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**Results of the Greenland Bottom Trawl Survey for Northern shrimp (*Pandalus borealis*)
Off East Greenland (ICES Subarea XIV b), 2008-2024**

by

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Abstract

The 2024 survey for Northern Shrimp (*Pandalus borealis*) in East Greenland estimate the biomass of shrimp to have decreased since the survey in 2023. The shrimp stock is concentrated in the area north of 65°N and in depth between 200 and 400 meter. The biomass for the entire survey area in East Greenland is low compared to West Greenland. Absence of the smaller male and juvenile shrimp less than 17.5 mm CL 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 are to obtain indices for stock biomass, abundance, 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. 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.

The sizes of the survey strata were revised and updated in 2024 based on more accurate depth information.

This document presents results on biomass, abundance and sex-composition from 2008 - 2024 surveys and attempt to compare these results with survey conducted in 1989-1996.

Materiel and Methods

The 2024 survey was 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. 2). Following the revision the total survey area has been estimated to 119,294 km², previous estimate was 118.107 km². The main revision is that Q1 0-200 m are now included. 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. Since 2022 the new research vessel *Tarajoq* have been used for the survey. The fishing gear (cosmos trawl, doors, bridles, Marport sensors on doors and headlines) from *Paamiut* were used for the surveys on other



vessels 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. 24/052). The stations are distributed in each strata using the buffered random sampling described in Kingsley et al (2004). In 2024, 102 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 the southern part of the survey area, Q6, ice coverage made it impossible to get any stations. In Q5-Q4 the ice coverage meant that all stations were taken in the eastern part of the area near the shelf edge. In Q1-Q3 ice impacted where it was possible to get stations, but it was possible to get good coverage in these areas. A total of 106 valid hauls were done in the 2024 (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. 24/052 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 15 s with a resolution of 0.01°C. The average temperature for each haul was calculated after retrieval of the sensor. All measurements were used to calculate a mean bottom temperature for the survey strata between 200 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 (SCR Doc. 24/052). Total biomass has been at a low level from 2012-2016 and has increase to the highest level seen in the timeseries in 2020. In 2022 the total biomass decreased and in 2023 it again showed an increase close to the level seen in 2020. The 2024 biomass estimate is similar to the 2022 value. The CV of the total estimated biomass has improved from previous years and is at 15.3 (Tab. 4). The stock is mainly located in the northern part in Q1 with 81% of total biomass in 2024 (Fig. 1 and Fig. 3). Shrimp biomass are at very low densities in the remaining southerly offshore areas (Q2-Q6), with the exception of Q3 with 15 % (Tab. 2 and Fig. 3). The shrimp occurs mainly between 200 - 400 meter and in 2024 69% 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 in the survey biomass (Tab. 6), exceptions being 2009 and 2020. In 2024, 52 % of the biomass was females (Tab. 6). Males have mostly been larger than 20mm CL 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, 2022, 2023 and in 2024 - although in small numbers (less than 0.5% of the total biomass in 2024). Biomass and abundance of female and males weighted up to total biomass are presented in Table 6 and Table 7. Female biomass average 2 354 tons for the entire survey time series. In 2024 female biomass was at 3524 tons (Tab. 6), which is above the timeseries average.

Total numbers of shrimp (males and females) in 2024 were estimated to 703 000. The average on 511 000 for the entire survey timeseries. The abundance of males in 2024 was 333 000. The proportion of males relative to females was 60.9%, which is close to the average (63%) for the survey timeseries (Tab. 7).

Bottom temperature and biomass

The overall mean bottom temperature in the survey area has fluctuated around 4°C for the survey period (Fig. 7). From 2008-2024 the areas south of 65°30 N (Q2-Q6) all have an average temperature between 3.9°C and 5.2°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). In 2024 the average temperature for the entire survey area was stable compared to 2023, for Q1 the temperature increased but is within the levels previously observed.

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 2024 has decreased compared to 2023. 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, 2008–2024.

	Vessel	Trawl	Bridle length (m)	Wing-spread (m)
2008–2016	Paamiut	Cosmos	54.0	28.1-30
2020	Helga Maria	Cosmos	54.0	32.8
2022-2024	Tarajoq	Cosmos	54.0	30.3-31.7

Table 2. Survey estimates of total biomass 2024. It was not possible to cover Q6 in 2024, it was therefore combined with Q5.

