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SURVEY REPORT FROM THE JOINT NORWEGIAN/RUSSIAN ECOSYSTEM SURVEY IN THE BARENTS SEA AUGUST-OCTOBER 2006

Volume 2

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SURVEY REPORT
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AUGUST – OCTOBER 2006
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Contents

1 Preface

The fourth joint ecosystem survey was carried out during the period 8th of August to 5th of October 2006. Results of investigations 0-group, the acoustic survey for pelagic fish, main oceanographic were included in Vol.1 of Report.

This volume include other materials of eco-survey 2006. and investigations have always formed a part of these surveys, and studies on plankton have been included for many years. In recent years, observations of sea mammals, seabirds, bottom fishes, and benthos have been included. Consequently, from 2003, these surveys were called “ecosystem surveys”.

It is results from the investigations on plankton, bottom fishes, benthos and etc.

A list of the participating vessels with their respective scientific crews is given in Survey report Vol.1. In addition to, the following specialists took part in preparing the Survey report vol.2: C. Hvingel (IMR), E. Orlova (PINRO),B. Bogstad (IMR),A. Dolgov (PINRO), A.Hoines (IMR).

2 Oceanography

2.1 Hydrochemical characteristic

In the surface layers on the Kola Section, the maximal concentrations of the dissolved oxygen varied from 6.8 ml/l in the Murmans coastal current to 7.1 ml/l in the central branch of the North Cape Current. Minimal concentrations of the dissolved oxygen (6.2-6.3 ml/l) were recorded in 50-75 m layer in the Murmans and Murmans Coastal Currents. In the deep and bottom layers, the concentrations of the dissolved oxygen varied from 6.4 ml/l in the Murmans Current to 7.1 ml/l in the central branch of the North Cape Current. In the surface layers, the distribution of the dissolved oxygen was close to the normal in all the branches of the current. Under the depth of 100% isooxygen, in 50-75 m layer, the negative anomalies varied from 0.2 ml/l in the central branch of the North Cape Current to 0.4 ml/l in the Murmans and Murman Coastal Currents. In the deep and bottom waters, the values of negative anomalies in the Murman Current reached 0.5 mkgatl/l approaching the long-term mean in the Murmansk coastal current and the central branch of the North Cape Current. (Fig.2.1.1) .

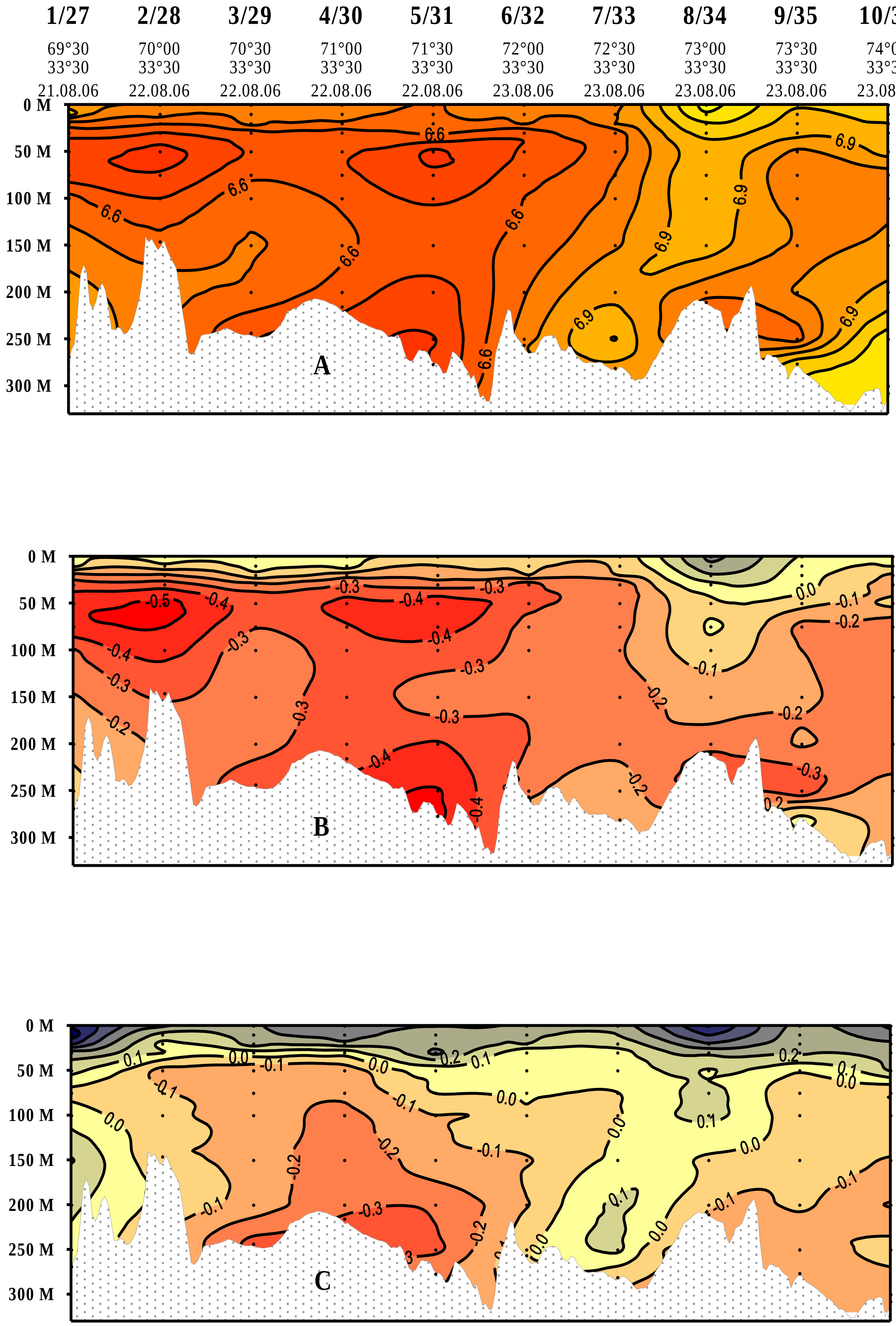

Figure 2.1.1 Distribution of oxygen (ml/l) and anomalies on the Kola section on August 2006

The distribution of water saturation with oxygen was of summer type, i.e. all the surface layers were covered with photosynthesis. The depth of the photosynthesis layer was 25-30 m in the Murman and Murman Coastal Current, and 48 m in the central branch of the North Cape

Current. Mean weighted values of the surface layer saturation varied from 3.2-4.0% in the Murmans and Murmans Coastal Currents to 4.0-4.8% in the central branch of the North Cape Current. Thus, the aeration of the photic layer was 1% higher than the normal. The saturation of Atlantic waters with oxygen was higher and the rate of water aeration different from the long-term mean. In the deeper layers the negative anomalies were 1-2% lower than the long-term mean. (Fig.2.1.2)

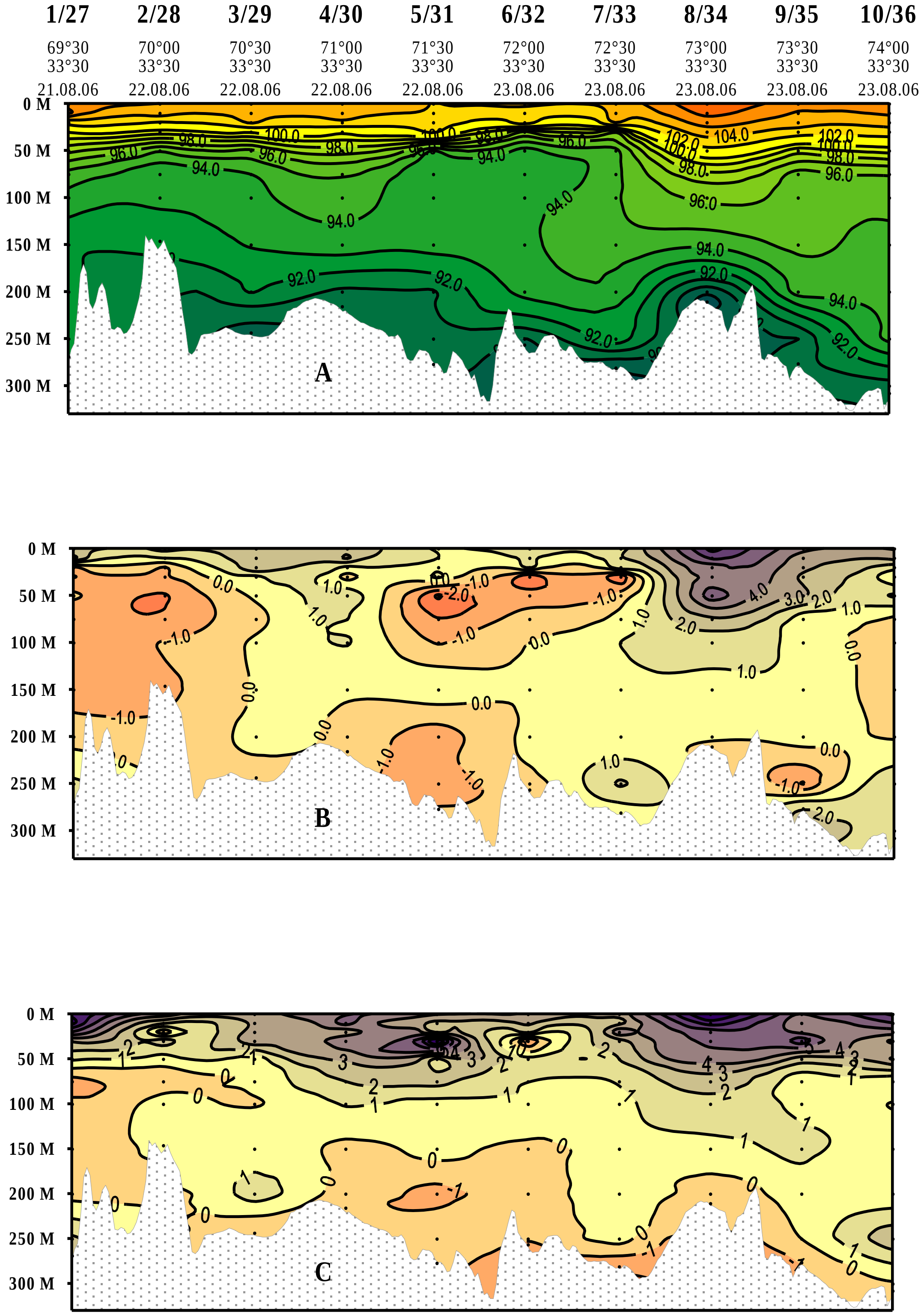

Figure 2.1.2 Distribution of dissolved oxygen (%) and anomalies on the Kola section on August 2006

The mineral phosphorus content in the Atlantic waters – both in the surface and the intermediate layers, had a clear tendency to increase northwards.. In the Atlantic waters the content of mineral phosphorus varied from 0.1 µmol/l to 0.6 µmol/l and was different from the long-term mean.

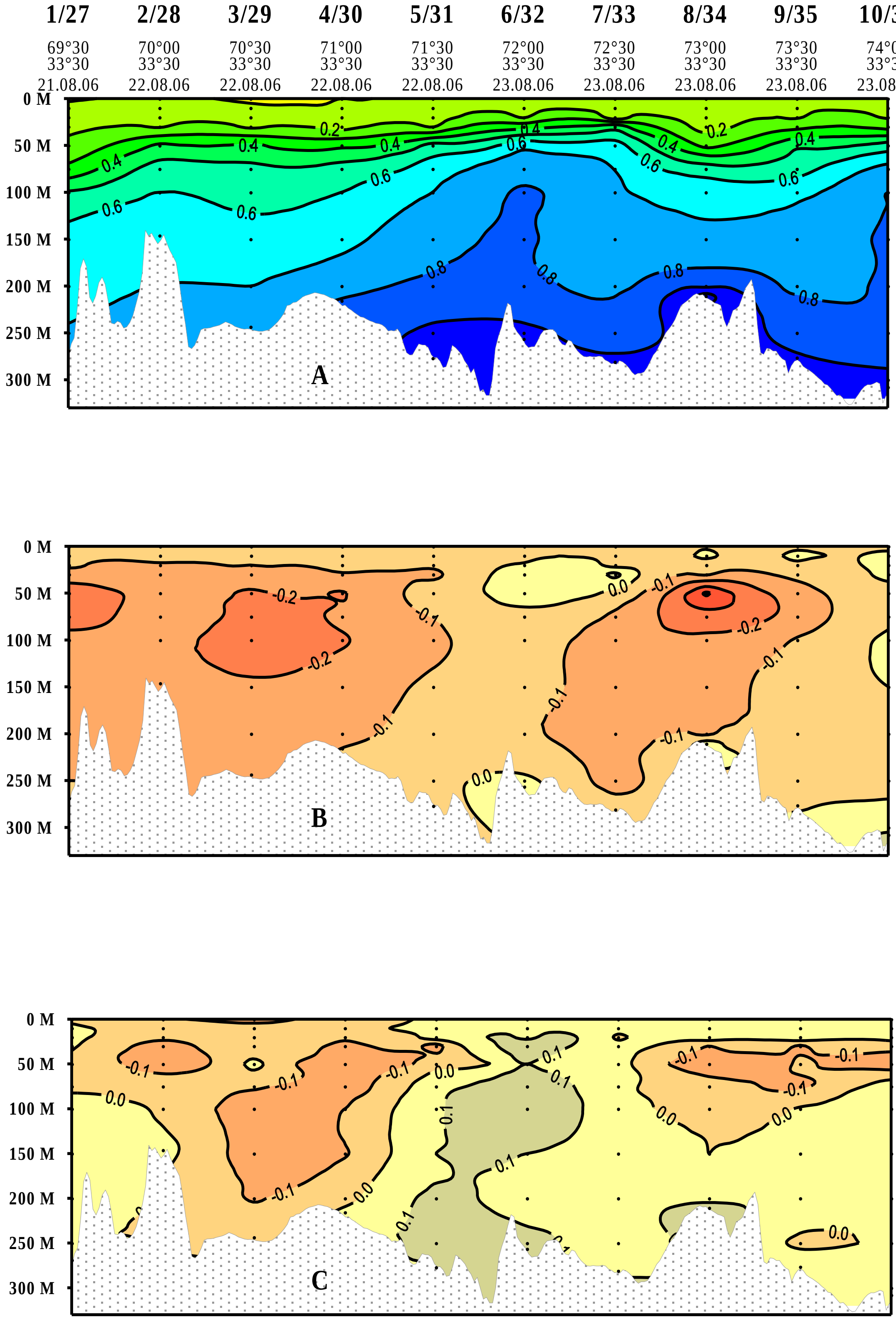

Figure 2.1.3 Distribution of phosphate (µmol/l) and anomalies on the Kola section on August 2006

In the photic layer, the concentrations of mineral phosphorus were to 0.1 µmol/l lower as compared to the long-term mean values. The negative anomalies increased with depth and maximal values (0.2 µmol/l) were registered in 50-75 m layer. In the deep and bottom layers, the spatial distribution of mineral phosphorus concentrations was identical to that one in the surface and intermediate layers. Also the concentrations of mineral phosphorus were higher in the

Atlantic waters and increased in the north direction. At the same time, the decrease in negative anomalies of mineral phosphorus was observed in the north direction where they were close to the normal in the bottom layers.(Fig.2.1.3)

The zonal section along 74°30’N (the Bear Island-East section) show a strong gradient in oxygen at about 25°E reflecting the northward-moving North Cape Current on the eastern side and the southward-moving Bear Island Current on the western side (Fig. 2.1.4). The Atlantic waters of the North Cape Current has low content of the dissolved oxygen while the waters of the Bear Island Current are more saturated with oxygen. At surface, the concentrations of the dissolved oxygen exceeded the mean long-term level by 0.1-0.2 ml/l in the North Cape Current. In the Bear Island Current, the dissolved oxygen was below the long-term mean at surface and well above (over 0.5 ml/l) in the intermediate layers. In the deep and bottom waters, the negative anomalies reached 0.3 ml/l in the northern branch of the North Cape Current. (Fig.2.1.4)

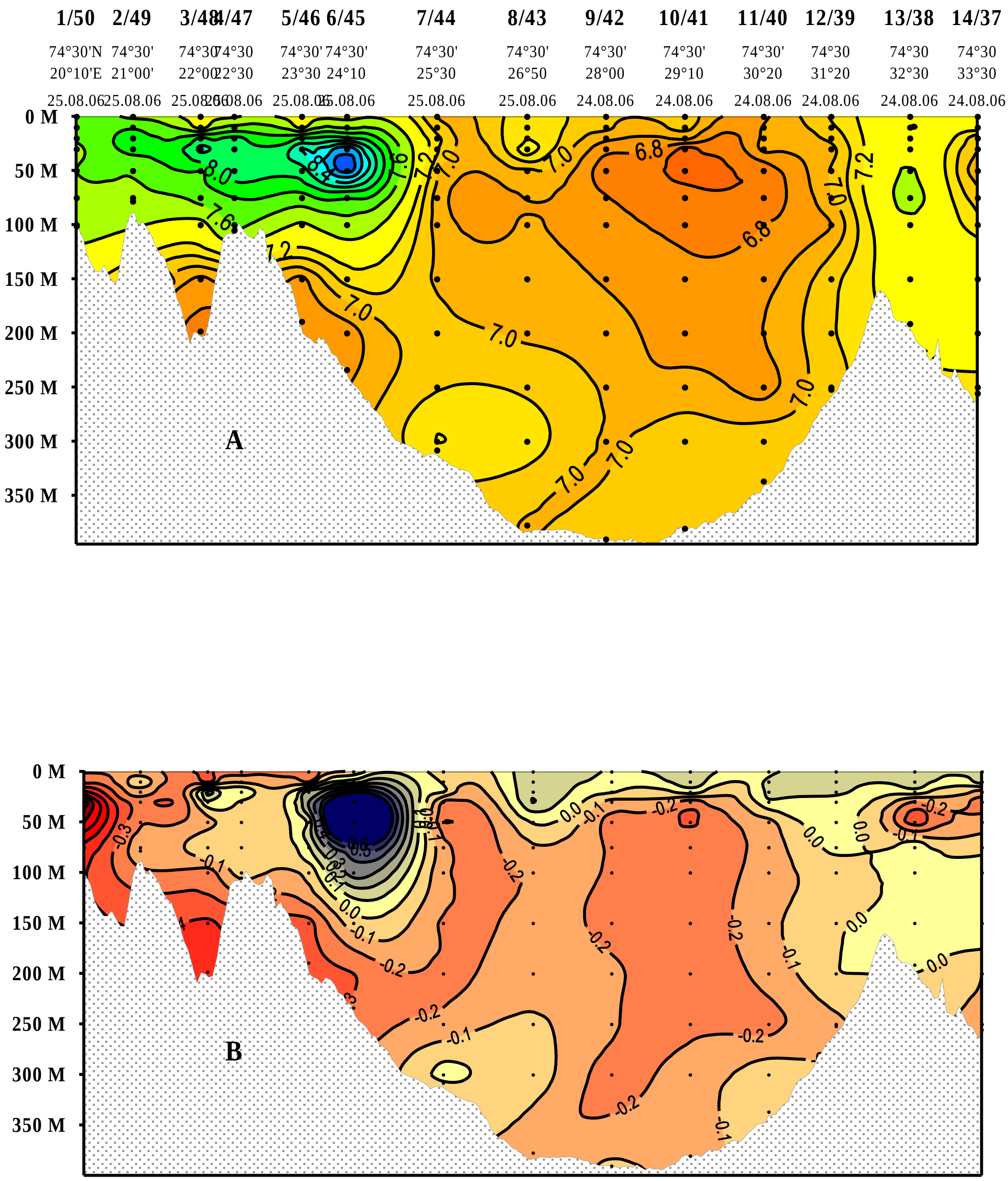

Figure 2.1.4 Distribution of oxygen (ml/l) and anomalies on the Bear Island East section? 29 section on August 2006

In the central latitudinal zone of the Barents Sea a typical summer situation was observed in the oxygen saturation (Fig. 2.1.5).The process of photosynthesis took place in all the surface layers. The depth of **100% isooxygen** was significantly differet in different areas . In the northern branch of the North Cape Current, the depth of the photosynthesis layer did not exceed 40 m while, in the arctic waters, 100% isooxygen reached 60-70 m. In the area of water mixing, the depth of the photic layer occurrence did not extend deeper than 25-30 m. The surface layer saturation of oxygen was 2-3% below the long-term mean in the northern branch of the North Cape Current and 6-7% above in the arctic waters. Below the photic layer, the saturation with oxygen was close to normal in the Atlantic waters and high (2-3% above normal) in the waters of arctic origin. (Fig.2.1.5)

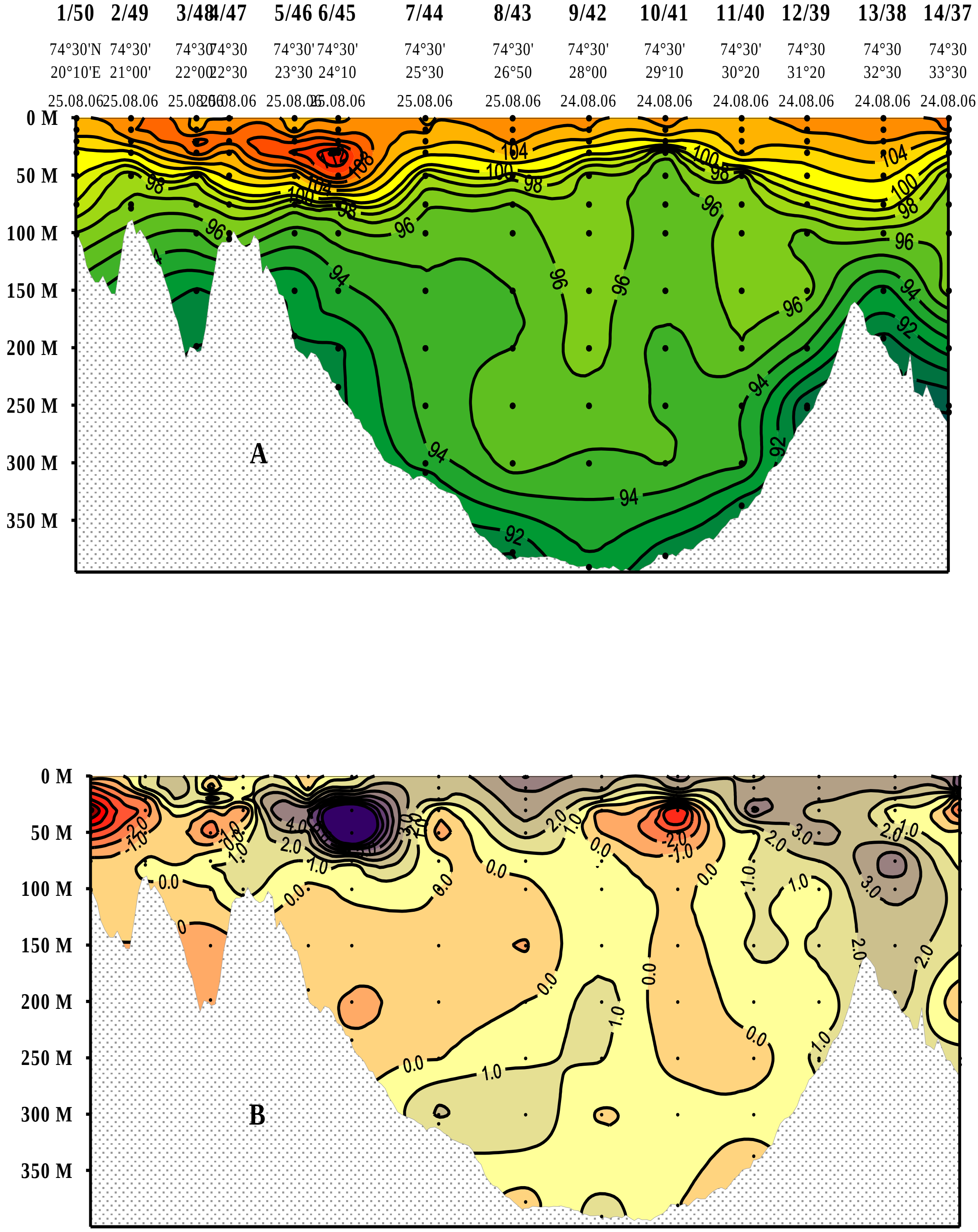

Figure 2.1.5 Distribution of dissolved oxygen (%) and anomalies on the Bear Island East section? 29 section on August 2006

