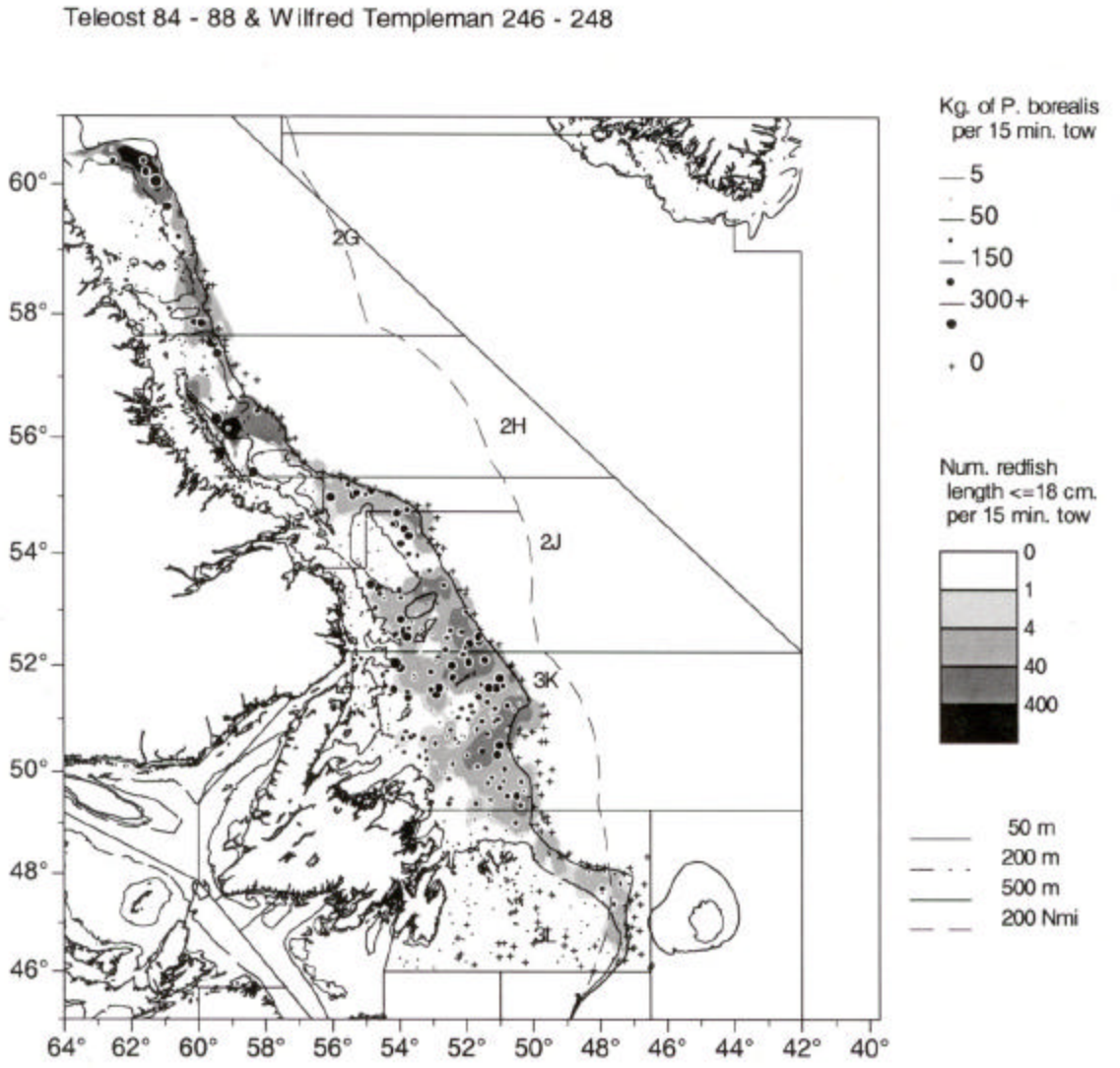


Fig. 10. Distribution of northern shrimp in relation to juvenile redfish with lengths ≤18 cm, collected during autumn 1999 Canadian multi-species research surveys. (Catches were made with a Campelen 1800 shrimp trawl, tows were standardized to 15 min.)

