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Divisions 3LNO Northern shrimp (*Pandalus borealis*) – Interim Monitoring Update

By

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Abstract

This document updates some of the indices for northern shrimp (*Pandalus borealis*) harvested within NAFO Divisions 3LNO. A full assessment for this resource was completed, within Scientific Council during autumn 2008, and management advice was provided for the years 2009 and 2010. The catch table (to September 2009) and biomass indices (autumn 1996-spring 2009) are updated within this report. Preliminary data indicate that 26 917 t of shrimp were taken against an annual TAC of 25 000 t in 2008 while 16 648 t were taken in 2009 against an annual TAC of 30 000 t. It is anticipated that the 2009 TAC will be taken.

The autumn 2008 3LNO biomass index was estimated to be 249,300 t, the second highest in the autumn time series, down from 275,700 t in 2007. The spring biomass index increased from 93,500 t in 2004 to 288,600 t in 2007, but has since decreased to 112,000 t in 2009, a decrease of 61.0% over two years.

Similarly, the autumn 3LNO fishable biomass index was estimated to be 204,600 t in 2008, the second highest in that time series, down from 230,800 t in 2008. The spring fishable biomass index increased from 83,300 t in 2004 to 280,900 t in 2007, but has since decreased to 97,600 t in 2009, a decrease of 65.2% over two years.

In 2008, Fishery Commission asked Scientific Council to provide a range of options at various levels of exploitation. Scientific Council provided a series of options during the 2008 NIPAG meeting (NAFO, 2008). Given the recent drop in spring biomass, it was felt prudent to recalculate the TAC options. The revised values are presented within this document.

Fishery and Management

TAC Determination

Prior to 2004, TACs were set at 15% of the average lower confidence interval of the survey biomass indices for the most recent four consecutive surveys. However, during 2004, Scientific Council (SC) felt it was necessary to base advice upon a new methodology due to the highly variable nature of the spring surveys. The TAC within an adjacent Canadian stock had been 12% of the fishable biomass since 1997. Applying this percentage to the inverse variance weighted average fishable biomass from the autumn 2002-spring 2004 surveys resulted in a TAC of 22 000 t. Had this new method been used in 2003, it is likely that the advised TAC for 2005 would have been around 22 000 t instead of the 13 000 t actually advised. Scientific Council noted that the TAC recommendation for this stock has always included advice that "the development of any fishery in the Div. 3L area take place in a gradual manner with conservative catch limits imposed and maintained for a number of years in order to monitor stock response." The initial TAC of 6 000 t was in place for 3 years (1999-2001), however the TAC of 13 000 t had been in place since the beginning of 2003. A two year period was insufficient to determine the impact of a 13 000 t catch level upon the stock; therefore SC recommended that the 13 000 TAC be maintained through 2005. Scientific Council recommended that the TAC for shrimp in Div. 3LNO in 2006 should not exceed 22 000 t.

In 2008, Fishery Commission asked Scientific Council to provide a range of options, at various levels of exploitation. The TAC for 2009 of 30,000 t translated into an exploitation rate of about 14.8%, based on inverse variance weighted average fishable biomass index in 2006-2008 surveys of 202,000 tons. 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, 2008).

Catch trends

Catches increased dramatically since 1999, with the beginning of a regulated fishery. Table 1 and the following discussion provide the available numbers to date. Over the period 2000-2008, catches increased from 4 711 to 26 917 t. By September of 2009, 16 648 t of shrimp had been caught in 3L and it is anticipated that the 30 000 t quota will be taken. As per NAFO agreements, Canadian vessels took most of the catch during each year. Canadian catches increased from 4 050 t in 2000 to 21 187 t in 2008. By September 2009, Canadian vessels took 12 938 t of shrimp and it is anticipated that the 24 990 t Canadian quota will be taken. Catches by other contracting parties increased from 661 t in 2000 to 7 674 t in 2006. Preliminary data indicate that non Canadian vessels took 5 730 t of northern shrimp in 2008 and by September 2009, had taken 3 710 t of shrimp. It is anticipated that the 5 010 t quota for non Canadian vessels will be taken by December 2009. Table 1 provides a breakdown of catches by contracting party and year since 2000, while figure 1 indicates catches and TAC since 1993.

Canadian Multi-species Bottom Trawl Research Survey Trends

Spring and autumn multi-species research surveys have been conducted onboard the Canadian Coast Guard vessels *Wilfred Templeman*, *Teleost* and *Alfred Needler* since 1995. Shrimp data have been available from autumn surveys since 1996 while shrimp data have been available from spring surveys since 1999. Fishing sets of 15 minute duration, with a tow speed of 3 knots, were randomly allocated to strata covering the Grand Banks and slope waters to a depth of 1 462 m in the autumn and 731 m in the spring, with the number of sets in a stratum proportional to its size (Fig. 2). All vessels used a Campelen 1800 shrimp trawl with a codend mesh size of 40 mm and a 12.7 mm liner. SCANMAR sensors were employed to monitor net geometry. Details of the survey design and fishing protocols are outlined in (Brodie 1996; Brodie and Stansbury 2007; McCallum and Walsh 1996).

Prior to autumn 2003, shrimp were frozen and returned to the Northwest Atlantic Fisheries Centre where species identifications were made, and number and weight per set were calculated. Beginning with the autumn 2003 survey, most of the shrimp samples have been processed at sea. Samples that could not be processed at sea were frozen and processed in the Northwest Atlantic Fisheries Centre upon return. Abundance and biomass indices were estimated *via* OGive MAPping calculations (Evans *et al.*, 2000). We refer to Orr *et al*. (2007) to provide the full comparison of Ogmap and areal expansion indices as presented during the October 2007 NAFO-ICES Pandalus Assessment Group (NIPAG) meeting.

It must be noted that deepwater strata (deeper than 731 m) within Divisions 3LNO as well as several shallow water strata within Division 3L were not surveyed during autumn 2004 (Brodie, 2005; Healey and Dwyer, 2006). Historically very few northern shrimp have been taken from the deepwater strata; therefore, the impact of not sampling the deepwater was felt to be negligible. Strata that were missed, in Division 3L, (autumn 2004) are highlighted in figure 3; however, all NAFO Regulatory Area (NRA) strata containing significant quantities of northern shrimp have been surveyed consistently throughout the time series.

Analyses of the autumn survey data indicate that the shallow (93-549 m) 3L strata missed in 2004 are important in determining the biomass indices. Typically these strata account for 25-61% of the 3L biomass (Orr *et al.* 2007). Figure 4 confirms the importance of these strata and that catches, within these strata, vary annually. Therefore, it was not appropriate to use a multiplicative model to estimate 3L biomass and abundance indices from the autumn 2004 survey.

