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**Results of the Greenland Bottom Trawl Survey for Northern shrimp (*Pandalus borealis*)  
Off East Greenland (ICES Subarea XIV b), 2008-2022**

by

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**Abstract**

The 2022 survey for Northern Shrimp (*Pandalus borealis*) in East Greenland estimate the biomass of shrimp to have decrease since the last survey in 2020. The shrimp stock is concentrated in the area north of 64°N and in depth between 200 and 400 meter and the biomass for the entire survey area is low compared to West Greenland. 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 a stratified-random trawl survey has been conducted to assess the stock status of northern shrimp in East Greenland. There were no surveys in 2017-2019 and 2021. 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 are not directly comparably with the recent survey time series 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 - 2022 surveys and attempt to compare these results with survey conducted in 1989-1996.

**Materiel and Methods**

The 2022 survey is carried out with the same gear and survey protocols as used in West Greenland (SCR Doc. 22/045). 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, 200-400 m and 400-600 m zones (area sizes are given in Tab. 1). Total survey area has been estimated to 118.107 km<sup>2</sup>. Standard tow duration was set to 15 minutes at all stations. Towing speed have been about 2.5 knots in all cases.

Surveys in 2008-2016 were conducted using research trawler *Paamiut* (722 GRT), which is no longer in use. There were no surveys in 2017-2019, and in 2020 chartered fishing vessel *Helga Maria* was used for the survey. In 2022 the new research vessel *Tarajoq* was used for the survey. The fishing gear (cosmos trawl, doors, bridles, Marport sensors on doors and headlines) from *Paamiut* were used for the 2020 and 2022 survey to ensure that fishing practices and handling of catch were exactly as on the research ship *Paamiut* (this was the same



procedure as used for the survey for Northern shrimp in West Greenland, see appendix 1 in SCR Doc. 22/045). This set up has also been used for the survey in West Greenland in 2018-2020 (SCR Doc. 22/045).

Stations were allocated to strata using the same method as the survey in West Greenland (SCR Doc. 22/045). The stations are distributed in each strata using the buffered random sampling described in Kingsley et al (2004). In 2022, 106 planned stations were selected, some of these were not deemed trawlable either due to poor seabed conditions, wrong depth at the location or other reasons. In most cases these stations were moved and a total of 95 valid hauls were done in the 2022 (table 2). Trawling has been carried out days and nights (24 hours). The influence of a possible light induced nocturnal vertical migrations of shrimp has not been taken 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 SCR Doc. 22/045 for details.

#### *Demography*

From each catch a sample of about 0.5 to 3 kg of shrimp was taken and sorted to species, or in cases of a small catch of shrimp the full catch was sorted. 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.

#### *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*

All strata biomass estimates have been calculated (Tab.2 and Tab.3) on the basis of the nominal swept area (Burmeister and Riget 2020). Total biomass has been at a low level from 2012-2016 and has increased to the highest level seen in the timeseries in 2020. In 2022 the total biomass had decreased. The CV of the total estimated biomass has improved from previous years and is the second lowest in the timeseries at 19.2 (Tab. 4). The stock is mainly located in the northern part in Q1 with 94% of total biomass in 2022 (Fig. 1 and Fig. 3). Shrimp biomass are at very low densities in the remaining southerly offshore areas (Q2-Q6) (Tab. 2 and Fig. 3). The shrimp occurs mainly between 200 - 400 meter and in 2022 67% of the biomass is found in here.

Throughout the current survey timeseries the demographic structure in East Greenland is close to equal proportions of males and females (Tab. 6), exceptions being 2009 and 2020. In 2022 where the proportion of females were 48 % and 52 %, respectively, of the total biomass (Tab. 6). Males are mostly large with 20mm CL as the smallest for several years (Fig. 4a and 4b). A calculation of the fishable biomass of individuals equal to and above 17 mm CL has therefore not been calculated. Smaller males between 10 and 17mm was registered in 2016, 2020 and in 2022 - although in small numbers. Biomass and abundance of female and males weighted up to total biomass are presented in Tab 6 and Tab 7. Female biomass average 2,025 tons for the entire survey time series. In 2022 female biomass was on 3,155 tons (Tab. 6) the second highest in the timeseries after the 2020 estimate.

Total numbers of shrimp (males and females) in 2022 was estimated to 612 million. The average on 446 million for the entire survey timeseries. The abundance of males in 2022 was 367 million. The proportion of males relative to females was 60% and similar to most years.

### *Bottom temperature and biomass*

The overall mean bottom temperature in the shrimp survey area was stable near 4°C from 2008 to 2020 and has dropped a bit in 2022 (Fig. 7). From 2008-2022 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. Most of the shrimp biomass is north of 65°30 N (Q1).

### **Comparison with earlier surveys**

Stratified-random trawl surveys has been carried out in Denmark Strait in 1989-1992 and in 1994-1996 the surveys were conducted by a sampling technique based on the Spline Designer Software System. The surveys in the 1980s and 1990s was 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 1980s and 1990s 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 estimates and the demographic structure in all surveys are similar.

### **Conclusions**

The biomass of shrimp in East Greenland in 2022 has decrease compared to 2020 which was the highest in the series. The survey biomass is concentrated in Q1, like the other years in the survey time series. 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, 2008–2022.

