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Experimental and development fishery for shrimp (Pandalus borealis) in Melville Bay, West Greenland waters North of 73°30'N, 2014 - 2016

by

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Abstract

A trial and development fishery has been carried out in 2014 to 2016 in Melville Bay, NAFO Division 0A, in attempt to expand the commercial shrimp fishing grounds. The experimental fishery had pre-defined fishing stations, whereas at the development part, attending commercial vessels could fish were it was commercially viable. .

In 2014, mainly two locations were fished, and samples were collected for scientific analysis from 32 hauls. In 2015, almost same fishing ground were investigated during the development fishery, and only 91 of the planned 494 positions at the trial fishery were fished in 2015. The following year geographical distribution of the fishery expanded. Itwas mainly distributed north of 74°53'N in Melville Bay, and 249 of the 315 planned stations were fished.

Number of hauls were less than 600 in the first years and 70% of fishery effort were concentrated along the East side of Isfjeld banke and offshore Nuussuaq. In 2016, the fishery moved Northwards, 921 hauls were conducted at the East, West and North of Isfjeldbanke but with less effort in the more Southern part of Melville Bay. Catches increased from 1400 t to 2800 t over the three years, so did average catch rates 346 kg/h in 2014 to 513 kg/h in 2016, however catch rates in Melville Bay were lower compared to the fishing grounds south of 73°30'N.

Carapace length of shrimps in Melville Bay were in general larger in size, than compared to shrimps measured during the annual survey South of 73°30'N. Both males and female shrimp carapace length increased with increasing fishing depth and carapace length was not decreasing over years of sampling.

Introduction

Since the early days of the shrimp fisheries in the 1960s, the fishing industry has developed the fishery and sought for new areas where it is possible to exploit the shrimp resource. Therefore, in the years 2014 to 2016, the fishing industry wanted to expand West Greenland shrimp fisheries to the area north of 73 ° 30N, Melville Bay. For this reason, a development and experimental fishing for shrimps was started in Melville Bay (Figure 5). A more comprehensive description of the background for the trial and development fishery can be found in Burmeister and Christensen (2015).

Material and Method

The goal of the development and experimental fishery was:

- to identify the distribution of shrimp in Melville Bay
- to identify the presence of other fish species
- identify possible vulnerable marine ecosystems (VME) in the area
- to collect data that can indicate the state of the stock for Greenland Self-government decisions on future management of the shrimp stock.

The fishery was planned so the stock was properly exploited, and so Greenland Institute of Nature could obtain sufficient data to evaluate the distribution of the stock and its composition. Furthermore, it was planned so the MSC certification of West Greenland fisheries for shrimp was not compromised.

Melville Bay is considered as a part of the shrimp area for which annual advice on TAC has been giving by NAFO Scientific Council. Hence it was included in the total TAC of the West Greenland Waters, an extra quota was given, 2000 t in 2014 and 3000 tons in both 2015 and 2016.

The fishing fleet was imposed certain restrictions, partly with the purpose to seek areas outside those where the trawlers achived high catch rates. The attending vessels were obliged to visit a certain number of fishing positions as a part of the trial fishery, before they were allowed to continue the development fishery in areas with high densities of shrimps.
At the pre-defined fishing positons, vessels were assigned a 30-minute haul, they had to report on bottom temperature and general logbooks information (position, fishing date and time, fishing depth, weight of shrimp caught and by-catch). In addition, from each hauls conducted at the pre-defined positions, sample from shrimp catches were collected for further examination at the Greenland Institute of Natural Resources.

All logbooks were analyzed to investigate geographical distribution of both trial – and development fishery and mean catch rates from 2014 to 2016. Shrimp samples from the attending vessels were sorted by stages of sexual development and carapace lengths (CL) and were measured to the nearest 0.1 mm. Data were used for Length-frequency analysis of sexual stages in the stock.

In 2014, 32 samples were taken from the catches during exploration fishing and 96 sample out of 496 were planned stations were sampled in 2015. In 2016, number of samples increased to 182.. The geographical distribution of collected samples is shown in Figure 3–5.

