

Northwest Atlantic



Fisheries Organization

Serial No. N7447

NAFO SCR Doc. 23/049

SCIENTIFIC COUNCIL AND STACFIS SHRIMP ASSESSMENT MEETING –SEPTEMBER 2023

**Results of the Greenland Bottom Trawl Survey for Northern shrimp (*Pandalus borealis*)
Off East Greenland (ICES Subarea XIV b), 2008-2023**

by

Tanja Buch, AnnDorte Burmeister

Pinngortitaleriffik, Greenland Institute of Natural Resources
P.O. Box 570, DK-3900 Nuuk, Greenland

Abstract

The 2023 survey for Northern Shrimp (*Pandalus borealis*) in East Greenland estimate the biomass of shrimp to have increased since the survey in 2022. The shrimp stock is concentrated in the area north of 65°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 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 were 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.

This document presents results on biomass, abundance and sex-composition from 2008 - 2023 surveys and attempt to compare these results with survey conducted in 1989-1996.

Materiel and Methods

The 2023 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. 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.

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 2022-2023 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 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. 23/045). The stations are distributed in each strata using the buffered random sampling described in Kingsley et al (2004). In 2023, 99 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 areas (survey areas Q4-6) ice coverage meant that all stations were taken in the eastern part of the area near the shelf edge. In Q1 it was not possible to take any stations in the depth range 0-200 m due to ice. In most cases these stations were moved and a total of 122 valid hauls were done in the 2023 (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. 23/045 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 et al, 2023). 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 CV of the total estimated biomass has improved from previous years and is the lowest in the timeseries at 13.8, likely due to additional stations taken in Q1 (Tab. 4). The stock is mainly located in the northern part in Q1 with 93% of total biomass in 2023 (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 2023 66% 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 2023 47 % 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 and in 2023 - although in small numbers (less than 1% of the total biomass in 2023). Biomass and abundance of female and males weighted up to total biomass are presented in Table 6 and Table 7. Female biomass average 2 257 tons for the entire survey time series. In 2023 female biomass was at 4 802 tons (Tab. 6), which is the highest in the timeseries.

Total numbers of shrimp (males and females) in 2023 was estimated to 1 024 000. The average on 495 000 for the entire survey timeseries. The abundance of males in 2023 was 652 000. The proportion of males relative to females was 63.7%, 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 2008-2023 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 2023 has increase compared to 2022 and is at a high level. 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

- ANDERSEN, M., CARLSSON, D. M. AND P. KANNEWORFF. 1994. Trawl survey for shrimp (*Pandalus borealis*) in Denmark Strait, 1994. *NAFO SCR Doc.*, No. 90, Serial No. N2477.
- BURMEISTER, AD AND BUCH, T. B. 2023. The West Greenland trawl survey for *Pandalus borealis*, 2023, with reference to earlier results. *NAFO SCR Doc.*, No. 23/045, Serial No. N7443.
- CARLSSON, D. M. 1996. Trawl survey for shrimp (*Pandalus borealis*) in Denmark Strait, 1996. *NAFO SCR Doc.*, No. 116, Serial No. N2813.
- CARLSSON, D. M., and P. KANNEWORFF. 1995. Trawl survey for shrimp (*Pandalus borealis*) in Denmark Strait, 1995. *NAFO SCR Doc.*, No. 109, Serial No. N2648.
- KANNEWORFF, P. and K.M. LEHMANN 1993. Stratified-Random Trawl Survey for shrimp (*Pandalus borealis*) in Denmark Strait, 1990. *NAFO SCR Doc.*, No. 52, Serial No. N1935.
- KINGSLEY, M.C.S., P. KANNEWORFF and D.M. CARLSSON. 2004. Buffered random sampling: a sequential inhibited spatial point process applied to sampling in a trawl survey for Northern shrimp *Pandalus borealis* in West Greenland waters. *ICES J. Mar. Sci.*, **61**: 12-24.

Table 1. Vessels, trawl types and rigging parameters used in the Greenland Bottom Trawl Survey for shrimp and fish, 2008–2023.

	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
2022-2023	Tarajoq	Cosmos	54.0	30.3-31.7

Table 2. Survey estimates of total biomass 2023.

