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Fixed Stations Survey for Shrimp Abundance Indices, 15 years Investigations in the Norwegian Deeps – Skagerrak.

by

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Abstract

The stock of shrimp in the Norwegian Deeps and Skagerrak on the south coast of Norway has been monitored by yearly cruises since 1984. Around 100 bottom trawl stations at fixed positions has been performed in October-November. The catch of 0-group *Pandalus borealis* give indications on the abundance of the yearclass, the catch of I-group give, however, a more reliable estimate, compared to analytical methods and LPUE statistics. In this paper comparisons are made between variations in shrimp abundance, growth and sex reversal to environmental factors and abundance of fish species.

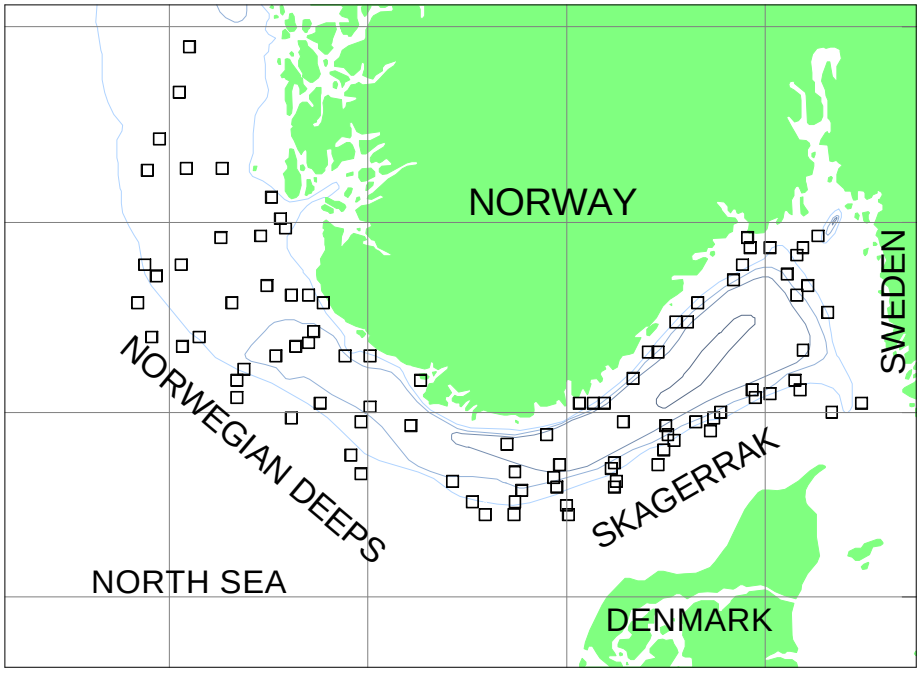

Figure 1. Bottom trawl hauls by Michael Sars performed yearly since 1984 in the October-November period.

Introduction

In the 60ties there was a collapse in the fishery for *Pandalus borealis* in the Skagerrak - Norwegian Deeps area (Figure 1). The Norwegian catch dropped from 9000 tonnes to 3000 from 1962 to 1966. Fishermen had to change target species or leave the fishery business. Slowly the fleet was rebuilt, landings increased and fishermen's organisations became more concerned about development of the stock and possibilities for further development of the fishery. On their enquiry, Institute of Marine Research started a trawl survey in 1984. It has since been conducted yearly in the October-November period. It was originally planned as a stratified randomly distributed stations swept area survey. The first year investigations showed, however, a great underestimation of the stock using traditional swept area methods, compared to the actual landed catch. In addition choices of locations for trawling are limited on the Norwegian side of the Deeps. It was therefore decided that a system with fixed stations would be better, hopefully giving reliable indices of abundance.

The international catch in the area consists, according to analytical assessment (ICES 2000), on an average of 31% I-group and 42% II-group by weight. An early indication on the development of the fishery is therefore desirable.

