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An update of information pertaining to Northern Shrimp (*Pandalus borealis*, Koyer) and Groundfish in NAFO Divisions 3LNO

By

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Abstract

This paper describes the 2003 northern shrimp (*Pandalus borealis*, Koyer) assessment completed for Divisions 3LNO. Status of the resource was inferred by examining trends in commercial catch, catch per unit effort, fishing pattern and size, sex and age compositions of catches. Canadian spring and autumn multi-species stratified random bottom trawl surveys have been used to estimate northern shrimp (*Pandalus borealis*, Kroyer) biomass and abundances in Div. 3LNO. These findings were compared with results from previous surveys.

Biomass and abundance of shrimp increased significantly since 1999 and remained broadly distributed over the study area. Consequently catch rates by Canadian and international shrimp fishing fleets remained stable or have increased since the fishery began in 2000.

The shrimp resource within Div. 3LNO is currently healthy with high abundances of males and females. The strong 1997-1999 year classes should support the fishery over the next few years.

Both multi-species survey and observer datasets were used in quantifying the potential impact of the shrimp fishery upon various commercially important groundfish species.

Introduction

The northern shrimp (*Pandalus borealis*) stock, in Div. 3LNO, extends beyond Canada's 200 Nmi limit, therefore, it is a NAFO regulated stock. Northern shrimp, within NAFO Div. 3LNO, have been under TAC regulation since 1999. At that time a 6 000 ton quota was established and fishing was restricted to Div. 3L, at depths greater than 200 m. The 6 000 ton quota was established as 15% of the lower confidence limit below the autumn 1998 Div. 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) (Orr *et al.*, 2003). 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 Div. 3LNO within the NAFO Regulatory Area (NRA), over the period 1995-1998, was approximately 17%. Therefore, a 5 000 ton quota was established in the Exclusive Economic Zone (EEZ) for Canada while a 1 000 ton quota was established in the NRA for all other Contracting Parties.

During November 2002, Scientific Council (SC) noted that there had been a significant increase in biomass and recruitment in Div. 3LNO shrimp since 1999. Applying a 15% exploitation rate to the lower 95% confidence interval of biomass estimates, averaged over the autumn 2000-2001 and spring 2001-2002 surveys, resulted in a catch of approximately 13 000 tons. Accordingly, SC recommended that the TAC for shrimp in Div. 3LNO in 2003 and 2004 should not exceed 13 000 tons. At that time, SC reiterated its recommendation that the fishery be restricted to Div. 3L and that the use of a sorting grate with a maximum bar spacing of 22 mm be mandatory for all vessels in the fishery (NAFO, 2002).

Full assessments of this stock are completed during the annual November shrimp assessment meetings. Results from these assessments provide necessary input for quota decisions made during Fishery Commission meetings, held during September. Autumn and spring Canadian multi-species surveys are completed in Div. 3LNO in the time between the assessment and the commission meetings. The additional biomass information derived from these surveys is provided, within interim monitoring reports, to NAFO SC just prior to the Annual Fishery Commission Meetings. The last interim monitoring report was presented to NAFO SC during September 2003.

The present document was produced for the November 2003 SC assessment meeting and therefore provides a full assessment of the Div. 3LNO shrimp resource.

The fishery overlaps the distribution of several groundfish stocks that are presently under moratoria. Hence, this paper also assesses the impact that the fishery may have upon groundfish co-existing in the area.

Methods and Materials

Data were collected from the following sources:

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

1. 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 less than 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, weights and length frequencies of by-caught species.

The Observer database was used to determine the catch-per-unit effort (CPUE) for the large vessel (>500 ton) shrimp fishing fleet. This database also provides catch at size/ maturity data from the large and small vessel (<=500 ton; LOA<100') vessel fleets.

The time series extends over only four years, therefore, no attempts were made to model CPUE. The observer dataset was used in determining an unstandardized CPUE index for large vessels. Observed data were used 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.

The observer database also provides information used to determine the potential impacts that shrimp fishing may have upon groundfish species. Groundfish by-catch is recorded to 1 kg precision for all observed fishing sets. Wherever possible, sexed length frequencies (1 cm. precision) were taken from randomly selected samples of commercial groundfish species. 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. An average length frequency distribution per kg of by-catch was produced and 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, species by species, basis. The length frequencies were aggregated to obtain total removals by species, year and size of vessel. Length frequencies were then applied to species specific population adjusted age length keys, from the previous autumn survey, to obtain estimates of number at age.

2. Canadian logbook database:

Logbooks must be completed for all fishers exploiting shrimp stocks within the northwest Atlantic. Data were used in small vessel CPUE calculations. The small vessel CPUE dataset was created using logbook data because all shrimp fishing vessels must complete logbooks, whereas, observer coverage in the small vessel shrimp fishery may be as low as 2%.

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 total groundfish by-catch on a species by species basis.

3. International observer and logbook information:

These data were made available by Contracting Parties that fish shrimp in Div. 3L. They were used in CPUE calculations and were added to the Canadian catches when determining a total catch. Where no information was provided by a Contracting Party, information was augmented through the use of Canadian surveillance data, as well as, NAFO STATLANT 21A and monthly provisional catch tables.

4. 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 bottom trawl surveys. These research surveys are conducted each spring and autumn 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 1 500 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	<7.5 mm
Age 1	7.5-11.0 mm
Age 2	11.5-15.0 mm
Age 3	15.5-17.5 mm
Age 4	18.0-22.0 mm
Age 5+	>22.0 mm

Season and age	carapace length modal range
Autumn	
Age 0	<8.5 mm
Age 1	8.5-13.0 mm
Age 2	13.5-16.0 mm
Age 3	16.5-18.5 mm
Age 4	19.0-22.0 mm
Age 5+	>22.0 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 (Díaz 2001, Nicolajsen, 2002, and Skűladóttir and Orr, 2002). 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:

lower 95% confidence interval below the biomass index,
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:

$$\text{Wt.} = 0.000838\text{Lt}^{2.929}$$ (Skűladóttir, 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; Hickey *et al.*, 1993), 24 cm (Nicolajsen, 1997), 14-18 cm (Hickey *et al.*, 1993, Kulka and Power, 1996; Kulka, 1998; Nicolajsen, 1997; Skűladóttir, 1997) and 23 cm (Orr *et al.*, 2000). Potential for impact was assessed through observations of these plots and previously discussed by-catch analyses using observer datasets.

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. These datasets also provide insight for the impact of shrimp fishing upon groundfish.

Logbook and research catches were plotted using Surfer 8.0 (Golden Software, 2002). The area fished each year was divided into 10 min. × 10 min. cells, catches were aggregated by cells, and aggregated catches were organized into a cumulative percent frequency (cpf). The cpf was used to determine the number of cells accounting for 95% of the catch each year (Swain and Morin, 1996). The plots and quantification of spatial coverage were used in describing changes in distribution thereby aiding the interpretation of CPUE trends.

Results and Discussion

Fishery Data

Catch trends

Canadian vessels caught 11 tons of shrimp in Div. 3L during 1989. However, Faroese fishermen are generally credited with beginning the exploratory fishery for Div. 3LNO shrimp within the NRA. The Faroese exploratory fishery began in 1993 and lasted until 1999. Over this 7 year period, the Faroese catches were 1789, 1865, 0, 171, 485, 544 and 706 tons, respectively (STATLANT 21A).

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 Div. 3LNO. The combined catch was 89 tons.

Catches increased dramatically since 1999, with the beginning of a regulated fishery. Since then, sixteen contracting nations have exercised their privileges to fish shrimp in Div. 3L. Over the period 2000-2002, catches were 4 869, 10 566, and 6 977 tons, respectively (Table 1; Fig. 2). Preliminary data indicate that 10 649 tons of shrimp were caught by 23 October 2003. It is possible that the entire 2003 quota may not be taken due to a glut in the internationals market for shrimp.

As per NAFO agreements, Canadian vessels took most of the catch during each year. Canadian catches increased from 4 250 tons in 2000 to 9 577 tons in 2003. Fishing vessels from contracting nations took 619, 5 437, 1 563 and 1 072 tons of shrimp during each respective year.

Figure 3 indicates CPUE trends among the Canadian and international fleets fishing shrimp in Div. 3L. Canadian small vessel, Icelandic and Russian trawl CPUE indices remained low compared to other CPUE indices. Since 1999, the small vessel, Icelandic and Russian indices ranged between 200 and 700 kg/hr. In contrast, Canadian large vessel single trawl CPUE indices increased each year since 2000. The large vessel single trawl CPUE was 900 kg/hr in 2000, but had increased to 2 800 kg/hr by 2003. The Canadian large vessel double trawl CPUE increased from 1 200 kg/hr in 2000 to 1 900 kg/hr in 2002 but then dropped to 1 700 kg/hr in 2003. The Greenlandic double trawl CPUE indices were 1 300 kg/hr in 2000 and 3 000 kg/hr in 2003. The 2003 Greenlandic single trawl CPUE index was 2 500 kg/hr.

Figures 4 and 5 indicate the distribution of Canadian small and large vessel catches. Between 2000 and 2002, the Canadian small vessel quota remained at 2 500 tons. Over this period, the number of cells accounting for 95% of the catch increased from 17 to 32 (Fig.. 4 and 6). The fact that a CPUE may be maintained over an increasing area suggests that the resource was healthy.

The small vessel areal index decreased to 19 during 2003. This decrease may be due to the fact that the fishery is still occurring and the logbook dataset accounted for only 1 648 tons of shrimp (25% of the 6 566 small vessel quota).

The large vessel areal index decreased from 16 cells during 2000 to 9 cells during 2002 and then increased to 11 cells in 2003 (2 386 tons; 68% of the 3 517 ton quota). The fishery began during 2000, thus the relatively high areal index may have been due to searching for large shrimp. Since the large shrimp tend to be near 200 Nmi limit (personal experience), it is not surprising that the fishery has since concentrated near the 200 Nmi limit (Fig. 5).

Figure 6 also presents the trend in number of cells accounting for 95% of total research catches. This index has shown general increases since 1995, indicating that the stock has been expanding spatially. For the most part the expansion has been along the edge at depths that may be fished under NAFO regulations. Thus the area occupied by large vessels has been contracting at a time when the spatial distribution of the stock has been increasing. The area fished by the large vessels was not representative of the stock area. Therefore, CPUE may not be a reliable indicator of stock status.

Size composition

Few length frequencies observations were taken from small vessel catches (4 sets in 2001; 14 sets in 2002 and 7 sets in 2003), leaving doubt as to whether they were representative of overall fleet catches. Therefore, no attempt was made to analyze these data.

Several length frequency observations were taken from large vessel catches (Fig.. 7). Catch at length from samples taken by observers on large vessels, showed dominance of the female component around 22-26 mm carapace length in most years (Fig. 7). The female component is broad suggesting that it consists of more than one age class. Modes indicating the 1997-1999 year-classes may easily be tracked over the short time series. As indicated in following sections on research data, the 1997-1999 year-classes are strong compared to previous year-classes. It is felt that these year-classes will be able to sustain the present fishery over the next few years.

The mean size of females and the size at sex inversion declined slightly since 2000, indicating a possible change in growth within the area. Although smaller females carry fewer eggs, reproductive potential has been maintained by the continued high abundance of females.

Observed length frequencies were not available from the 2003 large vessel fisheries.

By-catch

Most of the shrimp fishery, within the EEZ, occurs near the 200 Nmi limit, therefore, it is not surprising that the most of the by-catch also occurs near the 200 Nmi limit (Fig.. 8 and 9). A small amount of Greenland halibut was also taken in the northern portion of Div. 3L, near the 3K border. Tables 2 and 3 indicate that low numbers and weights of Atlantic cod (*Gadus morhua*), American plaice (*Hippoglossoides platessoides*) and redfish (*Sebastes* spp.) had been taken by Canadian shrimp fishing fleets. The 2003 total estimated by-catch of Atlantic cod was approx. 2 tons compared to an average trawlable biomass (over the 1999-2002 period) of 28 000 tons (DFO, 2003). The 2003 total estimated by-catch of American plaice was 7 792 tons compared to a Div. 3L biomass index of 44 000 tons in 2002 (Morgan *et al.*, 2003). Similarly, the total estimated by-catch of 13 045 tons compared to an average trawlable biomass (over the 1996-2002 period) of 21 000 tons in Div. 3L (Power, 2003). It is important to note the biomass indices for each of these groundfish species are very low compared to historic levels consequently each is under fishing moratoria.

Relative to other species, high levels of Greenland halibut (*Rheinhardtius hippoglossoides*) are taken in the shrimp fishery. The 2003 total estimated by-catch of Greenland halibut was 32 645 tons compared to a Div. 3L autumn 2002 biomass index of 22 377 tons (Dwyer and Bowering, 2003). High spatial overlap with shrimp, fusiform shape and the fact that Greenland halibut swim upright allowing relatively large animals to pass through the Nordmore Grate, result in a higher Greenland halibut by-catch within the shrimp fishery. As with the other groundfish species, the biomass of Greenland halibut in Div.3L has been declining over the past few years. Presently, the 2002 biomass index is the lowest since 1995 and represents a 50% reduction between 2001 and 2002.

Tables 2 and 3 provide an estimate of groundfish removals at age. This is important because each kg of fish removed may represent several juvenile fish. Caution should be used in reading tables 2 and 3 because weights are recorded in the observer dataset in kilograms. A fish weighing 5 grams would be recorded as being 1 kg. Thus by-catch levels presented in this document may be artificially high. However, it is still important to continue monitoring by-catch since many of the once commercially important groundfish stocks are in decline.

Levels of observer coverage are provided by the correction factors (logbook catch/observer catch). Almost 100% of the large vessel fishing sets were observed, as indicated by correction factors that were just slightly above 1. Thus there should be high confidence in the large vessel by-catch values for the period 2000-2002. Not all of the 2003 data were available in time for this assessment; however, there is no reason to believe that it is not representative of the fishery. On the other hand, small vessel observer coverage ranged between 1.6% (correction factor = 60.6 in 2003) and 5.9% (correction factor = 16.9 in 2002). There is less confidence in whether the small vessel by-catch estimates are representative of the fishery.

Due to the number of tasks undertaken by observers, and because conditions on vessels are not always conducive for detailed sampling of several species, few length measurements were taken. Where number of fish measured are low (<200), it is not clear whether the number at age were representative of the by-catch.

Research Survey Data

Results of the autumn 2002 and spring 2003 multi-species research survey indicate that shrimp continue to be widely distributed and abundant along the northern and eastern edges of Div. 3L (Fig.. 10-12; Tables 4-11). In general, the area accounting for 95% of the research biomass has been increasing over time (Fig. 6). An increasing biomass/ abundance of shrimp at a time when spatial distribution is expanding is an indication that the stock is healthy.

All estimates discussed below are for offshore strata only, because the inshore strata were not sampled each year.

In the following discussion, autumn and spring biomass indices will be treated separately as there may be seasonal influences upon catchability. Autumn biomass indices are presented in table 10. The index increased from 5 921 tons in 1995 to 46 202 tons during 1997, levelled off until 1999, after which it increased to 118 180 tons. The 2001 point estimate was 223 995 tons while in 2002 it was 215 008 tons.

The spring time series begins in 1999. During 1999 the spring index was 55 317 tons. The index for the following spring was 121 815 tons but was unreliable as the confidence intervals were wide enough that the lower interval was negative. The biomass index was 102 566 tons in 2001, 159 491 tons in 2002 and 193 766 tons in 2003.

The 95% confidence intervals around autumn 2000-2002 biomass indices were all above the upper 95% confidence interval above the autumn 1999 index. Similarly, the 95% confidence intervals around spring 2002 and 2003 biomass indices were all above the upper 95% confidence interval above the 1999 index. Thus we may conclude that there has been a significant increase in biomass since 1999.

The average minimum trawlable biomass from the last three autumn surveys was 98 958 tons (25 billion animals). The average minimum trawlable biomass from the last two spring surveys was 116 683 tons (25 billion animals).

Within survey variances can be high (Tables 10 and 11; Fig. 11 & 12). 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 (Fig. 4 & 5).

Distribution of shrimp in Div. 3L, 3N and 3O

Between 90.5 and 99.9% of the total Div. 3LNO biomass was found within Div. 3L, mostly within depths from 185 to 550 m. Over the study period, the area outside 200 Nmi accounted for between 12 and 32% of the total 3LNO biomass estimates (Tables 12 and 13; Fig. 10). Three year running averages were estimated in order to smooth the peaks and troughs within the data. They indicate that 16-28% of the total Div. 3LNO autumn biomass is within the NRA. Over the period 2000-2002 the three year average autumn percent biomass within the NRA was 22%. However, during the spring, the percent biomass within the NRA ranged between 18 and 32% while the three year running averages ranged between 24 and 30%. Over the period 2001-2003 the three year average spring percent biomass with the NRA was 24%.

In all surveys, Div. 3N accounted for .05-9% of the total Div. 3LNO biomass. More than 82% of the Div. 3N biomass was found outside the 200 Nmi limit. Division 3O accounted for less than 1% of the Div. 3LNO biomass. The area outside the 200 Nmi limit contributed between 0-34% of the Div. 3O biomass.

Stock composition

Length distributions representing abundance-at-length from the autumn 1996 to spring 2003 surveys are compared in Fig. 13. Tables 14-19 provide the detailed length frequency data obtained from each survey. Modes increase in height as one moved from ages 0-3 indicating that catchability of the research trawl improves as the shrimp get older. Tables 20-23 provide the modal analysis of males and the estimated demographics from each survey.

These time series provide a basis for comparison of relative year-class strength and illustrate the changes in stock composition over time. There appear to be two regimes; prior to 1998 the abundances at age are much lower than in the post 1997 time period. 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 1998-2000 year-classes appear moderately strong compared others. Modal length-at-age varies between years reflecting different growth rates for the different cohorts.