Mineral phosphorus content in the surface and intermediate layers in the central latitudinal zone of the Barents Sea was also different from the long-term mean level. In the photic layer, concentrations of mineral phosphorus were to 0.1 µmol/l lower than the long-term mean values. In the sub-surface layer, negative anomalies (more than 0.2 µmol/l) were recorded in arctic waters (less than 0.1 µmol/l). In the Atlantic waters of the North Cape Current the anomalies were positive with more than 0.2 μmol/l in the subsurface layers. In the intermediate layers, high content of mineral phosphorus (in relation to Atlantic and arctic waters) was typical for the deep and bottom layers. (Fig.2.1.6)

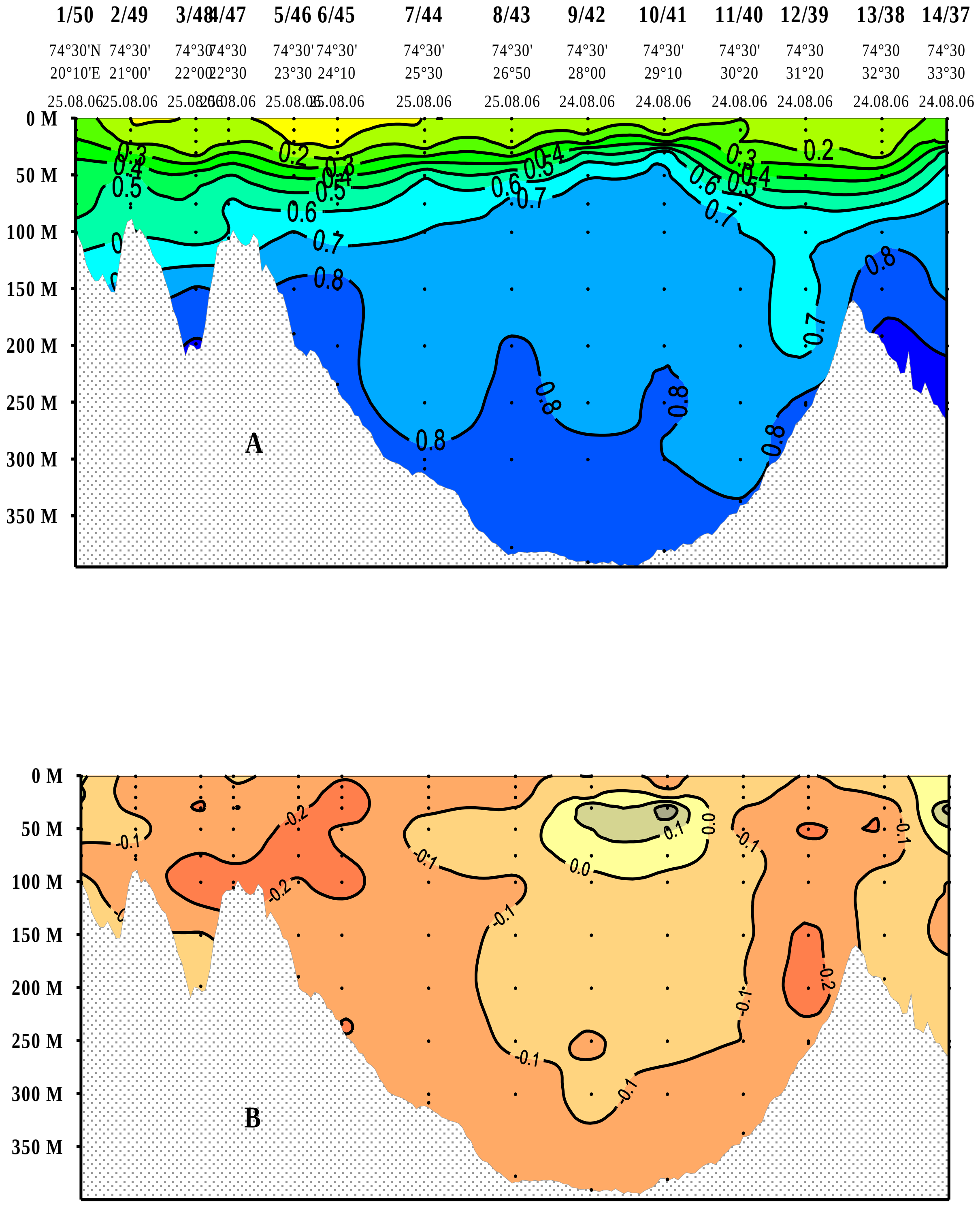

Figure 2.1.6 Distribution of phosphate (μmol /l) and anomalies on the Bear Island East section in August 2006

In early October, in the coastal branch of the North Cape Current, the highest content of dissolved oxygen was recorded in the subsurface and bottom layers of Atlantic waters. There, the variations of dissolved oxygen concentrations were 6.4-6.6 mkgat/l that was to 0.4 mkgat/l less than the mean long-term level. In the intermediate layers, the content of dissolved oxygen was close to the normal. (Fig.2.1.7)

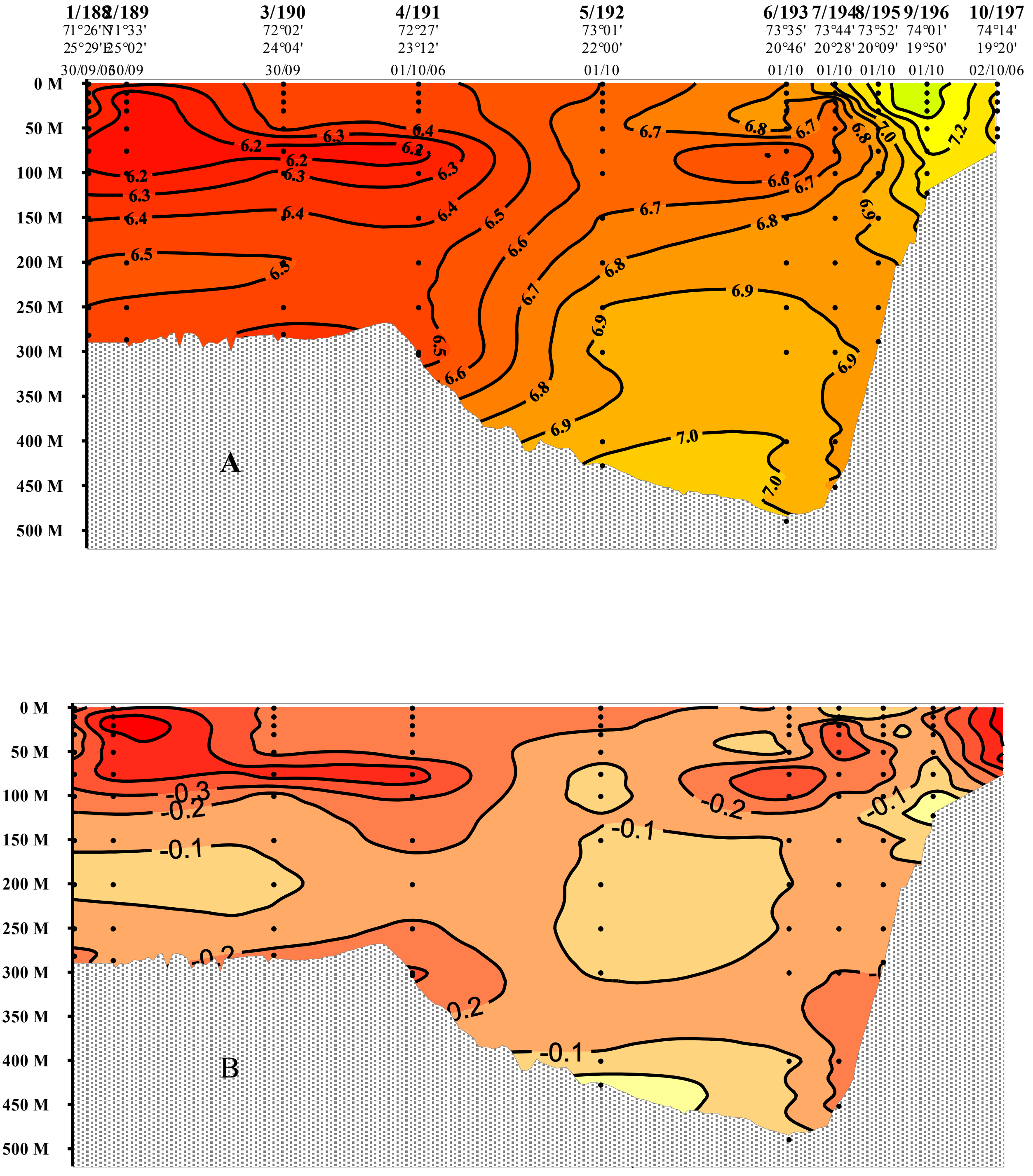

Figure 2.1.7 Distribution of oxygen (ml/l) and anomalies on section North Cape – Bear Island on September-October 2006

In branches of the North Cape and Bear Island Currents, the vertical distribution of oxygen resembled an autumn-winter situation . The photic layer was practically completely destroyed and saturation with oxygen did not exceed 99%. At that, the least (less than 99%) aeration of waters was recorded in the subsurface and bottom layers of Atlantic waters that was to 4% less than the mean long-term level. In the intermediate layers, water aeration with dissolved oxygen varied from being close to the long-term mean level in the coastal branch of the North Cape Current to 2-3% higher than the normal in the North Cape Current. (Fig.2.1.8)

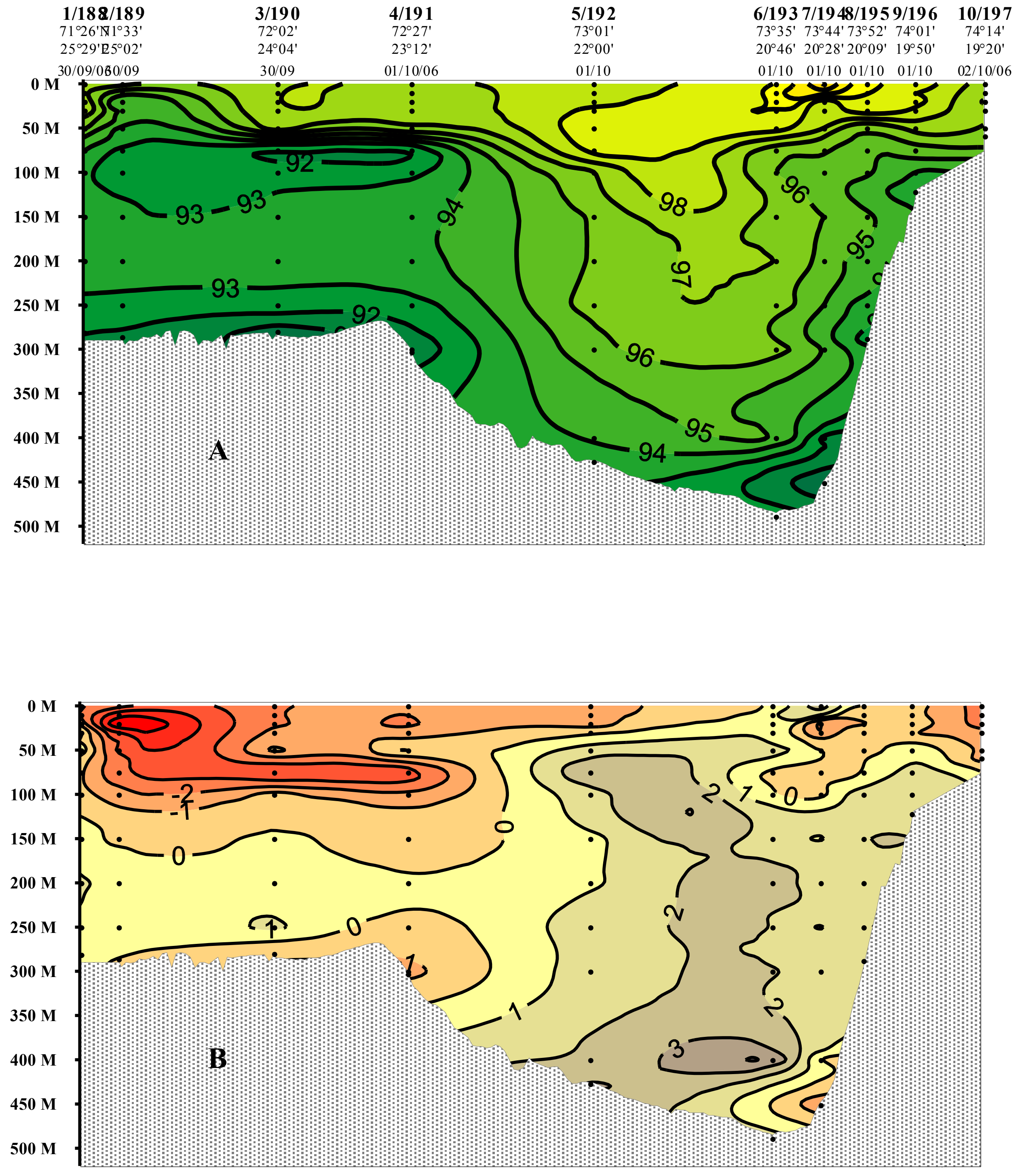

Figure 2.1.8 Distribution of dissolved oxygen (%l) and anomalies on the section North Cape – Bear Island September-October 2006

Vertical distribution of phosphates also transited to the autumn-winter type. While the surface layers were saturated with phosphate, there was a reduction in the phosphate concentration in the bottom layers compared to August. This was caused by the start of autumn-winter convective mixing and strengthening of heat advection to the deep layers. Stronger advection is also indicated by the increase in negative anomalies of dissolved oxygen in the deep layers of Atlantic waters. Throughout the section the concentration of mineral phosphorus in Atlantic waters were below the long-term mean. (Fig.2.1.9).

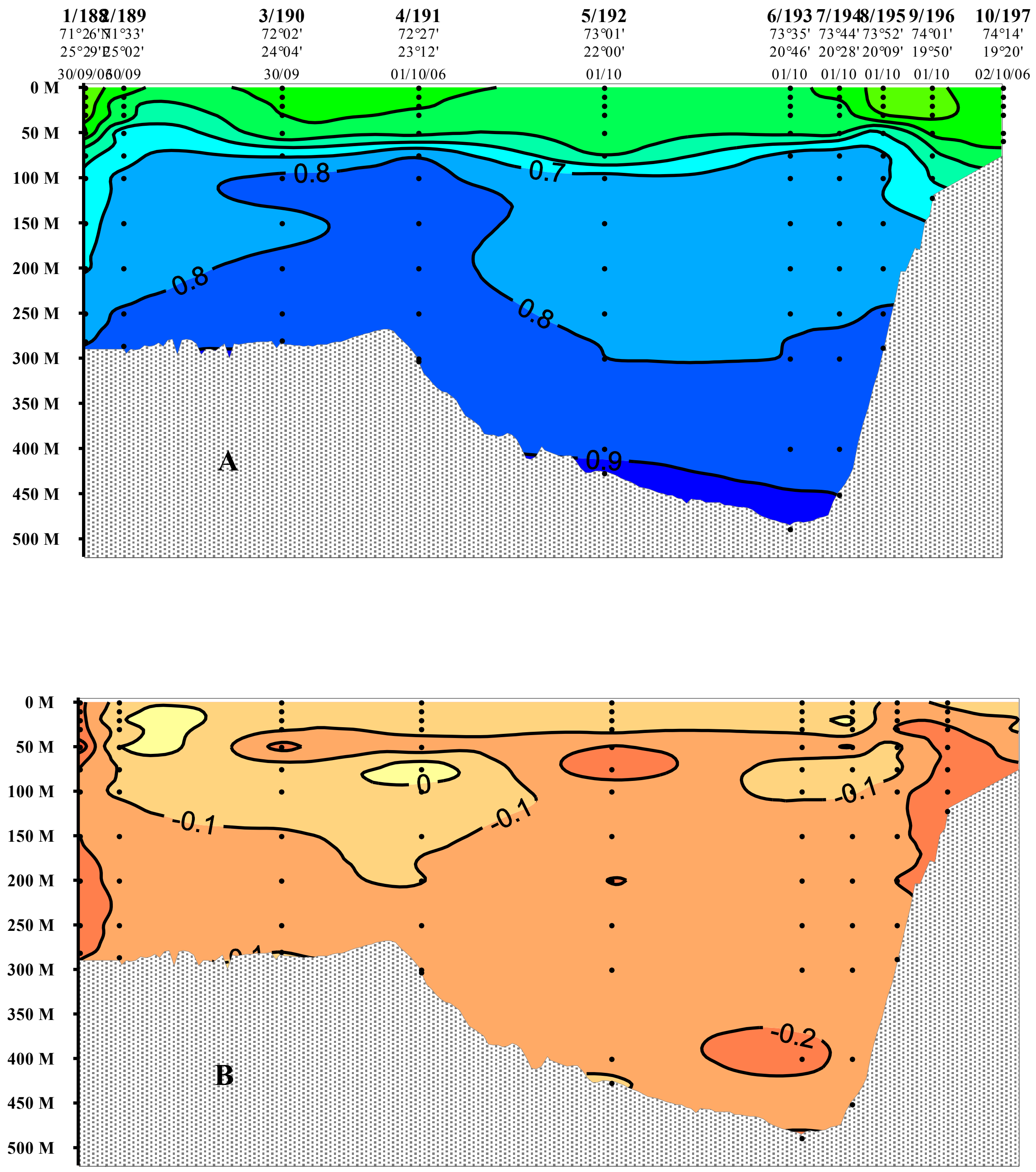

Figure 2.1.9 Distribution of phosphate (µmol/l) and anomalies on section North Cape – Bear Island on September-October 2006

2.2 Additional sections

The information about some hydrography sections were not included in Vol.1 and produce below.

The hydrography in the Fugløya-Bear Island and Vardø-North section are shown in Figs. 2.2.1-2.2.2. In the Fugløya-Bear Island section both temperature and salinity were above the long-term mean. Relatively large areas with salinity above 35.2 were observed, and this has not earlier been seen in this section. Also the Vardø-North section was warmer and saltier than normal, but not as much as the Fugløya-Bear Island section.

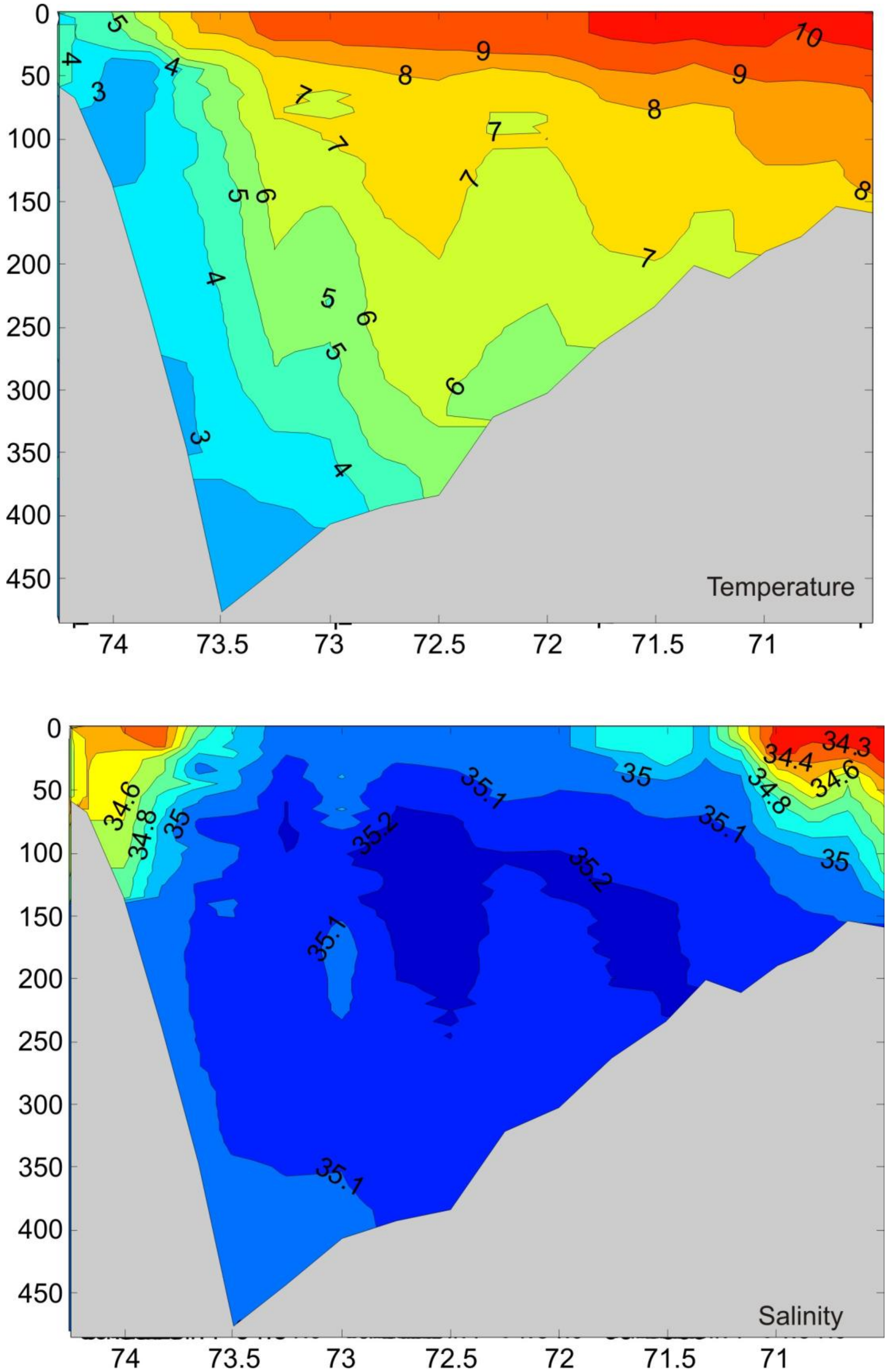

Figure 2.2.1 Oceanographic conditions; temperature and salinity along the Fugløya – Bear Island section in August – September 2006.