	Vessel	Trawl	Bridle length (m)	Wingspread (m)
2008–2016	Paamiut	Cosmos	54.0	28.1-30
2020	Helga Maria	Cosmos	54.0	32.8
2022	Tarajoq	Cosmos	54.0	30.3

**Table 2.** Survey estimates of total biomass 2022.

Stratum	Area (km <sup>2</sup> )	Stations	Biomass density (t/km <sup>2</sup> )	Biomass (Kt)	Biomass error variance	Error coefft of variation (%)
Q1-0	0	2	0.002	0.000	0.000	0.00
Q1-2	35662	15	0.105	3.757	1.221	29.41
Q1-4	6975	4	0.285	1.989	0.132	18.24
Overall Q1	42637	21	0.135	5.746	1.353	20.24
Q2-0	93	2	0.000	0.000	0.000	0.00
Q2-2	7657	8	0.013	0.100	0.009	93.79
Q2-4	1246	3	0.000	0.000	0.000	100.00
Overall Q2	8996	13	0.011	0.101	0.009	93.40
Q3-0	3363	10	0.000	0.000	0.000	68.83
Q3-2	22547	17	0.006	0.132	0.005	54.36
Q3-4	9830	8	0.001	0.012	0.000	63.80
Overall Q3	35740	35	0.004	0.145	0.005	50.00
Q4-0	1337	5	0.000	0.000	0.000	100.00
Q4-2	7770	4	0.000	0.000	0.000	0.00
Q4-4	2054	2	0.000	0.000	0.000	100.00
Overall Q4	11161	11	0.000	0.000	0.000	71.92
Q5-0	469	2	0.000	0.000	0.000	100.00
Q5-2	2785	4	0.001	0.003	0.000	63.82
Q5-4	1819	2	0.001	0.001	0.000	45.89
Overall Q5	5073	8	0.001	0.004	0.000	46.12
Q6-0	6307	4	0.014	0.086	0.002	56.76
Q6-2	6130	4	0.002	0.013	0.000	46.08
Q6-4	2063	1	0.006	0.013	0.000	95.00
Overall Q6	14500	9	0.008	0.112	0.003	45.43
Survey totals	118107	97	0.052	6.107	1.369	19.16

**Table 3.** Biomass estimates (t) for survey subdivisions and standard errors for the entire survey, 2008–2016, 2020 and 2022. Please note that there was no survey in 2017–2019 and 2021.

Year	Q1	Q2	Q3	Q4	Q5	Q6	Total	SE
2008	1,591	7	312	4	24	17	1,955	882
2009	6,945	325	1,157	1	1	17	8,446	1,861
2010	4,307	44	1,882	1	3	2	6,240	1,990
2011	5,701	0	367	0	0	9	6,077	1,432
2012	2,044	5	335	0	3	1	2,388	687
2013	2,532	9	37	0	1	3	2,581	1,041
2014	2,485	1	56	6	3	5	2,555	921
2015	1,559	15	103	1	3	8	1,688	451
2016	1,491	0	73	1	0	22	1,587	420
2020	10,293	1	141	3	3	40	10,481	1,804
2022	5,746	101	145	0	4	112	6,107	1,170

**Table 4.** Error coefficients of variation (%) for the biomass estimates for the entire survey area 2008–2016, 2020 and 2022.

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	60.0	28.8	99
2013	41.1	74.3	56.8	100.0	82.0	50.2	40.3	92
2014	37.1	66.7	41.9	42.6	49.4	41.6	36.0	80
2015	28.6	94.4	63.4	26.7	34.8	43.5	26.7	95
2016	28.0	100.0	53.6	100.0	65.4	76.2	26.4	101
2020	17.5	57.2	44.6	91.9	39.5	55.1	17.2	98
2022	20.2	22607.5	50.0	71.9	46.1	45.0	19.2	95
Mean 2008–2022							28.8	

**Table 5.** Estimated mean densities (kg/km<sup>2</sup>) for survey subdivisions in 2008–2016, 2020 and 2022.

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
2015	36.6	0.8	2.5	0.0	0.4	0.5	12.1
2016	35.0	0.0	1.8	0.1	0.0	1.5	11.4
2020	241.4	0.0	3.4	0.2	0.4	2.7	75.3
2022	134.8	5.3	3.5	0.0	0.5	7.7	43.9

