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An Update of Information Pertaining to Northern Shrimp (*Pandalus borealis*, Kroyer) and Groundfish in NAFO Divisions 3LNO

by

D. C. Orr, P. Veitch, and D. Sullivan

Science, Oceans & Envir. Br., Dept. of Fish. & Oceans,
P. O. Box 5667, St. John's, Nfld. A1C 5X1

Abstract

Since 1995, Canadian multi-species stratified random surveys have been used to estimate northern shrimp (*Pandalus borealis*, Kroyer) biomass and abundances in 3LNO. Biomass indices increased from approximately 6,000 t in 1995 to 224,000 t during autumn 2001, and then decreased to 159,000 t in spring 2002. Data from these surveys were used in age, relative year-class strength and year-class progression determinations. Fishery data were used in determining Catch – Per – Unit – Effort (CPUE) and exploitation levels. Additionally, both multi-species survey and observer data sets were used in quantifying the impact of the shrimp fishery upon various groundfish.

Introduction

The northern shrimp (*Pandalus borealis*) stock, in Div. 3LNO, extends beyond Canada's 200 Nmi limit, therefore, it is a NAFO regulated stock. The Faroese began fishing shrimp in the NAFO Regulatory Area (NRA) during 1993. In 1999, a 6,000 t quota was established and fishing was restricted to Division 3L, at depths greater than 200 m. The 6,000 t quota was established as 15% of the lower confidence limit around the autumn 1998 3L biomass estimate. This harvest level approximates those estimated for shrimp fishing areas along the coast of Labrador and off the east coast of Newfoundland (NAFO Div. 2HJ3K). It was recommended that this harvest level be maintained for a number of years until the response of the resource to this catch level could be evaluated (NAFO, 1999). The proportion of biomass in 3LNO, within the NRA, over the period 1995 – 1998, was approximately 17%. Therefore, a 5,000 t quota was established in the Exclusive Economic Zone (EEZ), for Canada, while a 1,000 t quota was established in the NRA for all other Contracting Parties.

The fishery is also important because the distribution of shrimp overlaps the distribution of several groundfish stocks that are presently under moratoria. In order to decrease bycatch, all vessels fishing this stock must utilize sorting grates with a maximum bar spacing of 22 mm. Hence, this paper assesses the status of the shrimp stock, as well as, the impact that the fishery has upon groundfish co-existing in the area.

Methods and Materials

Data were collected from the following sources:

1) Canadian autumn and spring multi-species research surveys;
2) Canadian observer databases;
3) Canadian logbook databases;
4) International observer databases, as well as,
5) International logbook databases.

1) Canadian spring and autumn multi-species research surveys:

Shrimp abundance, biomass, maturity and carapace length data have been collected since autumn 1995, as part of the Canadian multi-species surveys conducted using the CCG Wilfred Templeman, CCG Alfred Needler and CCG Teleost. Fishing sets of 15 minute duration and a tow speed of 3 knots were randomly allocated to strata covering the Grand Banks and slope waters to a depth of 1500 m (Fig. 1). All vessels used a Campelen 1800 shrimp trawl with a codend mesh size of 40 mm and a 12.7-mm liner. SCANMAR sensors estimated that the mean wingspread was 16.8 m. Details of the survey design and fishing protocols are outlined in (Brodie, 1996; McCallum and Walsh, 1996).

Shrimp were frozen and returned to the Northwest Atlantic Fisheries Centre where identification to species and maturity stage was made. The maturity of the shrimp was defined by five stages:

males;
transitionals;
primiparous females;
ovigerous females,
and multiparous females

as defined by Ramussen (1953), Allen (1959) and McCrary (1971). Oblique carapace lengths (0.1 mm) were recorded while number and weight per set was estimated from the sampling data. Stratified abundance and biomass indices were estimated via areal expansion using programs based upon Cochran (1997) and written in SAS (D. Orr unpublished). Inshore strata were not sampled in all years, therefore, the analysis was restricted to data collected from offshore strata only (Fig. 1).

Modal analysis using Mix 3.1A (MacDonald and Pitcher, 1979) was conducted on male research length frequencies. All other maturity stages were aged according to the following guides:

Season and age	carapace length modal range
Spring	
Age 0	<8.0 mm
Age 1	8.8 – 11.0 mm
Age 2	11.5 – 15.0 mm
Age 3	15.5 – 19.0 mm
Age 4	19.5 – 23.0 mm
Age 5+	>23.0 mm
Autumn	
Age 0	<8.5 mm
Age 1	8.5 – 13.0 mm
Age 2	13.5 – 17.0 mm
Age 3	17.5 – 20.0 mm
Age 4	20.5 – 23.5 mm
Age 5+	>23.5 mm

It is recognized that growth patterns vary over the years and throughout the geographic distribution of this species, however, there is general agreement between these guides and modal analyses conducted on shrimp caught on the Flemish Cap during recent assessments (D?az 2001, Nicolajsen, 2000, and Skuladóttir and D?az, 2001). Additionally, these guides provided useful starting points for the MIX analyses.

Abundances of age 2 males were plotted against fishable biomass to determine whether a recruitment – stock relationship exists. Such a relationship could be used to predict stock prospects.

Exploitation indices were developed by dividing total catch by each of the following estimates: biomass, spawning stock biomass (SSB), and fishable biomass. The fishable component of the population was defined as all

animals greater than 17 mm CL. Male biomass was determined by converting abundances to biomass using the autumn length weight regression:

$$Wt. = 0.000838Lt^{2.929}$$ (Skuladóttir, 1997).

Spawning stock biomass (transitionals + primiparous females and ovigerous + multiparous females) was determined by areal expansion. Female and male biomasses were added together to obtain total fishable biomass.

Distribution maps of juvenile Atlantic cod (*Gadus morhua*), American plaice (*Hippoglossoides platessoides*), Greenland halibut (*Rheinhardtius hippoglossoides*) and redfish (*Sebastes mentella*) were overlain with plots of survey shrimp catches to determine the degree of overlap. The term juvenile refers to the modal length of a species (LC_{50}) passing through a 22 mm Nordmore Grate. The respective LC_{50} values for Atlantic cod, Greenland halibut, redfish and American plaice were: 19 cm (Orr *et al*. 2000 and Hickey *et al* 1993), 24 cm (Nicolajsen, 1997), 14-18 cm (Hickey *et al*.1993, Kulka and Power, 1996, Kulka, 1998, Nicolajsen, 1997 and Skuladóttir, 1997) and 23 cm (Orr *et al*. 2000). Amounts of bycatch were assessed in relation to total shrimp catch.

2) Canadian observer database:

Approximately 12 large (=>500 ton) fishing vessels and more than 300 smaller (<500 ton; <100') vessels fish shrimp within Davis Strait, along the coast of Labrador and off the east coast of Newfoundland. There is 100% mandatory observer coverage of the large vessels, but only 10% coverage of the small vessels.

Observers working on large vessels collect detailed maturity stage length frequency information from random sets. Those working on small vessels collect ovigerous/ non-ovigerous length frequencies from random sets and one detailed maturity stage length frequency per trip. Observers on both types of vessels record: shrimp catches, effort, amount of discarding, approximate amounts of bycatch on a species by species basis and collect length frequencies of by-caught species. Length frequencies are collected for all by-caught Atlantic cod.

The Observer database was used to determine the catch-per-unit effort (CPUE) for the large vessel and small shrimp fishing fleets, catch at size and maturity, as well as, the impact of shrimp fishing upon groundfish species.

The time series extends over only three years, therefore, no attempts were made to model CPUE. However, we created a large vessel (=> 500 t) CPUE graph from a standard data set. The standard large vessel data set was created from the observer database because we wanted to present results that account for number of trawls and usage of windows (escape openings). The number of trawls and usage of windows are captured in the observer data set but not in the logbooks. In order to track only experienced fishers, the standard data set included only data from vessels with more than two years of shrimp fishing experience. This increased our confidence when interpreting results.

A similar standardized CPUE data set was not created for the small vessel fleet as observer coverage in the 3L shrimp fishery can be as low as 3%. Due to the low coverage, it was felt that results of analyses from this source would be unreliable.

3) Canadian logbook database:

The landings by small and large vessels allowed a comparison with the total observed catches for each fleet. This comparison provided an indication of percent of total catch observed. This percentage was used in estimating the number of shrimp – at – length caught and the total groundfish bycatch on a species by species basis.

Both the observer and logbook data sets complement the research trawl survey data sets. Research data are collected during the spring and autumn using stratified random set allocations that cover the Grand Banks. Conversely, the observer and logbook data sets are representative of the commercial fishery. They focus upon fishing areas and cover a much broader seasonal scale than the research data. All three were used in determining an exploitation index (catch/biomass), which is a proxy for fishing mortality, and provide insight for the impact of shrimp fishing upon groundfish.

4) International observer and logbook information:

These data were made available by Contracting Parties that fish for shrimp in Div. 3L. They were added to the Canadian catches when determining a total catch, CPUE and bycatch. Where no information was provided by a Contracting Party, information was augmented through the use of Canadian surveillance data.

Results and Discussion

FISHERY DATA

In 1993, Faroese fishermen began an exploratory fishery for 3LNO shrimp within the NRA. The exploratory fishery lasted until 1999. Over this 7 year period, the Faroese catches were 1789, 1910, 0, 171, 485, 544 and 706 t (NAFO STATLANT 21A) respectively.

During autumn 1995, the Canadian multi-species surveys began to use a Campelen 1800 shrimp trawl. It was at this time that shrimp were included in the multi-species survey data collections. As a result of Faroese and Canadian multi-species survey efforts, various nations became interested in exploiting shrimp in Div. 3LNO. During 1999, one Spanish and four Canadian exploratory fishing trips were made in 3LNO. The combined catch was 127 t. That year, the Fisheries Commission within NAFO set a Total Allowable Catch (TAC) of 5,000 t for Canada and a total of 1,000 t for all of the remaining convention member states. This level of removal was maintained over the period 2000 - 2002. The following table provides catches by nation:

Country	2000	2001	2002
Canada – Nfld.	3,843[1]	4,708[2]	4,810[2]
Canada – Mar.	458[1]	421[2]	680[2]
Estonia	64[1]	2,264[7]	NO DATA
Faroe Islands	42[1]	2,052[7]	NO DATA
Greenland	34[2]		
Iceland	97[2]	55[6]	39[6]
Latvia	64[1]	53[3]	46[3]
Lithuania	67[1]	51[3]	34[3]
Norway	77[1]	78[5]	70[5]
Poland	40[1]		
Portugal		61[4]	
Russia	67[1]	67[3]	67[3]
Spain		699[4]	
St. Pierre (France)	67[1]		
Ukraine		57[1]	
GRAND TOTAL	4,920	10,566	NO ESTIMATE

Sources:

1 NAFO Statlant 21A
2 Canadian Quota Report, or other preliminary sources
3 NAFO monthly records of provisional catches
4 Canadian surveillance reports
5 Observer datasets
6 Icelandic Fisheries Directorate.
7 STACFIS estimates

No estimate could be arrived at in 2002 because there was no catch data for Estonia and the Faroe Islands.

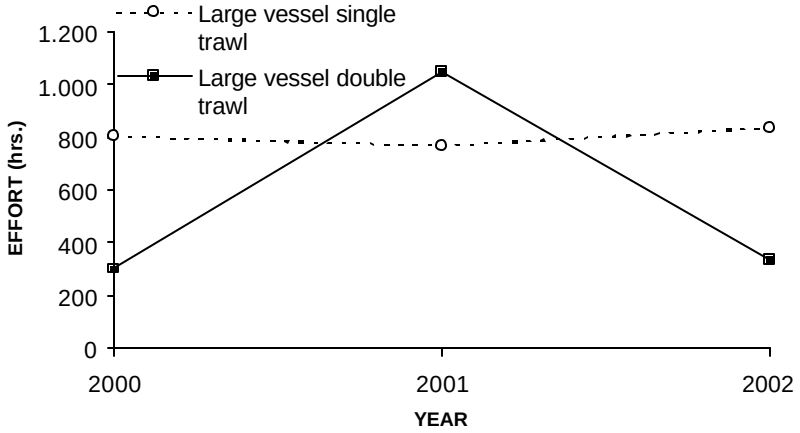
Catch Per Unit Effort (CPUE)

Within the EEZ

Canadian vessels have a 5,000 t quota that is evenly divided between the two fleet sectors. Combined fleet catches have increased from 4,250 t in 2000 to 5,500 t in 2002. Large vessel catches have increased from 1,000 t in 2000 to 2,500 t in 2002 (Table 1), while small vessel catches have varied between 2,700 t and 3,200 t.

There was low observer coverage of small vessel shrimp fishing activities (~3 %) and there was not enough time to properly check the quality of the small vessel logbook datasets, therefore, there was no analysis of the small vessel fleet CPUE.

The large vessel fleet made use of single and double trawls did not made use of windows. Between 21 and 79 percent of the total logbook catch was captured in the standard large vessel CPUE data set. Total catches were prorated (prorated catch = total catch / % catch attributed to each gear type) in order to calculate effort for each gear type (effort = prorated catch/ cpue). Large vessel single trawl fishing effort remained stable at between 766 and 837 hrs while double trawl effort varied between 300 and 1,000 hrs (Table 1).

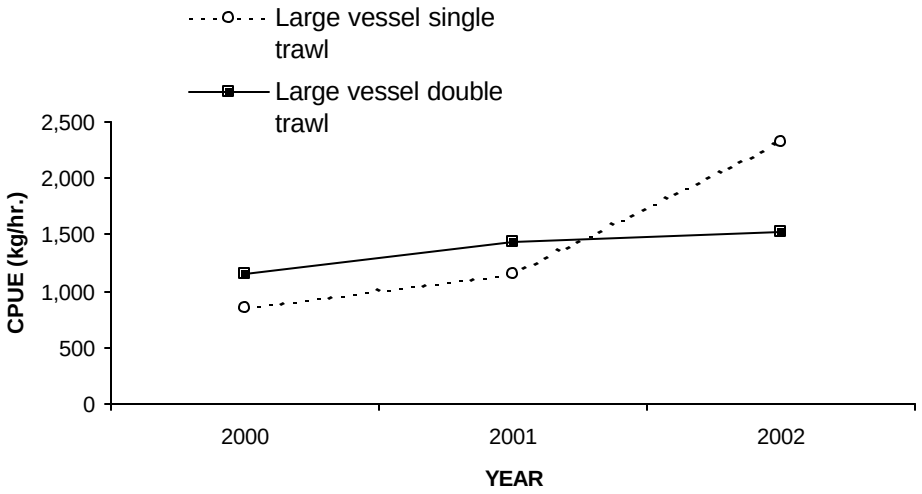


With each consecutive year, the large vessel fleet has been extending the season over which it has been fishing in 3L. During 2000, large vessels fished from April – June. During the next year the season extended from March – July and finally during 2001 these vessels fished sporadically from January – June. No clear seasonal pattern was evident within this fleet.

The fishing season for the small vessel fleet has been variable throughout the years. During 2000, most of the catch was taken during 3 months; June, July and October. The next year, the small vessel fishery extended from May – October. During that year an industry imposed shrimp closure, which affected the small vessel fleet, lasted from the beginning of July until the end of August. This closure was due to a glut in the world market for shrimp. The small vessels caught 75% of their quota prior to the closure and remaining 25% at the end of September. Finally during 2001, all of the quota was taken from April – June.

In general, both fleets fish over a broad area along the edge of 3L (Figures 2 and 3). However, in all years, there are concentrations of effort at the 200 Nmi limit and at the eastern edge of the 3L/3K border.

The large vessel single trawl CPUE gradually increased from 855 kg/hr in 2000 to 2328 kg/hr in 2002. Whereas the double trawl CPUE has remained relatively stable at between 1,144 and 1,521 kg/hr. Less than 25% of the 2002 observed data had been entered into the database, therefore, the 2002 single and double trawl CPUEs may not be accurate indicators of fleet performance.



Within the NRA

Since 2000, a 1,000 t quota has been maintained for non-Canadian vessels fishing in the NRA. Contracting countries each have a 67 t share of this quota. There are 16 member nations, however, the fishery has been exploited by vessels from only 12 nations (NAFO Statlant 21a). In 2000, foreign fleets harvested 509 t of shrimp while in 2001, they caught 5,437 t. STACFIS was not able to estimate the amount of shrimp taken in the NRA during 2002 2002. The number of vessels has decreased from 26 in 2001 to 18 in 2002, but it should be noted that some of these vessels may fish an allocation for two or more countries per trip.

The number of vessels fishing 3L by country and year

Country	2001	2002
Estonia	8[1]	4[1]
Faroe Island	5[1]	5[1]
Iceland	3[2]	3[2]
Latvia	3[1]	2[1]
Lithuania	3[1]	2[1]
Norway	1[3]	1[3]
Russia	2[1]	1[4]
Spain	1[1]	
Ukraine		
Total	26	18

[1] Canadian Surveillance database.
[2] Iceland logbook database.
[3] Norwegian observer database.
[4] Russian logbook database.

The Norwegian Government provided observer data for the period 2000 – 2001. One vessel fished during July 2000, while another fished during January, 2001. During 2000, 78 t of shrimp were taken with a single trawl fished for 54 hours. The second vessel made use of a double trawl and expended 67 hours of effort to capture 70 t of shrimp. The respective CPUE's were 1,444 kg/hr. and 1,045 kg/hr. These catch rates are within the range of values estimated for Canadian vessels fishing in the EEZ.

Figure 4 indicates the 2000 and 2001 Norwegian set positions. During 2000, the Norwegian vessel fished in a relatively small area near the nose of the Grand Banks, whereas, the next year, the vessel fished over a broader area to the south.

Icelandic logbook data was provided for the period 2001 – 2002. Three vessels fished in 3L during 2001 and 2002. In both years, vessels fished from March until December, with approximately 50% of the catch taken during September. They used both single and double trawls, but had much lower catch rates than either the Canadian or Norwegian vessels. During 2000, the single and double trawl CPUEs were 252 kg/hr and 407 kg/hr respectively. During 2001, the single and double trawl CPUEs were 1172 kg/hr. and 548 kg/hr. respectively. It should be noted that there were only two tows made with single trawls, therefore, the high single trawl catch rate is not a good indicator of fishery performance (Skuladóttir, pers. comm.)

Russian logbook data were provided for the 2002 3L shrimp fishery. One vessel fished a double trawl for 17, 7 hour tows over the period Jan 1 – 6, 2002. The total catch was 61 t while the CPUE was 512 kg/hr. The catches are plotted in Figure 5.

Size/ Age Composition

Length frequencies, produced from small vessel observer coverage indicate that at least 4 cohorts were taken in the fishery (Fig. 6). The 2000 and 2001 samples were dominated by 22 – 26 mm carapace length (CL) female shrimp believed to be age 5 and older. The 2002 plot was dominated by males 18.5-21 mm CL, which are assumed to be from the 98 and 99 year-classes. The small vessel length frequencies have a jagged appearance because a low number of sets were observed.

During 2000 and 2001, large vessel catches were dominated by males (Fig. 7). However, the 2002 male and female distributions appear to be equal in number. This was the result of the sex reversal of part of the relatively strong 97 year-class. As these animals changed sex, the dominance in number of males relative to females also shifted.

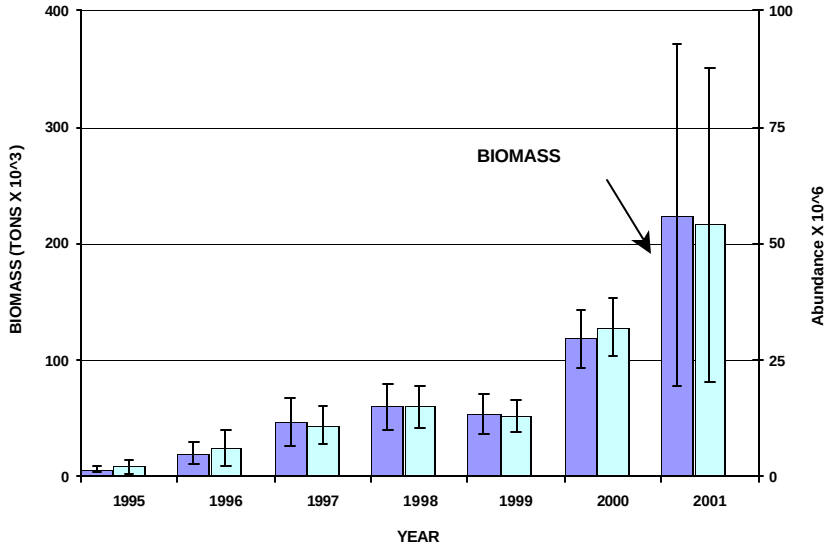
It is important to note, the 98 year-class appears relatively strong in both small and large vessel frequencies during 2002. Additionally, the female distributions are broad, in all frequencies, indicating the likely presence of more than one year-class.

Mean size of females and the size at sex inversion may have declined slightly in recent years (Fig. 6 and 7), indicating a possible change in the growth/ maturity schedule within the area. Although smaller females carry fewer eggs, reproductive potential has been maintained by the continued high abundance of females.

