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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 2005, and management advice was provided for the years 2006 and 2007. The catch table (to September 2006) and biomass estimates (autumn 1995-spring 2006) are updated within this report. Preliminary data indicate that 14 068 tons of shrimp were taken against an annual TAC of 13 000 tons in 2005 while 18 953 tons were taken in 2006 against an annual TAC of 22 000 tons. The autumn 2005 biomass index was estimated to be 264 000 tons (95% C.I. = ±65 000 tons), the highest on record. The spring 2006 biomass index could not be estimated for the entire of NAFO Div. 3LNO because shallow water strata 373 and 383 and most deepwater strata within Div. 3NO (depths greater than 93 m) were not surveyed. However, the offshore strata within Div. 3L (depths to 754 m) were completely surveyed during the spring of 2006. Historically greater than 97% of the Div. 3LNO shrimp biomass had been attributed to these strata within NAFO Div. 3L. The spring 2006 3L biomass index was 185 000 tons (95% C.I. = ±67 000 tons), the second highest in the spring time series. However, indices derived from spring surveys are thought to be less precise because the confidence intervals are sometimes broad with negative lower confidence limits.

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 tons. Had this new method been used in 2003, it is likely that the advised TAC for 2005 would have been around 22 000 tons instead of the 13 000 tons 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 tons was in place for 3 years (1999-2001), however the TAC of 13 000 tons 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 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. During the November 2005 shrimp assessment, SC decided that this advice should extend through 2007, and that the advice would be reviewed in September 2006 (NAFO, 2005).

Catch trends

Catches increased dramatically since 1999, with the beginning of a regulated fishery. Since then, seventeen contracting nations have exercised their privileges to fish shrimp in Div. 3L (Table 1). Over the period 2001-2006, catches were 10 566, 6 977, 11 947, 12 620, 14 068 and 18 953 tons, respectively. As per NAFO agreements, Canadian vessels took most of the catch during each year. Canadian catches increased from 5 129 tons in 2001 to 15,707 tons in 2006. Fishing vessels from other nations took 5 505, 1 563, 1 939, 2 007, 2 892, and 3 246 tons of shrimp in each respective year since 2001. Table 1 provides a breakdown of catches by nation and year. Figure 1 indicates catches and TAC since 1992.

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 (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; 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).

Due to operational difficulties it was not possible to survey all of the strata within NAFO Div. 3LNO during autumn 2004 (Brodie, 2005). The deepwater strata (deeper than 731 m) within Div. 3LNO as well as several shallow water strata within Div. 3L were not surveyed. 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 (Table 2). Strata that were missed in Div. 3L (autumn 2004) are highlighted in Table 2 and Fig. 3.

Please note that all strata, within the NRA, that contained significant quantities of northern shrimp, in previous spring and autumn surveys, were surveyed during autumn 2004.

Analyses of the autumn 1995-2003 and 2005 survey data indicate that the 3L strata missed in 2004 (93-549 m) are important in determining the biomass indices. Typically these strata account for 25-61% of the 3L biomass (Table 2). Figures 4 and 5 confirm the importance of these strata and that catches, within these strata, vary both seasonally and annually. For these reasons, it was not appropriate to use a multiplicative model to estimate 3L biomass and abundance indices for the missing strata from the autumn 2004 survey. However, analyses conducted on strata that had been consistently fished each autumn since 1995 resulted in biomass indices of 96 926 tons (95% C.I. = ±21 744 tons) and 125 300 tons (95% C.I. = ±52 693 tons) during autumn 2004 and 2005, respectively, the second the third highest values within this partial index time series. It should be noted that the confidence intervals of the biomass estimates from strata completed in these autumn surveys are relatively tight, indicating relatively low variances between catches. Further, the lower confidence limit of the partial autumn 2004 and 2005 surveys are above the lower confidence limits from the previous four autumn surveys (i.e. from the total 3L indices). 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 previous four years and that the biomass within these strata has been increasing.

All strata within 3LNO (<731 m) were surveyed during autumn 2005. The biomass index from this survey was 263 815 tons (95% C.I. = ±64 641 tons), the highest biomass index in the autumn time series (Fig. 6). Tables 2-5 provide the strata by strata break down of biomass by NAFO Division and year.

Tables 6-8 summarize the biomass indices from spring surveys broken down by NAFO Division and year. Tables 9 and 10 provide the overall summaries of biomass and abundance indices by year for combined Divisions.

Due to operational difficulties it was not possible to survey all of the strata within NAFO Div. 3NO during spring 2006. Strata 373 and 383 as well as most strata deeper than 92 m were not surveyed (Fig. 5). Analyses from the spring 1999-2005 surveys indicated that greater than 99% and 85% of the 3N and 3O biomass respectively may be attributed to the strata that were missed (Tables 7 and 8). Therefore spring 2006 biomass or abundance indices were not determined Div. 3NO. Historically, at least 97% of the 3LNO biomass is found within Div. 3L (Tables 6, 7, 8, 11 and 12). The spring 2006 Div. 3L biomass index was 185 156 tons (95% C.I. = ±115 048 tons), the second highest in the spring time series (Table 6). However, as noted earlier, the spring indices are thought to be less precise because the 95% confidence intervals are sometimes broad with negative lower confidence interval values (Tables 6-10; Fig. 7).

Conclusions

The autumn 2005 NAFO Div. 3LNO biomass index was 263 815 tons, the highest in the survey time series. Due to operational problems it was not possible to survey strata 373 and 383 and most strata deeper than 92 m in NAFO Div. 3NO during spring 2006. At least 85% of the biomass within NAFO Div. 3NO is found within these missed strata. Therefore it was not possible to estimate biomass indices for the entire of Div. 3LNO from the spring 2006 survey. At least 97% of the 3LNO biomass is found within NAFO Div. 3L. The spring 2006 Div. 3L biomass index was 185 156 tons (95% C.I. = ±115 048 tons), the second highest in the spring 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 tons in 2007.