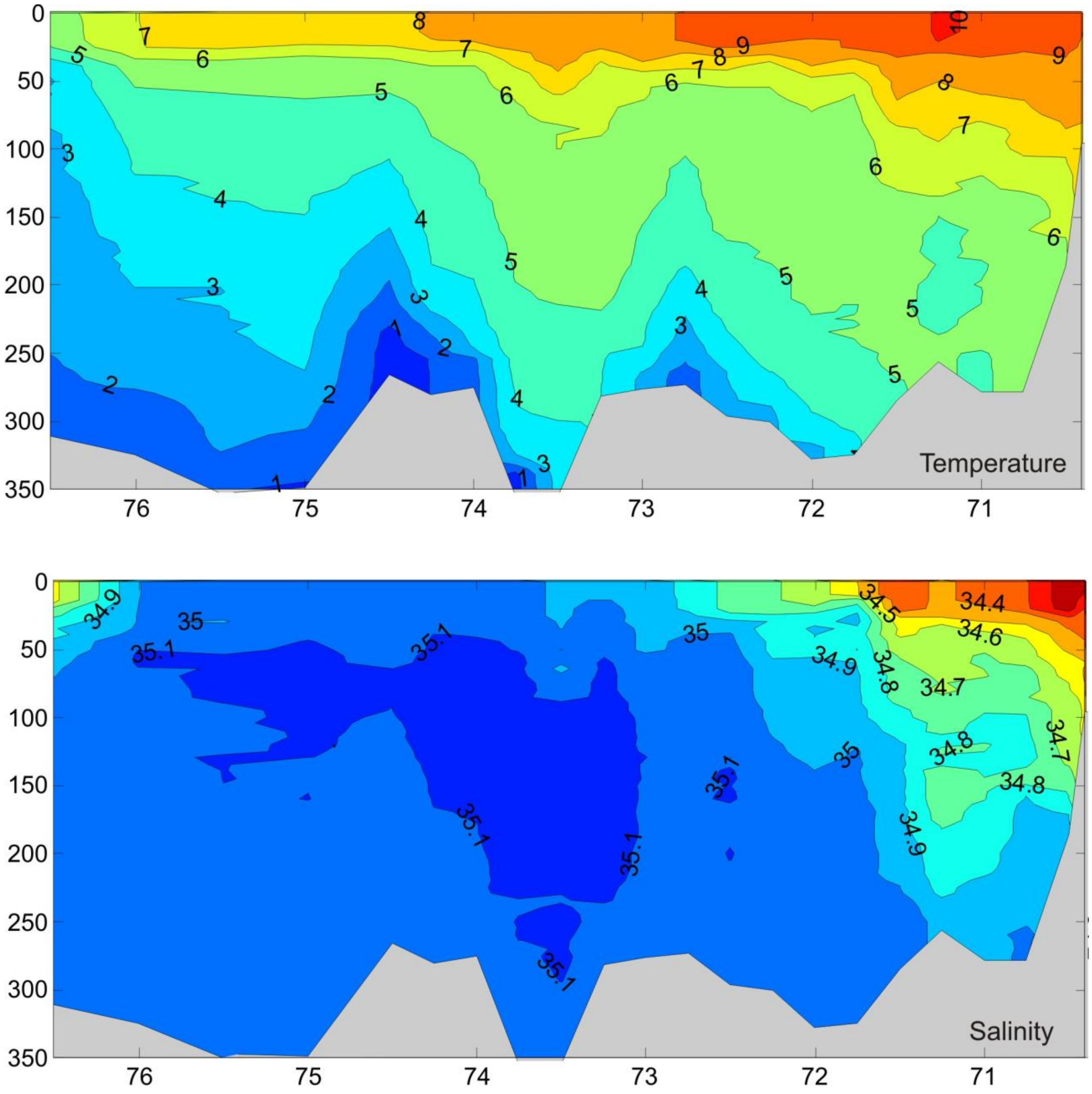

Figure 2.1.2 Oceanographic conditions; temperature and salinity along the Vardø - North section in August – September 2006.

The hydrography in the North Cape - Bear Island section is shown in Fig. 2.2.3. The central part of the section represents the North Cape Current and contains mostly Atlantic water masses. This part was warmer than normal and the temperature anomalies in the 0-50, 0-200 and 50-200 m layers were 0.8, 0.9 and 1.0°C, respectively. Atlantic water masses with salinity above 35 occupied the most area of the North Cape - Bear Island section. The core with maximum salinity (more than 35.1) was situated in the 100-350 m layer in the central part of the section.

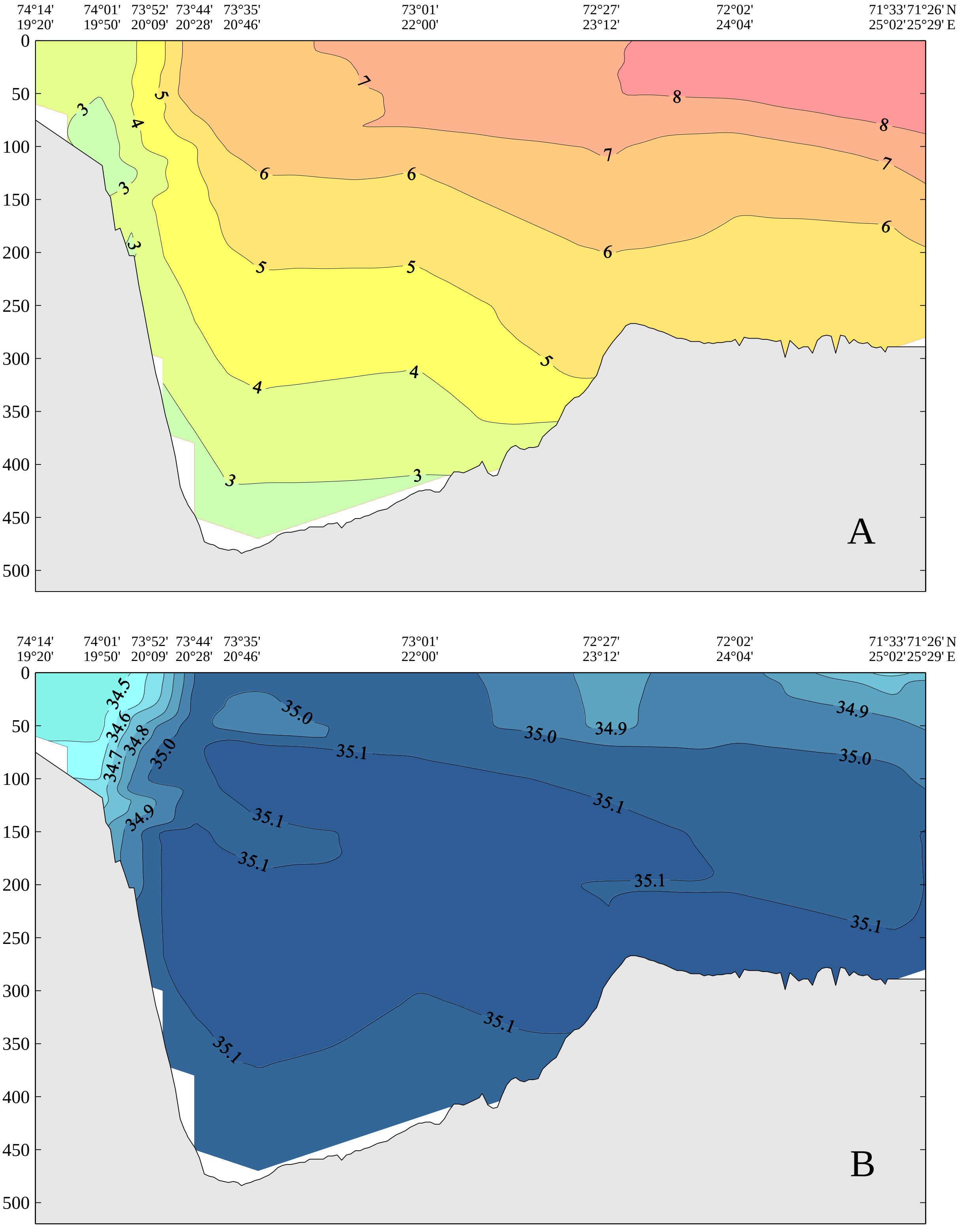

Figure 2.2.3. Temperature (A) and salinity (B) in the North Cape - Bear Island Section, 30th September - 1st October 2006

3 Demersal fish

In the current volume of the survey report an aged-based swept-area analysis of the demersal fish species was carried out. The methods used are described in "Extended survey report from the joint Norwegian/Russian Ecosystem survey in the Barents sea August – October 2004 Volume 2"

3.1 Assessment by age group

Some problems with data converting has been found in previous years. It should be check more carefully, so the time series below can be consider as preliminary only.

The age-groups based assessments for mean species of bottom fish are presented in Table 3.1.1-3.1.4.

Table 3.1.1 Age-based assessment of Northeast arctic cod in the Barents Sea in August – September 2006

Region		Age												
	Year	1	2	3	4	5	6	7	8	9	10	11	12+	Total
I (NEEZ+SVA)														
	2004	151.93	69.70	30.93	34.40	14.37	19.32	12.23	4.71	1.14	0.40	0.06	0.08	339.27
	2005	147.43	30.10	38.17	6.65	17.31	6.11	4.48	2.18	0.21	0.27	0.07	-	252.98
	2006	248.69	188.91	33.89	19.65	5.02	10.11	4.42	2.09	1.22	0.36	0.07	0.02	514.45
I (REEZ)														
	2004	87.12	204.23	38.45	273.62	115.72	40.97	18.37	3.75	0.23	0.23	0.03	0.08	782.80
	2005	115.19	45.21	121.39	20.60	42.40	17.95	6.67	3.37	0.66	0.33	-	0.06	373.83
	2006*	227.88	257.82	81.59	81.75	20.49	21.74	5.23	1.65	0.65	0.11	0.03	0.00	698.93
IIa														
	2004	10.57	5.72	1.74	6.45	2.01	2.41	0.49	0.32	0.12	-	-	-	29.83
	2005	13.15	3.22	6.00	2.08	2.60	1.46	0.95	0.14	0.01	-	0.05	-	29.66
	2006	9.33	4.95	4.99	4.47	3.35	4.79	1.21	0.63	0.23	0.04	0.04	-	34.03
IIb														
	2004	142.84	62.13	38.28	104.57	19.31	15.04	8.29	1.54	0.33	0.03	-	0.13	392.49
	2005	149.99	81.77	97.32	27.74	52.29	7.35	4.65	0.75	0.26	0.10	-	-	422.22
	2006	102.44	95.47	55.62	79.08	17.09	17.78	4.49	2.42	0.74	-	-	-	375.13
Total														
	2004	392.46	341.78	109.40	419.04	151.41	77.74	39.38	10.32	1.82	0.66	0.09	0.29	1 544.39
	2005	425.76	160.30	262.88	57.07	114.60	32.87	16.75	6.44	1.14	0.70	0.12	0.06	1 078.69
	2006	588.34	547.15	176.09	184.95	45.95	54.42	15.35	6.79	2.84	0.51	0.14	0.02	1 622.54

* No age information available. Age-length key from area I (NEEZ+SVA) was used.

Table 3.1.2 Age-based assessment of Northeast arctic haddock in the Barents Sea in August – September 2006

Region	Year	Age 1	2	3	4	5	6	7	8	9	10	11	12+	Total
I (NEEZ+SVA)														
	2004	23.92	35.99	12.84	3.65	3.38	3.79	0.22	0.36	-	-	-	-	84.15
	2005	87.85	12.64	16.24	4.42	1.82	1.40	1.45	0.10	0.10	-	-	-	126.02
	2006	641.65	175.23	14.50	18.28	2.68	3.32	1.77	0.44	0.05	0.09	0.06	-	858.07
I (REEZ)														
	2004	35.54	150.85	142.23	71.15	73.47	20.11	1.57	0.34	-	0.13	-	0.25	495.64
	2005	222.51	36.25	221.03	180.69	24.32	19.23	8.46	0.17	-	0.18	0.04	-	712.88
	2006*	1 856.34	1 183.49	128.83	162.02	12.54	13.80	5.34	1.40	0.07	0.13	0.11	-	3 364.07
IIa														
	2004	70.99	73.76	10.33	4.61	3.39	4.98	0.30	0.80	-	-	-	0.04	169.20
	2005	208.11	28.08	21.48	5.87	1.42	2.03	1.80	0.09	0.43	0.05	-	0.10	269.46
	2006	435.65	72.59	13.90	12.70	4.86	0.62	1.34	1.17	0.48	0.48			543.79
IIb														
	2004	24.29	5.89	2.19	1.50	3.64	2.97	0.11	1.12	-	-	-	-	41.71
	2005	151.77	5.38	10.85	0.72	2.46	3.68	1.96	-	0.01	0.01	0.08	-	176.92
	2006	541.62	122.37	1.71	5.11	2.97	1.59	4.86	3.25		0.20			683.68
Total														
	2004	154.74	266.49	167.59	80.91	83.88	31.85	2.20	2.62		0.13		0.29	790.70
	2005	670.24	82.35	269.60	191.70	30.02	26.34	13.67	0.36	0.54	0.24	0.12	0.10	1 285.28
	2006	3 475.26	1 553.68	158.94	198.11	23.05	19.33	13.31	6.26	0.60	0.90	0.17		5 449.61

* No age information available. Age-length key from area I (NEEZ+SVA) was used.

Table 3.1.3 Age-based assessment of deepwater redfish (*Sebastes mentella*) in the Barents Sea in August – September 2006

Region	Year	Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
I (NEEZ+SVA)																		
	2004		1 462	1 388	1 200	587	1 032	4 050	5 556	484	309	273	533	878	1 238	1 007	1 639	21 637
	2005	3 001		1 357	1 173	1 018	1 424	923	2 296	3 859	514	426	886	640	640	1 589	2 168	21 914
	2006		116 488		4 816	1 692	677	2 030	-	-	88	70	44	22	214	2 191	16 753	145 084
I (REEZ)*																		
	2004		1 491	4 884	1 696	1 485	333	56	30	34	16			0	3	15	106	10 148
	2005	1 392	1 999	517	189	61	23	23	30	33	5	1	0	1	10	19	34	4 336
	2006	412	2 594	1 432	586	245	41	40	152	122	144	87	55	27	92	249	785	7 063
IIa																		
	2004		714	1 572	1 546	734	2 152	2 520	2 613	11 741	17 967	26 372	26 970	15 216	25 779	28 272	31 876	196 045
	2005	433		1 576	3 035	895	1 534	2 393	5 548	4 960	3 820	11 408	12 121	19 382	34 814	24 581	35 035	161 534
	2006	34 510	19 498	1 279	413	1 719	2 545	593	5 754	1 714	1 105	8 721	9 437	1 480	7 535	25 292	65 706	187 301
IIb																		
	2004		4 527	6 048	3 056	5 196	486	2 836	208	5 058	4 079	14 323	6 127	1 390	8 343	969	28 110	90 756
	2005	427	5 371	1 945	1 939	4 187	2 663	6 019	6 578	11 057	9 621	10 259	8 208	13 768	12 566	13 184	25 919	133 710
	2006		60 866	13 821	3 013	3 300	2 509	4 513	19 404	17 967	62 652	37 600	19 818	13 113	27 185	45 009	62 608	393 378
Total																		
	2004		8 194	13 892	7 499	8 003	4 002	9 462	8 407	17 316	22 371	40 968	33 630	17 484	35 363	30 264	61 731	318 586
	2005	5 252	7 370	5 394	6 336	6 161	5 643	9 358	14 452	19 909	13 960	22 094	21 216	33 790	48 030	39 373	63 156	321 494
	2006	34 922	199 446	16 532	8 827	6 956	5 771	7 176	25 310	19 803	63 989	46 478	29 354	14 642	35 027	72 740	145 852	732 825

* No age information available. Age-length key from the three other areas combined was used.

Table 3.1.4 Age-based assessment of golden redfish (*Sebastes marinus*) in the Barents Sea in August – September 2006

Region		Age															
	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
I (NEEZ+SVA)																		
	2004					303	215	215	335	77	71	71	464	185	389	214	365	2 905
	2005		112				105	297	170	138	377			150		130	910	2 391
	2006**	352	1	0	12	18	69	95	355	312	857	268	259	259	257	354	3 536	7 005
I (REEZ)*																		
	2004			187		50	104	135	495	286	129	67	95	42	15	8	9	1 621
	2005		71	55	72	108	144	47	293	297	327	118	253	240	244	247	661	3 177
	2006**	450	1	0	15	23	84	66	133	67	202	61	46	41	20	17	123	1 350
IIa																		
	2004			102			228	225	276	413	177	303	391	341	136	609	1 809	5 010
	2005		82	1 098	469	702	2 456	1 552	2 985	769	726	189	348	326	461	411	1 306	13 881
	2006**							21	127	142	722	306	890	827	826	762	3 068	7 691
IIb																		
	2004					4	7		354	63	473	126	311	368	337	120	300	2 464
	2005			41				27	33	168	115	191	200	60	96	116	308	1 355
	2006**				16	24	56	35	96	71	288	99	159	149	135	130	404	1 663
Total																		
	2004			288		357	554	576	1 459	839	849	566	1 260	937	878	952	2 483	12 000
	2005		266	1 193	541	809	2 705	1 924	3 481	1 372	1 545	498	801	776	802	904	3 185	20 804
	2006**	802	2	0	43	65	209	217	711	592	2 069	734	1 355	1 276	1 238	1 263	7 130	17 709

* No age information available. Age-length key from the three other areas combined was used.

** Very few age samples available, total age-length key from 2005 used.

Table 3.1.5 Age-based assessment of Greenland Halibut in the Barents Sea in August – September 2006

Region Year	**5.0-9.9**	Length group (cm) **10.0-14.9**	**15.0-19.9**	**20.0- 24.9**	**25.0-29.9**	**30.0-34.9**	**35.0-39.9**	**40.0-44.9**	**45.0-49.9**	**50.0-54.9**	**55.0-59.9**	**60.0-64.9**	**65.0-69.9**	**70.0-74.9**	**75.0-79.9**	**80.0-84.9**	**85.0-89.9**	**Total**
I (NEEZ+SVA)																		
2004	598	1971	3119	10152	6263	2585	1923	757	1072	806	163	69	51					29529
2005	462	28972	7172	2560	3805	7422	4226	2849	2110	736	640	250	190	34				61428
2006		6863	4198	17766	9061	3415	7016	5985	4578	2302	1239	137	352	17	100			63029
I (REEZ)																		
2004	410	8342	14407	28861	17315	4832	1007	674	331	165	261	79						76684
2005	417	86380	20931	6839	16169	15604	3954	1355	751	87								152486
2006	919	42761	93927	167684	29266	3712	4703	1493	765	813	626	142	109					346921
IIa																		
2004							345	106	1044	1345	687	127	57	153				3864
2005						215	566	650	592	1303	995	552	72	81	92			5117
2006		779	111				658	577	518	1049	671	633	157	84				5237
IIb																		
2004	8331	2817	3998	3925	3864	2701	3700	3014	2346	1587	298	834	217	189	38	92	8	37958
2005	723	34337	21272	3536	5612	10337	9708	6940	4581	2339	841	295	266	44		42	32	100902
2006	1841	6803	4887	14878	7694	2152	4545	4870	3703	2110	1073	483	137	55	63	31		55324
Total																		
2004	9339	13130	21524	42938	27442	10118	6975	4551	4793	3904	1409	1109	325	342	38	92	8	148035
2005	1602	149690	49375	12935	25585	33577	18454	11794	8034	4464	2476	1097	528	158	92	42	32	319933
2006	2760	57205	103122	200328	46021	9279	16922	12925	9564	6274	3610	1395	756	156	164	31		470511

3.2 Composition of cod diet

3.2. Composition of cod diet

Cod stomachs were sampled both by Norwegian and Russian vessels. The Norwegian data were analysed in the laboratory at IMR, while the Russian data were analysed onboard the vessel. The methods used for stomach sampling, analysis and data recording are given by Anon. (1972), Mehl (1989), Mehl and Yaragina (1992) and Dolgov (1996). For each trawl station 1 stomach per 5 cm length group was collected by the Norwegian and Russian vessels.

Stomachs were sampled from 330 stations. Totally 2585 cod stomachs were analysed.

For each station, the mean Partial Fullness Index (PFI) was calculated to permit comparison of quantities of various prey groups in the stomachs of predators of various sizes (Lilly and Fleming 1981). This was done for cod age groups 1-2, 3-6 and 7-12, respectively, and for each of the prey groups. The PFI by predator age group and prey species group was then averaged over all fish sampled within each WMO square (1° N x 2° E). For WMO squares where less than 5 stomachs were sampled in the given age groups (1-2, 3-6, 7+), the data are not shown in the figures.

The PFI of prey group *i* in predator *k* is given by

$$PFI_{i,k} = \frac{S_{i,k}}{(L_k)^3} \times 10^4$$

where $S_{i,k}$ is the weight (g) of prey species *i* found in the stomach of predator *k*, and L_k is the length (cm) of predator *k*.

Table 3.1 shows the diet composition by cod age groups (summed over the whole area), as well as the stomach fullness. It is seen that the mean Total Fullness Index (PFI summed over all prey) increases with increasing predator age.

Figures 3.2.1-3.2.3 show the geographical distribution of diet (PFI) composition, for cod age groups 1-2 (N=840), 3-6 (N=1282) and 7+ (N=349), respectively.

For cod age 1 and 2, the diet composition was very variable between the areas. But in contrast to 2005, shrimp, fish and small krill were the most important prey groups (Table 3.2.1). Capelin, polar cod and amphipods were also important in some areas. Other important fish prey (not shown as a separate group on Figure 3.2.1) was long rough dab.

For cod age 3-6, the diet composition was very variable between the areas, reflecting the difference in geographical distribution of the various prey items. In general shrimp, fish (mostly capelin, haddock, herring and polar cod) dominated in cod diet (Table 3.2.1.). Fish including blue whiting was the dominant prey item in the south-western part, while shrimp, herring, krill, and capelin dominated in the south-eastern part. In the central Barents Sea shrimp and capelin were the most important prey in a large area, while polar cod dominated near Novaya Zemlya. In addition euphausids and haddock prevailed in cod feeding in some areas.

For cod age 7-12, the diet composition was to a large extent similar to that of age 3-6 cod, weight percentages of euphausids and shrimp were lower (Table 3.2.1.). Thus, fish including cod and haddock juveniles dominated in coastal areas near Russia. Polar cod, capelin and amphipods dominated north of 76° N, and polar cod dominated near Novaya Zemlya (the area east of 42° E and between 73° and 75° N). Shrimp was the dominant prey item in the central Barents Sea, but over a smaller area than for age 3-6 cod. In addition blue whiting was found in the western areas.