Stratum	Area (km ²)	Stations	Biomass density (t/km ²)	Biomass (Kt)	Biomass error variance	Error coefft of variation (%)
Q1-0	0	0	0.000	0.000	0.000	0.00
Q1-2	35662	26	0.171	6.105	0.771	14.39
Q1-4	6975	8	0.479	3.340	1.109	31.53
Overall Q1	42637	34	0.222	9.445	1.881	14.52
Q2-0	93	2	0.000	0.000	0.000	0.00
Q2-2	7657	9	0.011	0.081	0.004	76.23
Q2-4	1246	10	0.000	0.000	0.000	0.00
Overall Q2	8996	21	0.009	0.081	0.004	76.23
Q3-0	3363	4	0.000	0.000	0.000	61.20
Q3-2	22547	19	0.024	0.548	0.088	54.22
Q3-4	9830	9	0.007	0.068	0.002	68.83
Overall Q3	35740	32	0.017	0.617	0.091	48.81
Q4-0	1337	4	0.000	0.000	0.000	100.00
Q4-2	7770	9	0.000	0.001	0.000	77.08
Q4-4	2054	3	0.000	0.000	0.000	0.00
Overall Q4	11161	16	0.000	0.001	0.000	72.42
Q5-0	469	2	0.000	0.000	0.000	33.75
Q5-2	2785	3	0.005	0.015	0.000	45.86
Q5-4	1819	2	0.001	0.002	0.000	39.98
Overall Q5	5073	7	0.003	0.016	0.000	41.00
Q6-0	6307	3	0.000	0.001	0.000	69.48
Q6-2	6130	6	0.001	0.007	0.000	83.52
Q6-4	2063	3	0.000	0.001	0.000	52.12
Overall Q6	14500	12	0.001	0.009	0.000	65.77
Survey totals	118107	122	0.086	10.170	1.975	13.82

Table 3. Biomass estimates (t) for survey subdivisions and standard errors for the entire survey, 2008–2016, 2020 and 2022–2023. 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	1405

Table 4. Error coefficients of variation (%) for the biomass estimates for the entire survey area 2008–2016, 2020 and 2022–2023. 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
Mean 2008–2023							27.6	

Table 5. Estimated mean densities (kg/km²) for survey subdivisions in 2008–2016, 2020 and 2022–2023. 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

Table 6. Survey biomass estimates (tons) by sex based on length-weight distributions 2008–2016, 2020 and 2022–2023. 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
Average	2765	2257	5021	53	47

Table 7. Estimated numbers ('000) by sex from length analyses 2008–2016, 2020 and 2022–2023. 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
Average	325	170	495	63	37

Table 8. Two Greenlandic surveys from 1989-1996, 2008-2016, 2020 and 2022-2023 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 Stratified random
2008	1,598	16	54,633	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
2023	9,526	55	51,633	20	Stratified random technique