Results and Discussions

Geographical distribution of the fishery

In 2014 and 2015, fishing activities was completed between 72°30'N and 75 °30'N. The majority of fisheries were concentrated in two smaller areas (Figures 1a-b). In 2016, fishery was moved northward, mainly north of 74°53'N and most activities occurred both the east and west side of Isfjeld bank (Figure 1a-c).

Development fisheries took place in three defined areas: In 2014, majority of effort were distributed in the northern region from NM to NR (54%), and 57% of total catches in 2015, were fished in the southern most area from ND to NH. The following year, 70% of the total catches were based on fishery around the Isfjeldbank. On the East of Isfjeldbanke (35%), West of Isfjeld banke (29%) and North of Isfjeldbanke (6%).

Seasonal catch and effort

Seven trawlers were attending the trial fishery in 2014, six trawlers in 2015 and five trawlers in 2016. In 2014, a total of 548 hauls were taken and total catch amounted 1,407 t. In 2015, the number of hauls were increased to 580, and the total catch was 1,594 t. In 2016, the number of hauls increased further to 921 and total catch amounted 2,800 t (Table 1 and Table 2).

Fishing were conducted between September and December 2014, of were 62% of total catches were fished in October and less than 1% during December. Both, in 2015 and 2016 fishery occurred from September (October in 2016) to November. Most catches, 57- 61% of total, were achieved in October, while 32% of total catches were obtained in November 2015 and a bit less the subsequent year.

Catches and catch rate

The catches of the attending vessels ranged from 41 to 468 t in 2014, from 170 to 427 t in 2015 and from 232 to 848 t in 2016 (Table 1 and table 2). The vessel that made the most of hauls over the three years, also had the biggest catch. This vessel fished in the same area as the other vessels, but achieved a bigger catch all three years.

The average catch rate in 2014 showed a continuous decline from 569 kg/h in September to 174 kg/h in December. By 2015, the average catch rate was relatively stable at 410 kg/h during the three months of fishing. In 2016, the average catch rate was stable at 553 kg/h in September and October, but dropped to 433 kg/h in November. During the three years in which the investigative and development fisheries have been conducted, more knowledge has been gained about where the shrimps are. This may have been one of the reasons, why the average catch rates increased by 77kg/h from 2014 to 2015 and 112kg/h from 2015 to 2016 (Table 2). Highest average catch rate of 569 kg/h, however, was achieved in September 2014 and the lowest at 174 kg/h in December 2014.

The highest catch rates per "catch area" north of 73°30'N was obtained in 2014 at NE440, in 2015 at NG439 and in 2016 at NZ420 and NZ411 respectively (Figures 2a-c). Of the 62 positions that were fished in 2014, there were zero catches at 15 of the fished positions. By 2015, there were zero catches at 64 of 96 fished positions. Out of 249 fished position, 104 had zero catches.

Where catch rate were irrelevant to fishing depth in 2014 and 2015, catch rate in 2016 were significantly larger at depths from 150 to 400 m, compared to fishing at depths> 400 m (Simple linear regression: 2014, df= 547 r^2= 0.02, t= 0.50, P=0.619; 2015: df= 579, r^2= 0.045, t= -1.09, P=0.276; 2016: df=921, r^2= 0.138, t= 12.14, P=0.0002). In 2014, fishing was carried out on depths from 149 to 527 meters (average 352 m). In 2015, most hauls were conducted from 119 to 557 m (average 374 m) and in 2016 from 100 to 947 m (average 375 m).