Table 3.2.1. Food composition of cod during August-October 2006, % by total stomach content weight

Prey species	Cod age, year			Total, incl. 0-group
	1-2	3-6	7-12	
Hyperiids	1.46	2.49	2.21	2.31
Euphausiids	13.53	7.61	2.39	4.84
Shrimp	32.53	12.68	7.48	10.20
Herring	0.16	5.98	5.08	5.35
Capelin	10.69	11.69	11.18	11.38
Polar cod	5.67	5.79	9.79	8.02
Cod		3.00	5.86	4.53
Haddock	0.61	8.05	11.72	9.93
Blue whiting		3.48	5.83	4.72
Norway pout		0.76	0.38	0.54
Redfish	0.38	0.83	0.06	0.39
Long rough dab	4.98	2.24	2.83	2.64
Other fish	17.69	22.21	17.85	19.65
Other food	12.30	13.19	17.34	15.50
Number of stomachs	840	1282	349	2585
Empty stomachs, %	36.7	18.6	10.3	25.2
Mean Total Fullness Index	1.01	1.34	1.89	
Mean stomach fullness	1.3	1.7	2.1	1.6
Mean index of fullness, $^{0}/_{000}$	190.86	184.61	233.37	195.45
Mean length of cod (cm)	23.7	52.2	82.6	
Mean weight of cod (kg)	0.13	1.43	5.15	

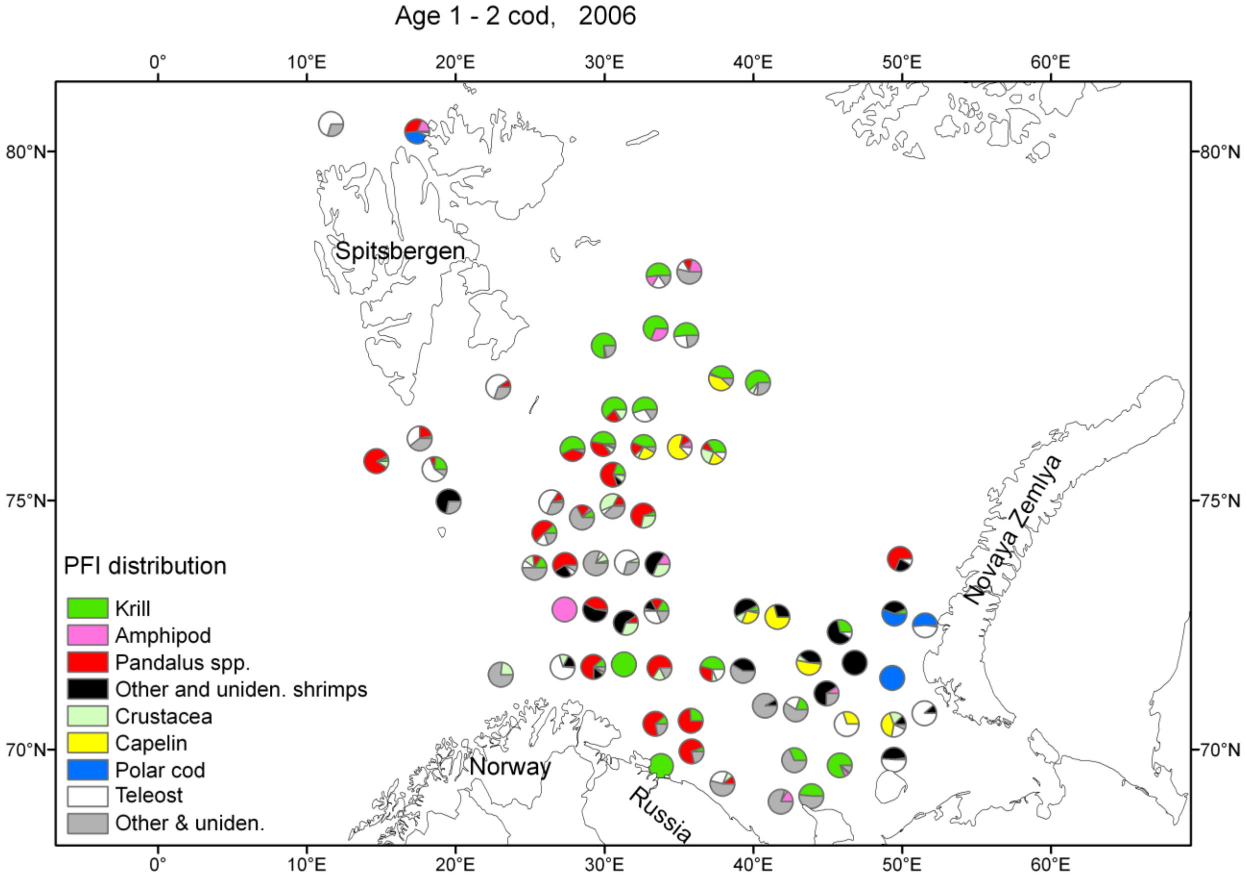

Figure 3.2.1. Geographical distribution of diet composition for age 1-2 cod during the ecosystem survey autumn 2006

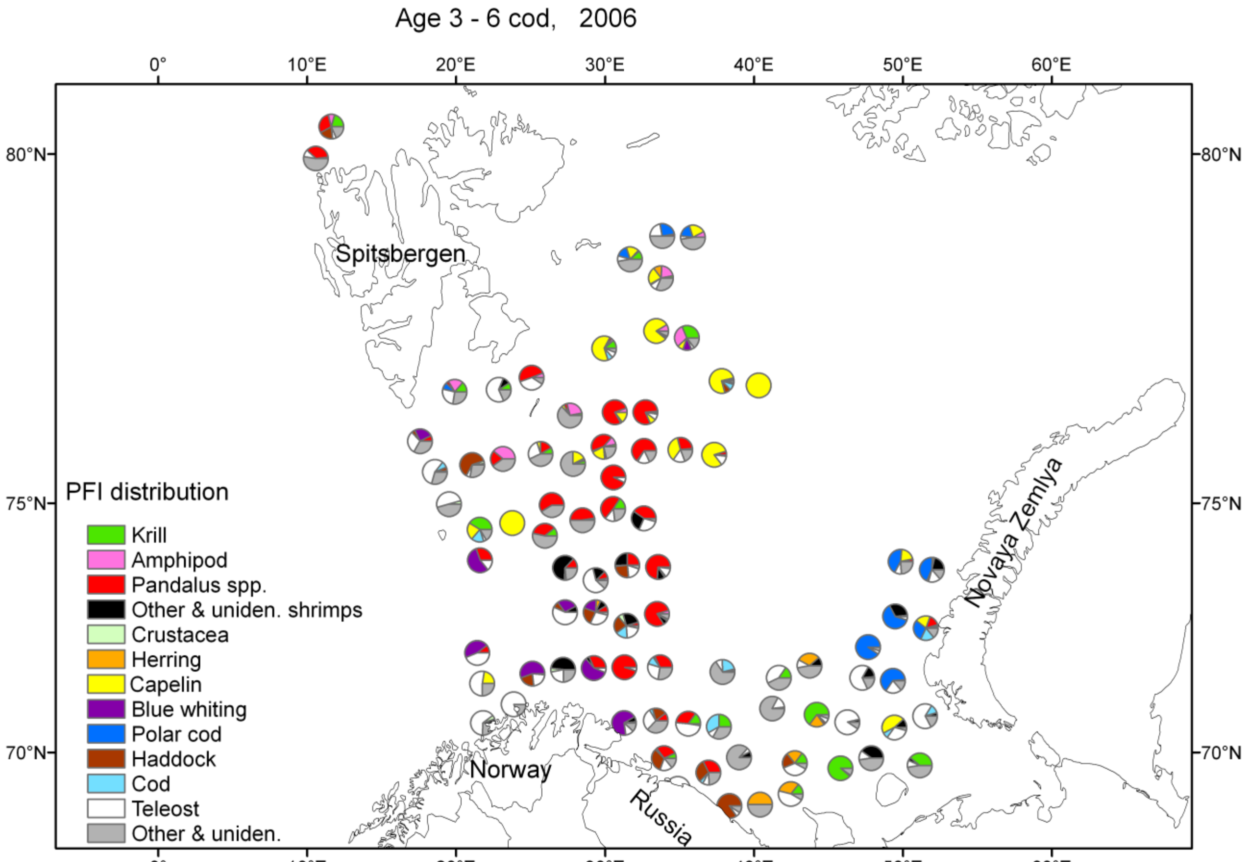

Figure 3.2.2. Geographical distribution of diet composition for age 3-6 cod during the ecosystem survey autumn 2006

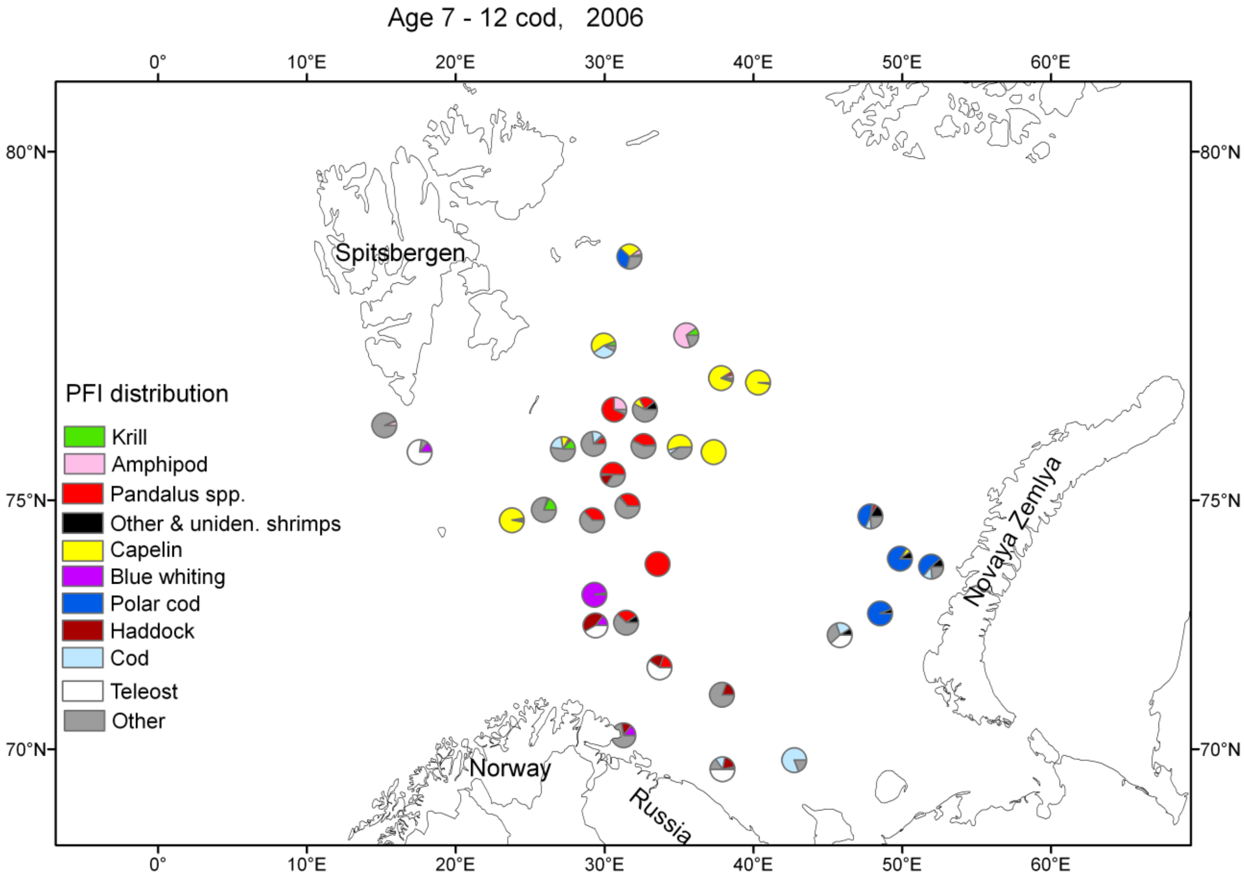

Figure 3.2.3. Geographical distribution of diet composition for age 7-12 cod during the ecosystem survey autumn 2006

4 Capelin

4.1 Capelin, swept-area assessment based on bottom trawl data

A swept-area assessment of capelin caught in the bottom trawl was carried out (using the SAS Survey 5.2 program), and the bottom component of the capelin stock was estimated to 45 thousand tonnes (1.8×10^9 individuals). The estimate is strongly affected by the inclusion of a few large catches, eg. catches of whole schools caught by incident. This problem illustrates the need for a thorough evaluation of the suitability of the swept-area method for assessing the bottom component of the capelin stock. For the calculations based on the current survey data, capelin catches from 1 station was excluded, as this would have increased the estimate to about 147 thousand tonnes (6.0×10^9 individuals). The distribution of capelin caught in the bottom trawl is shown in Figure 4.1.

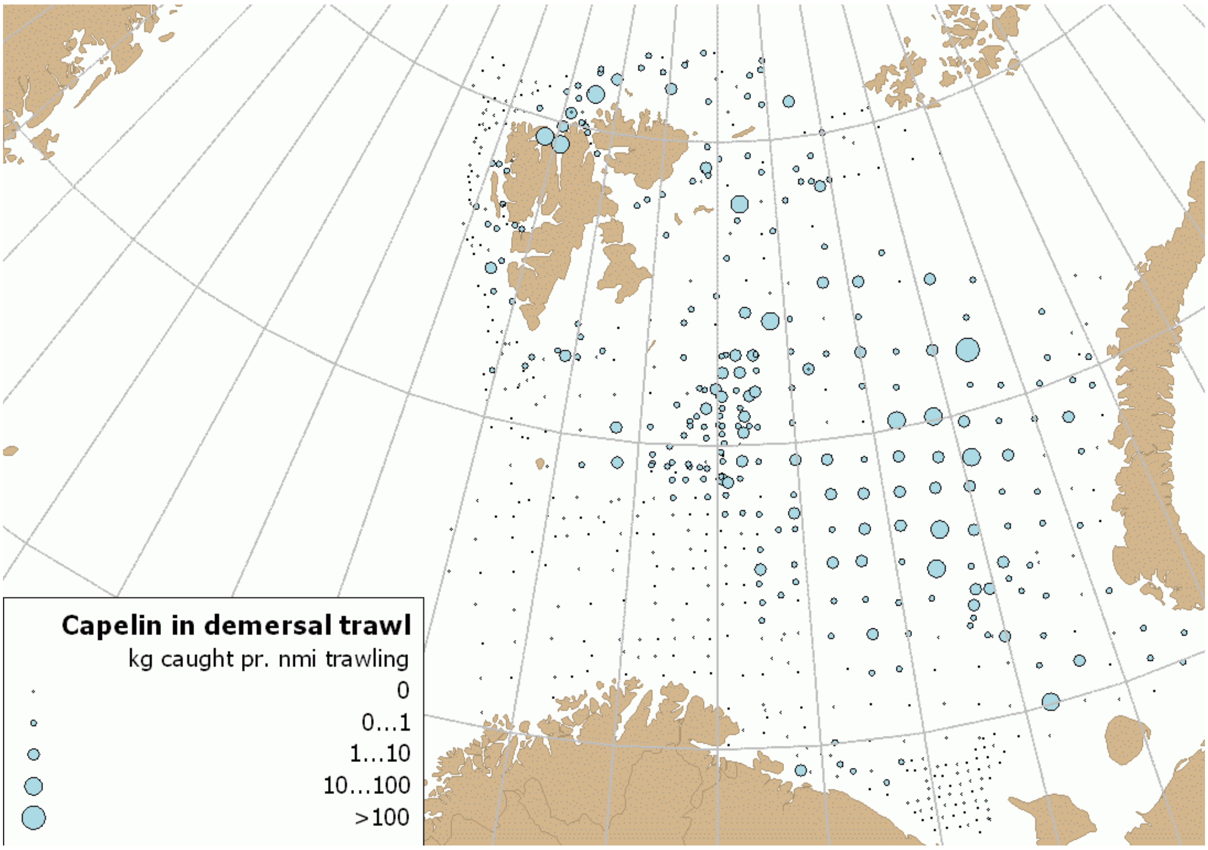

Figure 4.1 Distribution of capelin (*Mallotus villosus*) caught in demersal trawl during the ecosystem survey in the Barents Sea 2006

Table 4.1Age-composition of capelin caught in the bottom trawl (in percent)

Age-groups	1	2	3	4	5
All stations	3.6%	56.8%	38.0%	1.6%	0.0%
Excluding 1 outlying station	12.8%	58.6%	27.6%	1.0%	0.0%

4.2 Length distribution

Based on the stock estimate we found that 83% by number of the capelin were longer than 14 cm (considered to be the maturing part of the stock), which is a considerably higher proportion compared with the acoustic estimate of the pelagic component (25% by number longer than 14 cm).

4.3 Preliminary results of the research on capelin feeding in the Barents Sea

In 2006, also, the preliminary data on the character of capelin feeding in the different parts of the fish feeding area: the western part (the eastern slope of the Bear Island Bank) with the positions of 74-75°N, 23-26°E and the eastern part (The Novaya Zemlya Bank) with the positions of 75-76°N, 46-49°E were obtained. Those parts differed a little in biomass (8-63 g/m^2 in the first one and 17-37 g/m^2 in the second one), but it was large, on the whole. The total number of studied fish was 125 individuals (5 samples). Feeding was investigated by quantity and weight method, feeding intensity was expressed in the indices of stomach fullness (weight of stomach content divided to total fish weight and multiplied on 10 000, SFI, $^0/_{000}$).

In the areas of sampling, to analyze capelin feeding, significant differences in different size fish feeding intensity, which was estimated by SFI, $^0/_{000,}$ were noticed in the late August-early September. They were associated with differences in food supply and in the variability of food composition and condition factor of juveniles and adults in different daytime and layers.

At night, in the western areas, with the occurrence of big concentrations of large (13-17 cm) capelin in the water column (100 m), the fish stomachs contained, primarily, copepods (Figure 4.2) – *Calanus finmarchicus*, *C. glacialis* and *C. hyperboreus* which were exclusively individuals at Stage V and females. All fish had food in their stomachs, their SFI reached 500-800$^0/_{000}$. Taking into consideration that food was partly digested (Destruction Stage 3-5), it may be assumed that intensive digestion was in progress and the food had been eaten in lower layers in the morning and afternoon time. According to another sample taken in the evening further north, the SFI of juvenile capelin (9-13 cm) usually distributed in the upper layers (20-60 m) was very low (Figure 4.3). The stomachs contained primarily large copepods (*Calanus finmarchicus*, *C. hyperboreus* and *Metridia longa* at Stage V), the food was at Digestion Stage 2-5. Larger fish (13-17 cm) which stomachs mainly contained less digested (Stage 2-4) juvenile euphausiids (*Thysanoessa inermis*) had a very great SFI - 500$^0/_{000}$. As in the above-mentioned case, in that period, both small and large capelin were not feeding but digesting food. However, in that area, obviously, the copepods had been already eaten that was the reason for poor feeding in small fish.

In the eastern sea, where capelin feeding was studied in the late September, primarily, mature fish was the object of research. Feeding intensity showed both time and local differences. At the most southward station where, at night, the sample was taken in the lower layers (275 m), fish with the size of 13-19 cm occurring in small quantities there had a very low something missing (Figure 4.4). The smallest and largest individuals had the food (copepods and hyperiids, respectively) at Digestion Stage 5 in the stomachs, that explained a low SFI. Fish intermediate size (15-17 cm) consuming variable food, showed Digestion Stage 3-5 and the SFI was high (SFI – 150$^0/_{000}$). To the north, the intensive feeding of capelin (SFI – 250-370$^0/_{000}$) SFI was recorded in the afternoon time (Figure 4.5) when most of the fish usually occurred in lower layers (240 m). Food was mixed, but in smaller specimens copepods prevailed while larger fish gradually started to feed on euphausiids and hyperiids primarily. Small quantities of *Sagitta* were found in fish of all sizes. The “Copepod” part of the food consisted exclusively of large *Calanus* (*Calanus finmarchicus*, *C. glacialis* and *C. hyperboreus*) as well as the species preferring deeper layers (*Metridia longa*, *Pareuchaeta norvegica*). The euphausiids were represented by *T. inermis*. Judging by the stage of digestion (3-5) they had been mainly eaten in the morning. When taking the sample to study feeding, in the second half of the afternoon, in the water column (140-170 m), where a small part of capelin occurred, the fish SFI was low and practically the same for all fish sizes (Figure 4.6). However, the smallest individuals feeding on large copepods and juvenile euphausiids had food at Digestion Stage 2-5 in the stomachs. This indicate consumption of prey during the afternoon. As a whole, the available data allow us to draw a preliminary conclusion on more favourable conditions for capelin feeding in the studied western parts of the Barents Sea latitudinal zone, as compared to the conditions in the east in August-September 2006.

