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Results of the Greenland Bottom Trawl Survey for Northern shrimp (*Pandalus borealis*) Off East Greenland (ICES Subarea XIV b), 2008-2012

by

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Abstract

Since 2008 the Greenland Institute of Natural Resources has carried out annual stratified-random trawl surveys in East Greenland area in August and September to assess the *Pandalus borealis* stock biomass and obtain information on the size and sex composition of the stock as well as on the environmental conditions. A total number of 52, 97, 82, 85 and 98 valid hauls were made from 2008 - 2012. The surveys conducted since 2008 shows that the shrimp stock is concentrated in the area north of 64°N and in depth between 200 and 600 meter.

The biomass estimates (in tons) for the entire survey area are low compared to West Greenland. The survey biomass estimates is in agreement with the estimates obtained from another survey conducted from 1989-1996. 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). The historical surveys are 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 - 2012 surveys, and attempt to compare these results with the survey conducted in 1989-1996.

Materiel and Methods

The survey is carried out with the same gear and survey protocols as used in West Greenland (Kingsley *et al.*, 2012). Stratification was based on the "Q-areas" used for the East Greenland survey for Greenland halibut (Fig. 1.) The areas 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 trawl-able sites, however, a number of the selected positions were not deemed trawl-able. A total number of 52, 97, 82, 85 and 98 valid hauls were made from 2008 to 2012

(table 1). The hauls were conducted between 08:00 and 20:00 UTC, to take in to account the influence of light induced nocturnal vertical migrations of shrimp.

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 Kingsley et al, 2012 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 (0.000578537*ShrimpLength**2.9941)/1000) was used on the East Greenland shrimp sample to estimate the female and males' abundance and proportion of females.

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 (Kingsley *et al.*, 2012). The biomass estimates (in tons) for the entire survey area are:

EAR	BIOMASSE	+/-	PROCENT
2008	1953	1764	90.32
2009	8446	3852	45.61
2010	5758	3928	68.22
2011	5789	2760	47.68
2012	2200	1293	58.56

The highest biomass in 2008-2012 was found north of 64° N in area Q1 and Q3 (Fig. 1). Shrimp biomass in the remaining southerly offshore areas (Q4-Q6) showed very low densities (Tab. 2 and Fig. 3). The shrimp occurs mainly between 200 and 400 meter and in 400 – 600 meter (around 20% of total biomass) (Fig 3).

The demographic structure in East Greenland shows large males with 20 mm 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 2.105 tons (5 years). In 2012 female biomass was half of the average with only 1.070 tons and the second lowest in the series (tab. 7).

Total numbers of shrimp (males and females) in 2012 was estimated to 194 million or more than half of the average on 470 million for the five years time series. The abundance of males in 2012 is 117 million - or 1/3 of the average on 310 million in the time series.

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 65°N up to 67°N. The recent surveys in 2008 to 2012 covered the shelf area from Cap Farwell to Dorhn area up to 67°N. To compare the two survey time series only the areas Q1 and Q2 in the 2008-2012 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 from 2008 - 2011. 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 survey biomass index has decreased since 2009 and is now at the level seen at the beginning of the short time series in 2008. The historical survey is not directly comparably with the recent survey due to different areas covered, survey technique and trawling gear. However, the 1989-1996 survey estimated biomass and abundance at the same level as the 2008-2012 survey. In addition the standardised CPUE index calculated from the fishery show the same decreasing trend for stock biomass since 2009 (Hammeken Arboe and Siegstad 2012). 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.

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	Vessel	Trawl	Bridle length (m)	Wing- spread (m)	
2008-2012	Paamiut	Cosmos	54.0	28.1-30	**

Table 1. Vessels, trawl types and rigging parameters used in the Greenland Bottom Trawl Survey for shrimp and fish, 2008–2012.

Table 2. Survey estimates of total biomass 2012.

