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**Results of the Greenland Bottom Trawl Survey for Northern shrimp (*Pandalus borealis*)
Off East Greenland (ICES Subarea XIV b), 2008-2014**

by

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Abstract

The 2014 survey for Northern Shrimp (*Pandalus borealis*) in East Greenland estimate the biomass of shrimp to be at the same low level as in 2012 and 2013 and that the shrimp stock is concentrated in the area north of 64°N and in depth between 200 and 400 meter. The biomass for the entire survey area are low compared to West Greenland and the absence of the smaller male and juvenile shrimp in the survey area stresses that the total area of distribution and recruitment patterns of the stock are still unknown.

Introduction

Since 2008 stratified-random trawl surveys has been conducted to assess the stock status of northern shrimp in East Greenland. The main objectives were to obtain indices for stock biomass, abundance, recruitment and demographic composition. The area was also surveyed in 1985-1988 (Norwegian survey) and in 1989-1996 (Greenlandic survey), but the historic surveys is not directly comparably with the recent survey due to different area coverage, survey technique and trawling gear. However, both showed similar levels of biomass and abundance and the presence of large shrimps. Absence of the smaller male and juvenile shrimp in the survey area stresses that the total area of distribution and recruitment patterns of the stock are still unknown.

This document presents results on biomass, abundance and sex-composition from 2008 - 2014 surveys, and attempt to compare these results with survey conducted in 1989-1996.

Material and Methods

The survey is carried out with the same gear and survey protocols as used in West Greenland (Burmeister *et al.*, 2014). Stratification was based on the “Q-areas” used for the Greenland halibut survey (Fig. 1.) and the area are further depth stratified into 0-200 m, 200-400m and 400-600 m zones (area sizes are given in table 1). Total survey area has been estimated to 118.107 km². Standard tow duration was set to 15 minutes at all stations. Towing speed have been about 2.5 knots in all cases.

Stations were randomly selected from historical known trawable sites, however, a number of the selected positions were not deemed trawable. A total number of 80 valid hauls were made in 2014 (table 1) a little lower earlier years. Trawling has been carried out days and nights (24 hours). The influence of light induced nocturnal vertical migrations of shrimp has not been taking into account in the estimation of biomass.

Biomass estimation

For each tow, the catch was divided by the estimated swept area calculated from wingspread and track length to estimate haul by haul biomass density. Mean stratum densities were multiplied by the stratum area to compute stratum biomass, and corresponding coefficients of variation (CV, in %) for each stratum were calculated from the swept area estimate of the biomass (B) and the standard deviation of the density times the stratum area (STD) – see Burmeister *et al.*, 2014 for details.

Demography

From each catch a sample of about 0.5 to 3 kg of shrimp was taken and sorted to species. All specimens of Northern shrimp were grouped into males, primiparous and multiparous females based on their sexual characteristics according to Allen (1959) and McCrary (1971). The oblique carapace length (CL) of each shrimp in the sub sample was furthermore measured to the nearest 0.1 mm using callipers. The West Greenland length-weight relationship (Burmeister *et al.*, 2014) was used on the East Greenland shrimp sample to estimate the female and males abundance and proportion of females.

Temperature

Bottom temperature was measured with a *Starmon* sensor mounted on one of the trawl doors. It records at intervals of 30 s with a resolution of 0.01°C. The average temperature for each haul was calculated after retrieval of the sensor. All measurements taken at greater depths than 150 m were used to calculate a mean bottom temperature weighted for the areas of the survey strata between 150 and 600 m depth.

Results and Discussion

Biomass and Stock composition

For all strata biomass estimates have been calculated (Tab.2 and Tab.3) on the basis of the nominal swept area (Burmeister *et al.*, 2014). Total biomass has been low since 2012 and the stock is mainly located in the northern part in Q1 (Fig. 1) in 2013 and 2014 (Fig. 3) with 98% of total biomass. Shrimp biomass in the remaining southerly offshore areas (Q2-Q6) showed very low densities (Tab. 2 and Fig. 3). The shrimp occurs mainly between 200 - 400 meter and in 2014 more than 90% of the biomass is found in here.

The demographic structure in East Greenland shows large males with 20mm CL as the smallest (Fig. 4). A calculation of the fishable biomass of individuals equal to and above 17 mm CL has therefore not been calculated. Biomass and abundance of female and males weighted up to total biomass are presented in Tab 6 and Tab 7. Female biomass is on average on 1.936 tons (7 years). In 2014 female biomass was on 1.474 tons (tab. 7).