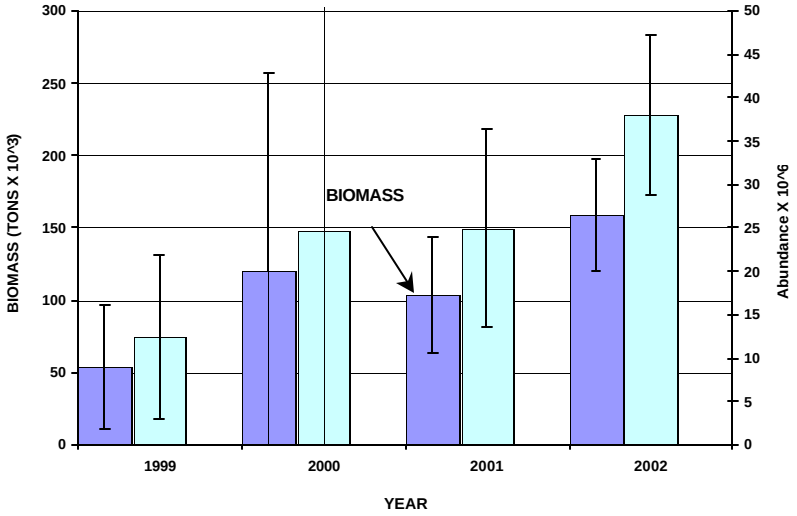
RESEARCH SURVEY DATA

Results of the autumn 1995 – spring 2002 Canadian multi-species surveys (Fig. 8-12; tables 2-10) indicate that shrimp have been widely distributed along the edge of 3L. All estimates discussed below are for offshore strata, because the inshore strata were not sampled each year. However, Fig. 8 –10 indicate the complete distribution of shrimp collected and include samples from the inshore strata. The biomass index increased from 5,921 t in autumn of 1995 to 46,202 t during autumn of 1997, remained stable until spring of 2000, at which time it increased to 121,815 t. In spring 2001, the biomass decreased to 102,566 t. The autumn 2001 – spring 2002, biomass point estimates were considerably higher than previous estimates. Biomass was estimated to be 223,995 t during autumn 2001, while the following spring estimate was 159,491 t.

Autumn multispecies survey biomass and abundances of 3LNO *P. borealis* (95% confidence intervals around the point estimates)



Spring multispecies survey biomass and abundances of 3LNO *P. borealis*(95% confidence intervals around the point estimates)



These charts indicate that there can be broad variances around survey estimates. This was true during spring of 2000 and autumn 2001. Confidence intervals, around the autumn 2001 point estimate are broad because three catches near the nose of the Grand Banks (678 kg - stratum 387; 387 kg – stratum 388 and 446 kg – stratum 389) were much higher than the other catches in that survey. Over the past few years, the fishery has been concentrated in this area.

Northern shrimp stock size estimates in NAFO divisions 3LNO							
	autumn research trawl surveys – offshore, 1995 - 2001.						
	Biomass (tons)			Abundance (numbers x 10^{-6})			Survey
	Lower C.I.	Estimate	Upper C.I.	Lower C.I.	Estimate	Upper C.I.	Sets
1995	3,639	5,921	8,202	659	2,054	3,449	337
1996	10,230	20,088	29,948	1,985	5,866	9,748	304
1997	25,530	46,202	66,875	6,280	10,523	14,766	318
1998	40,011	59,914	79,816	10,787	15,326	19,866	347
1999	36,202	53,144	70,086	9,588	13,060	16,533	313
2000	93,132	118,180	143,227	25,840	32,066	38,292	337
2001	77,563	223,995	370,427	20,177	54,077	87,978	362

The lower confidence limit around the 2001 point estimate is below the 2000 estimate, therefore, we conclude that there has not been a significant increase in biomass between autumn surveys in 2000 and 2001. However, using the same reasoning, there was a significant increase in biomass between 1995 and 1996, stability between 1997 and 1999, then a significant increase between 1999 and 2000. Biomass indices over the past three autumn surveys averaged 131,773 t (approximately 33 billion animals).

Northern shrimp stock size estimates in NAFO division 3LNO							
	from spring research trawl surveys – offshore, 1999 - 2002.						
	Biomass (tons)			Abundance (numbers x 10^{-6})			Survey
	Lower C.I.	Estimate	Upper C.I.	Lower C.I.	Estimate	Upper C.I.	Sets
1999	12,564	55,316	98,069	3,178	12,703	22,226	195
2000	-15,869	121,815	259,498	-54,743	25,012	104,768	298
2001	62,359	102,566	142,773	13,416	24,844	36,272	300
2002	121,067	159,491	197,916	28,310	37,512	46,714	300

Although not significant, there appears to have been an increase in the biomass index between the spring 2001 and 2002 surveys. The biomass index averaged 127,957 t (approximately 29 billion animals) during the 2000 – 2002 period.

The differences between spring and autumn point estimates, confidence limits and distributional charts (Tables 2 – 10; Figs. 8 – 10) indicate that there may be a seasonal influence upon shrimp catchability. For this reason, data from the autumn surveys are treated separately fromthe spring survey data.

Distribution of shrimp in Divisions 3L, 3N and 3O

Over the study period, the area outside 200 Nmi accounted for between 11 and 31% of the Divisions 3LNO biomass estimates (Tables 8 - 10; Figs. 8 - 10).

More than 90% of the biomass was found within Division 3L, mostly within depths from 185 to 550 m. Over the seven autumn surveys, the biomass within the NRA ranged between 11 and 29%. Various formulations of three year running averages were estimated in order to smooth the peaks and troughs within the data. They indicate that 14 – 23% of the autumn biomass was within the NRA. However, during the spring, the percent biomass within the NRA ranged between 18 and 31% while the three year running averages ranged between 25 and 29%.

In all surveys, the Division 3N accounted for less than 10% of the total 3LNO biomass. More than 80% of the 3N biomass was found outside the 200 Nmi limit. Division 3O accounted for less than 1% of the 3LNO biomass. The area outside the 200 Nmi limit contributed between 0 - 34% of the 3O biomass.

Stock composition

Length distributions representing abundance – at – length from the autumn 1995 to spring 2002 surveys are compared in Figures 11 and 12. Tables 11 – 17 provide the detailed length frequency data obtained from each survey. Tables 18 – 21 provide the modal analysis of males and the estimated demographics from each survey.

The time series provides a basis for comparison of relative year-class strength and illustrates the changes in stock composition over time. The 1996 year- class, at age 5 in 2001, age 4 in 2000, age 3 in 1999 and age 2 in 1998, is the weakest observed. Since the 1997 year-class was first seen, in 1998 at age 1, it has appeared to be the strongest year-class since the multi-species survey began. The next two year-classes, the 1998 and 1999 year-classes, appear to be as strong as the 1994 year-class did at similar ages. The 2000 year- class at age 1 appears average in the autumn 2001 and spring 2002 length frequencies. Modal length at age varies between years reflecting different growth rates for the different cohorts.

Abundances within the autumn 2001 survey data were dominated by males with a modal length of 19.0-mm CL, believed to have been the 97 year-class (age 4). The 98 year-class was evident near 17.0 mm while the 99 year-class had a mode at 14.5 mm. The largest males (>19 mm) and smallest females (< 22 mm) are thought to belong to the 1996 year-class. The relatively weak 1996 year-class is followed by the relatively strong 97 and 98 year-classes. The broad female distribution suggests that it consists of several year-classes. The relative strength of the 97 and 98 year-classes and the breath of the female distributions are consistent with the observations pertaining to the commercial length frequencies from both the small and large vessel fleets.

It is predicted that the affects of the weaker 96 year-class will be moderated by the residual female biomass as well as the stronger 97 and 98 year-classes.

Recruitment indices

Campelen shrimp trawl

The following is a plot of fishable biomass versus recruitment index (age 2 shrimp from the autumn multi-species surveys). The recruitment index was lagged by 2 years (to be consistent with the fact that many of these animals are recruited to the fishery at age 4). Fishable biomass $_{(t+2)}$ appears to be related to recruitment $_{(t)}$, and therefore may have predictive value, however, the time series is too short to be conclusive.

Exploitation Rates

Ratios of catch to the previous autumn biomass indices will be used to provide an exploitation rate index.

Year	Catch	total biomass	SSB	fishable biomass
1995		5,921	3,805	4,710
1996	79	20,088	3,554	12,142
1997	485	46,202	19,566	40,152
1998	515	59,914	16,793	53,644
1999	827	53,144	18,527	43,408
2000	4,759	118,180	32,517	100,709
2001	6,329	223,995	64,077	210,302
2002	4,687			

Year	Catch/total biomass	Catch/ SSB	Catch/fishable biomass
1996	0.013	0.021	0.017
1997	0.024	0.136	0.040
1998	0.011	0.026	0.013
1999	0.014	0.049	0.015
2000	0.090	0.257	0.110
2001	0.054	0.195	0.063
2002	0.021	0.073	0.022

Exploitation levels using ratios of catch/biomass, catch/SSB and catch/fishable biomass track the same trend. Overall, exploitation was low, with increased values in 2000 reflecting the start of the fishery under TAC regulation, followed by decreases as abundance and biomass indices increased.

DISTRIBUTION OF SHRIMP IN RELATION TO VARIOUS GROUNDFISH SPECIES

Bycatch

Overlays of shrimp distributions upon distributions of various juvenile groundfish species indicate some overlap with cod (Fig. 13) and American plaice (Fig. 15). There is considerable overlap in areas where juvenile redfish (Fig. 17) have traditionally been found, particularly along the edge of Div 3L As in past reports, there is considerable overlap throughout the distribution of shrimp and juvenile Greenland halibut (Fig. 19).

Table 22 provides estimates of bycatch for various groundfish species taken by the Canadian large vessel shrimp fishing fleet during 2001 and 2002. The estimates were determined by comparing the tonnage observed with the nominal shrimp catches. The ratio of nominal catch/ observed catch provided a correction factor used in estimating number and weight of bycatch. Using this method we estimated 229 kg (532 fish) of Atlantic cod, 1,116 kg of American plaice, 972 kg of redfish and 5,660 kg (52,473 fish) of Greenland halibut were by-caught in the large vessel shrimp fishery during 2001. An estimated 164 kg (436 fish) of Atlantic cod, 303 kg of American plaice, 1,424 kg of redfish and 4,754 kg (48,898 fish) of Greenland halibut were removed by this fishery in 2002. It is important to note that numbers of fish were estimated from length frequencies. Length frequencies are taken on an opportunistic basis. Therefore, if no measurements were taken, no estimated counts could be calculated, as is the case with American plaice and redfish. A ratio of total bycatch weight/ weight of fish measured is applied to the total number of fish measured per length. If low numbers of fish were measured as is the case with Atlantic cod, during both years, then the estimated number of removals is questionable. The estimated numbers of Greenland halibut removals in the large vessel fishery is probably reasonable because over 500 fish were measured during each year.

A similar analysis was conducted for the small vessel bycatch, however, the percent observer coverage of fleet activity was below 5% in either year. It was thought that results using such low coverage would not be representative of bycatch within the fishery, therefore, these analysis are not presented here.

Atlantic cod (Fig. 14), American plaice (Fig. 16), redfish (Fig. 18) and Greenland halibut (Fig. 20) all indicate that, on a species by species basis, there is a direct relationship between level of removals and level of fishing activity. The highest levels of removal are near the 200 Nmi limit, where the highest levels of fishing activities occur. Fishing is also concentrated near the 3L/3K border. Bycatch has also been recorded in that area.

Levels of bycatch are also in relation to size of the population being caught. The order of increasing bycatch: cod, American plaice, redfish and Greenland halibut matches the order of increasing number of juvenile fish in the research catches (Figs. 13, 15, 17 & 19; Table 22)

Norwegian bycatch information for 2000- 2001 was made available for this analysis. Neither measurements nor counts were recorded. Levels of bycatch are as follows:

Species	2000		2001	
	kg	kg/ton of shrimp	kg	kg/ton of shrimp
American plaice	0	0	31	0.44
Atlantic cod	0	0	0	0
Redfish	30	0.38	30	0.43
Greenland halibut	35	0.45	277	3.93

The 2001, bycatch per ton of shrimp is much higher than that for large Canadian vessels. However, the total Norwegian shrimp catch was only 70 t. This estimated kg/t could have been biased by a few large bycatches of Greenland halibut. The Canadian vessels could have experienced large individual bycatches also, but these high levels may have been outweighed by numerous catches with low amounts of Greenland halibut.

Resource Status

There was a significant increase in biomass between 1995 and 1996, stability between 1997 and 1999, then a significant increase between 1999 and 2000. Biomass indices over the past three autumn surveys averaged 131,773 t (approximately 33 billion animals). Biomass indices over the past three spring surveys averaged 127,957 t (approximately 29 billion animals). Research data showed that the 1996 year-class was weak compared to others produced during the 1990's. However, the 1997 - 1999 year-classes appear strong, the 97 year-class being the most abundant year-class, at age 4, within the time series. Residual 1994 class animals, as well as, the sex inversion of 1995 and 1996 year-classes maintained the spawning stock biomass (females) class animals. The inversion of several year-classes is suggested by the fact that the 2001 and 2002 commercial and research female length frequencies are broad. The positive effects of the stronger 1997 and 1998 year-classes on the spawning stock should be evident by 2003.

The fishery has been in existence for only 3 years, hence the time series was too short to be able to develop CPUE models. It is hoped that in the future it will be possible to model CPUE. All other indicators suggest that the resource in this area remains healthy with high biomass/abundance of male and female components. Exploitation has remained low and the fishery continues to cover a broad area, throughout much of the year. Therefore, fishery related impacts could not be detected from either the logbook, observer or the research data.

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TABLE 1. NORTHERN SHRIMP LARGE VESSEL (>500 T) FISHERY DATA FOR NAFO DIVISIONS 3LNO CPUE, 2000 - 2002

YEAR	TAC (t)	LOGBOOK CATCH[1] (t)	PERCENT IN STANDARD DATA SET[2]	GEAR	TOTAL OBSERVED CATCH / GEAR TYPE	LOGBOOK CATCH PRORATED/ GEAR[3] (t)	UNSTANDARDIZED CPUE (kg/hr)	EFFORT (hrs.)
2000	1,686	1,029	79	SINGLE	543	641	855	749
				DOUBLE	329	388	1,144	339
2001	2,500	2,394	58	SINGLE	803	827	1,156	715
				DOUBLE	1,521	1,567	1,442	1,087
2002	2,500	2,452	21	SINGLE	409	1,948	2,328	837
				DOUBLE	106	504	1,521	331

[1] **CATCH (TONS) IN CALENDAR YEAR AS REPORTED IN YEAR-END QUOTA REPORTS**

[2] **PERCENT OF THE TOTAL CATCH CAPTURED IN THE STANDARD CPUE DATA SET.**

[3] **LOGBOOK CATCH PRORATED BY RATIO OF TOTAL CATCH IN STANDARD DATASET / CATCH BY GEAR TYPE. EFFORT CALCULATED FROM CATCH/CPUE.**

Table 2. Total abundance (X 1000), biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the autumn 1995 - 2001 Canadian multi-species research surveys into NAFO Div. 3L. (All tows were standardized to 15 minutes; . means not sampled.).

Please note that these estimates were taken from strata numbers <784 so that estimates from all years would be comparable.

Depth	Area	Autumn 95		Autumn 96		Autumn 97		Autumn 98		Autumn 99		Autumn 2000		Autumn 200	
Range in m	in Nmi2	WT 176 - 179		WT 196 - 198,		WT 213-217		WT 230 - 233		WT 246 - 248		WT 321 - 323		WT 372 - 3	
		WT 181, Tel 22		WT 200 &		Tel 57 & 58		Tel 75 & 76				Tel 339, 342		AN 399, Tel	
		& Tel 23		Tel 41								& 343		358 & 361	
		abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass	abundance	
		(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)	(x 1000)	
30 - 56	9285	.	.	0	0	0	0	97	0	.	.	393	0	.	
57 - 92	18957	0	0	1.591	6	3.558	16	3.273	13	1.532	5	7.880	34	9.177	
93 - 183	7170	26.803	41	66.329	176	448.482	1.849	485.811	1.237	597.044	1.855	962.240	3.313	3.657.502	
184 - 274	399	254.635	787	989.385	3.518	5.284.488	25.015	8.806.344	32.516	9.312.284	36.423	22.399.779	73.001	27.754.377	
275 - 366	4030	1.659.530	4.374	4.271.393	14.647	4.624.501	18.515	5.186.605	22.691	3.056.209	14.390	8.585.977	41.292	22.326.096	
367 - 549	1192	12.073	142	15.004	218	50.610	353	5.649	25	32.400	187	45.685	232	170.181	
550 - 731	804	2.256	13	197	1	1.982	9	632	2	547	3	7.494	27	3.271	
732 - 914	957	0	0	0	0	86	1	13	0	0	0	265	2	3.311	
915 -1097	945	0	0	0	0	0	0	0	0	0	0	79	1	863	
1098 -1280	1745	.	0	35	0	0	0	0	0	0	0	0	0	40	
1281 -1463	773	.	0	0	0	0	0	0	0	0	0	0	0		
Total (000's)		1.957.945	5.358	5.346.560	18.566	10.419.805	45.758	14.471.183	56.485	13.013.407	52.863	32.019.951	117.902	53.924.100	
Upper 95% limit		3.335.665	7.397	9.051.691	28.893	14.661.173	66.426	18.820.969	76.064	16.485.962	69.804	38.245.868	142.949	87.822.964	
Lower 95% limit		580.225	3.318	1.641.430	8.238	6.178.437	25.090	10.121.396	36.905	9.540.852	35.923	25.794.034	92.855	20.025.236	
%<184m		1	1	1	1	4	4	3	2	5	4	3	3	7	
%184 - 549 m		98	99	99	99	96	96	97	98	95	96	97	97	93	
%>549 m		0	0	0	0	0	0	0	0	0	0	0	0	0	
							Outside 200 Nmi limit								
93 - 183	933	24	0	110	0	18.480	79	6.906	14	20.967	70	48.171	187	391.370	
184 - 274	791	8.806	26	429.678	1.635	290.656	1.246	1.005.018	4.454	1.346.964	6.486	4.405.969	19.197	5.240.571	
275 - 366	758	162.699	997	433.908	2.759	643.252	3.685	558.307	4.222	306.325	2.079	1.519.770	8.949	5.536.096	
367 - 549	636	275	4	7.328	110	11.499	102	3.954	17	13.288	98	18.808	113	137.827	
550 - 731	554	1.935	12	197	1	186	1	10	0	90	1	0	0	703	
732 - 914	607	0	.	0	0	86	1	13	0	0	0	119	1	3.227	
915 -1097	582	.	.	0	0	0	0	0	0	0	0	46	0	863	
1098 -1280	1.331	.	.	35	0	0	0	0	0	0	0	0	0	0	
1281 -1463	295	.	.	0	0	0	0	0	0	.	.	0	0	0	
Total (000's)		173.738	1.039	871.256	4.506	964.158	5.115	1.574.208	8.707	1.691.507	8.734	5.990.885	28.447	11.300.943	
Upper 95% limit		440.468	4.853	2.035.525	25.676	2.533.454	13.242	4.705.895	25.437	3.907.713	19.432	10.973.587	49.256	21.736.636	
Lower 95% limit		-92.992	-2.774	-293.013	-16.664	-605.137	-3.013	-1.557.479	-8.022	-524.699	-1.964	1.008.184	7.638	865.250	
%<184m		0	0	0	0	2	2	0	0	1	1	1	1	3	
%184 - 549 m		99	99	100	100	98	98	100	100	99	99	99	99	97	
%>549 m		1	1	0	0	0	0	0	0	0	0	0	0	0	

Table 3 Total abundance (X 1000), biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the autumn 1995 - 2001 Canadian multi-species research surveys into NAFO Div. 3N. (All tows were standardized to 15 minutes; . means not sampled.).

Please note that these estimates were taken from strata numbers <784 so that estimates from all years would be comparable.

