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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 2006, and management advice was provided for the years 2007 and 2008. The catch table (to September 2007) and biomass estimates (autumn 1995-spring 2007) are updated within this report. Preliminary data indicate that 24 015 t of shrimp were taken against an annual TAC of 22 000 t in 2006 while 16 865 t were taken in 2007 against an annual TAC of 22 000 t. It is anticipated that the 2007 TAC will be taken. The autumn 2006 3LNO biomass index was estimated to be 249 000 t (95% C.I. = $\pm 49\ 000$ t), the second highest in the autumn time series, while the spring 2007 biomass index was 280 000 t (95% C.I. = $\pm 88\ 000$ t), the highest on record.

Fishery and Management

TAC regulation

Prior to 2004, TACs were set as 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 ton 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. 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. During the November 2006 shrimp assessment, SC decided that this advice should extend through 2008, and that the advice would be reviewed in September 2007 (NAFO, 2006).

Catch trends

Catches increased dramatically since 1999, with the beginning of a regulated fishery. There are a number of sources that question the annual catches of shrimp in the NRA and in 3M. An attempt will be made to resolve the catch issue during the October – November 2007 shrimp assessment. Table 1 and the following discussion provide the available numbers to date. Over the period 2000-2006, catches increased from 4 869 to 24 015 t. As of September 2007, total catches in 3L were 16 865 t and it is anticipated that the quota will be taken. As per NAFO agreements, Canadian vessels took most of the catch during each year. Canadian catches increased from 4 250 t in 2000 to 18 271 t in 2006. By September 2007, Canadian vessels took 14 284 t of shrimp and it is anticipated that the 18 570 t Canadian quota (18 325 t quota plus transfers) will be taken. Catches by other contracting parties increased from 619 t in 2000 to 5 744 t in 2006. By September 2007, they had taken 2 581 t of shrimp and it is anticipated that their 3 430 t quota will be taken. Table 1 provides a breakdown of catches by contracting party and year since 1999, 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. 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 (Figure 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; 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. Stratified abundance and biomass indices were estimated *via* areal expansion using programs based upon Cochran (1997) and written in SAS (D.C. Orr, unpublished).

The autumn 2006 biomass estimate for NAFO Divisions 3LNO was 248 790 t (95% C.I. = \pm 48 785 t), the second highest biomass index in the autumn time series (Table 2; Figure 3). The spring 2007 biomass estimate for NAFO Divisions 3LNO was 280 372 t (95% C.I. = \pm 88 271 t), the highest biomass index in the survey time series (Table 3; Figure 4).

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 table 4 and figure 5. All NAFO Regulatory Area (NRA) strata containing significant quantities of northern shrimp, throughout the survey time series, were surveyed during autumn 2004 (Table 4; Figures 5 - 7).

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 (Table 4). Figure 6 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. However, analyses conducted on strata that had been consistently fished each autumn since 1995 resulted in biomass estimates of 96 926 t (95% C.I. = \pm 21 744 t) to 125 300 t (95% C.I. = \pm 52 693 t) over the period 2004 – 2006; three out of the four highest values within this partial index time series (Table 5). It should be noted that the confidence intervals of the biomass estimates from strata completed in this portion of the autumn surveys are relatively tight, indicating relatively low variances in catches. Further, the lower confidence limits of the partial autumn 2004 - 2006 surveys are above the lower confidence limits from the previous estimates in the partial survey time series. The inclusion of additional strata in the overall biomass index would result in the index increasing or staying the same. Therefore one may conclude that the partial biomass index from the autumn of 2004 was at least as high as it was in the past five years and that the biomass within these strata has increased since 1999.

All strata within 3LNO (<731 m) were surveyed during autumn 2006 (Figure 6). Tables 4 and 6 -8 provide the strata by strata break down of biomass by year and NAFO Division while table 8 provides percentages of the resource available to the NRA. Over 90% of the biomass may be attributed to NAFO Division 3L; 11 – 24% of the 3L biomass is found within the NRA. Between 0.2% and 9% of the 3LNO biomass is found within 3N while less than 1% of the total biomass is found within 3O (Table 8).

The spring 2007 3L biomass estimate was 280 091 t (95% C.I. = \pm 88 271 t) (Table 9; Figure 4). Throughout the history of the spring survey, it was possible to survey all NAFO Division 3L strata that are important for shrimp (100 m - 751 m). However, 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 (Figure 7). 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 (Tables 10 and 11). Therefore biomass and abundance indices were not determined for NAFO Divisions 3NO during spring 2006. Historically, at least 97% of the 3LNO biomass is found within Division 3L (Table 12). The spring 2006 3L biomass index was 185 156 tons (95% C.I. = \pm 115,048 tons), the third highest in the spring time series.

Tables 9 - 12 provide the strata by strata break down of biomass by year and NAFO Division while table 12 provides percentages of the resource available to the NRA. Over 97% of the spring biomass may be attributed to NAFO Division 3L; 12 – 30% of this biomass is found within the NRA. Between 0.05% and 3% of the 3LNO biomass is found within 3N while less than 0.2% of the total biomass is found within 3O (Table 12).

Conclusions

Preliminary data indicate that 16 865 t of shrimp had been taken in the 3L shrimp fishery by September 2007 and it is anticipated that the entire 22 000 t quota will be taken by the end of December 2007.

The autumn 2006 NAFO Divisions 3LNO biomass index was 248 790 t, the third highest in the survey time series. The spring 2007 Divisions 3LNO biomass index was 280 372 t, the highest in the survey time series; however the spring biomass indices are thought to be less precise. Based on the information available, no change is proposed for the Scientific Council advice for a TAC of 22 000 t in 2008.

Acknowledgements

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

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Canada	78 ¹	4,250 ²	5,129 ²	5,414 ²	10,008 ²	10,613 ²	11,176 ²	18,271 ²	14,284 ²	
Cuba				70 ³	146 ¹	145 ¹	136 ¹			
Estonia		64 ¹	2,264 ⁴	450 ⁵	152 ¹	87 ¹				
European Union					117 ¹	159 ¹	767 ¹	1751 ¹	1206 ¹	
Faroe Islands	706 ¹	42 ¹	2,052 ⁴	620 ⁵		614 ¹	1044 ¹	947 ¹	332 ¹	
France (SPM)		67 ¹		36 ³			147 ¹			
Greenland		34 ¹			672 ⁸	296 ¹	302 ¹	453 ⁸	455 ⁸	
Iceland		97 ¹	55 ⁷	55 ⁷	133 ⁷	105 ⁷	140 ¹¹	226 ⁷		
Latvia		64 ¹	67 ¹	59 ³	144 ¹	105 ¹				
Lithuania		67 ¹	51 ³	67 ³	142 ¹	62 ¹				
Norway		77 ¹	78 ⁶	70 ⁶	145 ⁹	148 ¹	144 ¹		246 ¹	
Poland		40 ¹	54 ¹			144 ¹				
Portugal			61 ⁵							
Russia		67 ¹	67 ³				144 ¹	248 ¹	97 ¹	
Spain	11 ¹		699 ⁴							
Ukraine			57 ¹		144 ¹	144 ¹		119 ¹⁰		
USA				69 ³	144 ¹		137 ¹		245 ¹	
Estimated additional catch								2,000 ⁵		
GRAND TOTAL	795	4,869	10,566	6,977	11,947	12,622	14,137	24,015	16,865	
TAC (tons)		6,000	6,000	6,000	13,000	13,000	13,000	22,000	22,000	22,000

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.
- 10 Ukrainian logbook dataset
- 11 Data provided by Icelandic Scientist

Table 2 Northern shrimp stock size estimates in NAFO divisions 3LNO from annual autumn Canadian multi-species bottom surveys, 1995 - 2006. Offshore strata only. (standard 15 min. tows)
Please note autumn 2004 indices were not determined due to missing strata.