Biological samples

During the experimental fishery in 2015 there were significantly more shrimps below 17mm CL compared to observations in 2014 and 2016. The results reflects the observations from shrimp surveys south of 73°30'N, both in 2015 and 2016, where a large number of age-2 shrimps and pre-recruits (3-4 year old shrimps) were observed (Burmeister and Kingsley 2015). In Melville Bay, the number of males range in carapace size from

17 to 22 mm Cl was significantly lower compared to the previous two years, and consistent with observations south of 73°30'N. In contrast, number of males from 23 to 24 mm CL were increasing over 2015. The results indicate a decline of age 2-shrimp, that pre-recruits (16 mm CL) were recruited into the fishable stock and an increase in growth of males (Figure 10). During all years males carapace length range from 8 to 27 mm CL, primipara females from 17-30 mm CL, and mulitipara females from 20 to 34 mm CL 10 (Figures 6 - 8).

Multipara females with carapace length from16 to 20 mm CL were found in 2014 samples, which is in contrast to observations from South of 73°'30'N. In fact, Greenland Institute of Natural History has never observed multipara females less than 20 mm CL. Therefore, an error might have occurred during classification of shrimps in samples from 2014.

There was a strong linear relationship between male average carapace length and average fishing depth in both 2015 and 2016 (simple linear regression: df = 3281, $r^2 = 0.1991$, t = 28.59, P < 0.001) and a post hoc test (Turkey-Kramer) indicated a significant (df = 3281, F = 180.53, p < 0.001) tendency of increasing carapace length with fishing depth (Figures 9-11, table 3-5). Same tendency were not for males in 2014. Furthermore, same pattern were found for both primipara where larger females were found with increasing depths (Simple linear regression; 2015: df = 3, $r^2 = 0.899$, t = 5.166, P = 0.014; 2016: df = 3, $r^2 = 0.943$, t = 7.09, P = 0.0193). Females were larger in carapace length at 300 to 500 m but no difference in carapace length were found at 100 to 200m (df = 4, F = 98.13, p < 0.001) (Figure xx). Multipara females carapace length were also increasing with increasing depth (simple linear regression; 2015: df = 3, $r^2 = 0.875$, t = 4.587, p = 0.019; 2016: df = 4, $r^2 = 0.9559$, t = 8.13, p = 0.0148) and largest females were found at 300 to 500 m (2015: df = 4, F = 53.57, p < 0.001; 2016: df= 3, F = 86.62, p < 0.001) (Figure 9 - 11, table 3 - 5).

By-catch of other species

The fish fauna seems homogeneous in Melville Bay, at least based on the samples conducted during the experimental fishery in all three years. The by-catch average approximately 1/3 of catches in 2014, whereas the by-catch was much lower in the two succeeding years (Burmeister and Christensen, 2015 and 2016). A total of 36 different fish species were registered as by-catch (Table 6). Polar cod was in all three years the most dominating species (72% of all by-catch), but also Greenland halibut was abundant in samples from both 2015 and 2016. Length of Polar cod in the samples ranging from 9 to 24 cm, with absolutely highest frequencies of polar cod at about 10 to 14 cm and those of Greenland halibut less than 48 cm.

Shrimps other than *Pandalus borealis* frequently appear in the samples, but much less in numbers, however *Eualus macilentus*, *Lebbeus Polaris*, *Eualus belcheri*, *Sabinea septemcarinata* and *Argis lar* were common during all years of sampling, which is consistent with earlier findings in the area (Lund, 1987).

References

BURMEISTER, AD., AND F.F RIGET. 2017. The West Greenland trawl survey for *Pandalus borealis*, 2017, with reference to earlier results. *NAFO SCR Doc*. 017/051, Ser. No. N6720. 39 pp.

BURMEISTER, AD., AND H.T. CHRISTENSEN 2016. FORSØGS- G UNDVIKLINGSFISKERI EFTER REJER I MELVILLE BUGT 2014 OG 2015. TEKNISK RAPPORT NR. 101, PINNGORTITALERIFFIK, GRØNLANDS NATUR INSTITUT. IN DANISH ONLY.

BURMEISTER, AD., AND H.T. CHRISTENSEN 2017. FORSØGS- OG UNDVIKLINGSFISKERI EFTER REJER I MELVILLE BUGT 2014 TIL 2016. TEKNISK RAPPORT NR. 103, PINNGORTITALERIFFIK, GRØNLANDS NATUR INSTITUT. IN DANISH ONLY.

