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Division 3M Northern shrimp (*Pandalus borealis*) – Interim Monitoring Update

By

J.M. Casas Sánchez

Abstract

This document updates some of the indices for northern shrimp (*Pandalus borealis*) harvested within NAFO Divisions 3M. The assessment for this resource was completed, within Scientific Council during autumn 2009. The indices of biomass in the July 2009 survey showed a sharp decline, confirming recent downward trends, even though the levels of exploitation have been low since 2005. The estimate of stock size was below B_{lim} and it has entered the collapse zone defined by the NAFO PA framework, and recruitment prospects remained poor. Therefore, Scientific Council recommended that the fishing mortality for 2010 and 2011 be set as close to zero as possible. The catch table (to September 2010) and biomass estimates (EU survey summer 1988-2010) are updated within this report. Preliminary data indicate that 5286 t of shrimp was taken in 2009 against an annual TAC of between 18000 and 27000 tons. In the 2010 EU survey the 3M total and female biomass index was 4894 and 3819 t respectively. These indexes were 75% higher than last year and although they were still low compared to historical average they are now above *Blim*. This new situation makes necessary the revision of the recommendation carried out within Scientific Council during autumn 2009.

UE Bottom Trawl Research Survey Trends

Summer multi-species research surveys have been conducted onboard the Spanish vessels R/V Cornide de Saavedra since 1988 and R/V Vizconde de Eza since 2003. From 1988 to 2002 the indexes estimated by the R/V Cornide de Saavedra were calibrated and transformed to the R/V Vizconde de Eza following the Warren's method. Fishing sets of 30 minute duration, with a tow speed of 3 knots, were randomly allocated to strata covering the Flemish Cap Bank to a depth of 1462 m since 2004, with the number of sets in a stratum proportional to its size (Figure 2). Both vessels used the same gear (Lofoten) with a codend mesh size of 35 mm. In order to obtain information about the juvenile fraction of the stock, since 2001 a bag with 6 mm mesh size was attached to the cod-end of the Lofoten gear. SIMRAD ITI and SCANMAR sensors were employed to monitor net geometry. Details of the survey design and fishing protocols are outlined in (Casas, 2008). In 2010 the number of tows planned was lower than previous years due to economic problems. Anyway all strata were sampled properly.

The increasing of biomass from 1988 to 1992, coincided with a period of time where there was not a directed fishery to shrimp and the cod stock began to decline. With the beginning of the shrimp fishery in 1993 the biomass declined up to 1997. After that from 1998 to 2008 the stock recovered reasonably well although with high annual variability (historical maximums in 2002 and 2005 were followed by years with lower biomass but at a relative high level). In 2009 the biomass decreased to values between the lowest of the historical series. The total and female biomass 4894 t and 3819 t respectively estimated in 2010 (Table 1), show an increase about 77 % compared to 2009. Despite this increase the values of biomass are still among the lowest recorded in the total of the historical series. This low values are likely associated to the increase of the cod stock experimented in the last years (Figure 2).

Biomass estimated by depth strata from 1988 to 2009 is shown in Table 2. The presence of shrimp in shallowest strata, with depths less than 140 fathoms (257 m), was scarce in the first years (1988-1995). However, since 1996, a noticeable amount of shrimp occurred in these strata and the estimated biomass increased up to 2002 and 2003 years where the 36 % and 40% respectively of the total biomass were estimated in depths lesser than 140 fathoms. After these years the biomass estimated in these depths declined each year and in 2008, 2009 and 2010 they were residual

(about 0.4 %, 2.4 % and 2.1% of total biomass respectively). The figure 3 shows this evolution between the years 2005-2010.

As in previous years the youngest specimens (age 1) didn't appear in the catches and the abundance at age 2 were weakly presents suggesting the absence of any strong year classes since 2003. (Fig. 4)

Considering the abundance at age 2 as indicator of recruitment, the number of shrimp of two years old in the survey and from juvenile bag (Fig. 5) were estimated and the index average-weighed. Since 2005, both indices showed low values indicating the sequence in the last years of weak year classes. This trend continues in 2010 with a further drop in the value of both indices.

Fishery and Management

Catch trends

The fishery for northern shrimp at Flemish Cap began in the spring of 1993 and has since continued with estimated annual catches (as estimated by STACFIS, Table 3 and Figure 6) of approximately 26000 t to 48000 t in the years 1993 through 1996. After 1996 the catches were lower and rising slowly from 26000 t in 1997 to 53000 t in 2000 and 2001. There was 50000 t taken in 2002. The catch increased in 2003, reaching the highest value in the catches series (64000t), declining in the following years to about 5286 in 2009. Removals to September 2010 (about 1100 t) are lower than the reported in 2009 for the same period and much lower than usually reported in previous years.