	Area		Biomass density	Biomass	Biomass error	Error coefft of variation
Stratum	(km^2)	Stations	(t/km^2)	(Kt)	variance	(%)
Q1-0	0	0	0.000	0.000	0.0000	0.0
Q1-2	35662	15	0.038	1.358	0.2831	39.2
Q1-4	6975	6	0.071	0.496	0.0567	48.0
Overall Q1	42637	21	0.043	1.855	0.3398	31.4
Q2-0	93	2	0.000	0.000	0.0000	0.0
Q2-2	7657	10	0.001	0.007	0.0000	100.0
Q2-4	1246	2	0.000	0.000	0.0000	0.0
Overall Q2	8996	14	0.001	0.007	0.0000	100.0
Q3-0	3363	3	0.000	0.000	0.0000	0.0
Q3-2	22547	15	0.015	0.330	0.0779	84.7
Q3-4	9830	10	0.001	0.005	0.0000	72.9
Overall Q3	35740	28	0.009	0.335	0.0779	83.4
Q4-0	1337	3	0.000	0.000	0.0000	100.0
Q4-2	7770	8	0.000	0.000	0.0000	0.0
Q4-4	2054	2	0.000	0.000	0.0000	0.0
Overall Q4	11161	13	0.000	0.000	0.0000	100.0
Q5-0	469	2	0.000	0.000	0.0000	0.0
Q5-2	2785	3	0.001	0.003	0.0000	100.0
Q5-4	1819	2	0.000	0.000	0.0000	100.0
Overall	1017	-	0.000	0.000	0.0000	10010
Q5	5073	7	0.001	0.003	0.0000	93.7
Q6-0	6307	6	0.000	0.000	0.0000	100.0
Q6-2	6130	8	0.000	0.000	0.0000	0.0
Q6-4	2063	1	0.000	0.001	0.0000	95.0
Overall Q6	14500	15	0.000	0.001	0.0000	70.4
Survey totals	118107	98	0.019	2.200	0.4177	29.4

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	3,814	55	1,882	1	3	2	5,758	1964
2011	5,413	0	367	0	0	9	5,789	1380
2012	1,855	7	335	0	3	1	2,200	646

Table 3.Biomass estimates (t) for survey subdivisions and standard errors for the entire survey, 2008-2012

Table 4. Error coefficients of variation (%) for the biomass estimates of five main survey regions and the entire survey area 2008–2012

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	23.8	78.3	92.6	75.0	92.5	42.4	34.1	82
2011	25.3		44.6	100.0		40.0	23.8	85
2012	31.4	100.0	83.4	100.0	93.7	93.7	29.4	98
Mean 2008-2012							30.9	

Table 5. Estimated mean densities (kg/km²) for survey subdivisions in 2008–2012

Year	Q1	Q2	Q3	Q4	Q5	Q6	Total
2008	37.3	0.8	8.7	0.4	4.8	1.2	16.8
2009	162.9	36.1	32.4	0.1	0.2	1.2	71.5
2010	89.5	6.2	52.6	0.1	0.6	0.2	48.8
2011	127.0	0.0	10.3	0.0	0.0	0.6	49.0
2012	43.5	0.7	9.4	0.0	0.6	0.1	18.6

Table 6. Survey biomass estimates (tons) by sex based on length-weight distributions 1988–2012.

Year	Males	Females	Total	Males %	Females %
2008	1025	930	1955	52.4	47.6
2009	5572	2874	8446	66.0	34.0
2010	2640	3118	5758	45.8	54.2
2011	3258	2531	5789	56.3	43.7
2012	1130	1070	2200	51.4	48.6
Average	2725	2105	4830	54.4	45.6

Year	Males	Females	Total	Males %	Females %
2008	129	72	202	64.1	35.9
2009	670	222	893	75.1	24.9
2010	288	231	519	55.5	44.5
2011	348	186	534	65.2	34.8
2012 1	117	77	194	60.2	39.8
Average	310.5	157.8	468.2	64.0	36.0

Table 7. Estimated numbers ('000) by sex from length analyses 2008–2012.

Table 8. Two Greenlandic surveys from 1989-1996 and 2008-2012 for comparision.

Q1-Q2 (North for 65)	Biomass tons	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	20	51,633	20	Stratified random technique
2009	7,270	47	51,633	20	Stratified random technique
2010	3,869	45	51,633	20	Stratified random technique
2011	5,413	31	51,633	20	Stratified random technique
2012	1,861	35	51,633	20	Stratified random technique



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



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



Fig. 2. Estimated total survey biomass (t) and average survey biomass density (kg/km) of Northern shrimp with standard errors 2008-2012.



Fig. 3. Survey biomass in percent in different areas and depths 2008-2012.



Fig.4. Numbers of shrimp by length group (CL) in the total survey area in 2008-2012, based on pooling of samples weighted by catch and stratum area.



Fig.5. Biomass from two different surveys series from 1989-1995 and 2008-2012 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 2008-2012 for the areas North of 65° N.