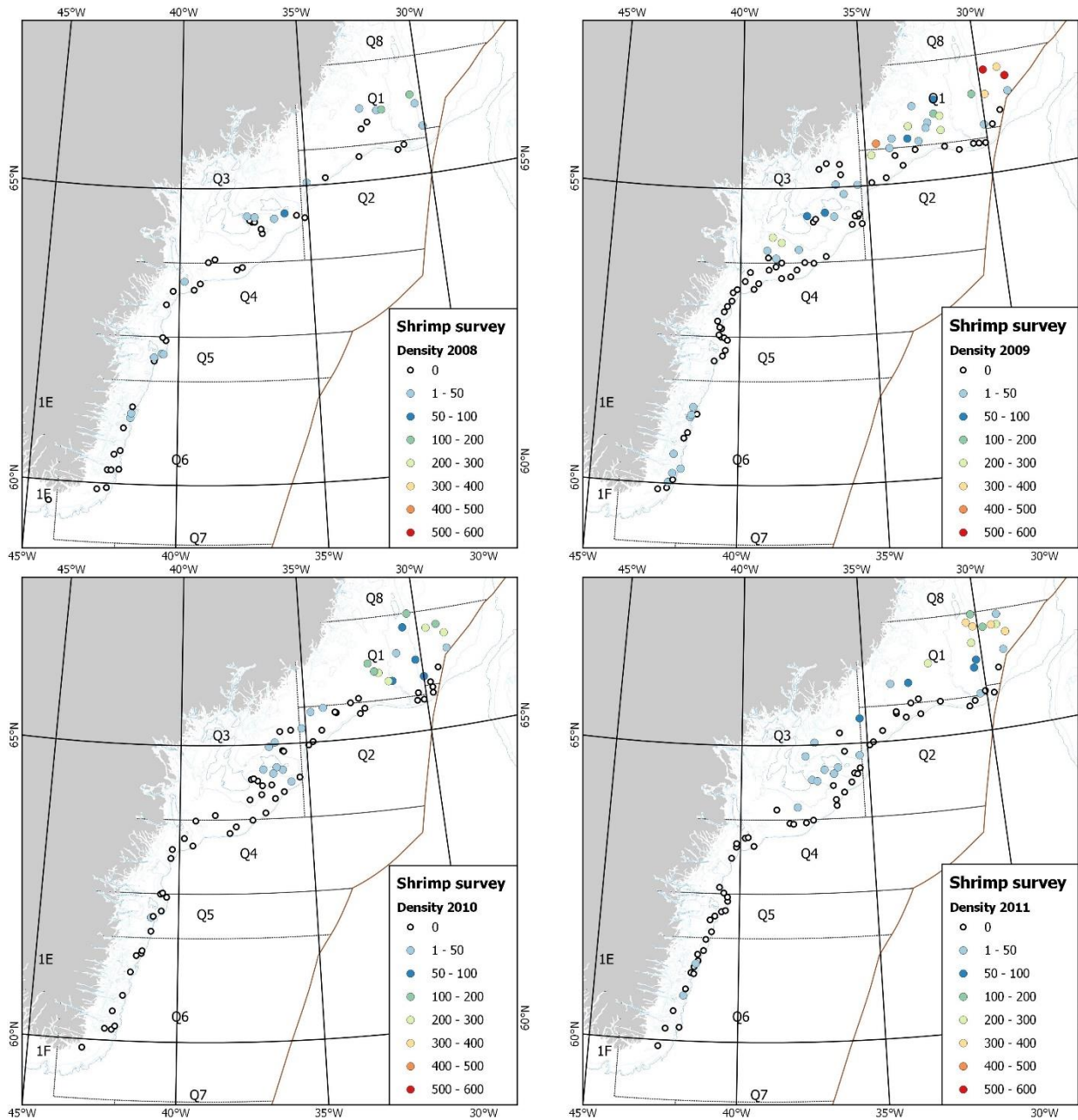


Figure 1a. Shrimp density (kg/km²) in survey area in 2008-2011. Line marks depths of 100-600m.