Total numbers of shrimp (males and females) in 2014 was estimated to 192 million or herby half of the average on 407 million for the seven years time series. The abundance of males in 2014 is 97 million – a proportion on 51% and the lowest on time series.

Bottom temperature and biomass

The overall mean bottom temperature in the shrimp survey area was stable near 4°C from 2008 -2014 (Fig. 6). From 2008-2014 the areas south of 65°30 N (Q2-Q6) all have an average temperature between 3°C and 5°C, however temperature in the north of 65°30 N (Q1) average temperature is between 1°C and 2°C. Almost all shrimp biomass is located in north of 65°30 N (Q1) (97% of total biomass).

Comparison with earlier surveys

Stratified-random trawl surveys have been carried out in Denmark Strait in 1989-1992 and in 1994-1996 the surveys was conducted by a sampling technique based on the Spline Designer Software System. The surveys in the 1980ties and 1990ties were conducted in the shrimp fishing area North of 65N up to 67N. The recent surveys since 2008 covered the shelf area from Cap Farwell to Dorhn area up to 67N. To compare the two survey time series only the areas Q1 and Q2 in recent surveys are used. Table 8 list the biomass estimates, numbers of stations, area covered, cod-end mesh size and survey technique from all surveys in 1980ties and 1990ties and the recent surveys since 2008. It is difficult to compare the different surveys due to different survey technique and trawling gear. However the low biomass estimate and the demographic structure in all surveys is very must in correspondence.

Conclusions

The biomass of shrimp in East Greenland in 2014 is estimated to be at the same low level as in 2008, 2012 and 2013 and to be the third lowest in the series. The 2009-2011 biomass was estimated to more than double of the 2012, 2013 and 2014 value. Absence of the smaller male and juvenile shrimp in the survey area stresses that the total area of distribution and recruitment patterns of the stock are still unknown.

References

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Table 1. Vessels, trawl types and rigging parameters used in the Greenland Bottom Trawl Survey for shrimp and fish, 2008–2014.

	Vessel	Trawl	Bridle length (m)	Wingspread (m)
2008–2014	Paamiut	Cosmos	54.0	28.1-30

Table 2. Survey estimates of total biomass 2014.

Stratum	Area (km ²)	Stations	Biomass density (t/km ²)	Biomass (Kt)	Biomass error variance	Error coefft of variation (%)
Q1-0	0	0	0.00	0.00	0.00	0.00
Q1-2	35662	14	0.07	2.34	0.84	39.24
Q1-4	6975	7	0.02	0.15	0.01	50.42
Overall Q1	42637	21	0.06	2.48	0.85	37.05
Q2-0	93	2	0.00	0.00	0.00	0.00
Q2-2	7657	10	0.00	0.00	0.00	66.67
Q2-4	1246	2	0.00	0.00	0.00	0.00
Overall Q2	8996	14	0.00	0.00	0.00	66.67
Q3-0	3363	0	0.00	0.00	0.00	0.00
Q3-2	22547	6	0.00	0.02	0.00	82.56
Q3-4	9830	6	0.00	0.04	0.00	47.99
Overall Q3	35740	12	0.00	0.06	0.00	41.86
Q4-0	1337	2	0.00	0.00	0.00	0.00
Q4-2	7770	5	0.00	0.00	0.00	54.09
Q4-4	2054	2	0.00	0.00	0.00	28.54
Overall Q4	11161	9	0.00	0.01	0.00	42.58
Q5-0	469	2	0.00	0.00	0.00	100.00
Q5-2	2785	5	0.00	0.00	0.00	66.83
Q5-4	1819	1	0.00	0.00	0.00	95.00
Overall Q5	5073	8	0.00	0.00	0.00	51.41
Q6-0	6307	5	0.00	0.00	0.00	0.00
Q6-2	6130	8	0.00	0.00	0.00	35.13
Q6-4	2063	3	0.00	0.00	0.00	63.76
Overall Q6	14500	16	0.00	0.01	0.00	41.63
Survey totals	118107	80	0.02	2.56	0.85	36.04

Table 3. Biomass estimates (t) for survey subdivisions and standard errors for the entire survey, 2008–2014