Abundances within the autumn 2002 survey data were dominated by males with a modal length of 19.5-mm CL, believed to have been the 1998 year-class (age 4). The 1999 year-class was evident near 17.0 mm while the 2000 year-class had a mode at 14.0 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 stronger 1997-1999 year-classes. The broad female distribution suggests that it consists of more than one year-class. The relative strength of the 1997-1999 year-classes and the breath of the female distributions are consistent with the observations pertaining to the commercial large vessel length frequencies. It is predicted that the strong 1997-1999 year-class will be able to sustain the fishery for the next few years.

Recruitment Index

Figure 14 provides a series of regression plots. The predictor is the age 2 abundance while the following is the order of the ordinate axes:

1) age 3 shrimp abundances$_{(time+1)}$;
2) fishable biomass (carapace length >17 mm) $_{(time+1)}$;
3) fishable biomass (carapace length > 17 mm) $_{(time+2)}$; and finally
4) age 4 + biomass $_{(time+2)}$.

There are two lag times for the fishable biomass because the definition of fishable biomass used in Scientific Council refers to animals with carapace lengths greater than 17 mm. Animals with a mode at 17 mm would be 3 years of age hence a lag of 1 year. Fishable biomass was also lagged by 2 years because the bulk of the commercial component of the biomass is thought to be age 4 animals.

Each of these regressors appears to be positively related to the age 2 abundances, and therefore the regressions may have predictive value; however, the time series is too short to be conclusive.

Exploitation Rates

Exploitation levels using ratios of catch/lower 95% confidence interval below the biomass estimate, catch/spawning stock biomss (SSB) and catch/fishable biomass track the same trend (Table 24). Overall, exploitation has been low. TAC for this stock was set in 1999 and again during 2002 by applying a 15% exploitation rate to the lower 95% confidence interval below recent biomass estimates, therefore, it is useful to discuss exploitation in terms of catch/ lower 95% confidence intervals below the biomass indices. This index was below 5% during the mid- to late-1990s, increased to 13.4% during 2000 reflecting the start of the fishery under TAC regulation, and then decreased as biomass indices increased. The ratio has never exceeded 15% of the minimum trawlable biomass and is presently 8.4%. It is important to note that these ratios are believed to over estimate the exploitation rate because the catchability of the research trawl is thought to be less than 1.

Distribution of shrimp in relation to various commercially important groundfish species

Atlantic cod

Relatively few juvenile cod (<=19 cm total length) have been caught during recent years, although, young cod were often found within Conception, Trinity and Bonavista Bays where their distribution overlapped with shrimp (Fig. 15). Concentrations appeared within Div. 3NO and the southern portion of Div. 3L. Few shrimp were found in these areas.

American plaice

Figure 16 indicates that juvenile American plaice (<=16 cm total length) are dispersed throughout the Grand Banks and that there is overlap between American plaice and large shrimp catches. However, most American plaice were found in water shallower than 200 m with the largest concentrations in the southern Grand Banks.

Redfish

Both shrimp and juvenile redfish (<=16 cm total length) are commonly found along the edge of the Grand Banks in water between 200 and 500 m (Fig. 17). Areas of overlap occur where juvenile redfish have traditionally been found, particularly in the Sackville Spur and on the nose of the Grand Banks. These are areas of highest shrimp concentrations. However, the largest concentrations of redfish are found along the southern edge of Div. 3NO.

Greenland halibut

Figure 18 indicates that large concentrations of juvenile Greenland halibut (<=24 cm total length) are sympatric with large concentrations of shrimp.

Information provided by these plots is in agreement with by-catch levels provided in Table 2. Levels of by-catch are generally in relation to abundances of juvenile groundfish and degrees of overlap between the species. There are relatively few Atlantic cod which for the most part are distributed away from the shrimp fishery; consequently by-catch of Atlantic cod has been below 200 kg. Juvenile American plaice are more abundant, but highest concentrations are in shallow water south of the fishery, consequently by-catch levels are higher than they are for cod but were still less than 7 tons during 2003. There is more overlap between juvenile redfish, Greenland halibut and the shrimp fishery. By-catch is greatest for these species.

Resource Status

Canadian small (<=500 t; LOA<100'), Icelandic and Russian shrimp fishing vessels have been able to maintain catch rates between 200 and 700 kg/hr. Canadian large (>500 ton), Greenlandic shrimp fishing vessel catch rates showed increases since the fishery began in 2000. The research survey biomass/ abundance estimates showed significant increases since 1999. The average minimum trawlable biomass from the last three autumn surveys was 98 958 tons (25 billion animals). The average minimum trawlable biomass from the last two spring surveys was 116 683 tons (25 billion animals). As a result of increases in biomass/ abundance, exploitation in terms of catch/ lower 95% confidence interval below the biomass index remained less than 8.4% during 2003 even though the TAC more than doubled.

The present female length frequency distributions are broad indicating that they consist of more than one year-class. Over the next few years, the present fishery should be sustained by the 1997-1999 year- classes which are strong relative to previous year-classes. Succeeding year-classes appear stronger than the 1995 and 1996 year-classes but are not as strong as the 1997-1999 year-classes at the same ages. However, the 2000-2002 year classes are still young and research indicates that catchability of the research trawl increases to age 3.

The fact that the spatial distribution of the stock is increasing is further evidence that the stock is presently healthy.

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Table 1 Nominal catches by country of northern pink shrimp (*Pandalus borealis*) caught in NAFO Div. 3L.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Canada	11[1]				2[1]					82[1]	78[1]	4,250[2]	5,129[2]	5,414[2]	9,577[2]
Cuba														70[3]	146[1]
Estonia												64[1]	2,264[4]	450[5]	68[1]
Faroe Islands					1,789[1]	1,865[1]		171[1]	485[1]	544[1]	706[1]	42[1]	2,052[4]	620[5]	
France (SPM)												67[1]		36[3]	
Greenland												34[1]			293[8]
Iceland												97[1]	55[7]	55[7]	
Latvia												64[1]	67[1]	59[3]	60[1]
Lithuania												67[1]	51[3]	67[3]	58[1]
Norway												77[1]	78[6]	70[6]	159[9]
Poland												40[1]	54[1]		
Portugal													61[5]		
Russia												67[1]	67[1]	67[3]	
Spain											11[1]		699[4]		
Ukraine													57[1]		144[1]
USA														69[3]	144[1]
GRAND TOTAL	11	0	0	0	1,791	1,865	0	171	485	567	795	4,869	10,566	6,977	10,649
TAC (tons)												6,000	6,000	6,000	13,000

Sources:

1 NAFO STATLANT 21A
2 Canadian Quota Report, or other preliminary sources
3 NAFO monthly records of provisional catches
4 Value agreed upon in STACFIS
5 Canadian surveillance reports
6 Observer datasets
7 Icelandic logbook dataset.
8 Greenlandic logbook dataset.
9 Norwegian logbook dataset.

Table 2. Estimated bycatch within the large vessel (>500 t) fleet fishing shrimp in 3L over the period 2000 - 2003.

	Atlantic cod				American plaice				redfish				Greenland halibut			
Year	2000	2001	2002	2003	2000	2001	2002	2003	2000	2001	2002	2003	2000	2001	2002	2003
Observed shrimp catch (t)	873	2,314	2,342	1,049	873	2,314	2,342	1,049	873	2,314	2,342	1,049	873	2,314	2,342	1,049
Logbook shrimp catch (t)	1,033	2,394	2,455	3,349	1,033	2,394	2,455	3,349	1,033	2,394	2,455	3,349	1,033	2,394	2,455	3,349
correction factor	1.184	1.035	1.048	3.192	1.184	1.035	1.048	3.193	1.184	1.035	1.048	3.193	1.184	1.035	1.048	3.193
estimated bycatch (kg)	96	227	137	70	526	115	312	1,149	727	993	1,685	2,927	2,551	5,818	4,293	11,804
Bycatch (kg)/ (t) shrimp	0.093	0.095	0.056	0.021	0.509	0.048	0.127	0.343	0.704	0.415	0.686	0.874	2.470	2.430	1.749	3.525
Number of fish measured	78	17	0	37	339	0	0	164	47	0	0	30	985	2732	1333	1045
	estimated number at age				estimated number at age				estimated number at age				estimated number at age			
age																
0	96	0	0	0	0	0	0	0	0	0	0	0	3,538	3,793	4,273	667
1	377	187	0	45	0	0	0	0	1,964	0	0	0	2,681	4,256	12,413	12,433
2	102	309	0	73	96	0	0	447	4,761	0	0	22,341	8,333	23,689	11,438	52,023
3	4	35	0	10	204	0	0	2,464	3,866	0	0	28,958	5,535	12,638	9,254	29,995
4	1	20	0	3	304	0	0	3,933	4,098	0	0	32,970	1,525	7,051	3,848	8,682
5	0	3	0	0	1,135	0	0	2,372	1,730	0	0	3,361	572	830	437	1,264
6	0	0	0	0	1,716	0	0	2,142	548	0	0	192	169	140	38	35
7	0	0	0	0	1,048	0	0	2,151	117	0	0	0	0	12	0	80
8	0	0	0	0	491	0	0	591	8	0	0	0	0	0	4	6
9	0	0	0	0	202	0	0	351	0	0	0	0	0	0	0	0
10	0	0	0	0	41	0	0	51	0	0	0	0	0	0	0	0
11	0	0	0	0	12	0	0	10	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total	579	555	0	131	5,250	0	0	14,511	17,092	0	0	87,821	22,353	52,410	41,704	105,186

Correction factor = logbook shrimp catch/ observed shrimp catch;
Estimated by-catch = observed by-catch * correction factor.

Table 3 Estimated bycatch within the small vessel (<=500 t; LOA <100') fleet fishing shrimp in 3L over the period 2000 - 2003.

	Atlantic cod				American plaice				redfish				Greenland halibut			
Year	2000	2001	2002	2003	2000	2001	2002	2003	2000	2001	2002	2003	2000	2001	2002	2003
Observed shrimp catch (t)	70	91	175	103	70	91	175	103	70	91	175	103	70	91	175	103
Logbook shrimp catch (t)	3217	2735	2959	6228	3217	2735	2959	6228	3217	2735	2959	6228	3217	2735	2959	6228
correction factor	45.666	30.181	16.948	60.585	45.666	30.181	16.948	60.585	45.666	30.181	16.948	60.585	45.666	30.181	16.948	60.585
estimated bycatch (kg)	0	272	153	1,878	0	1,177	559	6,543	776	1,388	1,305	10,118	2,694	2,113	2,898	20,841
Bycatch (kg)/ (t) shrimp	0	0.099	0.052	0.302	0.000	0.430	0.189	1.051	0.241	0.507	0.441	1.625	0.837	0.773	0.979	3.346
Number of fish measured	0	1	0	48	0	0	0	0	0	0	0	309	0	58	0	296
	estimated number at age				estimated number at age				estimated number at age				estimated number at age			
age																
0	0	0	0	242	0	0	0	0	0	0	0	0	0	1,419	0	14,904
1	0	272	0	3,575	0	0	0	0	0	0	0	15,207	0	3,893	0	76,882
2	0	0	0	1,272	0	0	0	0	0	0	0	54,405	0	2,414	0	145,768
3	0	0	0	61	0	0	0	0	0	0	0	84,516	0	1,237	0	23,931
4	0	0	0	0	0	0	0	0	0	0	0	186,178	0	1,268	0	7,634
5	0	0	0	0	0	0	0	0	0	0	0	35,382	0	60	0	0
6	0	0	0	0	0	0	0	0	0	0	0	13,026	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	2,120	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	182	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total	0	272	0	5,150	0	0	0	0	0	0	0	391,016	0	10,292	0	269,119

Correction factor = logbook shrimp catch/ observed shrimp catch;
Estimated by-catch = observed by-catch * correction factor.

Table 4. Total biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the autumn 1995 - 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	Area	Autumn 95	Autumn 96	Autumn 97	Autumn 98	Autumn 99	Autumn 2000	Autumn 2001	Autumn 2002
Range in m	in Nmi2	WT 176 - 179	WT 196 - 198,	WT 213-217	WT 230 - 233	WT 246 - 248	WT 321 - 323	WT 373 - 376	WT 428 - 431
		WT 181, Tel 22	Tel 41	Tel 57 & 58	Tel 75 & 76		Tel 339, 342	AN 399, Tel 357,	Tel 412, 413
		& Tel 23					& 343	358 & 361	& 415
		biomass	biomass	biomass	biomass	biomass	biomass	biomass	biomass
		(Kg X 1000)	(Kg X 1000)	(Kg X 1000)	(Kg X 1000)	(Kg X 1000)	(Kg X 1000)	(Kg X 1000)	(Kg X 1000)
30 - 56	9,285	.	.	.	.	.	.	.	.
57 - 92	18,957	0	6	16	13	5	34	38	654
93 - 183	7,170	41	176	1,849	1,237	1,855	3,313	13,909	12,260
184 - 274	399	787	3,518	25,015	32,516	36,423	73,001	96,620	109,364
275 - 366	4,030	4,374	14,647	18,515	22,691	14,390	41,292	111,602	87,367
367 - 549	1,192	142	218	353	25	187	232	946	789
550 - 731	804	13	1	9	2	3	27	17	18
732 - 914	957	.	0	1	0	0	2	13	0
915 -1097	945	.	0	0	0	0	1	4	0
1098 -1280	1,745	.	0	0	0	0	0	0	2
1281 -1463	773	.	0	0	0	.	0	0	0
Total (000's)		5,358	18,566	45,758	56,484	52,863	117,902	223,149	210,451
Upper 95% limit		7,397	28,893	66,426	76,064	69,804	142,949	369,574	299,083
Lower 95% limit		3,318	8,238	25,090	36,905	35,923	92,855	76,725	121,821
%<184m		1	1	4	2	4	3	6	0
%184 - 549 m		99	99	96	98	96	97	94	99
%>549 m		0	0	0	0	0	0	0	0
				Outside 200 Nmi limit					
93 - 183	933	0	0	79	14	70	187	1,590	2,119
184 - 274	791	26	1,635	1,246	4,454	6,486	19,197	20,467	21,384
275 - 366	758	997	2,759	3,685	4,222	2,079	8,949	29,397	11,408
367 - 549	636	4	110	102	17	98	113	817	774
550 - 731	554	12	1	1	0	1	0	4	15
732 - 914	607	.	0	1	0	0	1	12	0
915 -1097	582	.	0	0	0	0	0	4	0
1098 -1280	1,331	.	0	0	0	0	0	0	2
1281 -1463	295	.	0	0	0	.	0	0	0
Total (000's)		1,039	4,506	5,115	8,707	8,734	28,447	52,292	35,702
Upper 95% limit		4,853	25,676	13,242	25,437	19,432	49,256	111,814	100,372
Lower 95% limit		-2,774	-16,664	-3,013	-8,022	-1,964	7,638	-7,230	-28,968
%<184m		0	0	2	0	1	1	3	6
%184 - 549 m		99	100	98	100	99	99	97	94
%>549 m		1	0	0	0	0	0	0	0

Table 5 Total biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the autumn 1995 - 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	Autumn 95 WT 176, 177 biomass (Kg X 1000)	Autumn 96 Tel 41, 42 & AN 253 biomass (Kg X 1000)	Autumn 97 WT 212-214 biomass (Kg X 1000)	Autumn 98 WT 229, 230, WT 233, Tel 76 biomass (Kg X 1000)	Autumn 99 WT 245 - 247 biomass (Kg X 1000)	Autumn 2000 WT 320, 322 WT 323, Tel 338 & 339 biomass (Kg X 1000)	Autumn 2001 WT 372, 373 & Tel 357 biomass (Kg X 1000)	Autumn 2002 WT 411, 412, Tel 427 & 428 biomass (Kg X 1000)
<=56	3,092	0	0	1	0	1	0	1	0
57 - 92	11,490	36	13	6	13	4	14	15	207
93 - 183	1,168	0	2	44	119	1	10	8	1,953
184 - 274	546	45	776	318	3,023	104	65	308	1,546
275 - 366	386	2	144	40	82	90	57	423	646
367 - 549	420	450	578	17	25	61	88	28	66
550 - 731	352	0	1	1	97	12	17	42	16
732 - 914	394	.	.	.	0	.	17	10	7
915 -1097	411	.	.	.	0	.	1	1	2
1098 -1280	491	.	.	.	0	.	0	0	0
1281 -1463	773	.	.	.	0	.	0	0	0
Total (000's)		533	1,514	427	3,360	272	270	836	4,444
Upper 95% limit		6,272	13,314	2,694	36,474	731	1,175	5,244	35,204
Lower 95% limit		-5,206	-10,285	-1,840	-29,754	-188	-635	-3,573	-26,316
%<184m		7	1	12	4	2	9	3	49
%184 - 549 m		93	99	88	93	94	78	91	51
%>549 m		0	0	0	3	4	13	6	1
<=56	1,605	0	0	0	0	0	0	0	0
57 - 92	2,996	7	11	2	0	1	0	1	2
93 - 183	864	0	2	44	119	0	8	5	1,036
184 - 274	508	38	626	292	2,474	84	56	303	1,537
275 - 366	366	2	138	34	70	74	51	419	628
367 - 549	420	450	578	17	25	61	88	28	66
550 - 731	352	0	1	1	97	12	17	42	16
732 - 914	394	.	.	.	0	.	17	10	7
915 -1097	411	.	.	.	0	.	1	1	2
1098 -1280	491	.	.	.	0	.	0	0	0
1281 -1463	773	.	.	.	0	.	0	0	0
Total (000's)		497	1,356	391	2,786	232	240	809	3,295
Upper 95% limit		6,216	4,875	2,645	29,156	629	1,118	5,213	10,932
Lower 95% limit		-5,222	-2,164	-1,863	-23,585	-164	-638	-3,594	-4,343
%<184m		2	1	12	4	0	3	1	31
%184 - 549 m		98	99	88	92	95	82	93	68
%>549 m		0	0	0	3	5	15	7	1

