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Evaluation of State of Stock and Production Potential of Division 3M Shrimp Based on Area Comparison

by

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INTRODUCTION

Shrimp in area 3M Flemish Cap has recently given rise to an important fishery where many nations are involved. The insufficiency of reliable long term time series on stock abundance and composition from surveys, and the lack of basic knowledge on stock dynamics, have caused severe difficulties to tackle regulation of fishing effort on a scientific basis.

Canada conducted in 1996 a scientific survey in area 3M which apply a Campelen 1800 meshes shrimp trawl for sampling (Parsons *et al.* 1997). This is the same sampling gear as used in the Norwegian surveys for shrimp in the Barents Sea and Svalbard area. Further, Norwegian shrimp trawlers exploit the resources with the same type of commercial gear both in the eastern and western Atlantic. Consequent, there is presently a one point link in surveys between the two areas, and a continuous link in commercial catch per unit effort (CPUE) during the time of expansion of this fishery.

Assessment methodologies for shrimp in 3M was discussed during a NAFO *ad hoc* working group meeting in November 1996 (Parsons 1996). Due to the fact that the same sampling trawl is used in the Barents Sea and in 3 M it was proposed to investigate the potential of using the Norwegian survey and CPUE database from the north-eastern Atlantic to review the biomass situation of shrimp in 3M.

It is the aim of the present analysis to explore the possibility of applying the links between 3M and the Barents Sea and Svalbard area to improve the understanding of the state of the 3M shrimp stock with respect to abundance (biomass) which subsequently will give a better fundament for scientific catch advise. Effects of in sex and size composition are not considered.

MATERIAL AND METHODS

Commercial catch and effort data

Norwegian catch and effort data from the Barents Sea and Svalbard area from the period 1982 to 1996 and from the NAFO Division 3 M from the period 1993 to 1997 are presented. The data are produced by the Norwegian Fisheries Directorate on the basis of log books. Data for 1995, 1996 and 1997 are preliminary data. Annual CPUEs are compared with the Barents Sea -Svalbard survey results. When comparing 3M and Barents Sea - Svalbard CPUEs monthly statistics have been applied.

Survey data

Trawl surveys for shrimp (*Pandalus borealis*) have been conducted annually in the Barents Sea and the Svalbard area since 1980 by Norwegian research institutes. The surveys have been conducted in the period April to September for a duration of 25 to 97 days each year. Until 1992 the Institute of Marine Research in Bergen (IMR) carried out the investigations, and thereafter the Norwegian Institute of Fisheries and Aquaculture Ltd. (Fiskeriforskning) in Tromsø has been doing the work. All together four different vessels have been used.

The trawl used for sampling, a Campelen 1800 meshes modified commercial trawl, has been the same throughout the period, although with modifications of both the ground gear and the rigging. The modifications have had a influence on sampling performance over time. Since 1992 sampling has been performed day and night and tow distance has been 1 nautical mile.

The Svalbard area is stratified according to depth and latitude while the study area in the Barents Sea is stratified based on geographical areas of assumed homogenous density of shrimp together with a subjective division of the area into fishing grounds. A documentation and evaluation of these surveys has been presented by Aschan and Sunnanå (1997).

Three different approaches to survey design have been used - random stratified trawl stations, fixed trawl stations in a modified regular grid within a stratification of the area and fixed trawl stations in a depth stratified system. A study has been undertaken to calculate an optimum sampling density with respect to a desired level of precision (Harbitz *et. al.* 1997). In this analysis we use the biomass indices as given in latest assessment report (Aschan *et al.* 1996).

The Northeast Atlantic Fisheries Centre, St. John's, Newfoundland, Canada conducted a survey in area 3 M in the period 24 September to 12 October 1996. The sampling trawl is a copy of the Norwegian trawl with some modifications. Sampling was conducted day and night and tow distance was 0.75 nautical miles (Parsons *et al.* 1997).

In this study the "sweep width" is set to 11.7 m for all shrimp surveys in both areas resulting in a swept area of a 1 nautical mile haul of 0.006317 sq. n.m.