All important shrimp strata were surveyed in autumn 2008. The autumn 2008 biomass estimate for NAFO Divisions 3LNO was 249,300 t (95% confidence range = 195,800 – 301,800 t), the second highest biomass index in the autumn time series (Table 2; Fig. 5).

Due to operational difficulties it was not possible to survey all of the strata within NAFO Divisions 3NO during spring 2006. Strata 373 and 383 as well as most strata deeper than 92 m were not surveyed (Fig. 6). Analyses from the spring 1999 - 2007 surveys indicated that greater than 96% and 50% of the 3N and 3O biomass respectively may be attributed to the strata that were missed (Orr *et al.* 2007). Therefore biomass and abundance indices were not determined for NAFO Divisions 3NO during spring 2006. Historically, at least 95.9% of the spring 3LNO shrimp biomass has been found within Division 3L (Table 5); therefore, the spring 2006 indices were for NAFO Divisions 3L only. All 3LNO strata were surveyed during spring 2009. The spring 2009 survey biomass index was 112,500 t (95% confidence bounds = 62,850 – 167,500 t), a drop of approximately 61.0% since 2007.

Over 92.7% of the total 3LNO biomass, from either spring or autumn surveys, was found within Division 3L, mostly within depths from 185 to 550 m. Over the study period, the area outside 200 Nmi accounted for between 11.2 and 32.6% of the estimated total 3LNO biomass (Tables 5 and 6; Figs. 4 and 6; Orr *et al.* 2007). During the autumn, the percent biomass within the NRA ranged between 13.0 and 21.0%. Three year running averages were estimated in order to smooth the peaks and troughs within the data. They indicate that 14.5 – 20.1% of the total 3LNO autumn biomass was within the NRA (Table 4). Over the period 1996 – 2008 the overall average autumn percent biomass within the NRA was 17.0%. During the spring, the percent biomass within the NRA ranged between 11.2 and 32.6% (three year running average ranged between 19.2 and 25.0%) (Table 5). Over the period 1999 – 2009 the average spring percent biomass with the NRA was 22.2%. It must be noted that variances around the spring indices are greater than around autumn indices (Tables 2 and 3; Figs. 4-7).

In all surveys, Division 3N accounted for 0.2-8.1% of the total 3LNO biomass (Tables 4 and 6). Between 33.3 and 83.3% of the 3N biomass was found outside the 200 Nmi limit. Division 3O accounted for less than 1% of the 3LNO biomass. A negligible amount of the Division 3O biomass was found outside the 200 Nmi limit.

The autumn 3LNO fishable biomass index remained high since 2001 with a decrease from 230,800 t in 2007 to 204,600 t in 2008. The spring fishable biomass index increased from 83,400 t in 2004 to 280,900 t in 2007, but has since decreased to 188,200 t in 2008 with a further decrease to 97,600 t in 2009 (Table 6 and Fig. 8) The fishable biomass index decreased of 65.2% over 2 years.

TAC:

Table 7 provides the TAC determinations for various exploitation options. If the inverse variance weighted average fishable biomass from the autumn 2007-spring 2009 surveys is 174,000 t then harvests of 25 000 t, 26 000 t and 30 000 t would result in indices of exploitation of 14.37%, 14.96% and 17.24% respectively.

Autumn total biomass indices have remained at a high level since 2001, while spring indices increased between 2004 and 2007 but have since decreased by 61.0%. Similarly, autumn fishable biomass indices have remained at a high level since 2001 while spring indices increased between 2004 and 2007 but have since decreased by 65.2%.

Unfortunately, there is no analytical assessment for this stock therefore there is no risk analysis.

Conclusions

Preliminary data indicate that 16 648 t of shrimp had been taken in the 3L shrimp fishery by September 2009 and it is anticipated that the entire 30 000 t quota will be taken by the end of December 2009.

The autumn 2008 NAFO Divisions 3LNO total biomass index was 249,300 t, the second highest in the autumn survey time series. The spring Divisions 3LNO total biomass index decreased by 61% over the past two years and was 112,500 t in 2009. The autumn 2008 fishable biomass index was 204,600 t, the second highest in the autumn survey time series. The spring fishable biomass index decreased by 65.2% over the past two years and was 97,600 t in 2009.

It is important to note that confidence intervals around the spring indices are generally broader than they are for the autumn indices therefore, the spring indices are thought to be less precise.

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Table 1. Annual nominal catches (t) by country of northern shrimp (*Pandalus borealis*) caught in NAFO Div. 3L between 2000 and September 2009.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Canada	4,050[2]	4,984[2]	5,417[2]	10,701[2]	10,560[2]	11,109[2]	18,128[2]	18,312[2]	21,187[2]	12,938[2]
Cuba		46[1]	70[1]	81[1]	145[3]	136[1]	239[1]	240[1]	207[3]	334[3]
EU/Estonia	64[1]	2,264[4]	450[5]	299[6]	271[6]	569[6]	1,099[6]	1,453[6]	1092[1]	
European Union										1238[3]
Faroe Islands	42[1]	2,052[4]	620[5]	25[1]	1050[1]	1055[1]	1521[1]	1798[1]	2273[1]	757[3]
France (SPM)	67[1]	67[1]	36[1]	144[1]				245[1]	278[1]	
Greenland	34[1]			671[1]	299[1]	311[1]	453[8]	456[8]	488[3]	532[3]
Iceland	99[1]	55[7]	54[7]	133[7]	105[7]	140[1]	226[7]			
EU/Latvia	64[1]	67[1]	59[1]	144[1]	143[1]	144[1]	244[1]	310[1]	278[1]	
EU/Lithuania	67[1]	67[1]	67[1]	142[1]	144[1]	216[1]	486[1]	245[1]	182[1]	
Norway	77[1]	78[6]	70[6]	145[9]	165[9]	144[1]	272[9]	250[9]	345[1]	180[3]
EU/Poland	40[1]	54[1]		145[1]	144[1]	129[1]	244[1]			
Portugal		61[5]								
Russia	67[1]	67[1]	67[1]		141[1]	146[1]	248[1]	112[1]	278[1]	335[3]
EU/Spain	40[1]	699[4]		151[1]	140[1]	154[1]	305[6]	190[1]	183[1]	
Ukraine		57[1]		144[1]	145[1]		121[1]			334[3]
USA		66[1]	57[1]	144[1]		136[1]	245[1]	245[1]	278[3]	
Estimated additional catch							2,000[5]			
GRAND TOTAL	4,711	10,697	6,994	13,099	13,464	14,384	25,802	23,854	26,917	16,648
TAC (tons)	6,000	6,000	6,000	13,000	13,000	13,000	22,000	22,000	25,000	30,000

Sources:

1 NAFO Statlant 21A
2 Canadian Atlantic 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. Northern shrimp biomass estimates in NAFO divisions 3LNO from annual **autumn** Canadian multi-species bottom trawl surveys, 1996 – 2008. Offshore strata only (standard 15 min. tows). Please note that autumn 2004 indices were not determined due to missing strata. All indices were determined using Ogive Mapping calculations. Previous estimates made use of preliminary data. The estimates presented here were determined using finalized datasets. Direction and percent change in relation to previous estimates are provided within the brackets.