Stratum	Area (km ²)	Stations	Biomass density (t/km ²)	Biomass (Kt)	Biomass error variance	Error coefft of variation (%)
Q1-0	3169	1	0.002	0.006	0.000	95.00
Q1-2	32130	21	0.105	3.360	0.422	19.34
Q1-4	7289	12	0.284	2.073	0.132	17.54
Overall Q1	42589	35	0.128	5.439	0.554	13.69
Q2-0	76	2	0.000	0.000	0.000	0.00
Q2-2	7921	10	0.014	0.108	0.011	96.36
Q2-4	1293	6	0.000	0.000	0.000	90.50
Overall Q2	9290	18	0.012	0.108	0.011	96.28
Q3-0	2817	8	0.000	0.000	0.000	63.08
Q3-2	23633	13	0.042	0.987	0.438	67.06
Q3-4	9992	9	0.003	0.034	0.001	70.31
Overall Q3	36442	30	0.028	1.021	0.439	64.86
Q4-0	1272	6	0.000	0.001	0.000	72.12
Q4-2	8072	7	0.020	0.165	0.027	99.15
Q4-4	2043	2	0.000	0.000	0.000	0.00
Overall Q4	11387	15	0.015	0.165	0.027	98.84
Q5+6-0	6304	3	0.000	0.000	0.000	0.00
Q5+6-2	9404	3	0.000	0.003	0.000	51.82
Q5+6-4	3879	3	0.000	0.001	0.000	100.00
Overall Q5+6	19587	9	0.000	0.004	0.000	46.07
Survey totals	119294	106	0.056	6.737	1.031	15.07

Table 3. Biomass estimates (t) for survey subdivisions and standard errors for the entire survey, 2008–2016, 2020 and 2022–2024. 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
2023	9,445	81	617	1	16	9	10,170	1,405
2024	5,462	108	1,021	165	4*	-	6,760	1,035

* In 2024 Q6 was not covered, for the estimations Q6 and Q5 were combined.

Table 4. Error coefficients of variation (%) for the biomass estimates for the entire survey area 2008–2016, 2020 and 2022–2024. Please note that there was no survey in 2017–2019 and 2021.

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	93.4	50.0	71.9	46.1	45.0	19.2	95
2023	14.5	76.2	48.8	72.4	41.0	65.8	13.8	122
2024	14.1	96.3	64.9	98.8	46.1*	-	15.3	106

* In 2024 Q6 was not covered, for the estimations Q6 and Q5 were combined.

Mean
2008-
2024

26.7

Table 5. Estimated mean densities (kg/km²) for survey subdivisions in 2008–2016, 2020 and 2022–2024. Please note that there was no survey in 2017–2019 and 2021.

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
2023	221.5	4.2	15.0	0.1	2.3	0.6	73.0
2024	128.1	5.6	24.9	11.2	0.5*	-	48.5

* In 2024 Q6 was not covered, for the estimations Q6 and Q5 were combined.

Table 6. Survey biomass estimates (tons) by sex based on length-weight distributions 2008–2016, 2020 and 2022–2024. Please note that there was no survey in 2017–2019 and 2021.

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
2023	5349	4802	10151	52.7	47.3
2024	3242	3524	6766	47.9	52.1
Average	2801	2354	5155	52	48

Table 7. Estimated numbers ('000) by sex from length analyses 2008–2016, 2020 and 2022–2024. Please note that there was no survey in 2017–2019 and 2021.

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
2023	652	372	1024	63.7	36.3
2024	428	275	703	60.9	39.1
Average	333	178	511	63	37

Table 8. Two Greenlandic surveys from 1989–1996, 2008–2016, 2020 and 2022–2024 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	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	51,540	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	5,846	34	51,633	20	Stratified random technique
2023	9,526	55	51,633	20	Stratified random technique
2024	5,576	52	51,878	20	Stratified random technique