Material and Methods

The research vessel "Michael Sars" has been used the entire period. Sampling devise is the Norwegian standard survey trawl: Campelen 1800 sampling trawl (Engås & Godø 1989) with 20 mm meshes in the belly and a 6 mm cod end liner, 40 m sweep lines and rock hopper gear, towing speed 3 knots. Stations are shown in Figure 1.The towing time was originally one hour but from 1989 onwards 1/2-hour hauls are the standard. The catch or a proportion of it is sorted. Samples of all species are length measured and total weight and numbers are calculated. Approximately 200 shrimps are carapace measured to the nearest mm below and sexual stage determined according to Rasmussen (1953). The indices mostly used in this paper are total numbers of shrimp (separated by sex and age) caught in trawl hauls between 140 and 450 meter divided by total distance trawled. Separate indices are calculated for the Skagerrak and the Norwegian Deeps area. Another index is the stratified swept area indices applying the same trawl parameters as Teigsmark and Øynes (1983). The area is separated into 16 strata. Age structure is determined for each stratum separately.

In the Skagerrak area there is no overlapping between 0-group and I-group males. They are therefore aged by eye. Males in Norwegian Deeps and all females are separated into age groups by the Battacharia method implemented in ELEFAN (Pauly 1987)

A hydrographic section between Norway and Denmark across the deepest part of Skagerrak has been observed by monthly cruises since 1947 (Aure & Dahl 1994). Before 1987 temperature was measured at standard depths by high precision thermometers, from 1987 onwards by Neill Brown CTD-sonde. The inflow of Atlantic water to the Norwegian Deeps has been calculated at a section westwards from Utsira – Orkney (Skogen ?)

Results

The two methods for calculation of indices give similar results. The two results for I-group are compared in Figure 2. The relationships between the indices for the I-group and older age groups seems rather poor (Figure 3).

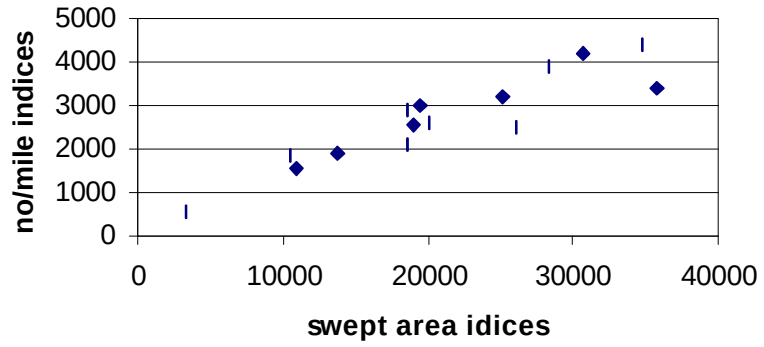

Figure 2. Comparison between swept area indices and no per mile for I-group shrimp. (r^2=0.92)

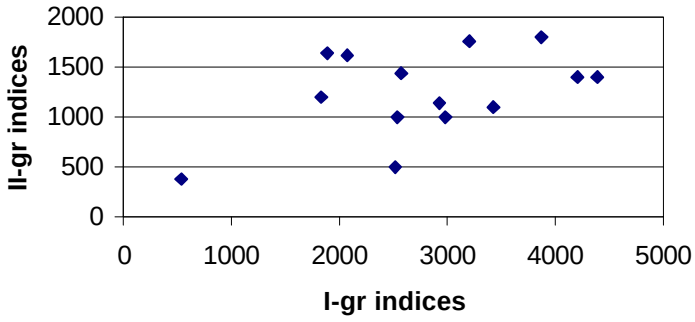

Figure 3. Relationship between I-group and II-group of yearclasses 1983-1996 (r^2=0.47)

The different fleet's landings per unit of effort (LPUE) are used as abundance indices. The Norwegian and Swedish series are in kg per hour, Danish in kg per day. We have in addition included the survey results in total kg per mile and the total biomass calculated by Extended Survivor Analysis XSA (ICES 2000). In Figure 4 these indices are presented as deviations from their average values. The LPUE and survey indices are independent measures; the total biomass is partly a result of the former since they are used for tuning the XSA model.