	Biomass (tons)			Abundance (numbers x 10^6)			Survey
	Lower C.I.	Estimate	Upper C.I.	Lower C.I.	Estimate	Upper C.I.	Sets
1996	20,150	24,700 (0%)	35,010	5,342	6,580 (+0.12%)	9,390	304
1997	32,410	44,000 (0%)	61,940	7,550	9,917 (+0.06)	13,870	318
1998	48,320	60,700 (0%)	76,650	11,950	14,980 (+0.03%)	19,130	347
1999	43,160	54,900 (0%)	72,400	10,620	12,997 (+0.03%)	16,520	313
2000	83,990	107,000 (0%)	139,200	20,890	27,901 (+0.01%)	35,830	337
2001	155,300	215,500 (+0.05%)	259,600	36,890	51,732 (0%)	62,040	362
2002	135,500	191,700 (0%)	239,500	31,110	44,475 (0%)	54,760	365
2003	144,000	191,000 (+0.11%)	243,400	30,470	39,669 (+0.48%)	49,590	316
2004		???			???		
2005	177,500	222,600 (-0.49%)	264,600	35,490	45,083 (-0.41%)	53,730	333
2006	172,900	215,400 (0%)	252,000	36,450	47,034 (-0.04%)	55,700	312
2007	214,600	275,700 (+0.22%)	349,800	43,620	56,852 (+0.81)	71,460	361
2008	195,800	249,300	301,800	40,740	53,252	65,020	256

Area compared each year = 272,766.3 sq. km.

Table 3. Northern shrimp biomass estimates in NAFO divisions 3LNO from annual **spring** Canadian multi-species bottom trawl surveys, 1999 – 2009. Offshore strata only (standard 15 min. tows). Please note that strata deeper than 93 m were not surveyed in 3NO during spring 2006. Historically more than 97% of the shrimp have been attributed to strata within 3L therefore the spring 2006 estimates are for 3L. All indices were determined using Ogive Mapping calculations. Previous estimates made use of preliminary data. The estimates presented here were determined using finalized datasets. Direction and percent change in relation to previous estimates are provided within the brackets.

Year	Biomass (tons)			Abundance (numbers x 10^6)			Survey
	Lower C.I.	Estimate	Upper C.I.	Lower C.I.	Estimate	Upper C.I.	Sets
1999	26,990	49,400 (0%)	76,190	6,564	11,418 (0%)	17,300	313
2000	65,710	113,300 (0%)	176,700	13,150	21357 (0%)	31,590	298
2001	52,680	82,500 (0%)	117,100	12,250	19,718 (+0.02%)	28,540	300
2002	87,390	133,800 (0%)	204,700	20,730	31,263 (0%)	47,660	304
2003	117,200	169,600 (0%)	222,600	26,370	38,967 (-0.08%)	53,790	300
2004	40,960	93,500 (0%)	169,100	8,172	17,999 (0%)	31,890	296
2005	85,630	133,400 (0%)	183,500	16,800	25,553 (+ 0.05%)	34,860	289
2006	107,400	177,200 (-1.23%)	246,300	21,260	34,086 (-1.49%)	46,340	195
2007	190,200	288,600 (0%)	379,200	35,340	54,306 (0%)	72,790	295
2008	170,800	223,200 (-3.96%)	277,200	35,150	45,997.2 (-4.58%)	55,980	273
2009	62,850	112,500	167,500	14,430	24,447	35,180	299

Area compared each year = 272,766.3 sq. km.

Table 4. NAFO Divisions 3LNO *Pandalus borealis* biomass estimates for entire divisions and outside the 200 Nmi limit. Shrimp were collected during the 1996 – 2008 **autumn** Canadian multi-species surveys using a Campelen 1800 shrimp trawl (standard 15 min tows). All indices were estimated using Ogmap calculations.

			Entire Division		Outside 200 Nmi limit			
Season	Year	Division	Biomass estimate (t)	Percent by division	Biomass estimate (t)	Percent biomass by division	percent biomass in NRA	3 year running average percent biomass in NRA
Autumn	1996	3L	22,900	92.71	4,000	85.11	17.47	
Autumn	1997	3L	43,400	98.64	5,500	91.67	12.67	
Autumn	1998	3L	56,000	92.26	8,900	81.65	15.89	15.34
Autumn	1999	3L	54,500	99.27	8,000	96.39	14.68	14.41
Autumn	2000	3L	105,800	98.88	22,100	98.22	20.89	17.15
Autumn	2001	3L	213,700	99.21	40,800	97.14	19.09	18.22
Autumn	2002	3L	187,800	97.97	35,200	92.39	18.74	19.57
Autumn	2003	3L	185,300	97.02	35,600	91.75	19.21	19.02
Autumn	2004	3L	???	???	???	???	???	???
Autumn	2005	3L	221,200	99.37	26,200	97.40	11.84	???
Autumn	2006	3L	213,700	99.21	27,100	96.44	12.68	???
Autumn	2007	3L	271,500	98.48	49,700	98.42	18.31	14.28
Autumn	2008	3L	246,200	98.76	32,900	97.92	13.36	14.78
Autumn	1996	3N	2,000	8.10	700	14.89	35.00	
Autumn	1997	3N	700	1.59	500	8.33	71.43	
Autumn	1998	3N	4,700	7.74	2,000	18.35	42.55	49.66
Autumn	1999	3N	500	0.91	300	3.61	60.00	57.99
Autumn	2000	3N	700	0.65	400	1.78	57.14	53.23
Autumn	2001	3N	1,700	0.79	1,200	2.86	70.59	62.58
Autumn	2002	3N	4,000	2.09	2,900	7.61	72.50	66.74
Autumn	2003	3N	4,700	2.46	3,200	8.25	68.09	70.39
Autumn	2004	3N	2,600	???	2,100	???	???	???
Autumn	2005	3N	1000	0.45	700	2.60	70.00	
Autumn	2006	3N	1,500	0.70	1000	3.56	66.67	
Autumn	2007	3N	1,300	0.47	800	1.58	61.54	66.07
Autumn	2008	3N	1,300	0.52	700	2.08	53.85	60.68
Autumn	1996	3O	0	0.00	0	0.00	0.00	
Autumn	1997	3O	0	0.00	0	0.00	0.00	
Autumn	1998	3O	100	0.16	0	0.00	0.00	0.00
Autumn	1999	3O	0	0.00	0	0.00	0.00	0.00
Autumn	2000	3O	0	0.00	0	0.00	0.00	0.00
Autumn	2001	3O	0	0.00	0	0.00	0.00	0.00
Autumn	2002	3O	100	0.05	0	0.00	0.00	0.00
Autumn	2003	3O	200	0.10	0	0.00	0.00	0.00
Autumn	2004	3O	200	???	0	???	???	???
Autumn	2005	3O	100	0.04	0	0.00	0.00	
Autumn	2006	3O	0	0.00	0	0.00	0.00	
Autumn	2007	3O	0	0.00	0	0.00	0.00	0.00
Autumn	2008	3O	0	0.00	0	0.00	0.00	0.00
	all divisions							
Autumn	1996		24,700	101	4,700	100	19.03	
Autumn	1997		44,000	100	6,000	100	13.64	
Autumn	1998		60,700	100	10,900	100	17.96	16.87
Autumn	1999		54,900	100	8,300	100	15.12	15.57
Autumn	2000		107,000	100	22,500	100	21.03	18.03
Autumn	2001		215,400	100	42,000	100	19.50	18.55
Autumn	2002		191,700	100	38,100	100	19.87	20.13
Autumn	2003		191,000	100	38,800	100	20.31	19.90
Autumn	2004		???		???		???	???
Autumn	2005		222,600	100	26,900	100	12.08	
Autumn	2006		215,400	100	28,100	100	13.05	
Autumn	2007		275,700	99	50,500	100	18.32	14.48
Autumn	2008		249,300	99	33,600	100	13.48	14.95