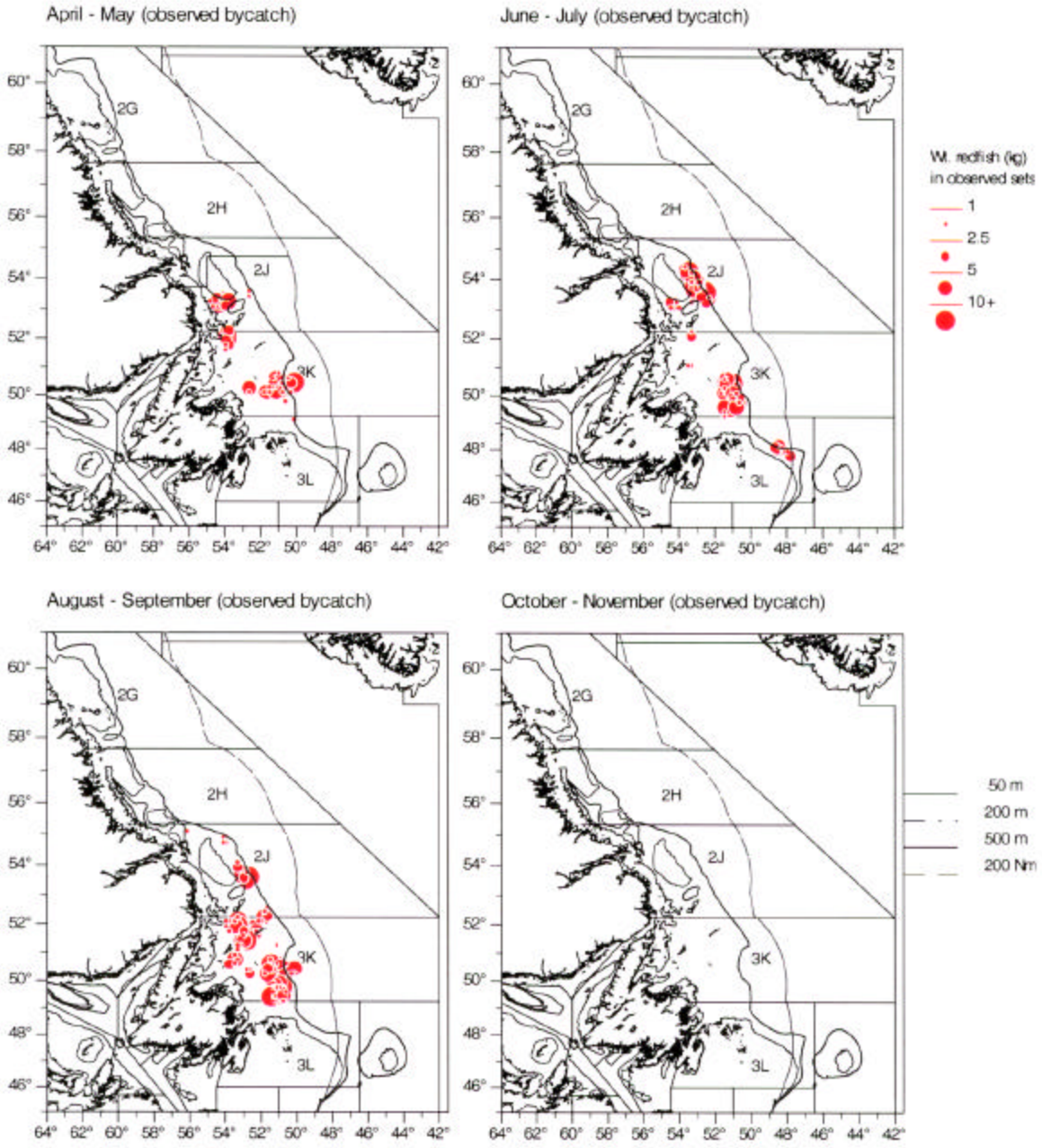


Fig. 11. Observed redfish by-catch during the April-November 2000 small vessel (<500 t; <100') shrimp fishery.