**Table 6.** Survey biomass estimates (tons) by sex based on length-weight distributions 2008–2016, 2020 and 2022.

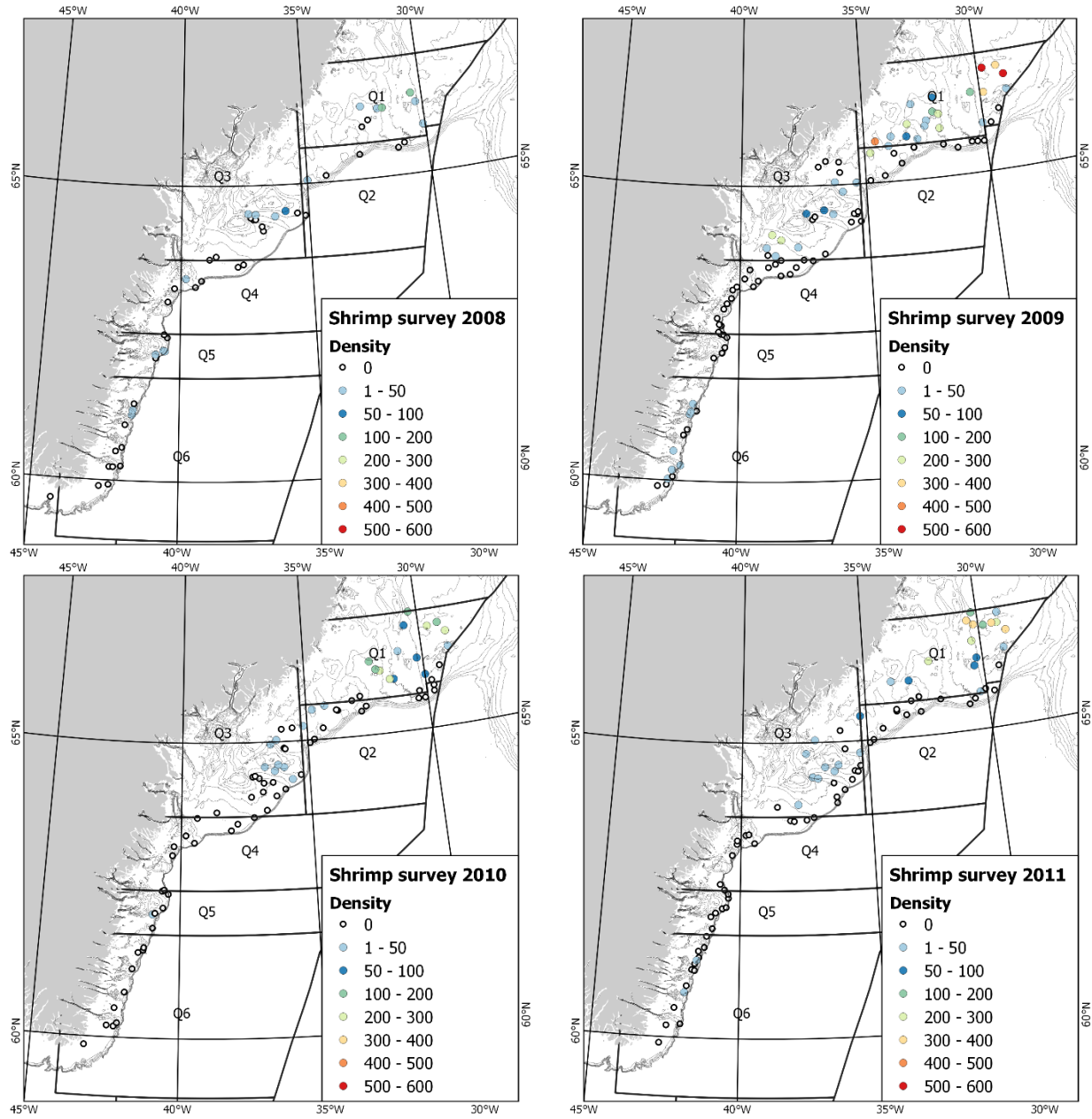
Year	Males	Females	Total	Males %	Females %
2008	1025	930	1955	52.4	47.6
2009	5572	2874	8446	66.0	34.0
2010	2940	3300	6240	47.1	52.9
2011	3414	2663	6077	56.2	43.8
2012	1230	1158	2388	51.5	48.5
2013	1425	1156	2581	55.2	44.8
2014	1081	1474	2555	42.3	57.7
2015	769	918	1687	45.6	54.4
2016	809	778	1587	51.0	49.0
2020	6610	3871	10481	63.1	36.9
2022	2952	3155	6107	48.3	51.7
Average	2530	2025	4555	53	47

**Table 7.** Estimated numbers ('000) by sex from length analyses 2008–2016, 2020 and 2022.

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
2015	71	55	126	56.3	43.7
2016	96	49	145	66.2	33.8
2020	853	328	1181	72.3	27.7
2022	367	244	612	60.0	40.0
Average	295	152	446	63	37