Table 5. NAFO Divisions 3LNO *Pandalus borealis* biomass estimates for entire divisions and outside the 200 Nmi limit. Shrimp were collected during the 1999 – 2009 **spring** Canadian multi-species surveys using a Campelen 1800 shrimp trawl (standard 15 min tows). Please note that strata deeper than 93 m were not surveyed in 3NO during spring 2006. Historically more than 97% of the shrimp have been attributed to strata within 3L therefore the spring 2006 estimates are for 3L. All indices were estimated using Ogmap calculations.

			Entire Division		Outside 200 Nmi limit			
Season	Year	Division	Biomass estimate (t)	Percent by division	Biomass estimate (t)	Percent biomass by division	percent biomass in NRA	3 year running average percent biomass in NRA
Spring	1999	3L	47,500	96.15	10,200	86.44	21.47	
Spring	2000	3L	108,700	95.94	23,800	87.18	21.90	
Spring	2001	3L	82,700	100.24	11,400	99.13	13.78	19.05
Spring	2002	3L	128,100	95.74	34,300	91.47	26.78	20.82
Spring	2003	3L	165,400	97.52	29,900	86.92	18.08	19.55
Spring	2004	3L	92,000	98.40	23,700	97.13	25.76	23.54
Spring	2005	3L	133,200	99.85	14,200	94.67	10.66	18.17
Spring	2006	3L	177,200	???	41,600	???	23.48	19.97
Spring	2007	3L	282,100	97.75	78,200	97.02	27.72	20.62
Spring	2008	3L	222,600	99.73	31,600	99.06	14.20	21.80
Spring	2009	3L	110,200	97.96	36,200	98.64	32.85	24.92
Spring	1999	3N	2,100	4.25	1,600	13.56	76.19	
Spring	2000	3N	4,700	4.15	3,500	12.82	74.47	
Spring	2001	3N	300	0.36	100	0.87	33.33	61.33
Spring	2002	3N	5,800	4.33	3,200	8.53	55.17	54.32
Spring	2003	3N	5,400	3.18	4,500	13.08	83.33	57.28
Spring	2004	3N	1,200	1.28	700	2.87	58.33	65.61
Spring	2005	3N	1,400	1.05	800	5.33	57.14	66.27
Spring	2006	3N	???	???	???	???	???	
Spring	2007	3N	3,100	1.07	2,400	2.98	77.42	
Spring	2008	3N	500	0.22	300	0.94	60.00	
Spring	2009	3N	700	0.62	500	1.36	71.43	69.62
Spring	1999	3O	100	0.20	0	0.00	0.00	
Spring	2000	3O	100	0.09	0	0.00	0.00	
Spring	2001	3O	0	0.00	0	0.00	0.00	0.00
Spring	2002	3O	100	0.07	0	0.00	0.00	0.00
Spring	2003	3O	200	0.12	0	0.00	0.00	0.00
Spring	2004	3O	200	0.21	0	0.00	0.00	0.00
Spring	2005	3O	100	0.07	0	0.00	0.00	0.00
Spring	2006	3O	???	???	???	???	0.00	0.00
Spring	2007	3O	0	0.00	0	0.00	0.00	0.00
Spring	2008	3O	0	0.00	0	0.00	0.00	0.00
Spring	2009	3O	0	0.00	0	0.00	0.00	0.00
	all divisions							
Spring	1999		49,400	100.61	11,800	100.00	23.89	
Spring	2000		113,300	100.18	27,300	100.00	24.10	
Spring	2001		82,500	100.61	11,500	100.00	13.94	20.64
Spring	2002		133,800	100.15	37,500	100.00	28.03	22.02
Spring	2003		169,600	100.83	34,400	100.00	20.28	20.75
Spring	2004		93,500	99.89	24,400	100.00	26.10	24.80
Spring	2005		133,400	100.97	15,000	100.00	11.24	19.21
Spring	2006		???	???	???	???	???	
Spring	2007		288,600	98.82	80,600	100.00	27.93	
Spring	2008		223,200	99.96	31,900	100.00	14.29	
Spring	2009		112,500	98.58	36,700	100.00	32.62	24.95

Table 6. Fishable biomass (t) indices (total weight of all females + weight of all males with carapace lengths => 17.5 mm) as determined using ogmap calculations from spring and autumn Canadian multi-species bottom trawl survey data, 1996 – 2009. Previous estimates made use of preliminary data. The estimates presented here were determined using finalized datasets. Direction and percent change in relation to previous estimates are provided within the brackets.