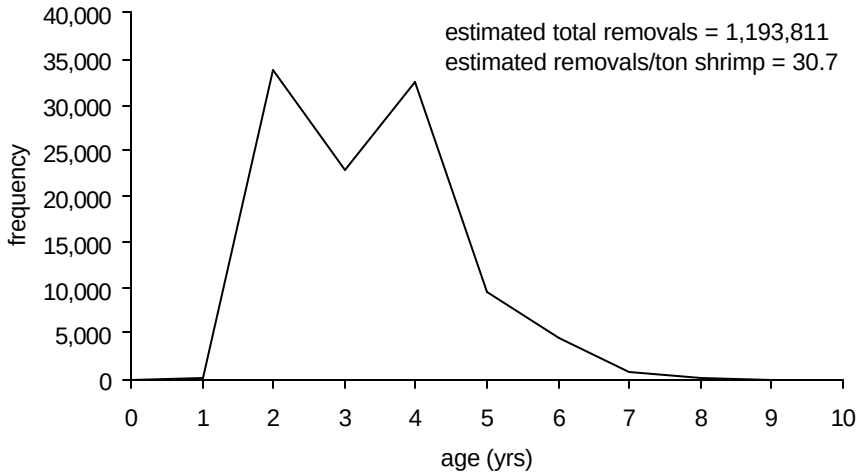


Fig. 12. Estimated number of redfish removed by the inshore (<100') vessels fishing northern shrimp in 2GHJ3KL during 2000.

Fig. 13. Percent redfish at age removed by inshore (<100') vessels fishing northern shrimp in 2GHJ3KL during 2000.

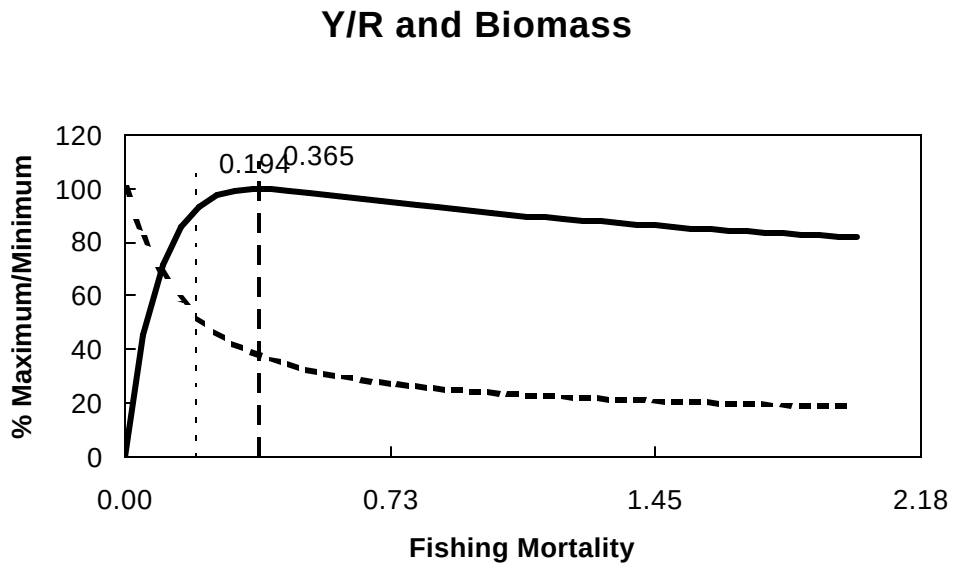


Fig. 14. A plot of redfish yield per recruit output under various fishing mortality scenarios.