Year	Biomass (t)			Abundance (numbers x 10 ⁶)			Survey Sets
	Lower C.I.	Estimate	Upper C.I.	Lower C.I.	Estimate	Upper C.I.	
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
2003	106,338	223,568	340,798	29,708	47,281	64,853	316
2004		???			???		
2005	199,173	263,815	328,456	40,080	52,964	65,847	333
2006	200,006	248,790	297,575	43,247	53,909	64,571	312

Table 3 Northern shrimp stock size estimates in NAFO divisions 3LNO from annual spring Canadian multi-species bottom surveys, 1999 - 2007. 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 are attributed to strata within 3L therefore the spring 2006 estimates are for 3L.

Year	Biomass (t)			Abundance (numbers x 10 ⁶)			Survey Sets
	Lower C.I.	Estimate	Upper C.I.	Lower C.I.	Estimate	Upper C.I.	
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	117,918	198,169	278,421	22,638	47,120	71,604	300
2004	-529,764	110,827	751,418	-97,747	21,696	141,395	296
2005	88,504	155,627	222,751	17,441	29,976	42,510	289
2006	69,546	180,642	291,738	14,271	35,199	56,127	195
2007	192,101	280,372	368,643	35,237	54,607	73,976	295

Table 4.

Biomass estimates (t) of northern shrimp (*Pandalus borealis*) Canadian autumn multi-species bottom trawl surveys in Div. 3L using a Campelen 1800 shrimp trawl during 1995 - 2006. Light shading indicates strata not fished during 2004. The inshore strata were not consistently sampled over the years therefore this table includes only offshore strata. (standard 15 min. tows).

Depth Range (m)	Area (Nmi2)	Stratum	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	
57 - 92	2071	350	0	0	1	3	1	1	2	31	38	4	2	5	
	1780	363	0	1	1	2	0	7	19	18	622	1	0	0	
	1121	371	0	0	1	0	0	7	5	10	23	0	3	4	
	2460	372	0	3	12	6	1	7	7	106	166	8	0	0	
	1120	384	0	2	1	1	2	12	5	489	38	6	0	8	
	1519	328	32	57	92	15	41	12	14	28	73	38	24	8	
	1574	341	0	81	41	4	18	27	21	52	58	37	1	17	
	585	342	0	1	0	25	4	444	4	35	48	1	0	0	
	525	343	0	1	1	5	1	5	4	5	4	19	24	0	
	2120	348	4	18	20	56	291	361	435	675	195	5,309	6,419	2,286	
2114	349	0	3	6	16	12	30	40	466	298	37	38	189		
2817	364	1	3	44	14	5	120	190	316	92	26	748	15		
1041	365	1	3	105	179	63	.	3,385	3,405	99	.	10,161	21,403		
1320	370	2	1	57	712	134	84	3,011	129	103	.	12	5,991		
2356	385	1	9	1,471	205	1,274	2,078	4,307	3,629	7,381	5,367	8,411	20,160		
1481	390	0	0	10	6	12	152	2,498	3,520	7,928	1,330	2,555	4,956		
184 - 274	1582	344	8	29	104	2,858	5,068	3,192	1,971	7,549	2,084	14,774	15,440	12,099	
	983	347	21	45	25	4,850	1,547	7,372	10,450	8,516	1,743	21,775	13,749	14,170	
	1394	366	674	560	11,878	5,425	7,673	24,193	25,316	27,047	22,959	.	34,421	45,134	
	961	369	23	182	1,843	6,319	3,939	3,353	10,842	6,694	21,994	.	28,648	15,906	
	983	386	18	304	9,299	5,981	7,884	6,161	15,245	25,131	22,962	.	21,600	32,261	
	821	389	42	2,007	1,630	6,917	10,065	25,088	32,443	34,321	17,502	11,248	12,341	25,356	
	282	391	0	391	236	166	246	3,643	353	106	7,838	2,312	2,072	745	
	1432	345	723	2,030	5,976	9,954	4,361	18,288	17,904	31,885	16,945	20,045	27,257	18,731	
	865	346	1,802	7,069	5,608	3,510	5,328	6,251	18,983	35,886	29,796	11,056	35,328	12,564	
	334	368	77	1,232	483	358	101	27	16,985	457	10,162	.	11,151	2,187	
718	387	1,199	2,393	4,258	7,197	3,908	12,013	43,798	11,890	44,725	.	23,107	11,024		
275 - 366	361	388	363	1,599	2,117	1,485	570	4,326	13,612	7,204	3,747	.	8,845	1,956	
	145	392	210	324	73	187	123	387	320	44	881	906	694	560	
	186	729	0	3	2	0	51	1	603	0	15	1	1	7	
	216	731	0	.	16	11	14	112	92	772	0	1,496	130	212	
	468	733	8	212	170	12	66	0	243	4	0	262	32	3	
	272	735	134	2	166	2	57	119	8	12	147	.	57	110	
	50	792	.	.	.	.	.	.	.	.	.	.	.	.
	170	730	0	1	0	0	0	0	1	0	0	0	29	1	
	231	732	12	0	0	0	1	0	2	9	0	866	4	0	
	228	734	0	0	1	0	0	0	1	9	0	.	1	0	
367 - 549	175	736	1	0	8	2	2	27	13	0	18	.	1	2	
	227	737	0	0	0	0	0	1	0	0	0	.	1	0	
	223	741	.	0	0	0	0	0	0	0	21	.	.	0	
	348	745	.	0	0	0	0	0	10	0	8	.	.	0	
	159	748	.	0	0	0	0	1	3	0	1	.	.	0	
	221	738	0	0	0	0	0	0	0	0	0	.	.	0	
	206	742	.	0	0	0	0	0	0	0	0	.	.	0	
	392	746	.	0	0	0	0	0	4	0	1	.	.	0	
	126	749	.	0	0	0	0	0	0	0	0	.	.	0	
	254	739	.	0	0	0	0	0	0	0	0	.	.	0	
732 - 914	211	743	.	0	0	0	0	0	0	0	0	.	.	0	
	724	747	.	0	0	0	0	0	0	1	0	.	.	0	
	556	750	.	0	0	0	0	0	0	1	0	.	.	0	
	264	740	.	0	0	0	0	0	0	0	0	.	.	0	
	280	744	.	0	0	0	0	0	0	0	0	.	.	0	
	229	751	.	0	0	0	0	0	0	0	0	.	.	0	
	Biomass estimate			5,358	18,566	45,758	56,485	52,863	117,902	223,149	210,451	220,711	96,925	263,307	248,067
	Upper 95% CL			7,397	28,893	66,426	76,064	69,804	142,948	369,574	299,083	337,873	118,669	327,947	296,846
	Lower 95% CL			3,318	8,238	25,090	36,904	35,923	92,855	76,725	121,821	103,549	75,182	198,667	199,289
	% of 3L biomass index within the missing strata			39.73	25.19	61.41	46.34	44.95	39.00	53.16	35.53	55.82	???	49.05	54.02

Table 5. Biomass indices (t) of northern shrimp (*Pandalus borealis*) from Canadian autumn research surveys in Division 3L using a Campelen 1800 shrimp trawl during 1995 - 2006. The analyses below are for strata sampled in all years. (standard 15 minute tows).