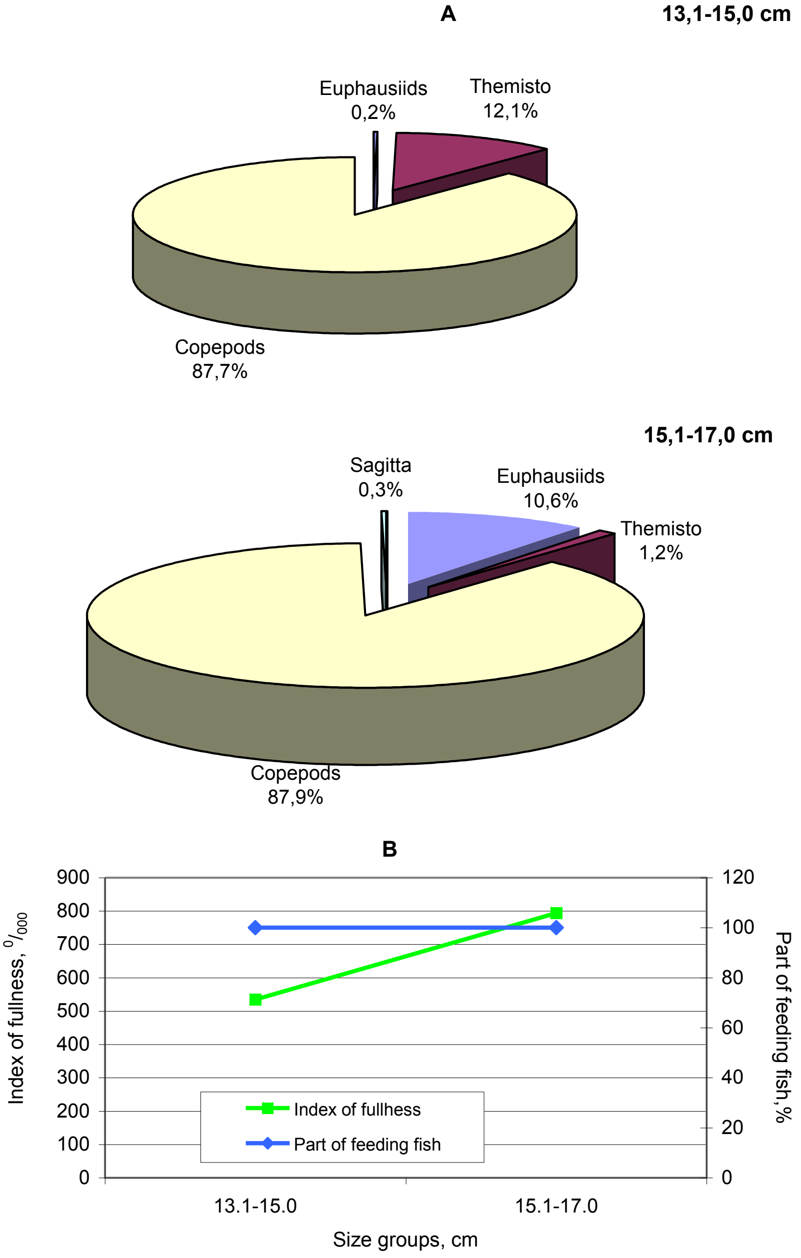

Figure 4.2. Different size capelin food composition (A) and intensity of its consumption (B), in the Bear Island Bank Eastern slope area, in the night time (0.06 a.m.) in 110 m layer in August 2006

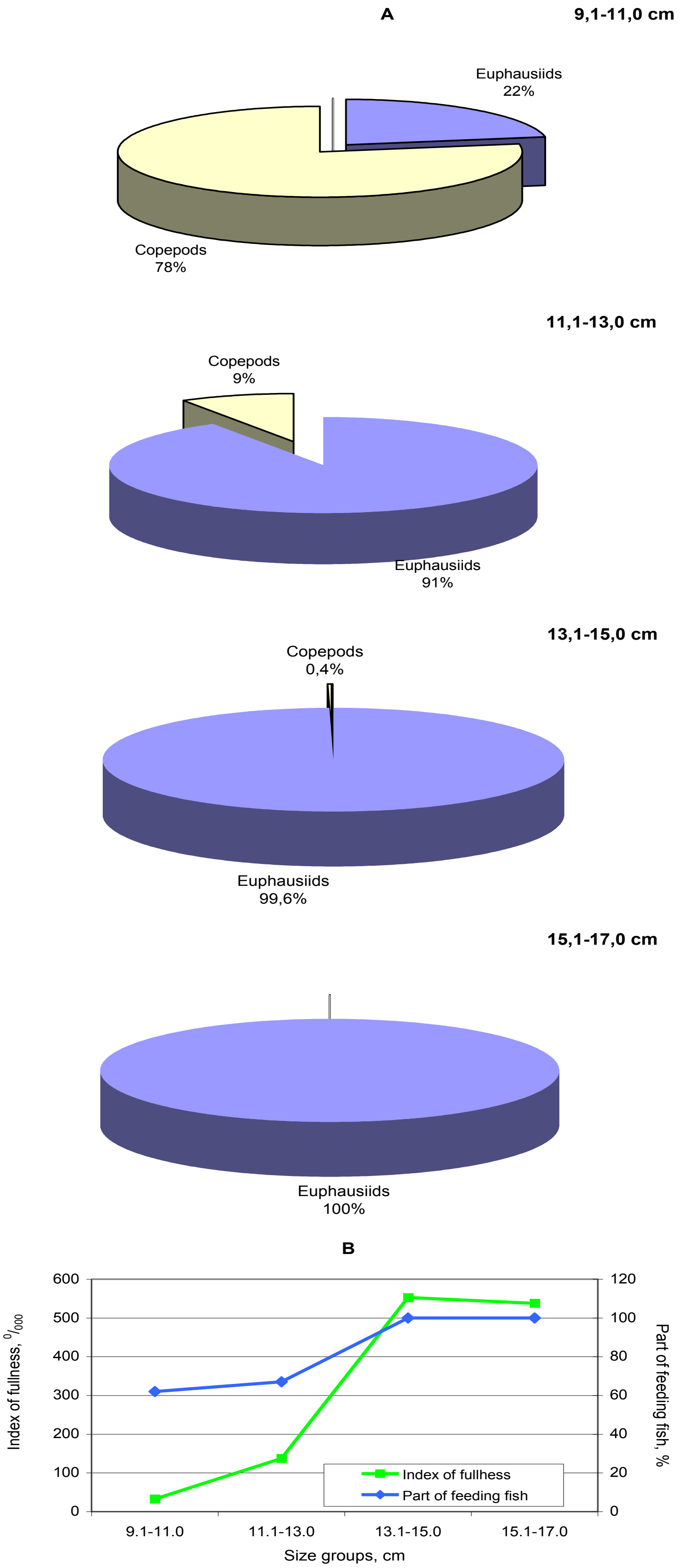

Figure 4.3. Different size capelin food composition (A) and intensity of its consumption (B), in the Bear Island Bank Eastern slope area, in the evening time (8.00 p.m.) in 20-60 m layer in September 2006

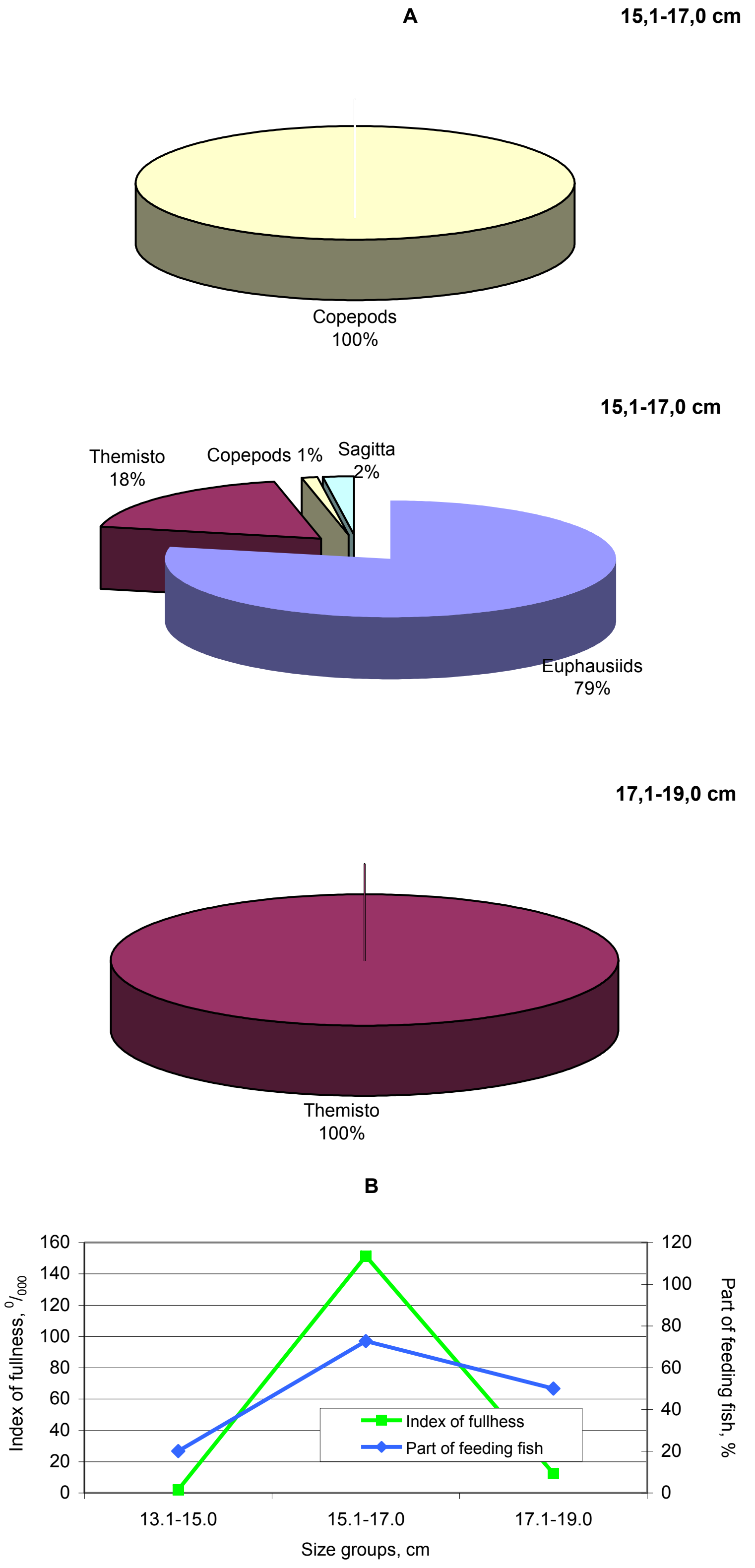

Figure 4.4. Different size capelin food composition (A) and intensity of its consumption (B), in the Novaya Zemlya Bank area, in the night time (0.10 a.m.) in 275 m layer in September 2006

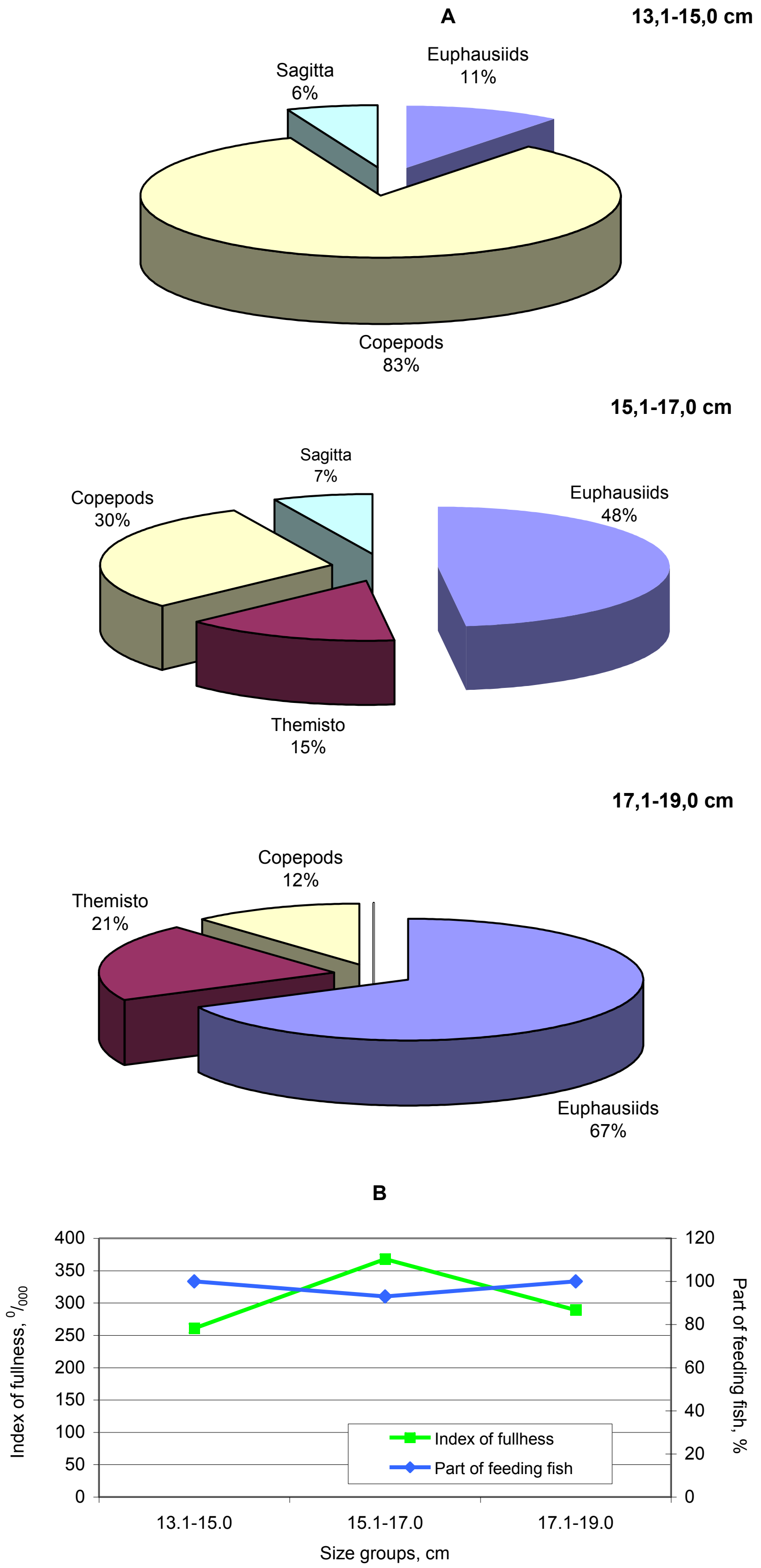

Figure 4.5. Different size capelin food composition (A) and intensity of its consumption (B), in the Novaya Zemlya Bank area, in the afternoon (1.30 p.m.) in 240 m layer in September 2006

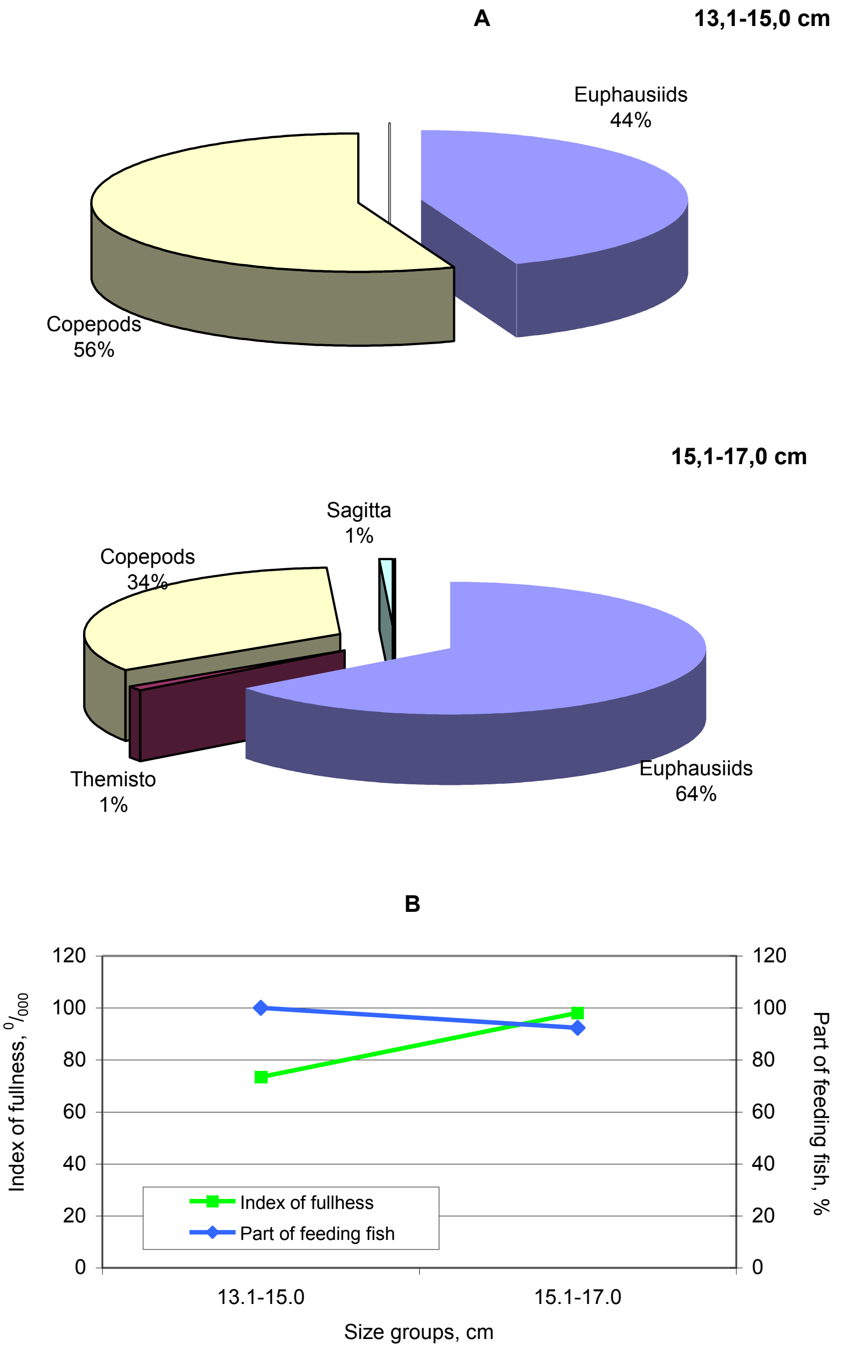

Figure 4.6. Different size capelin food composition (A) and intensity of its consumption (B), in the Novaya Zemlya Bank area, in the afternoon (4.30 p.m.) in 140-170 m layer in September 2006

5 Shrimp in the Barents Sea

5.1 Background

The resource of northern shrimp (*Pandalus borealis*) is distributed throughout most of the Barents Sea. Shrimp within this area is assessed as one stock (Martinez et al. 2006). A multinational fishery exploits the stock and annual landings have ranged from 30000-130000 tons.

A new assessment model was introduced in 2006 Hvingel (2006a). The model synthesized information from input priors, three independent series of shrimp biomasses and one series of shrimp catches. The three series of shrimp biomass indices were: a standardised series of annual commercial-vessel catch rates for 1980–2006 (Hvingel and Aschan 2006); and two trawl-survey biomass series one for 1982–2004 (Anon. 2005a) and the 2004-2006 joint Norwegian-Russian ecosystem survey (Hvingel 2006b).

5.2 Assessment results

5.2.1 Biomass

Since 1970s, the estimated median biomass-ratio has been above its MSY-level (Fig. 5.1) and the probability that it had been below the optimum level was small for most years (Fig. 5.2), i.e. it seemed likely that the stock had been at or above its MSY level since the start of the fishery. A steep decline in stock biomass was noted in the mid 1980s following some years with high catches and the median estimate of biomass-ratio went below the optimum (Fig. 5.1). Since the late 1990s the stock has varied with an overall increasing trend and reached a level in 2006 estimated to be close to the carrying capacity. The estimated risk of stock biomass being below BMSY in 2006 was 4% (Fig. 5.2).

5.2.2 Fishing mortality

The median fishing mortality ratio (F-ratio) has been well below 1 (the fishing mortality at MSY, FMSY) throughout the series (Fig. 5.1). However, as this parameter can only be estimated with relatively large uncertainty and thus there is some probability that the stock was fished above Fmsy (Fig. 5.2). Since 2003 there has been les than 8% risk of the F-ratio being above 1 (Fig. 5.2).

MSY

The posterior for MSY had a mode at 95 ktons and upper and lower quartiles at 91 ktons and 282 ktons. The right tail of the MSY-posterior showed some sensitivity to changes in the prior for caring capacity. However, no matter which prior used the model estimated a probability of at least 95% that MSY is higher than the 2005 TAC of 40 ktons.

5.2.3 Risk assessment for 2007

Given the high probabilities of the stock being considerably above BMSY, risk of stock biomass falling below this optimum level within a one-year perspective is low. Risk associated

Catch option (ktons)	30	50	70	90	110	130
Risk of falling below B_{lim}	<1%	<1%	<1%	<1%	<1%	1 %
Risk of falling below B_{MSY}	4 %	4 %	5 %	5 %	5 %	6 %
Risk of exceeding F_{MSY}	2 %	4 %	8 %	12 %	17 %	21 %

with six optional catch levels for 2007 are as follows:

5.2.4 Risk 10-year predictions

The risk profile associated with ten-year projections of stock development assuming annual catch of 50, 70 and 90 ktons were investigated (Fig. 5.2). For all options the risk of the stock falling below Bmsy in the short to medium term (1-5 years) is low, (<11%) (Fig. 5.2). However, it is less certain that these catch levels can be sustained in the longer term. The stock has a less than 1% risk of being below Blim and none of these catch options are likely to increase that risk above 5% over a 10 year period (Fig. 5.2).

A catch options of 50 ktons – 10 ktons above the advised maximum catch level for 2006 (ACFM 2005) – has a low risk of exceeding Flim and is likely to maintain the stock at its current high level.

Taking 70 ktons/yr will increase risk of going below Bmsy by about 5% during the ten years of projection. However, they will still be lower than 10% during the next 5 years. The risk of that catches of this magnitude will not be sustainable (p(F>Flim) see Fig. 5.2)) in the longer term doubles as compared to the 50 ktons-option but is still below or at 10% after five years .

If the catches are increased to 90 ktons/yr the stock are still not likely to go below its optimum in short term, but whether this catch level will be sustainable in the longer term is uncertain.

5.2.5 Environmental uncertainties

Both stock development and the rate at which changes might take place can be affected by changes in predation—in particular by cod, which has been estimated to consume on average 5 times the catches. If predation on shrimp were to increase rapidly outside the range previously experienced by the shrimp stock within the modelled period (1970–2006), the shrimp stock might decrease in size more than the model results have indicated as likely. However, as the total predation depends on the abundance both of cod and also of other prey species the likelihood of such large reductions is at present hard to quantify.

Changes in temperature, salinity, and large-scale water movements have been observed in the North Atlantic over the past few years (ICES 2006). The trend in the last decade (1995-2005) has been of warming and increasing salinity in the upper ocean. In the Barents Sea, the period 2001-2005 is the warmest five-year period observed since 1900.The bottom temperatures were between approx. 0.3 and 1.3 higher in autumn 2006 than in autumn 2005 in most of the Barents Sea except in the northern and eastern parts, where waters were colder than in 2005. The water temperature at depths of 100 and 200 m was in general higher in 2006 than in 2005 in most of the survey area.

Volume transport of warm Atlantic water into the Barents Sea increases primary production, which in turn might improve conditions for shrimp growth. On the other hand increased primary production could also lead to increase in the abundance of important shrimp predators, e.g. Atlantic cod.

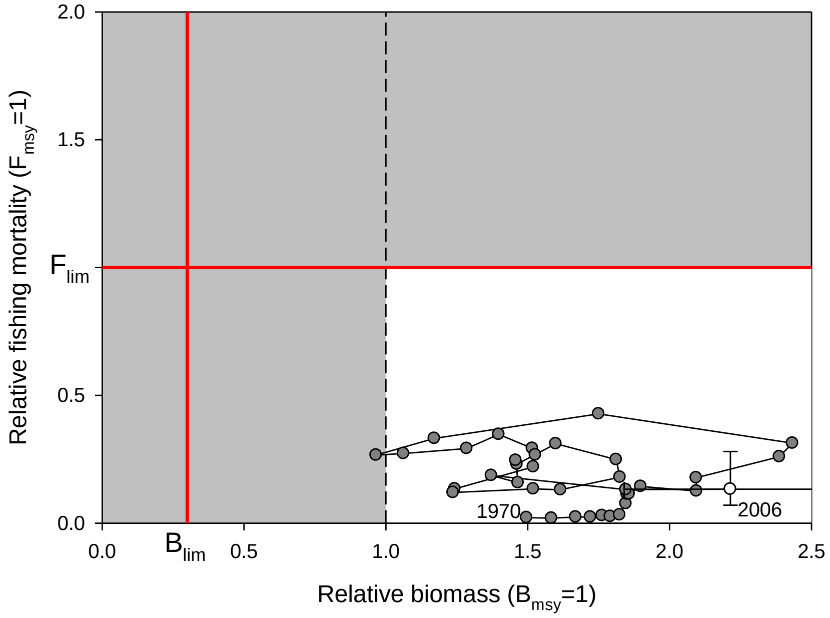

Fig. 5.1. Shrimp in the Barents Sea: estimated annual median biomass-ratio (B/B_{MSY}) and fishing mortality-ratio (F/F_{MSY}) 1970-2006. The reference points for stock biomas, B_{lim}, and fishing mortality, F_{lim}, are indicated by red lines.