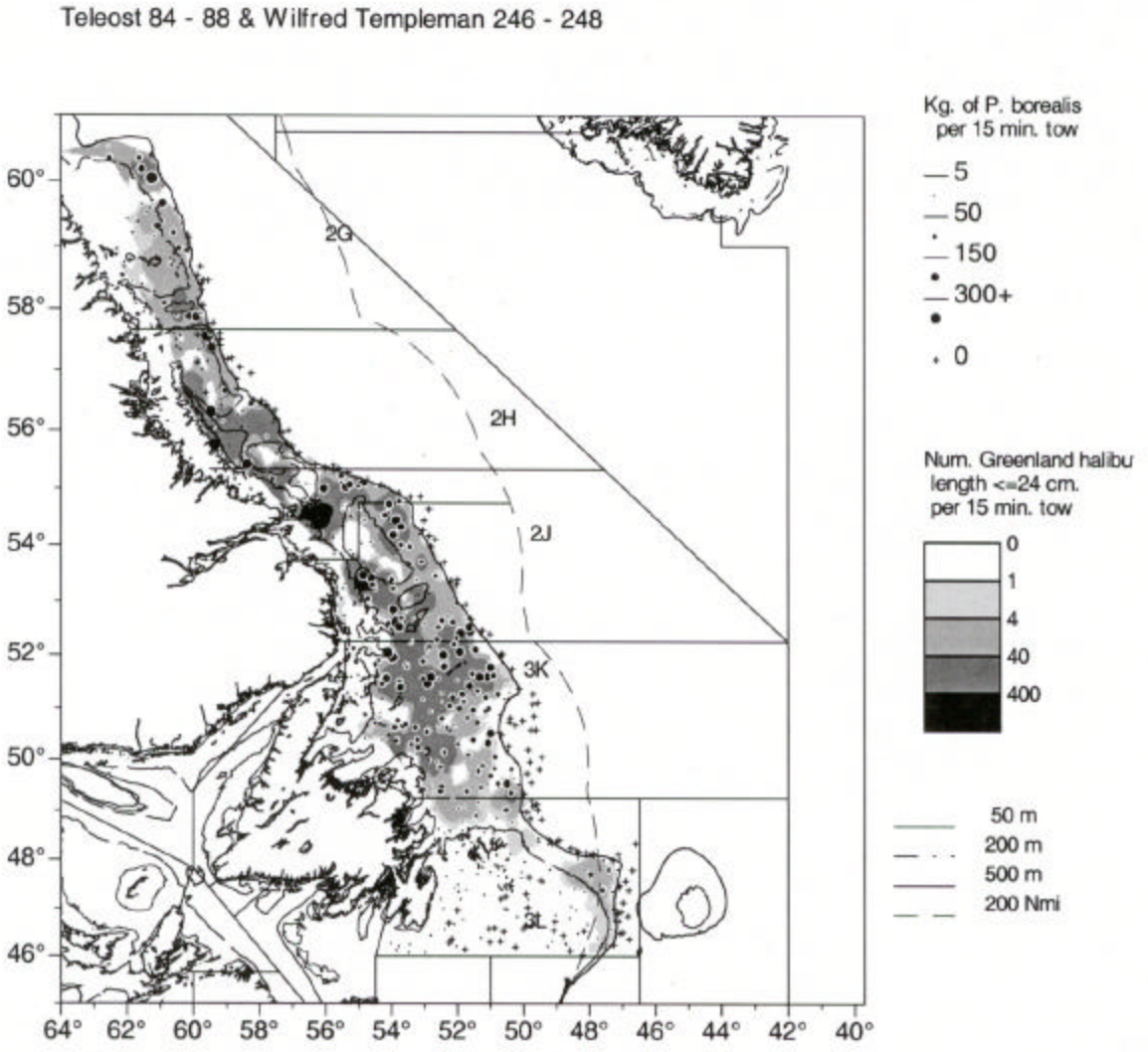


Fig. 15. Distribution of northern shrimp in relation to juvenile Greenland halibut with lengths ≤24 cm, collected during autumn 1999 Canadian multi-species research surveys. (Catches were made with a Campelen 1800 shrimp trawl, tows were standardized to 15 min.)