Acknowledgements

We would like to thank Mr. Gus Cossitt for producing Fig. 3, which indicates the 3L strata missed during the Canadian autumn 2004 research survey.

References

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

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007
Canada	78[1]	4,250[2]	5,129[2]	5,414[2]	10,008[2]	10,613[2]	11,176[2]	15,707[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]	1636[1]	
Faroe Islands	706[1]	42[1]	2,052[4]	620[5]		614[1]	1044[1]	834[1]	
France (SPM)		67[1]		36[3]			147[1]		
Greenland		34[1]			672[8]	294[1]	302[1]	324[8]	
Iceland		97[1]	55[7]	55[7]	133[7]	105[7]	71[1]	85[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]		
Poland		40[1]	54[1]			144[1]			
Portugal			61[5]						
Russia		67[1]	67[1]	67[3]			144[1]	248[1]	
Spain	11[1]		699[4]						
Ukraine			57[1]		144[1]	144[1]		119[10]	
USA				69[3]	144[1]		137[1]		
GRAND TOTAL	795	4,869	10,566	6,977	11,947	12,620	14,068	18,953	
TAC (tons)		6,000	6,000	6,000	13,000	13,000	13,000	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 Greenlandic logbook dataset.
7 Icelandic logbook dataset.
8 Norwegian logbook dataset.
9 Ukranian logbook dataset.

Table 2. Biomass estimates (tons) of northern shrimp (*Pandalus borealis*) Canadian autumn multi-species bottom trawl surveys in Div. 3L using a Campelen 1800 shrimp trawl during 1995 - 2005. 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 (Nmi^2)	Stratum	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
57 - 92	2071	350	0	0	1	3	1	1	2	31	38	4	2
	1780	363	0	1	1	2	0	7	19	18	622	1	0
	1121	371	0	0	1	0	0	7	5	10	23	0	3
	2460	372	0	3	12	6	1	7	7	106	166	8	0
	1120	384	0	2	1	1	2	12	5	489	38	6	0
	465	785	.	.	.	.	.	.	.	.	.	.	.
93 - 183	1519	328	32	57	92	15	41	12	14	28	73	38	24
	1574	341	0	81	41	4	18	27	21	52	58	37	1
	585	342	0	1	0	25	4	444	4	35	48	1	0
	525	343	0	1	1	5	1	5	4	5	4	19	24
	2120	348	4	18	20	56	291	361	435	675	195	5,309	6,419
	2114	349	0	3	6	16	12	30	40	466	298	37	38
	2817	364	1	3	44	14	5	120	190	316	92	26	748
	1041	365	1	3	105	179	63	.	3,385	3,405	99	.	10,161
	1320	370	2	1	57	712	134	84	3,011	129	103	.	12
	2356	385	1	9	1,471	205	1,274	2,078	4,307	3,629	7,381	5,367	8,411
	1481	390	0	0	10	6	12	152	2,498	3,520	7,928	1,330	2,555
184 - 274	1582	344	8	29	104	2,858	5,068	3,192	1,971	7,549	2,084	14,774	15,440
	983	347	21	45	25	4,850	1,547	7,372	10,450	8,516	1,743	21,775	13,749
	1394	366	674	560	11,878	5,425	7,673	24,193	25,316	27,047	22,959	.	34,421
	961	369	23	182	1,843	6,319	3,939	3,353	10,842	6,694	21,994	.	28,648
	983	386	18	304	9,299	5,981	7,884	6,161	15,245	25,131	22,962	.	21,600
	821	389	42	2,007	1,630	6,917	10,065	25,088	32,443	34,321	17,502	11,248	12,341
	282	391	0	391	236	166	246	3,643	353	106	7,838	2,312	2,072
	164	795	.	.	.	.	.	.	.	.	.	.	.
	72	789	.	.	.	.	.	.	.	.	.	.	.
	227	791	.	.	.	.	.	.	.	.	.	.	.
	100	798	.	.	.	.	.	.	.	.	.	.	.
275 - 366	1432	345	723	2,030	5,976	9,954	4,361	18,288	17,904	31,885	16,945	20,045	27,257
	865	346	1,802	7,069	5,608	3,510	5,328	6,251	18,983	35,886	29,796	11,056	35,328
	334	368	77	1,232	483	358	101	27	16,985	457	10,162	.	11,151
	718	387	1,199	2,393	4,258	7,197	3,908	12,013	43,798	11,890	44,725	.	23,107
	361	388	363	1,599	2,117	1,485	570	4,326	13,612	7,204	3,747	.	8,845
	145	392	210	324	73	187	123	387	320	44	881	906	694
	175	796	.	.	.	.	.	.	.	.	.	.	.
	81	800	.	.	.	.	.	.	.	.	.	.	.
367 - 549	186	729	0	3	2	0	51	1	603	0	15	1	1
	216	731	0	.	16	11	14	112	92	772	0	1,496	130
	468	733	8	212	170	12	66	0	243	4	0	262	32
	272	735	134	2	166	2	57	119	8	12	147	.	57
	50	792	.	.	.	.	.	.	.	.	.	.	.
550 - 731	170	730	0	1	0	0	0	0	1	0	0	0	29
	231	732	12	0	0	0	1	0	2	9	0	866	4
	228	734	0	0	1	0	0	0	1	9	0	.	1
	175	736	1	0	8	2	2	27	13	0	18	.	1
732 - 914	227	737	0	0	0	0	0	1	0	0	0	.	1
	223	741	.	0	0	0	0	0	0	0	21	.	.
	348	745	.	0	0	0	0	0	10	0	8	.	.
	159	748	.	0	0	0	0	1	3	0	1	.	.
915 -1097	221	738	0	0	0	0	0	0	0	0	0	.	.
	206	742	.	0	0	0	0	0	0	0	0	.	.
	392	746	.	0	0	0	0	0	4	0	1	.	.
	126	749	.	0	0	0	.	0	0	0	0	.	.
1098 -1280	254	739	.	0	0	0	0	0	0	0	0	.	.
	211	743	.	0	0	0	0	0	0	0	0	.	.
	724	747	.	0	0	0	0	0	0	1	0	.	.
	556	750	.	0	0	0	0	0	0	1	0	.	.
1281 -1463	264	740	.	0	0	0	0	0	0	0	0	.	.
	280	744	.	0	0	0	.	0	0	0	0	.	.
	229	751	.	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
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
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
% 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

Table 3. Biomass indices (tons) of northern shrimp (*Pandalus borealis*) from Canadian autumn research surveys in Division 3L using a Campelen 1800 shrimp trawl during 1995 - 2005. The analyses below are for strata sampled in all years. (standard 15 minute tows).