Depth Range (m)	Area (Nm ²)	Stratum	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
57 - 92	2071	350	0	0	1	3	1	1	2	31	38	4	2	5
	1780	363	0	1	1	2	0	7	19	18	622	1	0	0
	1121	371	0	0	1	0	0	7	5	10	23	0	3	4
	2460	372	0	3	12	6	1	7	7	106	166	8	0	0
	1120	384	0	2	1	1	2	12	5	489	38	6	0	8
	1519	328	32	57	92	15	41	12	14	28	73	38	24	8
93 - 183	1574	341	0	81	41	4	18	27	21	52	58	37	1	17
	585	342	0	1	0	25	4	444	4	35	48	1	0	0
	525	343	0	1	1	5	1	5	4	5	4	19	24	0
	2120	348	4	18	20	56	291	361	435	675	195	5,309	6,419	2,286
	2114	349	0	3	6	16	12	30	40	466	298	37	38	189
	2817	364	1	3	44	14	5	120	190	316	92	26	748	15
	2356	385	1	9	1,471	205	1,274	2,078	4,307	3,629	7,381	5,367	8,411	20,160
	1481	390	0	0	10	6	12	152	2,498	3,520	7,928	1,330	2,555	4,956
	1582	344	9	29	104	2,858	5,068	3,192	1,971	7,549	2,084	14,774	15,440	12,099
	983	347	21	45	25	4,850	1,547	7,372	10,450	8,516	1,743	21,775	13,749	14,170
184 - 274	821	389	42	2,007	1,630	6,917	10,065	25,088	32,443	34,321	17,502	11,248	12,341	25,356
	282	391	0	391	236	166	246	3,643	353	106	7,838	2,312	2,072	745
	1432	345	723	2,030	5,976	9,954	4,361	18,288	17,904	31,885	16,945	20,045	27,257	18,731
275 - 366	865	346	1,802	7,069	5,608	3,510	5,328	6,251	18,983	35,886	29,796	11,056	35,328	12,564
	145	392	210	324	73	187	123	387	320	44	881	906	694	560
367 - 549	186	729	0	3	2	0	51	1	603	0	15	1	1	7
	216	731	0	16	11	14	112	92	772	0	1,496	130	212	
	468	733	8	212	170	12	66	0	243	4	0	262	32	3
550 - 731	170	730	0	1	0	0	0	0	1	0	0	0	29	1
	231	732	12	0	0	0	1	0	2	9	0	866	4	0
Biomass estimate			2,866	12,290	15,543	28,824	28,533	67,597	90,817	128,472	93,766	96,826	125,300	112,096
Upper 95% CL			5,227	25,047	20,659	49,547	41,246	92,287	130,537	220,851	130,754	118,670	177,993	136,891
Lower 95% CL			506	-467	10,427	8,099	15,821	42,907	51,298	36,092	56,778	75,182	72,608	87,302

Table 6. Biomass estimates (t) of northern shrimp (*Pandalus borealis*) Canadian autumn multi-species bottom trawl surveys in Div. 3N using a Campelen 1800 shrimp trawl during 1995 - 2006. (Standard 15 min. tows).

Depth Range (m)	Area (Nm ²)	Stratum	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
<=56	1593	375	0	0	1	0	1	0	1	0	0	0	0	0
	1499	376	0	0	0	0	0	0	0	0	0	0	1	0
57 - 92	2992	360	0	11	2	0	1	1	1	2	1	0	1	0
	1853	361	0	0	0	0	0	0	0	0	0	1	0	0
	2520	362	4	1	2	1	1	5	11	22	24	2	0	1
	2520	373	0	0	2	6	2	0	1	67	17	2	8	4
	931	374	33	1	0	1	0	0	0	2	23	0	0	1
93 - 183	674	383	0	0	0	5	1	8	2	114	10	6	0	5
	421	359	0	0	0	0	0	0	0	2	0	0	10	0
	100	377	0	2	44	119	0	5	1	0	487	10	49	0
184 - 274	647	382	0	0	1	0	0	4	7	1,951	28	7	7	4
	225	358	0	29	2	41	3	10	173	113	276	120	20	2
	139	378	11	26	195	353	8	16	111	1,389	97	556	18	291
275 - 366	182	381	34	721	121	2,630	93	39	24	44	1,341	9	29	211
	164	357	2	0	6	12	.	1	0	119	222	4	198	17
	106	379	0	110	1	1	1	19	404	424	225	619	31	38
367 - 549	116	380	0	35	33	69	89	37	19	103	10	85	14	75
	155	723	0	0	0	19	1	2	1	41	4	0	16	6
	105	725	449	2	10	1	52	70	9	12	12	.	10	1
550 - 731	160	727	0	577	7	5	8	17	18	12	5	1	0	31
	124	724	0	0	0	0	0	11	3	11	.	0	0	1
	72	726	0	1	0	91	1	4	36	3	1	1	2	0
732 - 914	156	728	0	0	1	6	11	2	3	2	4	0	0	16
	134	752	.	.	.	0	.	0	0	0	.	.	.	.
	106	756	.	.	.	0	.	16	10	6	.	.	5	.
915 - 1097	154	760	.	.	.	0	.	1	0	2	.	.	0	.
	138	753	.	.	.	0	.	0	0	0	.	.	0	.
	102	757	.	.	.	0	.	1	1	2	.	.	0	.
1098 - 1280	171	761	.	.	.	0	.	0	0	0	.	.	0	.
	180	754	.	.	.	0	.	0	0	0	.	.	0	.
	99	758	.	.	.	0	.	0	0	0	.	.	0	.
1281 - 1463	212	762	.	.	.	.	.	0	0	0	.	.	0	.
	385	755	.	.	.	0	.	0	0	0	.	.	0	.
	127	759	.	.	.	0	.	0	0	0	.	.	5	.
	261	763	.	.	.	.	.	0	0	0	.	.	0	.
Biomass estimate			533	1,514	427	3,359	272	270	836	4,444	2,785	1,422	423	705
Upper 95% CL			6,272	13,314	2,694	36,474	731	1,175	5,244	35,204	18,695	2,536	3,033	5,229
Lower 95% CL			-5,206	-10,285	-1,840	-29,754	-188	-635	-3,573	-26,316	-13,125	309	-2,186	-3,820

Table 7. Biomass estimates (t) of northern shrimp (*Pandalus borealis*) Canadian autumn multi-species bottom trawl surveys in Div. 30 using a Campelen 1800 shrimp trawl during 1995 - 2006. (Standard 15 min. tows).