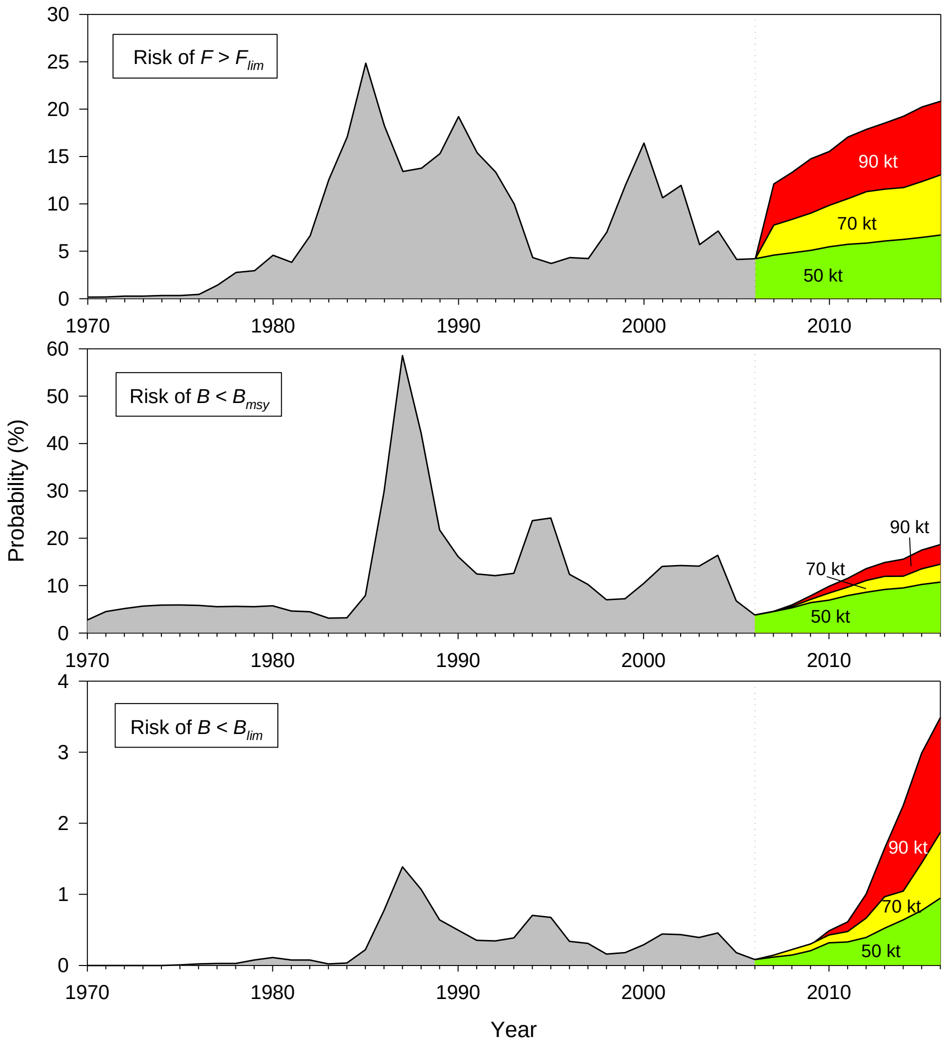

Fig. 5.2. Risk profiles: Estimated risk of exceeding F_{lim} (upper panel) or going below B_{msy} (middle panel) and B_{lim} (lower panel) for the historic period 1970-2005 (greyed area) and future (coloured area) until 2016. Projections are shown for 3 optional catches 50 (green), 70 (yellow) and 90 ktons/yr (red).

6 Zooplankton

This chapter presents the data on zooplankton biomass obtained by the Russian vessel “F. Nansen” (15 August- 5 October September 2006). Plankton was processed using Norwegian method of drying samples (by size fractions) at the vessel with following weighing in vitro. In total, 257 samples (125 ones were taken at 100-0 m depth and 132 – at bottom-0 m depth) were collected and their biomass was determined.

The preliminary analysis showed great differences in biomass over all the wide area of the Barents Sea (Figures 6.1, 6.2). The average biomass values calculated separately for western (18-32ºE), central (32-44ºE) and eastern (44-56ºE) parts were high, amounting to 50 (with 0.1-137 variation), 30 (with 0.2-63 variation) and 25 (with 0.5-56 variation) g/m2, respectively. Visual identification of plankton composition showed the prevalence of three Calanus species (Calanus finmarchicus, Calanus glacialis and Calanus hyperboreus) at elder stages of development, the occurrence of Euphausiacea and Sagitta of ample quantities and, in some cases, of Pteropoda often with high biomass values.

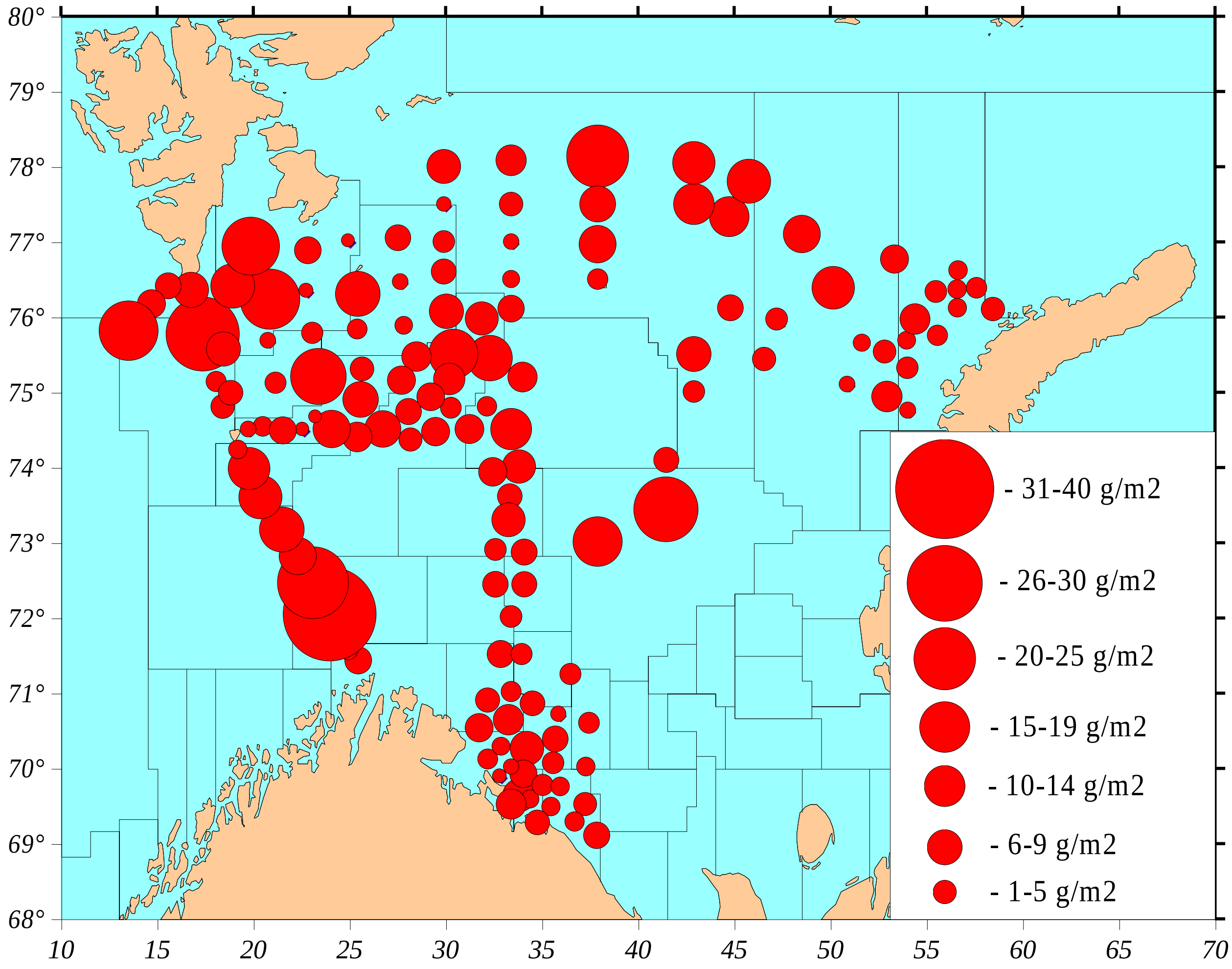

Figure 6.1. Zooplankton biomass distribution in the 0-bottom m layer in August-September 2006.

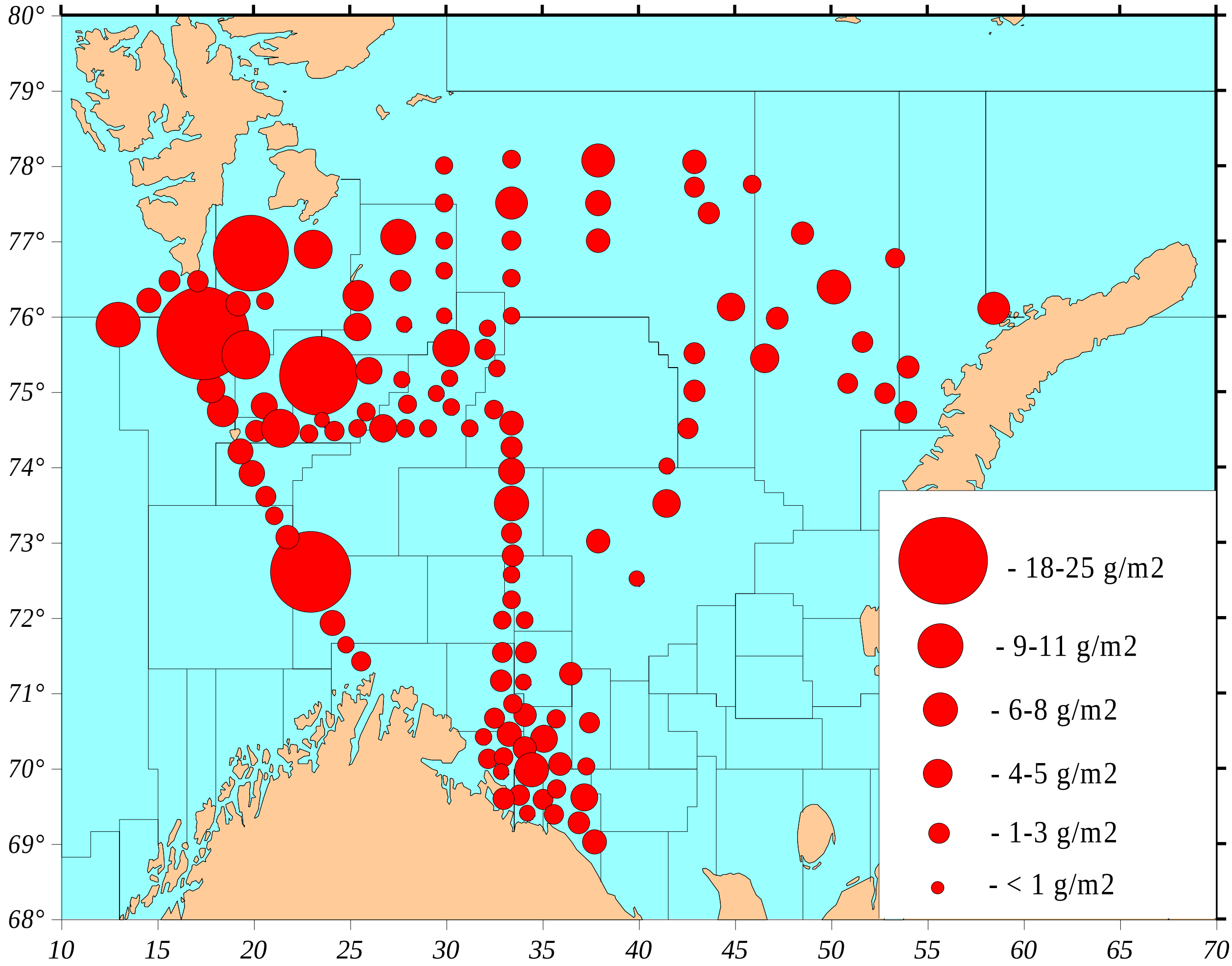

Figure 6.2. Zooplankton biomass distribution in the 0-100 m layer in August-September 2006.

That was also corroborated by the analysis of biomass by separate size fractions : 180-1000, 1000-2000 and >2000 µm. The corresponding mean value of each size fraction were different depending on the area geographical position as well as on the distribution in different layers. In 100-0 m layer, the biomass values of the smallest fraction (180-1000 µm) were approximately the same – 2-3 g/m^2, those ones of larger size fractions varied within (Fig. 6.3). In most of cases, higher biomass was registered in the western sea. As a whole, the biomass values were quite close to those ones in 2005. At the large depths (bottom – 0 m), the biomass was higher sometimes reaching 10-18 g/m^2 (mainly for the size fraction of 1000-2000 µm) (Fig. 6.4). As in 100-0 m layer, higher biomass, with a small exception, was primarily observed in the west areas.

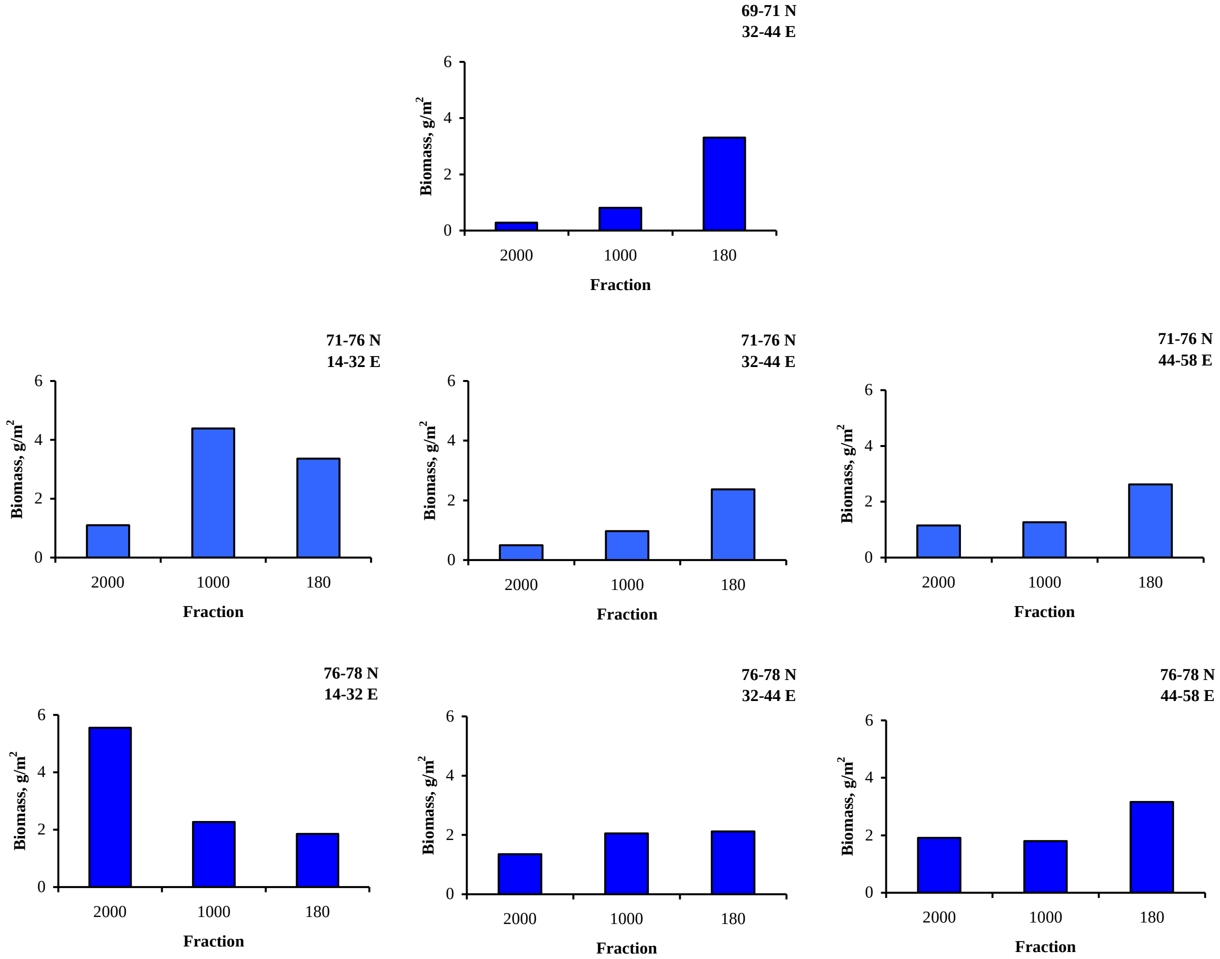

Figure 6.3. Biomass of zooplankton (g/m^2 of dry weight) from different size fractions (µm) in 0-100 m layer in different latitudinal ranges of the Barents Sea in August-September 2006.

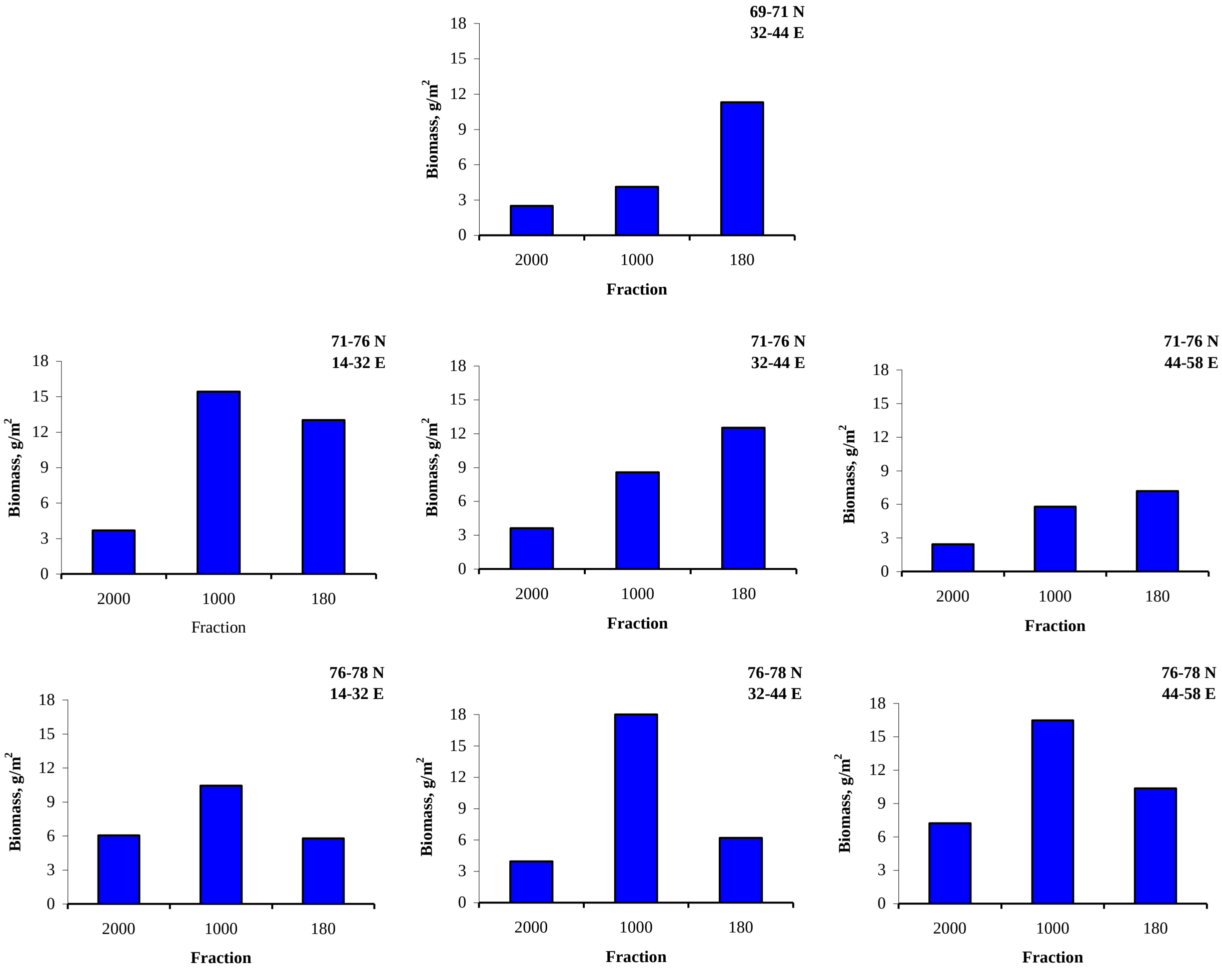

Figure 6.4. Biomass of zooplankton (g/m^2 of dry weight) from different size fractions (µm) in 0-bottom layer in different latitudinal ranges of the Barents Sea in August-September 2006.

7 Benthos

During the survey in by-catches taken by the Campelen trawl 403 taxons belonging to 16 types, 27 classes, 77 orders and 156 families of invertebrates were registered (Table 7.1).

A number of 261 of 403 totally registered taxons were determined to a species level, 81 – to genus, 17 – to the family, 12 – to the order, 19 – to the class and 8 – to the type.

Crustaceans, coelenterates, echinoderms and molluscs taxons are invertebrates the most often registered in by-catches taken by bottom trawls (Fig. 7.1) at more than half of all stations (Table 7.2).

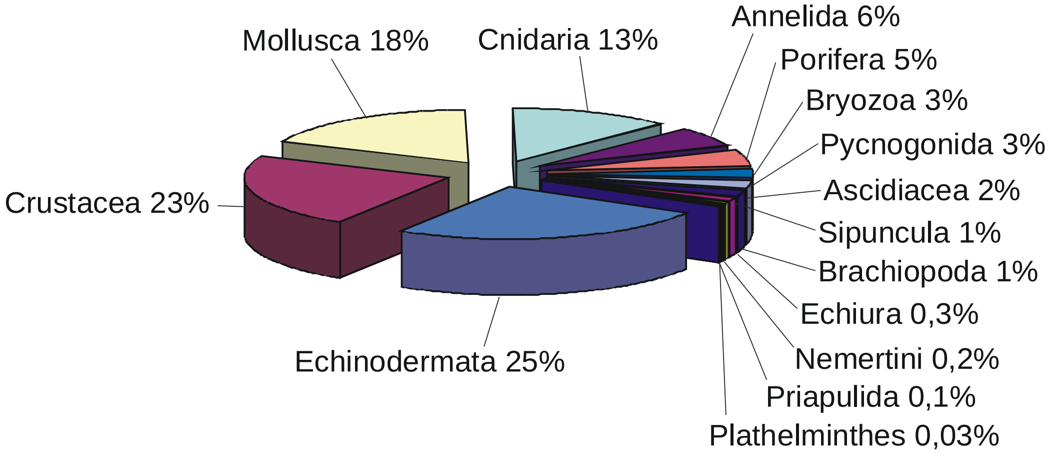

Figure 7.1 – Ratio between the main taxonomic groups of invertebrates by a number of taxons registrations in bottom trawlings by-catches.

It is obvious that some taxa groups are widely distributed and therefore frequently represented in the by-catch. Some of these taxa group are also species rich (Echinodermata, Crustacea, Cnidaria and Porifera) and should be given high taxonomic priority in future in order to evolve quantitative and qualitative comparable and high quality Russian and Norwegian data.