Depth	Area	Autumn 95		Autumn 96		Autumn 97		Autumn 98		Autumn 99		Autumn 2000		Autumn 2001	
Range in m	in Nmi2	WT 176,		Tel 41, 42		WT 212-214		WT 229, 230,		WT 245 - 247		WT 320, 322		WT 372, 373	
		177		& AN 253				WT 233,				WT 323, Tel 338 &		& Tel 357	
								Tel 76				Tel 339			
		abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass
		(x1000)	(Kg X 1000)	(x1000)	(Kg X 1000)	(x1000)	(Kg X 1000)	(x1000)	(Kg X 1000)	(x1000)	(Kg X 1000)	(x1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)
<=56	3,092	0	0	0	0	63	1	0	0	175	1	0	0	110	1
57 - 92	11,490	7,903	36	3,507	13	1,661	6	2,042	13	1,291	4	3,664	14	3,411	15
93 - 183	1,168	0	0	1,107	2	17,302	44	43,866	119	55	1	2,368	10	1,674	8
184 - 274	546	18,053	45	377,532	776	73,069	318	769,586	3,023	22,871	104	13,223	65	54,344	308
275 - 366	386	191	2	46,636	144	3,689	40	8,846	82	11,758	90	9,806	57	81,682	423
367 - 549	420	65,926	450	89,437	578	1,620	17	3,286	25	6,638	61	11,859	88	4,245	28
550 - 731	352	0	0	139	1	183	1	10,473	97	1,241	12	1,971	17	4,919	42
732 - 914	394	.	.	.	.	.	.	0	0	.	.	1,834	17	1,063	10
915-1097	411	.	.	.	.	.	.	0	0	.	.	102	1	57	1
1098-1280	491	.	.	.	.	.	.	0	0	.	.	7	0	7	0
1281-1463	773	.	.	.	.	.	.	0	0	.	.	13	0	56	0
Total (000's)		92,073	533	518,358	1,514	97,588	427	838,098	3,360	44,030	272	44,847	270	151,568	836
Upper 95% limit		952,009	6,272	5,139,701	13,314	692,829	2,694	9,394,044	36,474	108,302	731	90,560	1,175	1,038,959	5,244
Lower 95% limit		-767,863	-5,206	-4,102,986	-10,285	-497,654	-1,840	-7,717,847	-29,754	-20,243	-188	-865	-635	-735,823	-3,573
%<184m		9	7	1	1	19	12	5	4	3	2	13	9	3	3
%184 - 549 m		91	93	99	99	80	88	93	93	94	94	78	78	93	91
%>549 m		0	0	0	0	0	0	1	3	3	4	9	13	4	6
						Outside 200 Nmi limit									
<=56	1,605	0	0	0	0	11	0	0	0	30	0	0	0	19	0
57 - 92	2,996	1,732	7	3,029	11	658	2	20	0	51	1	48	0	102	1
93 - 183	864	0	0	1,107	2	17,235	44	43,866	119	33	0	1,887	8	983	5
184 - 274	508	15,225	38	304,211	626	68,154	292	629,225	2,474	18,870	84	11,846	56	53,490	303
275 - 366	366	191	2	44,894	138	3,143	34	7,560	70	9,764	74	8,694	51	81,141	419
367 - 549	420	65,926	450	89,437	578	1,620	17	3,286	25	6,638	61	11,859	88	4,245	28
550 - 731	352	0	0	139	1	183	1	10,473	97	1,241	12	1,971	17	4,919	42
732 - 914	394	0	.	0	.	0	.	0	0	0	.	1,834	17	1,063	10
915-1097	411	0	.	0	.	0	.	0	0	0	.	102	1	57	1
1098-1280	491	0	.	0	.	0	.	0	0	0	.	7	0	7	0
1281-1463	773	0	.	0	.	0	.	0	0	0	.	13	0	56	0
Total (000's)		83,073	497	442,817	1,356	91,005	391	694,430	2,786	36,627	232	38,262	240	146,082	809
Upper 95% limit		931,482	6,216	4,176,800	4,875	685,509	2,645	7,507,801	29,156	90,987	629	82,410	1,118	1,032,753	5,213
Lower 95% limit		-765,336	-5,222	-3,291,167	-2,164	-503,500	-1,863	-6,118,942	-23,585	-17,732	-164	-5,886	-638	-740,589	-3,594
%<184m		2	2	1	1	20	12	6	4	0	0	5	3	1	1
%184 - 549 m		98	98	99	99	80	88	92	92	96	95	85	82	95	93
%>549 m		0	0	0	0	0	0	2	3	3	5	10	15	4	7

Table 4 Total abundance (X 1000), biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the autumn 1995 - 2001 Canadian multi-species research surveys into NAFO Div. 3O. (All tows were standardized to 15 minutes; . means not sampled.).
Please note that these estimates were taken from strata numbers <784 so that estimates from all years would be comparable.

Depth	Area	Autumn 95		Autumn 96		Autumn 97		Autumn 98		Autumn 99		Autumn 2000		Autumn 2001	
Range in m	in Nmi2	WT 176,		Tel 41, 42		WT 212 & 213		WT 229, 230,		WT 244 - 246		WT 319, 320		WT 372 &	
		177		& AN 253				WT 233,				WT 322 & Tel 338		Tel 357	
								Tel 76							
		abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass	abundance	biomass
		(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)	(x 1000)	(Kg X 1000)
57 - 92	12541	0	0	674.76	5.77	727.19	3.65	6847.29	18.52	1083.42	2.73	643.79	3.47	469.8	3
93 - 183	4775	2488.01	10.44	1128.85	213	4305.34	9.05	5586.12	14.19	1358.62	2.87	0	0	122.74	1
184 - 274	371	1874.57	20	80.75	0.74	705.04	3.68	4626.47	35.5	143.13	1.08	459.78	3.63	750.86	4
275 - 366	215	0	0	0	0	27.29	0.27	46.22	0.53	23.69	0.12	0	0	256.67	1
367 - 549	318	0	0	15.68	0.21	12.18	0.12	22.63	0.17	44.2	0.5	28.43	0.1	156.12	1
550 - 731	332	6.82	0.07	6.42	0.06	11.71	0.12	9.22	0.09	184.22	1.77	34.12	0.41	0	0
732 - 914	339	.	.	.	.	.	.	7.22	0.07	.	.	15.41	0.08	0	0
915 -1097	390	.	.	.	.	.	.	0	0	.	.	0	0	9.1	0
1098 -1280	407	.	.	.	.	.	.	.	.	.	.	0	0	0	0
1281 -1463	488	.	.	.	.	.	.	.	.	.	.	0	0	0	0
Total (000's)		4,369	31	1,906	9	5,789	17	17,145	69	2,837	9	1,182	8	1,765	10
Upper 95% limit		28,725	280	14,756	15	38,940	86	26,763	301	5,351	17	3,239	51	3,502	21
Lower 95% limit		-19,986	-219	-10,943	3	-27,362	-52	7,527	-163	325	1	-876	-36	29	-1
%<184m		57	34	95	89	87	75	73	47	86	62	54	45	34	32
%184 - 549 m		43	66	5	11	13	24	27	52	7	19	41	49	66	65
%>549 m		0	0	0	1	0	1	0	0	6	20	4	6	1	1
						Outside 200 Nmi limit									
57 - 92	269	0	0	20	0	20	0	458	1	37	0	0	0	0	0
93 - 183	246	34	0	506	1	1,318	3	680	2	235	1	0	0	63.7	0.32
184 - 274	74	34	0	10	0	342	1	1,659	11	81	1	56	0	216.76	1.01
275 - 366	47	0	0	0	0	0	0	0	0	18	0	0	0	197.76	0.97
367 - 549	58	0	0	12	0	0	0	8	0	18	0	22	0	119.15	0.72
550 - 731	71	5	0	0	0	9	0	0	0	141	1	26	0	0	0
732 - 914	105	.	.	.	.	.	.	7	0	.	.	15	0	0	0
915 -1097	126	.	.	.	.	.	.	0	0	.	.	0	0	9.1	0.09
1098 -1280	147	.	.	.	.	.	.	.	.	.	.	0	0	0	0
1281 -1463	180	.	.	.	.	.	.	.	.	.	.	0	0	0	0
Total (000's)		73	1	548	1	1,688	4	2813	15	530	3	119	1	606	3
Upper 95% limit		279	5	6,987	11	18,447	36	25,261	162	4,137	23.340.77	292	5	1,886	8
Lower 95% limit		-134	-4	-5,891	-8	-15,071	-28	-19,635	-133	-3,077	-17	-53	-4	-673	-4
%<184m		47	31	96	82	79	65	40	22	51	27	0	0	11	11
%184 - 549 m		46	61	4	19	20	32	59	78	22	29	65	36	88	90
%>549 m		7	9	0	0	1	2	0	0	27	44	35	63	2	3

Table 5 Total abundance (X 1000), biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the spring 1999 - 2002 Canadian multi-species research surveys into NAFO Div. 3L. (All tows were standardized to 15 minutes; . means not sampled.).

Please note that these estimates were taken from strata numbers >784 so that estimates from all years would be comparable.

Depth Range in m	Area in Nmi2	Spring 99 WT 240 & 241		Spring 2000 WT 317 & 318		Spring 2001 WT 365 & WT 367 - 370		Spring 2002 WT 422, WT 423 & 424	
		abundance (x 1000)	biomass (Kg X 1000)	abundance (x 1000)	biomass (Kg X 1000)	abundance (x 1000)	biomass (Kg X 1000)	abundance (x 1000)	biomass (Kg X 1000)
30 - 56	9285	0	0	.	.	0	.	.	.
57 - 92	18957	123	1	40	0	45	0	1,074	4
93 - 183	7170	6,004	29	25,633	54	12,997	41	19,955	64
184 - 274	399	3,197,714	13,247	14,036,717	63,616	3,489,745	16,314	10,474,232	45,439
275 - 366	4030	9,158,773	40,320	10,359,484	54,779	21,356,705	85,143	25,959,680	109,058
367 - 549	1192	27,134	248	110,186	1,023	287,782	895	61,502	370
550 - 731	804	15,963	88	5,539	50	12,716	98	24,872	125
732 - 914	957	.	.	.	.	.	.	.	.
915 -1097	945	.	.	.	.	.	.	.	.
1098 -1280	1745	.	.	.	.	.	.	.	.
1281 -1463	773	.	.	.	.	.	.	.	.
Total (000's)		12,405,970	53,934	24,535,333	119,521	24,975,809	104,263	36,553,631	155,061
Upper 95% limit		21,924,774	96,644	104,192,465	257005.238.03	35,965,001	143,763	45,524,244	193,642
Lower 95% limit		2,887,166	11,223	-55,121,800	-17,963	13,986,617	64,762	27,583,018	116,481
%<184m		0	0	0	0	0	0	0	0
%184 - 549 m		100	100	100	100	101	98	100	100
%>549 m		0	0	0	0	0	0	0	0
				Outside 200 Nmi limit					
93 - 183	933	491	1	279	1	155	1	477	2
184 - 274	791	1,160,062	6,284	3,980,018	21,186	133,867	722	1,260,000	3,240
275 - 366	758	1,588,698	8,192	2,424,460	14,212	3,895,114	17,131	9,832,623	43,707
367 - 549	636	19,408	170	73,282	681	90,285	796	34,603	222
550 - 731	554	15,374	83	5,137	48	8,465	65	23,288	116
732 - 914	607	.	.	.	.	.	.	.	.
915 -1097	582	.	.	.	.	.	.	.	.
1098 -1280	1331	.	.	.	.	.	.	.	.
1281 -1463	295	.	.	.	.	.	.	.	.
Total (000's)		2,780,533	14,731	6,488,871	36,127	4,123,688	18,714	11,150,539	47,288
Upper 95% limit		7,145,264	37,178	57,253,651	301,999	31,466,669	125,743	38,568,913	161,375
Lower 95% limit		-1,584,198	-7,717	-44,275,909	-229,746	-23,219,293	-88,315	-16,267,834	-66,799
%<184m		0	0	0	0	0	0	0	0
%184 - 549 m		100	99	100	100	100	100	100	100
%>549 m		1	1	0	0	0	0	0	0

Table 6 Total abundance (X 1000), biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the spring 1999 - 2002 Canadian multi-species research surveys into NAFO Div. 3N. (All tows were standardized to 15 minutes; . means not sampled.).

Please note that these estimates were taken from strata numbers >784 so that estimates from all years would be comparable.

Depth Range in m	Area in Nmi2	Spring 99 WT 238 - 240		Spring 2000 WT 316 & 317		Spring 2001 WT 367 - 369		Spring 2002 WT 421, 422 & 424	
		abundance (x 1000)	biomass (Kg X 1000)	abundance (x 1000)	biomass (Kg X 1000)	abundance (x 1000)	biomass (Kg X 1000)	abundance (x 1000)	biomass (Kg X 1000)
<=56	3,092	0	0	0	0	0	0	833	5
57 - 92	11,490	804	3	45	0	176	2	478	3
93 - 183	1,168	87,864	101	142	1	347	1	332	2
184 - 274	546	67,373	231	158,291	319	2,341	5	33,507	179
275 - 366	386	117,656	940	305,982	1,886	7,742	43	909,256	4,153
367 - 549	420	10,200	74	4,678	40	474	3	3,091	20
550 - 731	352	47	0	114	1	0	0	4,634	34
732 - 914	394	.	.	.	.	.	.	.	
915 -1097	411	.	.	.	.	.	.	.	
1098 -1280	491	.	.	.	.	.	.	.	
1281 -1463	773	.	.	.	.	.	.	.	
Total (000's)		283,943	1,349	469,254	2,248	11,081	53	952,132	4,395
Upper 95% limit		862,737	11,209	4,430,958	24,096	47,633	278	11,963,959	54,237
Lower 95% limit		-294,852	-8,511	-3,492,450	-19,601	-25,471	-171	-10,059,695	-45,448
%<184m		31	8	0	0	5	4	0	0
%184 - 549 m		69	92	100	100	95	96	99	99
%>549 m		0	0	0	0	0	0	1	1
				Outside 200 Nmi limit					
<=56	1605	0	0	0	0	0	0	741	5
57 - 92	2996	10	0	0	0	0	0	0	0
93 - 183	864	87,864	101	75	1	347	1	176	1
184 - 274	508	63,910	220	128,087	260	1,981	4	29,282	156
275 - 366	366	116,431	932	303,944	1,876	6,545	37	755,829	3,455
367 - 549	420	10,200	74	4,678	40	474	3	3,091	20
550 - 731	352	47	.	114	1	0	0	4,634	34
732 - 914	394	.	.	.	.	.	.	.	.
915 -1097	411	.	.	.	.	.	.	.	.
1098 -1280	491	.	.	.	.	.	.	.	.
1281 -1463	773	.	.	.	.	.	.	.	.
Total (000's)		278,461	1,327	436,899	2,178	9,347	45	793,754	3,670
Upper 95% limit		856,035	11,176	4,236,408	23,915	39,743	232	9,908,448	44,929
Lower 95% limit		-299,112	-8,523	-3,362,610	-19,559	-21,049	-143	-8,320,940	-37,589
%<184m		32	8	0	0	4	1	0	0
%184 - 549 m		68	92	100	100	96	99	99	99
%>549 m		0	0	0	0	0	0	1	1

Table 7 Total abundance (X 1000), biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the spring 1999 - 2002 Canadi multi-species research surveys into NAFO Div. 3O. (All tows were standardized to 15 minutes; . means not sampled.).

Please note that these estimates were taken from strata numbers >784 so that estimates from all years would be comparable.

Depth Range in m	Area in Nmi2	Spring 99 WT 238 & 239		Spring 2000 WT 316 - 317		Spring 2001 WT 365, 367 & WT 368		Spring 2002 WT 419 & WT 421	
		abundance (x 1000)	biomass (Kg X 1000)	abundance (x 1000)	biomass (Kg X 1000)	abundance (x 1000)	biomass (Kg X 1000)	abundance (x 1000)	biomass (Kg X 1000)
57 - 92	12541	126	0	0	0	1,037	3	1,308	5
93 - 183	4775	8,592	12	508	1	3,540	13	474	2
184 - 274	371	2,528	11	2,269	7	486	2	1,004	5
275 - 366	215	1,097	8	3,983	29	7	0	28	0
367 - 549	318	298	3	264	2	263	2	3,697	22
550 - 731	332	0	0	797	7	0	0	30	0
732 - 914	339	.	.	.	.	.	.	.	.
915 -1097	390	.	.	.	.	.	.	.	.
1098 -1280	407	.	.	.	.	.	.	.	.
1281 -1463	488	.	.	.	.	.	.	.	.
Total (000's)		12,642	34	7,823	46	5,332	20	6,541	35
Upper 95% limit		35,594	63	61,843	399	27,536	99	17,006	95
Lower 95% limit		-10,311	5	-46,198	-307	-16,872	-60	-3,924	-25
%<184m		69	37	6	3	86	81	27	20
%184 - 549 m		31	63	83	83	14	19	72	80
%>549 m		0	0	10	14	0	0	0	1
				Outside 200 Nmi limit					
57 - 92	269	0	0	0	0	0	0	0	0
93 - 183	246	0	0	0	0	0	0	0	0
184 - 274	74	0	0	29	0	54	0	0	0
275 - 366	47	0	0	0	0	0	0	0	0
367 - 549	58	0	0	133	1	201	1	705.87	4
550 - 731	71	0	0	603	5	0	0	22.98	0
732 - 914	105	.	.	.	.	.	.	.	.
915 -1097	124	.	.	.	.	.	.	.	.
1098 -1280	147	.	.	.	.	.	.	.	.
1281 -1463	180	.	.	.	.	.	.	.	.
Total (000's)		0	0	764	6	255	2	729	4
Upper 95% limit		0	0	8,498	69	2,582	17	9,320	56
Lower 95% limit		0	0	-6,970	-58	-2,073	-14	-7,862	-48
%<184m		0	0	0	0	0	0	0	0
%184 - 549 m		0	0	21	15	100	100	97	97
%>549 m		0	0	79	85	0	0	3	3

Table 8 Various formulations of the average percent of the total *Pandalus borealis* biomass within the 3LNO NRA.
Shrimp were collected during the autumn Canadian multi-species surveys using a Campelen 1800 shrimp trawl.
(15 minute standard tows.)

Season	Year	Division	Entire Division biomass estimate (Kg x 1000)	Biomass estimate within NRA (Kg x 1000)	Percent of biomass within the NRA: raw percent	three year running average	three year running weighted average	three year running geometric mean
autumn	1995	3L	5,920	1,039	17.56	17.56	17.56	17.56
autumn	1996	3L	18,566	4,506	24.27	20.91	22.65	20.64
autumn	1997	3L	45,758	5,115	11.18	17.67	15.18	16.82
autumn	1998	3L	56,485	8,707	15.42	16.95	15.17	16.11
autumn	1999	3L	52,863	8,734	16.52	14.37	14.54	14.17
autumn	2000	3L	117,902	28,447	24.13	18.69	20.19	18.32
autumn	2001	3L	223,149	52,292	23.43	21.36	22.71	21.06
autumn	1995	3N	533	497	93.29	93.29	93.29	93.29
autumn	1996	3N	1,514	1,356	89.52	91.40	90.50	91.38
autumn	1997	3N	427	391	91.52	91.44	90.67	91.43
autumn	1998	3N	3,360	2,786	82.91	87.98	85.49	87.90
autumn	1999	3N	272	232	85.57	86.67	84.00	86.59
autumn	2000	3N	270	240	88.80	85.76	83.51	85.73
autumn	2001	3N	836	809	96.77	90.38	93.00	90.26
autumn	1995	3O	31	1	1.82	1.82	1.82	1.82
autumn	1996	3O	9	1	12.50	7.16	4.24	4.78
autumn	1997	3O	17	4	23.79	12.70	10.10	8.16
autumn	1998	3O	69	15	21.23	19.17	20.87	18.48
autumn	1999	3O	9	3	33.59	26.21	22.87	25.70
autumn	2000	3O	8	1	8.02	20.95	21.36	17.88
autumn	2001	3O	10	3	30.00	23.87	24.91	20.07
	all divisions							
autumn	1995		5,921	1,537	25.96	25.96	25.96	25.96
autumn	1996		20,089	5,862	29.18	27.57	28.45	27.52
autumn	1997		46,202	5,509	11.92	22.35	17.88	20.83
autumn	1998		59,914	11,508	19.21	20.10	18.13	18.84
autumn	1999		53,144	8,969	16.88	16.00	16.32	15.69
autumn	2000		118,180	28,687	24.27	20.12	21.26	19.89
autumn	2001		223,995	53,104	23.71	21.62	22.96	21.34

Table 9 Various formulations of the percent of the total *Pandalus borealis* biomass within the 3LNO 200 Nmi limit.
Shrimp were collected during the spring Canadian multi-species surveys using a Campelen 1800 shrimp trawl.
(15 minute standard tows.)

Season	Year	Division	Entire Division biomass estimate (Kg x 1000)	Biomass estimate within NRA (Kg x 1000)	Percent of biomass within the NRA raw percent	three year running average	three year running weighted average	three year running geometric mean
spring	1999	3L	53,934	14,731	27.31	27.31	27.31	27.31
spring	2000	3L	119,521	36,127	30.23	28.77	29.32	28.73
spring	2001	3L	103,378	18,714	18.10	25.21	25.13	24.63
spring	2002	3L	155,061	47,288	30.50	26.28	27.02	25.55
spring	1999	3N	1,349	1,327	98.34	98.34	98.34	98.34
spring	2000	3N	2,248	2,178	96.88	97.61	97.43	97.61
spring	2001	3N	53	45	83.89	93.04	97.23	92.80
spring	2002	3N	4,395	3,670	83.50	88.09	88.00	87.88
spring	1999	3O	34	0	0.00	0.00	0.00	0.00
spring	2000	3O	46	6	12.77	6.39	7.34	.
spring	2001	3O	20	2	7.84	6.87	7.44	.
spring	2002	3O	35	4	11.43	10.68	11.34	10.46
	all divisions							
spring	1999		55,317	16,057	29.03	29.03	29.03	29.03
spring	2000		121,815	38,310	31.45	30.24	30.69	30.21
spring	2001		102,566	18,761	18.29	26.26	26.15	25.56
spring	2002		159,491	50,962	31.95	27.23	28.14	26.39

Table 10 Various formulations of the average percent of the total *Pandalus borealis* biomass within the 3LNO NRA.
Shrimp were collected during the autumn Canadian multi-species surveys using a Campelen 1800 shrimp trawl.
Biomass estimates are the average between the spring and autumn for the period fall 1999 - spring 2002.

Year	Division	Entire Division	Biomass estimate	Percent of biomass within the NRA			
		biomass estimate	within NRA		three year	three year	three year
		(Kg x 1000)	(Kg x 1000)	raw percent	running average	running weighted	running geometric
						average	mean
1999	3L	53,399	11,732	21.97	21.97	21.97	21.97
2000	3L	118,711	32,287	27.20	24.58	25.58	24.45
2001	3L	189,105	49,790	26.33	25.17	25.97	25.06
1999	3N	810	779	96.20	96.20	96.20	96.20
2000	3N	1,259	1,209	96.01	96.11	96.09	96.11
2001	3N	2,616	2,240	85.62	92.61	90.25	92.48
1999	3O	31	2	4.87	4.87	4.87	4.87
2000	3O	4	3	84.53	44.70	13.58	20.30
2001	3O	23	4	15.56	34.99	14.35	18.58
	all divisions						
1999		54,240	12,513	23.07	23.07	23.07	23.07
2000		119,974	33,499	27.92	25.50	26.41	25.38
2001		191,743	52,033	27.14	26.04	26.79	25.95

Table 11 Abundance (000's) of male northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO during autumn Canadian research surveys during 1995 - 2001. The data were taken from strata <784 so that all years would be comparable.