Exploitation rate

Considering the Exploitation rate estimated as nominal catches divided by the EU survey biomass index of the same year (Figure 7 and Table 4), this was high in the years 1994-1997 when biomass was generally lower. In the years 1998-2004 the catch rate has been rather stable at a lower level. From 2005 to 2008 despite the exploitation rate remains stable at relative low values (between 1.9-1.5), the UE survey indexes estimated decreased year after year and in 2009 the estimated biomass was the second lowest of the historical series in the EU survey. The preliminary exploitation rate to 10 September 2010 remains low, but this is not based on projected catches and it will increase slightly when the total catch for the year is known.

Effort and TAC regulation

During 2009 meeting, Scientific Council (NAFO 2009) noted the stock was below B_{lim}, it was within the collapse zone defined by the NAFO PA framework, and recruitment prospects remained poor. To be consistent with the precautionary approach, fishing mortality should be kept as close to zero as possible when a stock is in the collapse zone. Therefore, Scientific Council reiterated its September 2009 recommendation for 2010 that the fishing mortality be set as close to zero as possible. Scientific Council recommended that fishing mortality in 2011 be set as close to zero as possible.

In the light of new information from EU Survey summer in 2010, although the stock is at low levels it is now out of the collapse zone. Also the recovery of the cod stock in recent years coinciding with the decline of shrimp stock suggest that this drastic decline of the shrimp biomass may also not be related only to fishing mortality. Annual catches in 2011 around 6500 tons would produce exploitation rates that not exceed the exploitation levels that have occurred from 2005 to 2008 corresponding with medium biomass values. However, because the stock level is now much lower than then this catches should be considered as maximums catches to estimate the exploitation level for 2011 and 2012.

Conclusions

Preliminary data indicate that 1087 t of shrimp had been taken in the 3M shrimp fishery by September 2010 and it is unlikely that the catches in 2010 exceeded those taken by the end of December 2009 (5286 t.).

The low values of the Total and Female biomass index in 2009 continues in 2010 confirming the strong decrease of this stock caused by the weak recruitments in the last six years and the increase of cod stock, one of their most important predators.

Based on the information available in October 2009 Scientific Council reiterated its September 2009 recommendation for 2010 and 2011 that the fishing mortality be set as close to zero as possible. However in the light of new information from EU Survey summer in 2010, although the stock is at low levels it is now out of the collapse zone and the advice ought to be revised.

References

Casas, J. M. 2008. Northern Shrimp (Pandalus borealis) on Flemish Cap Surveys 2007. NAFO SCR Doc.08/ 68, Serial No.N5600

NAFO. 2009. Scientific Council Meeting, 21-29 October, 2009. Appendix IV. Formulation of advice.

Table 1. Total and Female Biomass (tons) of shrimp estimated by swept area method in the years 1988-2010 on EU Flemish Cap surveys.

Year	Total Biomass (tons)	Female Biomass (tons)	Valid Sets Number*
1988	5615	4525	115
1989	2252	1359	116
1990	3405	1363	113
1991	11352	6365	117
1992	24508	15472	117
1993	11673	6923	101
1994[1]	3879	2945	116
1995	7276	4857	121
1996	10461	5132	117
1997	7449	4885	117
1998[2]	39367	11444	119
1999	24692	13669	117
2000	19003	10172	120
2001	27204	13336	120
2002	36510	17091	120
2003	21087	11589	177
2004	20182	12081	177
2005	30675	14381	176
2006	16235	11477	179
2007	17046	12843	176
2008	11092	8630	166
2009	2797	1764	178
2010	4894	3819	153

*Since 2003 the area surveyed and strata number increased up to depths from 740 to 1450 m. increasing proportionally the number of sets.