Depth Range (m)	Area (Nmi ²)	Stratum	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
57 - 92	2089	330	0	1	0	0	0	0	0	1	0	2	0	0
	456	331	0	0	0	0	0	0	0	0	0	0	0	0
	1898	338	0	1	2	2	0	0	0	2	2	3	0	0
	1716	340	0	0	0	0	1	0	0	3	0	3	0	0
	2520	351	0	3	2	11	1	3	2	46	1	5	9	0
	2580	352	0	0	0	1	0	0	0	3	1	1	1	0
	1282	353	0	1	0	4	0	0	0	0	0	3	0	0
	1721	329	0	0	1	1	1	0	0	2	7	4	0	0
93 - 183	1047	332	1	1	0	3	1	0	0	0	18	6	1	0
	948	337	9	0	1	4	0	0	0	1	12	5	6	0
	585	339	0	0	1	1	.	0	0	2	2	1	0	0
	474	354	0	1	5	5	1	0	1	21	0	4	54	6
	147	333	20	.	2	16	0	3	3	0	4	13	11	0
184 - 274	121	336	0	1	0	4	0	0	0	0	11	11	0	3
	103	355	0	0	2	16	1	0	1	25	9	12	3	8
	96	334	0	.	0	1	0	0	0	1	1	1	0	0
275 - 366	58	335	0	0	0	0	0	0	0	0	0	0	0	0
	61	356	0	0	0	0	0	0	1	1	1	0	0	0
	166	717	0	.	0	0	0	0	0	1	1	0	0	0
367 - 549	76	719	0	0	0	0	0	0	0	0	0	0	0	0
	76	721	0	0	0	0	0	0	1	3	0	0	0	2
	134	718	0	.	0	0	0	0	0	0	1	0	0	.
550 - 731	105	720	0	0	.	0	0	0	0	1	0	0	0	0
	93	722	0	0	0	0	2	0	0	0	1	0	0	0
	105	764	.	.	.	0	.	0	0	0	.	.	0	.
732 - 914	99	768	.	.	.	0	.	0	0	0	.	.	0	.
	135	772	.	.	.	0	.	0	.	0	.	.	0	.
	124	765	.	.	.	0	.	0	0	0	.	.	0	.
915 - 1097	138	769	.	.	.	0	.	0	0	0	.	.	0	.
	128	773	.	.	.	0	.	0	0	0	.	.	0	.
	144	766	.	.	.	.	.	0	0	0	.	.	0	.
1098 - 1280	128	770	.	.	.	.	.	0	0	0	.	.	0	.
	135	774	.	.	.	.	.	0	0	0	.	.	0	.
	1281 - 1463	158	767	.	.	.	.	.	0	0	0	.	.	0
	175	771	.	.	.	.	.	0	0	0	.	.	0	
	155	775	.	.	.	.	.	0	0	0	.	.	0	
Biomass estimate			30	9	17	69	9	8	10	113	72	77	84	18
Upper 95% CL			280	15	86	301	17	51	21	202	112	132	435	102
Lower 95% CL			-219	2	-52	-163	1	-36	-1	24	34	22	-266	-66

Table 8 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. (15 minute standard tows.)

Season	Year	Division	Entire Division		Outside 200 Nmi limit			3 year running average percent biomass in NRA
			iomass estimate (t)	Percent by division	Biomass estimate (t)	Percent biomass by division	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	2003	3L	220,711	98.72	45,383	94.92	20.56	20.32
Autumn	2004	3L	???	???	???	???	??	??
Autumn	2005	3L	263,307	99.81	29,409	98.55	11.17	10.58
Autumn	2006	3L	248,067	99.71	26,847	97.65	10.82	11.00
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	2003	3N	2,785	1.25	2,421	5.06	86.93	85.95
Autumn	2004	3N	1,422	???	1,392	???	???	???
Autumn	2005	3N	423	0.16	403	1.35	95.27	60.73
Autumn	2006	3N	705	0.28	635	2.31	90.07	92.67
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
Autumn	2003	3O	72	0.03	8	0.02	11.11	23.14
Autumn	2004	3O	77	???	12	???	???	???
Autumn	2005	3O	84	0.03	30	0.10	35.71	15.61
Autumn	2006	3O	18	0.01	10	0.04	55.56	45.63
all divisions								
Autumn	1995		5,921	100	1,537	100	25.96	25.96
Autumn	1996		20,089	100	5,862	100	29.18	27.57
Autumn	1997		46,202	100	5,509	100	11.92	22.35
Autumn	1998		59,914	100	11,508	100	19.21	20.10
Autumn	1999		53,144	100	8,969	100	16.88	16.00
Autumn	2000		118,180	100	28,687	100	24.27	20.12
Autumn	2001		223,995	100	53,104	100	23.71	21.62
Autumn	2002		215,008	100	39,029	100	18.15	22.04
Autumn	2003		223,568	100	47,813	100	21.39	21.08
Autumn	2004		???	???	???	???	???	???
Autumn	2005		263,815	100	29,842	100	11.31	10.90
Autumn	2006		248,790	100	27,492	100	11.05	11.18

Table 9. Biomass estimates (t) of northern shrimp (*Pandalus borealis*) Canadian spring multi-species bottom trawl surveys in Div. 3L using a Campelen 1800 shrimp trawl during 1999 - 2007. The inshore strata were not consistently sampled over the years therefore this table includes only offshore strata. (standard 15 min. tows).

Depth Range (m)	Area (Nmi ²)	Stratum	1999	2000	2001	2002	2003	2004	2005	2006	2007
57 - 92	2071	350	0	0	0	0	5	0	0	0	2
	1780	363	0	0	0	0	6	0	0	0	0
	1121	371	0	0	0	0	0	0	0	0	0
	2460	372	0	0	0	0	0	0	0	0	0
	1120	384	1	0	0	3	0	0	0	0	0
	465	785	.	.	.	.	.	.	.	.	.
93 - 183	1519	328	0	12	0	2	8	21	14	10	8
	1574	341	2	5	1	3	4	47	1	0	2
	585	342	3	1	0	8	1	5	0	0	10
	525	343	3	0	6	0	3	4	2	1	8
	2120	348	5	25	8	10	13	11	14	13	35
	2114	349	10	4	1	4	8	8	0	8	0
	2817	364	1	4	8	11	6	0	1	0	2
	1041	365	0	1	8	4	7	0	3	25	0
	1320	370	1	0	0	0	0	0	0	0	0
	2356	385	1	0	7	21	1	10	1	1	30
	1481	390	3	1	2	1	1	9	23	0	0
184 - 274	1582	344	38	12	56	189	955	13	3,245	1,018	188
	983	347	16	0	1,306	135	24	139	7,126	3,011	7,735
	1394	366	788	19,089	12,113	36,633	7,565	443	13,600	3,724	6,580
	961	369	7	1,581	0	3,223	38,854	415	20,385	4,694	16,296
	983	386	2,264	8,761	1,738	33	489	2,186	4,253	28,212	13,348
	821	389	10,135	34,172	1,000	5,226	15,643	1,272	15,146	53,698	31,649
	282	391	0	0	102	0	3,248	41	127	116	39,302
	1432	345	6,467	14,106	33,546	10,492	40,581	21,182	34,256	43,685	81,295
	865	346	13,287	15,471	20,814	27,134	14,860	11,337	37,086	8,010	56,224
	334	368	3,752	9,945	1,052	3,458	15,690	6,079	761	3,089	3,031
718	387	13,342	1,388	19,912	37,183	40,037	61,985	14,469	24,907	8,977	
275 - 366	361	388	3,403	13,706	9,047	30,777	8,418	4,197	2,825	9,272	12,841
	145	392	69	163	772	14	1,064	143	737	187	94
	186	729	0	7	16	2	339	3	116	331	1
	216	731	111	461	687	112	4,562	25	585	877	1,510
	468	733	118	425	176	216	2,703	14	124	196	901
	272	735	19	130	17	40	3	2	69	68	16
	50	792	.	.	.	.	.	.	.	.	.
367 - 549	170	730	0	1	0	0	1	0	0	0	0
	231	732	81	47	12	111	10	0	0	3	0
	228	734	4	0	79	7	1	0	0	2	3
	175	736	3	3	8	6	10	0	0	0	3
550 - 731											
Biomass estimate			53,934	119,521	102,493	155,061	195,121	109,589	154,970	185,156	280,091
Upper 95% CL			96,644	257,005	142,700	193,642	275,265	750,138	222,092	300,204	368,362
Lower 95% CL			11,223	-17,963	62,286	116,480	114,977	-530,958	87,848	70,109	191,821

Table 10. Biomass estimates (t) of northern shrimp (*Pandalus borealis*) Canadian spring multi-species bottom trawl surveys in Div. 3N using a Campelen 1800 shrimp trawl during 1999 - 2007. Light shading indicates strata not fished during 2006. (standard 15 min. tows).