Comparisons

The average commercial CPUE of the Barents Sea and the Svalbard area per year is compared with the annual survey index by means of a simple linear regression is done.

Comparisons of level and variability of CPUE between 3M and the north-eastern Atlantic are done for the period 1993-1997. Only data from the vessel size groups represented in both areas are used. Data are analysed on a monthly basis and seasonal effects and trends are estimated with the Proc. x11 in the SAS system (SAS 1993). To fill in empty cells in the monthly CPUE statistics we used the SAS Proc. expand.

The survey results of the shrimp and the Norwegian CPUE in 1996 in area 3M are compared to the Norwegian CPUE - survey index relationship from the Barents Sea - Svalbard survey.

RESULTS AND DISCUSSION

Barents Sea stock and catch

Total shrimp landings in the ICES areas I, IIa and IIb are in Figure 1 presented by country according to ICES statistics, data from the Norwegian Directorate of Fisheries and PINRO, Murmansk. The Norwegian share of landings have increased though there has been a reduction of total landings from 80.000 tons in 1992 to 27.000 tons in 1995.

Biomass indices for the Barents Sea and the Svalbard area are presented in Table 1. Main areas are shown in Figure 2. As seen in Figure 3 there is a concurrent variation in biomass indices, landings and CPUE in the Barents Sea and Svalbard area. However, there seem to be a time lag between biomass index and CPUE.

A linear regression for the CPUE (dependent variable) against the biomass (independent variable) was run:

$CPUE = 35.7 * density \qquad (r^2 = 0.94)$

The 'path' of the data from 1982 and onwards, however, indicate different relationships between survey density when the stock increases compared to when it is going down (Figure 4). If the survey is assumed to reflect density correctly CPUE relatively overestimate density when the stock decreases.

Comparison between the Barents Sea-Svalbard area and 3M

The CPUE for Norwegian vessels in area 3M in 1996 was 211 kg/hour. The survey in area 3M in 1996 give a mean biomass of 2.7 tons/sq. nautical mile when all strata are included. When strata with no shrimp (strata 501, 502 and 504) are excluded the mean biomass is 3.2 tons/sq. nautical

miles. This is comparable to the observations in the lover end of the density distribution observed in the Barents Sea and Svalbard area but nevertheless support a relatively high CPUE in the commercial fishery (Fig. 4)

The CPUE in area 3M and in the Svalbard and Barents Sea area is presented in Figure 5. The figures from the two areas show that the CPUE are similar and show same type of seasonal variation. When analysing them with a time series model (Proc. x11) this become even more evident. The CPUE both from original (Fig. 5) and modelled (Fig. 6) time series show that commercial catch rates in the two areas are similar, and that the variation observed in 3M do not suggest any dramatic situation compared to an area with a longer catch history. It should, however, be kept in mind that the trend in 3M is continuously downward. The reduction in recent year might be affected by few log books for 1997.
A comparison of CPUE of Norwegian vessels in 3M and in the north-east Atlantic can be done in many ways. Due to the strong seasonal effect on the catch rates in both area a seasonal difference in effort distribution between areas or by year may seriously bias the results. We have therefore tried to eliminate the seasonal effect from the data and arrive than at comparable level of catch.

The position of the 3 M point in the CPUE - density comparison in Figure 4 suggest that the Norwegian vessels are more effective in the 3 M area than in the Svalbard and Barents Sea , where a biomass of more than 4 tons/sq. nautical miles is needed before reaching a CPUE larger than 200 kg/hour. This may however, be explained by factors related both to the fisheries data and the survey results. The vessels operating in 3 M are generally larger and more efficient. Also, the efficiency of the the Campelen 1800 during the Canadian survey in area 3 M might be lower due to differences in equipment and operation. E.g. the use of "strapping" and other doors. Further, sampling day and night in the Barents Sea and the Svalbard area in the period May to August does not included sampling in darkness as is the case at Flemish Cap in October. If light measurements are available it could be possible to adjust survey data due to diurnal variation in catch rates.