LUND H., 1987. Trial fishery for shrimp *Pandalus borealis*, in West Greenland Waters North of 70°52'N in 1986. *NAFO SCR Doc*. 087/0xx, Ser. No. N1275. 9 pp.

Tables

Table 1. Total catch (tonnes) of shrimps in Melville Bay divided by attending vessels 2014 to 2016.

Year	Vessel	No. hauls	Total catch (t)
2014	1	68	243
2014	2	25	86
2014	3	138	468
2014	4	58	41
2014	5	115	247
2014	6	70	219
2014	7	46	97
2015	1	47	210
2015	3	126	427
2015	5	122	308
2015	6	80	190
2015	7	118	290
2015	8	58	170
2016	1	230	628
2016	2	51	232
2016	3	253	848
2016	6	210	629
2016	7	177	462

Table 2. Total catch (tonnes), no. of hauls and CPUE (kg/h) of shrimps by month in Melville Bay 2014 to 2016.

Year	Month	No. hauls	Catch in tonnes	CPUE kg/hour
2014	9	87	302	569
2014	10	342	868	331
2014	11	117	236	260
2014	12	2	1	174
2015	9	44	141	410
2015	10	370	966	385
2015	11	166	497	434
2016	9	290	735	557
2016	10	494	1596	550
2016	11	137	468	433

Table 3. Average carapace length of males, primipara and multipara females divided by depth from Melville Bay, 2014.

Year	Stage	Depth	N	CL_ave	CL_STD	CL_Var	CL_Min	CL_Max
2014	Male	200	441	19.50	2.75	7.54	10.13	25.39
2014	Male	300	3751	21.02	2.37	5.59	11.38	33.39
2014	Male	400	790	20.14	2.31	5.35	11.52	26.25
2014	Primi	200	28	23.50	1.93	3.74	17.18	27.17
2014	Primi	300	143	23.80	1.58	2.49	18.45	31.59
2014	Primi	400	10	23.37	1.70	2.90	21.41	26.41
2014	Multi	200	224	27.08	1.70	2.89	17.51	31.78
2014	Multi	300	2934	26.76	2.62	6.89	11.45	33.53
2014	Multi	400	158	27.04	1.97	3.87	21.29	31.87

Table 4. Average carapace length of males, primipara and multipara females divided by depth from Melville Bay, 2015.

Year	Stage	Depth	N	CL_ave	CL_STD	CL_Var	CL_Min	CL_Max
2015	Male	100	413	17.47	2.84	8.06	8.38	25.45
2015	Male	200	772	19.25	2.42	5.85	11.95	24.69
2015	Male	300	1782	20.24	2.58	6.65	8.84	26.68
2015	Male	400	203	21.82	2.76	7.60	11.94	27.89
2015	Male	500	113	23.07	2.75	7.56	11.06	28.46
2015	Primi	100	26	22.55	1.83	3.33	17.29	25.75
2015	Primi	200	97	22.17	1.60	2.56	17.23	24.9
2015	Primi	300	302	22.90	1.71	2.92	18.93	28.21
2015	Primi	400	33	25.20	2.29	5.24	21.32	30.97
2015	Primi	500	66	26.91	1.58	2.50	22.65	30.02
2015	Multi	100	68	26.92	1.71	2.94	22.27	31.03
2015	Multi	200	428	26.76	1.76	3.11	20.17	33.21
2015	Multi	300	1083	27.21	1.73	2.99	20.38	35.00
2015	Multi	400	452	27.69	1.74	3.03	21.55	33.03
2015	Multi	500	193	28.84	1.99	3.95	22.8	33.45

Table 5. Average carapace length of males, primipara and multipara females divided by depth from Melville Bay, 2016.