Depth Range (m)	Area (Nmi ²)	Stratum	1999	2000	2001	2002	2003	2004	2005	2006	2007
<=56	1593	375	0	0	0	0	0	0	0	0	0
	1499	376	0	0	0	5	0	0	0	0	0
	2992	360	0	0	0	0	0	0	0	0	0
	1853	361	0	0	0	0	0	0	0	0	0
	2520	362	0	0	0	0	1	0	0	0	5
	2520	373	2	0	1	2	0	1	0	.	4
57 - 92	931	374	0	0	0	0	0	0	0	0	0
	674	383	0	0	1	0	0	1	0	.	0
	421	359	1	0	1	0	1	0	0	.	0
	100	377	100	0	0	0	0	1	1	.	0
	647	382	0	1	0	2	2	0	4	.	0
184 - 274	225	358	8	0	0	0	9	200	4	.	0
	139	378	171	35	2	68	1,194	1	4	.	0
	182	381	52	284	2	110	25	366	28	.	17
275 - 366	164	357	727	0	3	0	112	128	0	.	0
	106	379	165	1,828	4	108	1,448	11	106	.	0
	116	380	49	57	37	4,044	58	0	35	.	144
367 - 549	155	723	0	1	0	14	0	0	0	.	13
	105	725	0	9	3	0	0	0	213	.	29
	160	727	74	31	1	6	1	387	131	.	48
550 - 731	124	724	0	0	0	0	0	1	0	.	1
	72	726	0	0	0	1	0	0	0	.	6
	156	728	0	1	0	32	0	.	4	.	0
Biomass estimate			1,349	2,248	53	4,395	2,852	1,098	530	?	269
Upper 95% CL			11,209	24,096	277	54,237	26,147	3,599	3,343	?	2,121
Lower 95% CL			-8,511	-19,600	-171	-45,448	-20,442	-1,402	-2,283	?	-1,584
% of 3N biomass index within the missing strata			99.76	99.98	98.56	99.83	99.94	99.85	99.92	?	96.79

Table 11. Biomass estimates (t) of northern shrimp (*Pandalus borealis*) Canadian spring multi-species bottom trawl surveys in Div. 3O using a Campelen 1800 shrimp trawl during 1999 - 2007. Light shading indicates strata not fished during 2006. (standard 15 min. tows).

Depth Range (m)	Area (Nmi ²)	Stratum	1999	2000	2001	2002	2003	2004	2005	2006	2007
57 - 92	2089	330	0	0	1	0	2	0	1	0	0
57 - 92	456	331	0	0	0	0	0	0	0	.	0
57 - 92	1898	338	0	0	0	0	4	0	0	0	1
57 - 92	1716	340	0	0	0	2	4	9	0	0	0
57 - 92	2520	351	0	0	0	0	2	0	0	0	0
57 - 92	2580	352	0	0	0	3	2	0	0	0	0
57 - 92	1282	353	0	0	0	0	0	0	0	0	0
93 - 183	1721	329	1	1	6	0	13	3	1	.	1
93 - 183	1047	332	9	0	0	0	8	33	18	.	0
93 - 183	948	337	0	0	0	1	141	0	11	.	0
93 - 183	585	339	2	0	7	1	7	33	4	0	0
93 - 183	474	354	0	0	0	0	0	0	16	.	7
184 - 274	147	333	5	0	0	5	3	3	65	.	0
184 - 274	121	336	6	7	1	0	3	0	0	.	0
184 - 274	103	355	0	0	0	0	3	9	11	.	0
275 - 366	96	334	8	26	0	0	1	46	0	.	0
275 - 366	58	335	0	3	0	0	0	0	0	.	0
275 - 366	61	356	0	0	0	0	0	0	0	.	0
367 - 549	166	717	3	0	0	6	3	0	0	.	0
367 - 549	76	719	0	0	0	11	0	0	0	.	0
367 - 549	76	721	0	1	2	6	0	1	0	.	1
550 - 731	134	718	0	0	0	0	0	0	0	.	0
550 - 731	105	720	0	0	0	0	0	0	0	.	0
550 - 731	93	722	0	7	0	0	0	0	0	.	0
Biomass estimate			34	46	20	35	196	138	127	?	12
Upper 95% CL			63	399	99	95	536	367	1,036	?	124
Lower 95% CL			5	-307	-60	-25	-145	-90	-782	?	-79
% of 3O biomass index within the missing strata			92.69	100.00	49.64	82.49	89.13	68.97	96.27		81.81

Table 12 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. (15 minute standard tows.)

Season	Year	Division	Entire Division		Outside 200 Nmi limit			3 year running average percent	
			Biomass estimate (t)	Percent by division	Biomass estimate (t)	Percent biomass by division	percent biomass in NRA	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	195,121	98.46	42,876	93.79	21.97	23.47	
Spring	2004	3L	109,589	98.88	27,262	96.37	24.88	25.78	
Spring	2005	3L	154,970	99.58	18,983	97.27	12.25	19.70	
Spring	2006	3L	185,156	???	52,271	???	28.23	21.79	
Spring	2007	3L	280,091	99.90	76,882	99.69	27.45	22.64	
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	2,852	1.44	2,835	6.20	99.40	89.27	
Spring	2004	3N	1,098	0.99	1,019	3.60	92.81	91.90	
Spring	2005	3N	530	0.34	515	2.64	97.17	96.46	
Spring	2006	3N	???	???	???	???	???	???	
Spring	2007	3N	269	0.10	232	0.30	86.25	91.71	
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	
Spring	2004	3O	138	0.12	9	0.03	6.52	6.32	
Spring	2005	3O	127	0.08	17	0.09	13.39	6.98	
Spring	2006	3O	???	???	???	???	???	???	
Spring	2007	3O	12	0.00	5	0.01	41.67	27.53	
all divisions									
Spring	1999		55,317	100.00	16,058	100.00	29.03	29.03	
Spring	2000		121,815	100.00	38,311	100.00	31.45	30.24	
Spring	2001		102,566	100.00	18,444	100.00	17.98	26.15	
Spring	2002		159,491	100.00	50,962	100.00	31.95	27.13	
Spring	2003		198,169	100.00	45,713	100.00	23.07	24.33	
Spring	2004		110,827	100.00	28,289	100.00	25.53	26.85	
Spring	2005		155,627	100.00	19,515	100.00	12.54	20.38	
Spring	2006		???	???	???	???	???	???	
Spring	2007		280,372	100.00	77,119	100.00	27.51	20.02	