Depth Range (m)	Area (Nmi2)	Stratum	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
57 - 92	2071	350	0	0	1	3	1	1	2	31	38	4	2
	1780	363	0	1	1	2	0	7	19	18	622	1	0
	1121	371	0	0	1	0	0	7	5	10	23	0	3
	2460	372	0	3	12	6	1	7	7	106	166	8	0
	1120	384	0	2	1	1	2	12	5	489	38	6	0
93 - 183	1519	328	32	57	92	15	41	12	14	28	73	38	24
	1574	341	0	81	41	4	18	27	21	52	58	37	1
	585	342	0	1	0	25	4	444	4	35	48	1	0
	525	343	0	1	1	5	1	5	4	5	4	19	24
	2120	348	4	18	20	56	291	361	435	675	195	5,309	6,419
	2114	349	0	3	6	16	12	30	40	466	298	37	38
	2817	364	1	3	44	14	5	120	190	316	92	26	748
	2356	385	1	9	1,471	205	1,274	2,078	4,307	3,629	7,381	5,367	8,411
	1481	390	0	0	10	6	12	152	2,498	3,520	7,928	1,330	2,555
184 - 274	1582	344	9	29	104	2,858	5,068	3,192	1,971	7,549	2,084	14,774	15,440
	983	347	21	45	25	4,850	1,547	7,372	10,450	8,516	1,743	21,775	13,749
	821	389	42	2,007	1,630	6,917	10,065	25,088	32,443	34,321	17,502	11,248	12,341
	282	391	0	391	236	166	246	3,643	353	106	7,838	2,312	2,072
275 - 366	1432	345	723	2,030	5,976	9,954	4,361	18,288	17,904	31,885	16,945	20,045	27,257
	865	346	1,802	7,069	5,608	3,510	5,328	6,251	18,983	35,886	29,796	11,056	35,328
	145	392	210	324	73	187	123	387	320	44	881	906	694
367 - 549	186	729	0	3	2	0	51	1	603	0	15	1	1
	216	731	0 .		16	11	14	112	92	772	0	1,496	130
	468	733	8	212	170	12	66	0	243	4	0	262	32
550 - 731	170	730	0	1	0	0	0	0	1	0	0	0	29
	231	732	12	0	0	0	1	0	2	9	0	866	4
Biomass estimate			2,866	12,290	15,543	28,824	28,533	67,597	90,917	128,472	93,766	96,926	125,300
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
Lower 95% CL			506	-467	10,427	8,099	15,821	42,907	51,298	36,092	56,778	75,182	72,608

Table 4. Biomass estimates (tons) 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 (Nmi²)	Stratum	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
<=56	1593	375	0	0	1	0	1	0	1	0	0	0	0
	1499	376	0	0	0	0	0	0	0	0	0	0	1
57 - 92	2992	360	0	11	2	0	1	1	1	2	1	0	1
	1853	361	0	0	0	0	0	0	0	0	0	1	0
	2520	362	4	1	2	1	1	5	11	22	24	2	0
	2520	373	0	0	2	6	2	0	1	67	17	2	8
	931	374	33	1	0	1	0	0	0	2	23	0	0
	674	383	0	0	0	5	1	8	2	114	10	6	0
93 - 183	421	359	0	0	0	0	0	0	0	2	0	0	10
	100	377	0	2	44	119	0	5	1	0	487	10	49
	647	382	0	0	1	0	0	4	7	1,951	28	7	7
184 - 274	225	358	0	29	2	41	3	10	173	113	276	120	20
	139	378	11	26	195	353	8	16	111	1,389	97	556	18
	182	381	34	721	121	2,630	93	39	24	44	1,341	9	29
275 - 366	164	357	2	0	6	12	.	1	0	119	222	4	198
	106	379	0	110	1	1	1	19	404	424	225	619	31
	116	380	0	35	33	69	89	37	19	103	10	85	14
367 - 549	155	723	0	0	0	19	1	2	1	41	4	0	16
	105	725	449	2	10	1	52	70	9	12	12	.	10
	160	727	0	577	7	5	8	17	18	12	5	1	0
550 - 731	124	724	0	0	0	0	0	11	3	11	.	0	0
	72	726	0	1	0	91	1	4	36	3	1	1	2
	156	728	0	0	1	6	11	2	3	2	4	0	0
732 - 914	134	752	.	.	.	0	.	0	0	0	.	.	.
	106	756	.	.	.	0	.	16	10	6	.	.	5
	154	760	.	.	.	0	.	1	0	2	.	.	0
915 -1097	138	753	.	.	.	0	.	0	0	0	.	.	.
	102	757	.	.	.	0	.	1	1	2	.	.	0
	171	761	.	.	.	0	.	0	0	0	.	.	0
1098 -1280	180	754	.	.	.	0	.	0	0	0	.	.	
	99	758	.	.	.	0	.	0	0	0	.	.	0
	212	762	.	.	.	.	.	0	0	0	.	.	0
1281 -1463	385	755	.	.	.	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
Upper 95% CL			6,272	13,314	2,694	36,474	731	1,175	5,244	35,204	18,695	2,536	3,033
Lower 95% CL			-5,206	-10,285	-1,840	-29,754	-188	-635	-3,573	-26,316	-13,125	309	-2,186