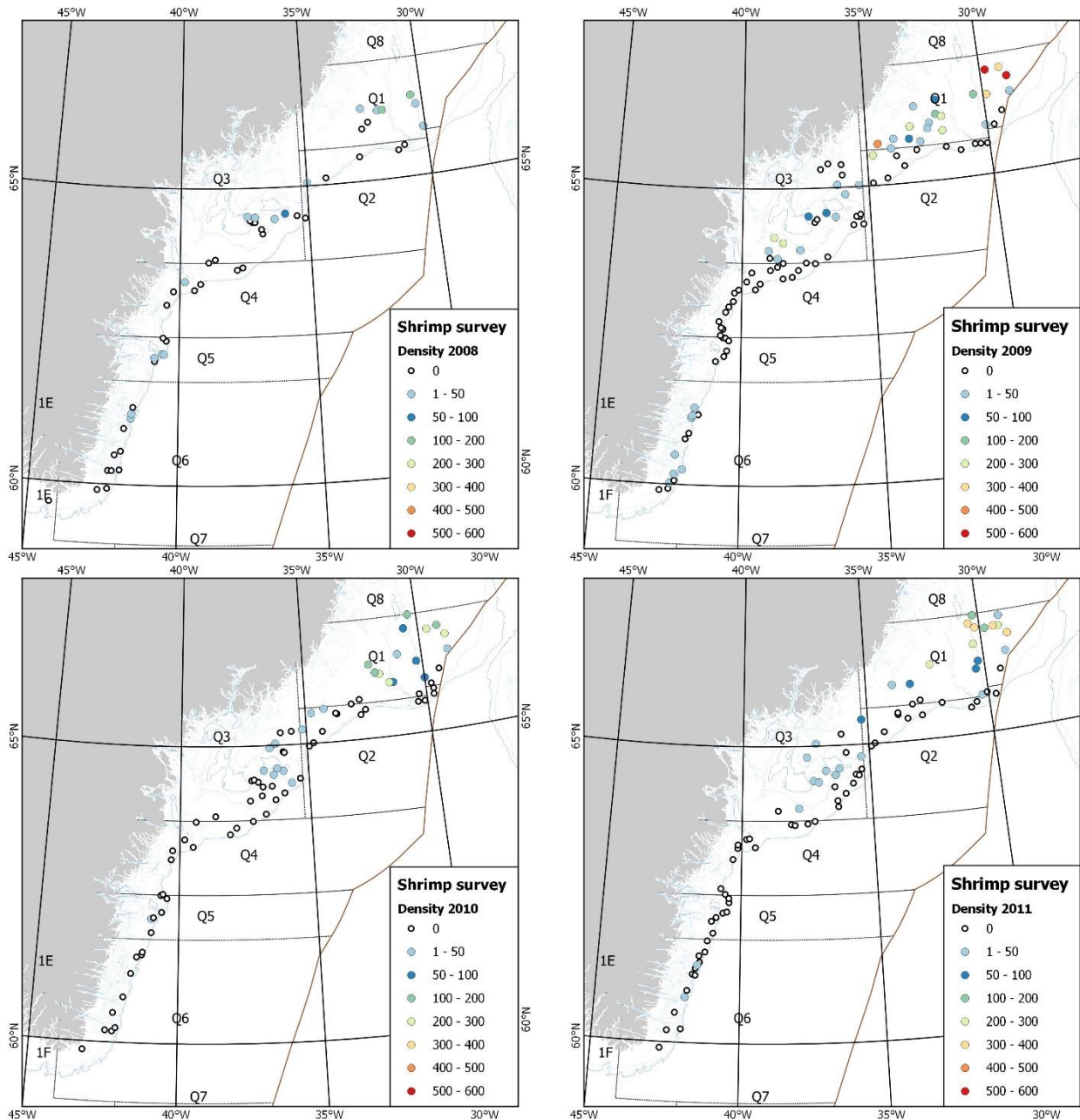


Figure 1a. Shrimp density (kg/km²) in survey area in 2008-2011. Line marks depths of 100-600m.