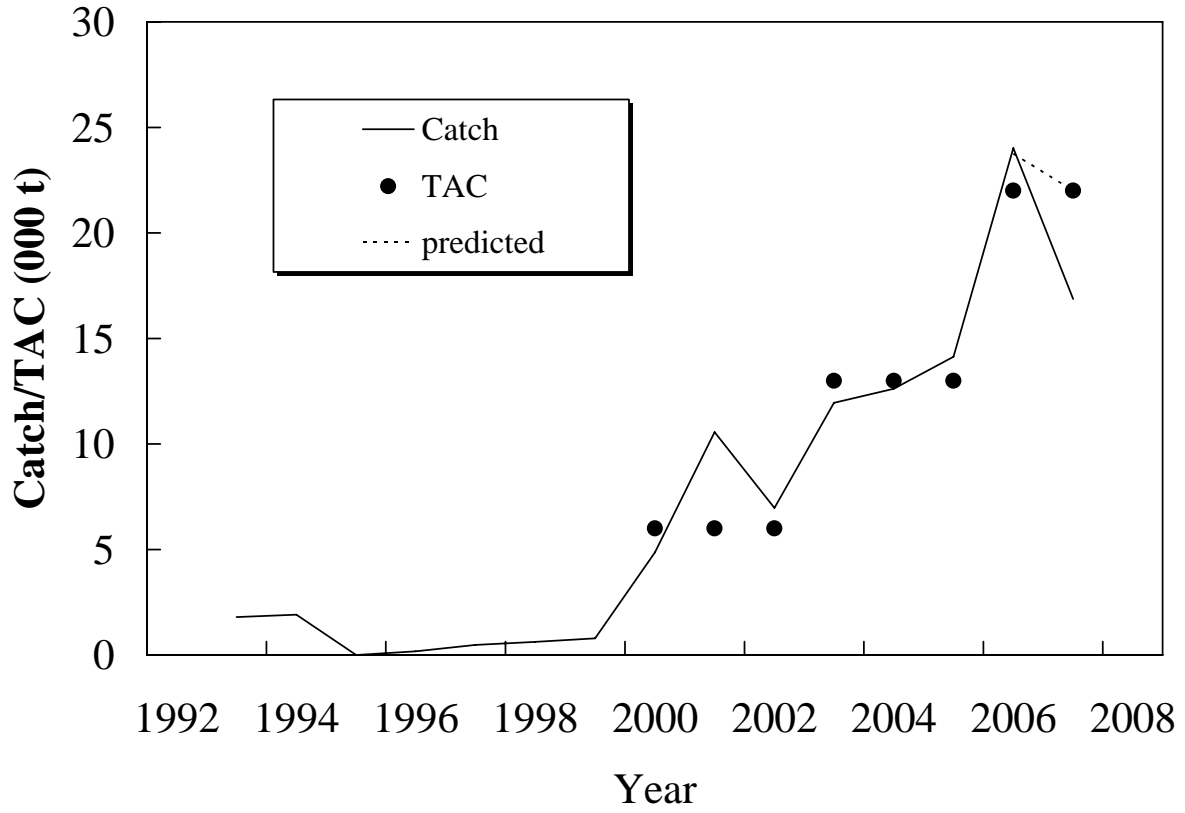


Figure 1. Trends in NAFO Div. 3LNO northern shrimp (*Pandalus borealis*) catch (t) and TAC over the period 1993-2007.

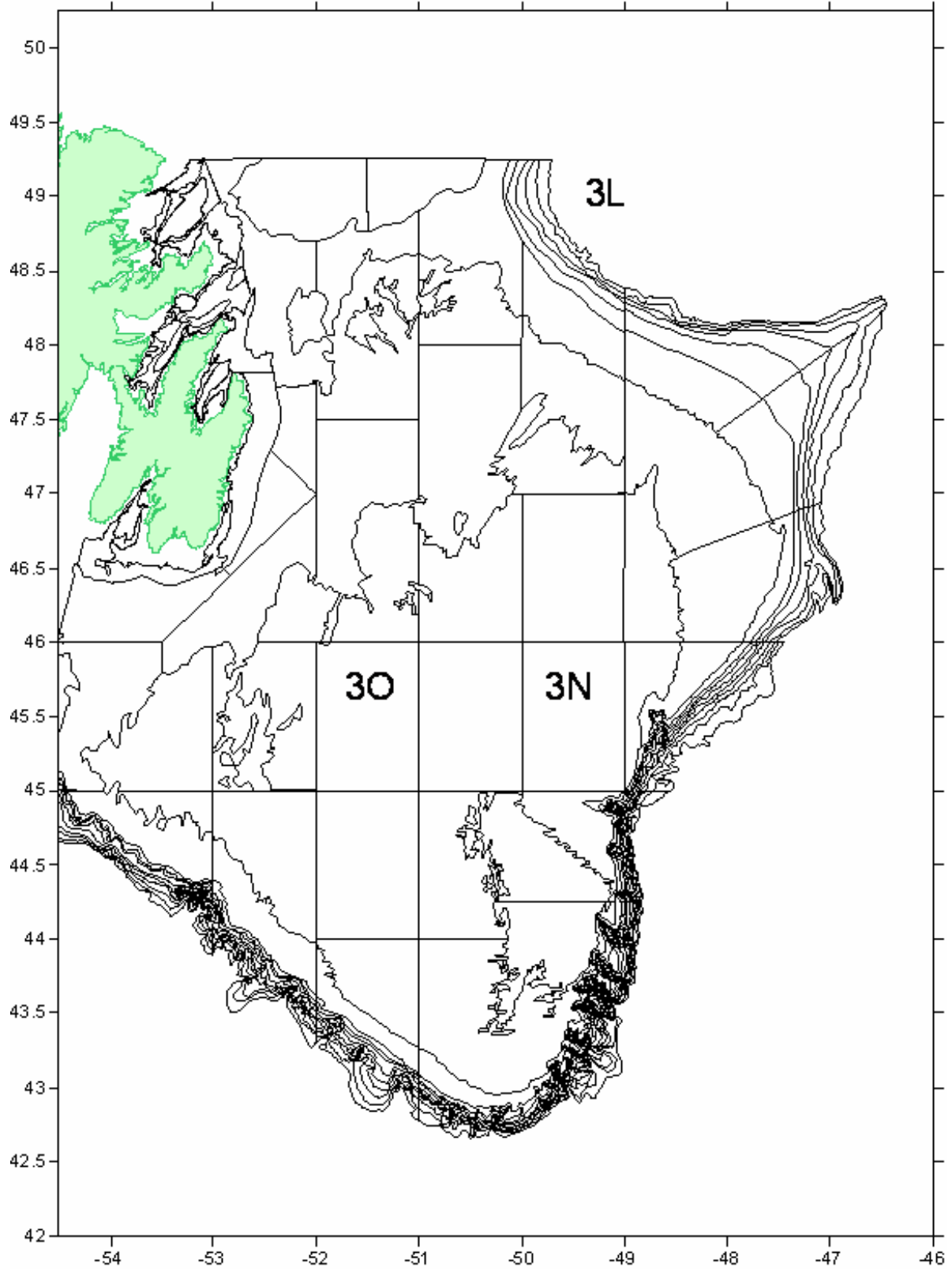


Figure 2. The NAFO 3LNO stratification scheme used in Canadian research bottom trawl survey set allocation.