Length in mm	Autumn 1995 WT 176 - 179 WT 181, Tel 22 & Tel 23	Autumn 1996 WT 196 - 198 Wt 200, AN 253, Tel 41 & 42	Autumn 1997 WT 212 - 217, Tel 57 & 58	Autumn 1998 WT 229 - 233 Tel 75 & 76	Autumn 1999 WT 244 - 248	Autumn 2000 WT 319 - 323, Tel 338, 339, 342 & Tel 343	Autumn 2001 WT 372 - 376, Tel 357, 358, 361 & AN 399
5,5	0	0	855	0	0	0	0
6,0	0	0	0	0	0	0	0
6,5	0	111	0	0	0	0	0
7,0	382	55	0	47	1.276	0	0
7,5	4.492	548	3.341	71	4.290	18.215	14.074
8,0	270	2.178	1.542	804	5.582	5.696	4.993
8,5	4.848	6.509	6.875	60.601	20.487	91.357	34.666
9,0	27.395	9.910	21.185	162.470	15.644	150.098	111.553
9,5	62.014	31.303	62.256	329.427	30.214	229.876	199.461
10,0	134.066	36.438	68.030	640.705	65.922	421.556	119.091
10,5	165.074	27.124	104.909	803.347	78.823	432.442	92.017
11,0	204.882	28.566	97.314	688.029	76.732	304.061	45.002
11,5	125.333	47.621	71.023	467.599	75.651	176.027	39.355
12,0	75.757	76.101	40.746	172.256	34.346	93.780	70.499
12,5	33.682	86.904	34.673	121.814	48.364	128.345	156.348
13,0	22.484	99.708	27.764	63.981	71.854	343.253	365.679
13,5	24.914	127.367	38.460	92.604	134.311	788.552	656.012
14,0	20.856	235.167	77.113	135.430	242.200	1.201.742	1.054.379
14,5	16.247	368.703	191.153	270.428	396.076	1.705.726	1.843.186
15,0	23.272	619.513	403.670	443.520	780.197	1.754.548	2.366.129
15,5	32.890	727.877	633.475	471.543	1.222.507	1.688.485	2.094.576
16,0	44.575	652.349	743.964	459.915	1.326.686	1.327.051	1.990.297
16,5	38.401	445.760	496.225	415.527	966.914	1.398.609	3.019.319
17,0	41.682	280.750	472.840	436.950	492.181	1.908.443	3.205.491
17,5	29.305	184.004	476.973	579.364	306.399	2.901.654	3.432.891
18,0	16.164	210.944	576.167	842.287	346.026	3.400.956	3.480.415
18,5	12.839	212.870	790.144	997.213	468.133	2.259.814	4.221.574
19,0	21.104	256.541	720.103	1.061.021	485.986	1.617.071	4.714.143
19,5	16.056	251.255	656.060	975.338	490.523	1.031.449	4.700.334
20,0	16.756	150.181	380.955	875.327	519.131	694.549	3.740.211
20,5	13.294	80.541	255.787	733.217	512.787	555.935	2.168.914
21,0	10.476	77.822	116.219	500.967	493.872	398.602	1.128.505
21,5	8.238	38.332	62.912	345.670	331.419	404.183	490.010
22,0	4.862	33.114	15.121	130.505	193.324	211.379	142.675
22,5	2.547	26.946	8.466	27.672	120.117	101.683	48.402
23,0	1.248	17.019	592	15.252	34.878	56.800	48.110
23,5	248	10.842	416	1.236	25.468	12.853	14.026
24,0	104	3.428	69	23	3.528	4.857	54
24,5	54	1.427	0	0	1.820	20	15
25,0	54	0	0	0	0	0	0
25,5	0	0	0	0	0	0	0
26,0	0	0	0	0	0	0	0
26,5	0	0	0	0	0	0	0
27,0	0	0	0	0	0	0	0
27,5	0	0	0	0	0	0	0
28,0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0
29,0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0
30,0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0
31,0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0
32,0	0	0	0	0	0	0	0
Total (000's)	1.256.864	5.465.828	7.657.395	13.322.160	10.423.664	27.819.667	45.812.405
Upper 95% limit	2.386.779	9.122.011	10.393.910	17.507.324	13.237.807	33.599.699	68.184.931
Lower 95% limit	126.949	1.809.644	4.920.880	9.136.997	7.609.522	22.039.635	23.439.879

Table 12 Abundance (000's) of transitional northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO during autumn Canadian research surveys during 1995 - 2001. The data were taken from strata <784 so that all years would be comparable.

Length in mm	Autumn 1995 WT 176 - 179 WT 181, Tel 22 & Tel 23	Autumn 1996 WT 196 - 198 Wt 200, AN 253, Tel 41 & 42	Autumn 1997 WT 212 - 217, Tel 57 & 58	Autumn 1998 WT 229 - 233 Tel 75 & 76	Autumn 1999 WT 244 - 248	Autumn 2000 WT 319 - 323, Tel 338, 339, 342 & Tel 343	Autumn 2001 WT 372 - 376, Tel 357, 358, 361 & AN 399
5,5	0	0	0	0	0	0	0
6,0	0	0	0	0	0	0	0
6,5	0	0	0	0	0	0	0
7,0	0	0	0	0	0	0	0
7,5	0	0	0	0	0	0	0
8,0	0	0	0	0	0	0	0
8,5	0	0	0	0	0	0	0
9,0	0	0	0	0	0	0	0
9,5	0	0	0	0	0	0	0
10,0	0	0	0	0	0	0	0
10,5	0	0	0	0	0	0	0
11,0	0	0	0	0	0	0	0
11,5	0	0	0	0	0	0	0
12,0	0	0	0	0	638	0	0
12,5	959	0	0	0	0	0	0
13,0	0	0	0	0	0	0	0
13,5	3.989	0	0	0	0	0	0
14,0	15.348	0	0	0	0	0	0
14,5	9.708	0	0	0	0	0	0
15,0	48.864	0	0	0	0	0	0
15,5	126.767	0	0	0	0	0	0
16,0	116.811	0	245	0	0	0	0
16,5	92.772	2.574	71	0	0	0	0
17,0	63.648	58	4.611	0	0	0	0
17,5	43.865	5.883	593	47	0	26	0
18,0	16.738	3.738	13.738	0	184	35.572	3.223
18,5	13.954	7.247	32.009	9.680	3.945	62.928	4.445
19,0	16.792	13.926	68.940	9.390	16.718	96.459	54.568
19,5	18.622	22.211	193.204	47.758	35.375	94.795	136.497
20,0	19.354	30.842	221.376	55.099	70.631	248.462	273.335
20,5	17.089	26.876	382.406	86.637	139.780	220.411	289.877
21,0	16.499	9.931	407.291	104.502	267.540	326.132	250.074
21,5	20.577	19.652	360.800	79.428	374.626	275.908	160.120
22,0	22.242	6.808	201.701	45.695	317.088	172.006	86.509
22,5	17.315	8.842	107.364	20.662	211.040	178.600	12.625
23,0	13.263	430	55.497	4.126	87.859	111.377	4.240
23,5	8.503	41	25.610	0	46.931	26.702	9.245
24,0	2.988	42	6.821	0	44.066	9.989	0
24,5	3.041	16	4.102	11	3.151	6.221	0
25,0	432	7	40	0	0	1.707	0
25,5	129	0	23	0	0	0	0
26,0	10	0	0	0	0	0	0
26,5	0	0	0	0	0	0	0
27,0	10	0	0	0	0	0	0
27,5	60	0	0	0	0	0	0
28,0	0	0	0	0	0	0	0
28,5	0	0	0	0	0	0	0
29,0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0
30,0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0
31,0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0
32,0	0	0	0	0	0	0	0
Total (000's)	730.345	159.123	2.086.440	463.035	1.619.572	1.867.295	1.284.757
Upper 95% limit	1.088.041	434.880	3.539.739	651.862	2.170.017	3.039.382	1.837.752
Lower 95% limit	372.650	-116.634	633.141	274.208	1.069.127	695.208	731.762

Table 13 Abundance (000's) of multiparous + ovigerous northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO during autumn Ca research surveys during 1995 - 2000. The data were taken from strata <784 so that all years would be comparable.

Length in	Autumn 1995	Autumn 1996	Autumn 1997	Autumn 1998	Autumn 1999	Autumn 2000	Autumn 2001
mm	WT 176 - 179	WT 196 - 198	WT 212 - 217,	WT 229 - 233	WT 244 - 248	WT 319 - 323,	WT 372 - 376,
	WT 181, Tel 22	Vt 200, AN 253,	Tel 57 & 58	Tel 75 & 76	Tel 338, 339, 342		Tel 357, 358, 361
	& Tel 23	Tel 41 & 42				& Tel 343	& AN 399
10,0	0	0	0	0	0	0	0
10,5	0	0	0	0	0	0	0
11,0	0	0	0	0	0	0	0
11,5	0	58	0	0	0	0	0
12,0	0	0	0	0	0	0	3.421
12,5	0	58	0	0	0	0	0
13,0	0	0	0	0	0	0	0
13,5	0	0	0	0	1.792	0	0
14,0	0	0	523	0	0	0	0
14,5	0	289	0	0	0	0	0
15,0	755	457	0	0	0	0	0
15,5	0	58	0	406	0	0	0
16,0	0	231	3.135	4.834	0	0	2.616
16,5	0	231	1.305	4.760	3.918	9.912	19.479
17,0	0	0	1.317	7.548	8.841	56	38.682
17,5	0	1.662	2.673	6.860	7.583	3.125	30.676
18,0	298	284	1.370	9.586	7.744	17.122	13.825
18,5	0	1.023	3.401	1.833	6.374	7.538	39.320
19,0	724	6.087	3.195	1.069	14.008	9.610	27.101
19,5	506	6	4.004	5.013	4.277	11.738	61.304
20,0	438	391	7.986	9.164	10.157	5.495	75.227
20,5	60	847	8.832	24.229	7.455	27.118	120.651
21,0	746	1.190	21.861	55.240	17.745	58.720	431.617
21,5	2.290	4.362	48.246	115.863	39.186	118.559	524.140
22,0	2.766	4.119	66.829	186.364	79.099	153.368	807.568
22,5	4.067	14.577	83.857	251.298	103.443	293.286	957.566
23,0	6.211	24.802	95.627	248.676	150.063	290.711	909.836
23,5	6.281	25.728	99.927	188.663	149.734	395.290	777.056
24,0	8.159	20.280	78.887	161.696	153.122	406.877	717.568
24,5	12.241	30.367	82.838	98.121	84.113	285.001	559.677
25,0	8.434	30.943	72.359	66.753	75.424	186.106	455.051
25,5	9.094	23.848	40.667	42.105	43.163	91.892	192.569
26,0	7.674	17.710	23.821	20.125	23.975	41.133	107.162
26,5	6.583	11.484	5.331	10.911	11.335	37.121	43.124
27,0	4.562	6.745	5.910	10.571	7.471	5.231	37.794
27,5	2.347	3.847	10.963	3.796	4.668	5.885	17.942
28,0	2.569	2.376	2.270	5.916	3.070	1.994	5.520
28,5	827	2.815	1.759	1.823	674	226	878
29,0	374	2.198	1.650	309	1.300	79	229
29,5	670	1.635	356	0	197	2.262	54
30,0	79	1.227	238	17	67	0	54
30,5	50	1.138	110	20	79	0	0
31,0	0	110	106	0	0	869	0
31,5	0	135	0	20	14	0	0
32,0	0	0	0	0	0	0	0
Total (000's)	88.805	243.314	781.349	1.543.586	1.020.090	2.466.323	6.977.708
Upper 95% limit	437.945	538.855	1.558.469	2.196.382	1.526.132	3.772.757	11.770.822

Table 14 Abundance (000's) of male northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO during spring Canadian research surveys during 1999 - 2002. The data were taken from strata <784 so that all years would be comparable.

Length in mm	Spring 1999 WT 238 - 241	Spring 2000 WT 315 - 318	Spring 2001 WT 365 & WT 367-370	Spring 2002 WT 419 & WT 421 - 424
5,5	0	0	0	0
6,0	0	0	0	0
6,5	629	0	2.909	3.092
7,0	10.950	14.387	7.218	28.159
7,5	4.505	46.869	36.791	159.756
8,0	21.825	95.301	36.831	136.376
8,5	26.815	135.840	11.852	93.359
9,0	15.785	74.180	137	27.860
9,5	28.176	39.831	9.711	10.798
10,0	14.367	34.300	20.829	17.085
10,5	15.123	60.587	36.128	129.491
11,0	24.841	50.993	184.768	122.222
11,5	29.581	169.630	201.256	367.118
12,0	49.207	274.247	312.945	399.854
12,5	135.597	455.568	614.303	579.093
13,0	267.629	891.854	689.768	432.246
13,5	704.706	994.659	744.396	405.781
14,0	804.028	1.028.440	681.121	298.773
14,5	840.930	716.927	508.801	362.284
15,0	741.258	742.644	484.341	760.694
15,5	435.207	614.294	795.068	1.304.791
16,0	192.745	613.210	879.612	1.608.691
16,5	121.670	771.835	1.351.224	1.945.095
17,0	283.562	1.358.786	1.288.397	2.329.591
17,5	339.923	1.647.536	1.540.283	2.616.479
18,0	518.383	1.633.388	1.575.429	2.497.661
18,5	479.302	1.241.221	1.787.205	2.354.153
19,0	490.357	617.208	1.901.729	2.220.763
19,5	593.703	687.161	1.647.032	2.046.579
20,0	742.174	435.102	1.007.472	1.767.802
20,5	690.630	547.918	452.165	1.083.680
21,0	484.495	409.895	232.646	467.015
21,5	413.102	247.461	87.887	150.834
22,0	115.645	179.686	52.072	41.214
22,5	54.782	116.076	13.845	10.202
23,0	23.786	13.182	8.716	5
23,5	6.794	8.366	15.237	0
24,0	1.089	189	20	0
24,5	0	0	0	0
25,0	0	0	0	0
25,5	0	0	4.183	0
26,0	0	0	0	0
26,5	0	0	0	0
27,0	0	0	0	0
27,5	0	0	0	0
28,0	0	0	0	0
28,5	0	0	0	0
29,0	0	0	0	0
29,5	0	0	0	0
30,0	0	0	0	0
30,5	0	0	0	0
31,0	0	0	0	0
31,5	0	0	0	0
32,0	0	0	0	0
Total (000's)	9.723.302	16.968.771	19.224.326	26.778.595
Upper 95% limit	18.079.360	36.240.923	29.374.530	34.873.186
Lower 95% limit	1.367.243	-2.303.381	9.074.122	18.684.004

Table 15 Abundance (000's) of transitional + primiparous northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO during spring Canadian research surveys during 1999 - 2002. The data were taken from strata <784 so that all years would be comparable.

Length in mm	Spring 1999 WT 238 - 241	Spring 2000 WT 315 - 318	Spring 2001 WT 365 & WT 367-370	Spring 2002 WT 419 & WT 421 - 424
15,0	0	0	24	0
15,5	0	0	48	0
16,0	0	0	18.876	1.506
16,5	0	0	72	37
17,0	156	3.153	11.856	0
17,5	2.752	5.615	7.865	0
18,0	4	13.755	72	6.328
18,5	6.041	11	9.508	16.462
19,0	2.314	15.948	27.507	14.549
19,5	21.171	60.712	127.445	190.044
20,0	13.436	117.600	240.083	785.681
20,5	48.071	254.028	430.125	1.290.489
21,0	96.358	328.120	440.732	1.703.644
21,5	182.755	601.082	428.310	1.625.473
22,0	390.113	636.319	376.987	1.249.021
22,5	498.405	811.106	353.202	607.802
23,0	403.913	861.544	300.325	230.005
23,5	349.581	843.773	136.802	55.564
24,0	186.312	376.890	106.178	29.508
24,5	89.024	246.273	42.713	9.749
25,0	39.463	147.609	34.772	9.347
25,5	7.782	44.764	1.090	50
26,0	1.582	19.820	855	152
26,5	46	1.121	233	0
27,0	0	230	166	0
27,5	0	0	0	0
28,0	0	0	0	0
28,5	0	0	0	0
29,0	0	0	0	0
29,5	0	0	0	0
30,0	0	0	0	0
30,5	0	0	0	0
31,0	0	0	0	0
31,5	0	0	0	0
32,0	0	0	0	0
Total (000's)	2.339.278	5.389.472	3.095.845	7.825.407
Upper 95% limit	4.226.450	11.814.756	4.679.470	9.566.813
Lower 95% limit	452.105	-1.035.812	1.512.221	6.084.002

Table 16 Abundance (000's) of ovigerous female northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO collected during spring Canadianresearch surveys during 1999 - 2002. The data were taken from strata <784 so that all years would be comparable.

Length in mm	Spring 1999 WT 238 - 241	Spring 2000 WT 315 - 318	Spring 2001 WT 365 & WT 367-370	Spring 2002 WT 419 & WT 421 - 424
18,5	0	0	11.034	0
19,0	0	0	0	0
19,5	0	0	0	0
20,0	0	0	0	0
20,5	0	0	0	0
21,0	0	0	0	76
21,5	2.792	0	0	76
22,0	2.222	0	0	124
22,5	0	0	106	76
23,0	0	2.435	0	0
23,5	0	46	0	0
24,0	0	23	0	0
24,5	0	1.351	0	0
25,0	32	56	0	0
25,5	0	11	0	0
26,0	0	0	51	60
26,5	0	0	0	0
27,0	0	0	0	60
27,5	0	0	0	0
28,0	0	0	0	0
28,5	0	0	0	0
29,0	0	0	0	0
29,5	0	0	0	0
30,0	0	0	0	0
30,5	0	0	0	0
31,0	0	0	0	0
31,5	0	0	0	0
32,0	0	0	0	0
Total (000's)	5.046	3.921	11.191	471
Upper 95% limit	17.120	12.743	151.399	1.699
Lower 95% limit	-7.028	-4.901	-129.016	-757

Table 17 Abundance (000's) of multiparous female northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO collected during spring Canadianresearch surveys during 1999 - 2002. The data were taken from strata <784 so that all years would be comparable.

Length in mm	Spring 1999 WT 238 - 241	Spring 2000 WT 315 - 318	Spring 2001 WT 365 & WT 367-370	Spring 2002 WT 419 & WT 421 - 424
13,5	0	0	7.841	0
14,0	0	0	0	0
14,5	0	0	0	0
15,0	0	3.153	0	0
15,5	0	0	0	0
16,0	0	0	0	1.979
16,5	0	0	2.651	32
17,0	257	0	14.678	19.046
17,5	4.309	22	12.677	26.020
18,0	6.357	24.194	2.789	3.049
18,5	6.452	19.307	15.383	42.140
19,0	10.509	18.883	18.738	20.218
19,5	2.204	14.316	24.397	12.510
20,0	2.723	22.939	36.410	27.532
20,5	2.296	36.349	13.971	98.216
21,0	10.165	36.223	33.871	100.823
21,5	6.067	152.084	76.698	195.630
22,0	33.072	217.812	198.823	255.134
22,5	42.180	288.943	208.713	355.844
23,0	61.102	315.931	355.834	367.421
23,5	87.701	384.238	394.172	368.020
24,0	110.767	407.007	385.297	412.853
24,5	78.498	317.258	317.707	203.134
25,0	60.844	160.754	205.918	182.827
25,5	60.492	94.156	155.971	78.257
26,0	23.344	58.375	91.262	61.327
26,5	11.183	48.109	57.068	54.885
27,0	4.979	19.528	21.669	18.430
27,5	8.045	5.589	4.161	578
28,0	2.968	3.358	13.606	70
28,5	3.230	3.077	1.304	0
29,0	1.148	2.604	1.022	71
29,5	581	254	437	0
30,0	327	363	0	16
30,5	52	36	0	0
31,0	212	57	0	0
31,5	0	62	0	0
32,0	0	36	0	0
Total (000's)	637.017	2.651.092	2.661.877	2.905.589
Upper 95% limit	889.555	9.114.943	3.504.919	4.421.310
Lower 95% limit	384.478	-3.812.759	1.818.836	1.389.867

Table 18 Modal analysis using MIX 3.1a (MacDonald and Pitcher, 1993) of male *P. borealis* collected during the autumn 1995 – 2001 Canadian research bottom trawl surveys in 3LNO.

Mean carapace length (Standard error/ constraints)

Year Class	1995	1996	1997	1998	1999	2000	2001
1992	19.5 (0.356)	21.0 (0.048)					
1993	15.5 (0.162)	19.0 (0.242)					
1994	10.5 (0.037)	15.5 (0.064)	19.0 (0.104)	20.5 (0.685)			
1995			15.5 (0.109)	18.5 (0.456)	21.0 (0.189)		
1996				15.5 (0.33)	19.0 (fized)	20.5 (0.155)	
1997				10.5 (0.059)	15.5 (0.063)	17.5 (0.076)	19.0 (0.001)
1998						14.5 (0.122)	17.0 (0.002)
1999						10.0 (0.125)	14.5 (0.001)
2000							

Estimated proportion (Standard error/ constraints) contributed by each year class

Year Class	1995	1996	1997	1998	1999	2000	2001
1992	.096 (0.017)	.048 (0.066)					
1993	.224 (0.019)	.210 (0.077)					
1994	.680 (0.037)	.742 (0.022)	.580 (0.035)	.186 (0.179)			
1995			.420 (0.035)	.349 (0.210)	.161 (0.031)		
1996				.205 (0.046)	.241 (0.045)	.073 (0.012)	
1997				.260 (0.014)	.598 (0.024)	.538 (0.033)	.505 (0.000)
1998						.324 (0.029)	.288 (0.000)
1999						.066 (0.008)	.206 (0.000)
2000							

Distribution Sigmas (Standard error/ constraints)

Year Class	1995	1996	1997	1998	1999	2000	2001
1992	1.47 (0.23)	0.99 (0.706)					
1993	1.35 (fixed)	0.82 (0.218)					
1994	0.91 (0.03)	1.11 (0.050)	1.11 (0.068)	0.84 (0.223)			
1995			0.95 (0.068)	0.93 (0.372)	0.90 (0.111)		
1996				1.16 (0.214)	0.97 (0.194)	0.80 (fixed)	
1997				0.88 (0.047)	1.00 (0.050)	0.96 (0.080)	0.99 (0.000)
1998						0.99 (0.092)	0.94 (fixed)
1999						0.87 (0.102)	0.99 (0.001
2000							

Table 19. Estimated demographics of the *P. borealis* population (x 1000) in 3LNO from Canadian autumn research bottom trawl survey data, 1995 – 2001.