	Spring			Autumn		
Year	Lower 95% C.I.	Estimate (t)	Upper 95% C.I.	Lower 95% C.I.	Estimate (t)	Upper 95% C.I.
1996				12,390	14,600 (0%)	22,790
1997				23,670	34,100 (0%)	48,900
1998				36,080	48,300 (0%)	63,770
1999	20,590	40,700 (0%)	64,080	32,230	41,000 (0%)	56,470
2000	42,080	80,900 (0%)	133,300	61,970	79,100 (0%)	105,200
2001	42,750	66,300 (0%)	93,630	123,400	173,200 (+0.06%)	217,600
2002	71,350	110,600 (-1.60%)	172,700	111,000	157,000 (0%)	198,700
2003	106,300	148,500 (0%)	193,100	123,700	167,300 (+0.6%)	217,300
2004	35,000	83,300 (+.012%)	152,900		???	
2005	73,190	116,100 (+0.09%)	161,200	143,500	180,700 (+.11%)	216,600
2006	91,250	158,300 (+0.06%)	218,900	138,300	173,100 (0%)	205,500
2007	183,500	280,900 (+8.79%)	415,300	176,500	230,800 (-5.02%)	297,200
2008	137,600	188,200 (+.21%)	237,500	157,400	204,600	251,300
2009	53,190	97,600	151,500			

Table 7. Various TAC scenarios using the inverse variance weighted average fishable biomass from the four most recent Canadian research surveys into 3LNO. Please note that due to rounding, it may not be possible to derive exactly the same fishable biomass or catch rates using the numbers presented in the tables below; however, the derived values should be within a few percent of the values shown in the tables.

Variance weighting factor = fishable biomass/(measure of variance)^2÷Σ fishable biomass/(measure of variance)^2

Survey	Fishable biomass (t)	Fishable biomass – lower 95% C.I.= measure of variance	Fishable biomass/ (measure of variance^2)	1/measure of variance^2	Variance weighting factor
Autumn 2007	230,800	54,300	1.400E-4	3.39E-10	0.201
Spring 2008	188,200	50,600	3.120E-5	3.91 E-10	0.232
Autumn 2008	204,600	47,200	1.07E-4	4.49E-10	0.266
Spring 2009	97,600	44,410	7.31E-5	5.07E-10	0.301
Grand total			2.931E-4-04	1.686E-09	1.000

Inverse variance weighted average fishable biomass = 2.931E-4÷1.686E-9
= 173,886 t
≃ 174,000 t

Inverse variance weighted average fishable biomass (t)	TAC options (t)		
174,000	25,000	26,000	30,000
Indices of exploitation (TAC/fishable biomass) expressed percents	14.37%	14.94%	17.24%

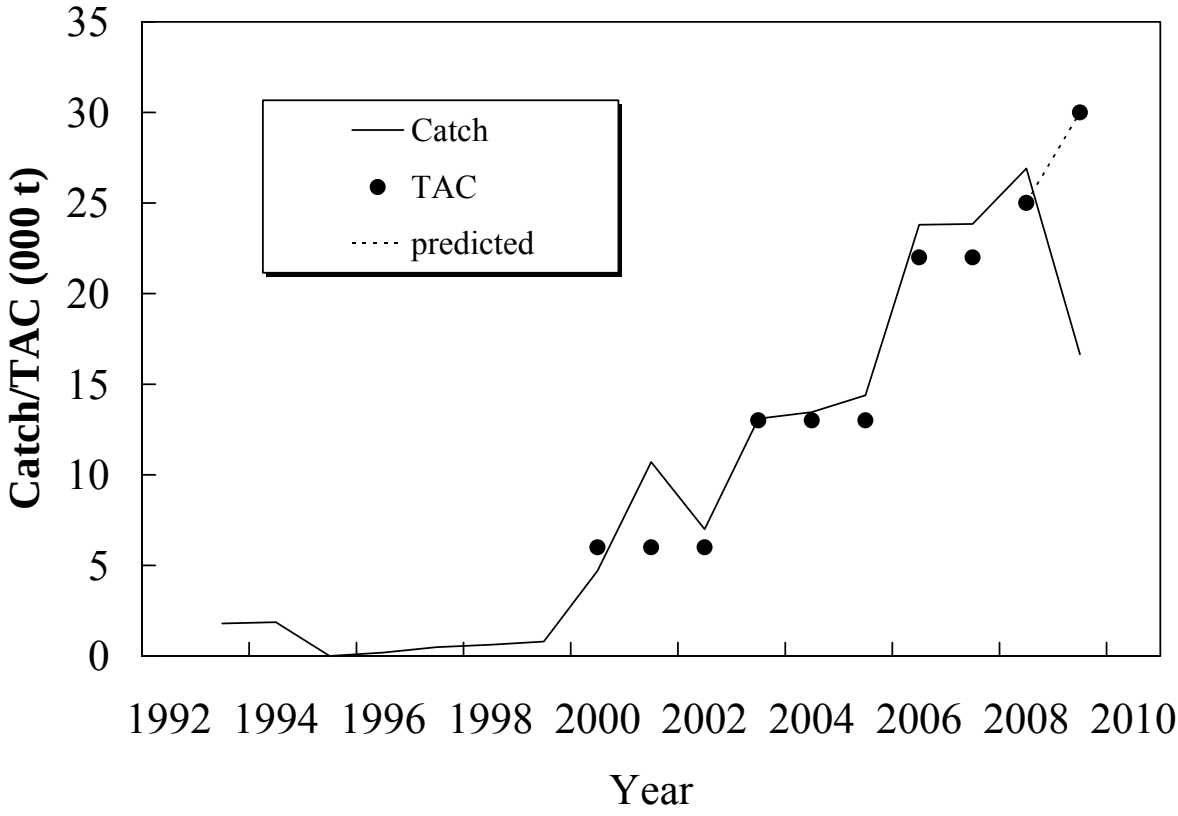

Figure 1. Trends in NAFO Div. 3LNO northern shrimp (*Pandalus borealis*) catch (t) and TAC over the period 1993-2009.