Year	Stage	Depth	N	CL_Ave	CL_STD	CL_Var	Cl_Min	CL_Max
2016	Male	100	64	18.27	2.15	4.64	12.88	23.24
2016	Male	200	1416	19.67	2.86	8.19	9.71	26.80
2016	Male	300	3062	20.98	2.80	7.82	10.64	27.80
2016	Male	400	863	21.94	2.76	7.6	10.89	27.87
2016	Male	500	278	22.25	2.10	4.42	15.39	28.18
2016	Multi	100	5	26.24	1.78	3.16	23.60	28.11
2016	Multi	200	554	27.12	2.01	4.05	18.55	36.42
2016	Multi	300	1866	27.45	2.14	4.6	18.66	34.70
2016	Multi	400	1689	28.41	2.05	4.18	18.57	35.41
2016	Multi	500	397	28.30	2.07	4.29	22.42	33.75
2016	Primi	100	2	22.15	0.78	0.61	21.60	22.70
2016	Primi	200	132	22.48	2.08	4.33	13.70	26.28
2016	Primi	300	505	23.62	1.50	2.25	18.11	30.26
2016	Primi	400	292	24.23	1.71	2.93	19.21	29.91
2016	Primi	500	67	23.79	2.11	4.46	15.21	27.79

Fig. 1a. Geographical distribution of the fishery in Melville Bay 2014 based on logbooks information. Blue color indicate low fishery effort and the red color areas of high effort.

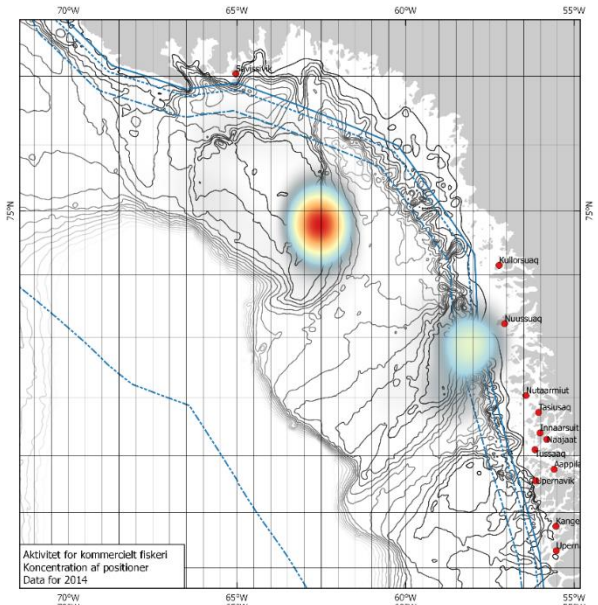


Fig. 1b. Geographical distribution of the fishery in Melville Bay 2015 based on logbooks information. Blue color indicate low fishery effort and the red color areas of high effort.

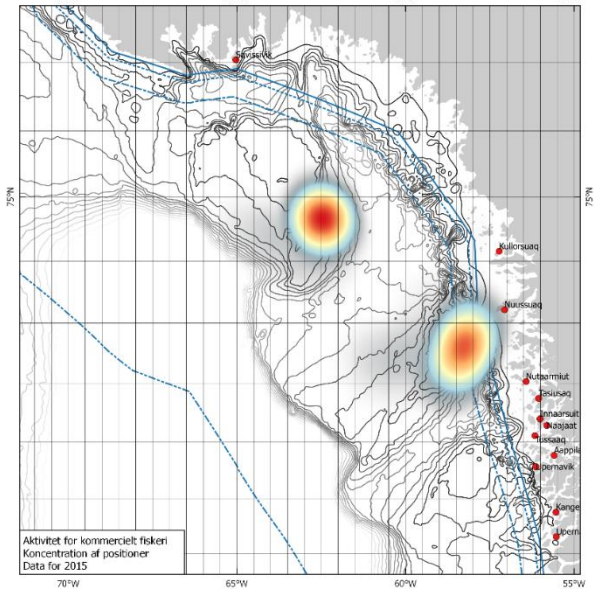
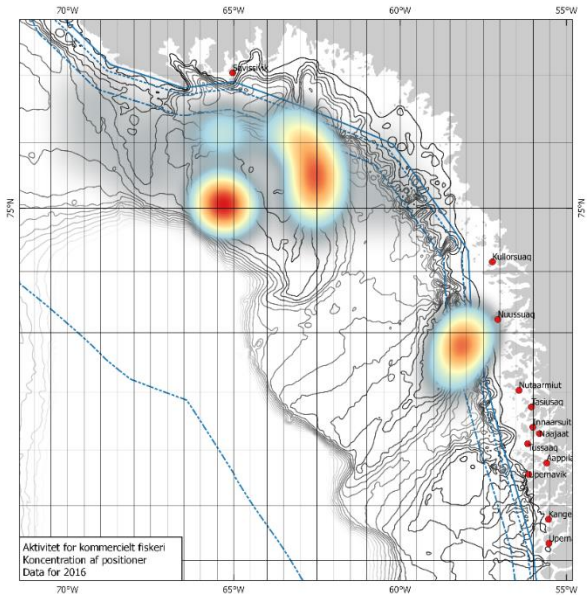