Table 5. Biomass estimates (tons) of northern shrimp (*Pandalus borealis*) Canadian autumn multi-species bottom trawl surveys in Div. 3O 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
57 - 92	2089	330	0	1	0	0	0	0	0	1	0	2	0
	456	331	0	0	0	0	0	0	0	0	0	0	0
	1898	338	0	1	2	2	0	0	0	2	2	3	0
	1716	340	0	0	0	0	1	0	0	3	0	3	0
	2520	351	0	3	2	11	1	3	2	46	1	5	9
	2580	352	0	0	0	1	0	0	0	3	1	1	1
	1282	353	0	1	0	4	0	0	0	0	0	3	0
93 - 183	1721	329	0	0	1	1	1	0	0	2	7	4	0
	1047	332	1	1	0	3	1	0	0	0	18	6	1
	948	337	9	0	1	4	0	0	0	1	12	5	6
	585	339	0	0	1	1	.	0	0	2	2	1	0
	474	354	0	1	5	5	1	0	1	21	0	4	54
184 - 274	147	333	20	.	2	16	0	3	3	0	4	13	11
	121	336	0	1	0	4	0	0	0	0	11	11	0
	103	355	0	0	2	16	1	0	1	25	9	12	3
275 - 366	96	334	0	.	0	1	0	0	0	1	1	1	0
	58	335	0	0	0	0	0	0	0	0	0	0	0
	61	356	0	0	0	0	0	0	1	1	1	0	0
367 - 549	166	717	0	.	0	0	0	0	0	1	1	0	0
	76	719	0	0	0	0	0	0	0	0	0	0	0
	76	721	0	0	0	0	0	0	1	3	0	0	0
550 - 731	134	718	0	.	0	0	0	0	0	0	1	0	0
	105	720	0	0	.	0	0	0	0	0	1	0	0
	93	722	0	0	0	0	2	0	0	0	1	0	0
732 - 914	105	764	.	.	.	0	.	0	0	0	.	.	0
	99	768	.	.	.	0	.	0	0	0	.	.	0
	135	772	.	.	.	0	.	0	.	0	.	.	0
915 -1097	124	765	.	.	.	0	.	0	0	0	.	.	0
	138	769	.	.	.	0	.	0	0	0	.	.	0
	128	773	.	.	.	0	.	0	0	0	.	.	0
1098 -1280	144	766	.	.	.	.	.	0	0	0	.	.	0
	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
Upper 95% CL			280	15	86	301	17	51	21	202	112	132	435
Lower 95% CL			-219	2	-52	-163	1	-36	-1	24	34	22	-266

Table 6. Biomass estimates (tons) of northern shrimp (*Pandalus borealis*) Canadian spring multi-species bottom trawl surveys in Div. 3L using a Campelen 1800 shrimp trawl during 1995 - 2005. 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
30 - 56	268	784	.	.	.	.	.	.	.	.
57 - 92	2071	350	0	0	0	0	5	0	0	0
	1780	363	0	0	0	0	6	0	0	0
	1121	371	0	0	0	0	0	0	0	0
	2460	372	0	0	0	0	0	0	0	0
	1120	384	1	0	0	3	0	0	0	0
	465	785	.	.	.	.	.	.	.	.
93 - 183	1519	328	0	12	0	2	8	21	14	10
	1574	341	2	5	1	3	4	47	1	0
	585	342	3	1	0	8	1	5	0	0
	525	343	3	0	6	0	3	4	2	1
	2120	348	5	25	8	10	13	11	14	13
	2114	349	10	4	1	4	8	8	0	8
	2817	364	1	4	8	11	6	0	1	0
	1041	365	0	1	8	4	7	0	3	25
	1320	370	1	0	0	0	0	0	0	0
	2356	385	1	0	7	21	1	10	1	1
	1481	390	3	1	2	1	1	9	23	0
	84	786	.	.	.	.	.	.	.	.
	613	787	.	.	.	.	.	.	.	.
	261	788	.	.	.	.	.	.	.	.
	89	790	.	.	.	.	.	.	.	.
	72	793	.	.	.	.	.	.	.	.
	216	794	.	.	.	.	.	.	.	.
	98	797	.	.	.	.	.	.	.	.
	72	799	.	.	.	.	.	.	.	.
184 - 274	1582	344	38	12	56	189	955	13	3,245	1,018
	983	347	16	0	1,306	135	24	139	7,126	3,011
	1394	366	788	19,089	12,113	36,633	7,565	443	13,600	3,724
	961	369	7	1,581	0	3,223	38,854	415	20,385	4,694
	983	386	2,264	8,761	1,738	33	489	2,186	4,253	28,212
	821	389	10,135	34,172	1,000	5,226	15,643	1,272	15,146	53,698
	282	391	0	0	102	0	3,248	41	127	116
	164	795	.	.	.	.	.	.	.	.
184 - 366	72	789	.	.	.	.	.	.	.	.
	227	791	.	.	.	.	.	.	.	.
	100	798	.	.	.	.	.	.	.	.
275 - 366	1432	345	6,467	14,106	33,546	10,492	40,581	21,182	34,256	43,685
	865	346	13,287	15,471	20,814	27,134	14,860	11,337	37,086	8,010
	334	368	3,752	9,945	1,052	3,458	15,690	6,079	761	3,089
	718	387	13,342	1,388	19,912	37,183	40,037	61,985	14,469	24,907
	361	388	3,403	13,706	9,047	30,777	8,418	4,197	2,825	9,272
	145	392	69	163	772	14	1,064	143	737	187
	175	796	.	.	.	.	.	.	.	.
	81	800	.	.	.	.	.	.	.	.
367 - 549	186	729	0	7	16	2	339	3	116	331
	216	731	111	461	687	112	4,562	25	585	877
	468	733	118	425	176	216	2,703	14	124	196
	272	735	19	130	17	40	3	2	69	68
	50	792	.	.	.	.	.	.	.	.
550 - 731	170	730	0	1	0	0	1	0	0	0
	231	732	81	47	12	111	10	0	0	3
	228	734	4	0	79	7	1	0	0	2
	175	736	3	3	8	6	10	0	0	0
Biomass estimate			53,934	119,521	102,493	155,061	195,121	109,589	154,970	185,156
Upper 95% CL			96,644	257,005	142,700	193,642	275,265	750,138	222,092	300,204
Lower 95% CL			11,223	-17,963	62,286	116,480	114,977	-530,958	87,848	70,109