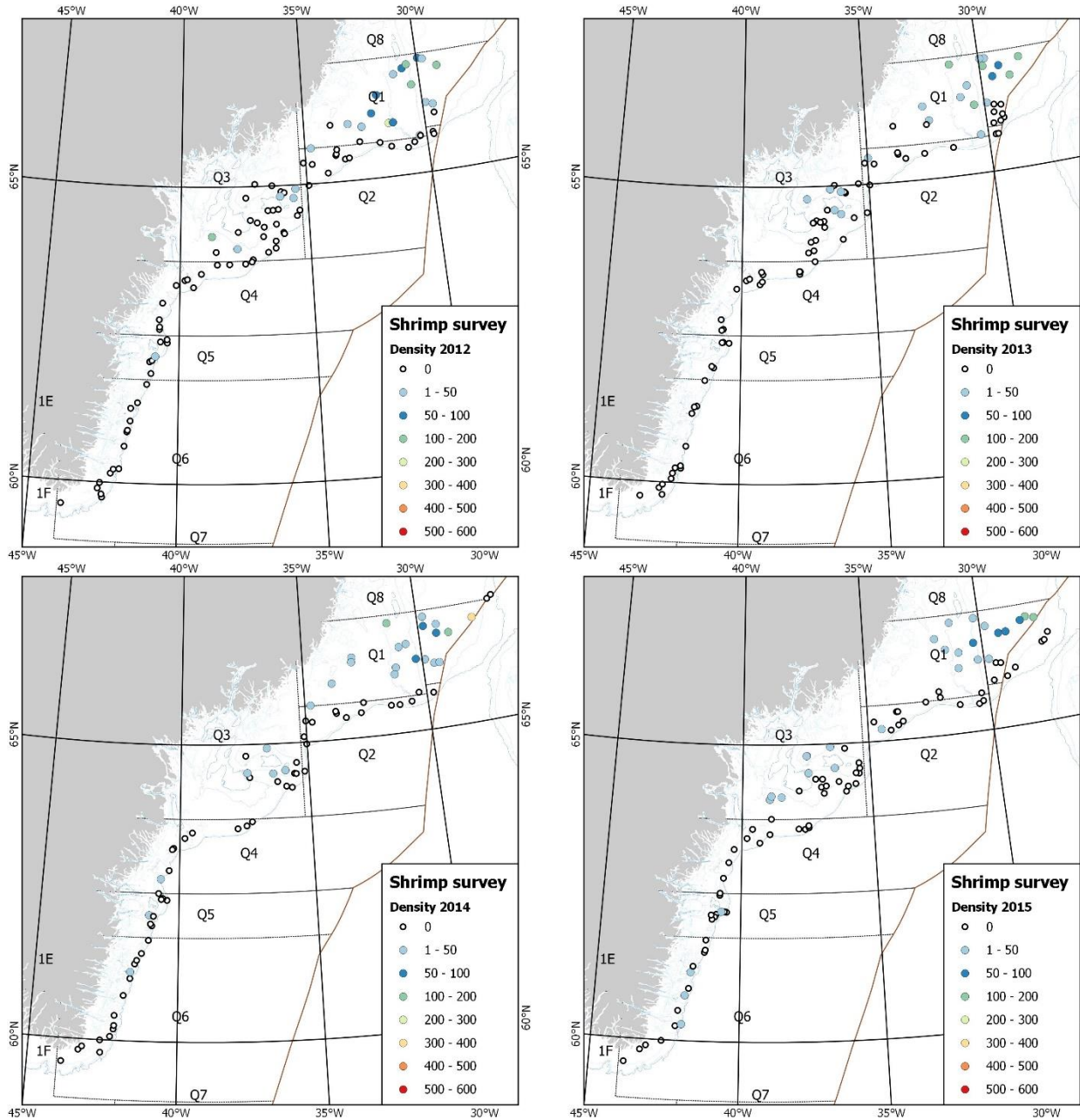


Figure 1b. Shrimp density (kg/km²) in survey area in 2012-2015. Line marks depths of 100-600m.

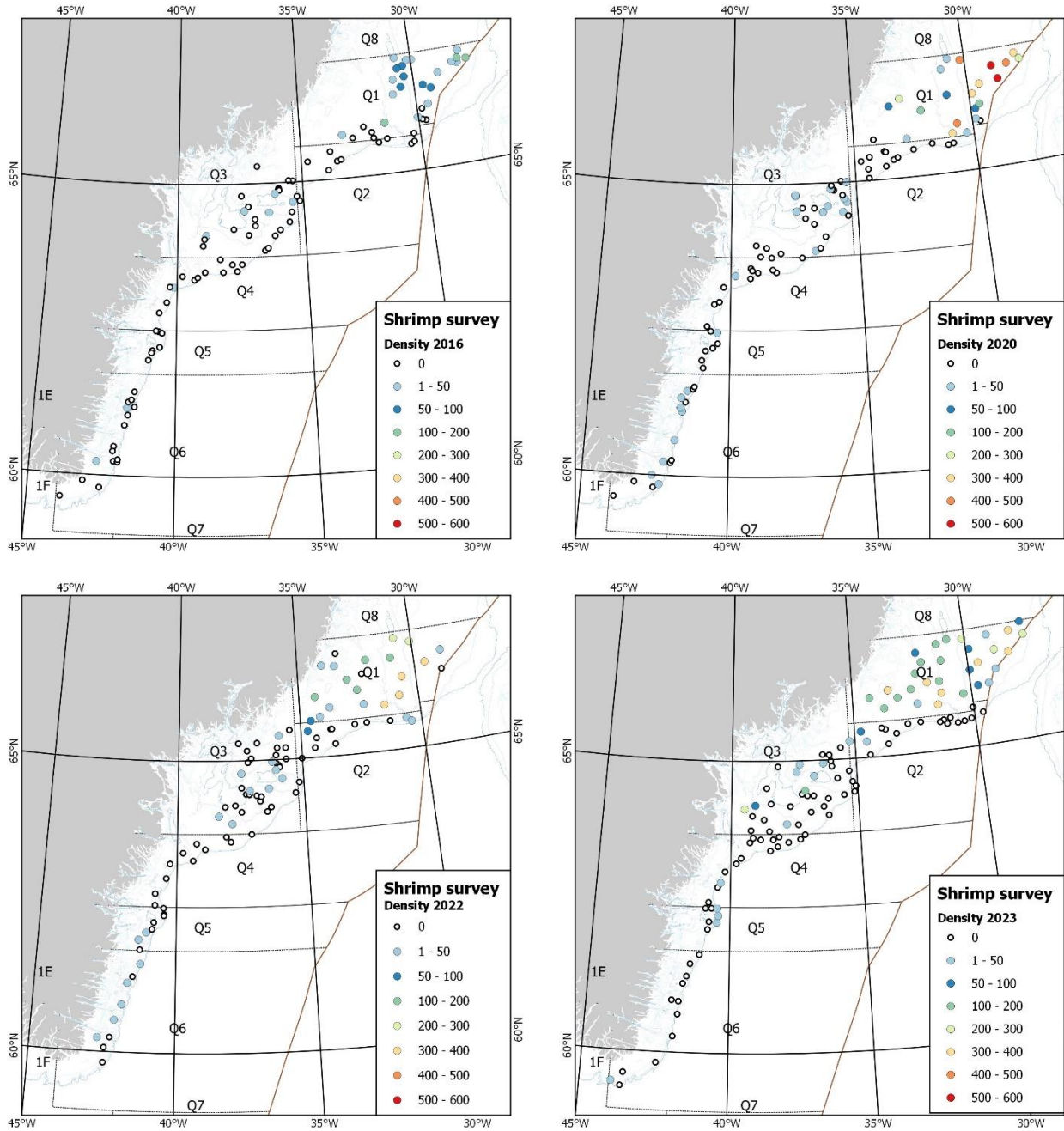


Figure 1c. Shrimp densitet (kg/km²) in surveyarea in 2016, 2020 and 2022-2023. Line marks depths of 100-600m.