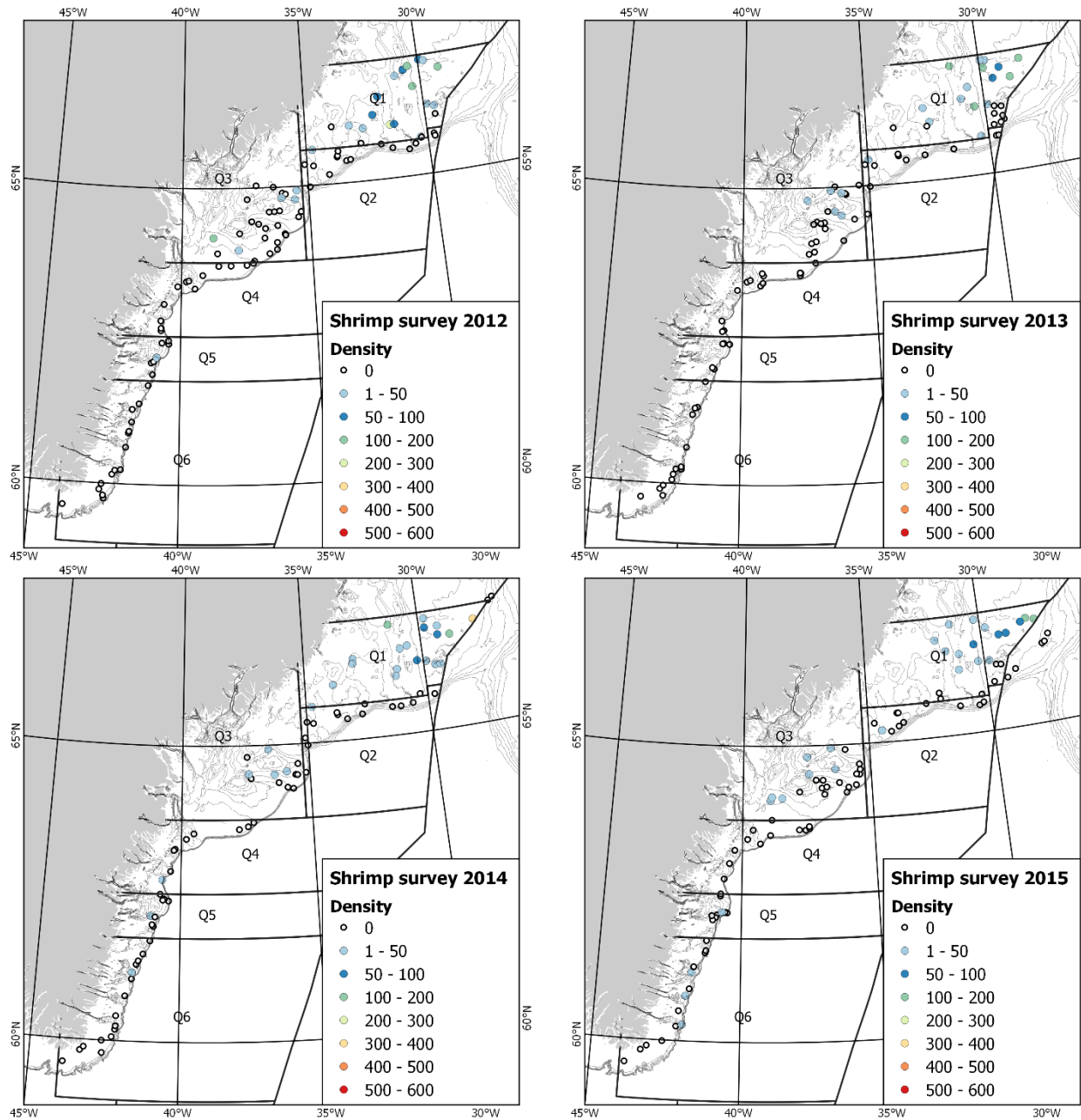
**Table 8.** Two Greenlandic surveys from 1989-1996, 2008-2016, 2020 and 2022 for comparison, for areas Q1 and Q2.

Q1-Q2 (N. for 65)	Biomass	No. Station	Area	Cod- end	Survey method
1989	4,879	87	33,971	44	Stratified random technique
1990 1991	1,860	99	33,971	44	Stratified random technique
1992 1993	1,044	37	43,439	44	Stratified random technique
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
2015	1,574	37	51,633	20	Stratified random technique
2016	1,491	39	51,633	20	Stratified random technique
2020	10,294	35	51,633	20	Stratified random technique
2022	5,946	31	51,633	20	Stratified random technique