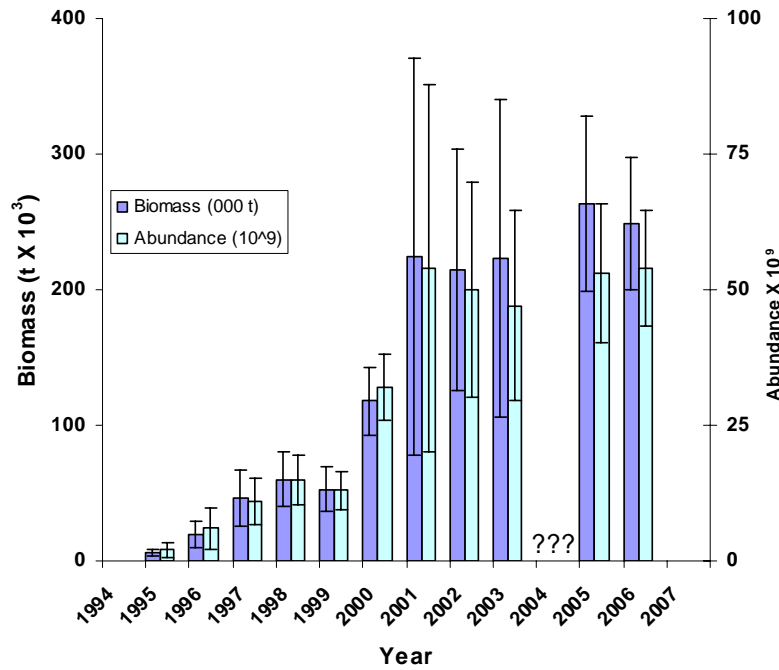


Figure 3. Autumn northern shrimp (*Pandalus borealis*) abundance and biomass estimates within NAFO Div. 3LNO. Data were from Canadian multi-species bottom trawl surveys using a Campelen 1800 trawl. (Standard 15 min. tows.)

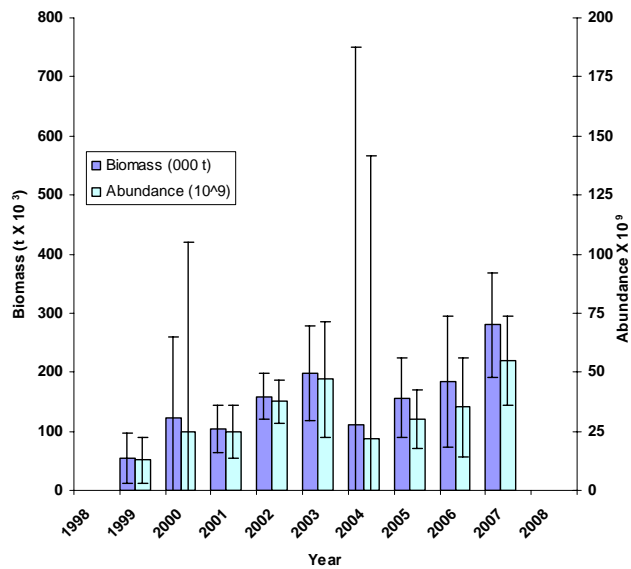


Figure 4. Spring northern shrimp (*Pandalus borealis*) abundance and biomass estimates within NAFO Div. 3LNO. Please note that due to operational problems, it was not possible to survey all of Div. 3NO during spring 2006. The indices for 2006 are for Div. 3L only. Data were from Canadian multi-species bottom trawl surveys using a Campelen 1800 trawl. (Standard 15 min. tows.)

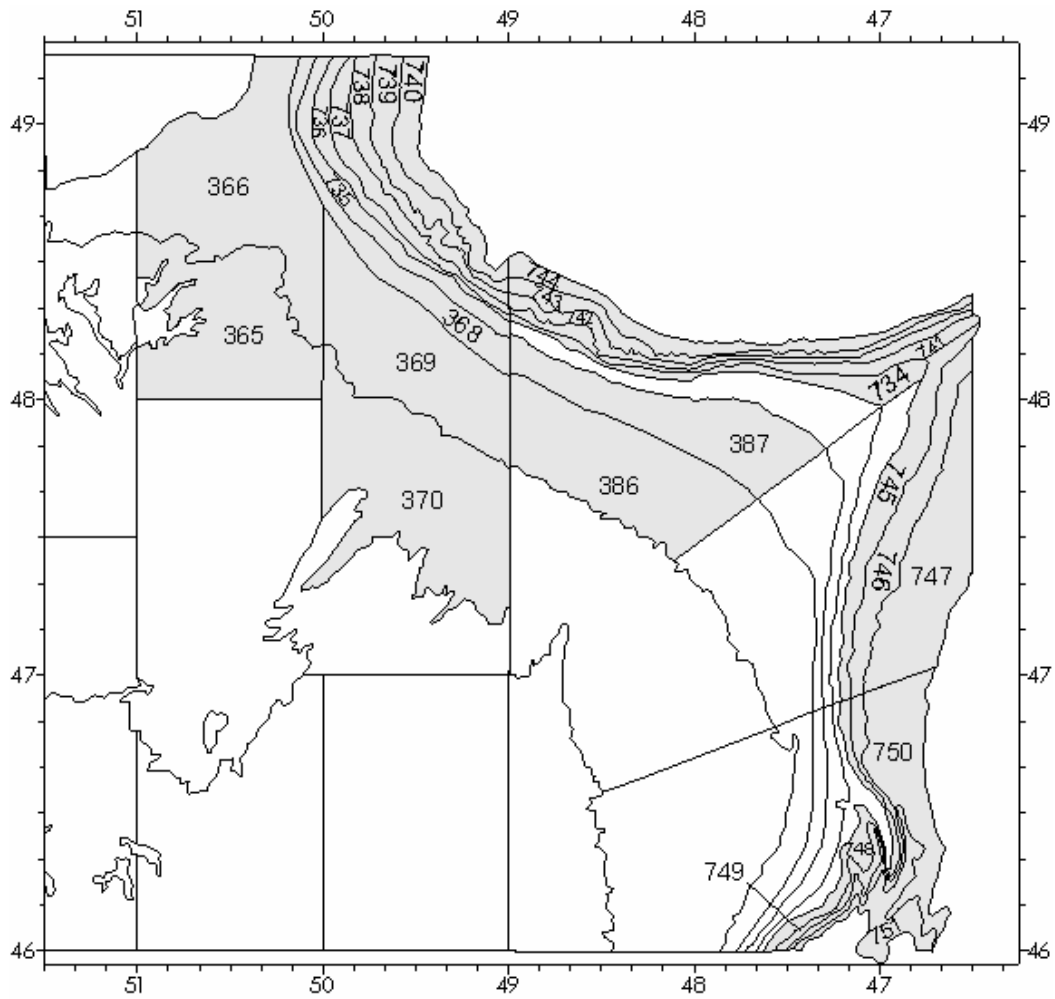


Figure 5. Strata in Div. 3L that were not surveyed (numbered and shaded area) during autumn of 2004.