Males

Ages	1995	1996	1997	1998	1999	2000	2001
0	5,144	2,893	5,738	922	11,148	23,911	19,067
1	850,782	350,477	507,011	3,460,131	446,182	1,827,106	711,644
2	279,857	3,769,677	2,999,014	2,738,721	5,960,555	8,981,677	9,287,971
3	120,622	1,067,965	4,144,557	4,648,007	2,399,801	14,901,267	12,975,067
4	461	242,101	1,007	2,473,121	1,600,531	2,011,175	22,756,452
5+		32,716	69	1,259	5,348	74,531	62,205
Total	1,256,866	5,465,829	7,657,396	13,322,161	10,423,565	27,819,667	45,812,406

Transitionals + Primiparous Females

Ages	1995	1996	1997	1998	1999	2000	2001
0	0	0	0	0	0	0	0
1	959	0	0	0	638	0	0
2	477,906	2,631	4,927	0	0	0	0
3	129,324	83,847	529,860	121,974	126,853	538,242	472,068
4	115,487	72,580	1,540,668	341,051	1,444,864	1,311,136	812,689
5+	6,669	65	10,986	11	47,217	17,917	0
Total	730,345	159,123	2,086,441	463,036	1,619,572	1,867,295	1,284,757

Multiparous and Ovigerous Females

Ages	1995	1996	1997	1998	1999	2000	2001
0	0	0	0	0	0	0	0
1	0	116	0	0	0	0	3,421
2	755	1,266	6,279	17,547	14,551	9,968	60,777
3	1,966	9,452	22,628	33,524	50,143	54,627	247,452
4	22,421	75,623	425,179	1,070,332	546,724	1,337,052	4,528,434
5+	63,664	156,858	327,264	422,182	408,672	1,064,676	2,137,624
Total	88,806	243,315	781,350	1,543,585	1,020,050	2,466,323	6,977,708

Combined maturity stage

Ages	1995	1996	1997	1998	1999	2000	2001
0	5,144	2,893	5,738	992	11,148	23,911	19,067
1	851,741	350,593	507,011	3,460,131	446,821	1,827,106	715,065
2	758,517	3,773,574	3,010,219	2,756,268	5,975,106	8,991,645	9,348,748
3	251,912	1,161,263	4,697,044	4,803,505	2,576,796	15,494,137	13,694,588
4	138,369	390,304	1,966,854	3,884,503	3,592,120	4,659,363	28,097,575
5+	70,333	189,639	338,319	423,452	461,237	1,157,124	2,199,829
Total	2,076,016	5,868,266	10,525,185	15,328,851	13,063,228	32,153,286	54,074,872

Table 20. Modal analysis using MIX 3.1a (MacDonald and Pitcher, 1993) of male *P. borealis* collected during the spring 1999 – 2002 Canadian research bottom trawl surveys in 3LNO.

Mean carapace length (Standard error/ constraints)

Year Class	1999	2000	2001	2002
1995	20.0 (0.148)			
1996	17.5 (0.175)	20.0 (0.299)		
1997	14.0 (0.054)	17.5 (0.087)	18.5 (0.202)	
1998		13.5 (0.116)	16.0 (0.252)	18.5 (0.030)
1999		8.0 (0.160)	13.0 (0.192)	16.5 (0.028)
2000				12.5 (0.031)
2001				7.5 (0.026)

Estimated proportions (Standard error/ constraints)

Year Class	1999	2000	2001	2002
1995	.391 (0.0388)			
1996	.162 (0.0400)	.162 (0.0327)		
1997	.447 (0.0170)	.429 (0.0427)	.540 (0.0760)	
1998		.384 (0.0224)	.225 (0.0872)	.510 (0.099)
1999		.025 (0.0051)	.235 (0.0251)	.366 (0.017)
2000				.107 (0.022)
2001				.017 (0.000)

Distribution Sigmas (Standard error/ constraints)

Year Class	1999	2000	2001	2002
1995	1.024 (0.088)			
1996	0.719 (0.143)	1.092 (0.166)		
1997	0.953 (0.043)	0.862 (0.090)	1.091 (0.101)	
1998		1.312 (0.091)	0.829 (0.217)	1.136 (0.019)
1999		0.707 (0.130)	1.221 (0.123)	1.000 (fixed)
2000				1.100 (0.024)
2001				0.506 (0.020)

Table 21. Estimated demographics of the *P. borealis* population (x 1000) in 3LNO from Canadian spring research bottom trawl survey data, 1999 – 2002.

Males

Age	1999	2000	2001	2002
0	16,084	0	46,918	0
1	146,932	424,175	58,531	445,596
2	4,275,446	6,505,091	4,473,146	2,853,794
3	1,546,582	7,275,932	4,299,547	9,811,140
4	3,737,168	2,755,017	10,303,994	13,668,060
5+	1,089	8,556	41,999	5
Total	9,723,301	16,968,771	19,224,135	26,778,595

Transitionals + Primiparous Females

Age	1999	2000	2001	2002
0	0	0	0	0
1	0	0	0	0
2	0	0	24	0
3	11,267	38,482	75,804	38,882
4	1,654,222	3,670,511	2,697,208	7,682,158
5+	673,789	1,680,479	322,809	104,369
Total	2,339,278	5,389,472	3,095,845	7,825,409

Ovigerous + Multiparous Females

Age	1999	2000	2001	2002
0	0	0	0	0
1	0	0	0	0
2	0	3,153	7,841	0
3	27,884	62,406	66,917	112,483
4	159,807	1,084,596	948,718	1,413,110
5+	454,371	1,504,859	1,649,593	1,380,467
Total	642,062	2,655,014	2,673,069	2,906,060

Combined Maturity Stage

Age	1999	2000	2001	2002
0	16,084	0	46,918	0
1	146,932	424,175	58,531	445,596
2	4,275,446	6,508,244	4,481,012	2,853,794
3	1,585,734	7,376,820	4,442,268	9,962,505
4	5,551,197	7,510,125	13,949,920	22,763,327
5+	1,129,250	3,193,893	2,014,401	1,484,841
Total	12,704,643	25,013,257	24,993,050	37,510,063

Table 22. Estimated bycatch of Atlantic cod (*Gadus morhua*), redfish (*Sebastes mentella*), American plaice (*Hippoglossoides platessoides*) and Greenland halibut (*Rheinhardtius hippoglossoides*) taken by the large vessel (=> 500 t) fleet during 2001 and 2002. (. Means missing value)

	2001	2002
Observed shrimp catch (t)	2,313 t	582 t
Nominal shrimp catch (t)	2,394 t	2,452 t
Percent observed	96.6%	23.7%
Correction factor	1.0	4.2
Number of vessels observed	7	3
Number of trips observed	13	5
Number of sets observed	491	113
Species		
American plaice		
Bycatch (corrected by ratio observed)	1116 kg	303 kg
Kg/ton shrimp caught	0.466 kg/t	0.123 kg/t
Number measured	0	0
Number in bycatch (corrected by ratio observed)	.	.
Number of sets with American plaice (corrected by ratio observed)	347	206
Atlantic cod		
Bycatch (corrected by ratio observed)	229 kg	164 kg
Kg/ton shrimp caught	0.096 kg/t	0.067 kg/t
Number measured	17	6
Number in bycatch (corrected by ratio observed)	556	328
Number of sets with Atlantic cod (corrected by ratio observed)	178	147
Redfish		
Bycatch (corrected by ratio observed)	972 kg	1424 kg
Kg/ton shrimp caught	0.406 kg/t	0.580 kg/t
Number measured	0	0
Number in bycatch (corrected by ratio observed)	.	.
Number of sets with redfish (corrected by ratio observed)	442	454
Greenland halibut		
Bycatch (corrected by ratio observed)	5,660 kg	4,754 kg
Kg/ton shrimp caught	2.364 kg/t	1.939 kg/t
Number measured	2,732	577
Number in bycatch (corrected by ratio observed)	52,473	48,898
Number of sets with Greenland halibut (corrected by ratio observed)	488	336

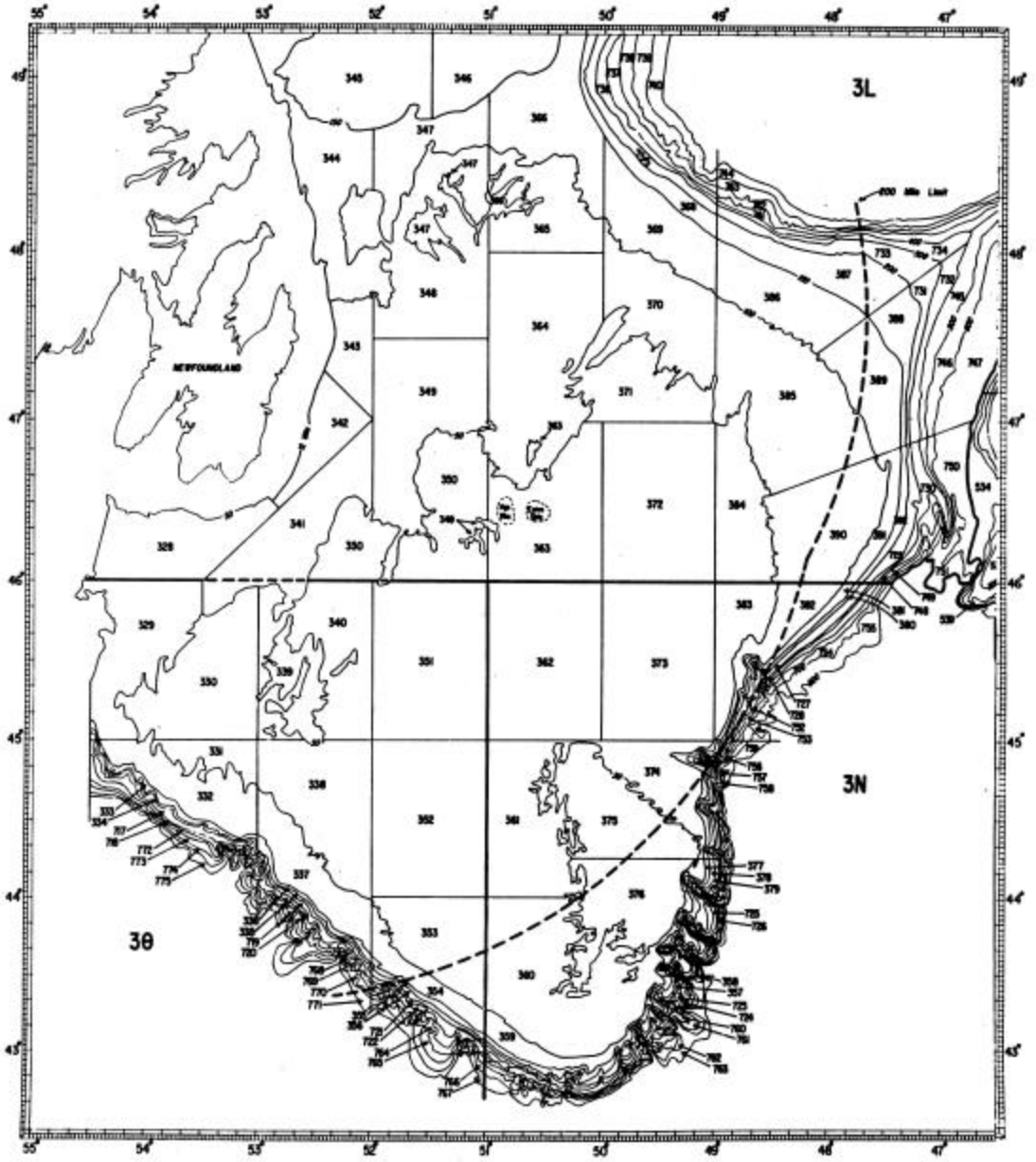

Figure 1. Stratified area for Canadian research trawl surveys in NAFO Div. 3LNO.

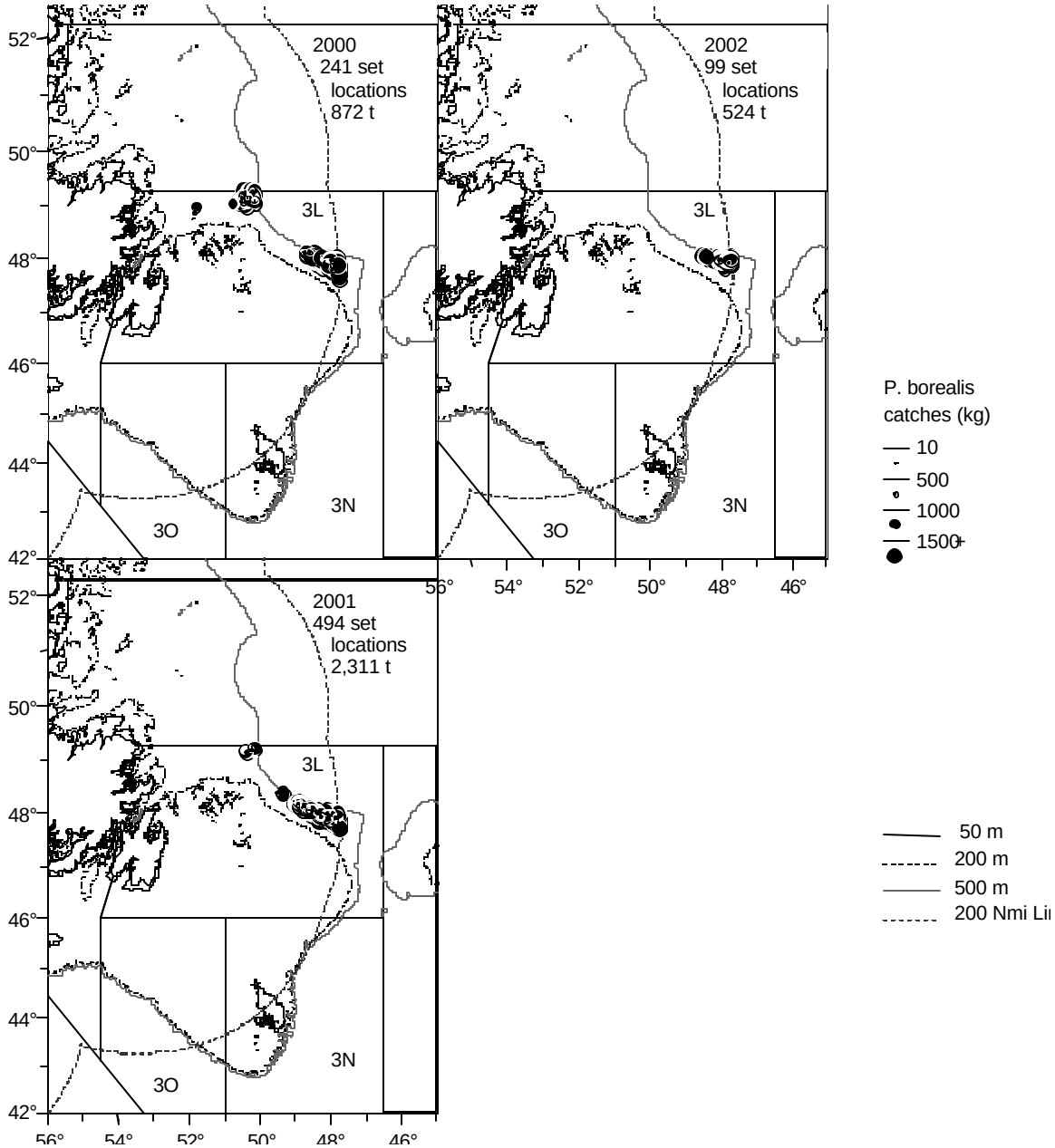

Figure 2 Canadian large vessel (=>500 t) shrimp catches during 2000 – 2002. (Observer data)

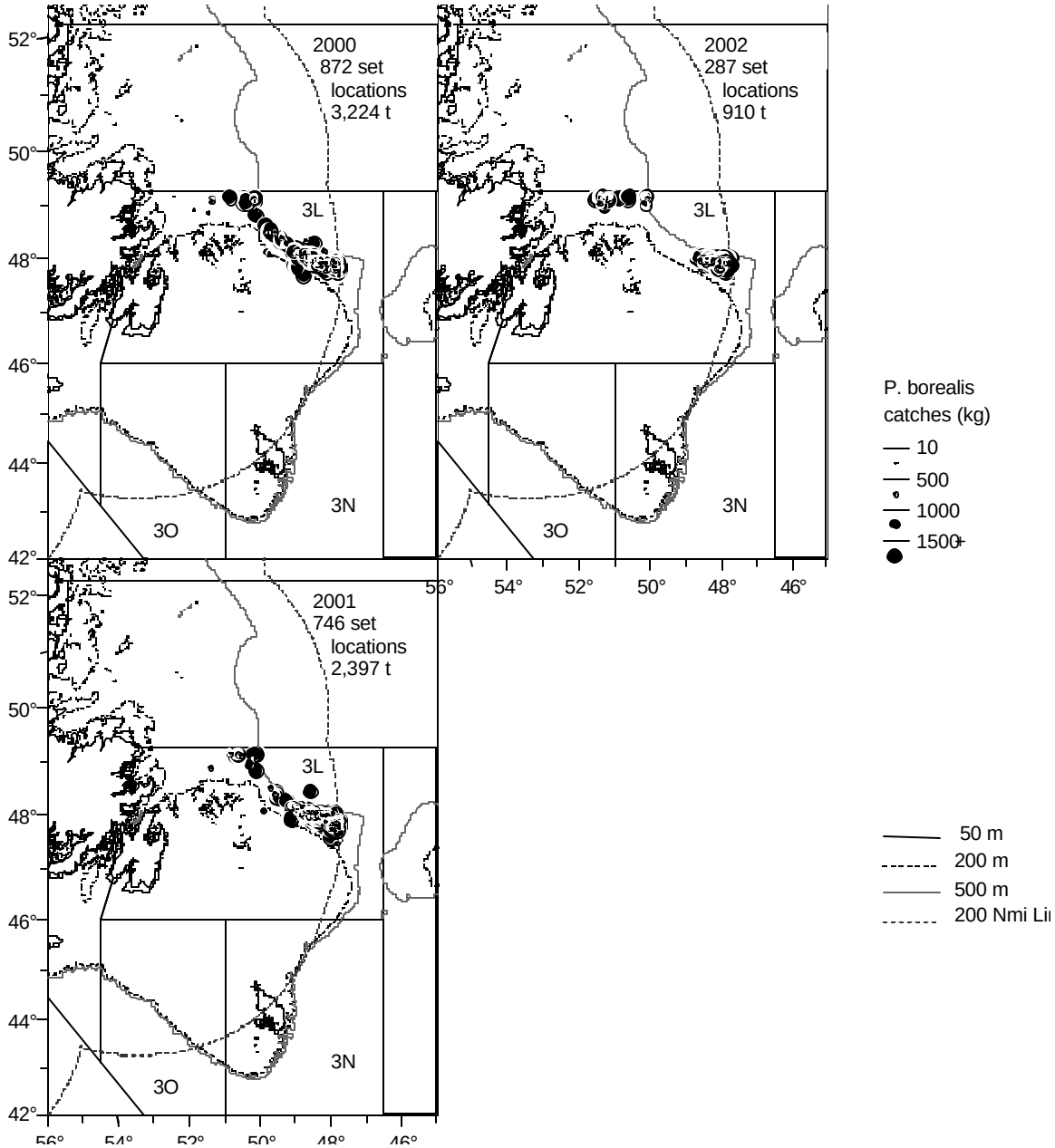

Figure 3 Canadian small vessel (<500 t; <100') shrimp catches during 2000 – 2002. (Logbook data)

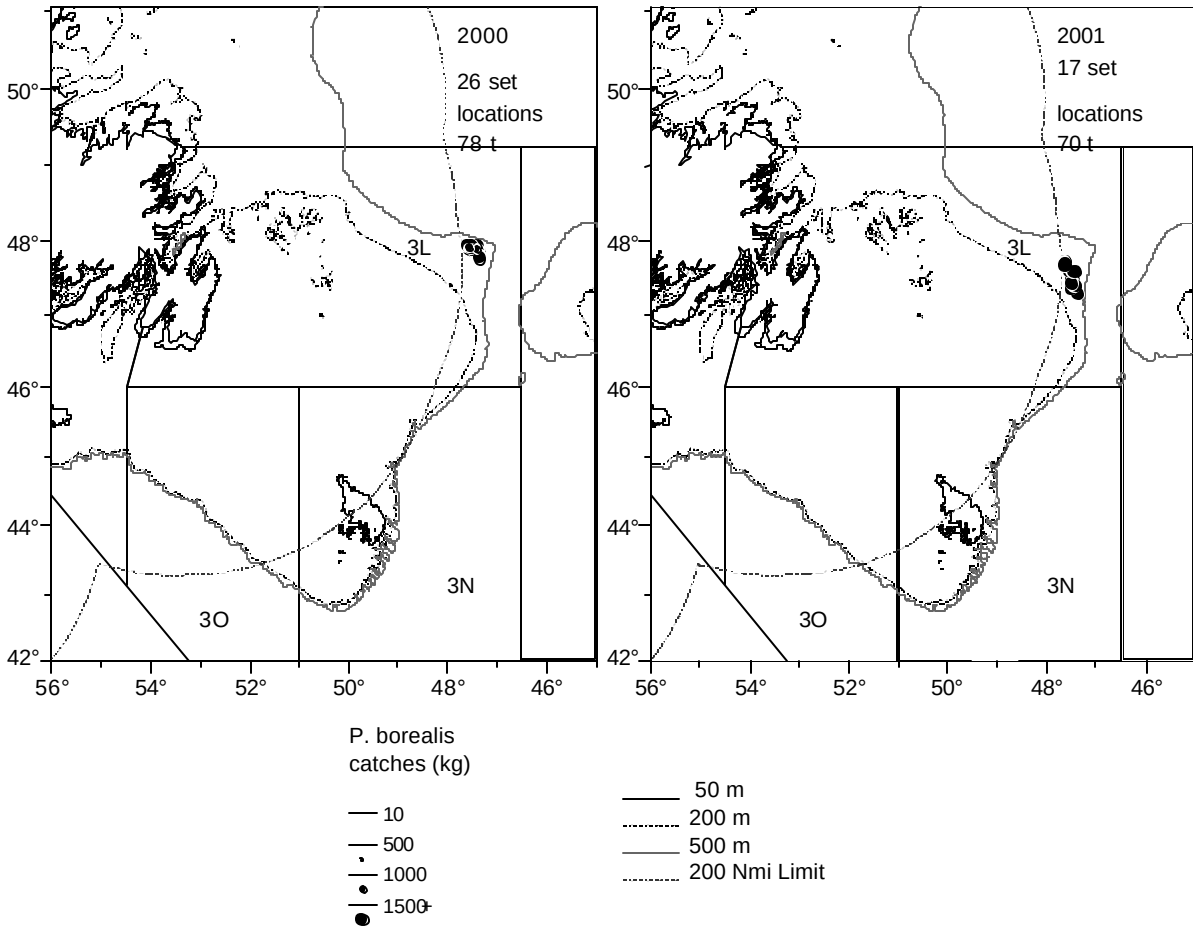

Figure 4 Norwegian shrimp catches during 2000 – 2001. (Observer data).