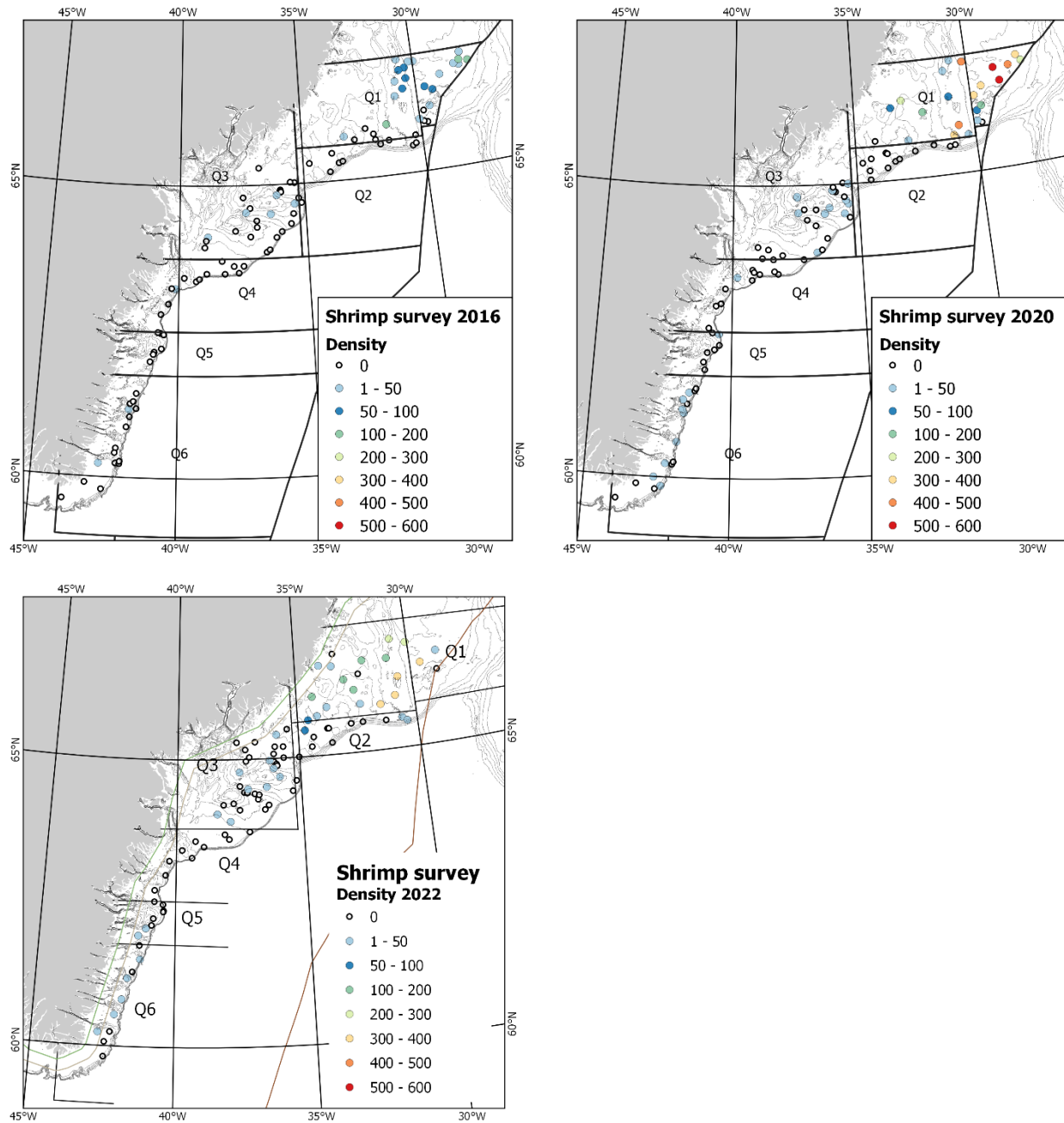


**Figure 1a.** Shrimp densitet (kg/km<sup>2</sup>) in surveyarea in 2008-2011. Line marks depths of 100-600m.

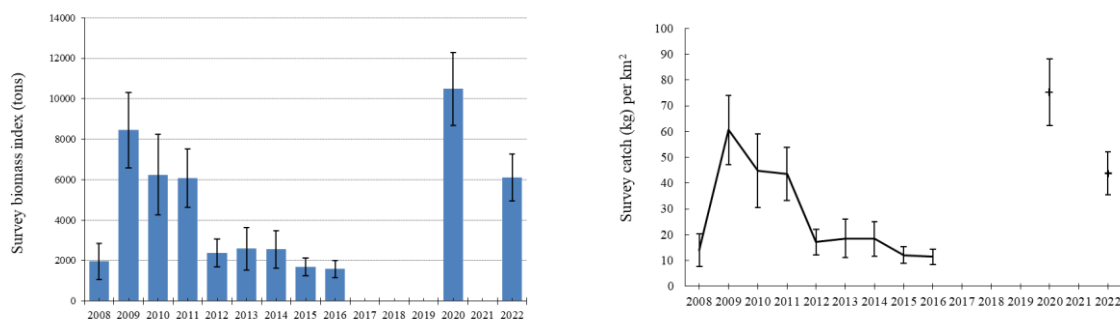




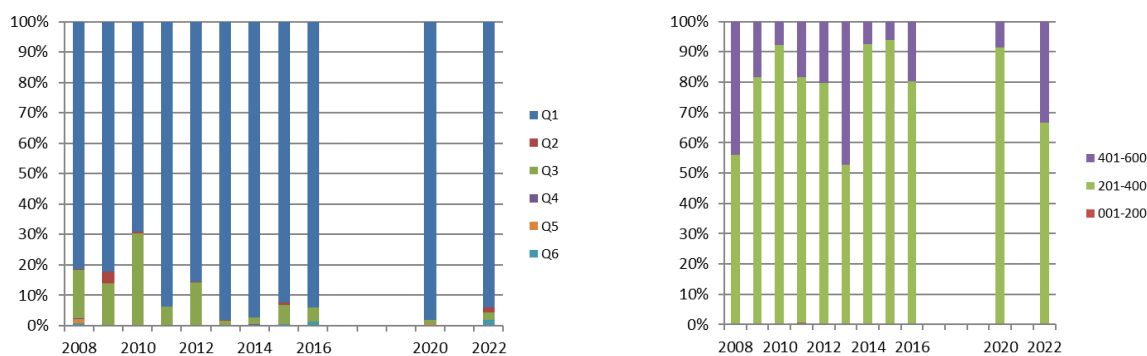
**Figure 1b.** Shrimp density (kg/km<sup>2</sup>) in survey area in 2012-2015. Line marks depths of 100-600m.