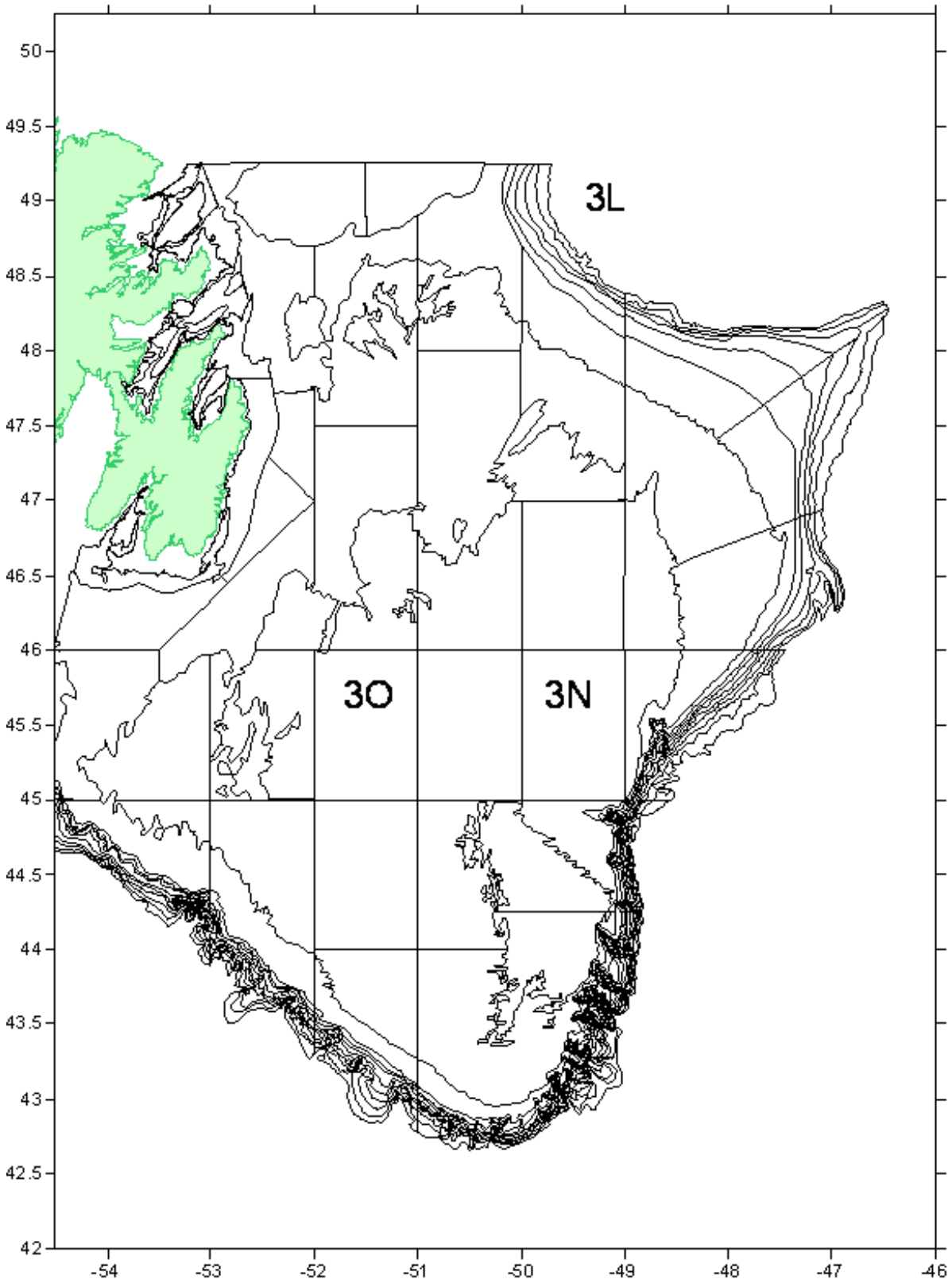

Figure 2. The NAFO 3LNO stratification scheme used in Canadian research bottom trawl survey set allocation.

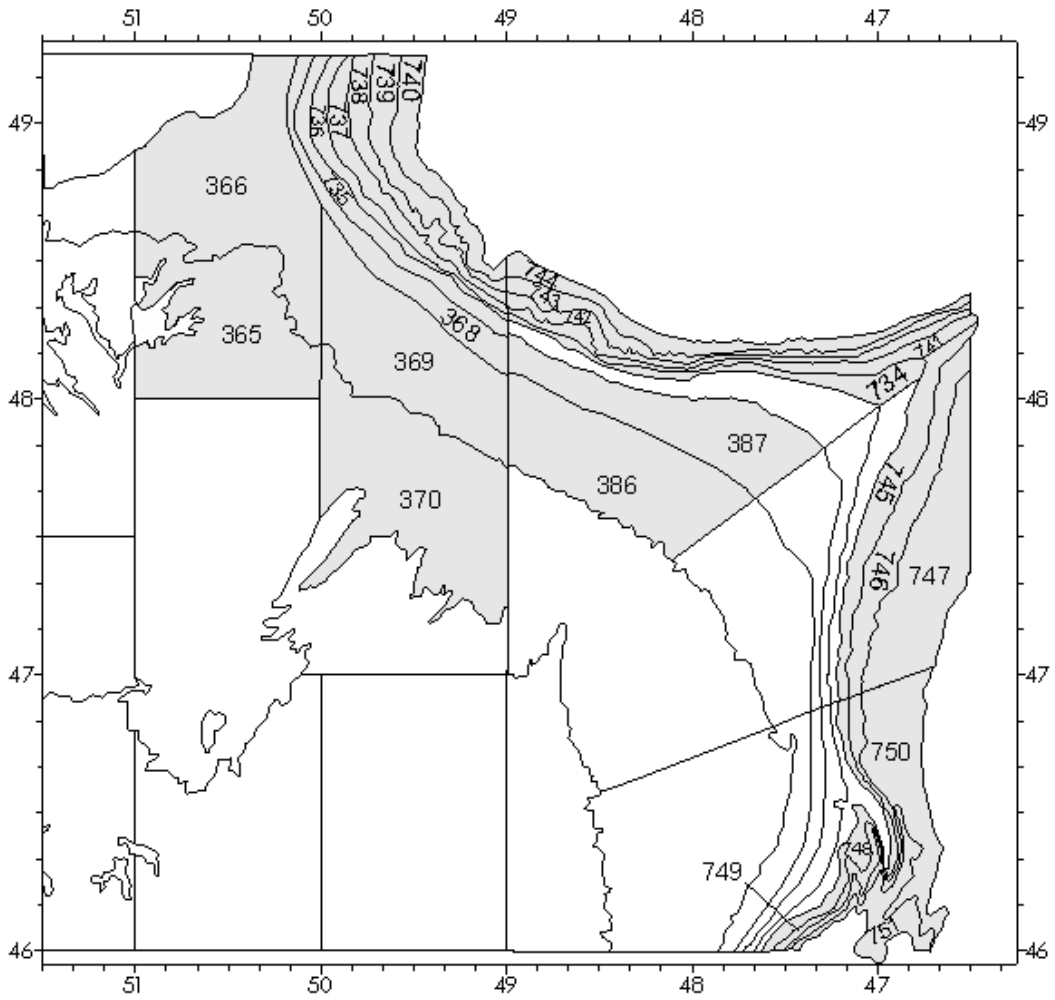

Figure 3. Strata in Div. 3L that were not surveyed (numbered and shaded area) during autumn of 2004.