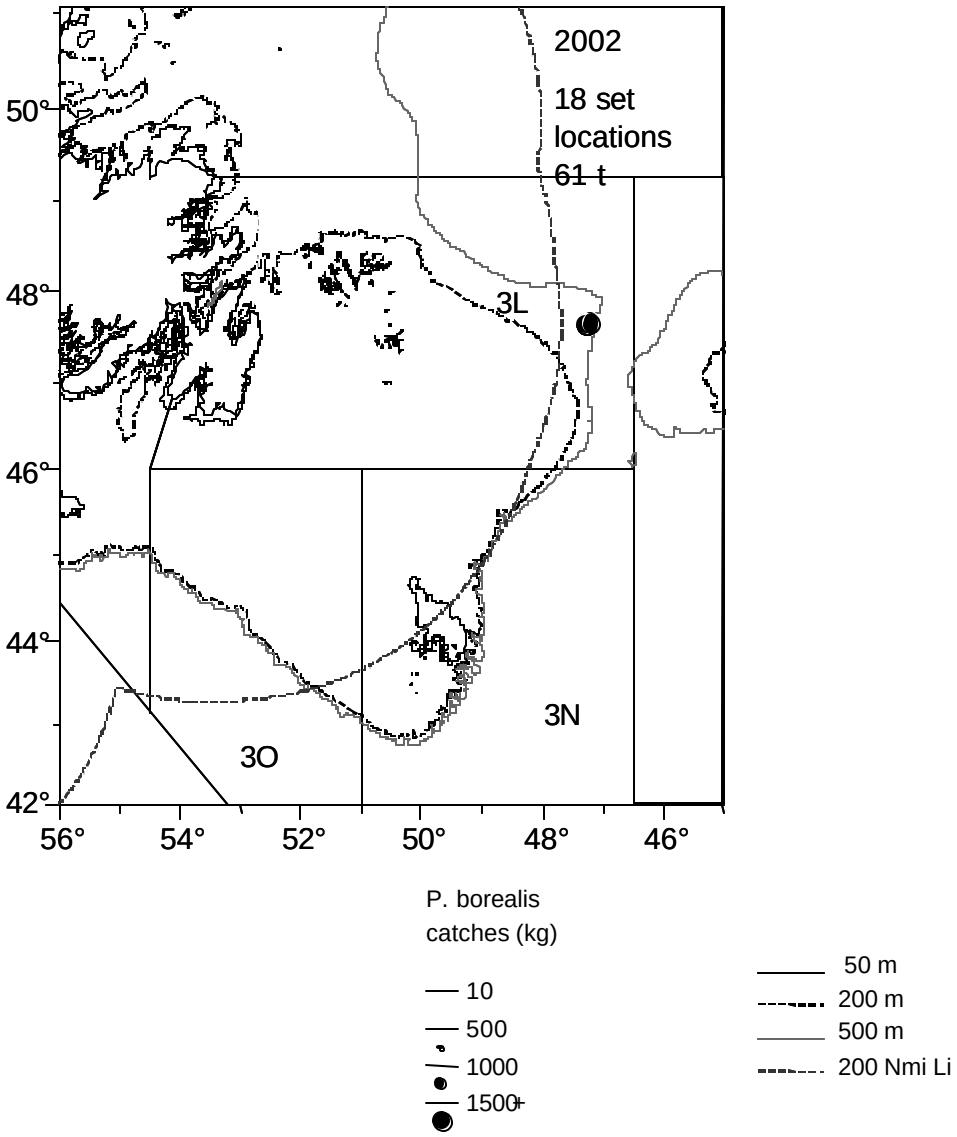

Figure 5 Russian shrimp catches during 2002 (Logbook data).

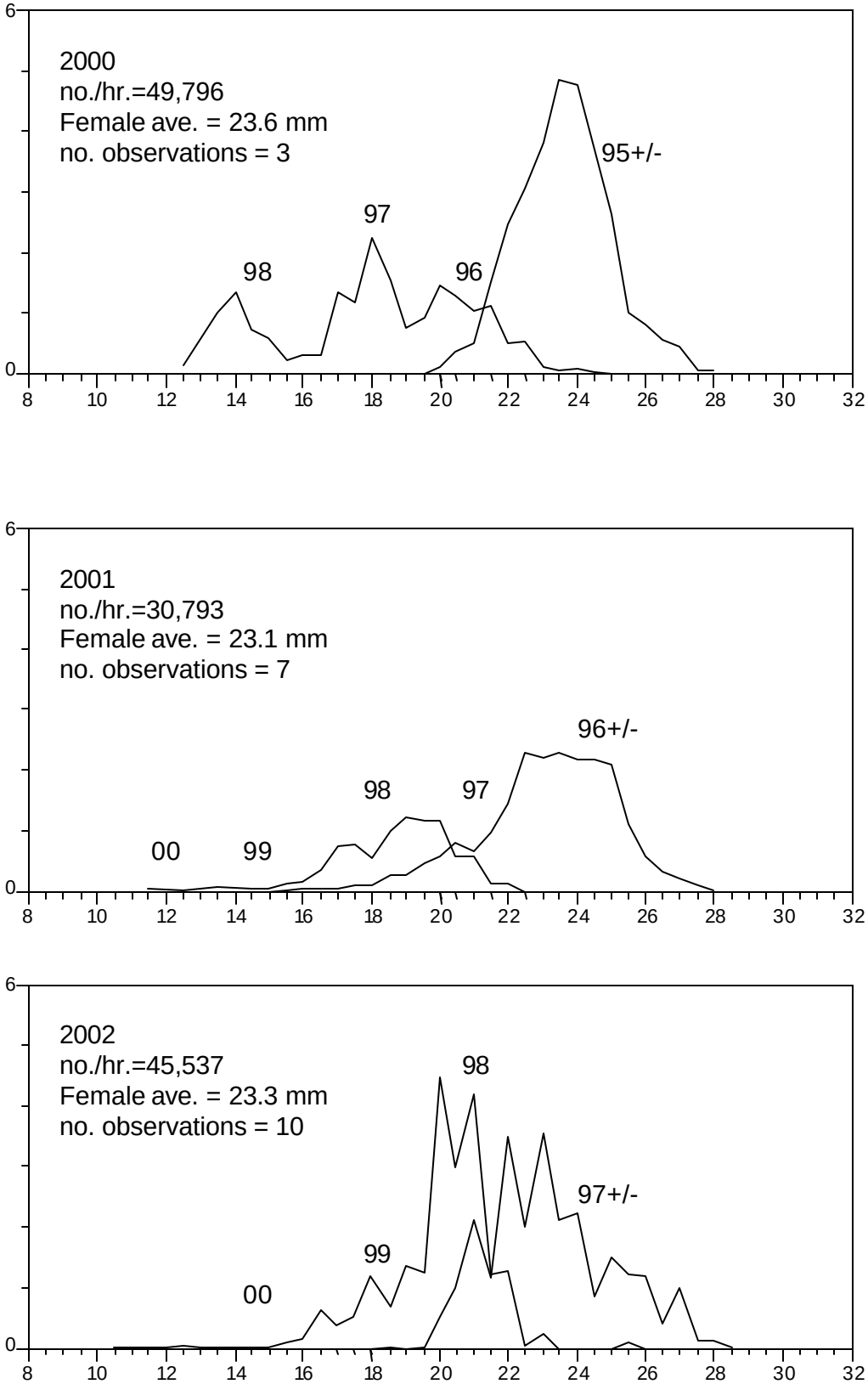

Figure 6. Standardized catch of *P. borealis* in numbers – per – hour (000) taken in 2000 – 2002 by the Canadian small vessel (<500 t; <100') fleet (NAFO 3LNO). (Solid line = males; dashed line = females).

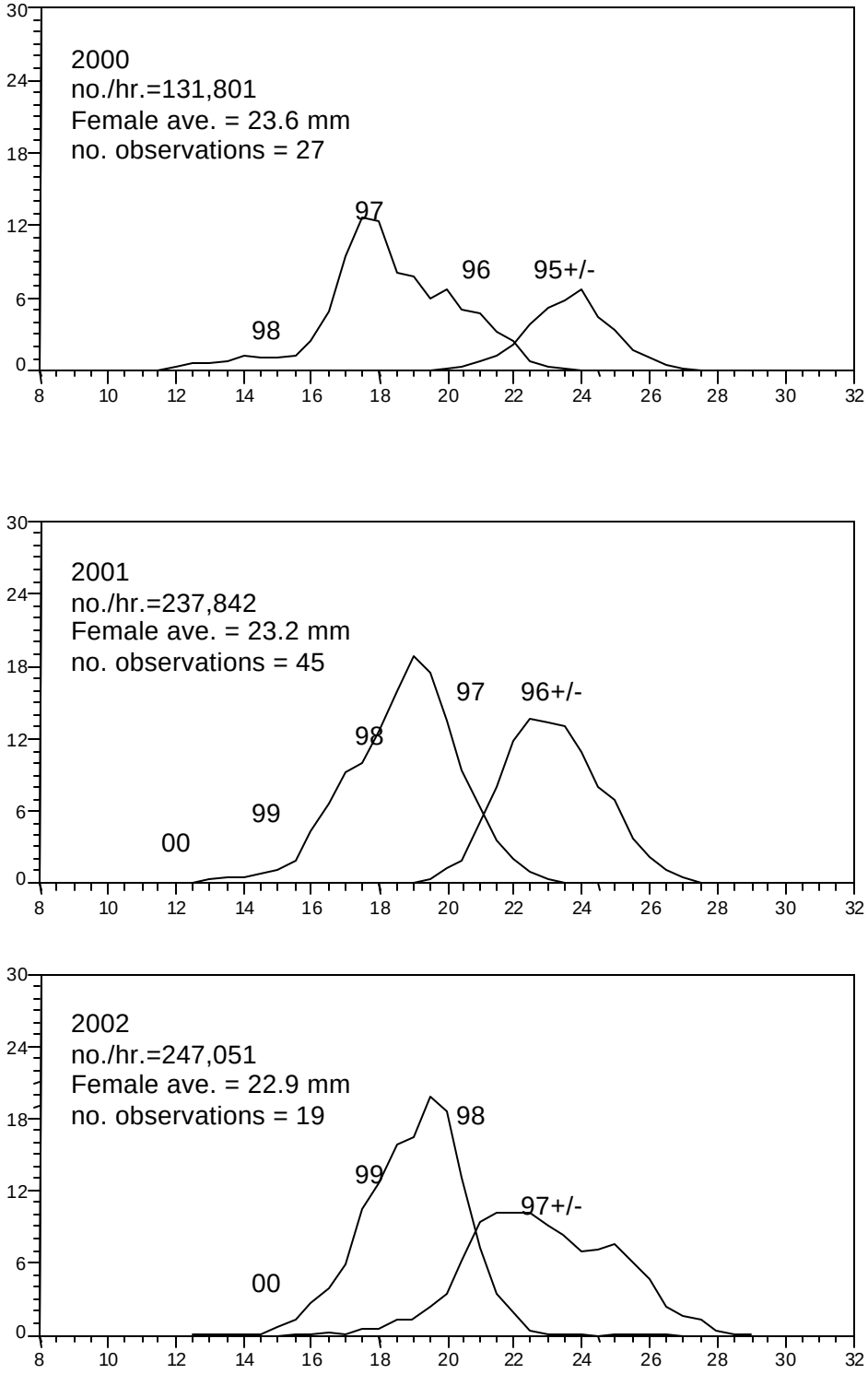

Figure 7 Standardized catch of *P. borealis* in numbers – per – hour (000) taken in 2000 – 2002 by the Canadian large vessel (=>500 t) fleet (NAFO 3LNO). (Solid line = males; dashed line = females).

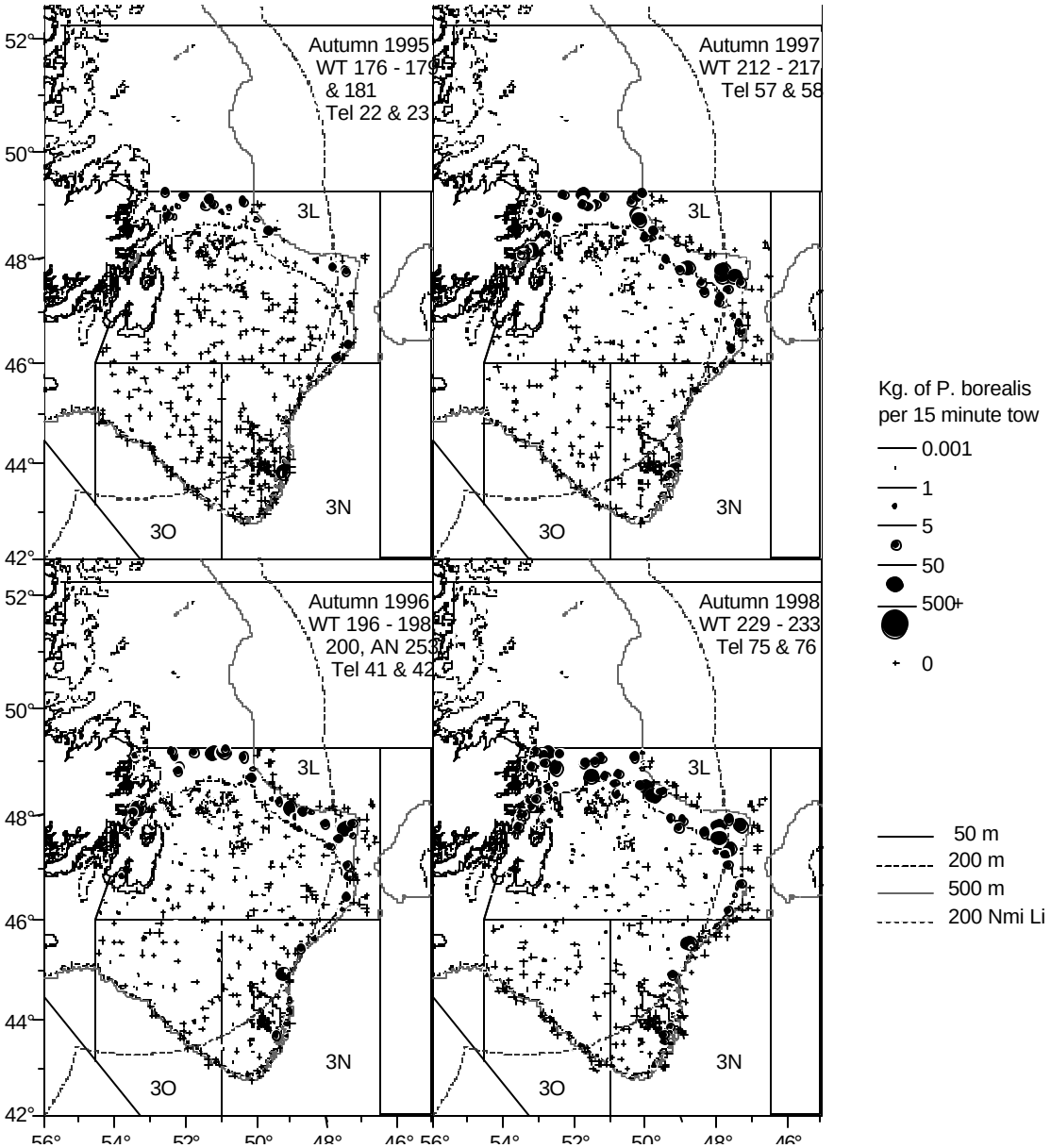

Figure 8 Catches of shrimp (*P. borealis*) obtained during the 1995 – 1998 autumn multi-species bottom trawl surveys into NAFO divisions 3LNO using a Campelen 1800 shrimp trawl. (standard 15 min. tows)

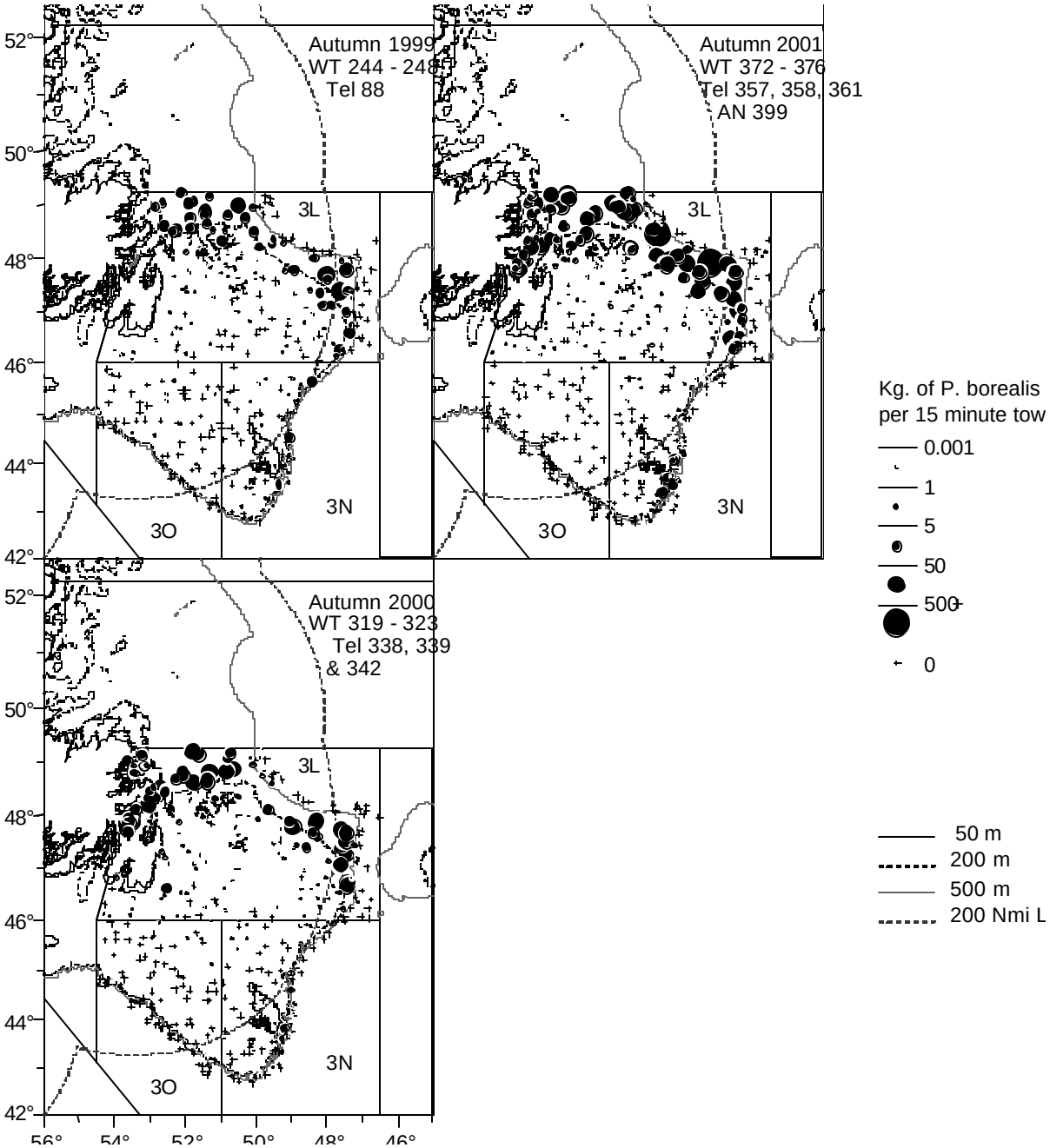

Figure 9 Catches of shrimp (*P. borealis*) obtained during the 1999 – 2001 autumn multi-species bottom trawl surveys into NAFO divisions 3LNO using a Campelen 1800 shrimp trawl. (standard 15 min. tows).