Year	Q1	Q2	Q3	Q4	Q5	Q6	Total	SE ⁴
2008	1,591	7	312	4	24	17	1,955	882
2009	6,945	325	1,157	1	1	17	8,446	1861
2010	4,307	44	1,882	1	3	2	6,240	1990
2011	5,701	0	367	0	0	9	6,077	1432
2012	2,044	5	335	0	3	1	2,388	687
2013	2,532	9	37	0	1	3	2,581	1041
2014	2,485	1	56	6	3	5	2,555	921

Table 4. Error coefficients of variation (%) for the biomass estimates for the entire survey area 2008–2014

Year	Q1	Q2	Q3	Q4	Q5	Q6	Total	Number of hauls
2008	54.7	69.3	45.2	100.0	62.9	30.7	45.1	52
2009	25.2	99.8	47.4	52.8	75.0	33.6	22.0	97
2010	22.4	79.0	92.6	75.0	92.5	42.4	31.9	82
2011	25.0		44.6	100.0		40.0	23.6	85
2012	30.7	100.0	83.4	100.0	93.7	93.7	28.8	99
2013	41.1	74.3	56.8	100.0	82.0	82.0	40.3	92
2014	37.1	66.7	41.9	42.6	49.4	49.4	36.0	80
Mean 2008-2014							32.0	

Table 5. Estimated mean densities (kg/km²) for survey subdivisions in 2008–2014

Year	Q1	Q2	Q3	Q4	Q5	Q6	Total
2008	37.3	0.4	7.6	0.3	3.4	1.2	14.0
2009	162.9	17.0	28.2	0.1	0.2	1.2	60.6
2010	101.0	2.3	45.9	0.1	0.4	0.2	44.8
2011	133.7	0.0	8.9	0.0	0.0	0.6	43.6
2012	47.9	0.3	8.2	0.0	0.4	0.1	17.1
2013	59.4	0.5	0.9	0.0	0.1	0.2	18.5
2014	58.3	0.1	1.4	0.4	0.4	0.3	18.3

Table 6. Survey biomass estimates (tons) by sex based on length-weight distributions 1988–2014

Year	Males	Females	Total	Males %	Females %
2008	1025	930	1955	52.4	47.6
2009	5572	2874	8446	66.0	34.0
2010	2940	3300	6240	47.1	52.9
2011	3414	2663	6077	56.2	43.8
2012	1230	1158	2388	51.5	48.5
2013	1425	1156	2581	55.2	44.8
2014	1081	1474	2555	42.3	57.7
Average	2384	1936	4320	53.0	47.0

Table 7. Estimated numbers ('000) by sex from length analyses 2008–2014

Year	Males	Females	Total	Males %	Females %
2008	129	72	202	64.1	35.9
2009	670	222	893	75.1	24.9
2010	320	244	564	56.7	43.3
2011	364	196	560	65.0	35.0
2012	127	84	211	60.2	39.8
2013	148	79	227	65.2	34.8
2014	97	94	191	50.8	49.2
Average	265	142	407	64.2	37.6

Table 8. Two Greenlandic surveys from 1989-1996 and 2008-2014 for comparison

Q1-Q2 (North for 65)	Biomass	No. Station	Area	Cod-end	Surveymethode
1989	4,879	87	33,971	44	Stratified random technique
1990	1,860	99	33,971	44	Stratified random technique
1991					
1992	1,044	37	43,439	44	Stratified random technique
1993					
1994	3,800	69		20	Spline Designer Designer
1995	4,558	72		20	Spline Designer Designer
1996	No estimate	40		20	Spline Designer Designer
2008	1,598	16	54,903	20	Stratified random technique
2009	7,270	33	51,633	20	Stratified random technique
2010	4,352	33	51,633	20	Stratified random technique
2011	5,701	31	51,633	20	Stratified random technique
2012	2,050	36	51,633	20	Stratified random technique
2013	2,541	37	51,633	20	Stratified random technique
2014	2,486	35	51,633	20	Stratified random technique