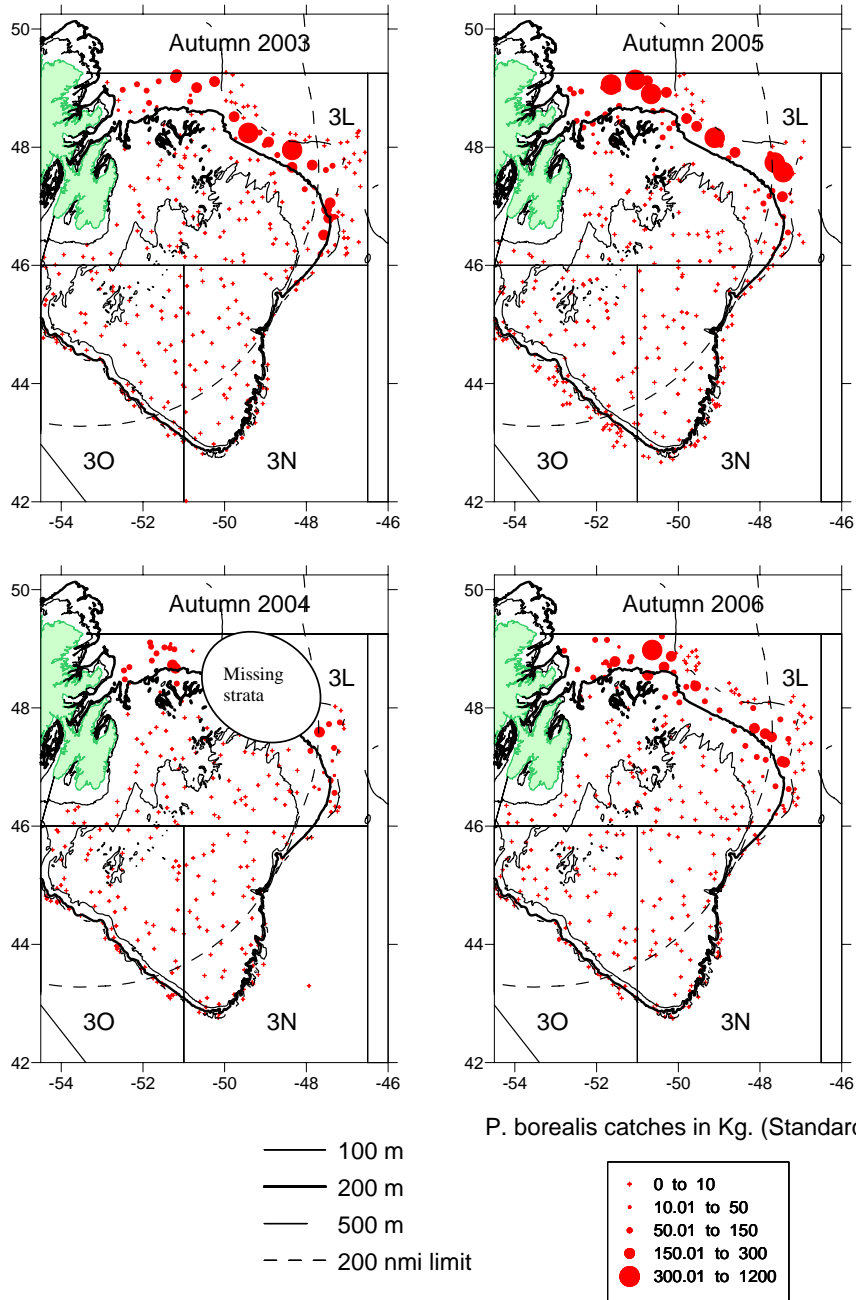


Figure 6. Distribution of NAFO Div. 3LNO northern shrimp (*Pandalus borealis*) catches kg/tow as obtained from autumn research bottom trawl surveys conducted over the period 2003-2006.

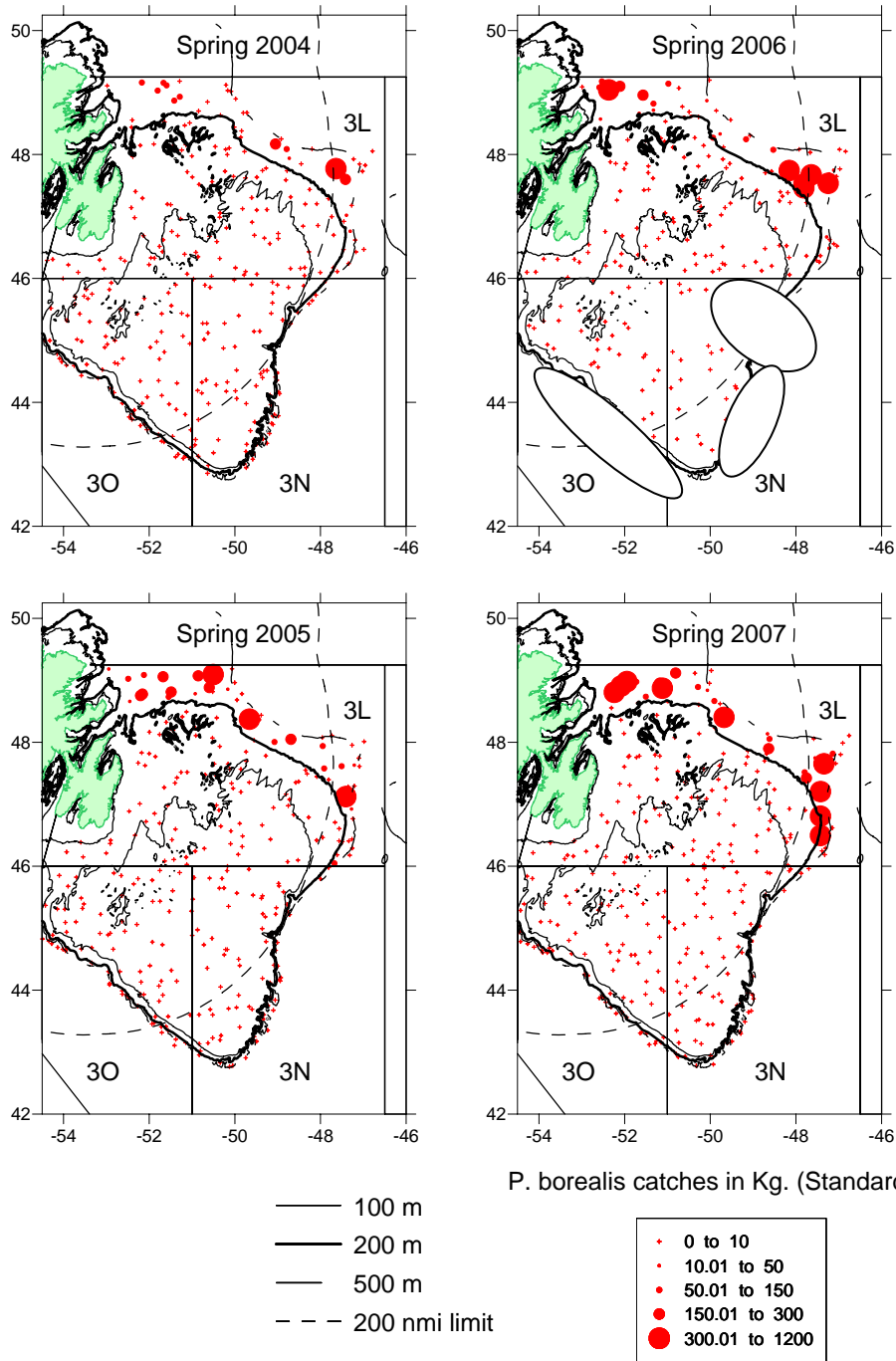


Figure 7. Distribution of NAFO Div. 3LNO northern shrimp (*Pandalus borealis*) catches kg/tow) as obtained from spring research bottom trawl surveys conducted over the period 2004-2007. Ellipses indicate strata not surveyed during spring 2006.