This first comparison suggests that valuable information might emerge when comparable CPUE and survey results are available. It is, however, apparent that the more thorough and detailed analysis potentially could improve the results. Further work to consider:

- Careful comparison of Canadian and Norwegian sampling performance and rigging of trawl.
- Study variation in catches related to diurnal migration on Flemish Cap (introduction of sigmoid curves, light measurements).
- Limit the CPUE data to the periods when surveys are performed.
- Comparison as above, but limited to the most important fishing grounds or areas with similar topography as in 3 M, e.g. the Svalbard area.
- Include biological comparison

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Table 1. Biomass indices for shrimp from Norwegian surveys in the years 1984-1997 by main areas. (1000 tons)

Main Area	A East Finnmark	B Tiddly Bank	C Thor Iversen Bank	D Bear Island Trench	E Hopen	F Bear Island	G Storfjord Trench	H Spits-bergen	Total	Sum. A,B, C, E
Strata	1 - 4	6 - 7	10 - 12	5, 8, 9, 13	14 - 18, 24	19-22 31 - 40	41 - 50	51 - 70		
Year										
1982	35	34	44	53	66	56	17	22	327	179
1983	40	57	61	53	112	52	21	33	429	270
1984	40	51	64	60	141	66	20	29	471	296
1985	23	17	27	18	96	31	17	17	246	163
1986	10	7	13	25	57	34	10	10	166	87
1987	29	13	18	23	31	10	9	13	146	91
1988	26	18	18	36	32	24	13	14	181	94
1989	41	17	13	17	33	53	22	20	216	104
1990	31	13	25	42	58	43	27	23	262	127
1991	22	28	22	54	120	44	21	10	321	192
1992	18	22	33	37	62	38	14	15	239	135
1993	17	19	32	29	85	20	12	19	233	153
1994	19	8	13	15	52	33	9	12	161	92
1995	10	10	11	17	83	33	16	13	193	114
1996	21	8	26	26	88	41	21	22	253	143
1997	20	35	20	36	91	36	21	22	281	166
+% 96/95	110	-20	143	55	6	24	31	69	31	26
+% 97/96	-5	338	-23	38	3	-12	0	0	11	16

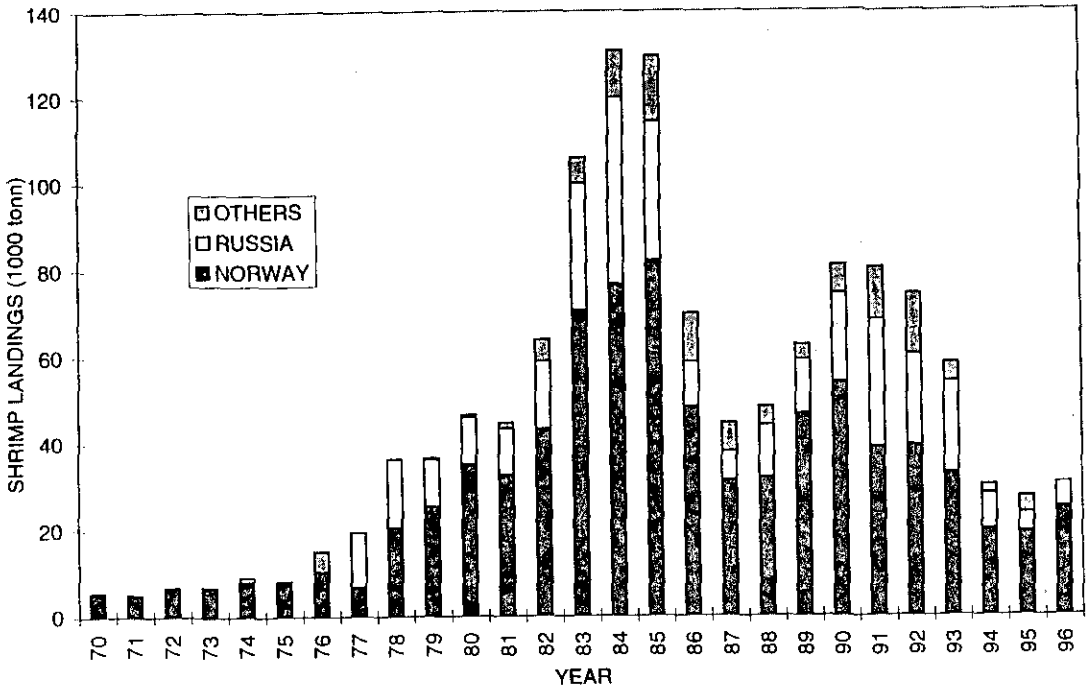

Figure 1. Annual landings in ICES area I, Iia and Iib.