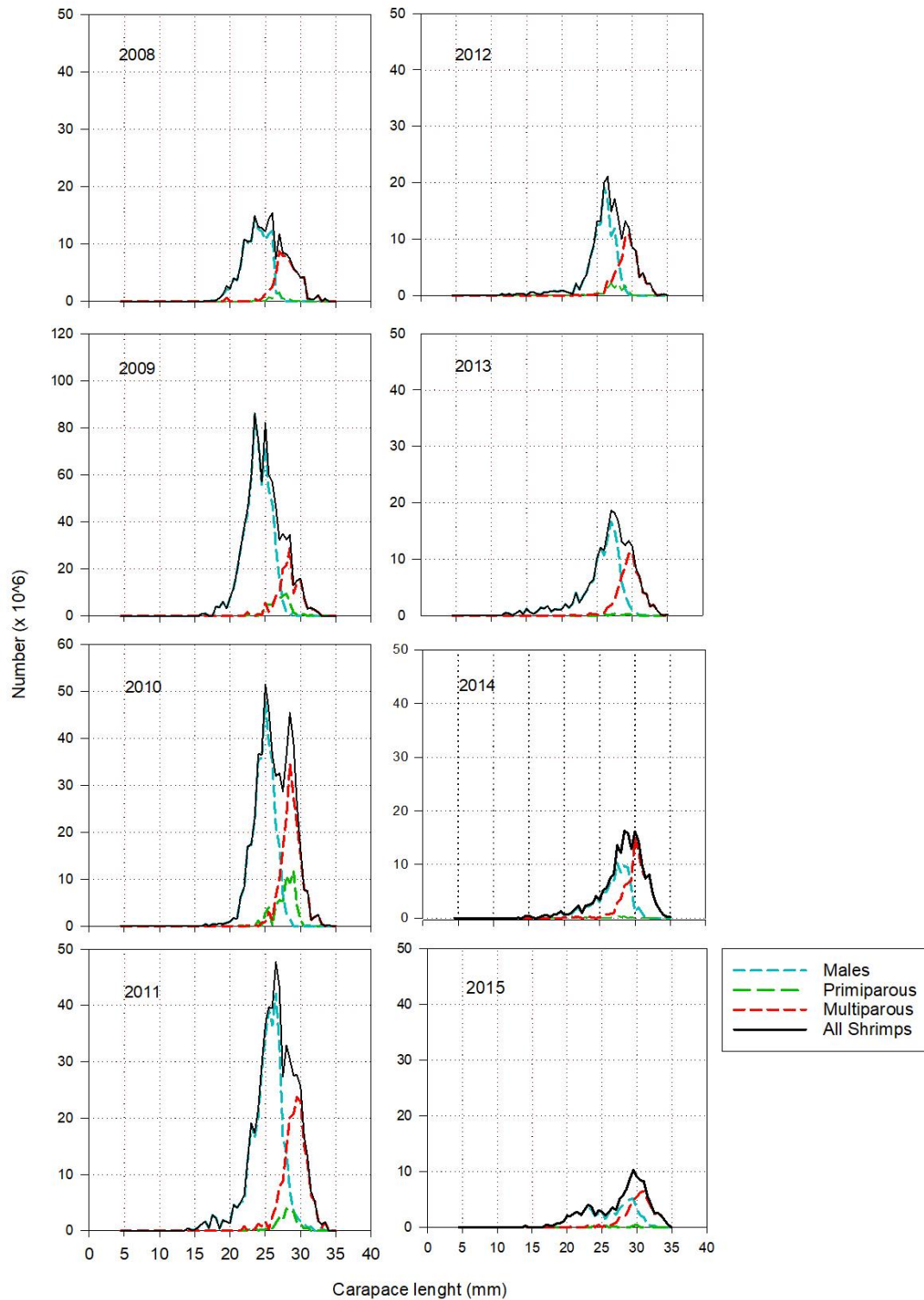
**Figure 1c.** Shrimp densitet ( $\text{kg}/\text{km}^2$ ) in surveyearea in 2016, 2020 and 2022. Line marks depths of 100-600m.



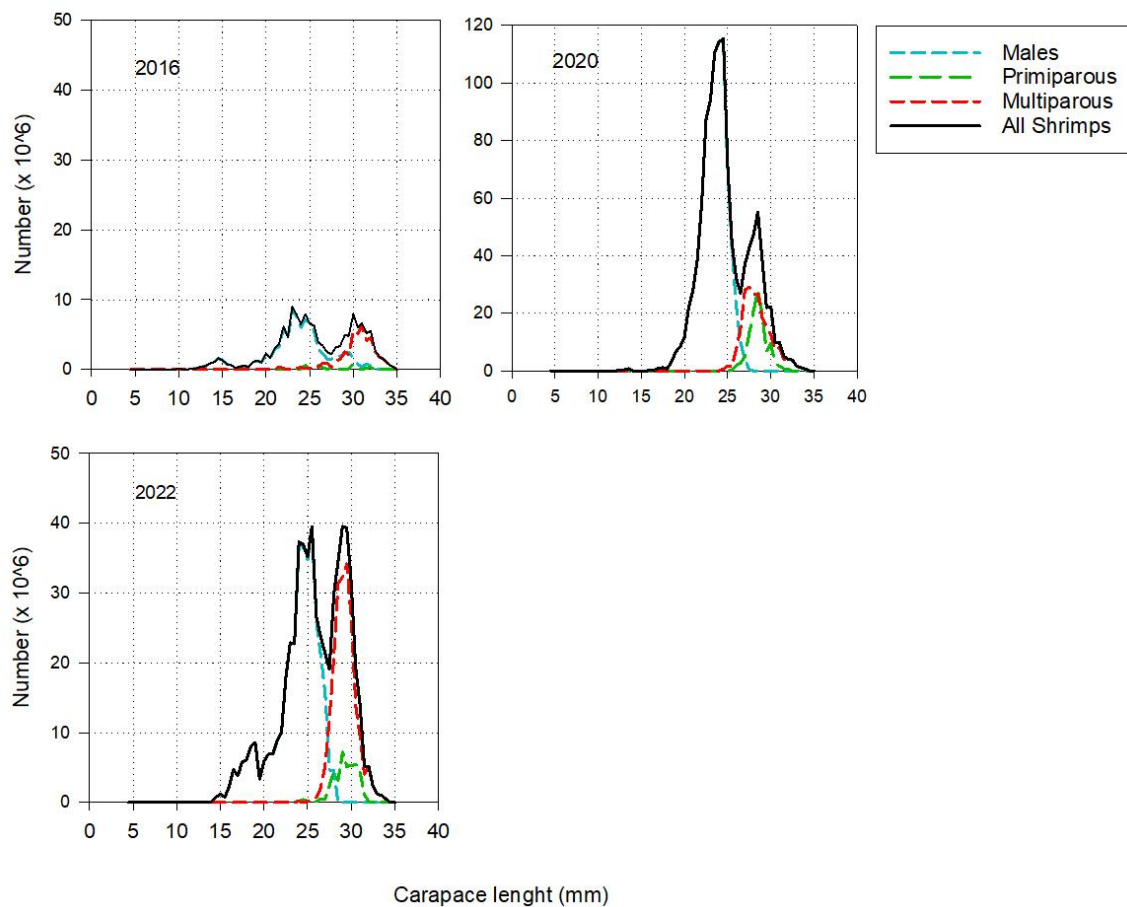
**Figure 2.** Estimated total survey biomass (t) and average survey biomass density (kg/km) of Northern shrimp with standard errors 2008-2016, 2020 and 2022.