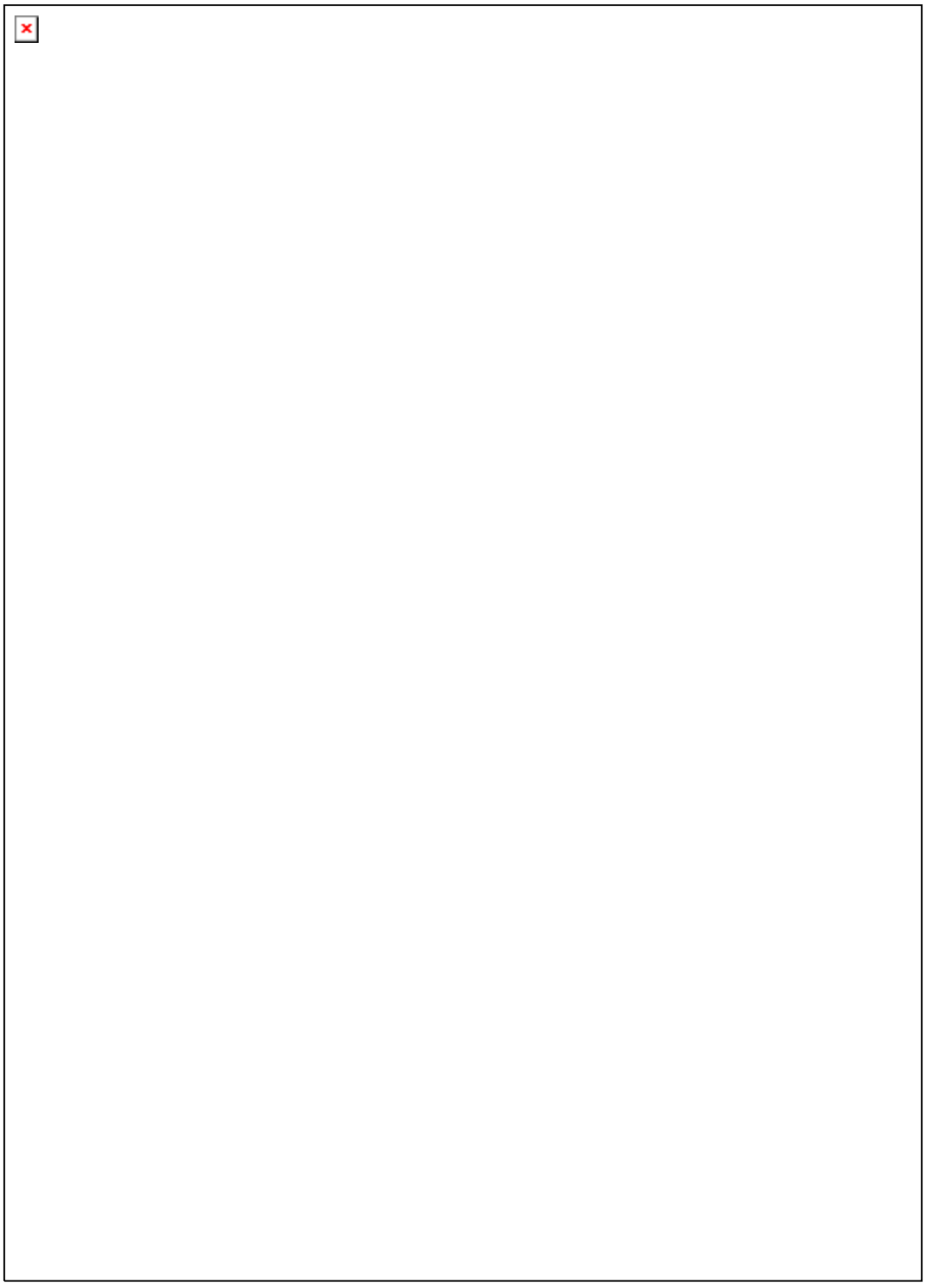

Figure 4. Distribution of NAFO Div. 3LNO northern shrimp (*Pandalus borealis*) catches kg/tow) as obtained from **autumn** research bottom trawl surveys conducted over the period 2005-2008.

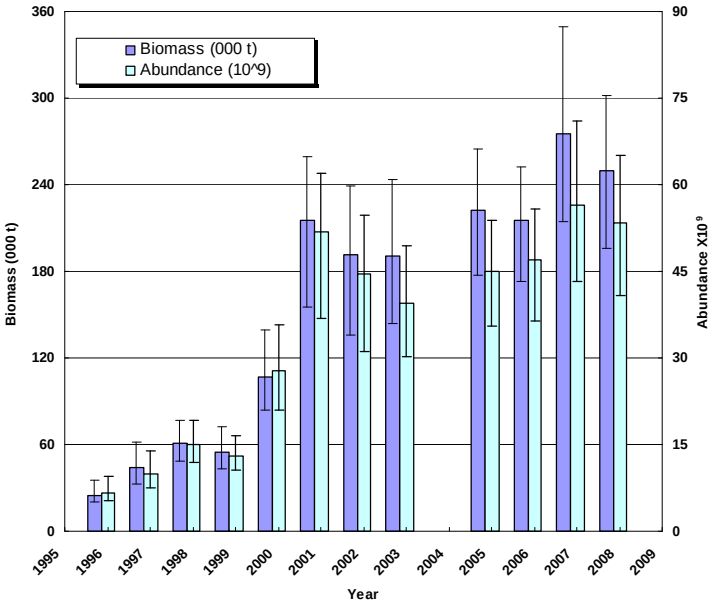

Figure 5. **Autumn** northern shrimp (*Pandalus borealis*) abundance and biomass estimates within NAFO Div. 3LNO. Data were from Canadian multi-species bottom trawl surveys using a Campelen 1800 trawl. (Standard 15 min. tows.)