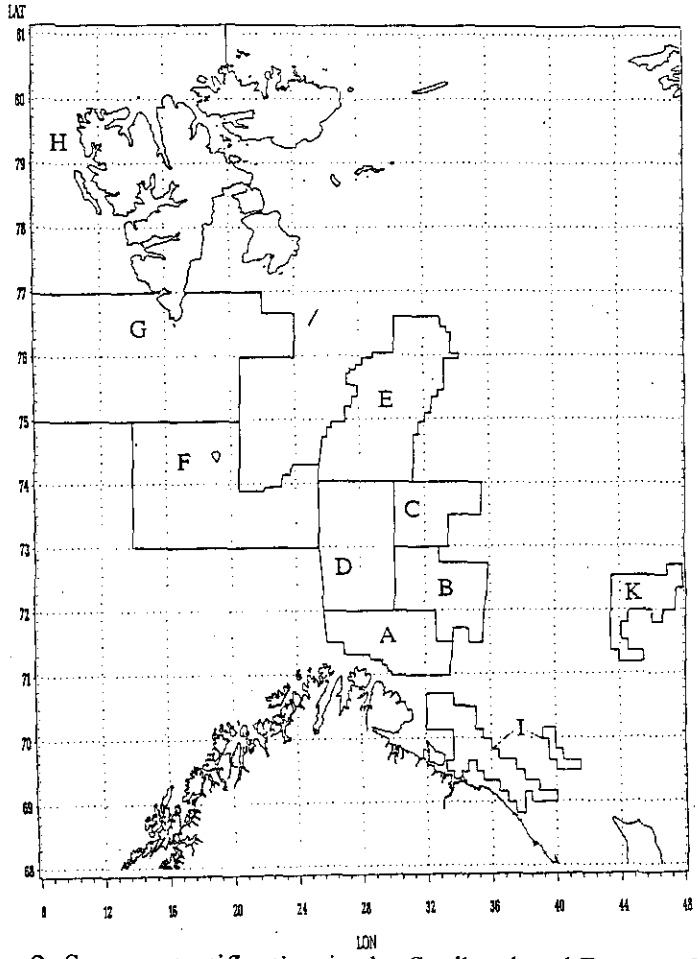

Figure 2. Survey stratification in the Svalbard and Barents Sea.