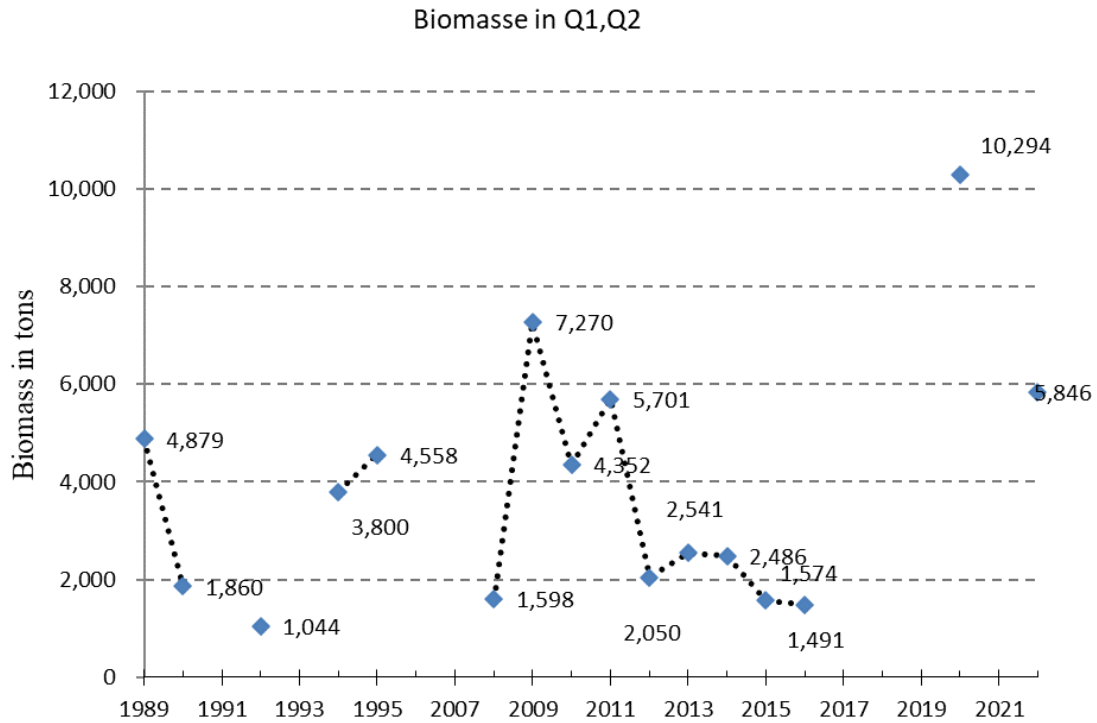
**Figure 3.** Survey biomass in percent in different areas (Q1-Q6) and depths (1-200m, 201-400m, 401-600m) 2008-2016, 2020 and 2022.



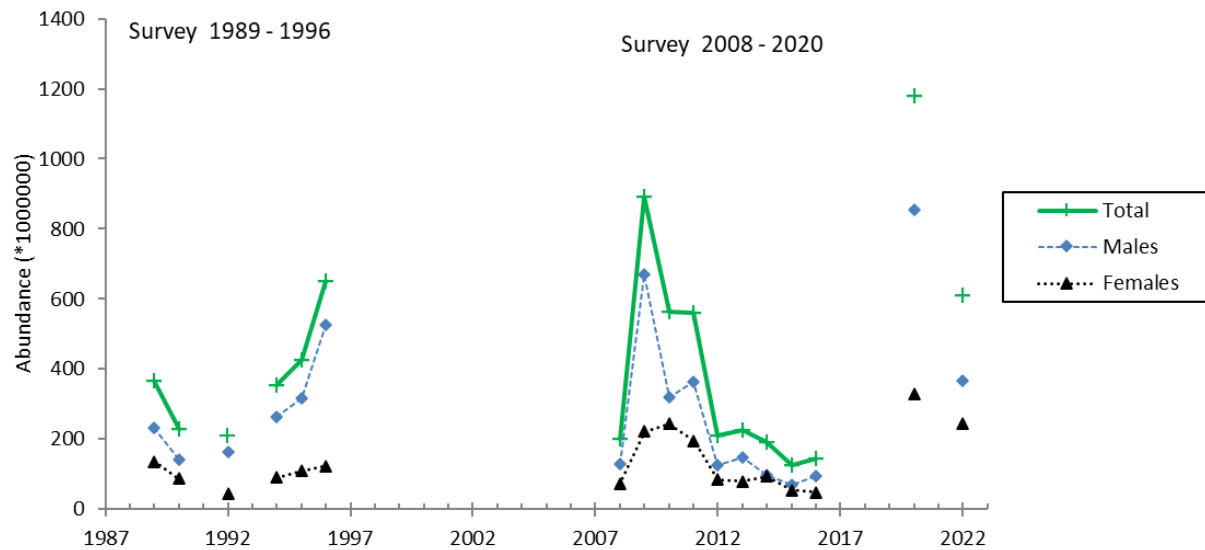
**Figure 4a.** Numbers of shrimp by length group (CL) in the total survey area in 2008 - 2015 (Please note that the scale in the figure for 2009 2010 differs from other years).