Table 6 Total biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the autumn 1995 - 2002 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 Range in m	Area in Nmi2	Autumn 95 WT 176 & 177	Autumn 96 WT 200, Tel 42 & AN 253	Autumn 97 WT 212 & 213	Autumn 98 WT 229, 230, WT 233, Tel 76	Autumn 99 WT 244 - 246	Autumn 2000 WT 319, 320, 322 & Tel 338	Autumn 2001 WT 372 & Tel 357	Autumn 2002 Wt 427 & Tel 411
		biomass	biomass	biomass	biomass	biomass	biomass	biomass	biomass
		(Kg X 1000)	(Kg X 1000)	(Kg X 1000)	(Kg X 1000)	(Kg X 1000)	(Kg X 1000)	(Kg X 1000)	(Kg X 1000)
57 - 92	12541	0	5.77	3.65	18.52	2.73	3.47	3	56
93 - 183	4775	10.44	2.13	9.05	14.19	2.87	0	1	26
184 - 274	371	20	0.74	3.68	35.5	1.08	3.63	4	26
275 - 366	215	0	0	0.27	0.53	0.12	0	1	2
367 - 549	318	0	0.21	0.12	0.17	0.5	0.1	1	4
550 - 731	332	0.07	0.06	0.12	0.09	1.77	0.41	0	0
732 - 914	339	.	.	.	0.07	.	0.08	0	0
915 -1097	390	.	.	.	0	.	0	0	0
1098 -1280	407	.	.	.	.	.	0	0	0
1281 -1463	488	.	.	.	.	.	0	0	0
Total (000's)		31	9	17	69	9	8	10	113
Upper 95% limit		280	15	86	301	17	51	21	202
Lower 95% limit		-219	3	-52	-163	1	-36	-1	24
%<184m		34	89	75	47	62	45	32	72
%184 - 549 m		66	11	24	52	19	49	65	28
%>549 m		0	1	1	0	20	6	1	0
				Outside 200 Nmi limit					
57 - 92	269	0	0	0	1	0	0	0	0
93 - 183	246	0	1	3	2	1	0	0.32	10.83
184 - 274	74	0	0	1	11	1	0	1.01	18.17
275 - 366	47	0	0	0	0	0	0	0.97	0.87
367 - 549	58	0	0	0	0	0	0	0.72	2.21
550 - 731	71	0	0	0	0	1	0	0	0
732 - 914	105	.	.	.	0	.	0	0	0.07
915 -1097	126	.	.	.	0	.	0	0.09	0
1098 -1280	147	.	.	.	.	.	0	0	0
1281 -1463	180	.	.	.	.	.	0	0	0.12
Total (000's)		1	1	4	15	3	1	3	32
Upper 95% limit		5	11	36	162	23	5	8	187
Lower 95% limit		-4	-8	-28	-133	-17	-4	-2	-123
%<184m		31	82	65	22	27	0	11	34
%184 - 549 m		61	19	32	78	29	36	90	66
%>549 m		9	0	2	0	44	63	3	1

Table 7. Total biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the spring 1999 - 2003 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 biomass (Kg X 1000)	Spring 2000 WT 317 & 318 biomass (Kg X 1000)	Spring 2001 WT 365 & biomass (Kg X 1000)	Spring 2002 WT 422, 423 & WT 424 biomass (Kg X 1000)	Spring 2003 WT 481 & 482 biomass (Kg X 1000)
30 - 56	9285	0	.	.	.	.
57 - 92	18957	1	0	0	4	11
93 - 183	7170	29	54	41	64	52
184 - 274	399	13,247	63,616	16,314	45,439	63,530
275 - 366	4030	40,320	54,779	85,143	109,058	119,586
367 - 549	1192	248	1,023	895	370	7,517
550 - 731	804	88	50	98	125	22
732 - 914	957	.	.	.	.	0
915 -1097	945	.	.	.	.	0
1098 -1280	1745	.	.	.	.	0
1281 -1463	773	.	.	.	.	0
Total (000's)		53,934	119,521	102,493	155,061	190,718
Upper 95% limit		96,644	257,005	142,700	193,642	272,074
Lower 95% limit		11,223	-17,963	62,286	116,481	109,361
%<184m		0	0	0	0	0
%184 - 549 m		100	100	100	100	100
%>549 m		0	0	0	0	0
			Outside 200 Nmi			
93 - 183	933	1	1	1	2	1
184 - 274	791	6,284	21,186	722	3,240	9,699
275 - 366	758	8,192	14,212	16,819	43,707	22,600
367 - 549	636	170	681	791	222	6,162
550 - 731	554	83	48	65	116	12
732 - 914	607 .	.	.	.	.	
915 -1097	582 .	.	.	.	.	
1098 -1280	1331 .	.	.	.	.	
1281 -1463	295 .	.	.	.	.	
Total (000's)		14,731	36,127	18,397	47,288	38,473
Upper 95% limit		37,178	301,999	126,486	161,375	59,938
Lower 95% limit		-7,717	-229,746	-89,691	-66,799	17,007
%<184m		0	0	0	0	0
%184 - 549 m		99	100	100	100	100
%>549 m		1	0	0	0	0

Table 8. Total biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the spring 1999 - 2003 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 biomass (Kg X 1000)	Spring 2000 WT 316 & 317 biomass (Kg X 1000)	Spring 2001 WT 367 - 369 biomass (Kg X 1000)	Spring 2002 WT 421, 422 & WT 424 biomass (Kg X 1000)	Spring 2003 WT 480 & 481 biomass (Kg X 1000)
<=56	3,092	0	0	0	5	0
57 - 92	11,490	3	0	2	3	2
93 - 183	1,168	101	1	1	2	3
184 - 274	546	231	319	5	179	1,228
275 - 366	386	940	1,886	43	4,153	1,619
367 - 549	420	74	40	3	20	2
550 - 731	352	0	1	0	34	0
732 - 914	394	.	.	.	.	
915 -1097	411	.	.	.	.	
1098 -1280	491	.	.	.	.	
1281 -1463	773	.	.	.	.	
Total (000's)		1,349	2,248	53	4,395	2,853
Upper 95% limit		11,209	24,096	278	54,237	26,147
Lower 95% limit		-8,511	-19,601	-171	-45,448	-20,442
%<184m		8	0	4	0	0
%184 - 549 m		92	100	96	99	100
%>549 m		0	0	0	1	0
<=56	1605	0	0	0	5	0
57 - 92	2996	0	0	0	0	0
93 - 183	864	101	1	1	1	2
184 - 274	508	220	260	4	156	1,223
275 - 366	366	932	1,876	37	3,455	1,609
367 - 549	420	74	40	3	20	2
550 - 731	352	.	1	0	34	0
732 - 914	394	.	0	0	.	
915 -1097	411	.	0	0	.	
1098 -1280	491	.	0	0	.	
1281 -1463	773	.	0	0	.	
Total (000's)		1,327	2,178	45	3,670	2,835
Upper 95% limit		11,176	23,915	232	44,929	26,129
Lower 95% limit		-8,523	-19,559	-143	-37,589	-20,459
%<184m		8	0	1	0	0
%184 - 549 m		92	100	99	99	100
%>549 m		0	0	0	1	0

Table 9. Total biomass (Kg. X1000) of northern shrimp (*Pandalus borealis*) collected during the spring 1999 - 2003 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 Range in m	Area in Nmi2	Spring 99 WT 238 & 239 biomass (Kg X 1000)	Spring 2000 WT 316 - 317 biomass (Kg X 1000)	Spring 2001 WT 365, 367 & WT 368 biomass (Kg X 1000)	Spring 2002 WT 419 & 421 biomass (Kg X 1000)	Spring 2003 WT 479 & 480 biomass (Kg X 1000)
57 - 92	12541	0	0	3	5	14
93 - 183	4775	12	1	13	2	169
184 - 274	371	11	7	2	5	8
275 - 366	215	8	29	0	0	1
367 - 549	318	3	2	2	22	3
550 - 731	332	0	7	0	0	1
732 - 914	339	.	.	.	. .	
915 -1097	390	.	.	.	. .	
1098 -1280	407	.	.	.	. .	
1281 -1463	488	.	.	.	. .	
Total (000's)		34	46	20	35	196
Upper 95% limit		63	399	99	95	536
Lower 95% limit		5	-307	-60	-25	-145
%<184m		37	3	81	20	93
%184 - 549 m		63	83	19	80	6
%>549 m		0	14	0	1	0
57 - 92	269	0	0	0	0	0
93 - 183	246	0	0	0	0	0
184 - 274	74	0	0	0	0	2
275 - 366	47	0	0	0	0	0
367 - 549	58	0	1	1	4	0
550 - 731	71	0	5	0	0	0
732 - 914	105	.	.	.	. .	
915 -1097	124	.	.	.	. .	
1098 -1280	147	.	.	.	. .	
1281 -1463	180	.	.	.	. .	
Total (000's)		0	6	2	4	2
Upper 95% limit		0	69	17	56	22
Lower 95% limit		0	-58	-14	-48	-17
%<184m		0	0	0	0	0
%184 - 549 m		0	15	100	97	86
%>549 m		0	85	0	3	14

Table 10 Northern shrimp stock size estimates in NAFO divisions 3LNO from annual autumn Canadian multi-species bottom surveys. Offshore strata only. (standard 15 min. tows)

	Biomass (tons)			Abundance (numbers x 10^{-6})			Survey
Year	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	5,867	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
2002	126,180	215,008	303,837	30,469	50,257	70,044	365

Table 11 Northern shrimp stock size estimates in NAFO divisions 3LNO from annual spring Canadian multi-species bottom surveys. Offshore strata only. (standard 15 min. tows)

	Biomass (tons)			Abundance (numbers x 10^{-6})			Survey
Year	Lower C.I.	Estimate	Upper C.I.	Lower C.I.	Estimate	Upper C.I.	Sets
1999	12,564	55,317	98,069	3,178	12,702	22,227	313
2000	-15,869	121,815	259,498	-54,743	25,012	104,768	298
2001	62,359	102,566	142,773	13,417	24,845	36,272	300
2002	121,067	159,491	197,916	28,311	37,512	46,714	300
2003	112,299	193,766	275,233	21,857	46,295	70,732	300

Table 12 NAFO divisions 3LNO *Pandalus borealis* biomass estimates for entire divisions and outside the 200 Nmi limit. Shrimp were collected during the autumn Canadian multi-species surveys using a Campelen 1800 shrimp trawl. (standard 15 min. tows).

			Entire Division		Outside 200 Nmi limit			
Season	Year	Division	Biomass estimate (Kg x 1000)	Percent by division	Biomass estimate (Kg x 1000)	Percent biomass by division	percent biomass in NRA	3 year running average percent biomass in NRA
Autumn	1995	3L	5,357	90.48	1,039	67.63	19.40	19.40
Autumn	1996	3L	18,566	92.42	4,506	76.86	24.27	21.84
Autumn	1997	3L	45,758	99.04	5,115	92.83	11.18	18.28
Autumn	1998	3L	56,485	94.28	8,707	75.66	15.42	16.95
Autumn	1999	3L	52,863	99.47	8,734	97.38	16.52	14.37
Autumn	2000	3L	117,902	99.77	28,447	99.16	24.13	18.69
Autumn	2001	3L	223,149	99.62	52,292	98.47	23.43	21.36
Autumn	2002	3L	210,451	97.88	35,702	91.48	16.96	21.51
Autumn	1995	3N	533	9.00	497	32.34	93.29	93.29
Autumn	1996	3N	1,514	7.54	1,356	23.12	89.52	91.40
Autumn	1997	3N	427	0.92	391	7.09	91.52	91.44
Autumn	1998	3N	3,360	5.61	2,786	24.21	82.91	87.98
Autumn	1999	3N	272	0.51	232	2.59	85.57	86.67
Autumn	2000	3N	270	0.23	240	0.84	88.80	85.76
Autumn	2001	3N	836	0.37	809	1.52	96.77	90.38
Autumn	2002	3N	4,444	2.07	3,295	8.44	74.14	86.57
Autumn	1995	3O	31	0.52	1	0.04	1.82	1.82
Autumn	1996	3O	9	0.04	1	0.02	12.50	7.16
Autumn	1997	3O	17	0.04	4	0.07	23.79	12.70
Autumn	1998	3O	69	0.12	15	0.13	21.23	19.17
Autumn	1999	3O	9	0.02	3	0.03	33.59	26.21
Autumn	2000	3O	8	0.01	1	0.00	8.02	20.95
Autumn	2001	3O	10	0.00	3	0.01	30.00	23.87
Autumn	2002	3O	113	0.05	32	0.08	28.32	22.11
	all divisions							
Autumn	1995		5,921		1,537		25.96	25.96
Autumn	1996		20,088		5,862		29.18	27.57
Autumn	1997		46,202		5,509		11.92	22.36
Autumn	1998		59,914		11,508		19.21	20.11
Autumn	1999		53,144		8,969		16.88	16.00
Autumn	2000		118,180		28,687		24.27	20.12
Autumn	2001		223,995		53,104		23.71	21.62
Autumn	2002		215,008		39,029		18.15	22.04

Table 13 NAFO divisions 3LNO *Pandalus borealis* biomass estimates for entire divisions and outside the 200 Nmi limit. Shrimp were collected during the spring Canadian multi-species surveys using a Campelen 1800 shrimp trawl. (standard 15 min. tows)

			Entire Division		Outside 200 Nmi limit			
Season	Year	Division	Biomass estimate (Kg x 1000)	Percent by division	Biomass estimate (Kg x 1000)	Percent biomass by division	percent biomass in NRA	3 year running average percent biomass in NRA
Spring	1999	3L	53,934	97.50	14,731	91.74	27.31	27.31
Spring	2000	3L	119,521	98.12	36,127	94.30	30.23	28.77
Spring	2001	3L	102,493	99.93	18,397	99.75	17.95	25.16
Spring	2002	3L	155,061	97.22	47,288	92.79	30.50	26.22
Spring	2003	3L	190,718	98.43	38,473	93.13	20.17	22.87
Spring	1999	3N	1,349	2.44	1,327	8.26	98.37	98.37
Spring	2000	3N	2,248	1.85	2,178	5.69	96.89	97.63
Spring	2001	3N	53	0.05	45	0.24	84.91	93.39
Spring	2002	3N	4,395	2.76	3,670	7.20	83.50	88.43
Spring	2003	3N	2,853	1.47	2,834	6.86	99.33	89.25
Spring	1999	3O	34	0.06	0	0.00	0.00	0.00
Spring	2000	3O	46	0.04	6	0.02	13.04	6.52
Spring	2001	3O	20	0.02	2	0.01	10.00	7.68
Spring	2002	3O	35	0.02	4	0.01	11.43	11.49
Spring	2003	3O	196	0.10	2	0.00	1.02	7.48
	all divisions							
Spring	1999		55,317		16,057		29.03	29.03
Spring	2000		121,815		38,310		31.45	30.24
Spring	2001		102,566		18,444		17.98	26.15
Spring	2002		159,491		50,962		31.95	27.13
Spring	2003		193,766		41,310		21.32	23.75

Table 14 Abundance (000's) of male northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO during autumn Canadian research surveys during 1995 - 2002. The data were taken from strata <784 so that all years would be comparable.

Length in mm	Autumn 95 WT 176 - 179 WT 181, Tel 22 & Tel 23	Autumn 96 WT 196 - 198, Tel 41	Autumn 97 WT 213-217 Tel 57 & 58	Autumn 98 WT 230 - 233 Tel 75 & 76	Autumn 99 WT 246 - 248	Autumn 2000 WT 321 - 323 Tel 339, 342 & 343	Autumn 2001 WT 373 - 376 N 399, Tel 357, 358 & 361	Autumn 2002 WT 428 - 431 Tel 412, 413 & 415
5.5	0	0	855	0	0	0	0	0
6.0	0	0	0	0	0	0	0	0
6.5	0	111	0	0	0	0	0	0
7.0	382	55	0	47	1,276	0	0	0
7.5	4,492	548	3,341	71	4,290	18,215	14,074	0
8.0	270	2,178	1,542	804	5,582	5,696	4,993	13,271
8.5	4,848	6,509	6,875	60,601	20,487	91,357	34,666	47,774
9.0	27,395	9,910	21,185	162,470	15,644	150,098	111,553	162,999
9.5	62,014	31,303	62,256	329,427	30,214	229,876	199,461	217,316
10.0	134,066	36,438	68,030	640,705	65,922	421,556	119,091	430,628
10.5	165,074	27,124	104,909	803,347	78,823	432,442	92,017	318,584
11.0	204,882	28,566	97,314	688,029	76,732	304,061	45,002	142,390
11.5	125,333	47,621	71,023	467,599	75,651	176,027	39,355	81,501
12.0	75,757	76,101	40,746	172,256	34,346	93,780	70,499	171,780
12.5	33,682	86,904	34,673	121,814	48,364	128,345	156,348	244,495
13.0	22,484	99,708	27,764	63,981	71,854	343,253	365,679	474,890
13.5	24,914	127,367	38,460	92,604	134,311	788,552	656,012	896,804
14.0	20,856	235,167	77,113	135,430	242,200	1,201,742	1,054,379	1,100,277
14.5	16,247	368,703	191,153	270,428	396,076	1,705,726	1,843,186	1,371,170
15.0	23,272	619,513	403,670	443,520	780,197	1,754,548	2,366,129	958,101
15.5	32,890	727,877	633,475	471,543	1,222,507	1,688,485	2,094,576	1,021,447
16.0	44,575	652,349	743,964	459,915	1,326,686	1,327,051	1,990,297	1,404,120
16.5	38,401	445,760	496,225	415,527	966,914	1,398,609	3,019,319	2,690,245
17.0	41,682	280,750	472,840	436,950	492,181	1,908,443	3,205,491	3,877,847
17.5	29,305	184,004	476,973	579,364	306,399	2,901,654	3,432,891	3,356,620
18.0	16,164	210,944	576,167	842,287	346,026	3,400,956	3,480,415	3,476,615
18.5	12,839	212,870	790,144	997,213	468,133	2,259,814	4,221,574	3,745,035
19.0	21,104	256,541	720,103	1,061,021	485,986	1,617,071	4,714,143	2,986,152
19.5	16,056	251,255	656,060	975,338	490,523	1,031,449	4,700,334	3,035,047
20.0	16,756	150,181	380,955	875,327	519,131	694,549	3,740,211	2,903,310
20.5	13,294	80,541	255,787	733,217	512,787	555,935	2,168,914	2,275,945
21.0	10,476	77,822	116,219	500,967	493,872	398,602	1,128,505	1,340,849
21.5	8,238	38,332	62,912	345,670	331,419	404,183	490,010	684,487
22.0	4,862	33,114	15,121	130,505	193,324	211,379	142,675	287,333
22.5	2,547	26,946	8,466	27,672	120,117	101,683	48,402	32,933
23.0	1,248	17,019	592	15,252	34,878	56,800	48,110	5,542
23.5	248	10,842	416	1,236	25,468	12,853	14,026	32
24.0	104	3,428	69	23	3,528	4,857	54	0
24.5	54	1,427	0	0	1,820	20	15	0
25.0	54	0	0	0	0	0	0	32
25.5	0	0	0	0	0	0	0	0
26.0	0	0	0	0	0	0	0	0
26.5	0	0	0	0	0	0	0	0
27.0	0	0	0	0	0	0	0	0
27.5	0	0	0	0	0	0	0	0
28.0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0
29.0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0
30.0	0	0	0	0	0	0	0	0
30.5	0	0	0	0	0	0	0	0
31.0	0	0	0	0	0	0	0	0
31.5	0	0	0	0	0	0	0	0
32.0	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	39,755,566
Upper 95% limit	2,386,779	9,122,011	10,393,910	17,507,324	13,237,807	33,599,699	68,184,931	54,588,882
Lower 95% limit	126,949	1,809,644	4,920,880	9,136,997	7,609,522	22,039,635	23,439,879	24,922,251

Table 15 Abundance (000's) of transitional northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO during autumn Canadian research surveys during 1995 - 2002. The data were taken from strata <784 so that all years would be comparable.