Sponges made up the larges biomass (11,5 tonnes, 41 % of the total catch of 789 stations) (Fig. 7.2). This sponge hotspot of 140g wet weight per m^2 (this weight does not include other associated animals) was mainly recorded in the southwestern part of the Barents Sea. Crustaceans (including prawns, crabs, and squat lobsters) made up 33 % (9,3 tonnes) of the total catch and were mainly made up by deep sea prawn (*Pandalus borealis*) in the Hopen-depth, and king crabs *(Paralithodes camtschtica)* in the southeaster Russian zone of the Barents Sea. Echinodermata (including sea stars, sea urchins, brittle stars, sea cucumbers and sea lilies) made up 50 % (2,5 tonnes) of the catch. These three, main mega-epibenthic, animal groups were followed in biomass by Tunicates (sea squirts), Cnidaria (sea anemones, corals and hydroids) and Mollusca (snails, bivalves, cuttlefish/squids). Then several small groups were represented in varying amounts from 0,2 - 0,005 %.

Weight, % distribution

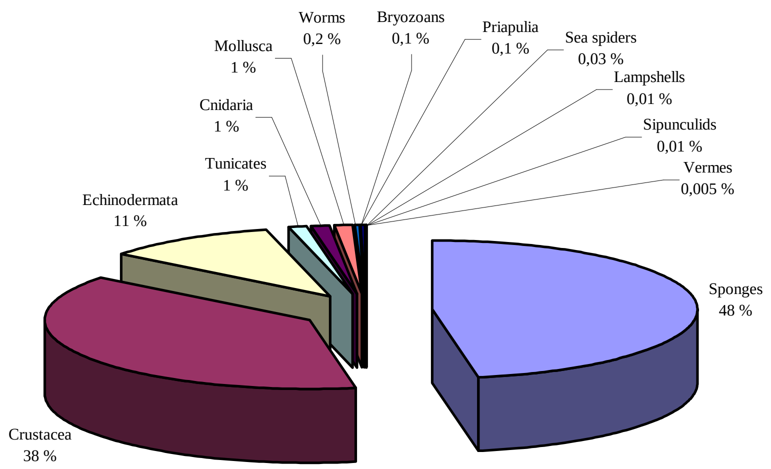

Figure 7.2. The main taxonomic groups of mega epibenthos presented as the % distribution of wet weight, taken as by-catch in August September 2006 from 789 stations in the Barents Sea.

Table 7.2 – Number of stations (total no of stations: 789), at which groups of invertebrates were registered in bottom trawling by-catches.

TAXA	No. of stations, where the taxa was registered	
Malacostraca	710	
Decapoda (prawns, crabs, king crab etc)		536
Amphipoda		294
Isopoda		141
Euphausiacea		81
Cumacea		2
Cnidaria	664	
Pel. cnidaria*		279
Scyphozoa		10
Hydrozoa		126
Anthozoa (sea anemones)		463
Echinodermata	559	
Asteroidea (sea stars)		516
Ophiuroidea (brittle stars)		435
Echinoidea (sea urchins)		312
Holothuroidea (sea cucumbers)		234
Crinoidea (sea lilies)		89
Mollusca	552	
Aplacophora		9
Polyplacophora		7
Bivalvia		381
Gastropoda (snails)		420
Scaphopoda (sea tooth)		4
Cephalopoda (squids)		251
Polychaeta	350	
Pycnogonida	255	
Ascidiacea	182	
Gymnolaemata	161	
Sipunculidea	88	
Porifera	86	
Cirripedia	39	

Rhynchonellata	30
Echiurida	24
Priapulida	10
Turbellaria	3

** Pelagic forms of Cnidaria (Scyphozoa, Ctenophora, Hydromeduzae)*

Table 7.2.1 – A number and percentage of stations, at which representatives of main taxonomic groups of invertebrates were registered in bottom trawlings by-catches..

Taxa	Number of stations, where the taxa was registered	Frequency of registration in the station, %
Crustacea:	711	90
Decapoda	625	79
Amphipoda	314	40
Isopoda	148	19
Euphausiacea	84	11
Cumacea	14	2
Mysidacea	3	0,4
Cnidaria:	665	84
Anthozoa	464	59
Pel. cnidaria*	280	36
Hydrozoa	127	16
Sciphozoa	11	1
Echinodermata	560	71
Asteroidea	517	66
Ophiuroidea	436	55
Echinoidea	313	40
Holothuroidea	234	30
Crinoidea	90	11
Mollusca	552	70
Gastropoda	421	53
Bivalvia	382	48
Cephalopoda	252	32
Aplacophora	10	1
Scaphopoda	5	0,6
Porifera	359	46
Polychaeta	350	44
Pycnogonida	256	32
Ascidiacea	182	23
Bryozoa	162	21
Sipuncula	106	13
Brachiopoda	53	7
Echiura	31	4
Nemertini	23	3
Priapulida	10	1
Plathelminthes	3	0,4

** Pelagic forms of Cnidaria (Scyphozoa, Ctenophora, Hydromeduzae)*

Among crustaceans the most representative group is decapods found in 90% of stations; less represented groups are Amphipods and Isopods (Table 7.2).

Coelenterates are mainly presented in by-catches by *Anthozoa* (predominantly by actinians and soft corals from Alcyonacea) and by pelagic forms: jellyfish and ctenophores (Table 7.2).

The pre-dominating species among echinoderms in by-catches are starfish, ophiurans and, to a less extent, sea urchins and Holothurians. Crinoids were found at less than one third of all stations (Table 7.2).

The predominating groups in by-catches among molluscs are gastropods and bivalves (Table 7.2). Polychaetes are poorly fished by the Campelen trawl. Although this group is distributed over the whole Barents Sea, its representatives were found in by-catches at less than half of all stations (Table 7.2).

Among four main groups presented in by-catches (Crustacea, Echinodermata, Cnidaria and Mollusca) the largest identification problems were with coelenterates and Porifera. A number of registrations of the species range constituted only 30 % during the survey, of which a half of identifications is attributed to Hydrozoa group and was carried out on board of the Russian R/V "F. Nansen" by a specialist in taxonomy of this group. It should also be mentioned that the most of registrations of coelenterates in bottom trawlings by-catches (22 %) belong to pelagic forms, such as jellyfish and ctenophores. Just this group registered in by-catches of Norwegian vessels constituted 279 registrations of the lowest type level (Table 7.3).

Table 7.3 – A number of registrations of various taxonomic ranges of main taxonomic groups of invertebrates found in bottom trawlings by-catches during the ecosystem survey in 2006.

Taxa	Phylum	Class	Order	Family	Genus	Species
Echinodermata		843		31	302	1486 (56%)
Crustacea		7	284	104	273	1354 (67%)
Mollusca		668	63	15	180	960 (51%)
Cnidaria	279	61	480	3	114	395 (30%)
Annelida		247		112	59	214 (34%)
Sipuncula	19					93 (83%)
Porifera	345		5	30	57	77 (15%)
Bryozoa	122				96	67 (24%)
Ascidiacea		161			4	36 (18%)
Brachiopoda	26					32 (55%)
Echiura	7					26 (79%)
Priapulida		4				6 (60%)
Pycnogonida		220			53	
Nemertini	23					
Plathelminthes		3				

The comparative analysis has shown that the best identification situation during the ecosystem survey is with crustaceans. 67 % of the registered taxons of this group were identified to the species level. For echinoderms and mollusks this index is somewhat lower and constitutes slightly higher than a half of registrations (Table 7.3).

The identification accuracy is very small for such an important group as sponges, the frequency of occurrence of which in by-catches constituted 46 % (they were registered at 46 % of stations) (Table 7.2). More than a half of sponges registrations in by-catches (67 %) have the lowest level of identifications – to the type. Identification of sponges to the species level constitutes only 15 % of registrations (Table 7.3).

Taxonomic identification of bryozoans, ascidians and polychaetes is at the same low level (Table 7.3).

Accuracy of taxonomic identification for groups with low species diversity (*Brachyopoda, Echiura, Priapulida*) occurred rarely in by-catches is also not high in spite of quite high percentage of species identifications (Table 7.3).

The lowest taxonomic accuracy of identification was for nemertineans, sea spiders and flatworms. No one representative of this group was identified to the species level during the ecosystem survey.

Analysis of quality of the taxonomic processing of by-catches onboard of various vessels has shown that the main factor determining the level of this index is a professional skill of specialists on taxonomic processing of bottom invertebrates. A good illustration of this is the ratio between taxons of different ranks in results of processing of invertebrates by-catches onboard of various vessels during the ecosystem survey (Table 7.4, Fig. 7.3). The presence of specialists on benthos onboard of R/V "F. Nansen" and "G. O. Sars" improved the quality of taxonomic processing of by-catches compared to vessels ("Smolensk", "Jan Mayen" and "Johan Hjort"), where such specialists were absent.

Table 7.4 – A number of taxons of different ranks in results of processing of invertebrates by-catches during bottom trawling by various vessels in the period of the ecosystem survey in 2006.

Rank taxa	F. Nansen	Smolensk	G.O.Sars	Jan Mayen	Johan Hjort
Fylum	5	3	5	6	7
Class	9	9	14	13	15
Order	8	6	7	5	5
Family	9	2	11	1	1
Genus	52	14	44	0	0
Species	220	40	100	1	2
Total:	**303**	**75**	**184**	**29**	**35**

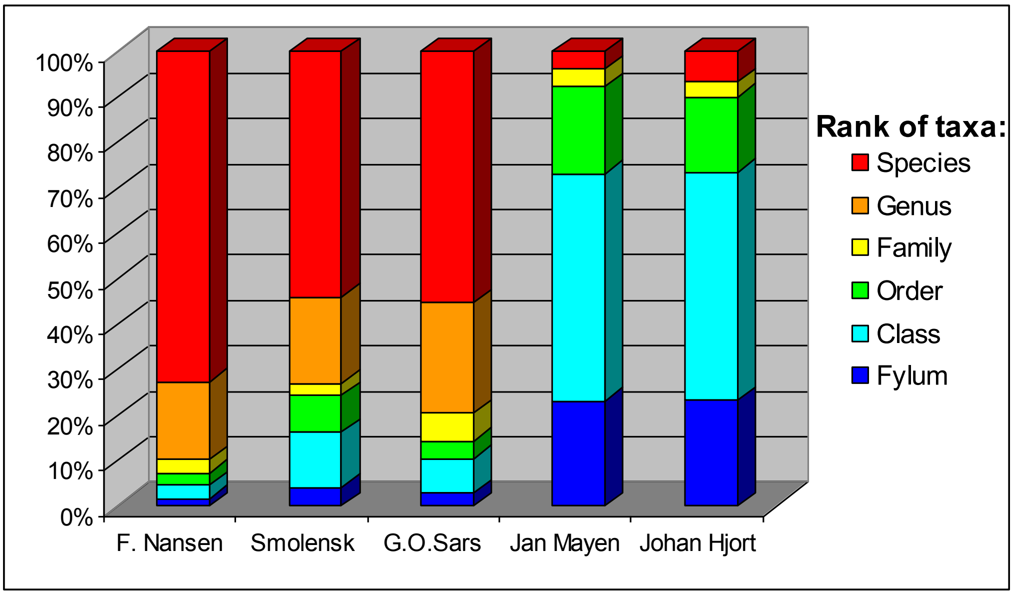

Figure 7.3 – Quality of taxonomic processing of invertebrate by-catches during bottom trawlings by various vessels in the period of the ecosystem survey in 2006: correlation of taxons of different ranks in results of processing.

It is evident that under the present-day range of quality of processing of by-catches the comparison and summation of results obtained by various vessels is of low profit.

Since both institutes – PINRO and IMR – have a limited number of qualified specialists on benthos, it is necessary to take this fact into account when planning the cruises of vessels participating in the ecosystem survey and when choosing the strategy of studying of benthos by by-catches. Minimum three variants of the strategy of studying of invertebrates by-catches during the ecosystem surveys are possible.

1. In order to make up a complete description of bottom communities on the base of by-catches over the whole area covered by the survey, the routes of vessels with a qualified benthos group on board should supplement each other and be changed during a series of years.

2. In order to make the annual monitoring of benthos highly qualified in some local areas, the survey by vessels with specialists on benthos onboard should be carried out just in those areas.

3. The survey carried out in accordance with the first scenario will permit to give during three years a qualitative picture of distribution and status of bottom communities over the whole studied area. Such a strategy of material collection being repeated each 3-4 years will provide for spatially complete and qualitative description of macrozoobenthos distribution, as well as a long-term series of observations with 3-4-year interval.

Table 7.1 – Taxonomical list of invertebrates, recorded in bottom trawling during ecosystem survey in 2006 and a number of stations where the taxons were recorded by different vessels.

Phylun	Class	Order	Family	Taxa	F. Nansen	Smolensk	G.O.Sars	Jan Mayen	Johan Hjort
Porifera				Porifera g. sp.	78	58	73	50	86
	Demospongiae			Tetraxonidae g. sp.	5				
		Astrophorida	Geodiidae	*Geodia* sp.	2		7		
			Pachastrellidae	*Thenea muricata* (Bowerbank, 1858)			18		
			Tetillidae	*Tetilla cranium* (O.F. Mueller, 1776)			5		
				Tetilla sp			2		
		Hadromerida	Polymastiidae	*Polymastia hemisphaericum* (Sars, 1872)	1				
				Polymastia mammillaris (Mueller, 1806)	11				
				Polymastiidae g. sp.	2	4	24		
				Radiella grimaldi (Topsent, 1913)	20				
				Tentorium semisuberites (Schmidt, 1870)	6		2		
				Trichostemma sp.			12		
			Stylocordylidae	*Stylocordyla borealis* (Loven, 1866)			8		
			Suberitidae	*Pseudosuberites* sp.			3		
			Tethyidae	*Tethya norvegica* Bowerbank, 1872			5		
		Halichondrida	Axinelliidae	*Phakellia* sp.	21		7		
				Phakellia ventilabrum (Johnston, 1842)			1		
			Halichondriidae	*Halichondria* sp.	3				
Cnidaria	Hydrozoa			Hydrozoa g. sp.	2		2	37	19
		Athecata	Eudendriidae	*Eudendrium* sp.	3				
				Eudendrium vaginatum Norman, 1864	4				
		Thecaphora	Aglaophenidae	*Cladocarpus integer* (G. O. Sars, 1874)	1				
			Campanulariida	*Gonothyraea loveni* (Allman, 1859)	1				
			Campanulariidae	*Campanularia volubilis* (L., 1758)	3				
				Laomedea flexuosa Hincks in Alder, 1856	1				
				Obelia longissima (Pallas, 1766)	2				
				Rhizocaulus verticillatus (L., 1758)	12				
			Campanulinidae	*Calycella syringa* (L., 1767)	2				
				Lafoeina maxima Levinsen, 1893	12				
				Tetrapoma quadridentata (Hincks, 1874)	1				
			Haleciidae	*Halecium beani* (Johnston, 1838)	4				
				Halecium marsupiale Bergh, 1887	2				
				Halecium muricatum (Ellis & Solander, 1786)	15				
				Halecium sp.	1				
			Lafoeidae	*Grammaria immersa* Nutting, 1901	16				
				Lafoea fruticosa (M. Sars, 1850)	27				
			Sertulariidae	*Abietinaria abietina* (L., 1758)	28				
				Diphasia fallax (Johnston, 1847)	1				
				Diphasia pulchra Nutting, 1904	1				
				Hydrallmania falcata (L., 1758)	2				
				Sertularella gigantea Mereschkowsky, 1878	3				
				Sertularia albimaris Mereschkowsky, 1878	2				
				Sertularia mirabilis (Verrill, 1873)	6				
				Sertularia tenera G.O. Sars, 1874	5				

Phylun	Class	Order	Family	Taxa	F. Nansen	Smolensk	G.O.Sars	Jan Mayen	Johan Hjort
				Symplectoscyphus tricuspidatus (Alder, 1856)	13				
				Thuiaria breitfussi (Kudelin, 1914)	4				
				Thuiaria lonchitis Naumov, 1960	7				
				Thuiaria sp.	1				
				Thuiaria thuja (L., 1758)	4				
			Tiarannidae	*Modeeria plicatile* (M. Sars, 1863)	10				
			Zygophylaxidae	*Zygophylax pinnata* (G. O. Sars, 1874)	7				
	Scyphozoa	Semaeostomeae	Cyaneidae	*Cyanea capillata* (L., 1758)	8				
			Ulmaridae	*Aurelia aurita* (L., 1758)	5				
		Stauromedusae	Eleutherocarpidae	*Lucernaria quadricornis* O. F. Mueller, 1776	1				
	Anthozoa			Anthozoa g. sp.	1				
		Stolonifera	Clavulariidae?	*Clavularia arctica* (M. Sars, 1860)	3				
		Alcyonacea		Alcyonacea g. sp.	5	45	25	28	31
			Nephteidae	*Capnella* sp.			21		
				Drifa glomerata (Verrill, 1869)	15				
				Duva florida (Rathke, 1806)	7				
				Gersemia fruticosa (M. Sars, 1860)	21		15		
				Gersemia rubiformis (Ehrenberg, 1834)	10				
				Gersemia sp.	42				
		Pennatulacea	Umbellulidae	*Umbellula encrinus* (L., 1758)		2			
		Actiniaria		Actiniaria g. sp.	20	109	68	41	85
			Actiniidae	*Bolocera* sp.			1		
				Tealia sp.			1		
			Actinostolidae	*Actinostola* sp.	25				
			Hormathiidae	*Hormathia digitata* (O.F. Mueller, 1776)	77		32		
				Hormathia nodosa (Fabricius, 1780)			6		
				Hormathia sp.	1		1		
		Zoanthacea	Epizoanthidae	*Epizoanthus* sp.	7		10		
		Madreporaria		Madreporaria g. sp.			8	2	13
	Pelagic cnidaria (Scyphozoa, Ctenophora, Hydromeduza)*			Cnidaria g. sp.			47	124	108
Plathelminthes	Turbellaria			Turbellaria g. sp.	3				
Nemertini				Nemertini g. sp.	15		7		1
Cephaloryncha	Priapulida			Priapulida g. sp.			3		1
		Priapulomorpha	Priapulidae	*Priapulopsis bicaudatus* (Danielssen, 1868)	3	1			
				Priapulus caudatus Lamarck, 1816	1				
Annelida	Polychaeta			Polychaeta g. sp.	38	36	38	44	91
		Phyllodocida	Aphroditidae	*Laetmonice filicornis* Kinberg, 1855	5				
			Euphrosinidae	*Euphrosine cirrata* M. Sars, 1862			1		
				Euphrosine sp.	11				
			Nephtyidae	Nephtyidae g. sp.	12				
				Nephtys sp.			5		
			Phyllodocidae	Phyllodocidae g. sp.			3		
			Polynoidae	*Harmothoe* sp.			3		
				Polynoidae g. sp.	59		19		
		Eunicida	Lumbrineridae	*Scoletoma fragilis* (Mueller, 1776)	2				
			Onuphidae	*Nothria hyperborea* (Hansen, 1878)	17				
		Chaetopterida	Chaetopteridae	*Spiochaetopterus typicus* M. Sars, 1856	11				

Phylun	Class	Order	Family	Taxa	F. Nansen	Smolensk	G.O.Sars	Jan Mayen	Johan Hjort
			Spiochaetopteridae	*Spiochaetopterus* sp.			24		
		Flabelligerida	Flabelligeridae	*Brada* af. *granulosa* Hansen, 1880	29				
				Brada af. *inhabilis* (Rathke, 1843)	53				
				Brada af. *nuda* Annenkova, 1922	2				
				Brada granularis			4		
				Brada granulosa Hansen, 1880			2		
				Brada inhabilis (Rathke, 1843)			42		
				Brada sp.			1		
				Brada villosa (Rathke, 1843)			18		
				Pherusa plumosa (O.F. Mueller, 1776)	1				
				Pherusa sp.	1				
		Opheliida	Opheliidae	*Travisia forbesii* Johnston, 1840	8				
			Scalibregmatidae	*Scalibregma inflatum* Rathke, 1843			1		
		Terebellida	Ampharetidae	*Ampharete* sp.			2		
			Pectinariidae	*Pectinaria hyperborea* (Malmgren, 1865)	17				
				Pectinaria sp.			12		
			Terebellidae	Terebellidae g. sp.			10		
		Sabellida	Sabellidae	Sabellidae g. sp.	3		1		
			Serpulidae	*Filograna implexa* Berkeley, 1827	1				
				Serpulidae g. sp.	5				
Echiura				Echiura g. sp.				1	6
	Echiurida	Bonelliida	Bonelliidae	*Hamingia arctica* Danielssen & Koren, 1881	10		15		
		Echiurida	Echiuridae	*Echiurus echiurus echiurus* (Pallas, 1767)	1				
Sipuncula				Sipuncula g. sp.	3			2	14
	Sipunculidea	Golfingiiformes	Phascolionidae	*Phascolion strombus strombus* (Montagu, 1804)	47		34		
			Golfingiidae	*Golfingia margaritacea margaritacea* (M. Sars, 1851)	4	1			
				Golfingia vulgaris vulgaris (de Blainville,1827)	5				
				Nephasoma diaphanes diaphanes (Gerould, 1913)	2				
Vermes indet.				Vermes indet.		18			
Articulata (Chelicerata)	Pycnogonida	Pantopoda		Pycnogonida g. sp.	81	27	36	25	51
			Colossendeidae	*Colossendeis* sp.	5				
			Nymphonidae	*Nymphon* sp.			25		
			Pycnogonidae	*Pycnogonum* sp.			23		
Articulata (Crustacea)	Cirripedia			Cirripedia g. sp.				2	5
		Thoracica	Balanomorpha	*Balanus balanus* (L., 1758)	14				
				Balanus sp.	1	12			
			Scalpellidae	*Ornatoscalpellum stroemii* (M. Sars, 1859)	3				
				Scalpellum sp.	2				
	Malacostraca	Euphausiacea	Euphausiidae	Euphausiidae g. sp.			27	33	22
		Amphipoda		Amphipoda g. sp.	5		54	68	49
				Gammaridea g. sp.	10	35	3		
			Hyperiidae	*Themisto libellula* (Lichtenstein,1882)	1				
			Acanthonotozomatidae	*Acanthostepheia malmgreni* (Goes, 1866)	9				
				Acanthostepheia sp.	8				
			Amathillopsidae	*Amathillopsis spinigera* Heller, 1875	3				