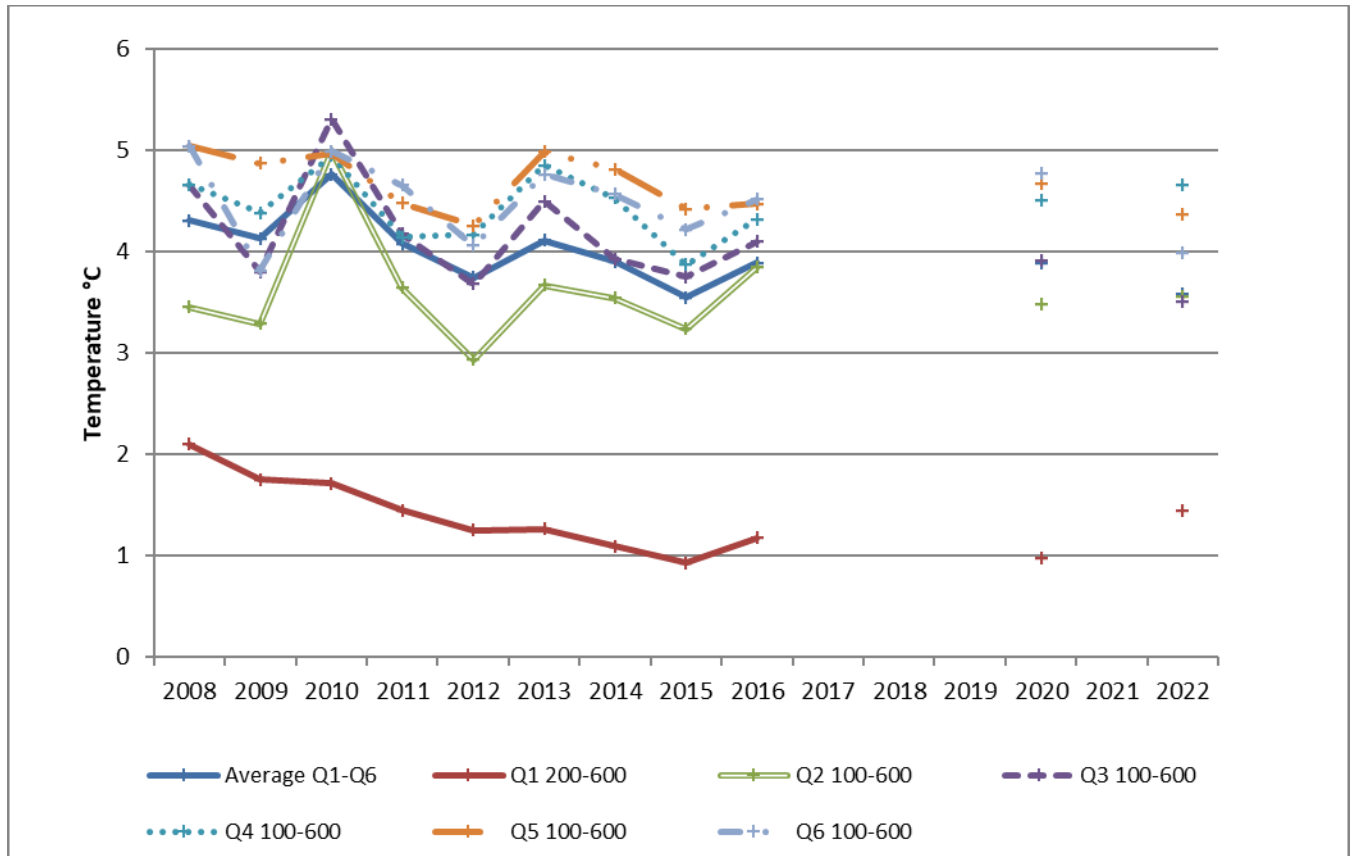
**Figure 4b.** Numbers of shrimp by length group (CL) in the total survey area in 2016, 2020 and 2022. (Note that the scale in the figure for 2020 differs from other years).



**Figure 5.** Biomass from two different surveys series from 1989-1995 and 2008-2022 for the areas North of 65°N and stratum area Q1 and Q2 for comparison.



**Figure 6.** Abundance of males and females in two different surveys series from 1989-1995 and 2008-2022.



**Figure 7.** Temperature in the surveyarea Q1-Q6 from 2008-2022.