Fig. 1c. Geographical distribution of the fishery in Melville Bay 2016 based on logbooks information. Blue color indicate low fishery effort and the red color areas of high effort.



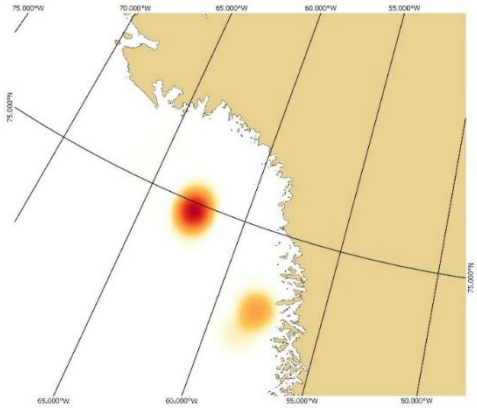


Fig. 2a. CPUE (kg/hour) during the fishery in 2014. Yellow color red areas with high CPUE and Yellow areas with low CPUE.

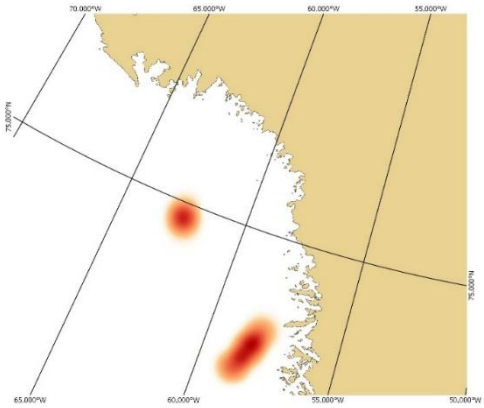


Fig. 2b. CPUE (kg/hour) during the fishery in 2015. Yellow color red areas with high CPUE and Yellow areas with low CPUE.

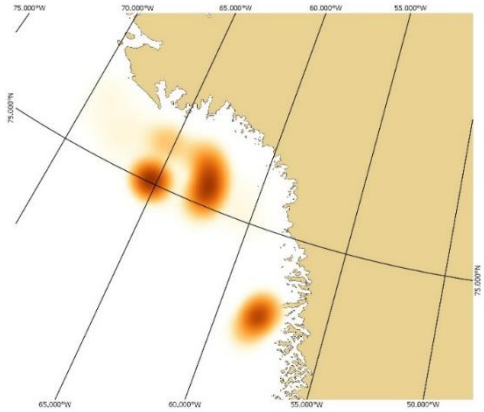


Fig. 2c. CPUE (kg/hour) during the fishery in 2016. Yellow color red areas with high CPUE and Yellow areas with low CPUE.