Table 2. Total shrimp biomass estimated by strata (tons) in the years 1988-2010 from EU Flemish Cap surveys. Between 1988 and 2002 data were transformed by Warren's method. *(cells with 0 values corresponding to strata with biomass lower than 0.5 t; empty cells corresponding to strata with biomass = 0 t.)*

Stratum	(Fathoms)	1988	1989	1990	1991	1992	1993	1994[1]	1995	1996	1997	1998[2]	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	70-80																3	0			0			
2	81-100											175			69	112	690	217	164	8	50	0	0	1
3	101-140				10					148	39	639	450	1486	2169	5527	1817	2107	1023	477	20	11	36	21
4	101-140											239	596	306	1099	1942	637	785	2395	1195	11	1	3	15
5	101-140					8				26	110	1107	1948	2135	2782	2445	3780	867	695	664	558	11	28	21
6	101-140				32	2	5		20	422	161	2915	1142	657	2112	2951	1667	1250	883	299	462	23	1	43
7	141-200		30	400	1265	3763	2704	117	506	1336	988	4056	3072	2213	3006	4632	1521	3108	2607	1370	1642	468	32	495
8	141-200			88	248	1662	826	4	248	676	393	2402	2507	1140	2900	4257	1110	2043	4585	3084	709	1938	308	326
9	141-200	133	69	35			135		613	459	412	3981	1139	1110	1483	1754	819	673	583	1435	1277	1159	48	235
10	141-200	275	75	321	2103	3235	1778	752	1315	1148	1099	7186	4052	2771	3760	3748	4685	2489	2447	614	3248	671	154	467
11	141-200	263		148	1144	4096	1335	447	650	1235	1018	6049	3017	3005	4091	3460	3003	2350	2284	1086	2878	368	174	712
12	201-300	2170	505	512	2361	4654	2115	636	1201	1295	1195	2042	2127	1082	845	1468	378	1222	1510	1524	1965	1585	569	1060
13	201-300		66	64	89	38	136		28	687	554	1580	1465	43	620	217	23	230	689	691	373	1080	149	80
14	201-300	618	375	623	995	2543		679	792	1076	426	3034	1717	689	843	2014	303	726	2155	923	1481	1593	215	305
15	201-300	963	451	855	2004	3605	2292	1078	1370	1278	478	2575	1156	1753	837	1108	483	993	1039	1539	1597	1944	649	824
16	301-400	777	253	355	179	420	139	49	57	237	168	515	172	464	375	506	92	696	1099	840	526	136	145	188
17	301-400						35									3			5	196	56	33	2	
18	301-400						175			43	9			6		44		42	42	115	8	10	3	20
19	301-400	134	359		792	388		118	467	397	404	887	109	121	229	311	61	366	402	173	187	61	278	77
20	401-500																	6	250	29	20	7	1	0
28	401-500																	52	130	175	54	71	26	6
33	401-500																		5		0	0	7	
21	501-600																		0			0	0	
34	501-600																		13		0	1	0	
29	501-600																							1
32	501-600																							0
22	601-700																						0	
30	601-700																							0
	<140	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.3%	5.7%	4.2%	12.9%	16.8%	24.2%	30.2%	35.6%	40.8%	25.9%	21.0%	16.3%	6.5%	0.4%	2.4%	2.1%

[1] codend mesh-size 40 mm
[2] codend mesh-size 25 mm liner

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

Nation	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
Canada	3724	1041	970	906	807	484	490 [2]	618 [1]	295 [2]	16				10 [2]				
Cuba							119 [1]	46 [1]	1037 [1]	1537 [1]	1462	969 [1]	964 [1]	1126 [1]	446	11		
EU/Estonia		1081	2092	1900	3240	5694	10835 [2]	13256 [1]	9851 [2]	14215 [1]	12851 [1]	13444 [2]	12009 [2]	8466 [2]	10607 [2]	10255 [2]	1884 [1]	
EU/Denmark	800	400	200			437	235		[1] 93	[1] 359								
EU/Latvia		300	350	1940 [1]	997 [1]	1191 [1]	3080 [1]	3105 [1]	2961 [1]	1892 [1]	3533 [1]	3059 [1]	2212 [1]	1330 [1]	1939	1285	1198 [1]	
EU/Lithuania		1225	675	2900 [1]	1785 [1]	3107 [1]	3370 [1]	3529 [1]	2701 [1]	3321 [1]	3744 [1]	4802 [1]	3652 [1]	1245 [1]	1992	410		619 [4]
EU/Poland					824 [1]	148 [1]	894 [1]	1692 [1]	209			1158 [1]	458 [1]	224				
EU/Portugal	300		150	[1]	170 [1]	203 [1]	227 [1]	289 [1]	420 [1]	16		50 [1]					3 [1]	
EU/Spain	240	300	158	50 [1]	423 [1]	912 [1]	1020 [1]	1347 [1]	855 [1]	674 [1]	857 [1]	1049 [2]	725 [2]	997 [2]	768	406	640 [1]	
EU/United Kingdom											547 [1]							
Faroe Is.	7333	6791	5993	8688	7410	9368	9199 [2]	7719 [2]	10228 [2]	8516 [2]	12676 [1]	4952 [1]	2457 [1]	1102 [1]	2303	1201	1348 [1]	468 [4]
France (SPM)					150			[1] 138	[1] 337	[1] 161		[1]	487		[1] 741		193 [3]	
Greenland	[1] 3788	[1] 2275	[1] 2400	[1] 1107 [1]	104	866 [1]	576	[1] 1734		[1] 644	[2] 1990		[1] 12	[2] [1] 778				
Iceland	2243	[1] 2355	7623	[1] 20680 [1]	7197 [1]	6572	9277	[2] 8912	[2] 5265	[1] 5754	[1] 4715	[1] 3567	[1] 4014	[1] 2099				
Japan								[1] 114	[1] 130	[1] 100	[1] 117							
Norway	7183	8461	9533	5683 [1]	1831 [1]	1339 [1]	2975	[2] 2669	[1] 12972	[1] 11833	[1] 21238	[1] 11738	[1] 223	[2] 890	[1] 1872	321		
Russia		350	3327	4445	1090		1142	[1] 7070	[1] 5687	[1] 1176	[1] 3	[1] 654	[1] 266	[1] 46	[1] 73	20	20 [1]	
Ukraine									[1] 348		[1] 237	[1] 315		[1] 282				
USA								[1] 629										
Total	25611	24579	33471	48299	26028	30321	43439	52867	53389	50214	63970	45757	27479	18595	20741	12889	5286	1087