Table 7. Biomass estimates (tons) of northern shrimp (*Pandalus borealis*) Canadian spring multi-species bottom trawl surveys in Div. 3N using a Campelen 1800 shrimp trawl during 1995 - 2005. 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
<=56	1593	375	0	0	0	0	0	0	0	0
	1499	376	0	0	0	5	0	0	0	0
57 - 92	2992	360	0	0	0	0	1	0	0	0
	1853	361	0	0	0	0	0	0	0	0
	2520	362	0	0	0	0	24	0	0	0
	2520	373	2	0	1	2	17	1	0	.
	931	374	0	0	0	0	23	0	0	0
	674	383	0	0	1	0	10	1	0	.
93 - 183	421	359	1	0	1	0	0	0	0	.
	100	377	100	0	0	0	487	1	1	.
	647	382	0	1	0	2	28	0	4	.
184 - 274	225	358	8	0	0	0	276	200	4	.
	139	378	171	35	2	68	97	1	4	.
	182	381	52	284	2	110	1,341	366	28	.
275 - 366	164	357	727	0	3	0	222	128	0	.
	106	379	165	1,828	4	108	225	11	106	.
	116	380	49	57	37	4,044	10	0	35	.
367 - 549	155	723	0	1	0	14	4	0	0	.
	105	725	0	9	3	0	12	0	213	.
	160	727	74	31	1	6	5	387	131	.
550 - 731	124	724	0	0	0	0	.	1	0	.
	72	726	0	0	0	1	1	0	0	.
	156	728	0	1	0	32	4	.	4	.
Biomass estimate			1,349	2,248	53	4,395	2,852	1,098	530	?
Upper 95% CL			11,209	24,096	277	54,237	26,147	3,599	3,343	?
Lower 95% CL			-8,511	-19,600	-171	-45,448	-20,442	-1,402	-2,283	?
% of 3N biomass index within the missing strata			99.75	99.97	99.42	99.82	95.40	99.90	99.86	?

Table 8. Biomass estimates (tons) of northern shrimp (*Pandalus borealis*) Canadian spring multi-species bottom trawl surveys in Div. 3O using a Campelen 1800 shrimp trawl during 1995 - 2005. 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
57 - 92	2089	330	0	0	1	0	2	0	1	0
57 - 92	456	331	0	0	0	0	0	0	0	.
57 - 92	1898	338	0	0	0	0	4	0	0	0
57 - 92	1716	340	0	0	0	2	4	9	0	0
57 - 92	2520	351	0	0	0	0	2	0	0	0
57 - 92	2580	352	0	0	0	3	2	0	0	0
57 - 92	1282	353	0	0	0	0	0	0	0	0
93 - 183	1721	329	1	1	6	0	13	3	1	.
93 - 183	1047	332	9	0	0	0	8	33	18	.
93 - 183	948	337	0	0	0	1	141	0	11	.
93 - 183	585	339	2	0	7	1	7	33	4	0
93 - 183	474	354	0	0	0	0	0	0	16	.
184 - 274	147	333	5	0	0	5	3	3	65	.
184 - 274	121	336	6	7	1	0	3	0	0	.
184 - 274	103	355	0	0	0	0	3	9	11	.
275 - 366	96	334	8	26	0	0	1	46	0	.
275 - 366	58	335	0	3	0	0	0	0	0	.
275 - 366	61	356	0	0	0	0	0	0	0	.
367 - 549	166	717	3	0	0	6	3	0	0	.
367 - 549	76	719	0	0	0	11	0	0	0	.
367 - 549	76	721	0	1	2	6	0	1	0	.
550 - 731	134	718	0	0	0	0	0	0	0	.
550 - 731	105	720	0	0	0	0	0	0	0	.
550 - 731	93	722	0	7	0	0	0	0	0	.
Biomass estimate			34	46	20	35	196	138	127	?
Upper 95% CL			63	399	99	95	536	367	1,036	?
Lower 95% CL			5	-307	-60	-25	-145	-90	-782	?
% of 3O biomass index within the missing strata			98.91	99.96	85.15	85.26	92.73	93.47	99.32	

Table 9 Northern shrimp stock size estimates in NAFO divisions 3LNO from annual autumn Canadian multi-species bottom surveys, 1995 - 2005. Offshore strata only. (standard 15 min. tows) Please note autumn 2004 indices not determined due to missing strata.

	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
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

Table 10 Northern shrimp stock size estimates in NAFO divisions 3LNO from annual spring Canadian multi-species bottom surveys, 1999 - 2006. Offshore strata only. (standard 15 min. tows) Please note that strata deeper than 93 m were not surveyed in 3NO during spring 2006. Historically > 97% of the biomass is attributed to 3L therefore the spring 2006 biomass and abundance indices are for 3L

	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	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	70,108	185,156	300,204	14,330	36,124	57,918	195

Table 11 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.)

			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	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	15.87
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	91.10
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	23.41
	all divisions							
Autumn	1995		5,921		1,537		25.96	25.96
Autumn	1996		20,089		5,862		29.18	27.57
Autumn	1997		46,202		5,509		11.92	22.35
Autumn	1998		59,914		11,508		19.21	20.10
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
Autumn	2003		223,568		47,813		21.39	21.08
Autumn	2004		???		???		???	???
Autumn	2005		263,815		29,842		11.31	16.35

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.)