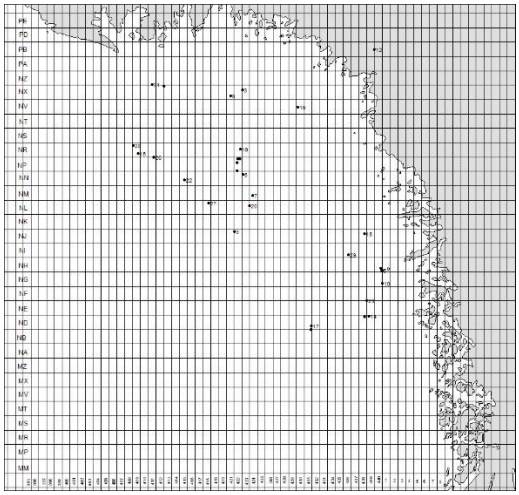


Fig. 3.Geographical distribution of samples conducted by the attending vessels in the investigative fishery in Melville Bay 2014.

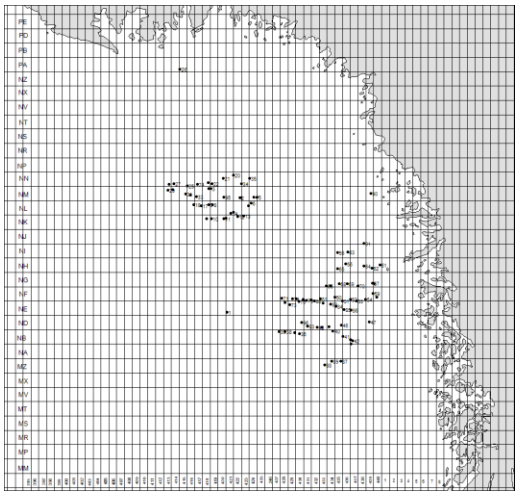


Fig. 4. Geographical distribution of samples conducted by the attending vessels in the investigative fishery in Melville Bay 2015.

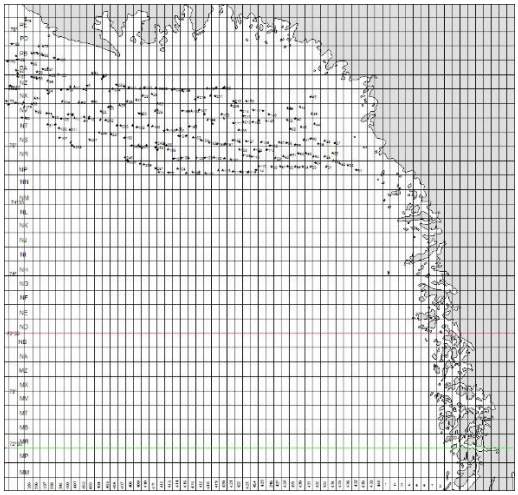


Fig. 5. Geographical distribution of samples conducted by the attending vessels in the investigative fishery in Melville Bay 2016.

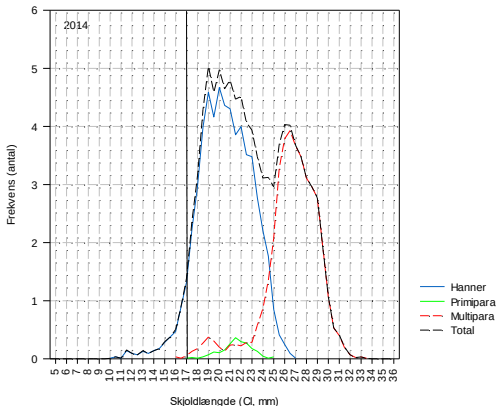


Fig.6. Length frequencies of shrimps samples from the trial fishery in Melville Bay 2014.