Length in mm	Autumn 95 WT 176 - 179 WT 181, Tel 22 & Tel 23	Autumn 96 WT 196 - 198, Tel 41	Autumn 97 WT 213-217 Tel 57 & 58	Autumn 98 WT 230 - 233 Tel 75 & 76	Autumn 99 WT 246 - 248	Autumn 2000 WT 321 - 323 Tel 339, 342 & 343	Autumn 2001 WT 373 - 376 N 399, Tel 357, 358 & 361	Autumn 2002 WT 428 - 431 Tel 412, 413 & 415
5.5	0	0	0	0	0	0	0	0
6.0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0
7.0	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0
8.0	0	0	0	0	0	0	0	0
8.5	0	0	0	0	0	0	0	0
9.0	0	0	0	0	0	0	0	0
9.5	0	0	0	0	0	0	0	0
10.0	0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	0	0
11.0	0	0	0	0	0	0	0	0
11.5	0	0	0	0	0	0	0	0
12.0	0	0	0	0	638	0	0	0
12.5	959	0	0	0	0	0	0	0
13.0	0	0	0	0	0	0	0	0
13.5	3,989	0	0	0	0	0	0	0
14.0	15,348	0	0	0	0	0	0	0
14.5	9,708	0	0	0	0	0	0	0
15.0	48,864	0	0	0	0	0	0	0
15.5	126,767	0	0	0	0	0	0	0
16.0	116,811	0	245	0	0	0	0	0
16.5	92,772	2,574	71	0	0	0	0	0
17.0	63,648	58	4,611	0	0	0	0	0
17.5	43,865	5,883	593	47	0	26	0	25,879
18.0	16,738	3,738	13,738	0	184	35,572	3,223	0
18.5	13,954	7,247	32,009	9,680	3,945	62,928	4,445	7,301
19.0	16,792	13,926	68,940	9,390	16,718	96,459	54,568	13,719
19.5	18,622	22,211	193,204	47,758	35,375	94,795	136,497	183,043
20.0	19,354	30,842	221,376	55,099	70,631	248,462	273,335	279,563
20.5	17,089	26,876	382,406	86,637	139,780	220,411	289,877	208,057
21.0	16,499	9,931	407,291	104,502	267,540	326,132	250,074	282,056
21.5	20,577	19,652	360,800	79,428	374,626	275,908	160,120	141,035
22.0	22,242	6,808	201,701	45,695	317,088	172,006	86,509	153,467
22.5	17,315	8,842	107,364	20,662	211,040	178,600	12,625	14,583
23.0	13,263	430	55,497	4,126	87,859	111,377	4,240	11
23.5	8,503	41	25,610	0	46,931	26,702	9,245	0
24.0	2,988	42	6,821	0	44,066	9,989	0	22
24.5	3,041	16	4,102	11	3,151	6,221	0	0
25.0	432	7	40	0	0	1,707	0	0
25.5	129	0	23	0	0	0	0	0
26.0	10	0	0	0	0	0	0	0
26.5	0	0	0	0	0	0	0	0
27.0	10	0	0	0	0	0	0	0
27.5	60	0	0	0	0	0	0	0
28.0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0
29.0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0
30.0	0	0	0	0	0	0	0	0
30.5	0	0	0	0	0	0	0	0
31.0	0	0	0	0	0	0	0	0
31.5	0	0	0	0	0	0	0	0
32.0	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	1,308,734
Upper 95% limit	1,088,041	434,880	3,539,739	651,862	2,170,017	3,039,382	1,837,752	2,490,132
Lower 95% limit	372,650	-116,634	633,141	274,208	1,069,127	695,208	731,762	127,336

Table 16 Abundance (000's) of multiparous + ovigerous northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO during autumn Canadian research surveys during 1995 - 2002. The data were taken from strata <784 so that all years would be comparable.

Length in mm	Autumn 95 WT 176 - 179 WT 181, Tel 22 & Tel 23	Autumn 96 WT 196 - 198, Tel 41	Autumn 97 WT 213-217 Tel 57 & 58	Autumn 98 WT 230 - 233 Tel 75 & 76	Autumn 99 WT 246 - 248	Autumn 2000 WT 321 - 323 Tel 339, 342 & 343	Autumn 2001 WT 373 - 376 N 399, Tel 357, 358 & 361	Autumn 2002 WT 428 - 431 Tel 412, 413 & 415
10.0	0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	0	0
11.0	0	0	0	0	0	0	0	0
11.5	0	58	0	0	0	0	0	0
12.0	0	0	0	0	0	0	3,421	0
12.5	0	58	0	0	0	0	0	0
13.0	0	0	0	0	0	0	0	0
13.5	0	0	0	0	1,792	0	0	0
14.0	0	0	523	0	0	0	0	0
14.5	0	289	0	0	0	0	0	0
15.0	755	457	0	0	0	0	0	0
15.5	0	58	0	406	0	0	0	0
16.0	0	231	3,135	4,834	0	0	2,616	0
16.5	0	231	1,305	4,760	3,918	9,912	19,479	6,342
17.0	0	0	1,317	7,548	8,841	56	38,682	7,167
17.5	0	1,662	2,673	6,860	7,583	3,125	30,676	24,254
18.0	298	284	1,370	9,586	7,744	17,122	13,825	26,845
18.5	0	1,023	3,401	1,833	6,374	7,538	39,320	1,728
19.0	724	6,087	3,195	1,069	14,008	9,610	27,101	35,774
19.5	506	6	4,004	5,013	4,277	11,738	61,304	96,264
20.0	438	391	7,986	9,164	10,157	5,495	75,227	316,121
20.5	60	847	8,832	24,229	7,455	27,118	120,651	676,823
21.0	746	1,190	21,861	55,240	17,745	58,720	431,617	1,369,431
21.5	2,290	4,362	48,246	115,863	39,186	118,559	524,140	1,475,710
22.0	2,766	4,119	66,829	186,364	79,099	153,368	807,568	1,230,444
22.5	4,067	14,577	83,857	251,298	103,443	293,286	957,566	887,953
23.0	6,211	24,802	95,627	248,676	150,063	290,711	909,836	761,183
23.5	6,281	25,728	99,927	188,663	149,734	395,290	777,056	632,914
24.0	8,159	20,280	78,887	161,696	153,122	406,877	717,568	595,282
24.5	12,241	30,367	82,838	98,121	84,113	285,001	559,677	415,733
25.0	8,434	30,943	72,359	66,753	75,424	186,106	455,051	210,292
25.5	9,094	23,848	40,667	42,105	43,163	91,892	192,569	171,418
26.0	7,674	17,710	23,821	20,125	23,975	41,133	107,162	106,152
26.5	6,583	11,484	5,331	10,911	11,335	37,121	43,124	83,363
27.0	4,562	6,745	5,910	10,571	7,471	5,231	37,794	27,720
27.5	2,347	3,847	10,963	3,796	4,668	5,885	17,942	24,808
28.0	2,569	2,376	2,270	5,916	3,070	1,994	5,520	3,488
28.5	827	2,815	1,759	1,823	674	226	878	450
29.0	374	2,198	1,650	309	1,300	79	229	3,555
29.5	670	1,635	356	0	197	2,262	54	100
30.0	79	1,227	238	17	67	0	54	18
30.5	50	1,138	110	20	79	0	0	0
31.0	0	110	106	0	0	869	0	0
31.5	0	135	0	20	14	0	0	0
32.0	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	9,191,329
Upper 95% limit	437,945	538,855	1,558,469	2,196,382	1,526,132	3,772,757	11,770,822	13,820,674
Lower 95% limit	-260,335	-52,227	4,230	890,789	514,049	1,159,889	2,184,595	4,561,984

Table 17 Abundance (000's) of male northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO during spring Canadian research surveys during 1999 - 2003. 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	Spring 2003 WT 479 - 482
5.5	0	0	0	0	0
6.0	0	0	0	0	23,923
6.5	629	0	2,909	3,092	12,101
7.0	10,950	14,387	7,218	28,159	21,826
7.5	4,505	46,869	36,791	159,756	100,993
8.0	21,825	95,301	36,831	136,376	242,612
8.5	26,815	135,840	11,852	93,359	63,145
9.0	15,785	74,180	137	27,860	7,757
9.5	28,176	39,831	9,711	10,798	4,984
10.0	14,367	34,300	20,829	17,085	47,778
10.5	15,123	60,587	36,128	129,491	91,323
11.0	24,841	50,993	184,768	122,222	219,941
11.5	29,581	169,630	201,256	367,118	239,194
12.0	49,207	274,247	312,945	399,854	632,961
12.5	135,597	455,568	614,303	579,093	1,018,971
13.0	267,629	891,854	689,768	432,246	845,115
13.5	704,706	994,659	744,396	405,781	850,194
14.0	804,028	1,028,440	681,121	298,773	703,124
14.5	840,930	716,927	508,801	362,284	689,566
15.0	741,258	742,644	484,341	760,694	785,500
15.5	435,207	614,294	795,068	1,304,791	1,080,682
16.0	192,745	613,210	879,612	1,608,691	1,621,842
16.5	121,670	771,835	1,351,224	1,945,095	1,643,746
17.0	283,562	1,358,786	1,288,397	2,329,591	2,122,068
17.5	339,923	1,647,536	1,540,283	2,616,479	2,854,997
18.0	518,383	1,633,388	1,575,429	2,497,661	2,999,946
18.5	479,302	1,241,221	1,787,205	2,354,153	2,878,284
19.0	490,357	617,208	1,901,729	2,220,763	3,708,917
19.5	593,703	687,161	1,647,032	2,046,579	2,695,621
20.0	742,174	435,102	1,007,472	1,767,802	2,237,773
20.5	690,630	547,918	452,165	1,083,680	1,407,544
21.0	484,495	409,895	232,646	467,015	636,248
21.5	413,102	247,461	87,887	150,834	352,115
22.0	115,645	179,686	52,072	41,214	54,220
22.5	54,782	116,076	13,845	10,202	25,178
23.0	23,786	13,182	8,716	5	1,728
23.5	6,794	8,366	15,237	0	1,728
24.0	1,089	189	20	0	0
24.5	0	0	0	0	2,237
25.0	0	0	0	0	0
25.5	0	0	4,183	0	0
26.0	0	0	0	0	0
26.5	0	0	0	0	0
27.0	0	0	0	0	0
27.5	0	0	0	0	0
28.0	0	0	0	0	0
28.5	0	0	0	0	0
29.0	0	0	0	0	0
29.5	0	0	0	0	0
30.0	0	0	0	0	0
30.5	0	0	0	0	0
31.0	0	0	0	0	0
31.5	0	0	0	0	0
32.0	0	0	0	0	0
Total (000's)	9,723,302	16,968,771	19,224,326	26,778,595	32,925,882
Upper 95% limit	18,079,360	36,240,923	29,374,530	34,873,186	54,982,936
Lower 95% limit	1,367,243	-2,303,381	9,074,122	18,684,004	10,868,828

Table 18 Abundance (000's) of transitional + primiparous northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO during spring Canadian research surveys during 1999 - 2003. 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	Spring 2003 WT 479 - 482
15.0	0	0	24	0	0
15.5	0	0	48	0	0
16.0	0	0	18,876	1,506	0
16.5	0	0	72	37	0
17.0	156	3,153	11,856	0	4,405
17.5	2,752	5,615	7,865	0	5,140
18.0	4	13,755	72	6,328	748
18.5	6,041	11	9,508	16,462	4,034
19.0	2,314	15,948	27,507	14,549	15,678
19.5	21,171	60,712	127,445	190,044	83,783
20.0	13,436	117,600	240,083	785,681	256,688
20.5	48,071	254,028	430,125	1,290,489	814,686
21.0	96,358	328,120	440,732	1,703,644	1,131,001
21.5	182,755	601,082	428,310	1,625,473	1,726,895
22.0	390,113	636,319	376,987	1,249,021	1,595,229
22.5	498,405	811,106	353,202	607,802	926,605
23.0	403,913	861,544	300,325	230,005	578,262
23.5	349,581	843,773	136,802	55,564	220,895
24.0	186,312	376,890	106,178	29,508	82,081
24.5	89,024	246,273	42,713	9,749	64,748
25.0	39,463	147,609	34,772	9,347	5,801
25.5	7,782	44,764	1,090	50	115
26.0	1,582	19,820	855	152	0
26.5	46	1,121	233	0	0
27.0	0	230	166	0	0
27.5	0	0	0	0	0
28.0	0	0	0	0	0
28.5	0	0	0	0	0
29.0	0	0	0	0	0
29.5	0	0	0	0	0
30.0	0	0	0	0	0
30.5	0	0	0	0	0
31.0	0	0	0	0	0
31.5	0	0	0	0	0
32.0	0	0	0	0	0
Total (000's)	2,339,278	5,389,472	3,095,845	7,825,407	7,516,794
Upper 95% limit	4,226,450	11,814,756	4,679,470	9,566,813	10,174,460
Lower 95% limit	452,105	-1,035,812	1,512,221	6,084,002	4,859,127

Table 19. Abundance (000's) of female northern shrimp (*Pandalus borealis)* collected in NAFO Div. 3LNO collected during spring Canadian research surveys during 1999 - 2003. 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	Spring 2003 WT 479 - 482
13.5	0	0	7,841	0	0
14.0	0	0	0	0	0
14.5	0	0	0	0	0
15.0	0	3,153	0	0	0
15.5	0	0	0	0	0
16.0	0	0	0	1,979	13,807
16.5	0	0	2,651	32	0
17.0	257	0	14,678	19,046	4,405
17.5	4,309	22	12,677	26,020	32,267
18.0	6,357	24,194	2,789	3,049	12,646
18.5	6,452	19,307	15,383	42,140	57,795
19.0	10,509	18,883	18,738	20,218	28,782
19.5	2,204	14,316	24,397	12,510	28,423
20.0	2,723	22,939	36,410	27,532	130,514
20.5	2,296	36,349	13,971	98,216	183,206
21.0	10,165	36,223	33,871	100,823	450,808
21.5	6,067	152,084	76,698	195,630	846,229
22.0	33,072	217,812	198,823	255,134	1,039,550
22.5	42,180	288,943	208,713	355,844	913,190
23.0	61,102	315,931	355,834	367,421	678,789
23.5	87,701	384,238	394,172	368,020	440,657
24.0	110,767	407,007	385,297	412,853	332,477
24.5	78,498	317,258	317,707	203,134	241,130
25.0	60,844	160,754	205,918	182,827	98,586
25.5	60,492	94,156	155,971	78,257	124,286
26.0	23,344	58,375	91,262	61,327	84,563
26.5	11,183	48,109	57,068	54,885	59,462
27.0	4,979	19,528	21,669	18,430	23,918
27.5	8,045	5,589	4,161	578	26,355
28.0	2,968	3,358	13,606	70	118
28.5	3,230	3,077	1,304	0	57
29.0	1,148	2,604	1,022	71	96
29.5	581	254	437	0	0
30.0	327	363	0	16	0
30.5	52	36	0	0	39
31.0	212	57	0	0	0
31.5	0	62	0	0	0
32.0	0	36	0	0	0
Total (000's)	642,062	2,655,014	2,673,069	2,906,060	5,852,153
Upper 95% limit	894,893	9,122,670	3,516,292	4,421,781	8,353,418
Lower 95% limit	389,231	-3,812,642	1,829,846	1,390,339	3,350,888

Table 20. Modal analysis using MIX 3.1a (MacDonald and Pitcher, 1993) of male *P. borealis* collected during the autumn 1995-2002 Canadian research bottom trawl surveys in Div. 3LNO.

Mean carapace length (Standard error/ constraints)

Year Class	1995	1996	1997	1998	1999	2000	2001	2002
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 (fixed)	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)	19.5 (0.001)
1999						10.0 (0.125)	14.5 (0.001)	17.0 (0.001)
2000								14.0 (0.000)
2001								9.5 (0.001)

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

Year Class	1995	1996	1997	1998	1999	2000	2001	2002
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)	.367 (0.000)
1999						.066 (0.008)	.206 (0.000)	.452 (0.001)
2000								.145 (0.000)
2001								.035 (0.000)

Distribution Sigmas (Standard error/ constraints)

Year Class	1995	1996	1997	1998	1999	2000	2001	2002
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)	.99 (0.001)
1999						0.87 (0.102)	0.99 (0.001	.97 (0.001)
2000								.97 (0.001)
2001								.75 (0.001)

Table 21. Estimated demographics of the *P. borealis* population (x 1000) in 3LNO from Canadian autumn research bottom trawl survey data, 1995 – 2002.