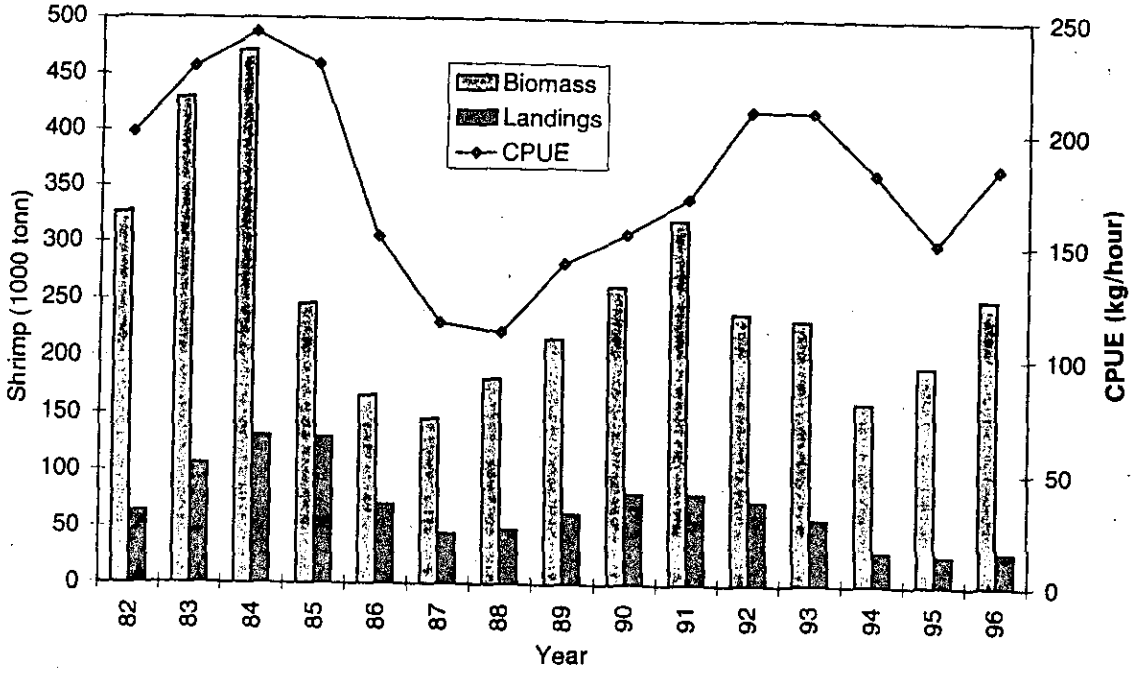

Figure 3. Biomass indices from the Norwegian surveys, total landings and Norwegian CPUE for ICES areas I , IIa and IIb.

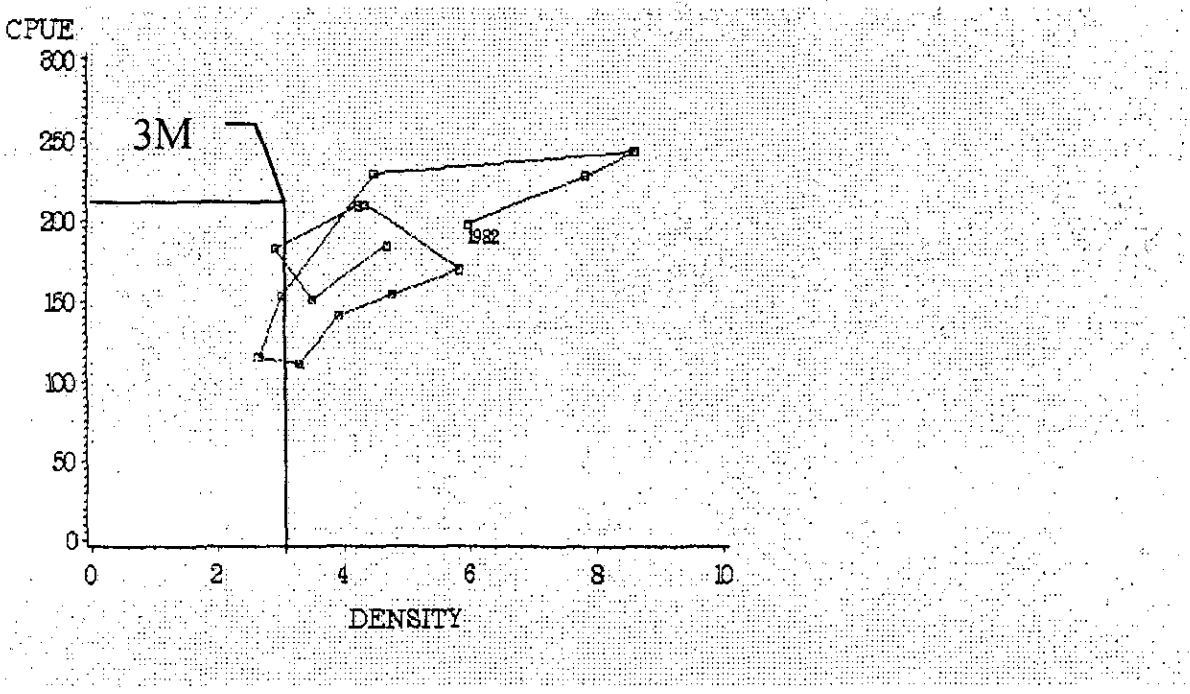

Figure 4. Annual CPUE (kg/hour) and shrimp density (kg/sqnmile) in the Svalbard and Barents Sea area for the years 1982-1996.