Phylun	Class	Order	Family	Taxa	F. Nansen	Smolensk	G.O.Sars	Jan Mayen	Johan Hjort
			Ampeliscidae	*Ampelisca eschrichti* Kroeyer, 1842	1				
				Ampelisca sp.	1				
				Haploops sp.	2				
			Epimeriidae	*Epimeria loricata* G.O. Sars, 1879	27		18		
				Paramphithoe hystrix (Ross, 1835)	14		2		
			Eusiridae	*Rhachotropis aculeata* (Lepechin, 1780)	5				
				Rhachotropis sp.		6			
			Lysianassidae	Lysianassidae g. sp.	3				
				Anonyx sp.	9	21	1		
			Stegocephalidae	Stegocephalidae g. sp.	18				
				Stegocephalus inflatus Kroeyer, 1842	16		1		
				Stegocephalus sp.	4	6	3		
		Cumacea		Cumacea g. sp.	3	3			
			Diastylidae	*Diastylis goodsiri* (Bell, 1855)	7				
		Decapoda		"Crabs"			8	12	37
				Brachyura g. sp.			2	5	52
				Natantia g. sp.		6	39	94	73
			Crangonidae	Crangonidae g. sp.			1		
				Crangon allmanni Kinahan, 1864			2		
				Pontophilus arcticus ??			1		
				Pontophilus norvegicus M. Sars, 1861	22	5	13		
				Sabinea sarsi Smith, 1879	10		1		
				Sabinea septemcarinata (Sabine, 1821)	79	62	33		
				Sabinea sp.		55			
				Sclerocrangon boreas (Phipps, 1774)	10	13			
				Sclerocrangon ferox (G.O. Sars, 1821)	23	37	15		
				Sclerocrangon sp.		15			
			Galatheidae	*Munida bamffica* (Pennant, 1777)	1				
				Munida sarsi Huus, 1935			6		
			Hippolitydae	*Bythocaris payeri* (Heller, 1875)		5			
				Eualus gaimardi (Milne-Edwards, 1837)	10	19			
				Eualus gaimardi gibba (Kroeyer, 1841)	3				
				Eualus sp.	8				
				Lebbeus polaris (Sabine, 1821)	23	24	1		
				Spirontocaris lilljeborgii (Danielssen, 1859)			1		
				Spirontocaris phippsii (Kroeyer, 1841)	1				
				Spirontocaris sp.	7				
				Spirontocaris spinus (Sowerby, 1802)	21	22			
			Lithodidae	*Lithodes maja* (L., 1758)	2		3		
				Paralithodes camtschatica (Tilesius, 1815)	4	58			8
			Majidae	*Chionoecetes opilio* (Fabricius, 1788)	9	17	1		
				Hyas araneus (L., 1758)	28		8		
				Hyas coarctatus Leash, 1815	8		9		
				Hyas sp.		64	2		
			Paguridae	*Pagurus bernhardus* (L., 1758)	2		3		
				Pagurus pubescens (Kroeyer, 1838)	31	8			
				Pagurus sp.	6		9		

Phylun	Class	Order	Family	Taxa	F. Nansen	Smolensk	G.O.Sars	Jan Mayen	Johan Hjort
			Pandalidae	*Pandalus borealis* Kroeyer, 1837	85	80	55	117	158
			Pasiphaeidae	*Pasiphaea multidentata* Esmark, 1886	1	3			
				Pasiphaea sivado (Risso, 1816)		1			
				Pasiphaea sp.	3				
		Isopoda		Isopoda g. sp.			17	1	36
			Aegidae	*Aega* sp.	1		1		
				Aega ventrosa M. Sars, 1859			1		
			Idotheidae	*Saduria sabini* (Kroeyer, 1849)	36		27		
				Saduria sp.		26			
			Paranthuridae	*Calathura brachiata* (Stimpson, 1854)	7				
		Mysidacea		Mysidacea g. sp.					1
Mollusca	Polyplacophora			Polyplacophora g. sp.	1				5
		Chitonida	Ischnochitonidae	*Stenosemus albus* (L., 1767)	1				
	Aplacophora	Solenogastres	Neomeniidae	Neomeniidae g. sp.			2		
				Proneomenia sluiteri Huebrecht, 1880	2				
			Simrothiellidae	*Kruppomenia* sp.			5		
	Gastropoda			Gastropoda g. sp.	17	72	56	49	92
				Opistobranchia g. sp.			1		
		Patelliformes	Lepetidae	*Lepeta coeca* (O.F. Mueller, 1776)	2				
			Tecturidae	*Capulacmaea radiata* (M. Sars, 1851)	9				
		Pleurotomariiformes	Fissurellidae	*Puncturella noachina* (L., 1771)	1				
		Trochiformes	Trochidae	*Margarites costalis* (Gould, 1841)	11				
				Margarites groenlandicus groenlandicus (Gmelin, 1790)	10				
		Cerithiiformes	Naticidae	*Bulbus smithii* Brown in Smith, 1839			8		
				Cryptonatica clausa (Broderip & Sowerby, 1828)	25				
				Lunatia pallida (Broderip & Sowerby, 1829)	30				
				Polinices sp.			5		
			Velutinidae	*Limneria undata* (Brown, 1838)	17				
				Marsenina glabra (Couthouy, 1838)	2				
				Onchidiopsis glacialis (M. Sars, 1851)	16				
				Velutina sp.	2				
				Velutina velutina (Mueller, 1776)	8				
		Bucciniformes	Beringiidae	*Beringius ossiani* (Friele, 1879)	8		2		
				Beringius turtoni (Bean, 1834)	1		1		
				Beringius sp.	1				
			Buccinidae	Buccinidae g. sp.			5		
				Buccinum angulosum Gray, 1839	2				
				Buccinum ciliatum ciliatum (Fabricius, 1780)	1				
				Buccinum ciliatum sericatum Hancock, 1846	11		1		
				Buccinum elatior (Middendorff, 1849)	14				
				Buccinum finmarchianum Verkruezen, 1875	14		2		
				Buccinum fragile Verkruezen in G.O. Sars, 1878	1		1		
				Buccinum glaciale L., 1761	11				
				Buccinum hydrophanum Hancock, 1846	39		7		
				Buccinum micropoma Jensen in Thorson, 1944			2		
				Buccinum polare Gray, 1839	2				
				Buccinum sp.	13		7		

Phylun	Class	Order	Family	Taxa	F. Nansen	Smolensk	G.O.Sars	Jan Mayen	Johan Hjort
				Buccinum undatum L., 1758	5				
				Colus altus (S. Wood, 1848)	10				
				Colus altus/verkruezeni			1		
				Colus holboelii (Moeller,1842)			2		
				Colus islandicus (Mohr, 1786)	18		19		
				Colus kroyeri (Moeller,1842)	1				
				Colus med sjøanemone			1		
				Colus pubescens (Verrill, 1882)	1				
				Colus sabini (Gray, 1824)	51		2		
				Colus sp.	5		18		
				Neptunea communis (Middendorff, 1901)	3				
				Neptunea denselirata Brogger, 1901	10		6		
				Neptunea despecta (L., 1758)	13		2		
				Neptunea sp.	2		3		
				Turrisipho dalli (Friele, 1881)			1		
				Turrisipho lachesis (Moerch, 1869)	14		6		
				Turrisipho moebii (Dunker & Matzger, 1874)	2				
				Turrisipho voeringi Bouchet & Waren, 1985			4		
				Volutopsis norvegicus (Gmelin, 1790)	16		1		
			Muricidae	*Boreotrophon truncatus* (Stroem, 1767)	2				
		Coniformes	Admetidae	*Admete viridula* (Fabricius, 1780)	4				
			Turridae	*Oenopota* sp.	2				
				Propebela exarata (Moeller, 1842)	1				
		Cephalaspidea	Philinidae	*Philine finmarchica* G.O. Sars, 1878	31		2		
				Philine quadrata (S. Wood, 1839)	2				
				Philine sp.	7		2		
			Scaphandridae	*Scaphander lignarius* (L., 1758)			2		
				Scaphander punctostriatus (Mighels & Adams, 1842)	21		1		
				Scaphander sp.			1		
		Nudibranchia		Nudibranchia g. sp.	39	7	10		
			Aldisidae	*Aldisia zetlandica* (Alder & Hancock, 1854)	1				
	Bivalvia			Bivalvia g. sp.		41	35	34	100
		Nuculiformes	Nuculanidae	*Nuculana pernula* (Mueller, 1779)	1				
			Yoldiidae	*Yoldia hyperborea* (Torell, 1859)	2				
				Yoldiella intermedia (M. Sars, 1865)	2				
		Mytiliformes	Arcidae	*Bathyarca glacialis* (Gray, 1842)	36		27		
				Bathyarca glacialis arctica Messjatzev	1				
				Bathyarca pectunculoides (Scacchi, 1834)	10				
			Mytilidae	*Musculus discors* (L., 1767)	1				
				Musculus laevigatus (Gray, 1824)	3				
				Musculus sp.	1				
		Pectiniformes	Anomiidae	*Anomia squamula* (L., 1767)	2				
			Pectinidae	*Chlamys islandica* (O.F. Mueller, 1776)	33	15	5		
				Chlamys sp.	1		3		
				Chlamys sulcata (O.F. Mueller, 1776)	6				
				Delectopecten vitreus (Gmelin, 1791)	3				
				Pseudamussium septemradiatum (Moeller, 1776)			10		

Phylun	Class	Order	Family	Taxa	F. Nansen	Smolensk	G.O.Sars	Jan Mayen	Johan Hjort
			Propeamussiidae	*Arctinula greenlandica* (Sowerby, 1842)	32	19	18		
				Cyclopecten imbrifer (Lovén, 1846)	1				
		Luciniformes	Astartidae	*Astarte arctica* (Gray, 1824)	2				
				Astarte borealis Schumacher, 1817	1				
				Astarte crenata (Gray, 1842)	65				
				Astarte elliptica (Brown, 1827)	1				
				Astarte sp.	2		36		
			Hiatellidae	*Hiatella arctica* (L., 1767)	22				
				Hiatella rugosa (L., 1758)	1				
		Cardiiformes	Cardiidae	Cardiidae g. sp.			10		
				Clinocardium ciliatum (Fabricius, 1780)	37				
				Serripes groenlandicus (Bruguiere, 1789)	2				
			Myidae	*Mya truncata* L., 1767	4				
			Tellinidae	*Macoma calcarea* (Gmelin, 1791)	1				
		Pholadomyiformes	Lyonsiidae	*Lyonsia arenosa* (Moeller, 1842)	1				
		Cuspidariiformes	Cuspidariidae	*Cuspidaria arctica* (M. Sars, 1859)	23	4	1		
				Cuspidaria sp.			13		
	Scaphopoda			Scaphopoda g. sp.		4			
	Cephalopoda			Cephalopoda g. sp.	1		14	71	75
		Sepiida	Sepiolidae	*Rossia glaucopis* Lovén, 1845			3		
				Rossia sp.	44	4	1		
		Teuthida	Gonatidae	*Gonatus fabricii* (Lichtenstein, 1818)	15		20		
		Octopoda		Octopoda g. sp.		5			
			Octopodidae	*Bathypolypus arcticus* (Prosch, 1849)	16				
Brachiopoda				Brachiopoda g. sp.	7		4	5	10
	Rhynchonellata	Rhynchonellida	Hemithyrididae	*Hemithyris psittacea* (Gmelin, 1790)	12	2			
		Terebratulida	Cancellothyrididae	*Terebratulina retusa* (L., 1758)	6				
			Macandreviidae	*Macandrevia cranium* (O.F. Mueller, 1776)			12		
Bryozoa				Bryozoa g. sp.	59	8	18	9	28
	Gymnolaemata	Ascophora	Phidoloporidae	*Reteporella beaniana* (King, 1846)			7		
		Cheilostomida	Celleporidae	*Cellepora* sp.	20				
			Flustridae	*Flustra* sp.	18				
			Myriaporidae	*Myriapora* sp.	2				
			Reteporidae	*Sertella septentrionalis* Jullen, 1933	12				
			Schizoporellidae	*Myriozoella crustacea* Smitt, 1868	2				
				Myriozoella sp.	6				
			Scrupariidae	*Eucratea loricata* (L., 1758)	15				
		Ctenostomata	Alcyonidiidae	*Alcyonidium disciforme* (Smitt, 1878)		1			
				Alcyonidium gelatinosum (L., 1767)	14				
				Alcyonidium sp.	35	14			
		Cyclostomata	Horneridae	*Hornera* sp.	1				
				Stegohornera lichenoides (L., 1758)	16				
Echinodermata	Holothuroidea			Holothuroidea g. sp.		56	25	2	45
		Dendrochirotida	Cucumariidae	*Cucumaria frondosa* (Gunnerus, 1867)	6				
				Ekmania barthi (Troschel, 1846)			2		
			Phillophoridae	*Thyonidium drummondi* (Thompson, 1840)	3		1		
			Psolidae	*Psolus phantapus* Strussenfelt, 1765	9		2		

Phylun	Class	Order	Family	Taxa	F. Nansen	Smolensk	G.O.Sars	Jan Mayen	Johan Hjort
				Psolus sp.	1				
		Aspidochirotida	Stichopodidae	*Parastichopus tremulus* (Gunnerus, 1767)			3		
		Molpadiida	Caudinidae	*Eupyrgus scaber* Luetken, 1857	4		1		
			Molpadiidae	Molpadiidae g. sp.	2				
				Ankyroderma jeffreysii Danielssen & Koren, 1879	1				
				Molpadia borealis (M. Sars, 1859)	36		37		
		Apodida	Chiridotidae	*Chiridota laevis* (Fabricius, 1780)	2				
			Myriotrochidae	*Myriotrochus rinkii* Steenstrup, 1851	6				
				Myriotrochus sp.	17				
	Echinoidea			Echinoidea g. sp.			24	40	67
		Echinoida	Echinidae	*Echinus* sp.			1		
			Strongylocentrotidae	*Strongylocentrotus droebachiensis* O.F. Mueller, 1776	9				
				Strongylocentrotus pallidus (G.O. Sars, 1871)	62				
				Strongylocentrotus sp.	5	75	30		
		Spatangoida	Schizasteridae	*Brisaster fragilis* (Dueben & Koren, 1846)	7		2		
	Asteroidea			Asteroidea g. sp.			39	92	108
		Paxillosidae	Astropectinidae	*Leptychaster arcticus* (M. Sars, 1851)	8		10		
				Psilaster andromeda (Mueller & Troschel, 1842)		2			
			Goniopectinidae	*Ctenodiscus crispatus* (Retzius, 1805)	87	88	50		
		Notomiotida	Benthopectinidae	*Pontaster tenuispinus* (Dueben & Koren, 1846)	59	39	45		
		Valvatida	Goniasteridae	*Ceramaster granularis* (Retzius, 1783)	2		8		
				Hippasteria phrygiana (Parelius, 1768)	12		5		
				Pseudarchaster parelli Dueben & Koren, 1846			3		
			Poraniidae	*Poraniomorpha hispida* (Sars, 1872)	5	1	18		
				Poraniomorpha tumida (Stuxberg, 1878)	14	10	2		
				Poraniidae g. sp.			5		
		Spinulosida	Echinasteridae	*Henricia* sp.	50		22		
		Velatida	Korethrasteridae	*Korethraster hispidus* W. Thomson, 1873	4		1		
			Pterasteridae	*Diplopteraster* sp.			1		
				Hymenaster pellucidus W. Thomson, 1873	19	12	7		
				Pteraster militaris (O.F. Mueller, 1776)	16	13	19		
				Pteraster obscurus (Perrier, 1891)	10	2	1		
				Pteraster pulvillus M. Sars, 1861	8	2	2		
				Pteraster sp.	3		2		
			Solasteridae	*Crossaster papposus* (L., 1768)	29	16	3		
				Crossaster sp.			10		
				Lophaster furcifer (Dueben & Koren, 1846)	16	8	3		
				Solaster endeca (L., 1771)	7	7			
				Solaster syrtensis Verrill, 1894	13				
				Solaster sp.	4	8	3		
		Forcipulatidae	Asteriidae	Asteriidae g. sp.		23	1		
				Asterias rubens L., 1758		7	1		
				Icasterias panopla (Stuxberg, 1879)	40	26	15		
				Icasterias glacialis ??			3		
				Leptasterias groenlandica (Steenstrup, 1857)	6				
				Leptasterias hyperborea (Danielssen & Koren, 1883)	2	7			
				Leptasterias muelleri (M. Sars, 1846)	2				

Phylun	Class	Order	Family	Taxa	F. Nansen	Smolensk	G.O.Sars	Jan Mayen	Johan Hjort
				Leptasterias sp.	1	5			
				Marthasterias glacialis (Linnaeus, 1758)			1		
				Stephanasterias albula (Stimpson, 1853)	1				
				Urasterias linckii (Mueller & Troschel, 1842)	39	34	9		
	Ophiuroidea			Ophiuroidea g. sp.		72	38	91	79
		Phrynophiurida	Gorgonocephalidae	*Gorgonocephalus arcticus* (Leach, 1819)	15	1			
				Gorgonocephalus eucnemis (Mueller & Troschel, 1842)	12				
				? Gorgonocephalus lamarcki (Mueller & Troschel, 1842)	1				
				Gorgonocephalus sp.	5	46	1		
			Ophiomyxidae	*Ophioscolex glacialis* Mueller & Troschel, 1842	42		20		
		Ophiurida	Ophiacanthidae	*Ophiacantha bidentata* (Retzius, 1805)	68		1		
			Ophiactidae	*Ophiopholis aculeata* (L., 1767)	62		20		
			Ophiuridae	*Ophiocten sericeum* (Forbes, 1852)	15				
				Ophiopleura borealis Danielssen & Koren, 1877	5				
				Ophiura robusta (Ayers, 1851)	20				
				Ophiura sarsi Luetken, 1855	69		39		
				Ophiura sp.			12		
	Crinoidea			Crinoidea g. sp.		19	22	17	7
		Comatulida	Antedonidae	*Heliometra glacialis* (Owen, 1833)	24				
Chordata	Ascidiacea			Ascidiacea g. sp.	50	21	45	5	40
		Aplousobranchia	Polyclinidae	*Synoicum tirgens* Phipps, 1774	4				
		Phlebobranchia	Ascidiidae	*Ascidia* sp.	1				
			Cionidae	*Ciona intestinalis* (L., 1767)	16	7	1		
		Stolidobranchia	Pyuridae	*Hyalocynthia pyriformis* (Rathke, 1806)	2				
			Styelidae	*Botryllus schlosseri* (Pallas, 1776)	1				
				Pelonaia corrugata (Forbes & Good, 1841)	1				
				Styela rustica (L., 1767)	4				
				Styela sp.	3				
				Unidentified taxa				7	

Comment: Taxonomical arrangement is given according: Sirenko B.I. (editor). List of species of free-living invertebrates of eurasian arctic seas and adjacent deep waters. In: Explorations of the fauna of the seas. 51(59). St.-Petersburg, 2001. 76 p.

8 Pollution levels

The level of radioactive pollution in the Barents Sea is very low. But it exists in all the analysed sediment samples from the area. Measurements of radioactive caesium (^{137}Cs) in fish muscle from Barents Sea fish shows a very low content of ^{137}C; less than 1,0 Bq/kg (fresh weight).

Radioactive contamination has been transported into the Barents Sea throughout several decades. The most important sources are fallout from atmospheric bomb tests, the Tsjernobyl accident and discharge from European nuclear industry, and the Sellafield complex in particular. The radioactive contamination in the Barents Sea must also be seen in connection with the vicinity to Russia and its nuclear industry and some unsettled conditions regarding the handling of nuclear waste.

The monitoring of radioactive contamination on the Institute of Marine Research is based on measurement of ^{137}Cs and technetium-99 (^{99}Tc) in seawater, sediments and biota. ^{137}Cs is present in most radioactive discharges, while ^{99}Tc is discharged from Sellafield. In cooperation with Norwegian Radiation Protection Authority (NRPA) has there also been done examinations on other isotopes.

Throughout a tenyear period there are analysed surface sediments from approx. 230 positions in the Barents Sea. The content of all these sediment samples showed values lower than 10 Bq/kg (dry weight). The last analysed series is from 2005, and the content of ^{137}Cs in these samples where <0,6 Bq/kg to 4,7Bq/kg (dry weight).

Fishsamples from the Barents Sea are analysed for ^{137}Cs and the level is shown in figure 1. The samples collected were analysed singlewise from each station. The level varied however not particularly from station to station and the results is presented as main content of ^{137}Cs in the different species from all the stations. The examined species are: long rough dab *(Hippoglossoides platessoides)* (50), capelin *(Mallotus villosus)* (75), Greenland halibut *(Reinhardtius hippoglossoides)* (43), redfish *(Sebastes marinus)* (32), polar cod *(Boreogadus saida)* (50), cod *(Gadus morhua)* (310) and haddock *(Melanogrammus aeglefinus)* (50). The numbers in brackets are the numbers of individs included in the average value. Average content of ^{137}Cs in cod is somewhat lower than cod from the North Sea; in these studies respectively 0,2 and 0,5 Bq/kg (wet weight). (Klungsøyr and Sværen, 2006).

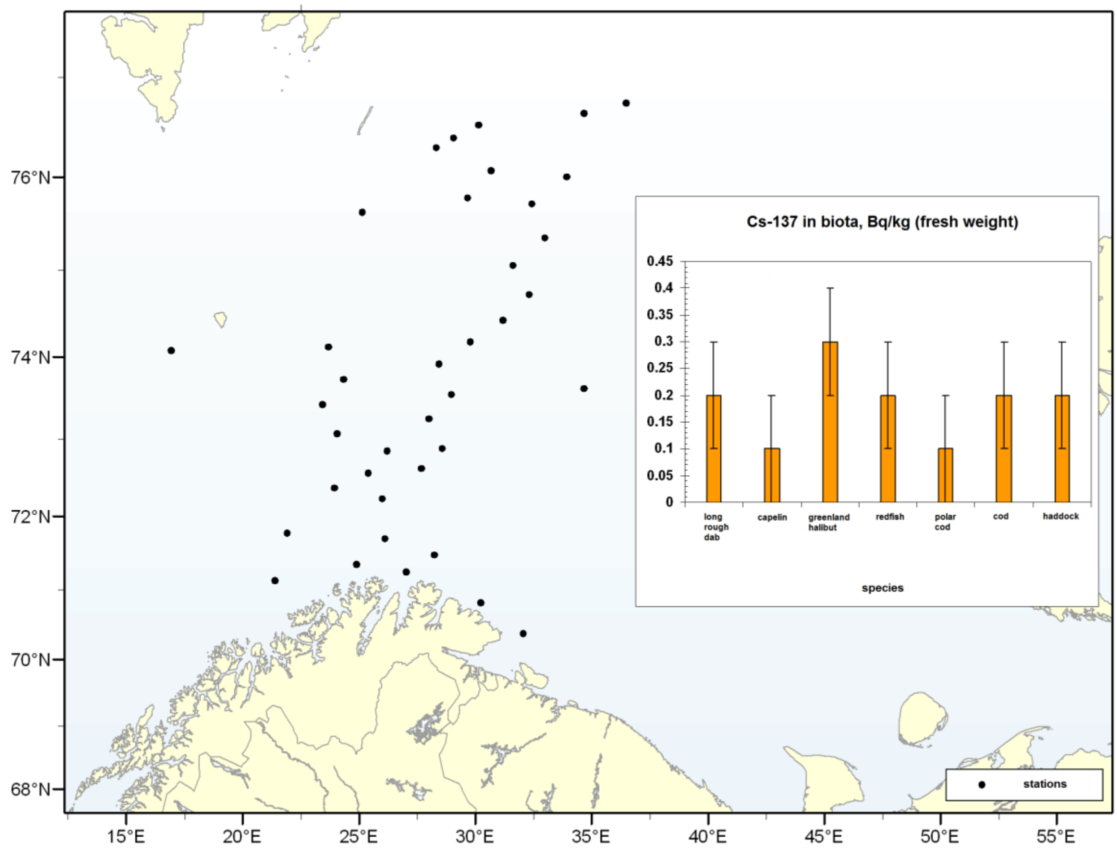

Figure 8.1: ^{137}Cs in fish muscle from Barents Sea fish; Bq/kg (wet weight)

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Institute of Marine Research
Nordnesgaten 50,
5817 Bergen
Norway

Polar Research Institute of Marine Fisheries and Oceanography (PINRO)
6 Knipovich Street,
183763 Murmansk
Russia