1 NAFO Statlant 21 A
2 From the fisheries biologist of respective countries
3 Assessed by Stacfis
4 Reported to NAFO provisionally
* Provisional reported to 10 September

Table 4.- Exploitation Rate of Shrimp (Div. 3M) as Nominal Catches (tons) divided by UE Survey Index (tons).

Year	Nominal Catches	UE Survey Female Index	Exploitation Rate
1993	25611	6923	3.7
1994	24579	2945	8.3
1995	33471	4857	6.9
1996	48299	5132	9.4
1997	26028	4885	5.3
1998	30321	11444	2.6
1999	43439	13669	3.2
2000	52867	10172	5.2
2001	53389	13336	4.0
2002	50214	17091	2.9
2003	63970	11589	5.5
2004	45757	12081	3.8
2005	27479	14381	1.9
2006	18595	11359	1.6
2007	20741	12843	1.6
2008	12889	8630	1.5
2009	5286	1764	3.0
2010*	1087	3818	0.3

* Preliminary data to 10 August

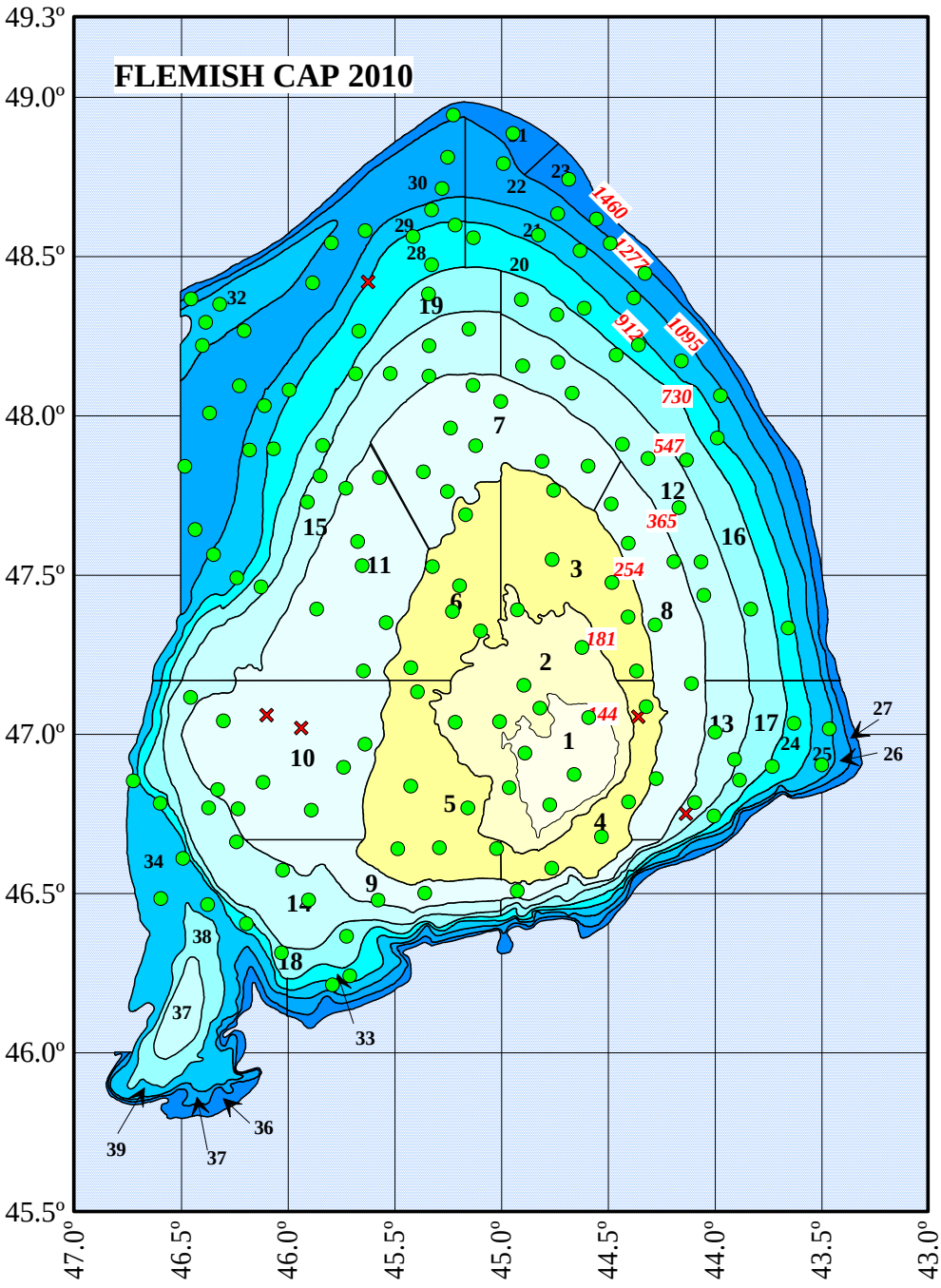

Figure 1.The NAFO 3M stratification scheme used in EU research bottom trawl survey showing the sets carried out in 2010.

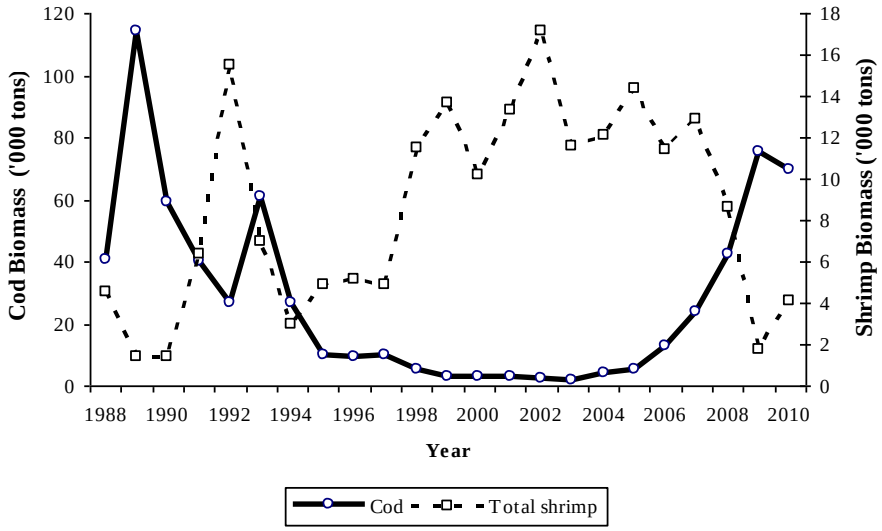

Figure 2. EU survey cod biomass (gross solid line) and total shrimp biomass (dashed line) in the years 1988-2010 on Flemish Cap.