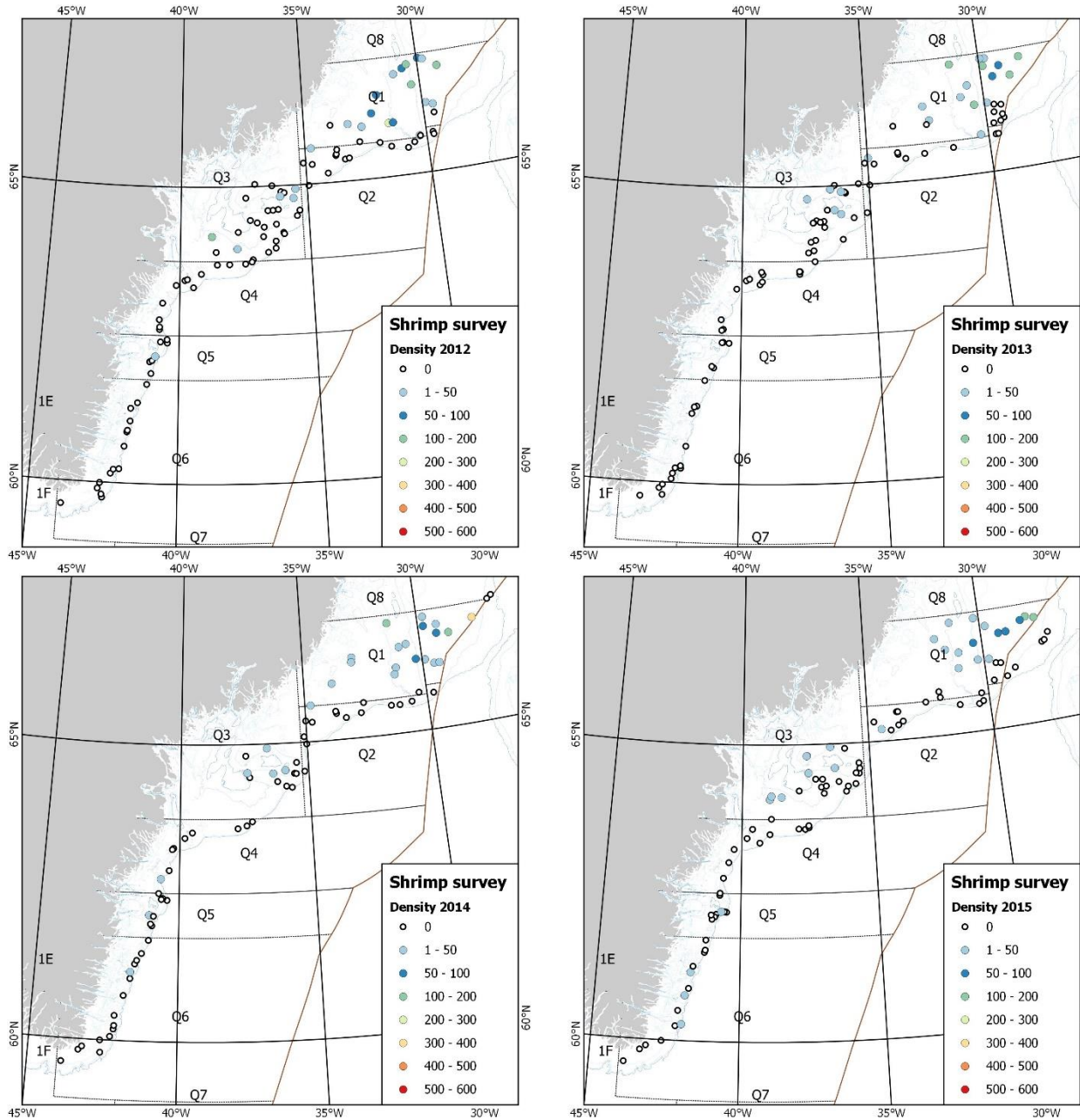


Figure 1b. Shrimp density (kg/km²) in survey area in 2012-2015. Line marks depths of 100-600m.

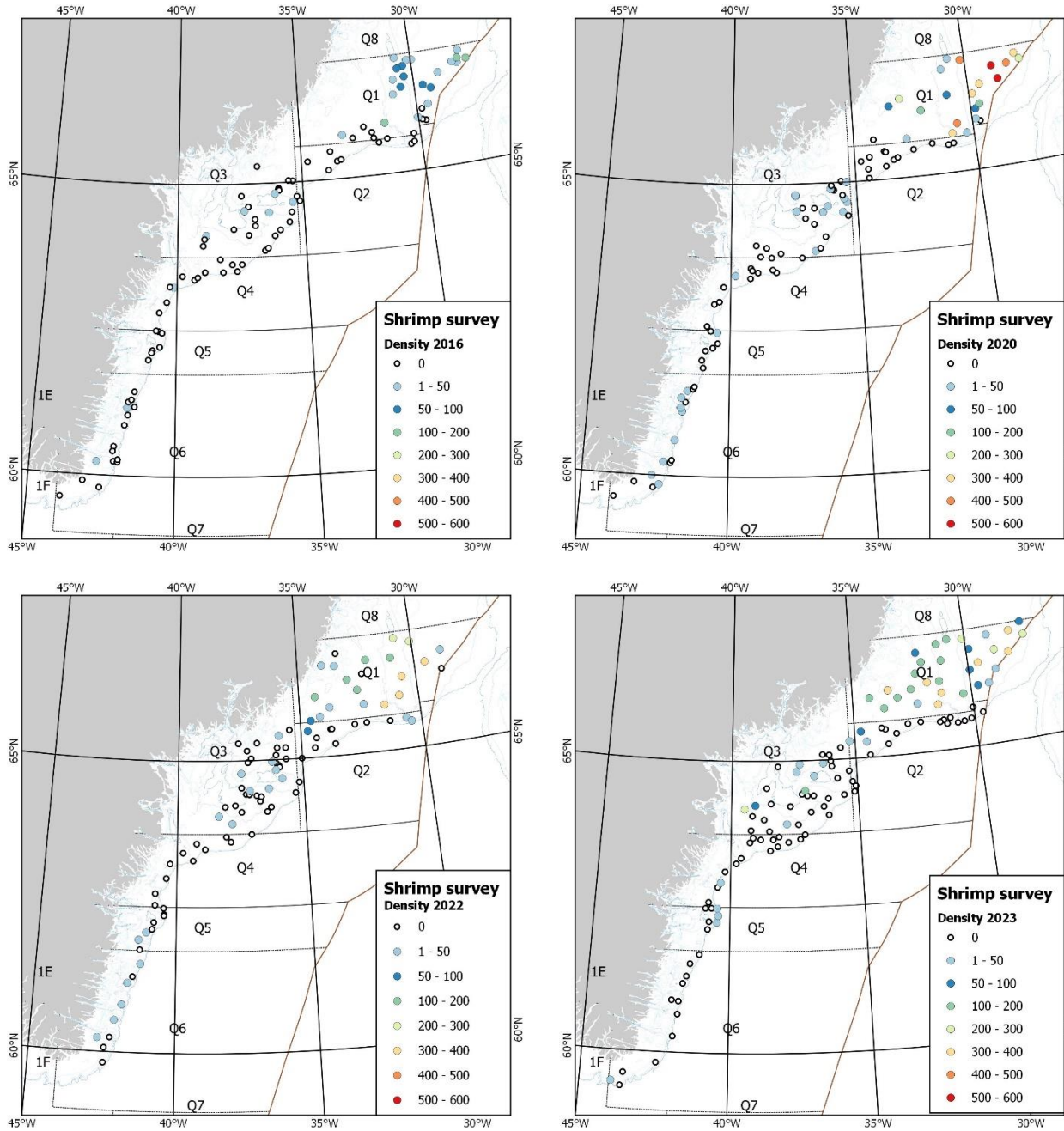


Figure 1c. Shrimp densitet (kg/km^2) in surveyarea in 2016, 2020 and 2022-2023. Line marks depths of 100-600m.