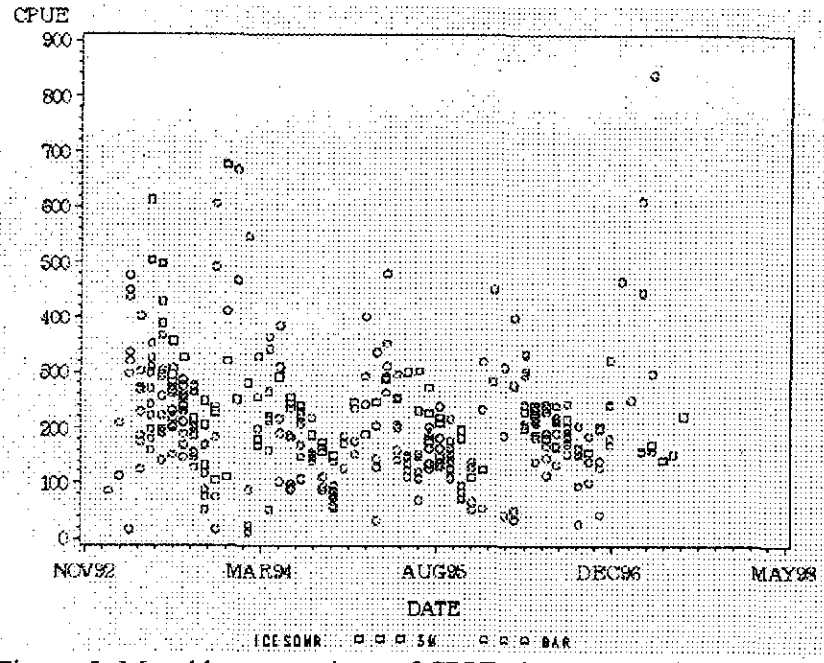

Figure 5. Monthly comparison of CPUE from 3M and the Barents Sea.

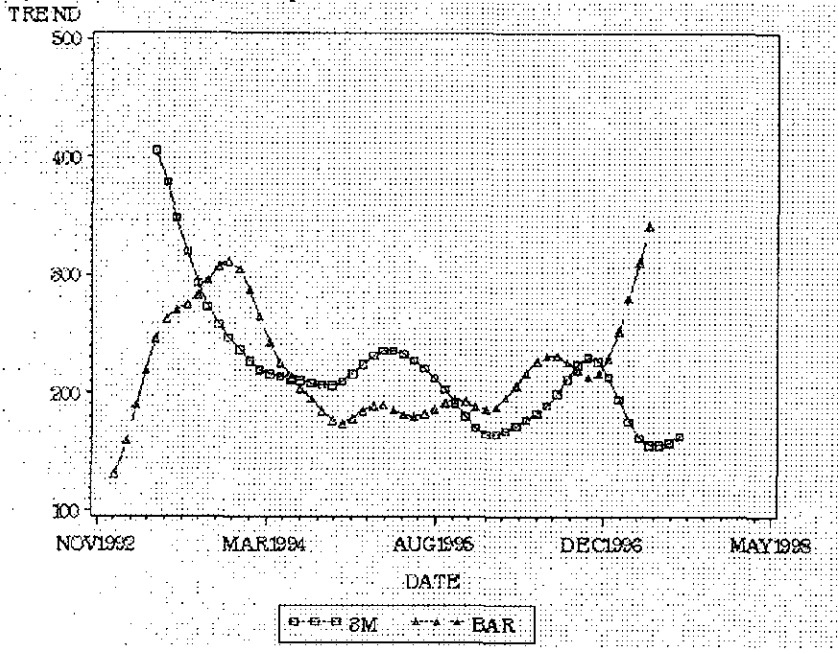

Figure 6. Comparison between Svalbard and 3M trends as estimated by proc. x11.