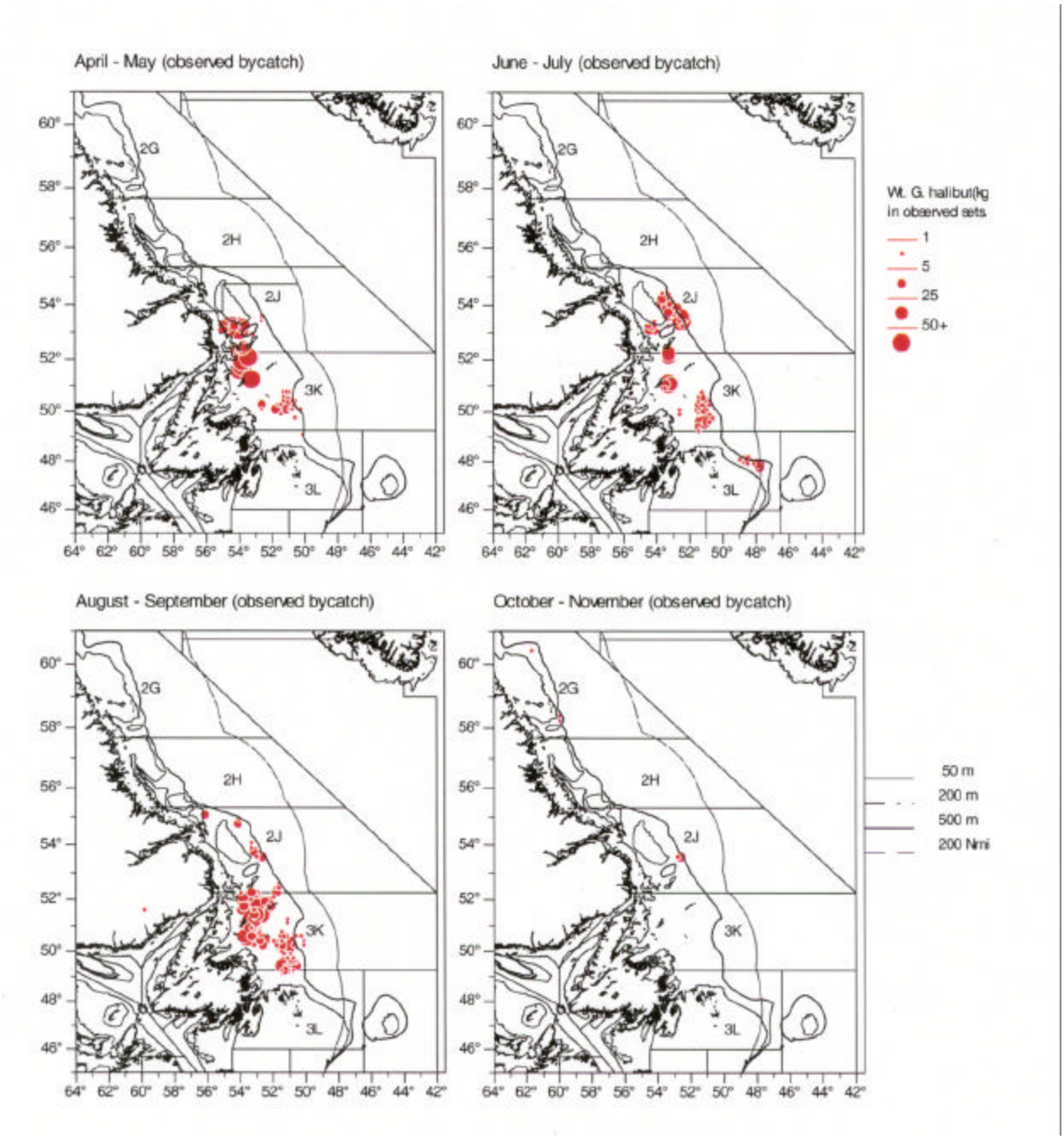


Fig. 16. Observed Greenland halibut by-catch during the April-November 2000 small vessel (<500 t; <100') shrimp fishery.

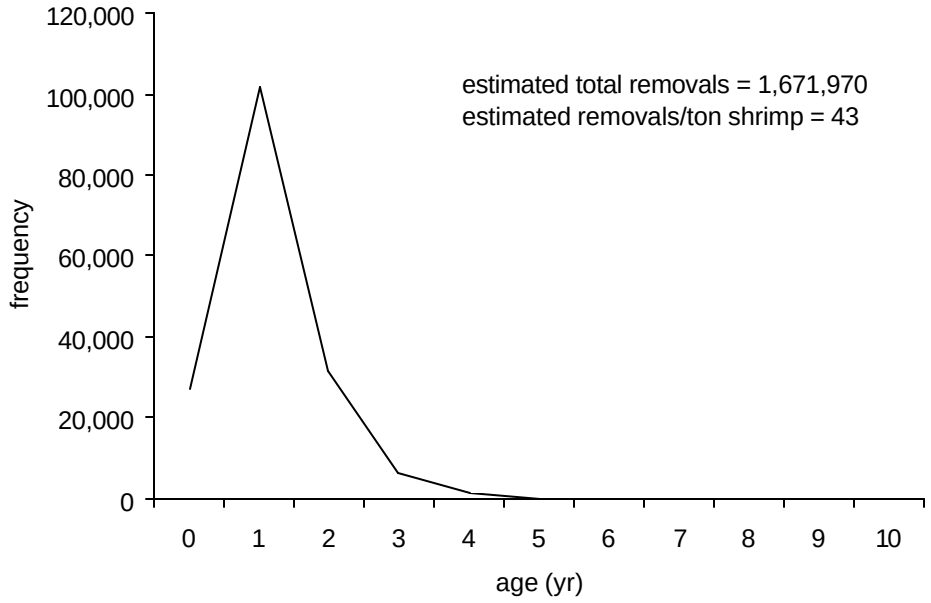


Fig. 17. Estimated number of Greenland halibut removed by the inshore (<100') vessels fishing northern shrimp in 2GHJ3KL during 2000.