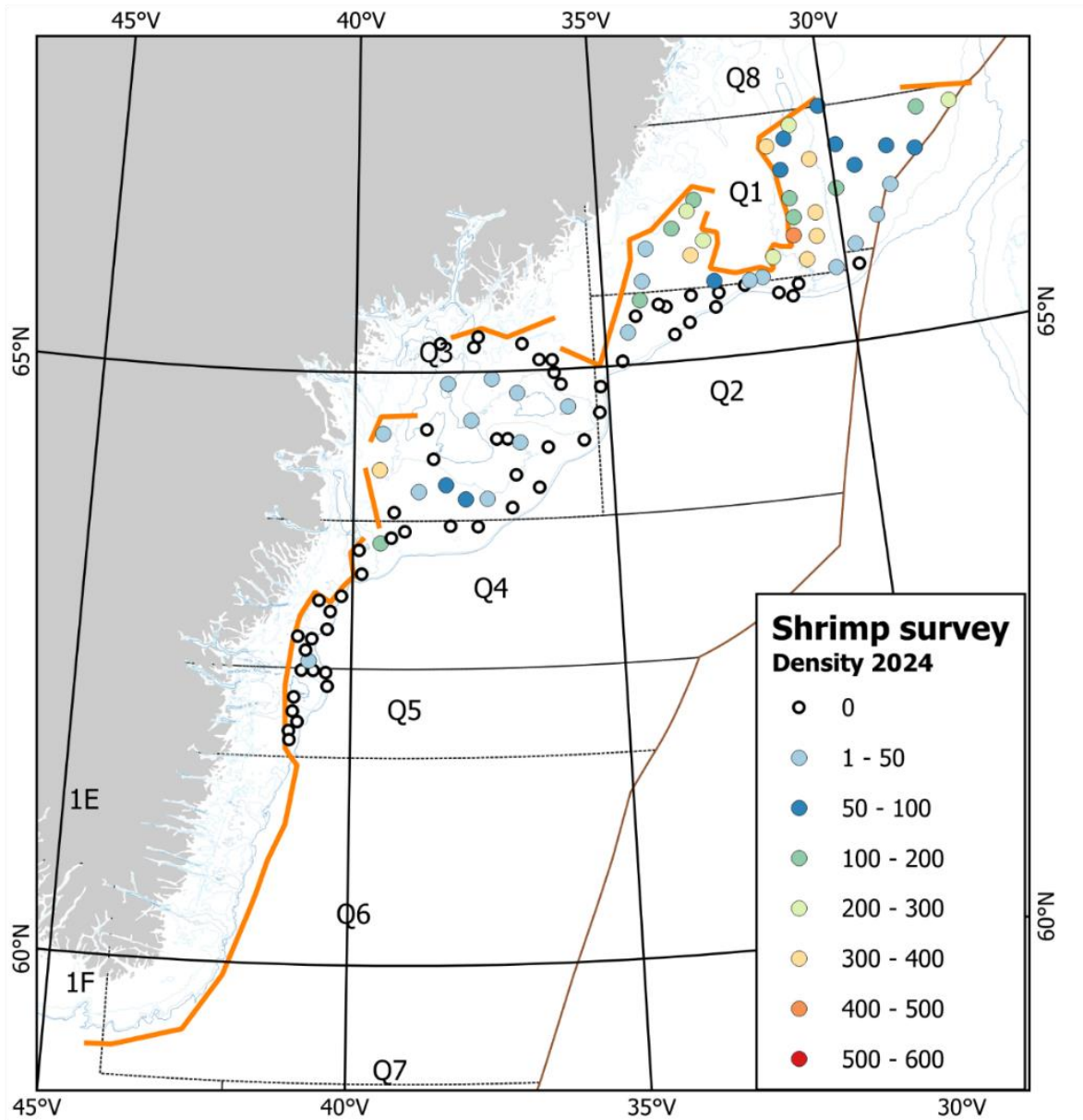


Figure 1d. Shrimp densitet (kg/km²) in surveyarea in 2024. Line marks depths of 100-600m. Orange line show extend of ice.

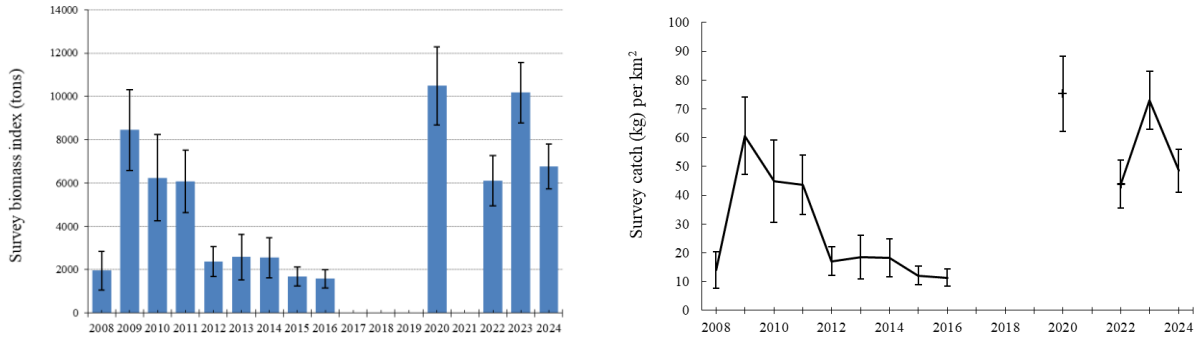


Figure 2. Estimated total survey biomass (t) and average survey biomass density (kg/km) of Northern shrimp with standard errors 2008-2016, 2020 and 2022-2024. In 2024 Q6 was not covered, for the estimations Q6 and Q5 were combined.