Table 1 shows the relationship between numbers per age group calculated by XSA and the swept area analysis. In October the 0-group is to a great extent still in the pelagic phase and is therefore not representatively caught by the trawl. The I-III groups are underestimated by the swept area method compared to the XSA analytical method by a factor mostly between 2 and 5.

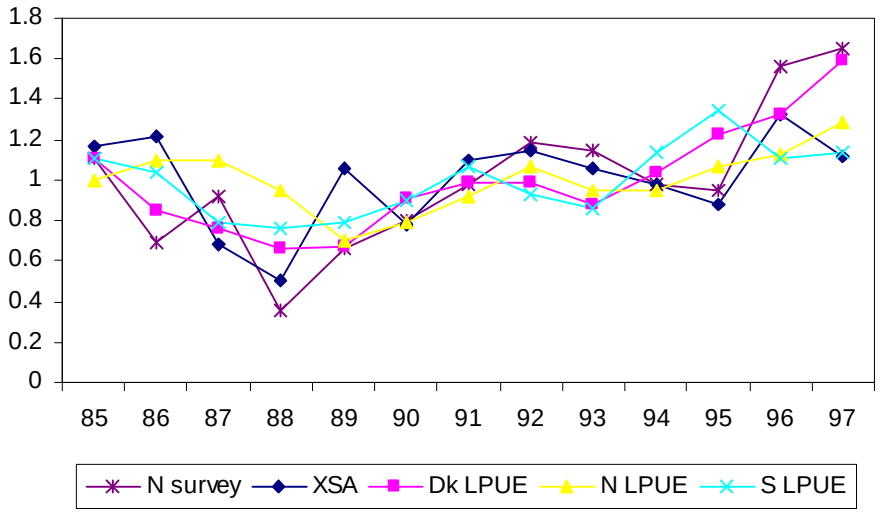

Figure 4. Deviation from the mean different indices of abundance for the shrimp stock in Skagerrak-Norwegian Deeps.

Table 1. XSA total numbers per yearclass divided by survey swept area estimates.

	0-gr	I-gr	II-gr	III-gr	IV-gr
1985	60.22	2.80	3.41	1.41	1.06
1986	105.32	7.32	5.70	6.14	4.28
1987	94.76	2.49	2.56	1.56	5.22
1988	85.89	12.08	5.30	1.73	5.06
1989	22.41	4.56	2.63	2.43	5.01
1990	39.00	5.67	3.02	2.96	10.70
1991	53.27	3.32	3.42	3.23	2.04
1992	13.01	2.96	2.81	2.12	2.57
1993	33.98	4.52	2.16	1.75	2.02
1994	55.03	4.10	5.15	0.86	0.70
1995	120.12	5.02	4.14	1.66	1.93
1996	31.07	3.42	2.36	1.52	3.35
1997	53.18	3.85	2.20	0.92	0.23
average	45.99	4.20	3.21	2.07	3.54
Stdev	33.20	2.56	1.24	1.38	2.77

There is a positive correlation (r^2 =0.45) between the I-group index and the yearly average temperature measured at 300 m depth in the Skagerrak (Fig.5). The salinity is highly correlated to the temperature and therefore giving the same picture. The flow of Atlantic deepwater into the Norwegian Deeps and Skagerrak is one of the sources to the variations, especially the figures for the second quarter is positively correlated to I-group shrimp abundance (r^2 =0.55). There is no correlation to the sum of potential predators. For those species where it has been possible to give yearclass strength, it is most common with positive correlation.