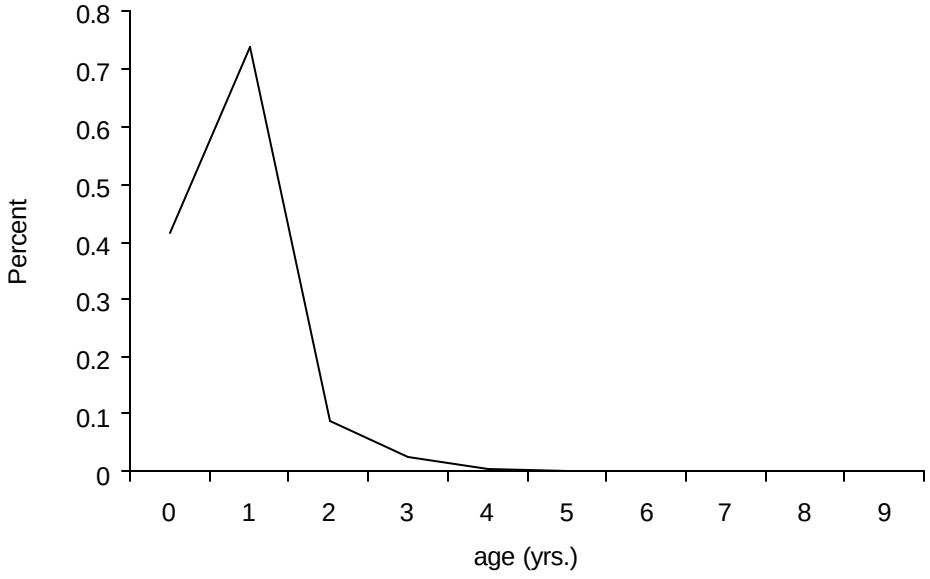


Fig. 18. Percent Greenland halibut at age removed by inshore (<100') vessels fishing northern shrimp in 2GHJ3KL during 2000.

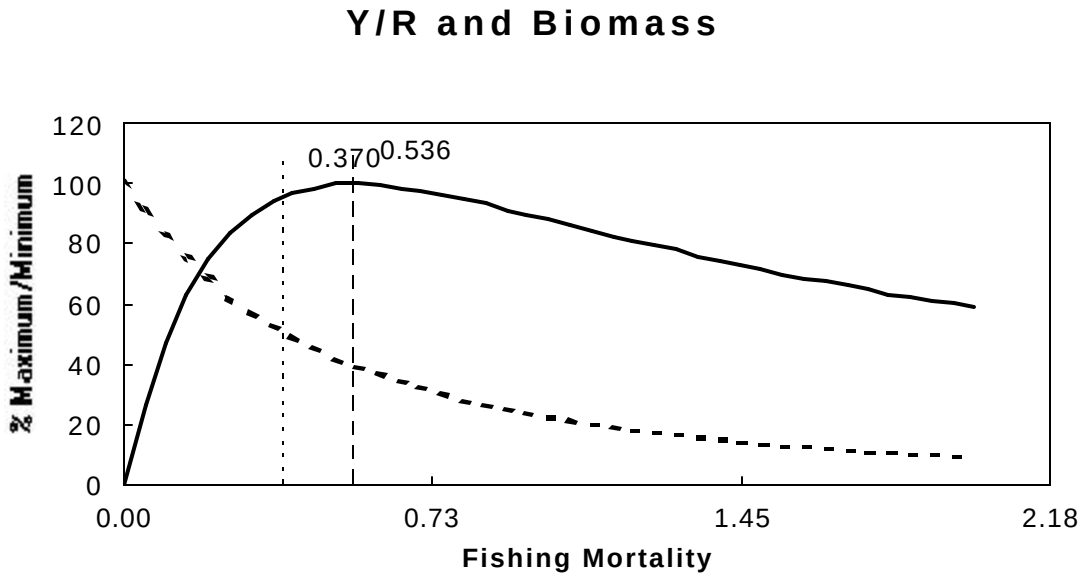


Fig. 19. A plot of Greenland halibut yield per recruit output under various fishing mortality scenarios.