Males

Ages	1995	1996	1997	1998	1999	2000	2001	2002
0	5,144	2,893	5,738	922	11,148	23,911	19,067	0
1	850,782	350,477	507,011	3,460,131	446,182	1,827,106	711,644	1,408,539
2	279,857	3,769,677	2,999,014	2,738,721	5,960,555	8,981,677	9,287,971	5,772,901
3	120,622	1,067,965	4,144,557	4,648,007	2,399,801	14,901,267	12,975,067	17,977,453
4	461	242,101	1,007	2,473,121	1,600,531	2,011,175	22,756,452	14,596,642
5+		32,716	69	1,259	5,348	74,531	62,205	32
Total	1,256,866	5,465,829	7,657,396	13,322,161	10,423,565	27,819,667	45,812,406	39,755,567

Transitionals + Primiparous Females

Ages	1995	1996	1997	1998	1999	2000	2001	2002
0	0	0	0	0	0	0	0	0
1	959	0	0	0	638	0	0	0
2	321,486	0	245	0	0	0	0	0
3	230,977	19,499	51,022	9,728	4,129	98,525	7,668	33,180
4	131,175	130,246	1,835,717	428,508	1,221,759	1,434,174	1,250,980	1,260,939
5+	45,749	9,378	199,457	24,799	393,046	334,596	26,110	14,615
Total	730,345	159,123	2,086,441	463,036	1,619,572	1,867,295	1,284,757	1,308,734

Multiparous and Ovigerous Females

Ages	1995	1996	1997	1998	1999	2000	2001	2002
0	0	0	0	0	0	0	0	0
1	0	116	0	0	0	0	3,421	0
2	755	1,035	3,658	5,240	1,792	0	2,616	0
3	298	3,199	10,065	30,587	34,461	37,753	141,981	66,337
4	7,531	17,000	160,953	396,940	171,926	384,608	2,047,608	5,200,565
5+	80,222	221,965	606,674	1,110819	811,912	2,043,963	4,782,082	3,924,428
Total	88,806	243,315	781,350	1,543,585	1,020,050	2,466,323	6,977,708	9,191,329

Combined maturity stage

Ages	1995	1996	1997	1998	1999	2000	2001	2002
0	5,144	2,893	5,738	992	11,148	23,911	19,067	0
1	851,741	350,593	507,011	3,460,131	446,821	1,827,106	715,065	1,408,539
2	602,097	3,770,711	3,002,916	2,743,961	5,962,346	8,981,677	9,290,587	5,772,901
3	351,896	1,090,663	4,205,643	4,688,321	2,438,391	15,037,545	13,124,716	18,076,969
4	139,166	389,347	1,997,677	3,298,569	2,994,216	3,829,956	26,055,039	21,058,146
5+	125,971	264,059	806,200	1,136,877	1,210,306	2,453,090	4,870,396	3,939,074
Total	2,076,016	5,868,266	10,525,185	15,328,851	13,063,228	32,153,286	54,074,872	50,255,629

Table 22. Modal analysis using MIX 3.1a (MacDonald and Pitcher, 1993) of male *P. borealis* collected during the spring 1999-2003 Canadian research bottom trawl surveys in 3LNO.

Mean carapace length (Standard error/ constraints)

Year Class	1999	2000	2001	2002	2003
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)	18.5 (0.001)
2000				12.5 (0.030)	16.5 (0.002)
2001				7.5 (0.026)	12.5 (0.001)

Estimated proportions (Standard error/ constraints)

Year Class	1999	2000	2001	2002	2003
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 (0.010)	
1999		.025 (0.0051)	.235 (0.0251)	.366 (0.009)	.565 (0.000)
2000				.107 (0.002)	.274 (0.000)
2001				.017 (0.001)	.161 (0.000)

Distribution Sigmas (Standard error/ constraints)

Year Class	1999	2000	2001	2002	2003
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 (0.017)	
1999		0.707 (0.130)	1.221 (0.123)	1.000 (fixed)	1.138 (0.001)
2000				1.099 (0.024)	1.126 (fixed)
2001				0.505 (0.020)	1.131 (0.001)

Table 23. 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	2003
0	16,084	0	46,918	0	158,844
1	146,932	424,175	58,531	445,596	313,514
2	4,275,446	6,505,091	3,975,621	2,853,794	5,217,193
3	1,546,582	7,275,932	5,622,528	9,811,140	8,901,712
4	3,737,168	2,755,017	9,478,728	13,668,060	18,332,381
5+	1,089	8,556	41,999	5	2,237
Total	9,723,301	16,968,771	19,224,135	26,778,595	32,925,882

Transitionals + Primiparous Females

Age	1999	2000	2001	2002	2003
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	24	0	0
3	2,912	22,523	38,788	7,871	10,293
4	760,258	2,013820	2,080,696	6,875,362	5,627,994
5+	1,576,108	3,353,129	976,337	942,175	1,878,507
Total	2,339,278	5,389,472	3,095,845	7,825,409	7,516794

Ovigerous + Multiparous Females

Age	1999	2000	2001	2002	2003
0	0	0	0	0	0
1	0	0	0	0	0
2	0	3,153	7,841	0	0
3	10,923	24,216	32,796	50,126	63,125
4	73,487	517,913	418291	752,203	2,765,305
5+	557,653	2,109,733	2,214,140	2,103,731	3,023,724
Total	642,062	2,655,014	2,673,069	2,906,060	5,852,153

Combined Maturity Stage

Age	1999	2000	2001	2002	2003
0	16,084	0	46,918	0	158,844
1	146,932	424,175	58,531	445,596	313,514
2	4,275,446	6,508,244	3,983,487	2,853,794	5,217,193
3	1,560,417	7,322,671	5,694,112	9,869,137	8,975,130
4	4,570,913	5,286,750	11,977,716	21,295,624	26,725,680
5+	2,134,850	5,471,417	3,232,476	3,045,912	4,904,468
Total	12,704,643	25,013,257	24,993,050	37,510,063	46,294,829

Table 24. Division 3LNO northern shrimp (*Pandalus borealis*) exploitation rates based upon the ratios of commercial catch to the previous autumn Canadian multi-species bottom trawl survey indices.

Year	catch (tons)	lower 95% around biomass estimate (tons)	spawning stock biomass (SSB) (tons)	fishable biomass (tons)
1995		3,639	3,806	4,710
1996	171	10,230	3,555	12,142
1997	485	25,530	19,566	40,152
1998	567	40,011	16,794	53,644
1999	795	36,202	18,527	43,408
2000	4,869	93,132	32,517	100,709
2001	10,566	77,563	64,077	210,302
2002	6,977	126,180	76,444	205,312
2003	10,649			

Year	catch/ lower C.I. biomass	catch/SSB	catch/fishable biomass
1996	0.047	0.045	0.036
1997	0.047	0.136	0.040
1998	0.022	0.029	0.014
1999	0.020	0.047	0.015
2000	0.134	0.263	0.112
2001	0.113	0.325	0.105
2002	0.090	0.109	0.033
2003	0.084	0.139	0.052

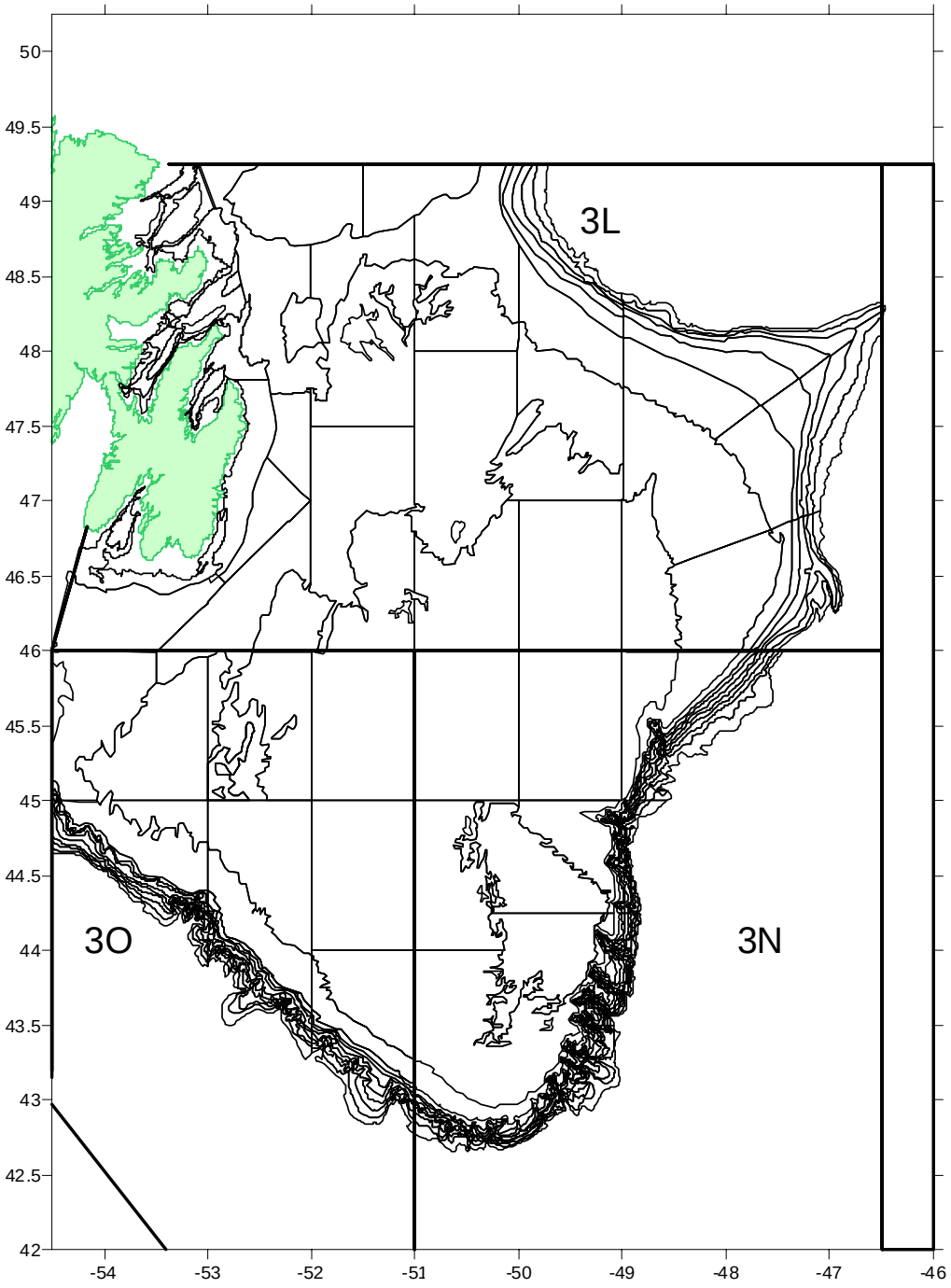

Fig. 1. Stratification for Canadian multi-species bottom trawl surveys in NAFO Div. 3LNO.

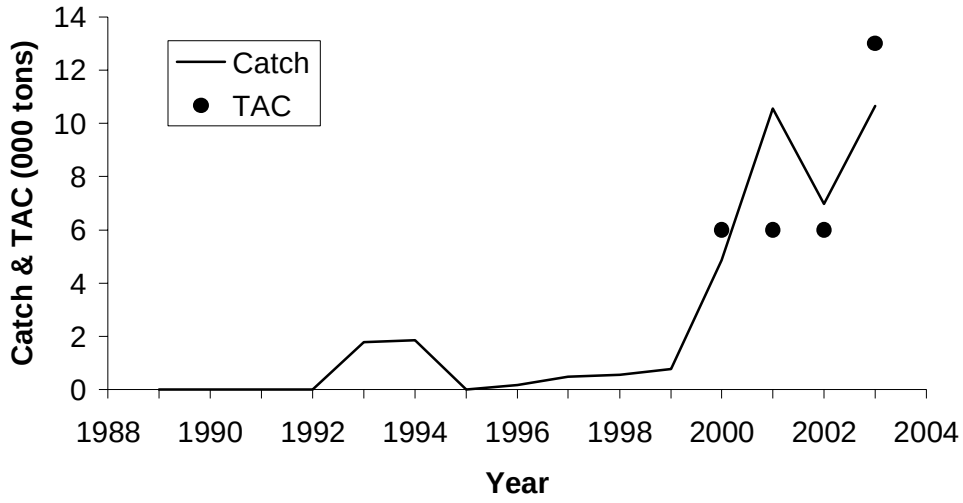

Fig. 2. Trends in NAFO Div. 3LNO northern shrimp (*Pandalus borealis*) catch and TAC over the period 1993-2003.

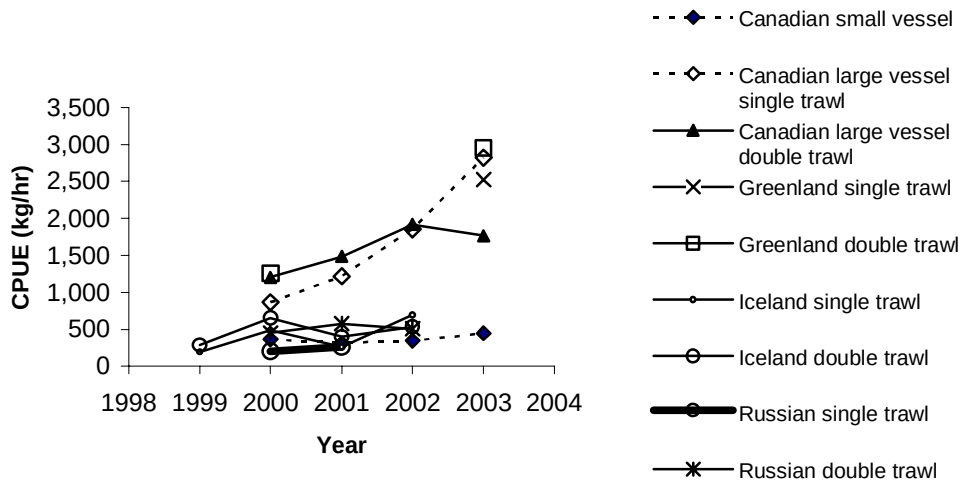

Fig. 3. Catch rate trends among fleets catching northern shrimp (*P. borealis*) in NAFO Div. 3LNO.

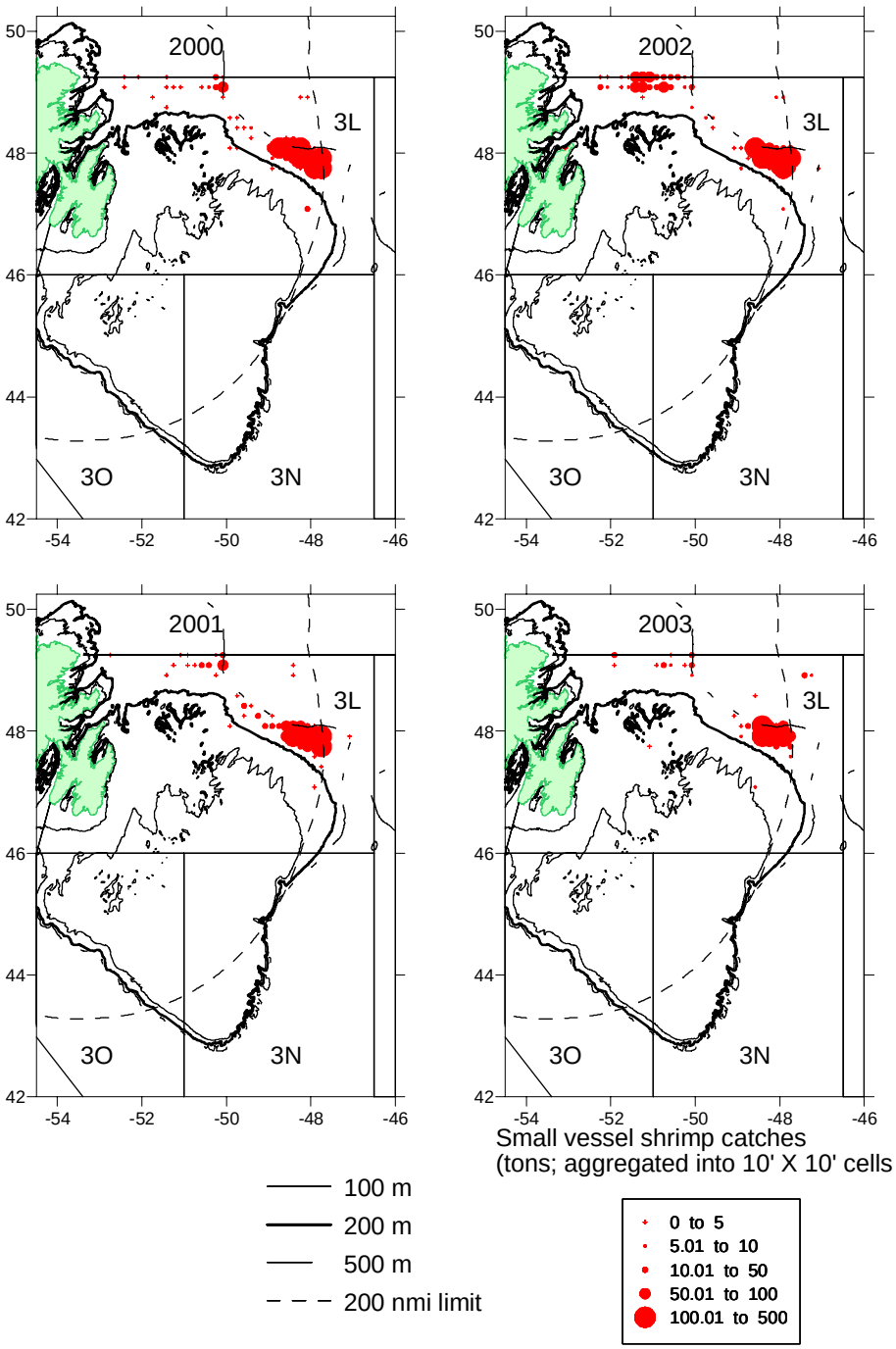

Fig. 4. Distribution of Canadian small vessel (<= 500 t; LOA<100') northern shrimp (*Pandalus borealis*) catches in NAFO Div. 3LNO, 2000-2003.