			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	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		
Spring	2006	3L	185,156	???				
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	
Spring	2006	3N	???	???	???			
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	
Spring	2006	3O	???	???	???			
	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		
Spring	2006		???					

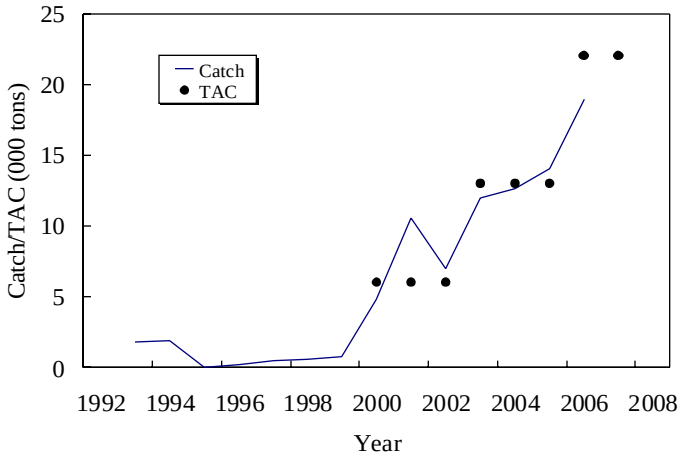

Fig. 1. Trends in NAFO Div. 3LNO northern shrimp (*Pandalus borealis*) catch and TAC over the period 1993-2006.

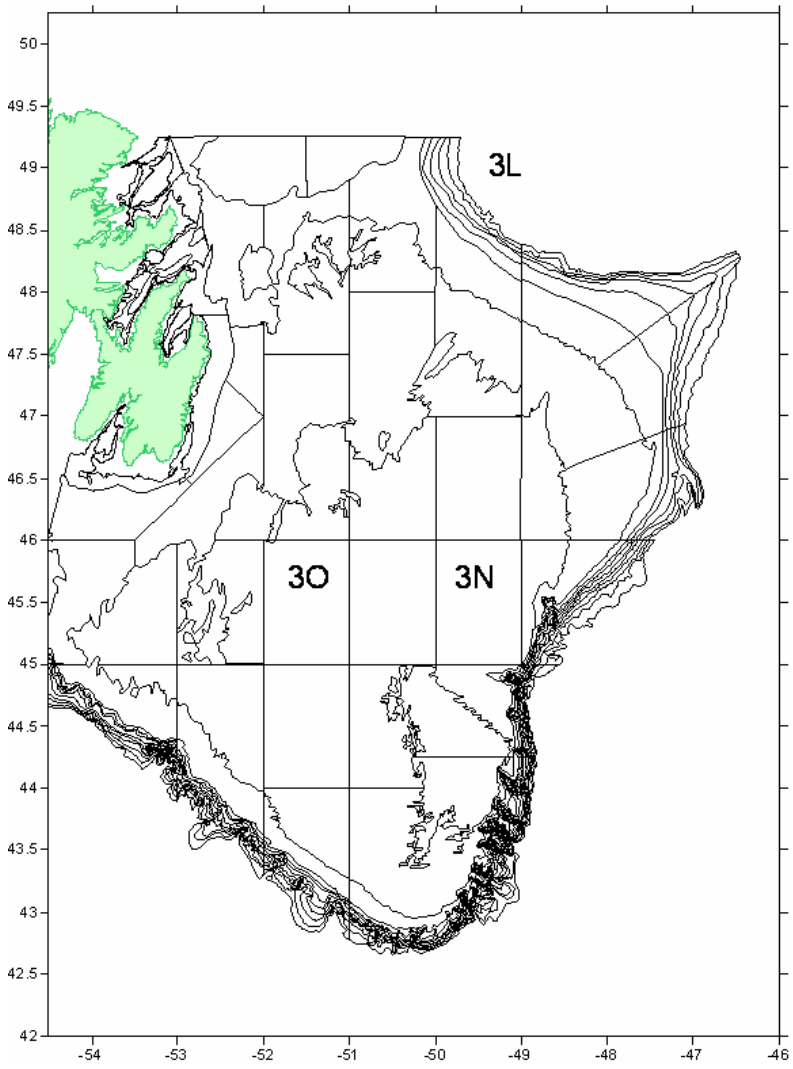

Fig. 2. The NAFO 3LNO stratification scheme used in Canadian research bottom trawl survey set allocation.