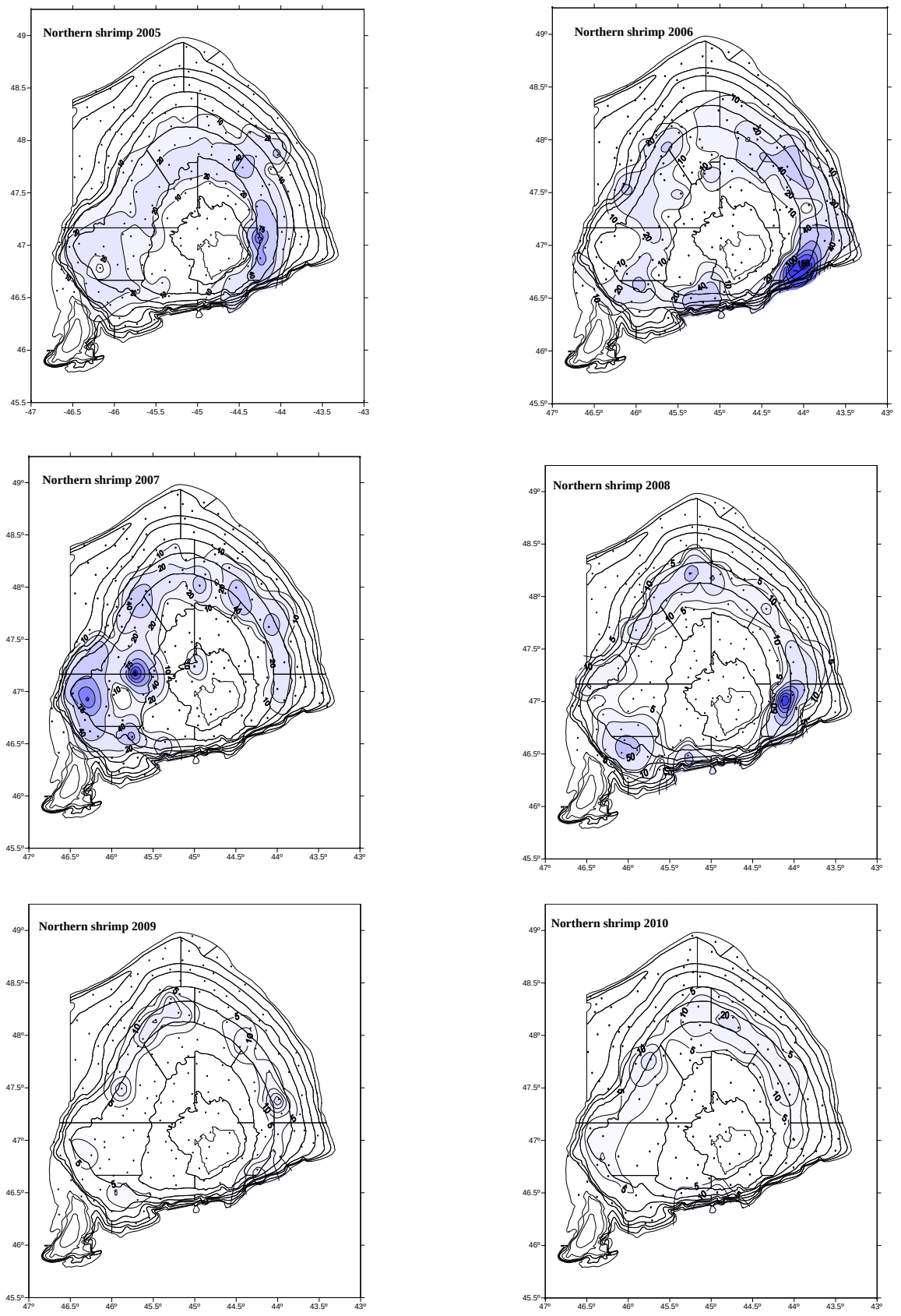

Figure 3.- Distribution of NAFO Div. 3M Northern shrimp (*Pandalus borealis*) catches kg/tow as obtained from EU research bottom trawl surveys conducted over the period 2005-2010.