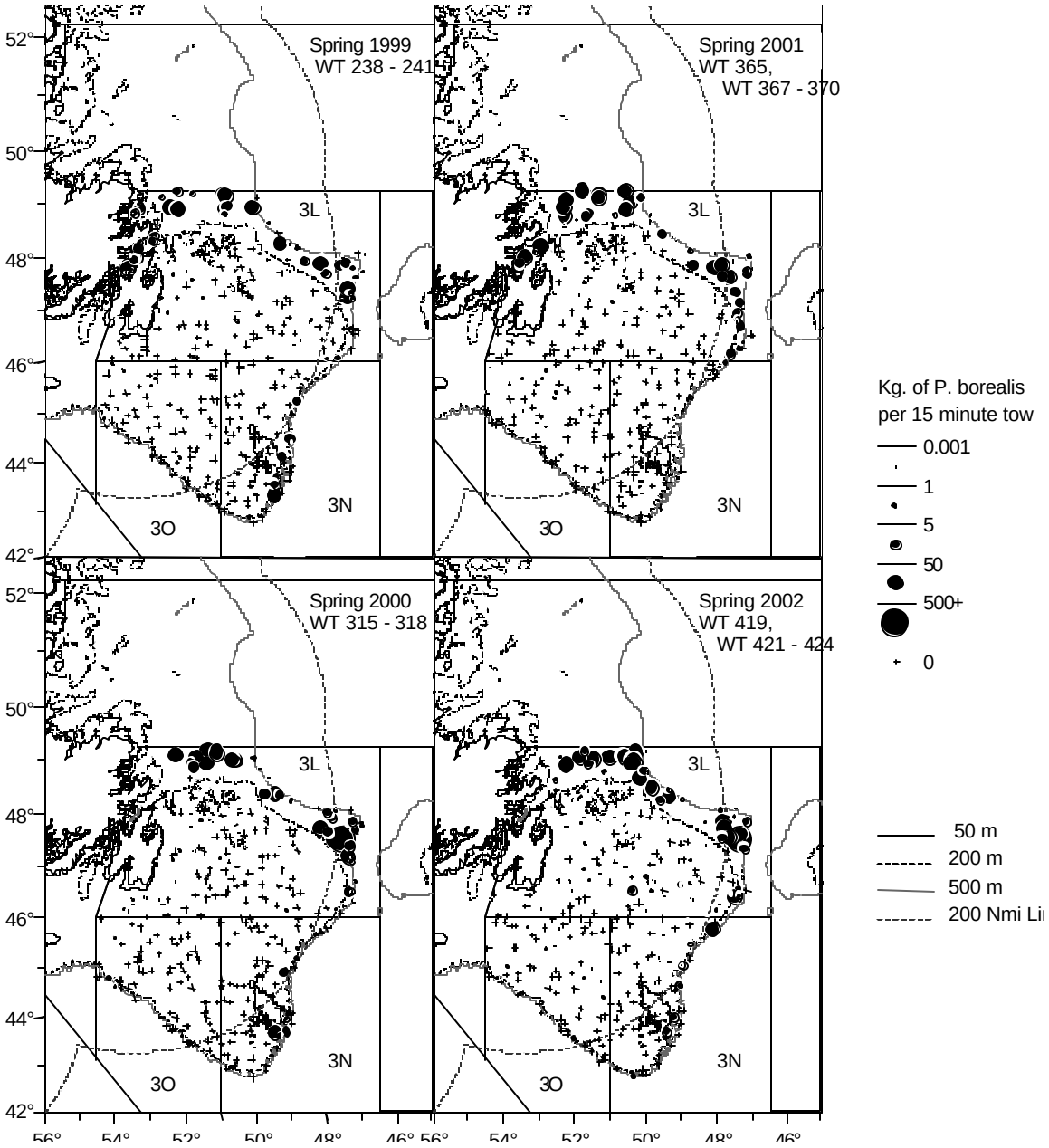

Figure 10 Catches of shrimp (*P. borealis*) obtained during the 1999 – 2002 spring multi-species bottom trawl surveys into NAFO divisions 3LNO using a Campelen 1800 shrimp trawl. (standard 15 min. tows).

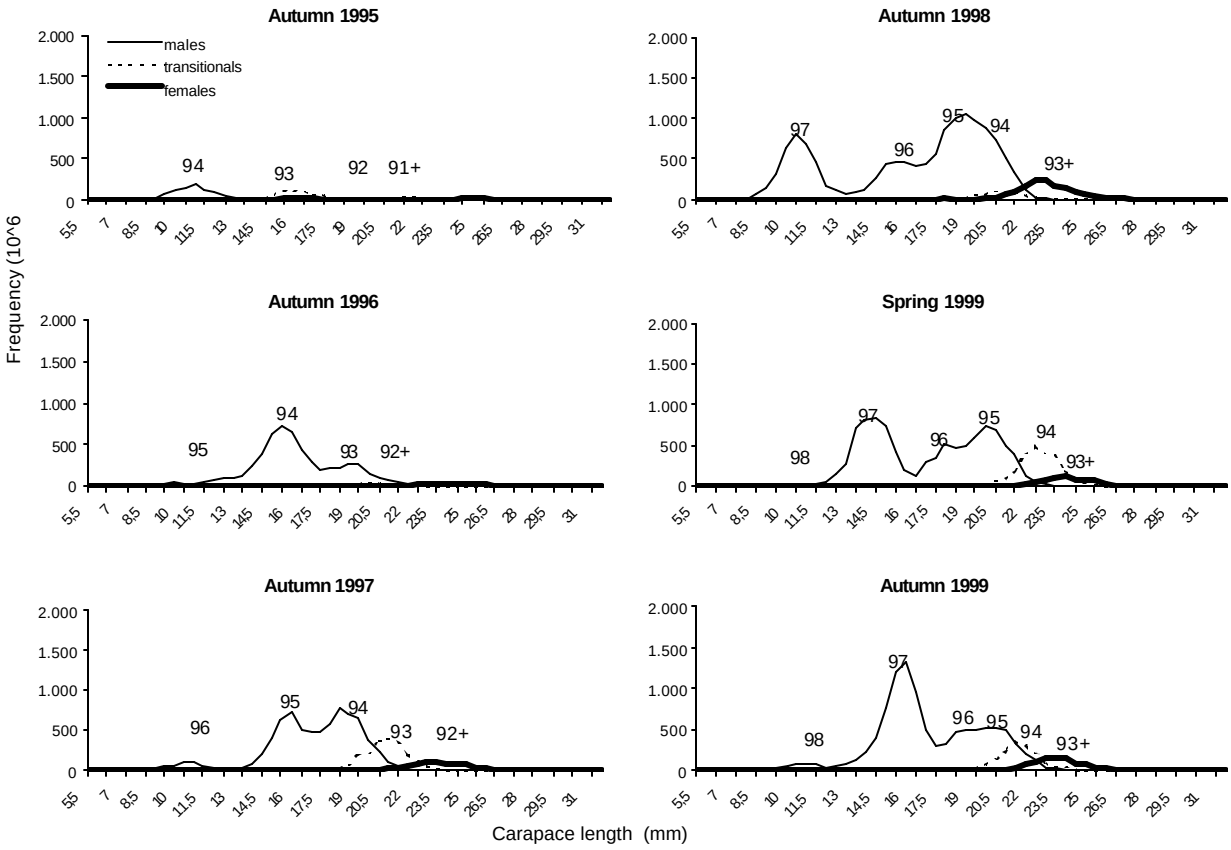

Figure 11. Abundance at length for NAFO divs. 3LNO shrimp (*P. borealis*) estimated by areal expansion of Canadian spring and autumn multi-species bottom trawl survey data 1995 – 1999.

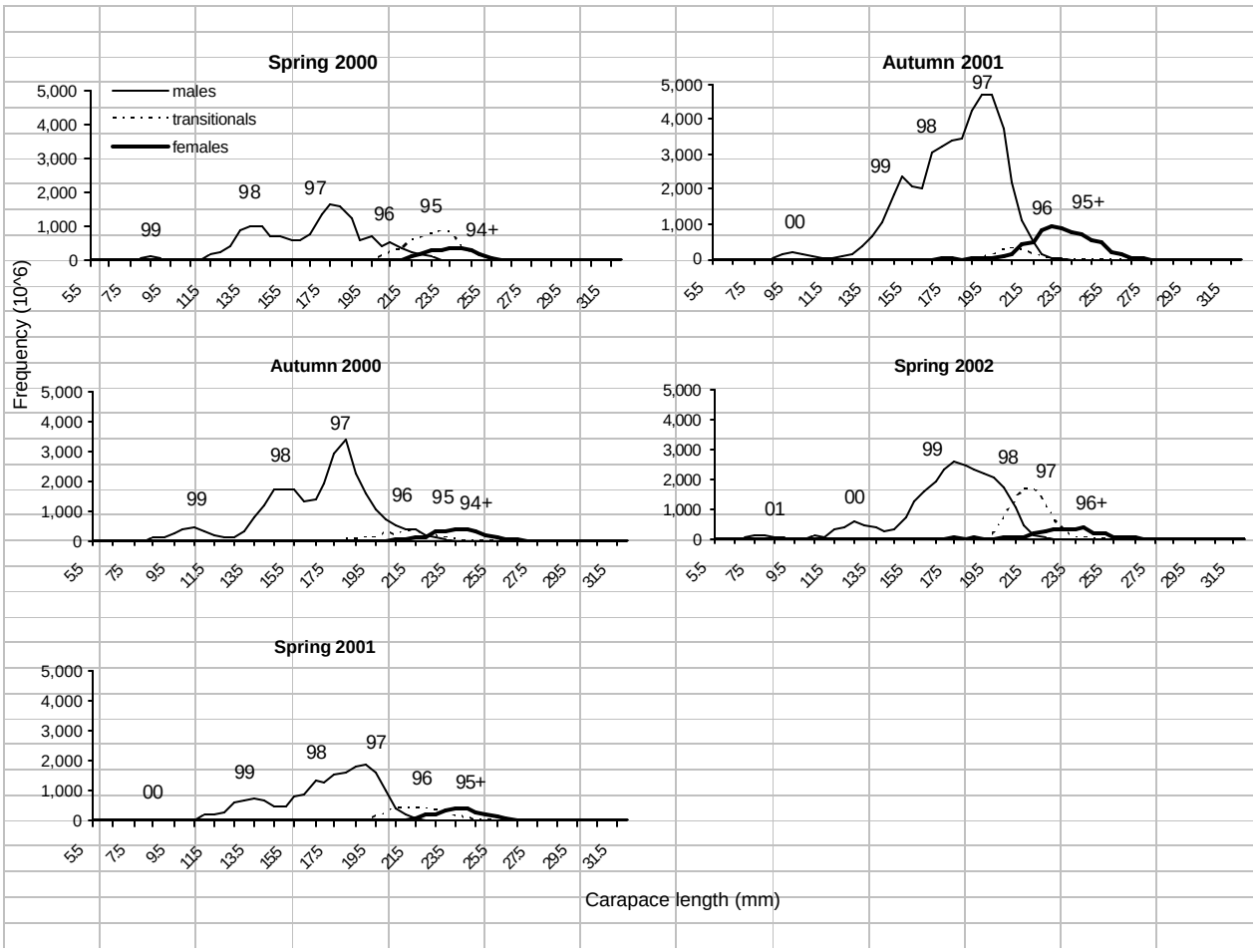

Figure 12. Abundance at length for NAFO divs. 3LNO shrimp (*P. borealis*) estimated by areal expansion of Canadian spring and autumn multi-species bottom trawl survey data 2000 – 2002.

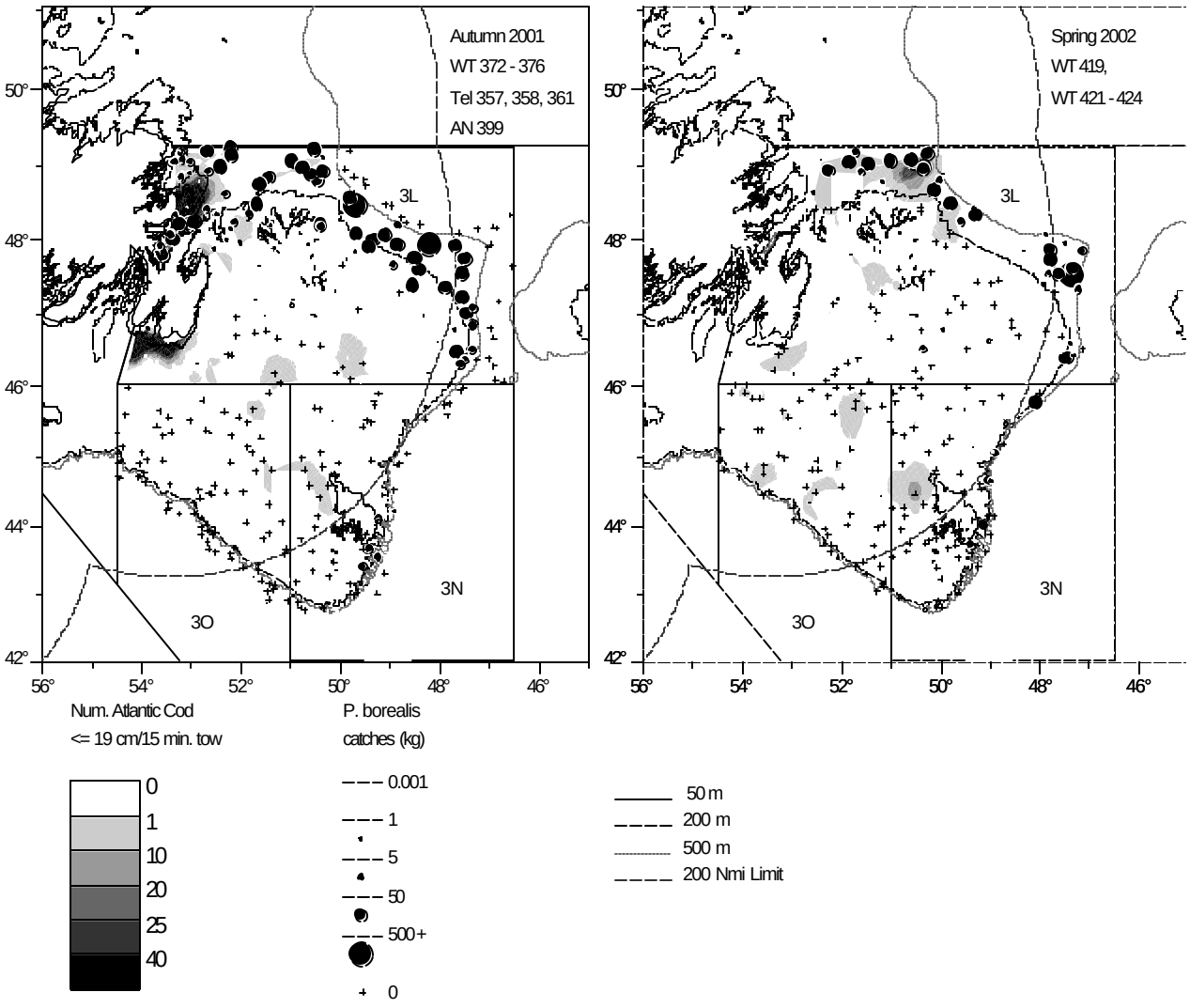

Figure 13. Distribution of northern shrimp in relation to Atlantic cod (TL <= 19 cm) collected during Canadian autumn 2001 and spring 2002 multi-species bottom trawl surveys. (Catches were made with a Campelen 1800 shrimp trawl, tows were standardized to 15 min.)

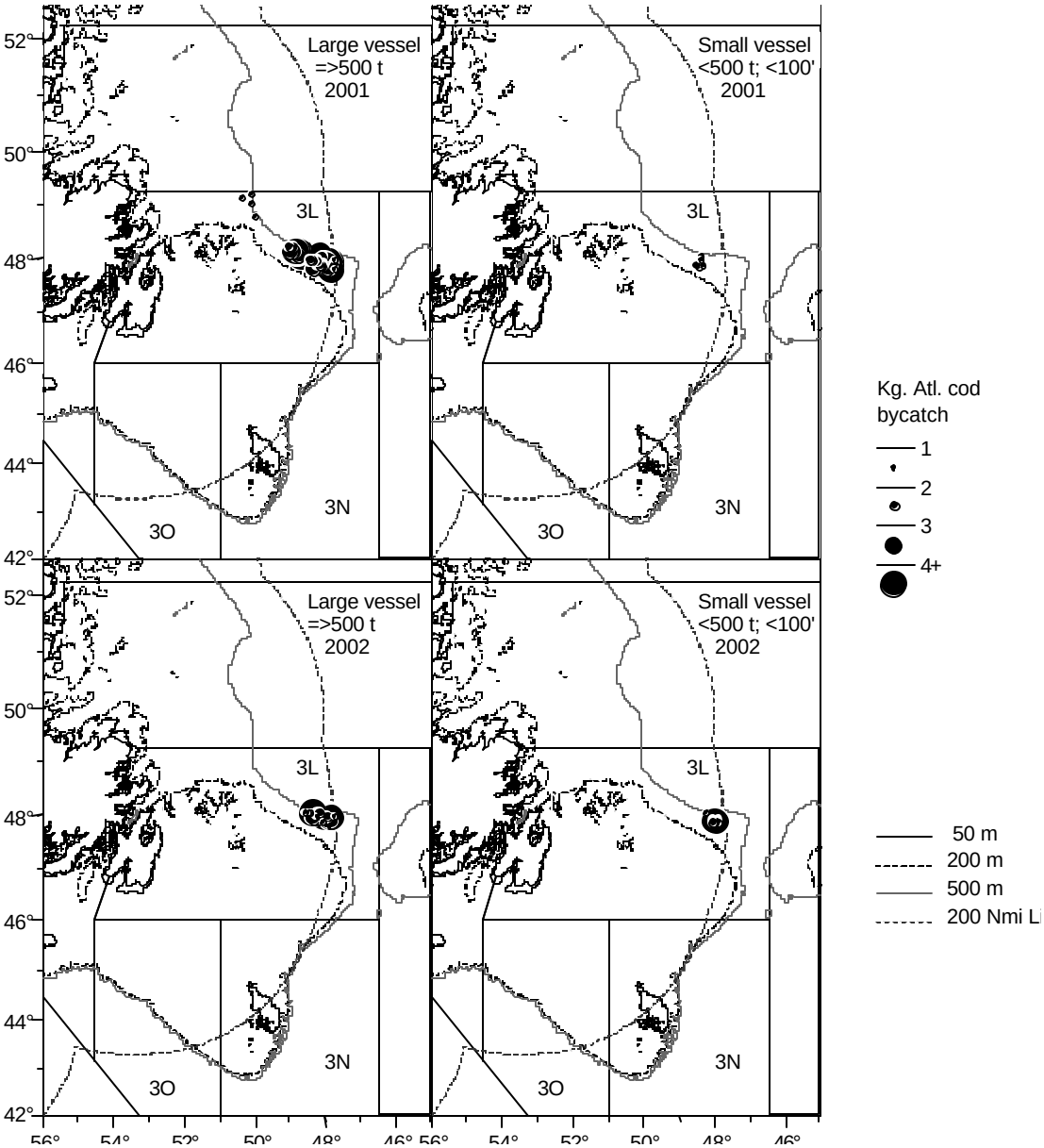

Figure 14. Distributions of Atlantic cod bycatch removed by the Canadian large (=>500 t) and small (<500 t; <100') fleet during 2001 and 2002. (Data are aggregated to 5 min. squares)

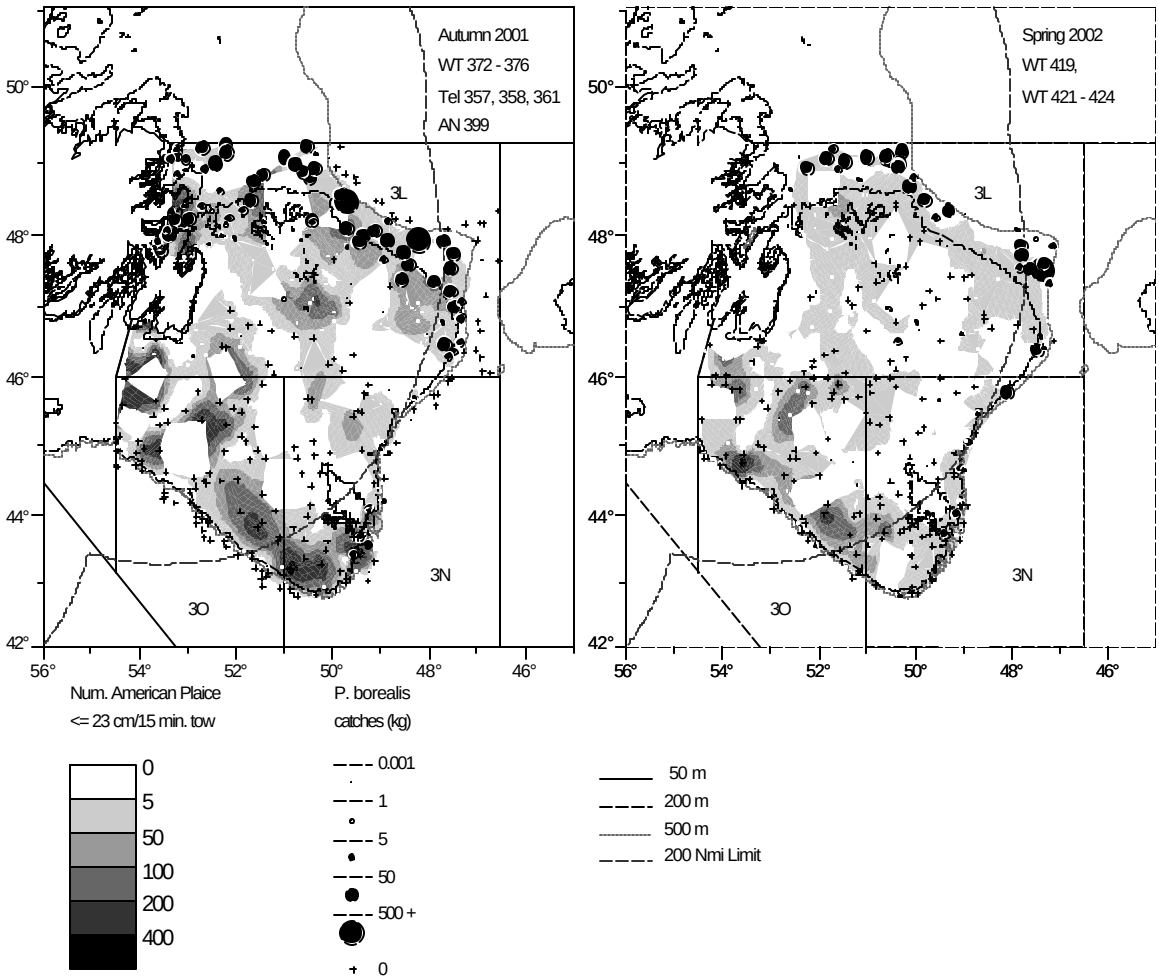

Figure 15 Distribution of northern shrimp in relation to American plaice (TL <= 23 cm) collected during Canadian autumn 2001 and spring 2002 multi-species bottom trawl surveys. (Catches were made with a Campelen 1800 shrimp trawl, tows were standardized to 15 min.)