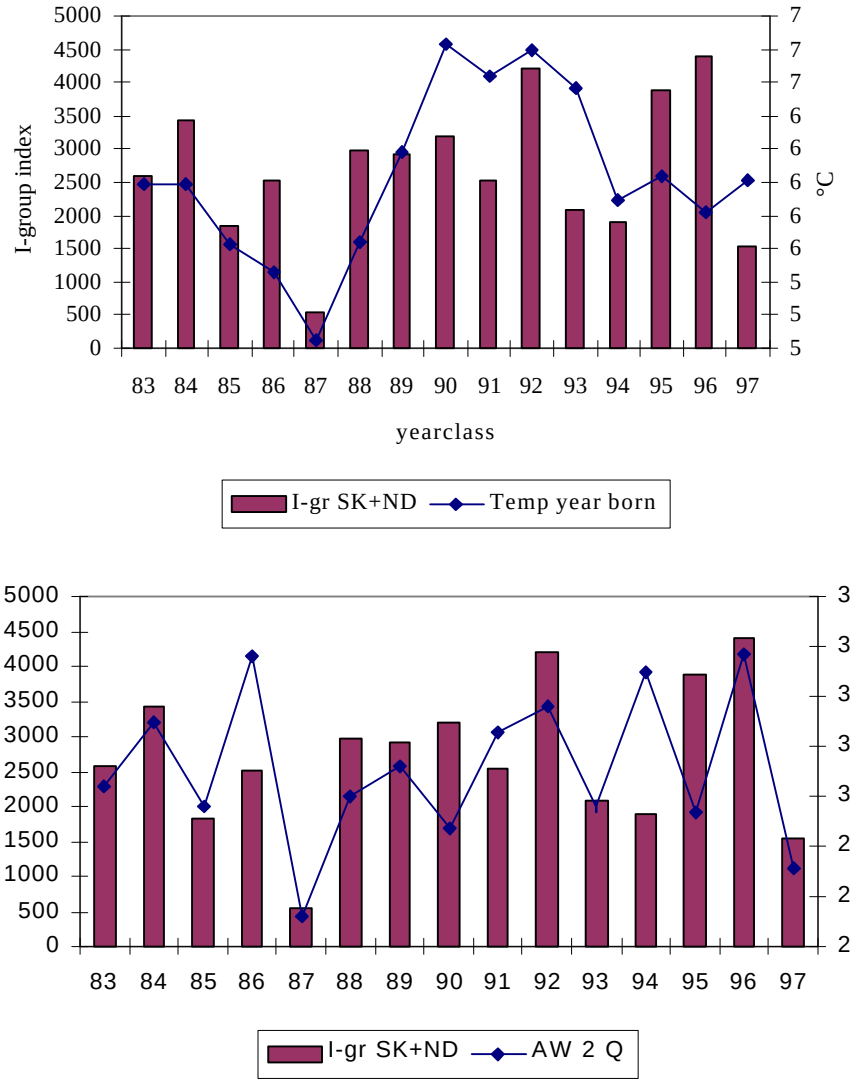

Figure 5. I-group indices and yearly average temperature in 300m depth in Skagerrak (upper) and flow of Atlantic deepwater into the area (lower)

In the Skagerrak area up to 37% of the I-group and all of the II-group shrimps are female in October. In the Norwegian Deeps there is a great variation in the time of sex reversal from 7 to 72 % of the II-group are still male (Figure 6). In both areas this is positively correlated to the yearly average temperature (r^2 = 0.6-0.7) for the 1984-1997 period, however, if 1998 figures are included, the correlation drops considerably. With the relatively high temperature in 1998 one should expect high growth rate and early sex reversal, but the proportion of male II-group has never been so high and the attained size is among the lowest observed. The abundance of mature females has never been so high as in 1997 and 1998.