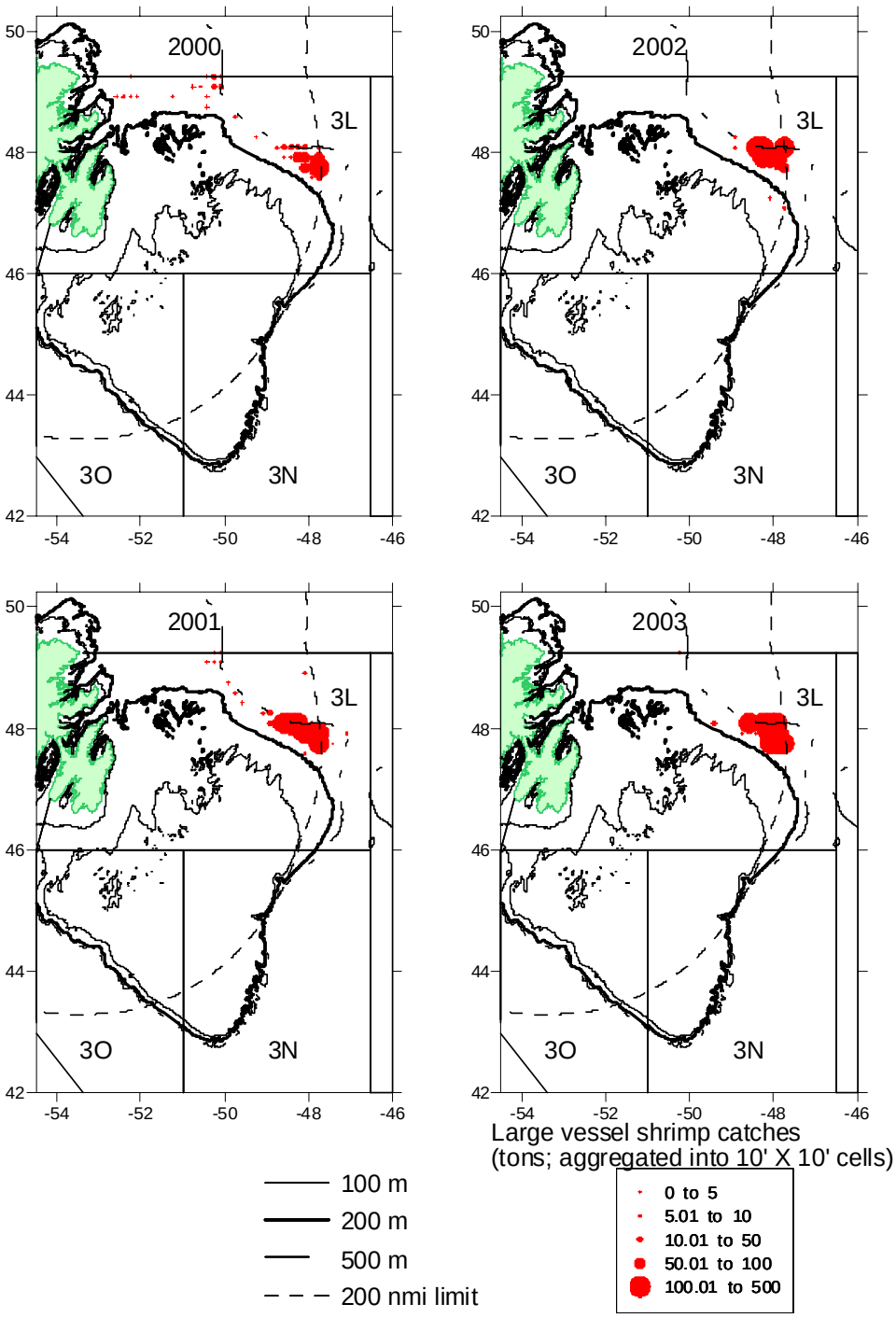

Fig. 5. Distribution of Canadian large vessel (>500 t) northern shrimp (*Pandalus borealis*) catches in NAFO Div. 3LNO, 2000-2003.

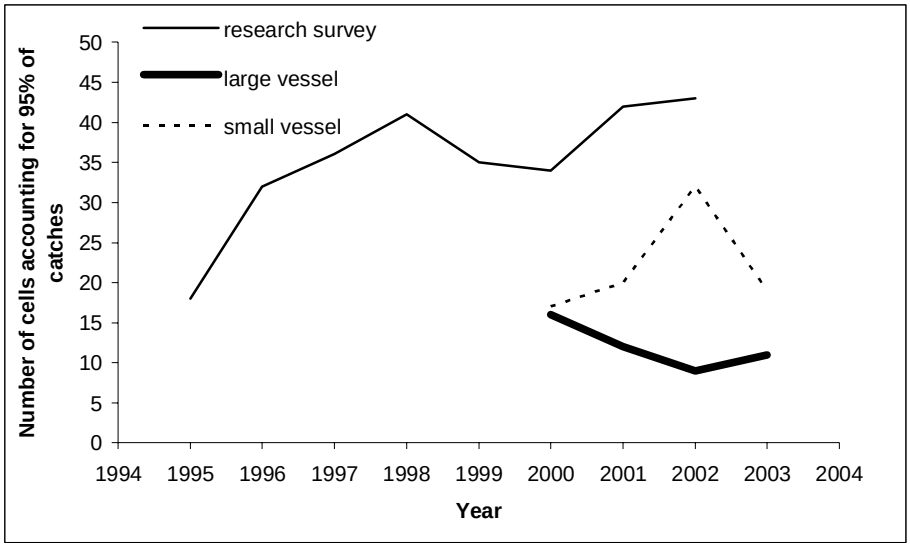

Fig. 6. Trends in the index of area accounting for 95% of the autumn research and commercial catches in NAFO Div. 3LNO over the period 1995-2003

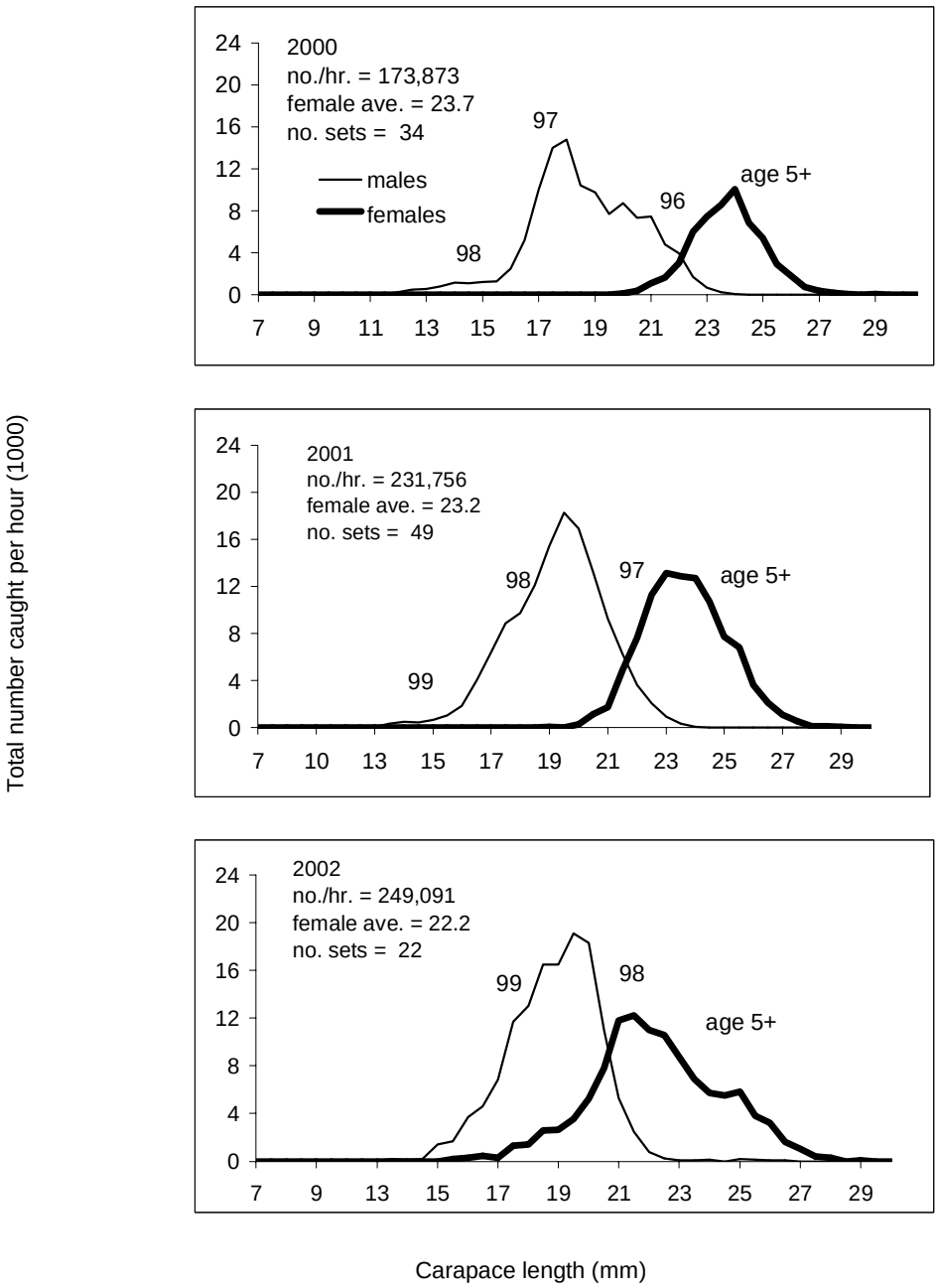

Fig. 7. Unstandardized catch of northern shrimp (*Pandalus borealis*) in number per hour (000) taken by the Canadian large vessel (>500 t) fleet, in NAFO Div. 3LNO, over the period 2000-2002.

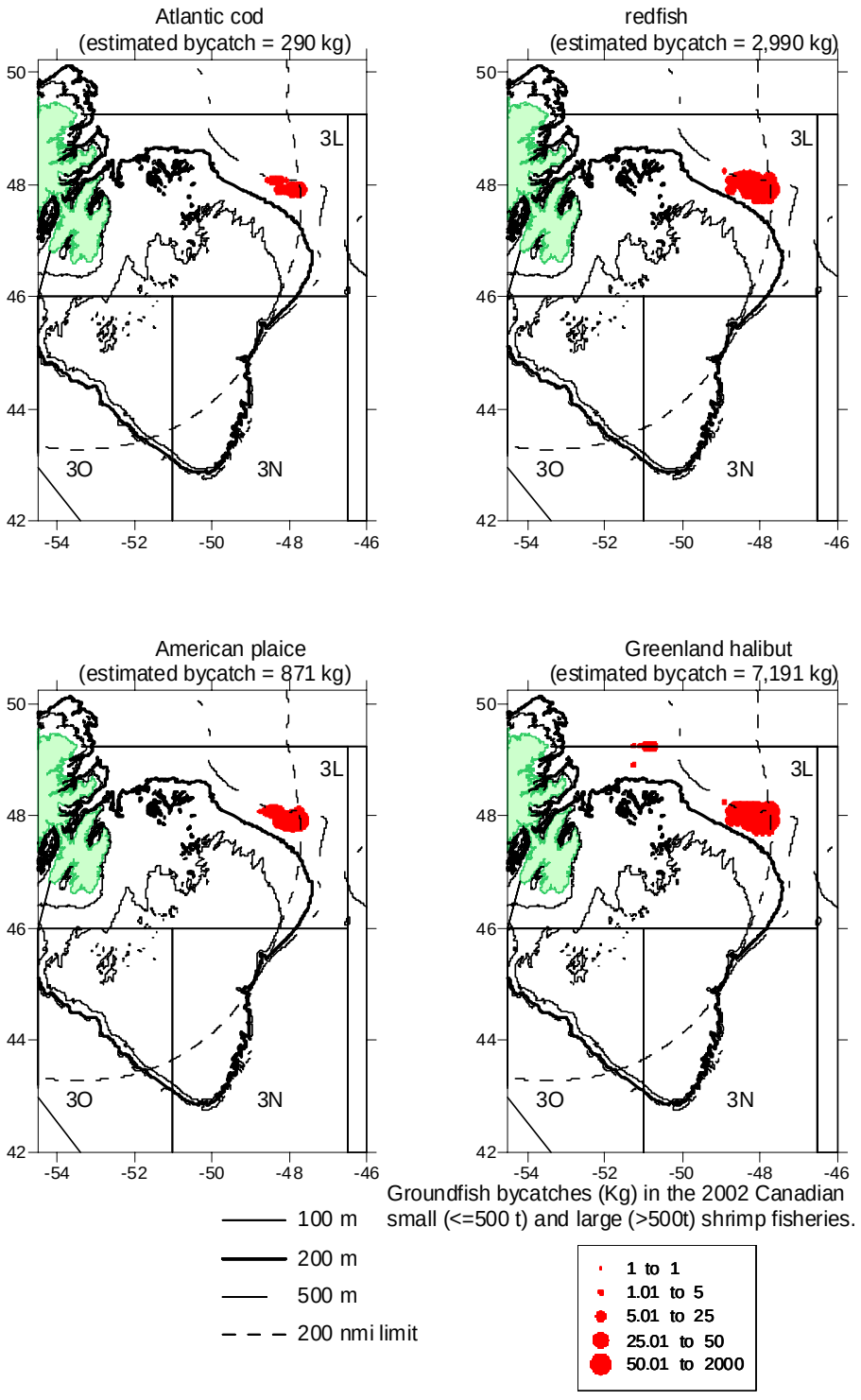

Fig. 8. Distribution of commercially important groundfish by-caught by Canadian vessels fishing northern shrimp (*Pandalus borealis*) during 2002.

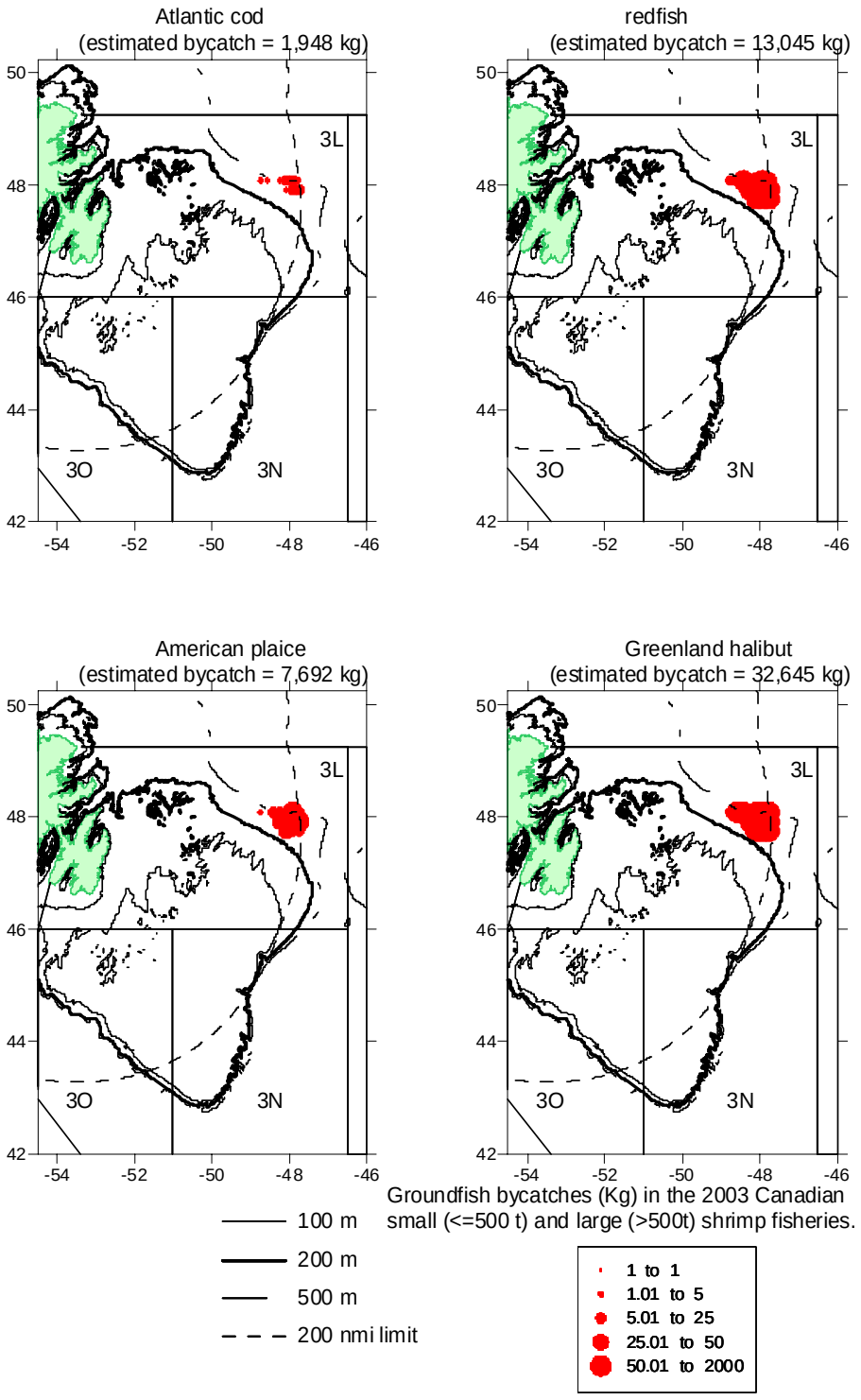

Fig. 9. Distribution of commercially important groundfish by-caught by Canadian vessels fishing northern shrimp (*Pandalus borealis*) during 2003.