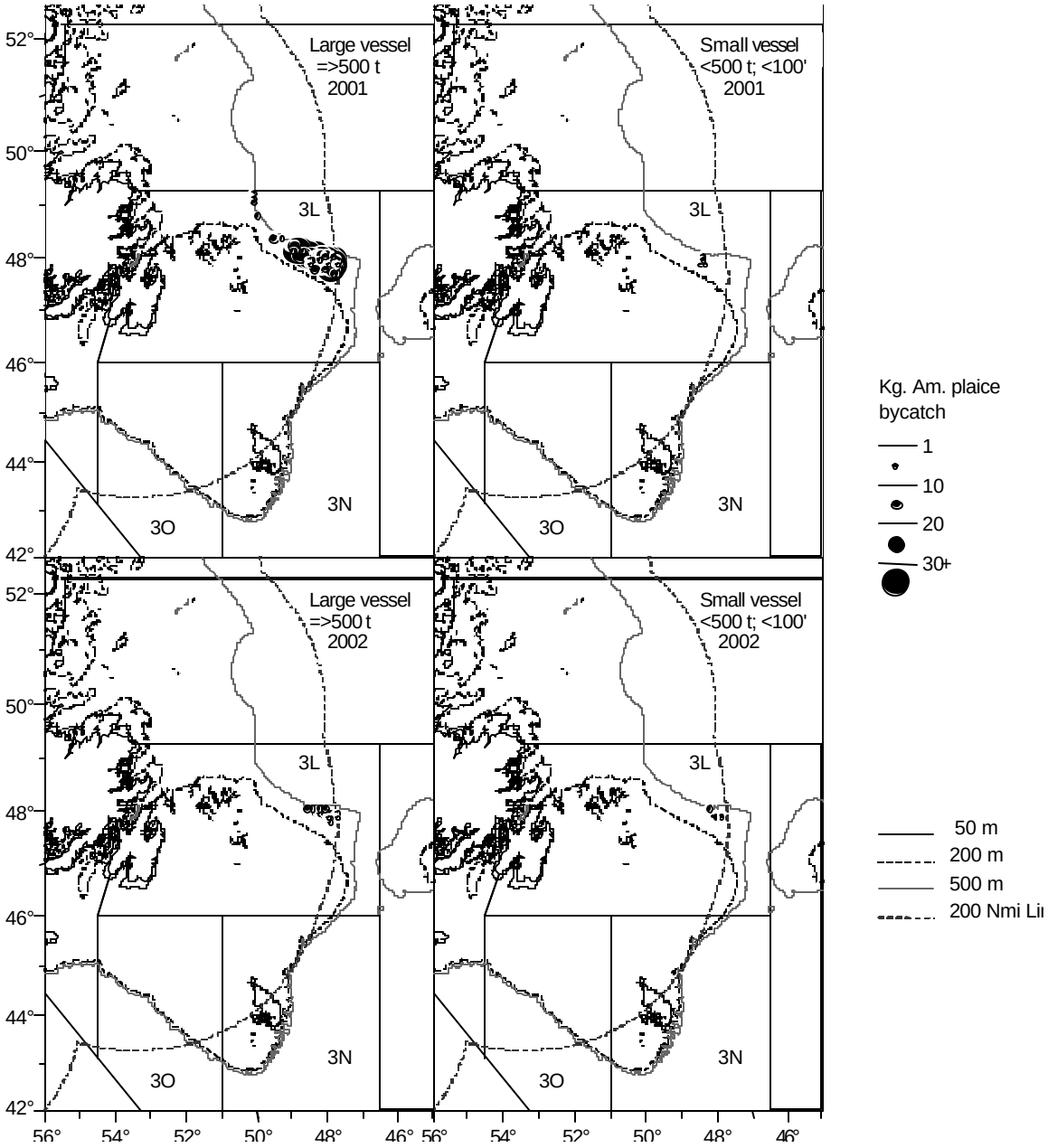

Figure 16. Distributions of American plaice bycatch removed by the Canadian large (=>500 t) and small (<500 t; <100') fleet during 2001 and 2002. (Data are aggregated to 5 min. squares)

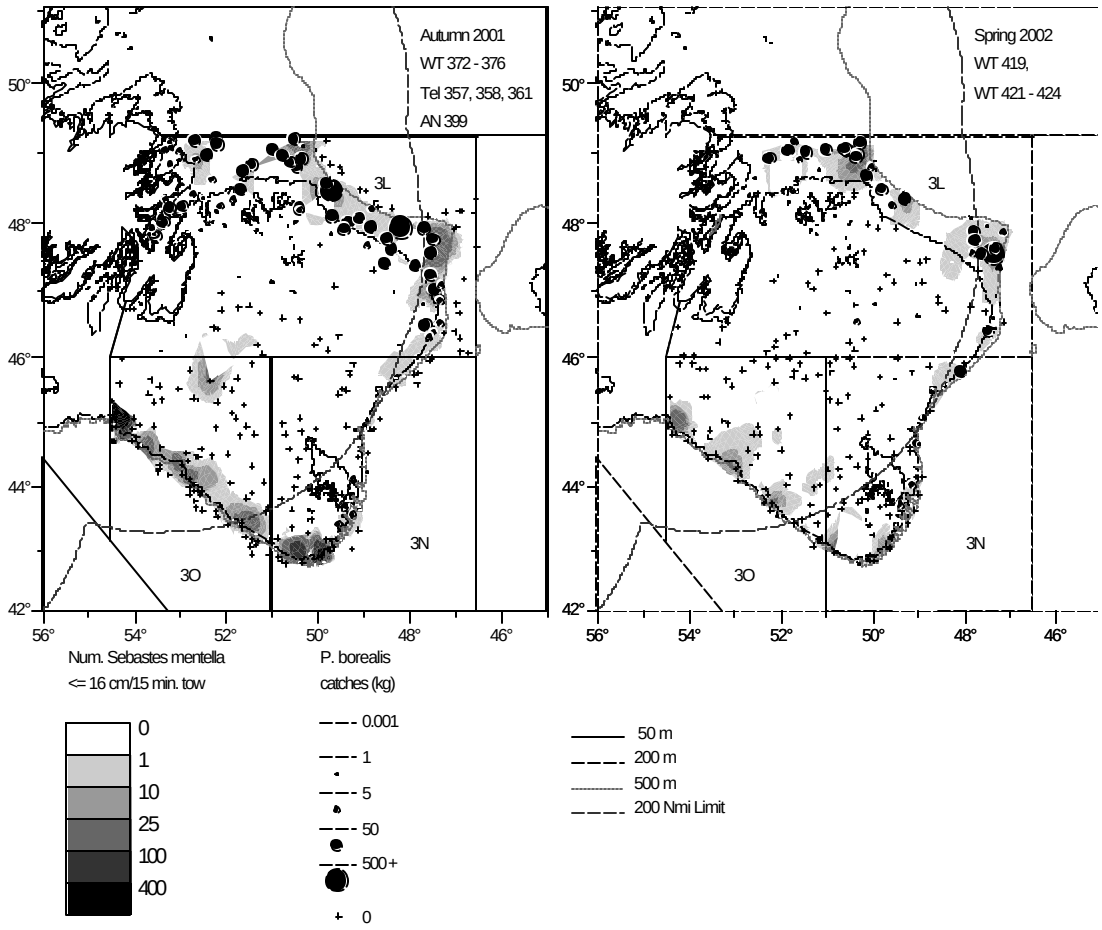

Figure 17 Distribution of northern shrimp in relation to redfish (*Sebastes mentella*) (TL <= 23 cm) collected during Canadian autumn 2001 and spring 2002 multi-species bottom trawl surveys. (Catches were made with a Campelen 1800 shrimp trawl, tows were standardized to 15 min.)

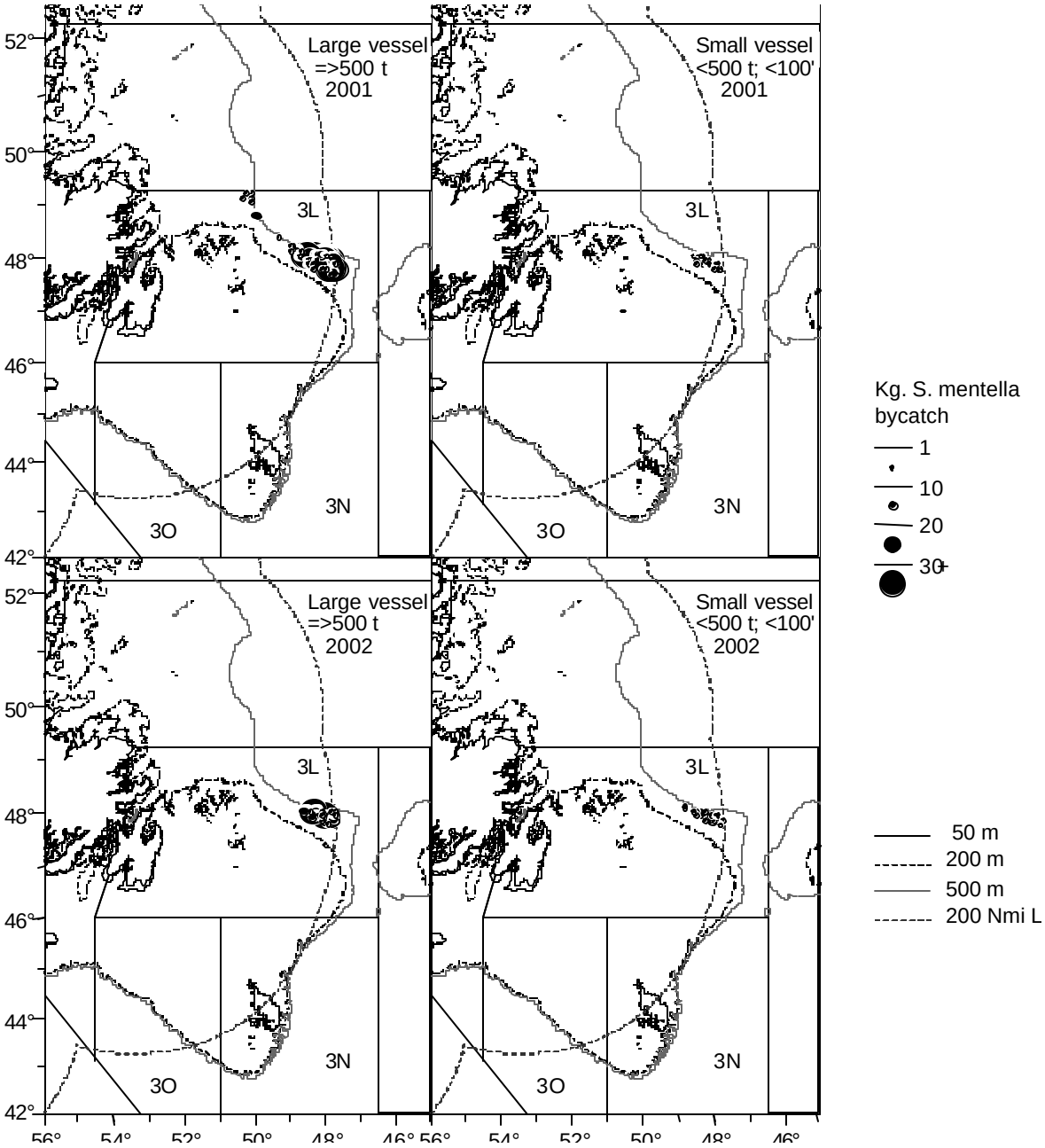

Figure 18. Distributions of redfish (*Sebastes mentella*) bycatch removed by the Canadian large (=>500 t) and small (<500 t; <100') fleet during 2001 and 2002. (Data are aggregated to 5 min. squares)

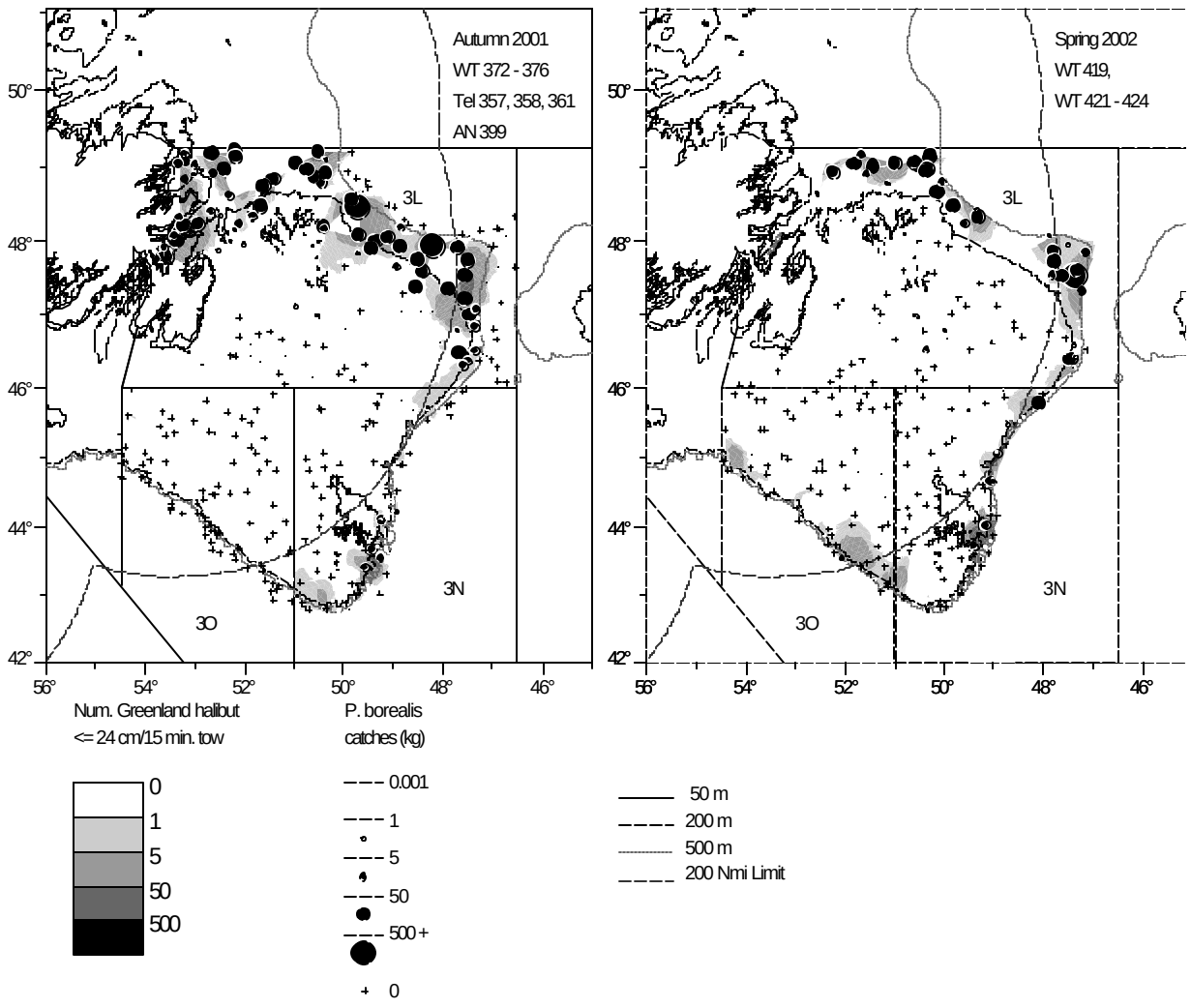

Figure 19 Distribution of northern shrimp in relation to Greenland halibut (TL <=24 cm) collected during Canadian autumn 2001 and spring 2002 multi-species bottom trawl surveys. (Catches were made with a Campelen 1800 shrimp trawl, tows were standardized to 15 min.)

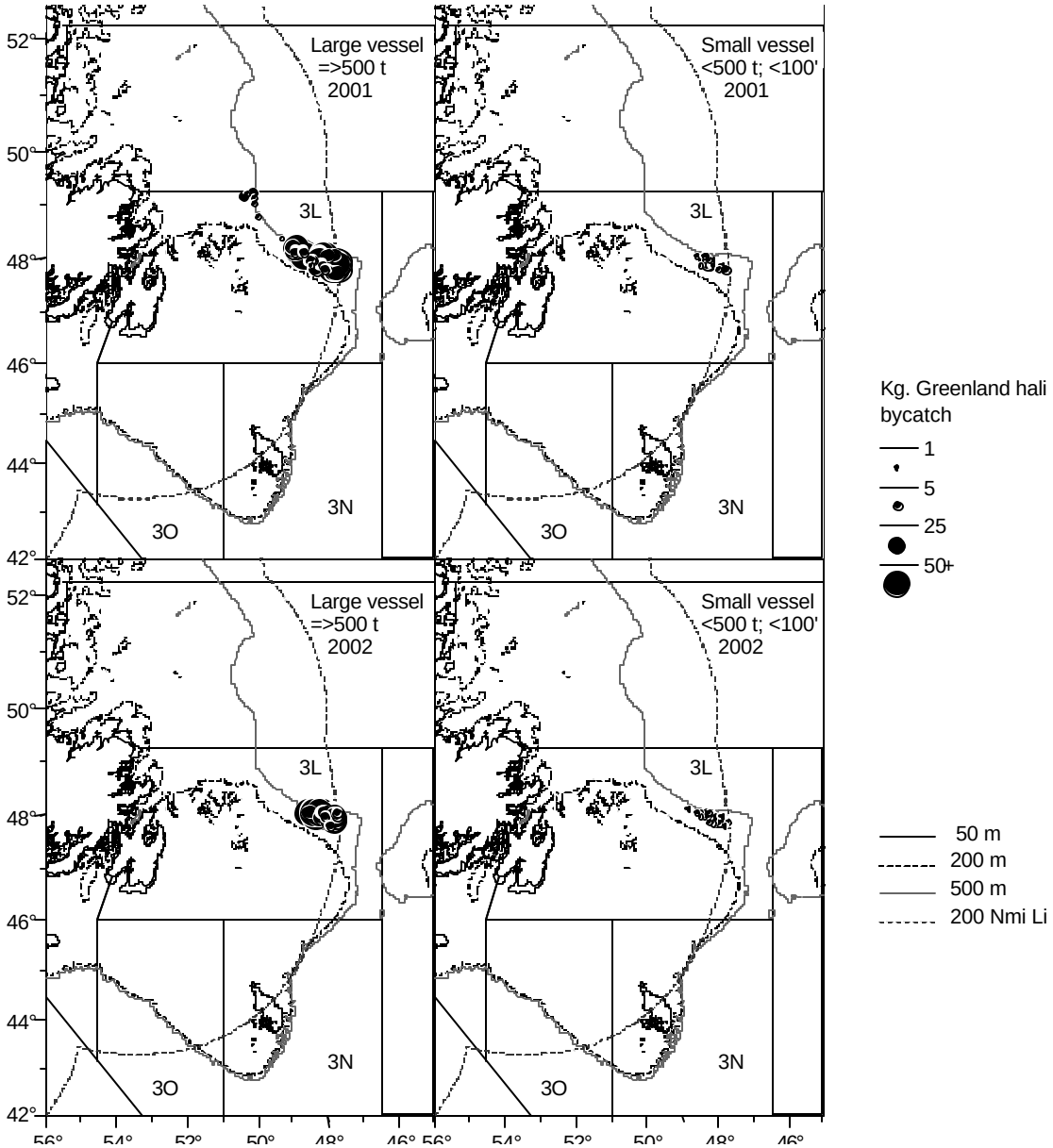

Figure 20. Distributions of Greenland halibut bycatch removed by the Canadian large (=>500 t) and small (<500 t; <100') fleet during 2001 and 2002. (Data are aggregated to 5 min. squares)