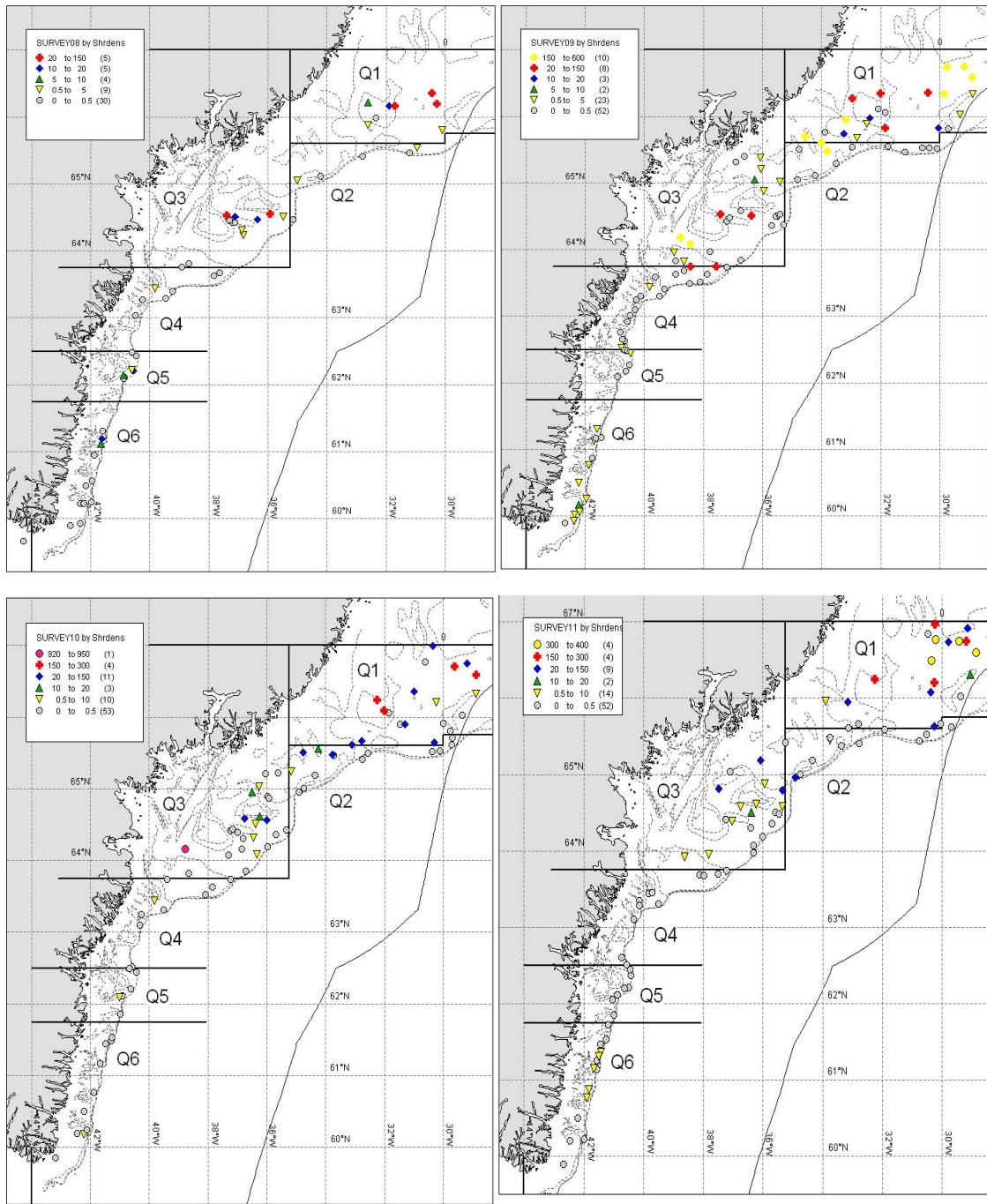


Fig.1a Shrimp densitet in surveyarea in 2008-2011

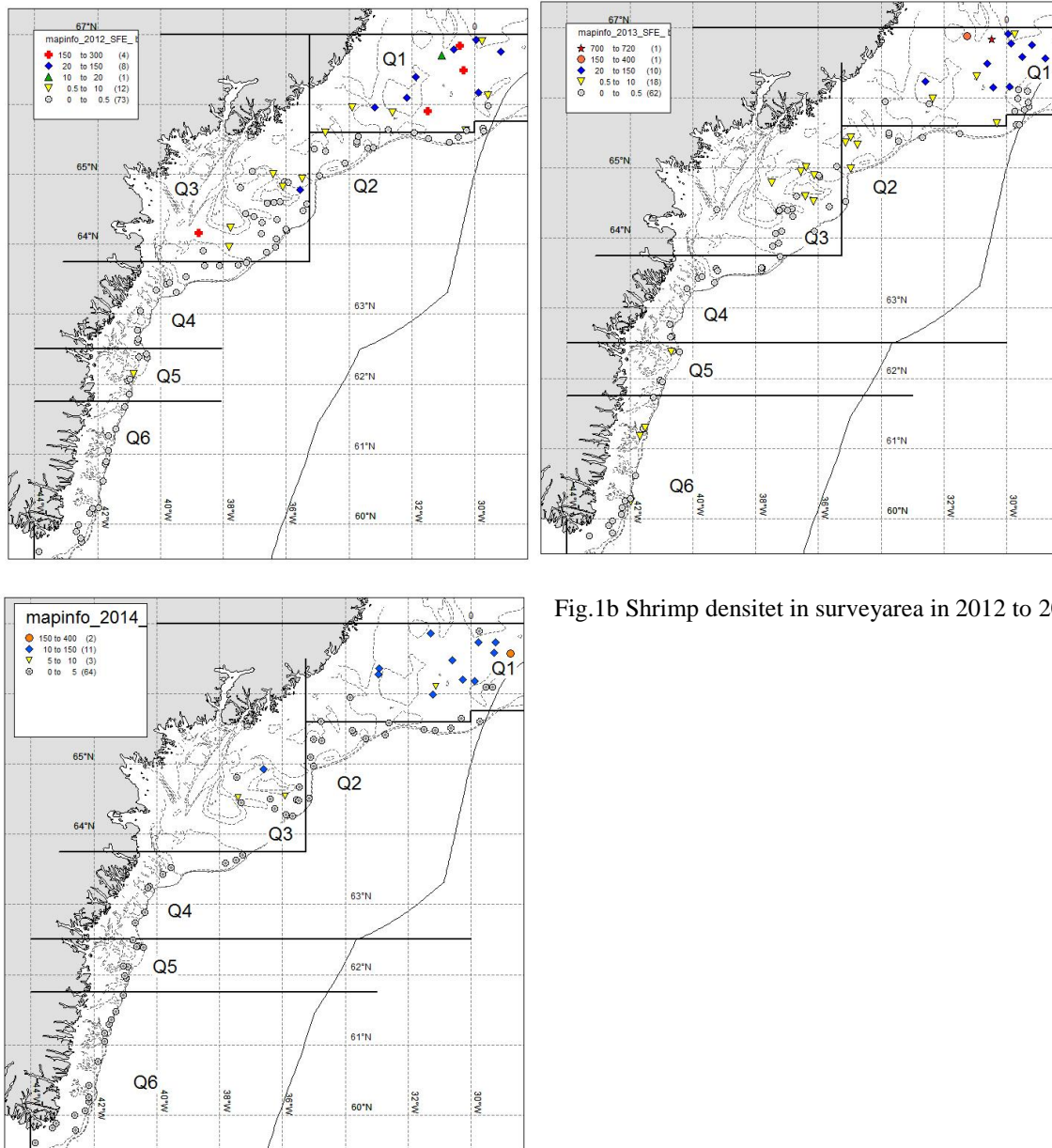


Fig.1b Shrimp densitet in surveyarea in 2012 to 2014

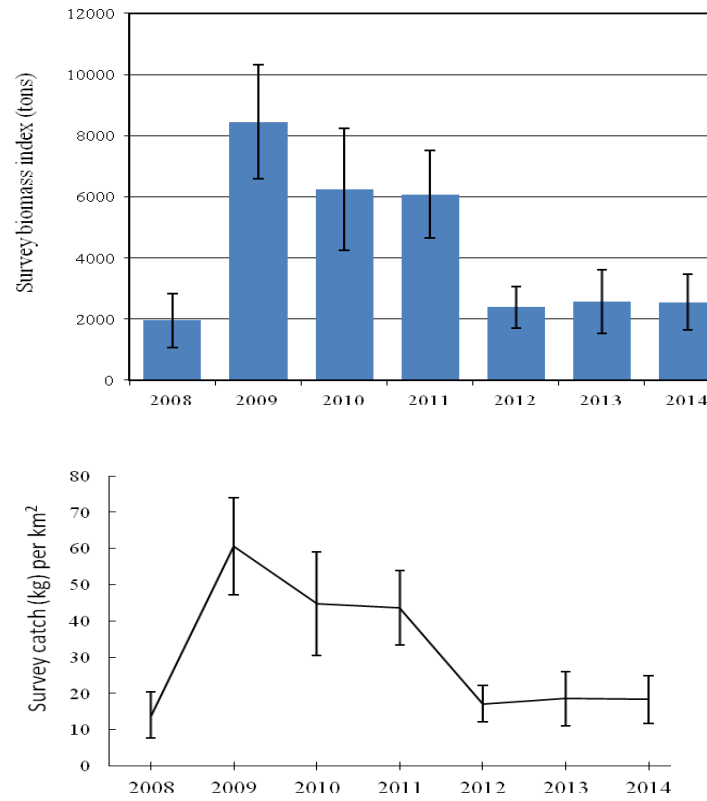


Fig. 2 Estimated total survey biomass (t) and average survey biomass density (kg/km) of Northern shrimp with standard errors 2008-2014.



Fig. 3 Survey biomass in percent in different areas and depths 2008-2014.