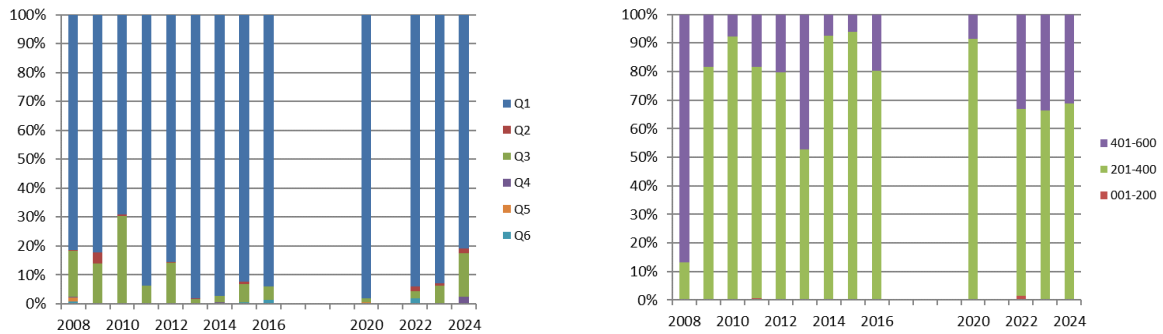


Figure 3. Survey biomass in percent in different areas (Q1-Q6) and depths (1-200m, 201-400m, 401-600m) 2008-2016, 2020 and 2022-2024.