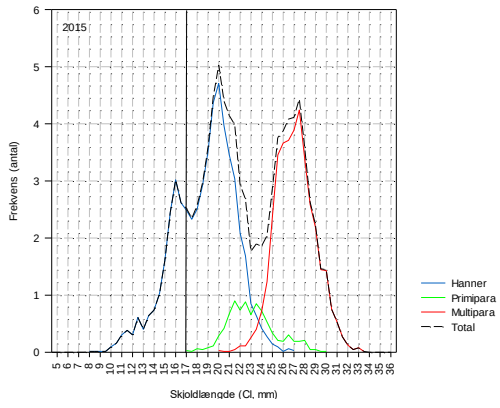


Fig.7. Length frequencies of shrimps samples from the trial fishery in Melville Bay 2015.

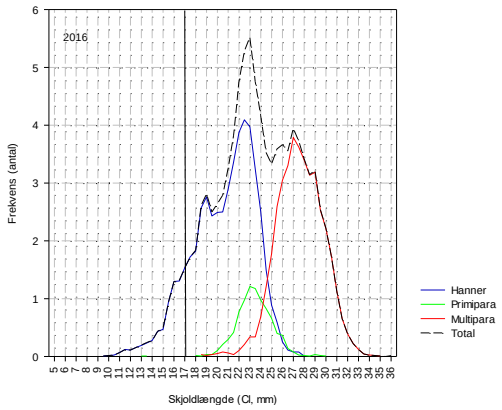


Fig.8. Length frequencies of shrimps samples from the trial fishery in Melville Bay 2016.

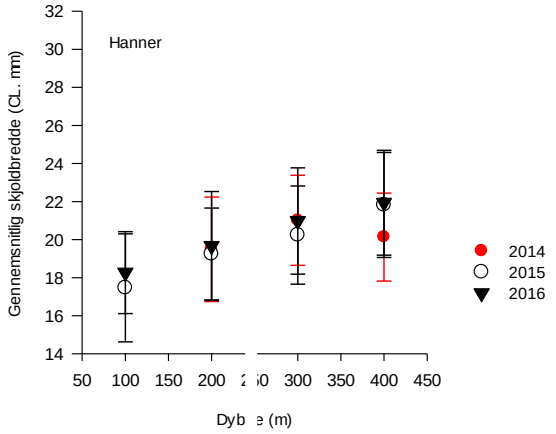


Fig. 9. Male shrimp average carapace length as a function of the depth, based on samples from Melville Bay 2014 - 2016.

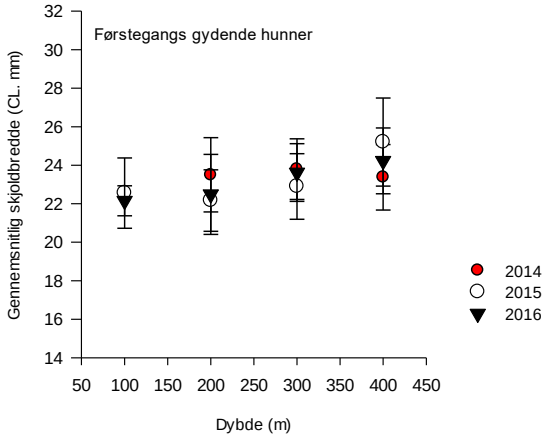


Fig. 10. Primipara female average carapace length as a function of the depth, based on samples from Melville Bay 2014 - 2016.

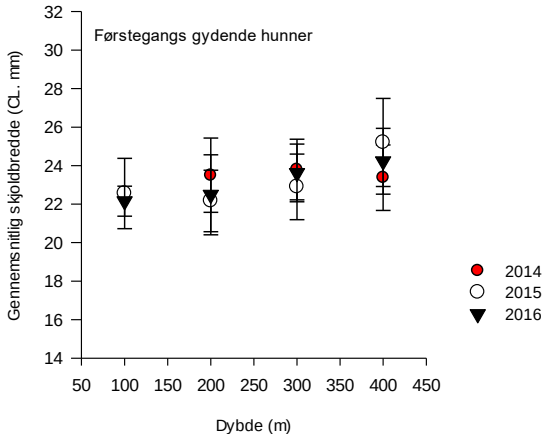


Fig.11. Multipara female average carapace length as a function of the depth, based on samples from Melville Bay 2014 - 2016.