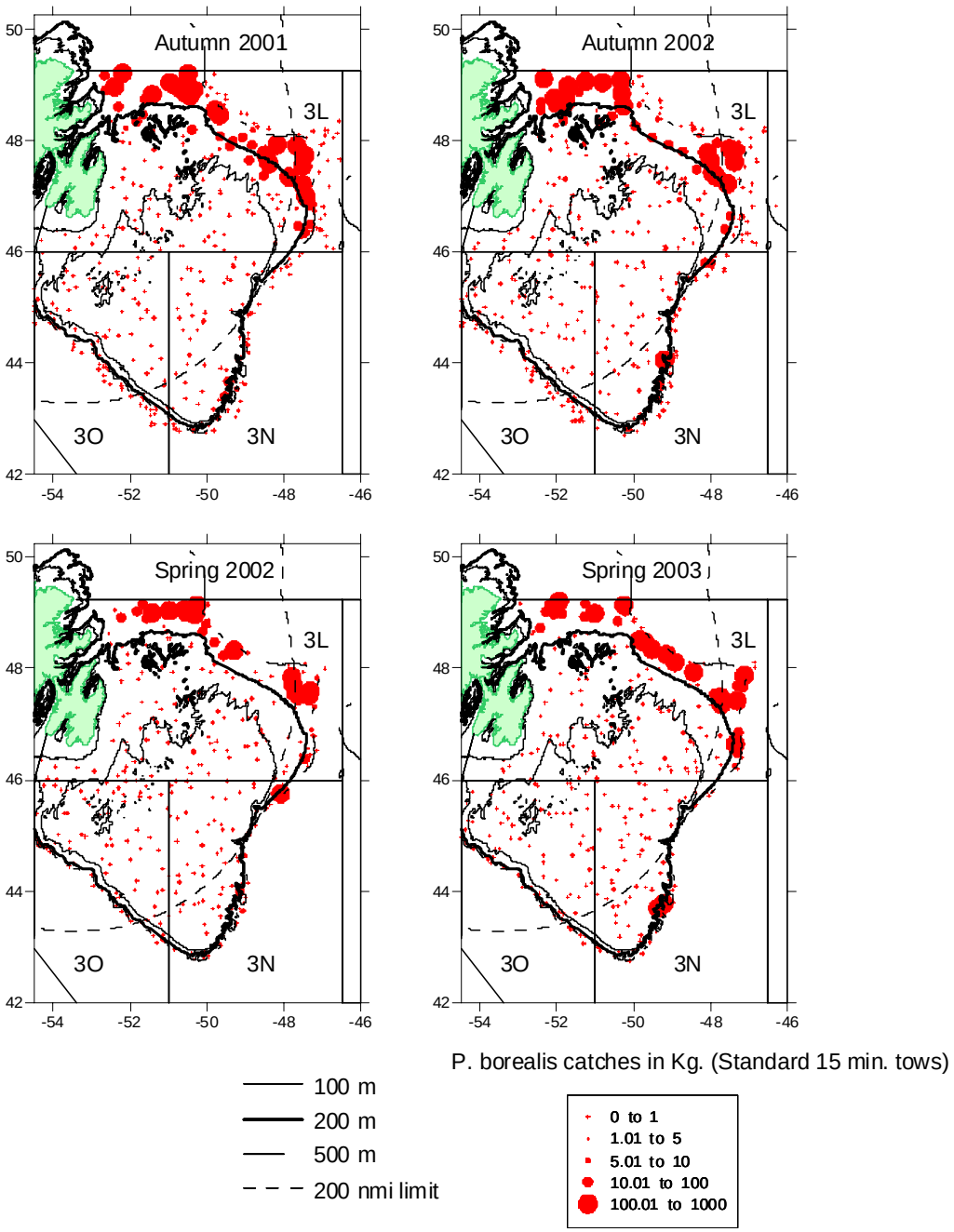

Fig. 10. Catches of shrimp (*Pandalus borealis*) obtained during the autumn 2001-spring 2003 Canadian multi-species bottom trawl surveys into NAFO Div. 3LNO using a Campelen 1800 shrimp trawl.

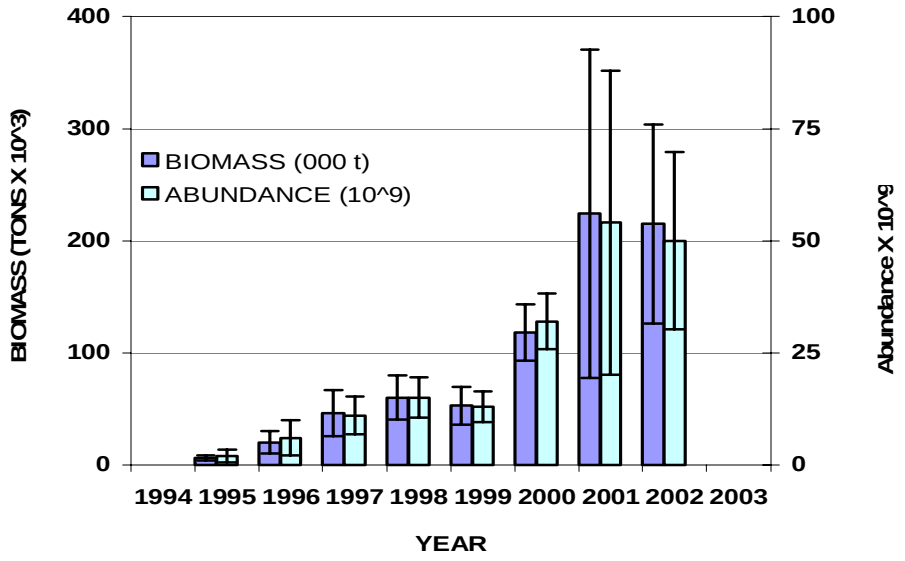

Fig. 11. Autumn biomass and abundance indices from Canadian offshore bottom trawl surveys in NAFO Div. 3LNO.

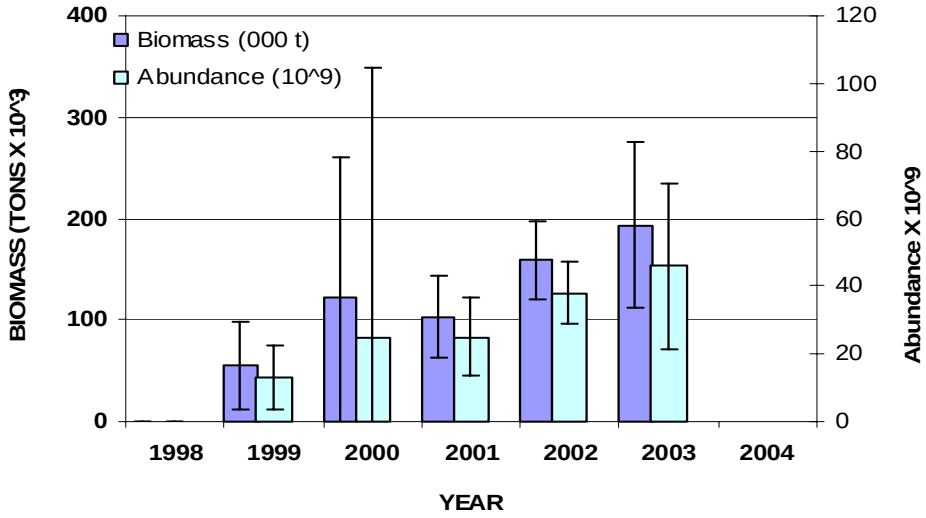

Fig. 12. Spring biomass and abundance indices from Canadian offshore bottom trawl surveys in NAFO Div. 3LNO.

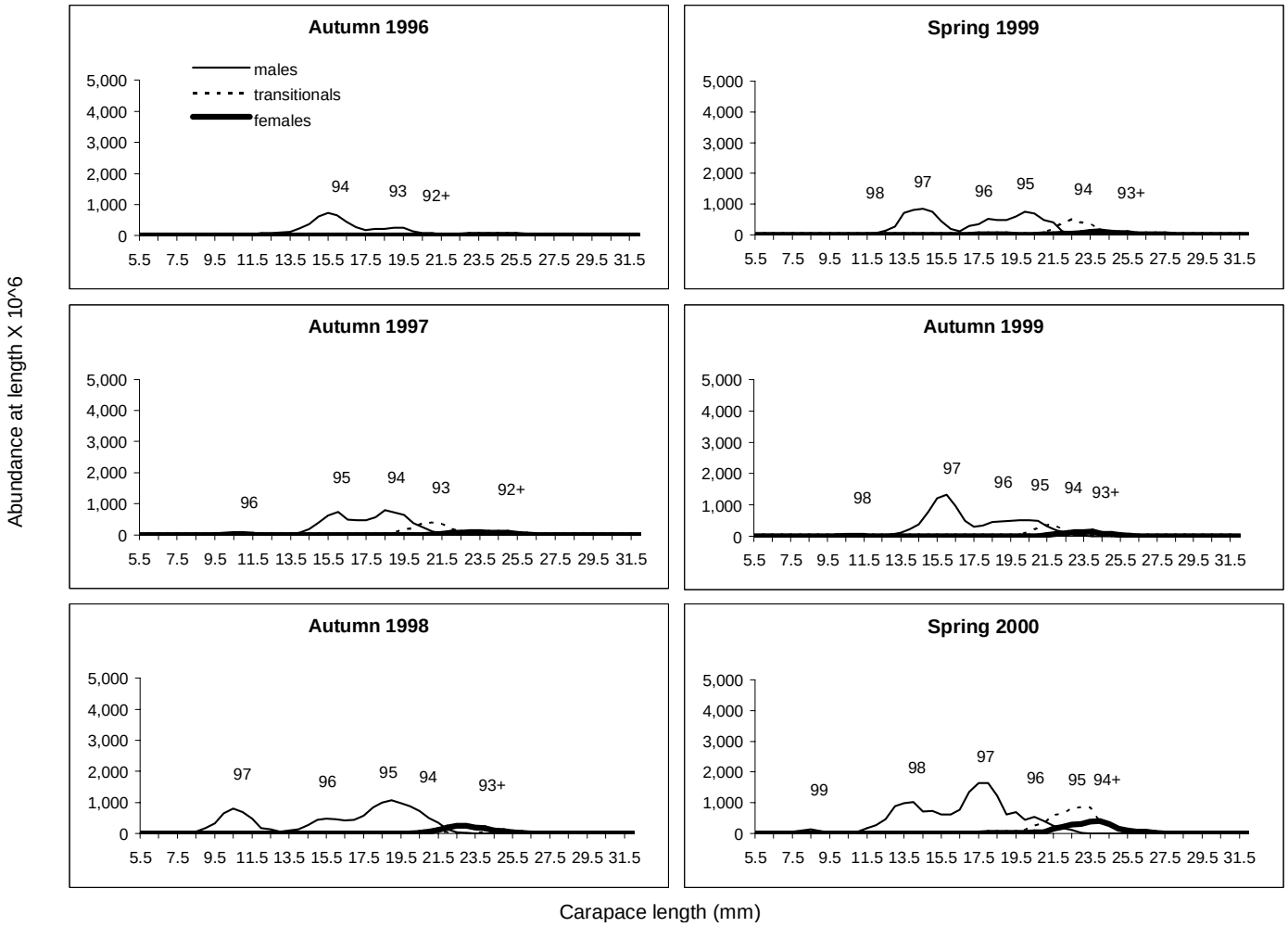

Fig. 13. Abundance at length for NAFO Div. 3LNO shrimp (*P. borealis*) estimated by areal expansion of Canadian spring and autumn multi-species bottom trawl survey data 1996-2003.

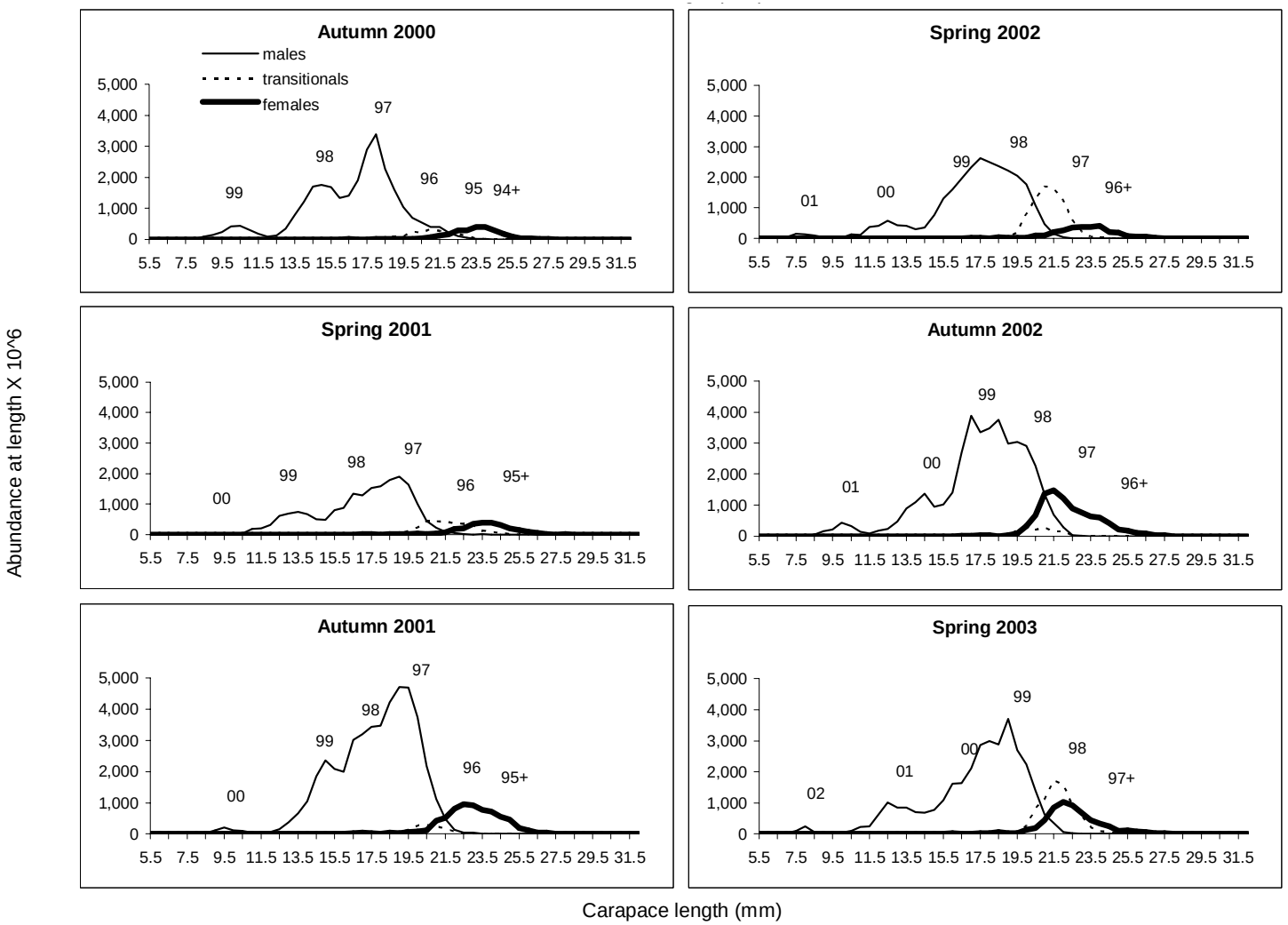

Fig. 13. (continued) Abundance at length for NAFO Div. 3LNO shrimp (*P. borealis*) estimated by areal expansion of Canadian spring and autumn multi-species bottom trawl survey data 1996-2003.

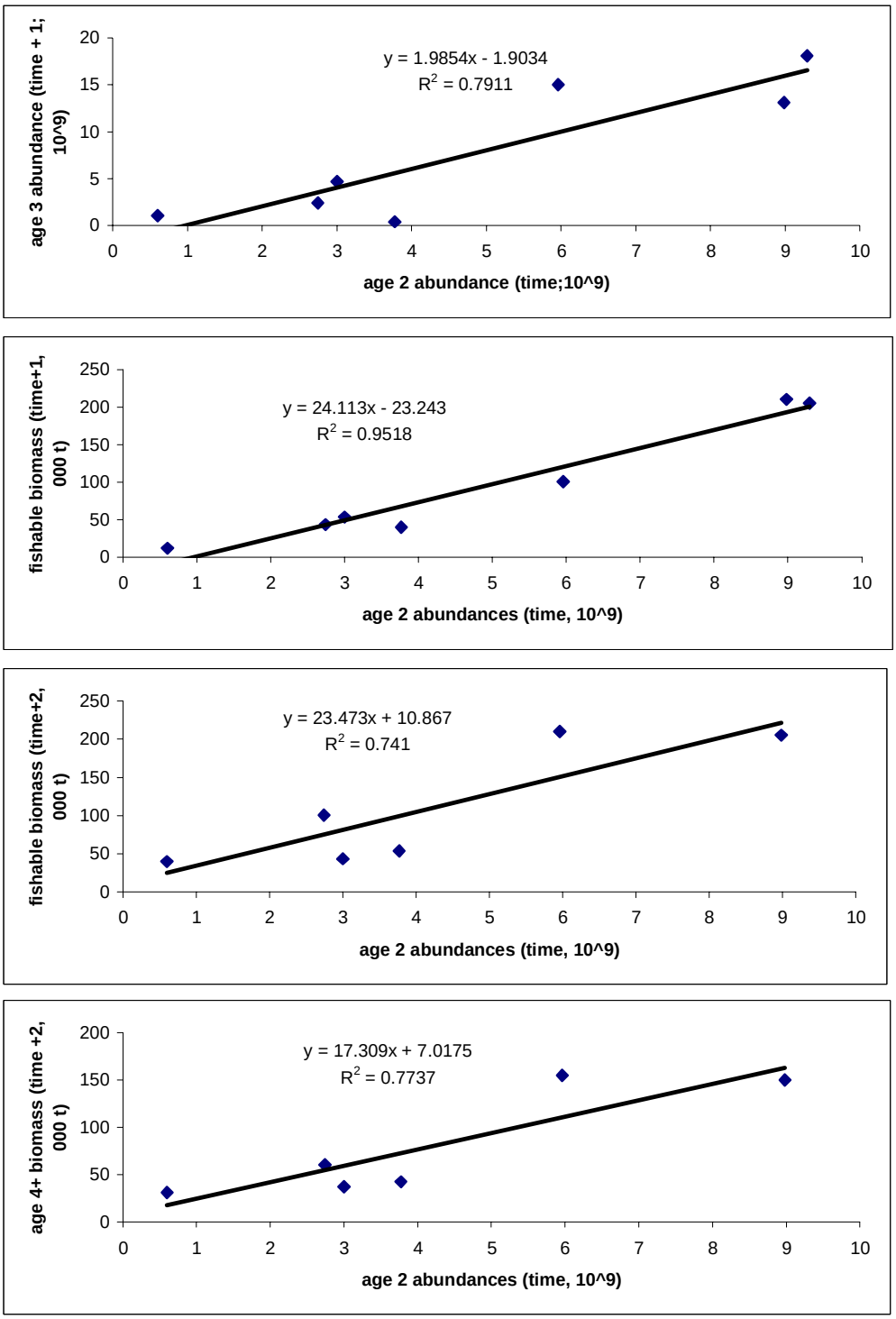

Fig. 14. A recruitment index using the age 2 abundances from the autumn multi-species survey to predict age 3 abundances and future fishable biomass.