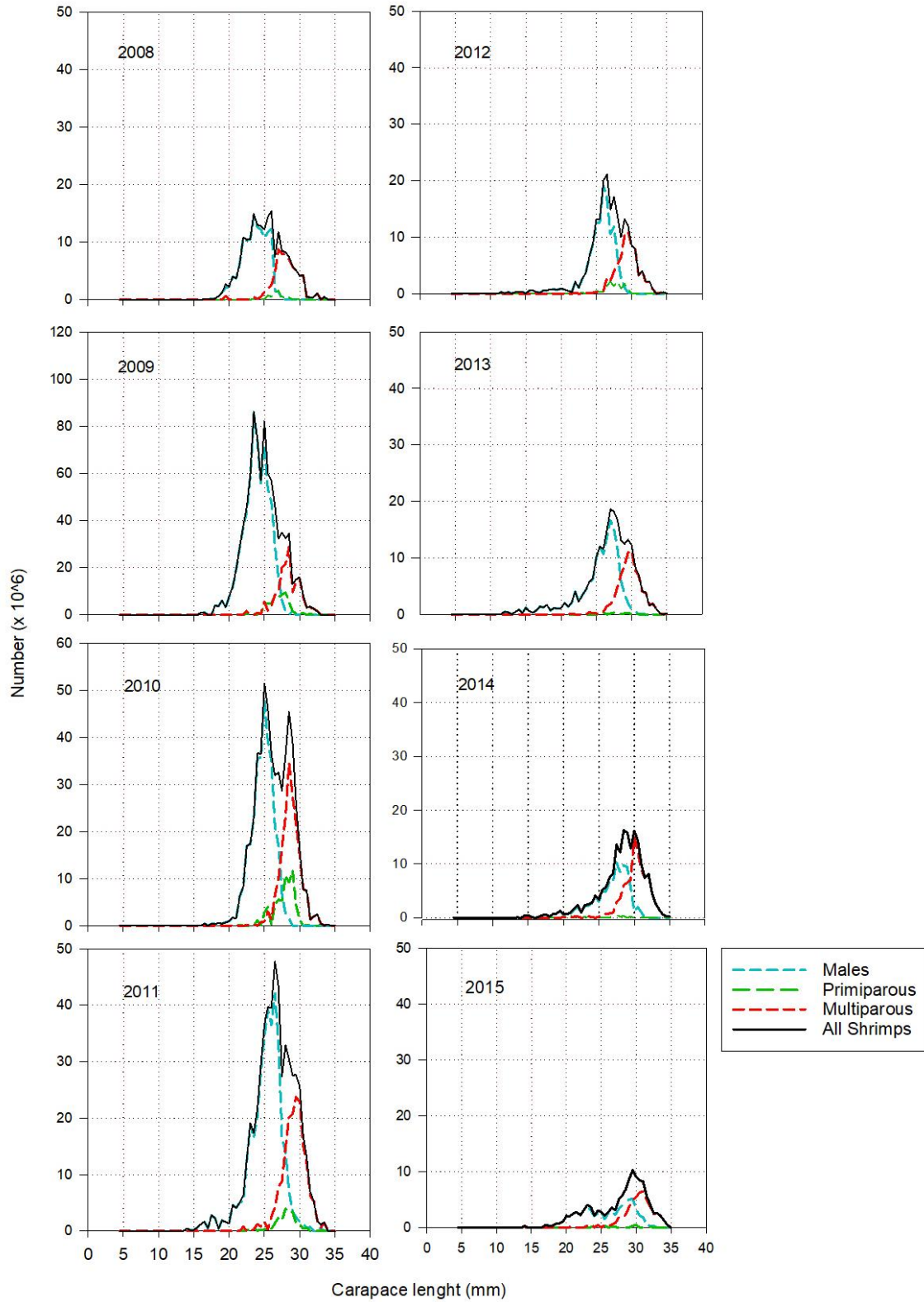


Figure 4a. Numbers of shrimp by length group (CL) in the total survey area in 2008 - 2015 (Please note that the scale in the figure for 2009 2010 differs from other years).

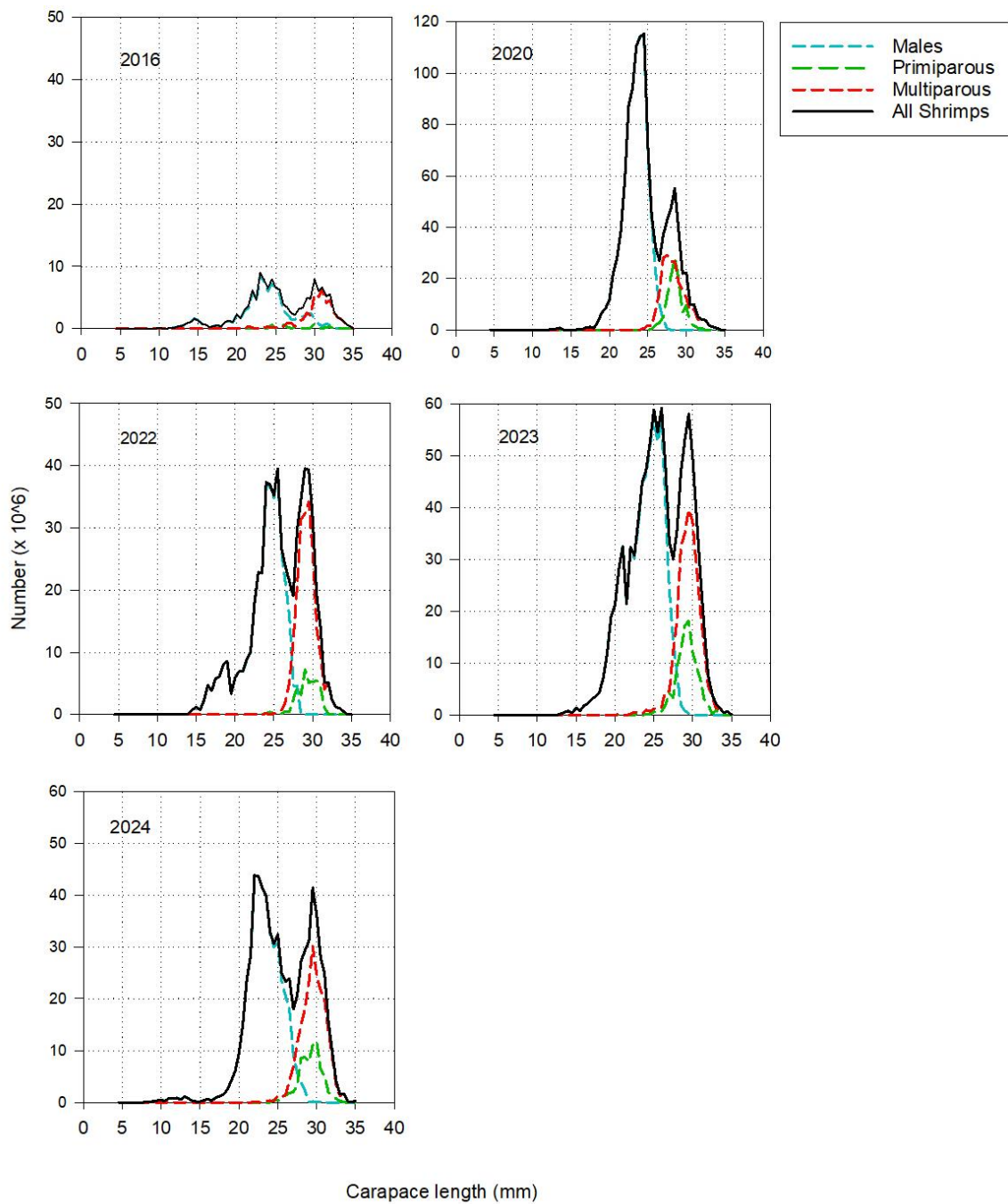


Figure 4b. Numbers of shrimp by length group (CL) in the total survey area in 2016, 2020 and 2022-2024. (Note that the scale in the figure for 2020 and 2023-2024 differs from other years).