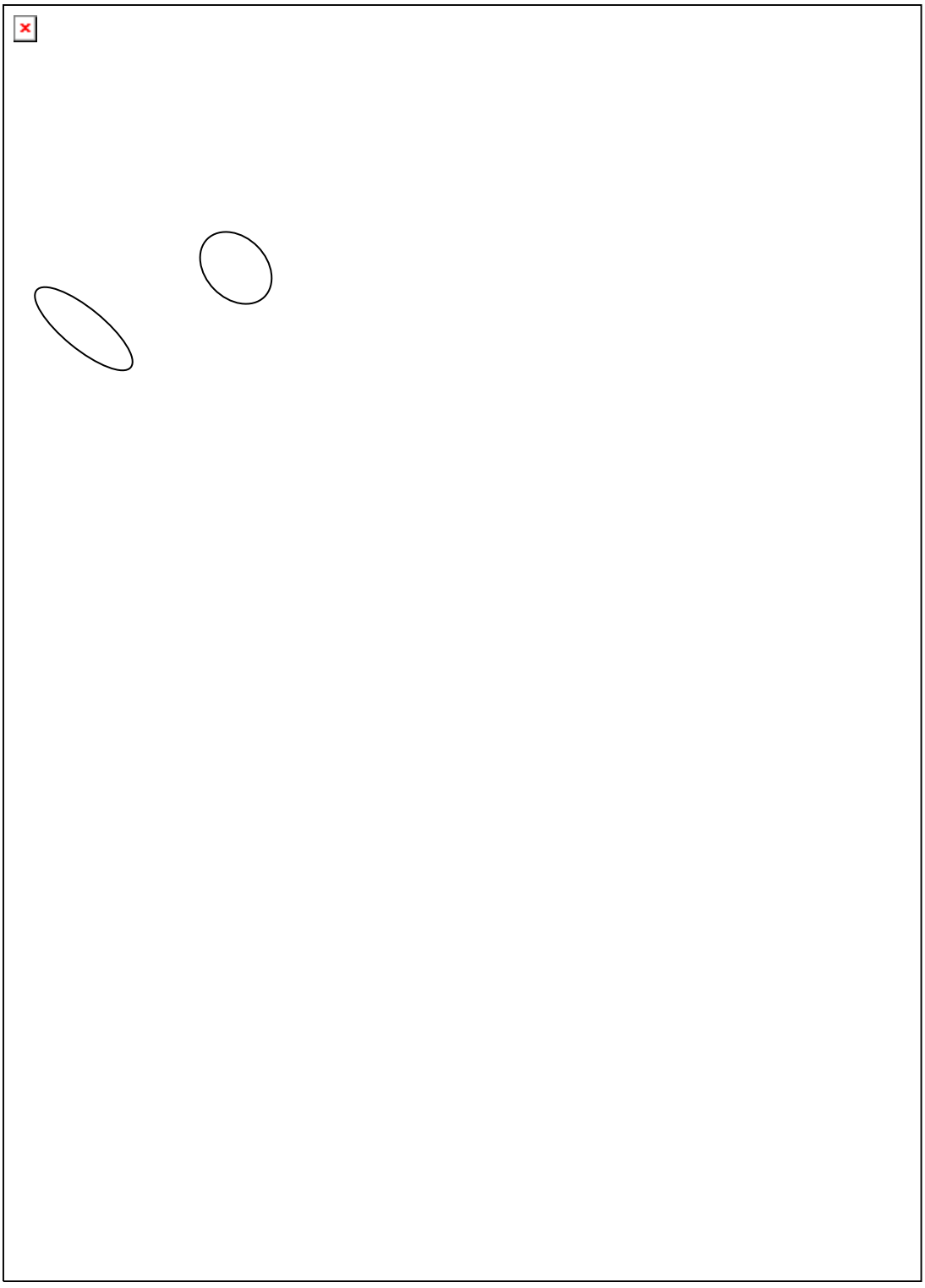

Figure 6. Distribution of NAFO Div. 3LNO northern shrimp (*Pandalus borealis*) catches kg/tow) as obtained form **spring** research bottom trawl surveys conducted over the period 2006-2009. Ellipses indicate strata not surveyed during spring 2006.

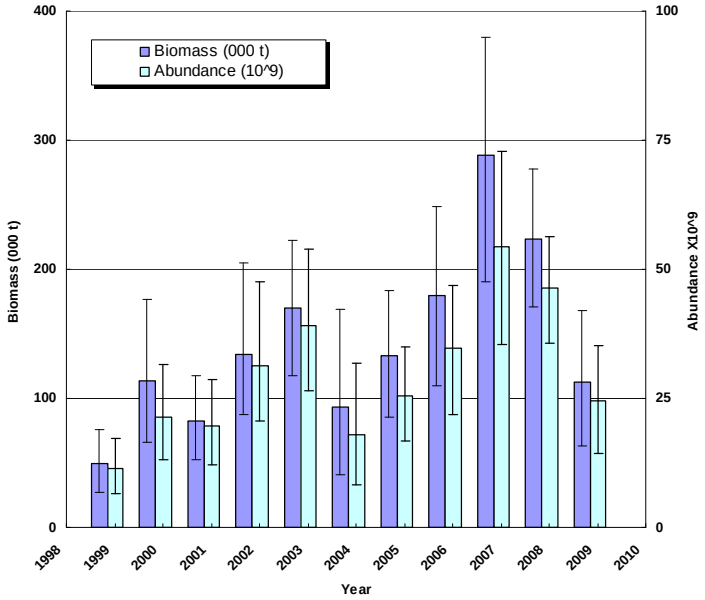

Figure 7. **Spring** northern shrimp (*Pandalus borealis*) abundance and biomass estimates within NAFO Div. 3LNO. Please note that due to operational problems, it was not possible to survey all of Div. 3NO during spring 2006. The indices for 2006 are for Div. 3L only. Data were from Canadian multi-species bottom trawl surveys using a Campelen 1800 trawl. (Standard 15 min. tows.)

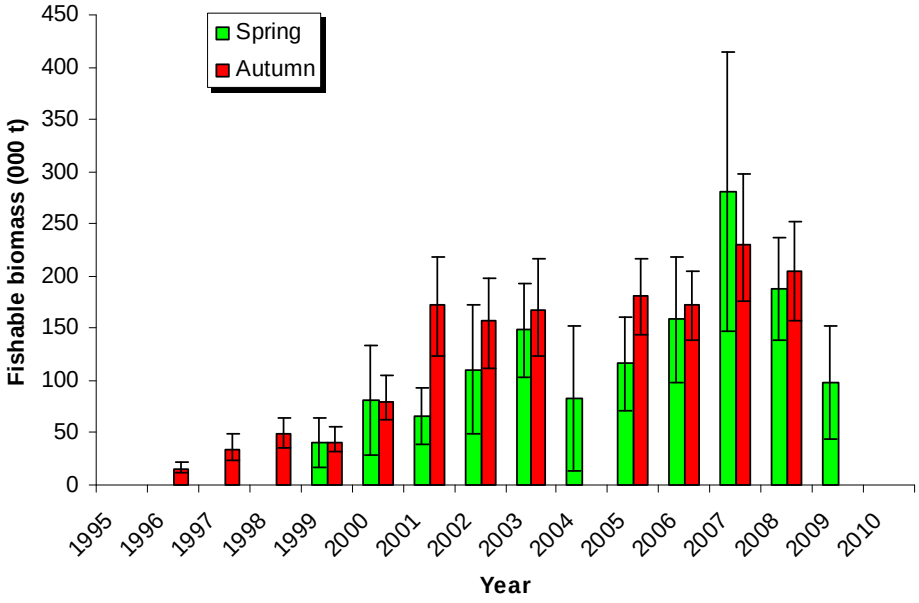

Figure 8. Fishable biomass (t) indices (total weight of all females + weight of all males with carapace lengths => 17.5 mm) as determined using ogmap calculations from autumn and spring Canadian multi-species bottom trawl survey data, 1996 – 2009. The bars represent 95% confidence intervals around the proposed fishable biomass indices.