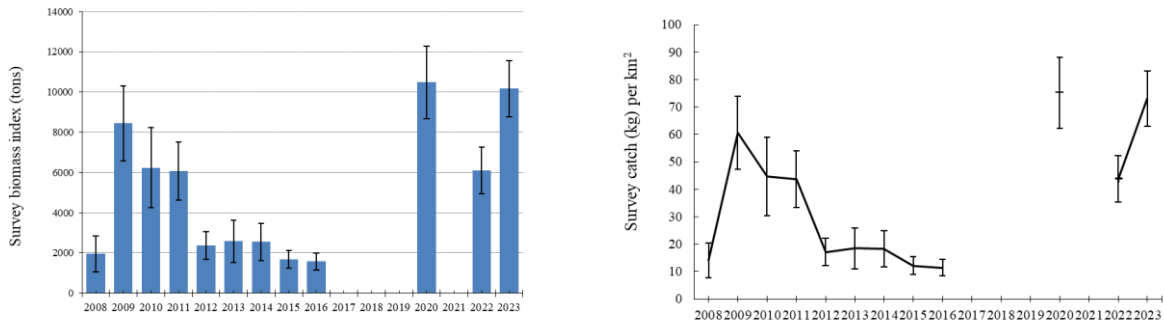


Figure 2. Estimated total survey biomass (t) and average survey biomass density (kg/km) of Northern shrimp with standard errors 2008-2016, 2020 and 2022-2023.

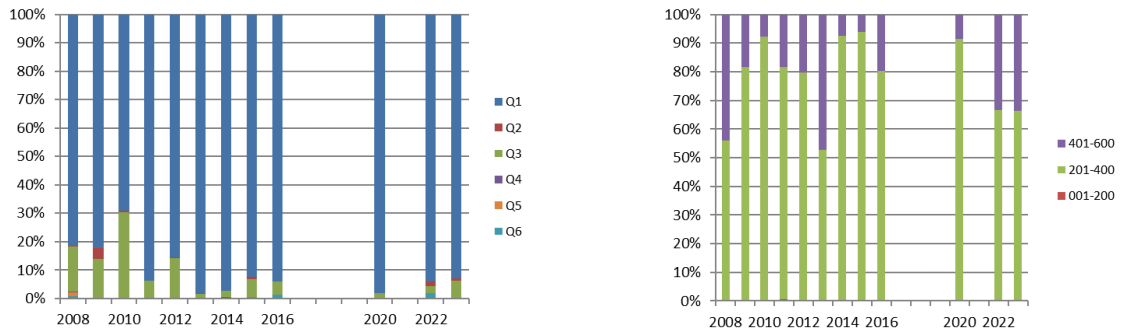


Figure 3. Survey biomass in percent in different areas (Q1-Q6) and depths (1-200m, 201-400m, 401-600m) 2008-2016, 2020 and 2022-2023.