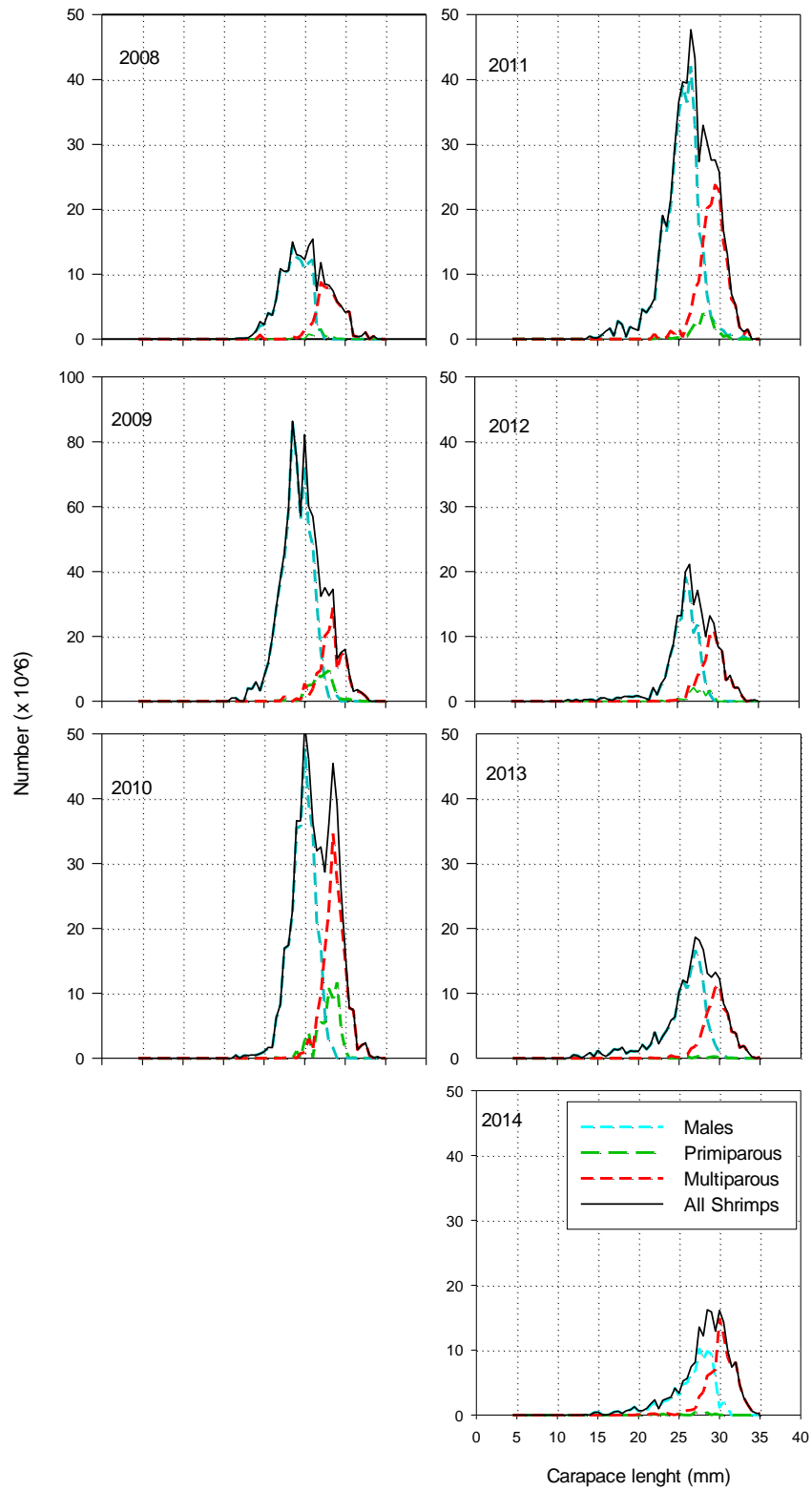


Fig.4 Numbers of shrimp by length group (CL) in the total survey area in 2008 - 2014 (Please note that the scale in the figure for 2009 differs from other years).

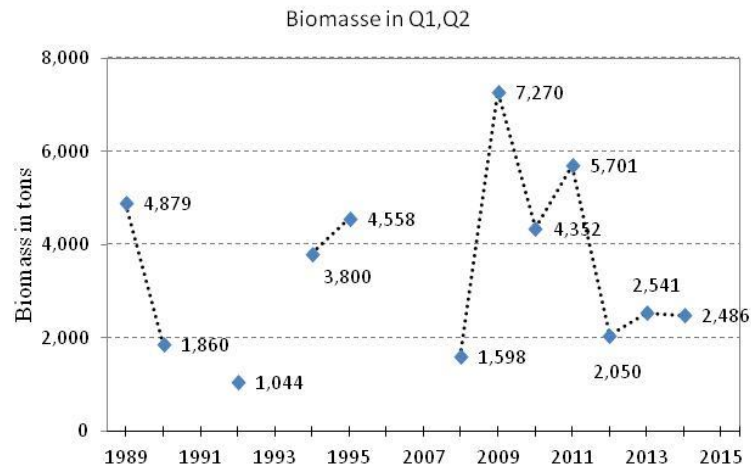


Fig.5 Biomass from two different surveys series from 1989-1995 and 2008-2014 