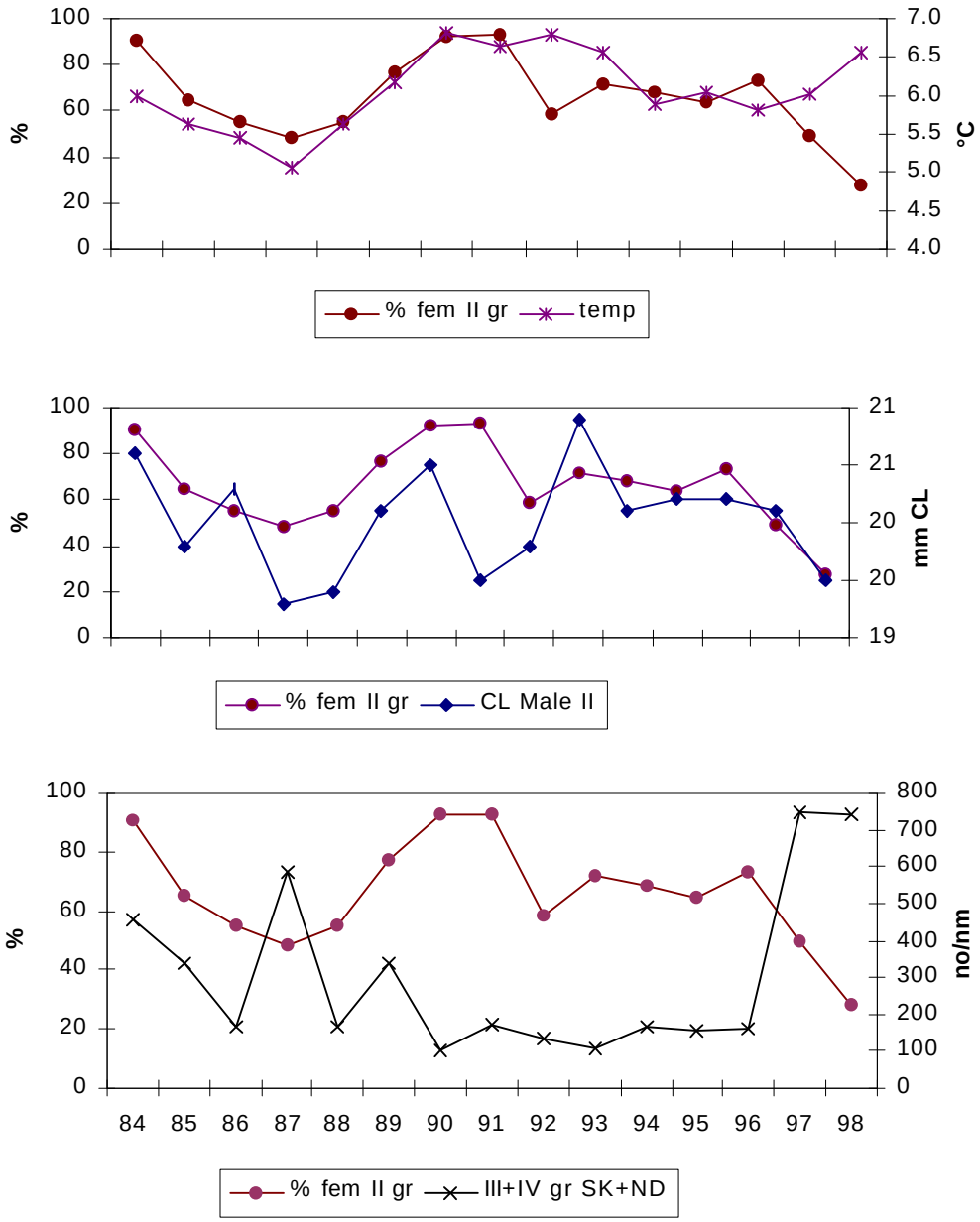

Figure 6. *Percentage female II-group shrimp compared to average yearly temperature, carapace length of male II-group shrimp and abundance of mature female.*

Conclusions

Compared to fishery indices and analytical assessment the survey results seem acceptable as indicator of yearclass fluctuation. The correlation between age groups of each yearclass could have been better, however, this is believed to be as much a problem with proper aging as variable results between years. The method is fishery independent and most of the period there has been few restrictions in the fishery, which means there should be scope for converting the indices to absolute values. The period for management purposes are relatively short since reliable yearclass estimates are only obtained after the yearclass already has been exploited one year. On an average the rest 70% will be caught the next three years.

Temperature is an indicator of some factor(s), which influence the recruitment, growth rate and sex reversal. 1998 is clearly an exception in the row of high growth rate and early sex revesal in years with high temperature, if it also will be poor recruitment remains to see. The only factor that can be pointed at from this investigation is the high abundance of mature females.

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