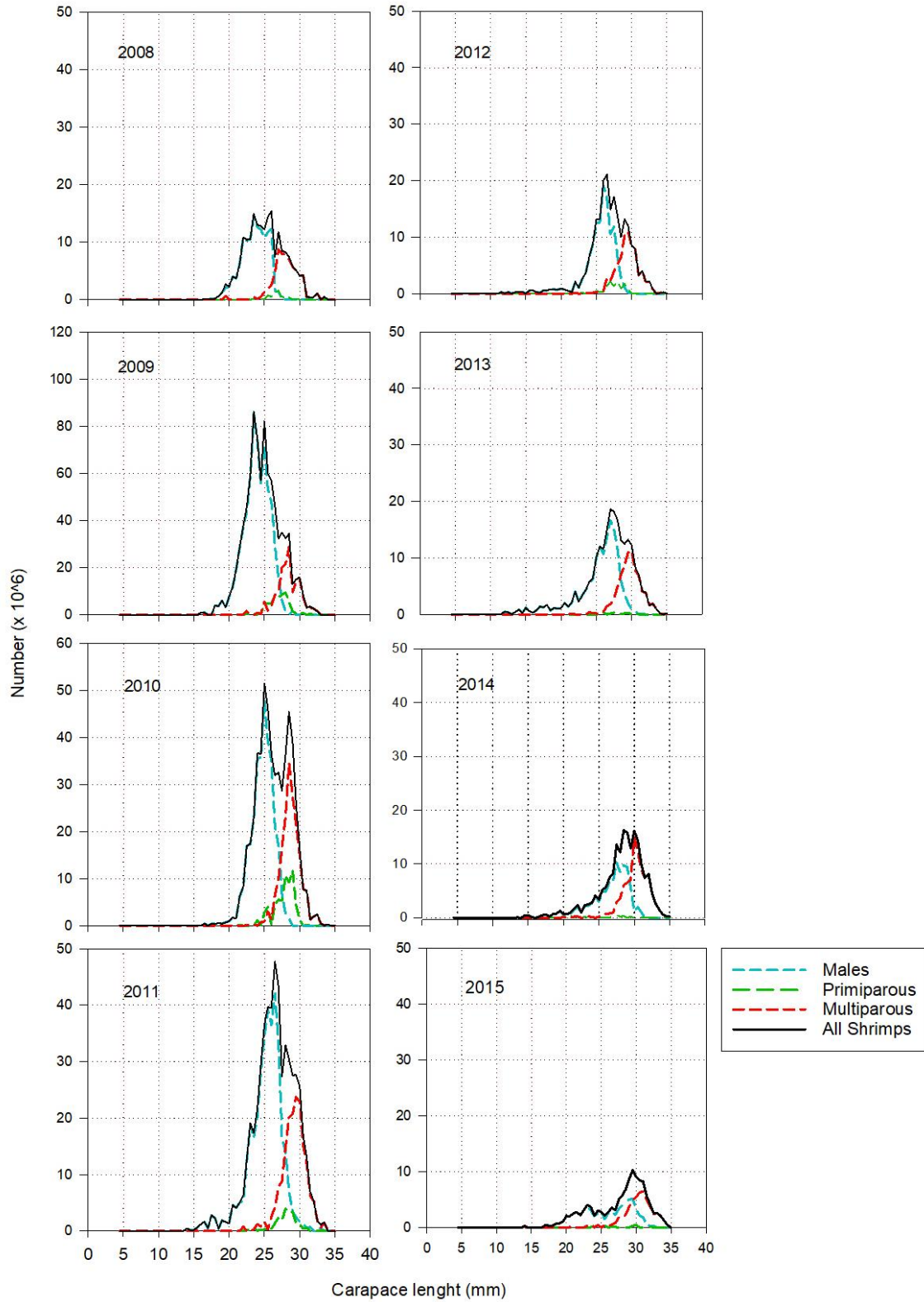


Figure 4a. Numbers of shrimp by length group (CL) in the total survey area in 2008 - 2015 (Please note that the scale in the figure for 2009 2010 differs from other years).