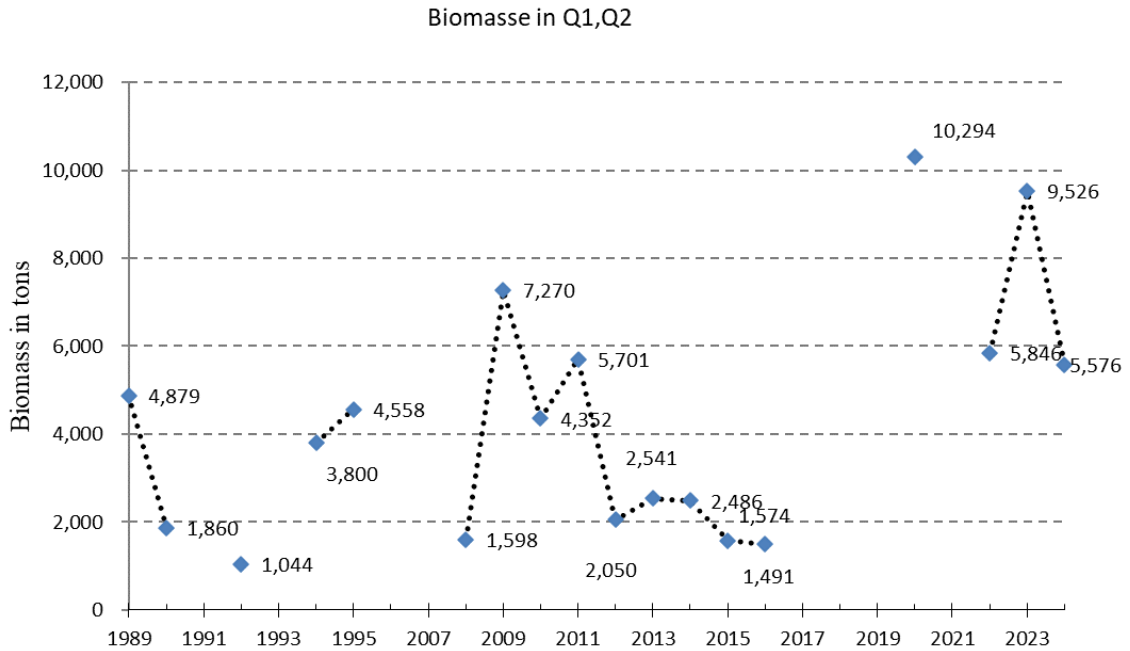


Figure 5. Biomass from two different surveys series from 1989-1995 and 2008-2024 for the areas North of 65°N and stratumarea Q1 and Q2 for comparison.

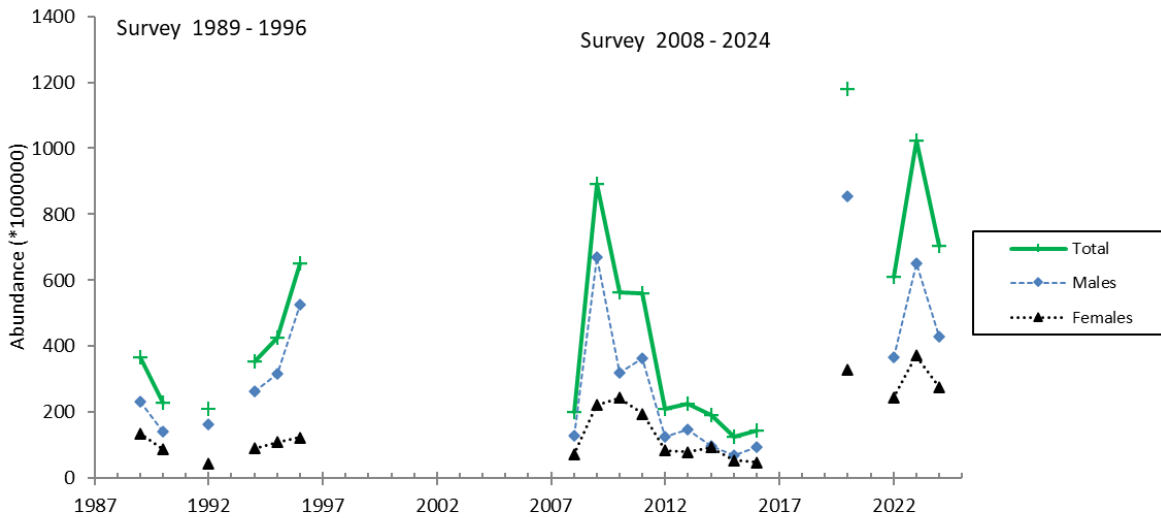


Figure 6. Abundance of males and females in two different surveys series from 1989-1995 and 2008-2024.



Figure 7. Temperature in the survey area Q1-Q6 from 2008-2024. Q6 was not covered in 2024.