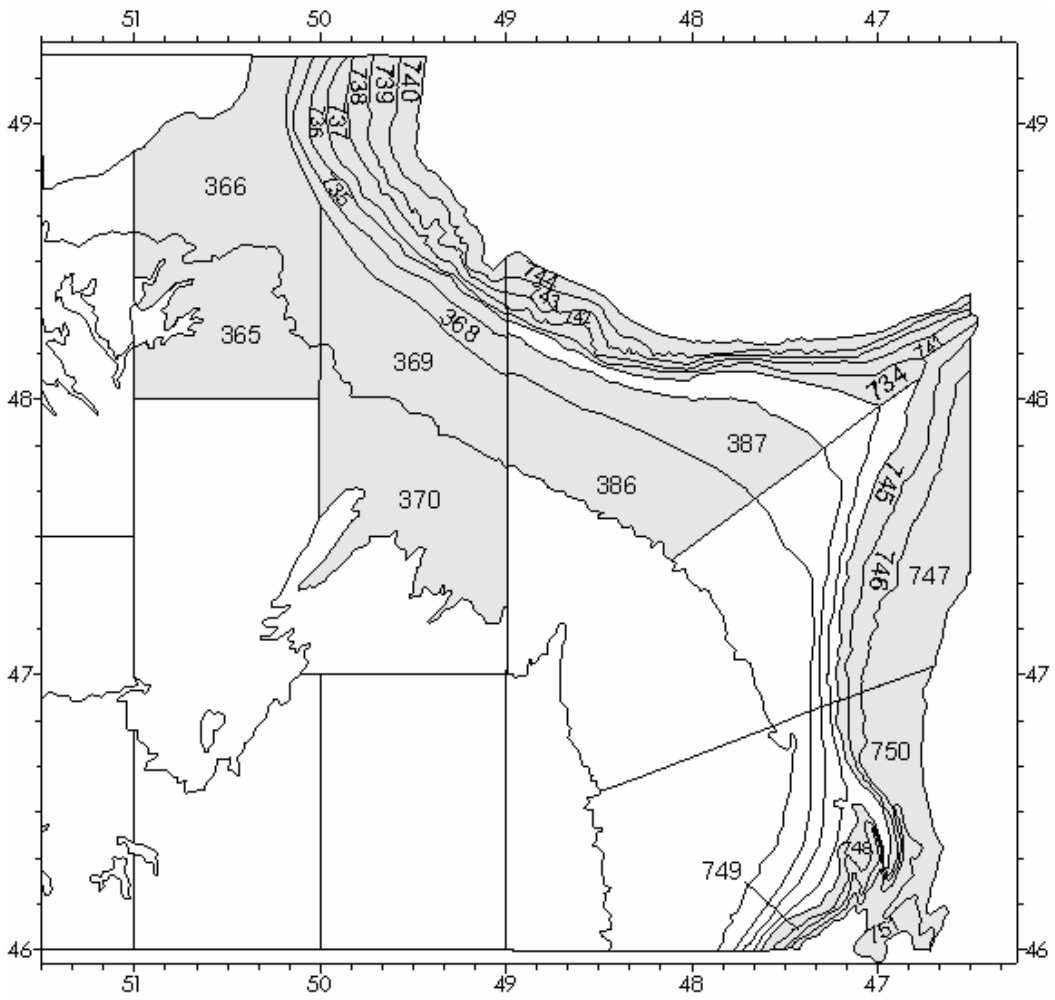

Fig. 3. Strata in Div. 3L that were not surveyed (numbered and shaded area) during autumn of 2004.

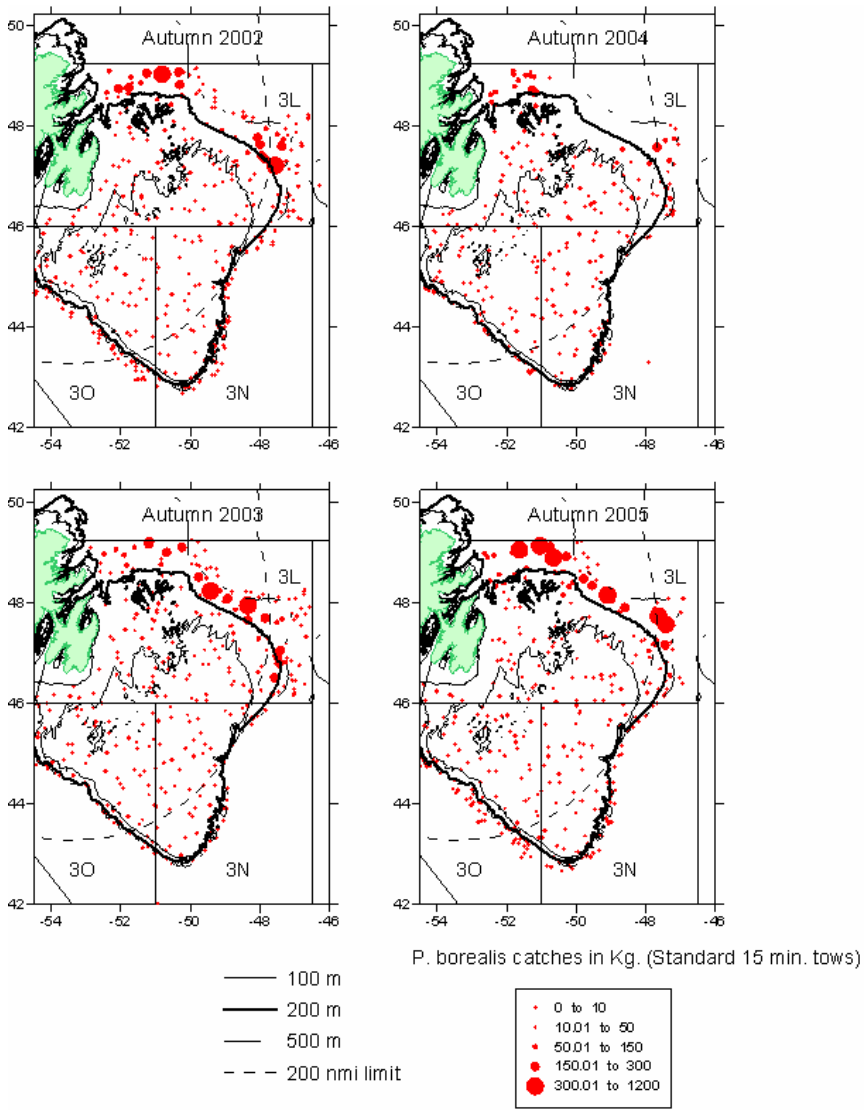

Fig. 4. Distribution of NAFO Div. 3LNO northern shrimp (*Pandalus borealis*) catches kg/tow) as obtained from autumn research bottom trawl surveys conducted over the period 2002-2005.