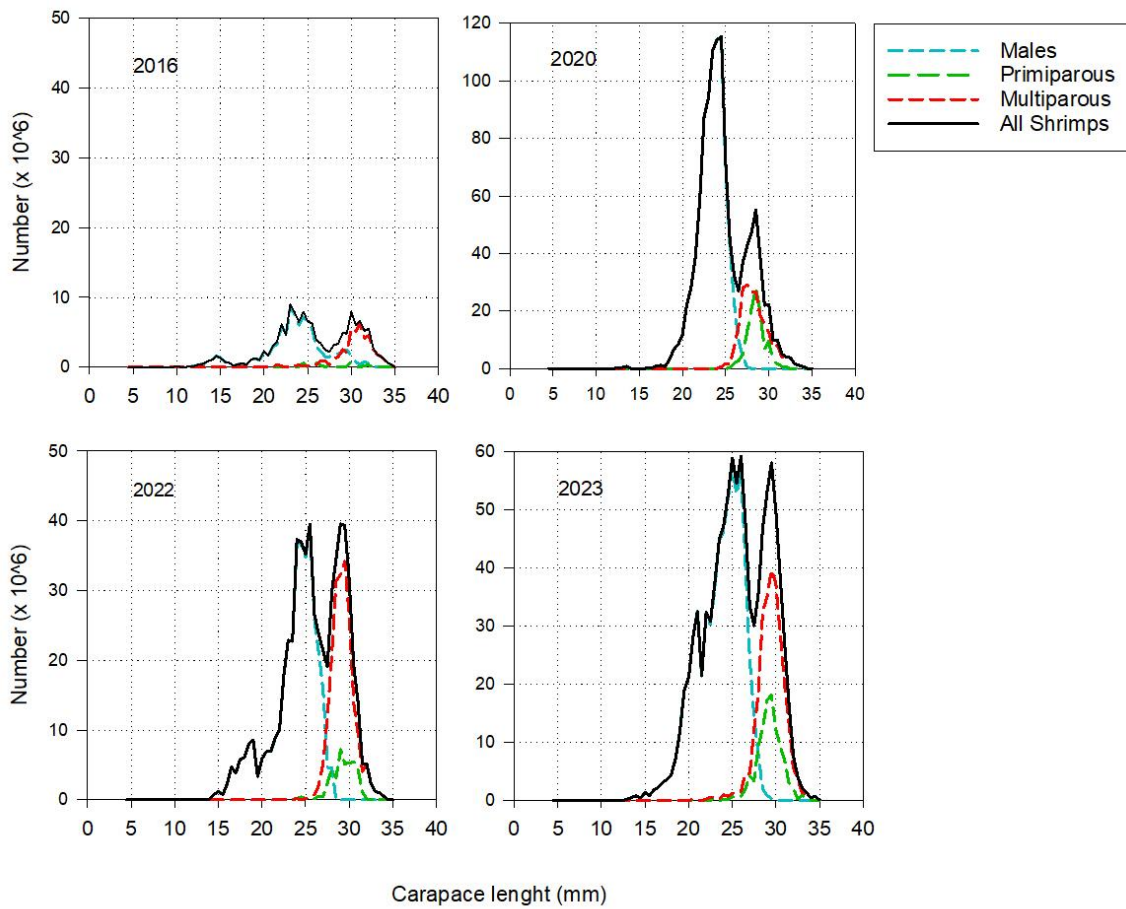


Figure 4b. Numbers of shrimp by length group (CL) in the total survey area in 2016, 2020 and 2022-2023. (Note that the scale in the figure for 2020 and 2023 differs from other years).

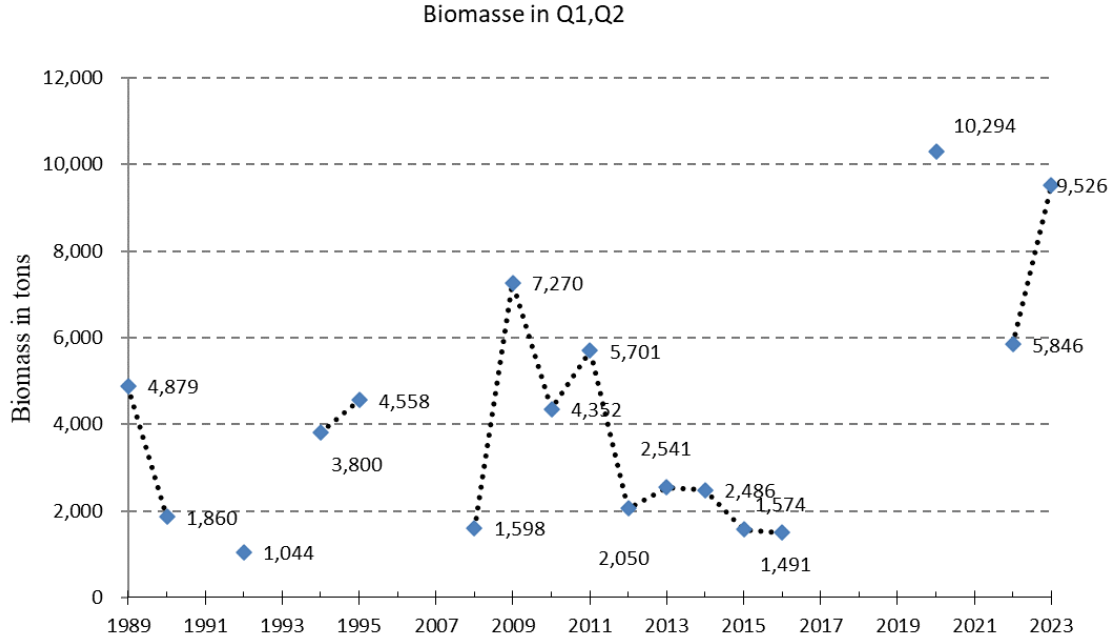


Figure 5. Biomass from two different surveys series from 1989-1995 and 2008-2023 for the areas North of 65°N and stratumarea Q1 and Q2 for comparison.