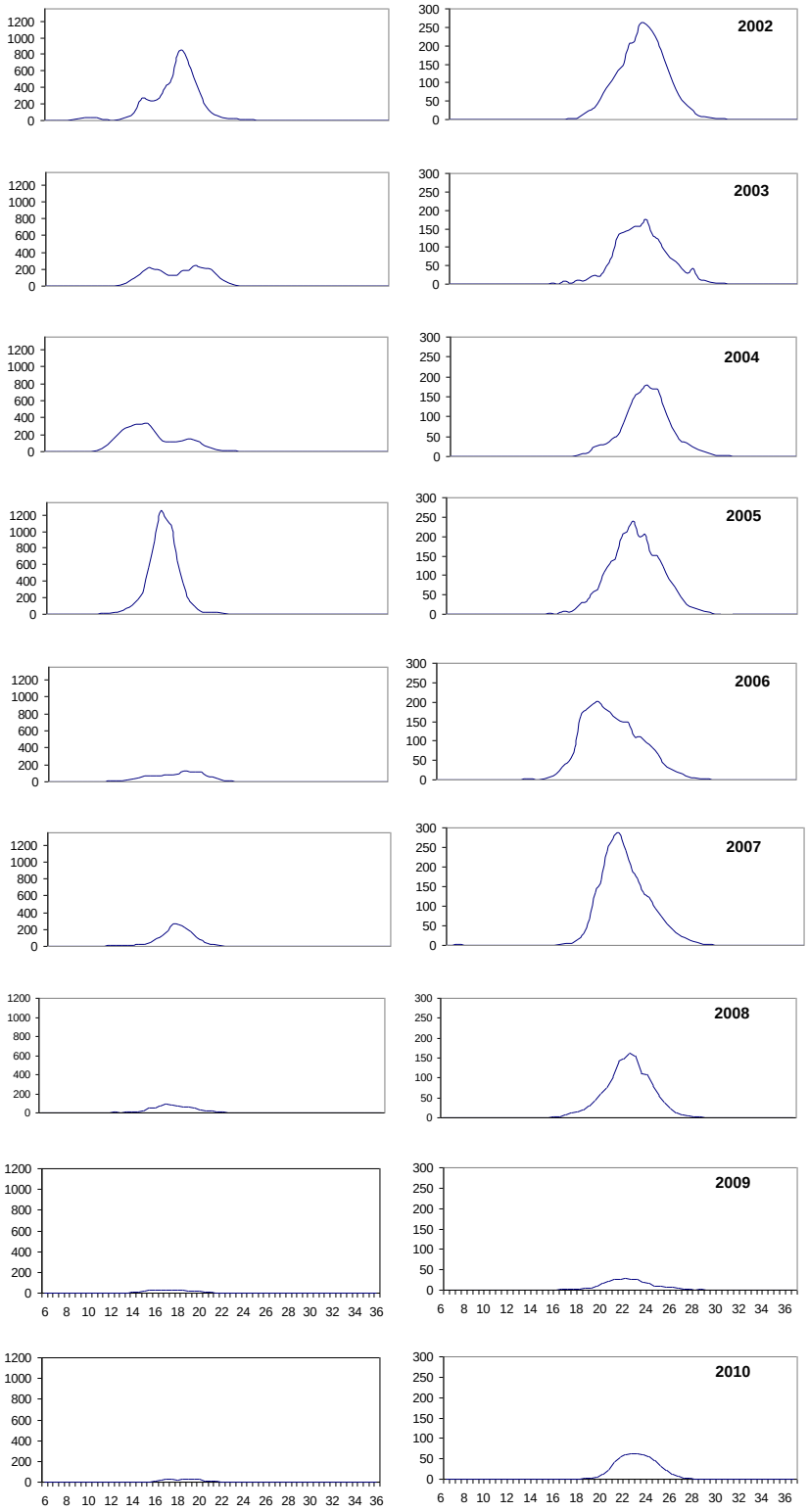

Figure 4. Shrimp size distribution from Flemish Cap 2002-2010 surveys. Y-Axis=Frequency (10^6), X-Axis=Carapace Length (mm).

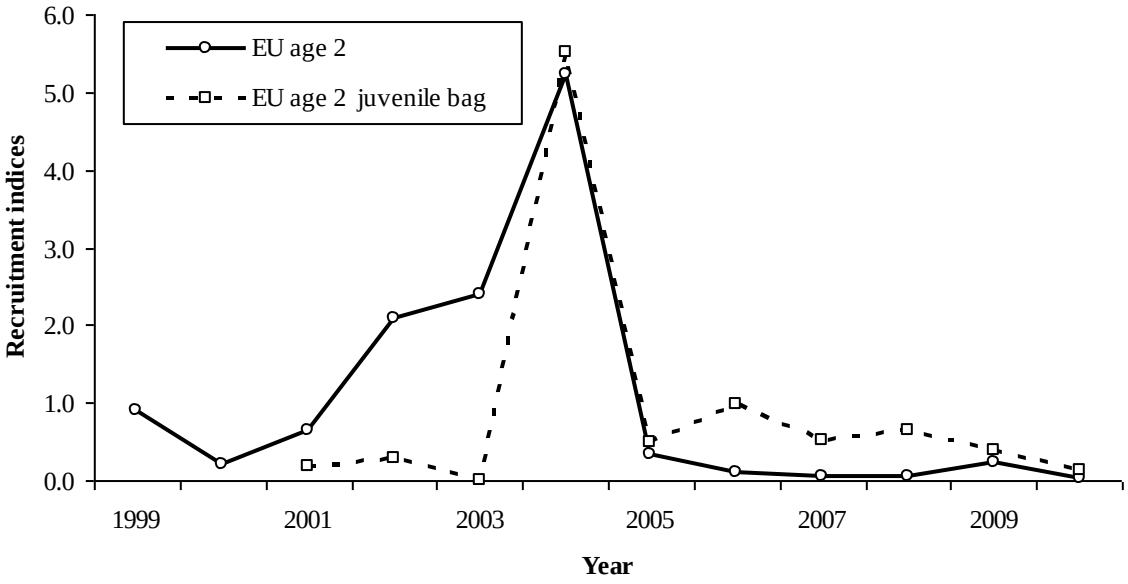

Figure 5. Abundance indexes at age 2 obtained in EU Flemish Cap surveys from Lofoten gear (black line) and Juvenile bag (dotted line).