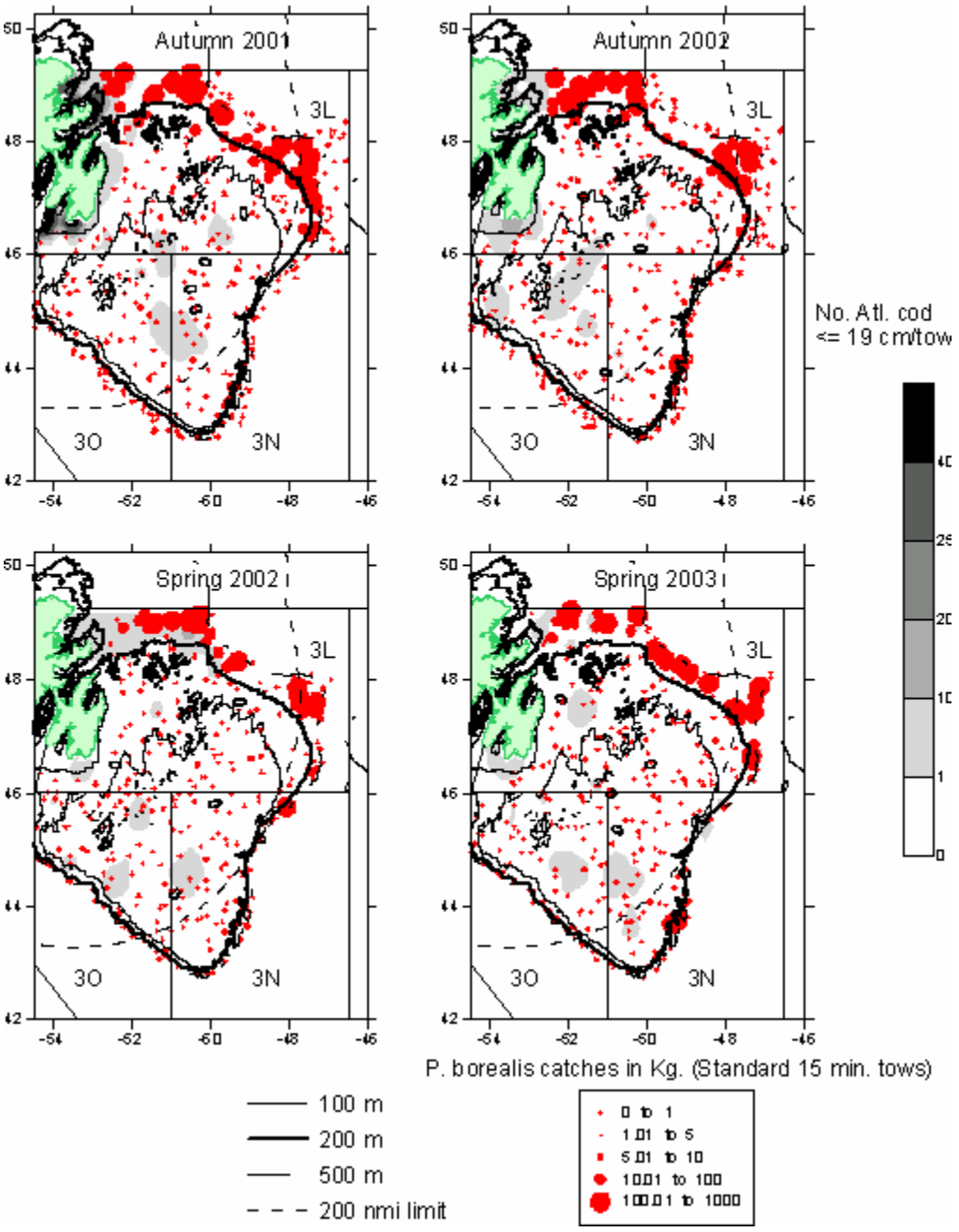

Fig. 15. Distribution of northern shrimp in relation to Atlantic cod (TL <=19 cm)collected during Canadian autumn 2001-spring 2003 multi-species bottom trawl surveys. (Catches were made using a Campelen 1800 shrimp trawl; standard 15 min. tows).

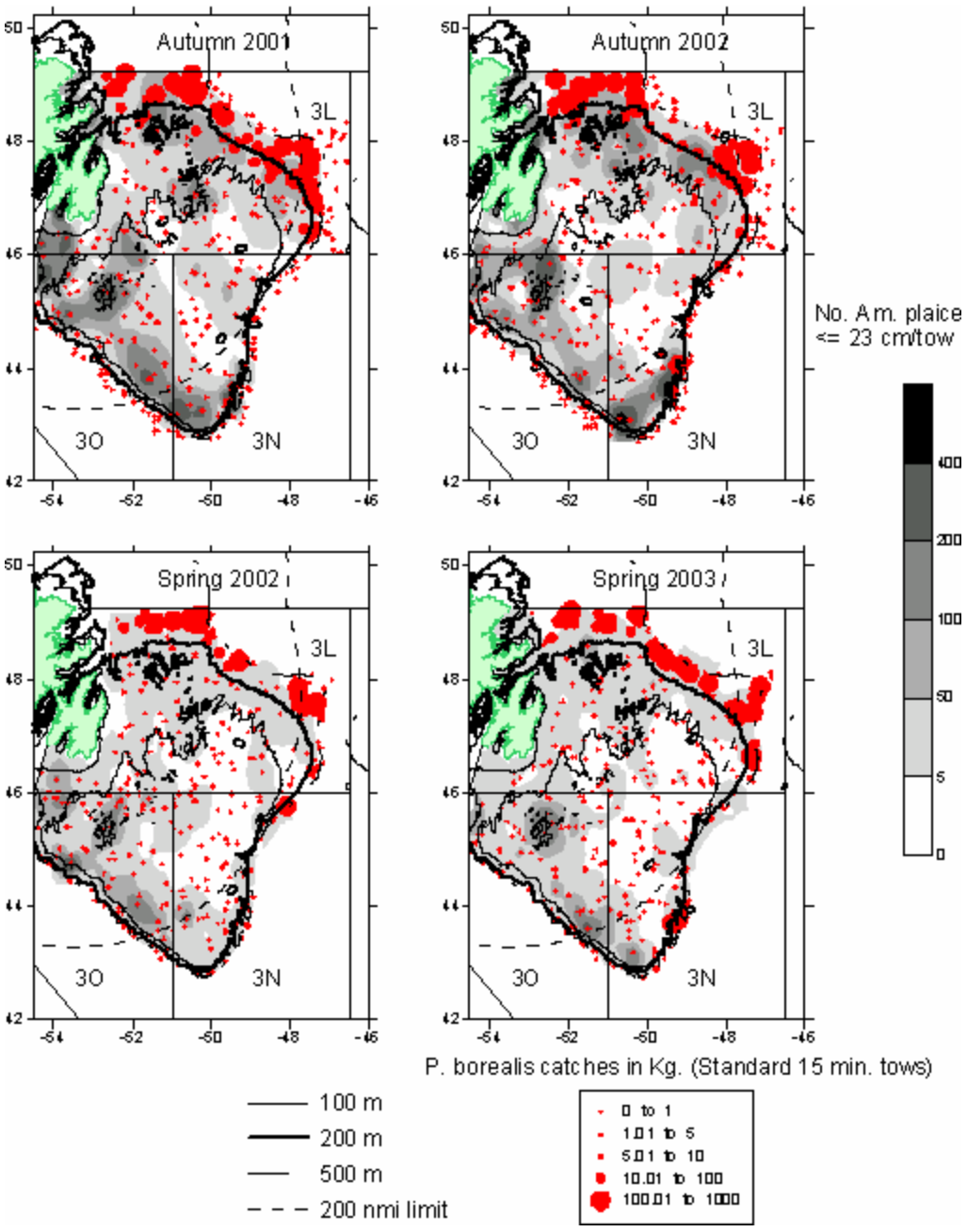

Fig. 16. Distribution of northern shrimp in relation to American plaice (TL <=23 cm) collected during Canadian autumn 2001-spring 2003 multi-species bottom trawl surveys. (Catches were made using a Campelen 1800 shrimp trawl; standard 15 min. tows).

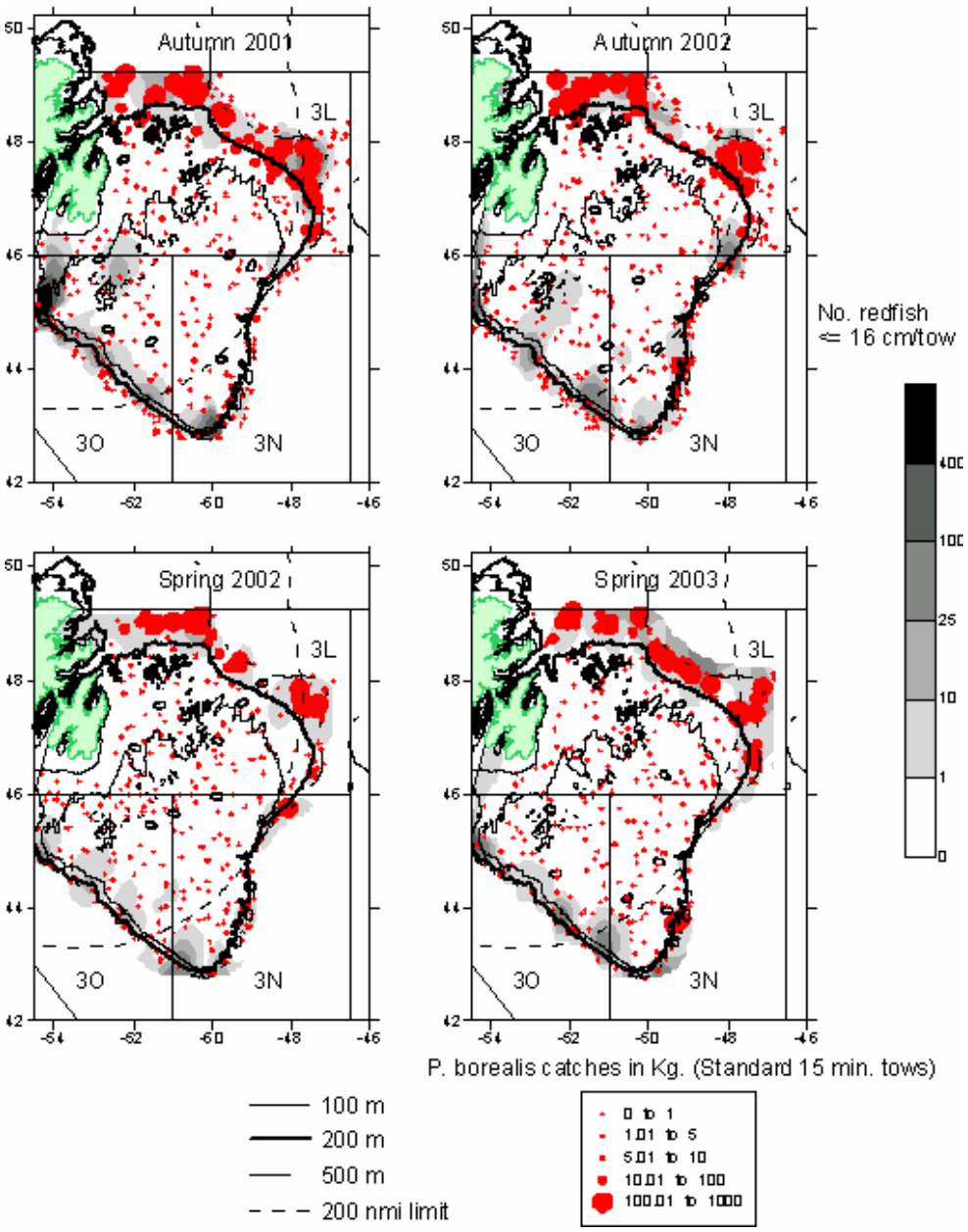

Fig. 17. Distribution of northern shrimp in relation to redfish (*Sebastes spp.*) (TL <=16 cm) collected during Canadian autumn 2001-spring 2003 multi-species bottom trawl surveys. (Catches were made using a Campelen 1800 shrimp trawl; standard 15 min. tows).

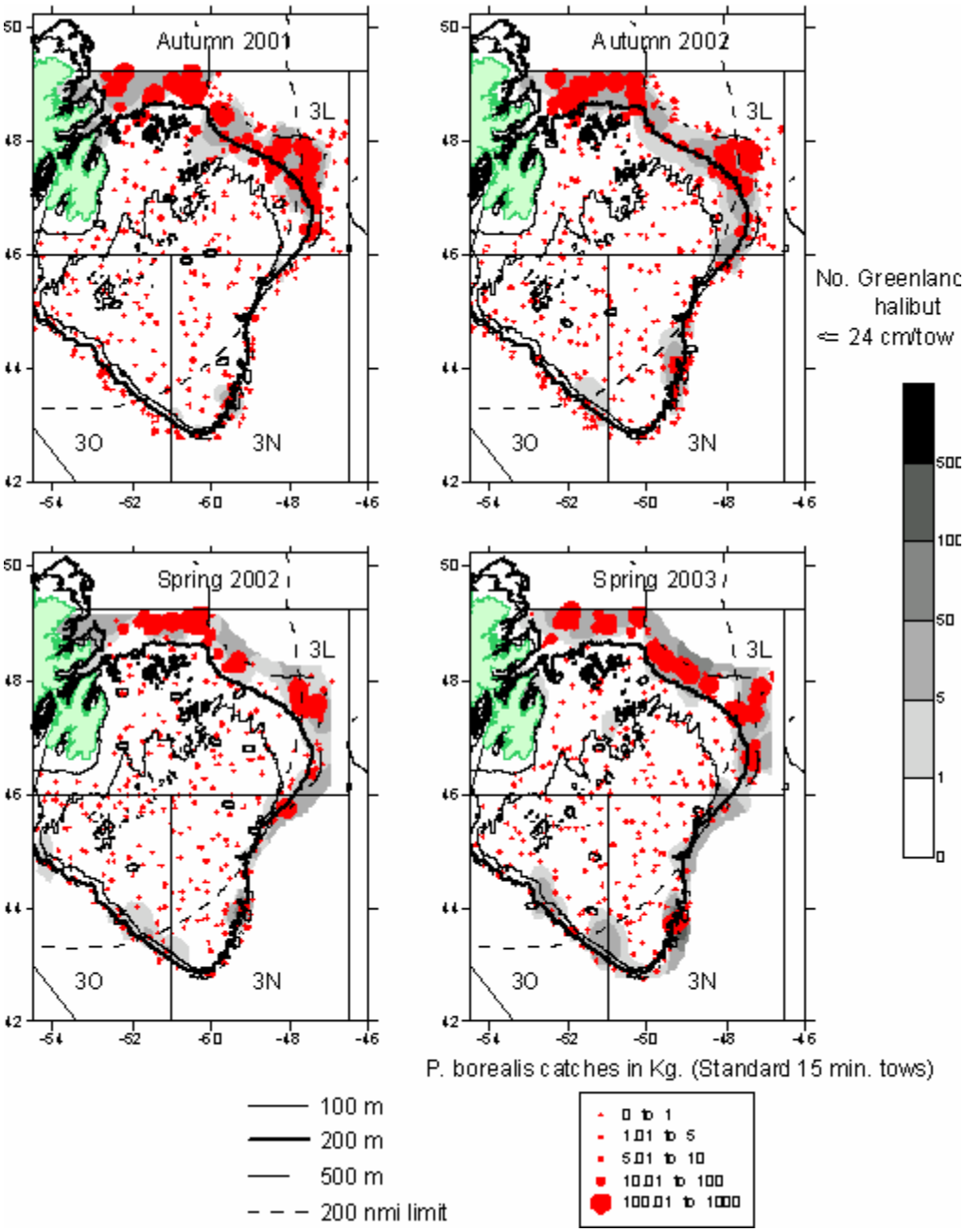

Fig. 18. Distribution of northern shrimp in relation to Greenland halibut (TL <=24 cm) collected during Canadian autumn 2001-spring 2003 multi-species bottom trawl surveys. (Catches were made using a Campelen 1800 shrimp trawl; standard 15 min. tows).