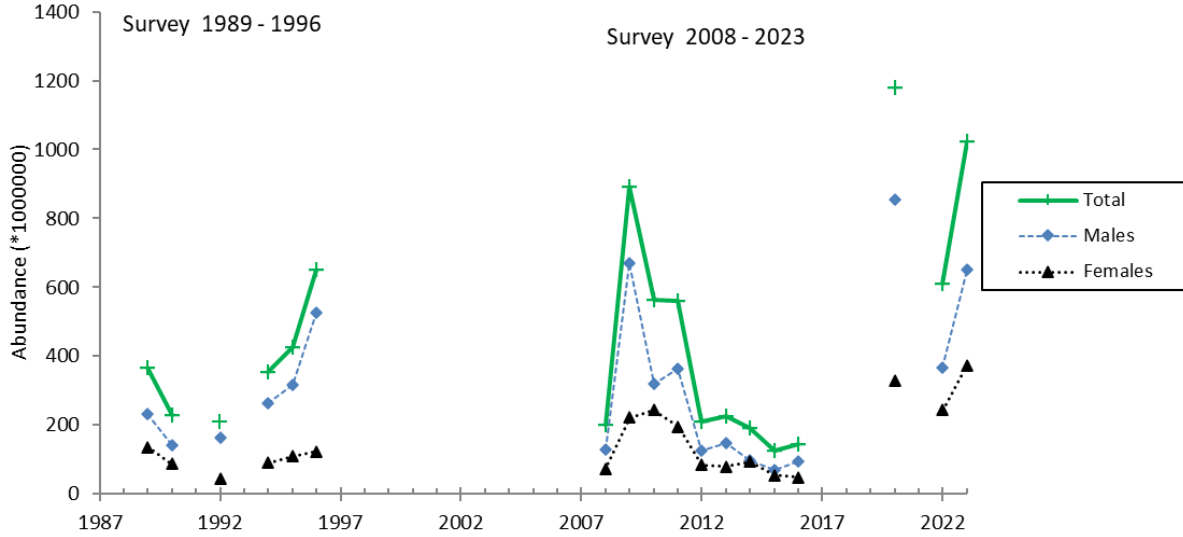


Figure 6. Abundance of males and females in two different surveys series from 1989-1995 and 2008-2023.

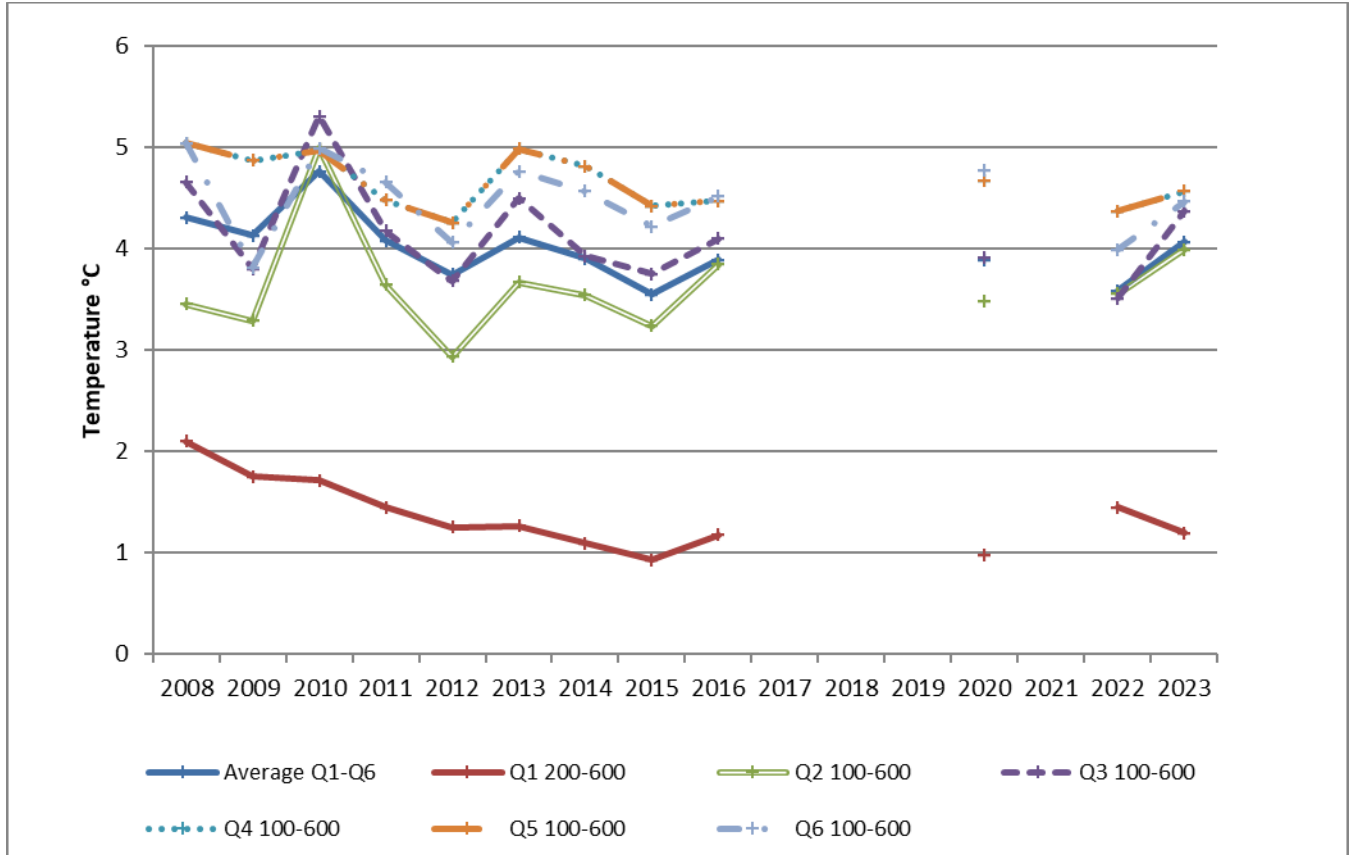


Figure 7. Temperature in the survey area Q1-Q6 from 2008-2023.