for the areas North of 65°N and stratumarea Q1 and Q2 for comparison.

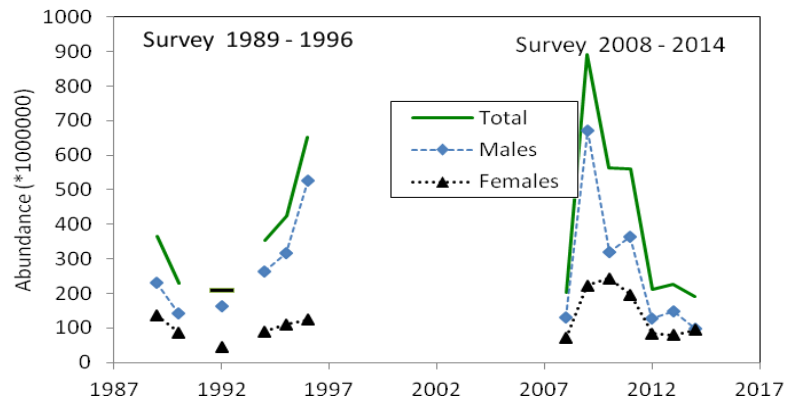


Fig.6 Abundance of males and females in two different surveys series from 1989-1995 and 2008-2014 for the areas North of 65°N.

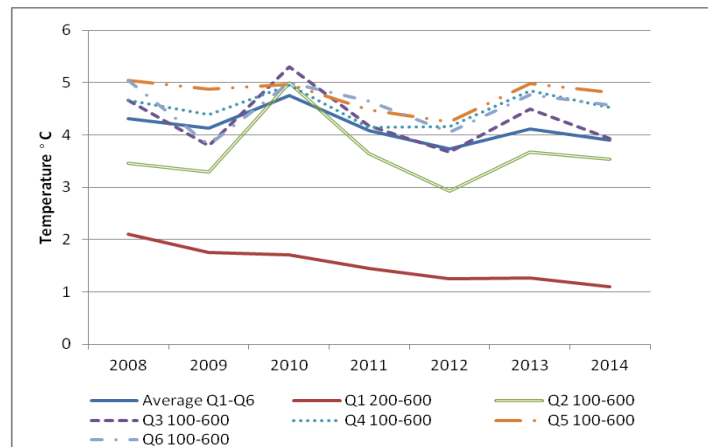


Fig.7 Temperature in the surveyarea Q1-Q6.