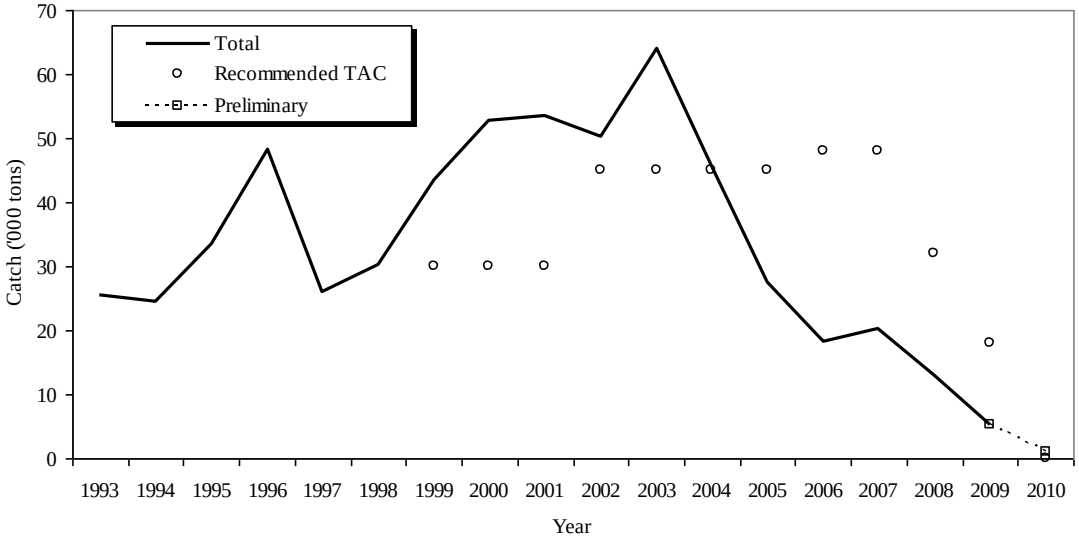

Figure 6. Trends in NAFO Div. 3M northern shrimp (*Pandalus borealis*) catch (t) and TAC over the period 1993-2010.

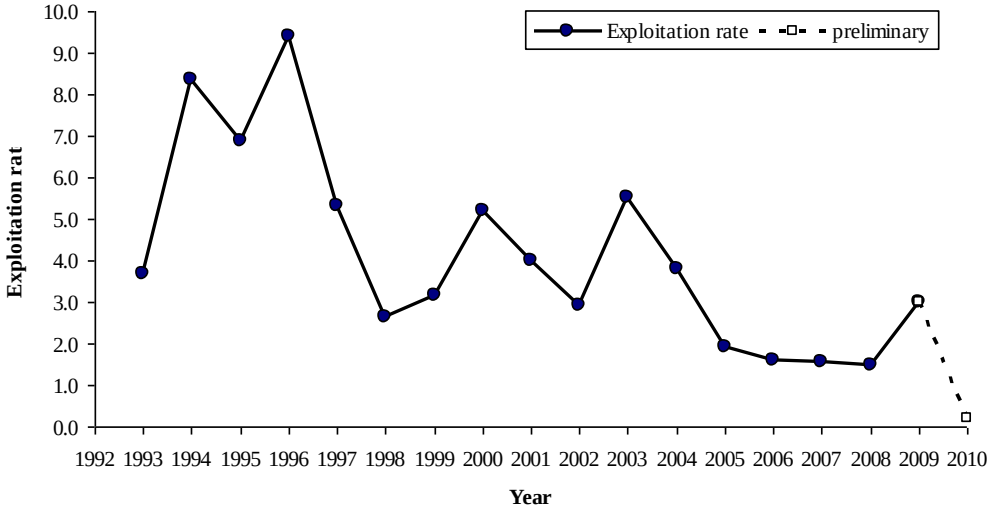

Figure 7. Exploitation rates as nominal catch divided by the EU survey biomass index of the same year. Dashed line shows the preliminary data in 2010