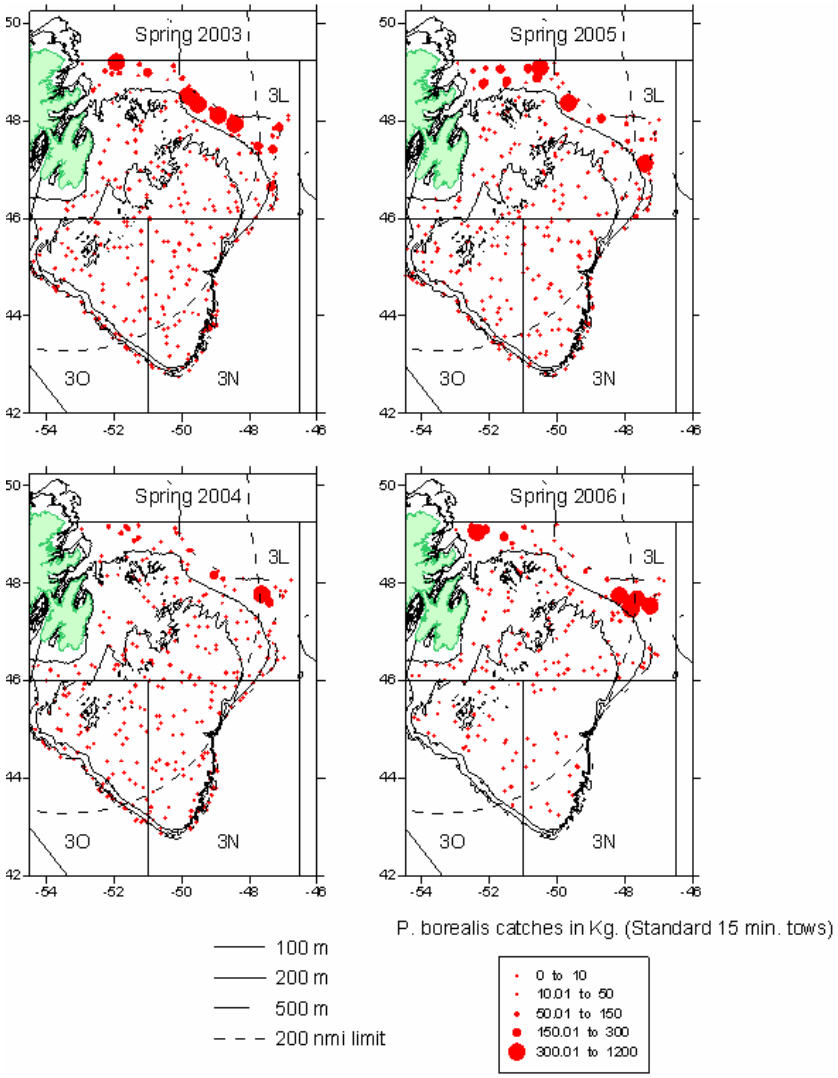

Fig. 5. Distribution of NAFO Div. 3LNO northern shrimp (*Pandalus borealis*) catches kg/tow) as obtained form spring research bottom trawl surveys conducted over the period 2003-2006.

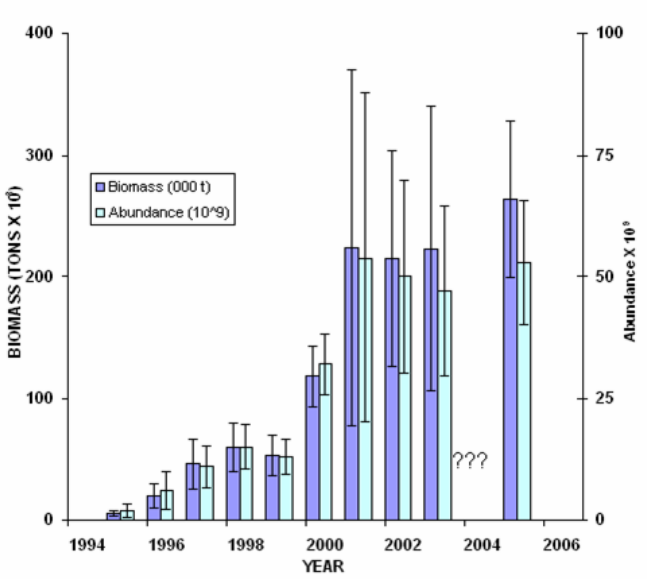

Fig. 6. Autumn northern shrimp (*Pandalus borealis*) abundance and biomass estimates within NAFO Div. 3LNO. Data were from Canadian multi-species bottom trawl surveys using a Campelen 1800 trawl. (Standard 15 min. tows.)

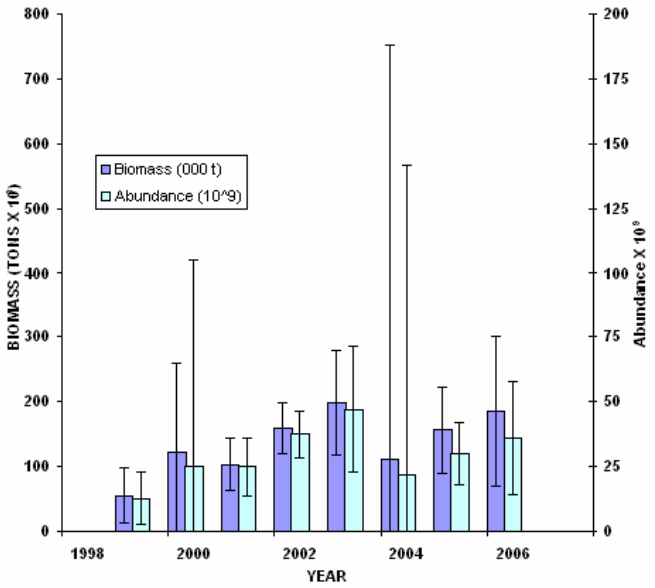

Fig. 7. Spring northern shrimp (*Pandalus borealis*) abundance and biomass estimates within NAFO Div. 3LNO. Please note that due to operational problems, it was not possible to survey all of Div. 3NO during spring 2006. The indices for 2006 are for Div. 3L only. Data were from Canadian multi-species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