BARENTS SEA RED KING CRAB (*Paralithodes camtschatica*): A REVIEW AND DISCUSSION OF SAMPLING METHODS

by

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ABSTRACT

Stock assessments for Barents Sea red king crab are based on catch and effort data from research vessel surveys and trial fishery. Different methods can be used for sampling red king crab abundance, such as trawl, traps and underwater TV surveys (Hufthammer *et al.*, 1996a). Advantages and disadvantages using the different methods are discussed, and suggestions are given for future sampling.

INTRODUCTION

The long term objective is to build up a king crab population in the Barents Sea and the adjacent inshore coastal waters, which may sustain a significant commercial fishery. To achieve this, the following management measures should be enforced (Hufthammer *et al.*, 1996b):

- Prevent overexploitation and secure a sustainable harvest of high quality crabs.
- Safeguard recruitment to the exploitable stock by protecting the immature crabs as well as the females and the adults of both sexes during moulting/mating season.
- Reduce incidental crab mortality resulting from king crab being taken as bycatch in the commercial fisheries for other species.

In Alaska, quotas are set after predicting abundance by annual trawl surveys (Otto, 1986). In the Barents Sea region, quota recommendations are based on annual research surveys and trial fishery with traps and trawl. The minimum legal size of males recommended by the Russian-Norwegian Fisheries Commission is presently 15 cm carapace width. Females and undersized males are released when captured, and the fishery is closed in early spring, during the moulting/mating season, to protect the crabs. During this period and for some time thereafter the crab meat is in general of poor quality, and commercial fishing should also for this reason be closed.

Many crustacean fisheries have restrictions on destructive gears such as trawls or tangle nets, often limiting gear to pots only, so as to minimise the handling mortality of female and under-sized male crabs (Basson and Hoggarth, 1993). Most crustacean stocks appear to have highly variable recruitment and fluctuate widely in abundance.

The king crab assessments submitted to The Mixed Russian-Norwegian Fisheries Commission in 1993 and 1994, were for both countries based on trap surveys to map crab distribution and to provide estimates of average catch rates in the various subareas of crab distribution. In 1995 and 1996, Russian trawl survey data were used to estimate crab density in the Russian zone, while Norway continued with trap surveys.

There exists a general difficulty in assessing abundance of benthic organisms. Traps, trawl, remote photography or television, manned submersibles and SCUBA-diving are all methods used to estimate abundance, and they all have their limitations.

TRAWL

Bottom trawl surveys are relatively efficient and convenient for sampling in areas where the crab are distributed on trawlable grounds. However, at present the Barents Sea king crab also inhabits large coastal areas, which for topographic reasons are not accessible for trawl surveys. In other parts of the main distribution area, trawl surveys are and have been successfully conducted by PINRO. Fig. 1 and 2 show the trawl used by PINRO for crab surveys. The method is based on a constant catching efficiency of the trawl gear used and that the swept area can be reliably estimated or measured. The assumptions for the trawl surveys of Barents Sea king crab are so far based on experience from similar work in the Russian Far East.

A standard tow is conducted by towing at a fixed target speed of 3 knots for 30 minutes. A bottom trawl with footrope "rockhopper" design was used. Biomass estimates are then obtained using equations given by Gunderson (1993).

The swept area method is not always applicable to mobile benthic stocks such as crabs owing to sharp slopes and rough bottoms for trawling (Arena *et al.*, 1994). Trawl also introduce large errors possibly due to the net bouncing on the bottom and thus allowing crabs to escape underneath the ground rope (Melville-Smith, 1986). It is also a destructive gear, resulting in high mortality of animals caught.

Population estimates and biological information from trawl surveys are used in conjunction with fishery statistics as the basis for management of red and blue king crab in the Eastern Bering Sea (Otto, 1986).

Prohibitions against the use of trawls and tangle nets were instituted to reduce handling mortality of females and sublegal males.

TRAPS

According to Miller (1990), the catchability coefficient can be useful for converting catch per trap to stock density if it can be estimated with enough accuracy and precision. He also says that catch rates by traps remain the most convenient measure of relative or absolute population density for most decapod species. However, a disadvantage with traps is that the catchability of the target species changes with many biological and physical variables. Fig. 3 shows the trap used for king crab in the Barents Sea.

Research vessel surveys and trial fishing with traps may provide good seasonal and geographical coverage of the main coastal distribution area as well as annual estimates of relative abundance. To convert these into absolute stock strength in terms of crab numbers, a measure of the trap's nominal, effective fishing area has to be applied. Since no relevant Barents Sea data for evaluating this is at present available, a nominal trap fishing area of 7900 square meters, derived from data by Nizyaev (1991), was used in the assessments previously reported to the Commission (table 1) (Berenboim and Olsen, 1993; Kuzmin and Olsen, 1994, 1995; Hufthammer *et al.*, 1996c). This value was estimated from comparisons in the Russian Far East between trawl and trap catches of king crab. For snow crab in Canadian waters, analysis of trap catches and crab density estimates from an underwater-photography survey gave a nominal trap catching area of 4100 square meters (Miller, 1975), which provides estimates 1.9 times higher than those by applying the Russian value.

However, such area-estimates to calculate densities are fraught with difficulty. Many factors are involved, such as water currents, topography, type and amount of bait, size of trap, distance between traps, trap mesh size, soak time and detection abilities of the animals. It is therefore great uncertainty on how large the effective fishing area of a trap actually is. According to Basson and Hoggarth (1993) food detection is likely to be highly developed in benthic animals, and there are a strong possibility of overestimating abundance by such methods.

The method assumes that all crabs within the effective fishing area of the trap are caught. Melville-Smith (1986) finds this assumption unlikely, so that the calculated effective fishing area of a trap is probably an overestimate. Separate assessments for some of the fjords in the Varanger-area clearly indicate that the method underestimates the standing stock of crabs in these areas. Thus, the estimated numbers in September/October 1994 and 1995 of large male crabs in Kobbholmfjord amounted to only a fraction of the actual catches taken there during the same periods. Possibly the very varying topography of the coastal areas restricts the effective catching areas of the traps.

Vienneau *et al.* (1993) observed different conical snow crab traps by means of underwater video camera. The location of the bait and the number of entrances seem to be important factors governing the performance of the trap. The most efficient trap of those tested in the study was the conventional single large entrance trap which was baited in the centre, at lower than middle height.

DIRECT METHODS

Underwater TV surveys could be useful for direct estimations of crab stock. PINRO has carried out experiments in coast regions (Kuzmin and Serebrov 1995) and in Kola Bay (Zaferman, 1997) which showed a possibility of observing and counting crabs under water. The underwater visibility by TV in Kola Bay was about 5-6 m, which provided very good observations. UW-TV trials conducted by IMR in South Varanger crab locations with soft bottom indicated restricted visibility due to turbid water. Additional experiments are needed to adapt the method to various water conditions, and to develop the method to obtain standardised transect data.

All sampling gears have limitations. Miller (1975) found that both beam trawl catches and sight counts from a submersible underestimated crab density. Bottom photography was found to be a more accurate method, and based on this, he calibrated a commercial crab trap for effective fishing area. However, photography is a reliable but slow method, and only relatively small areas can be covered (Melville-Smith 1986). High turbidity results in reduced visibility. Manned submersibles share the disadvantages of film and video with the addition of high cost.

SCUBA-diving is limited to a practical survey depth of 20 m, the search area is small, areas of high relief can be searched only slowly if at all, and specially trained personnel is required. PINRO carried out SCUBA-diving investigation in summer 1996 and spring 1997 in Kola Bay.

DISCUSSION

Scientists dealing with assessment methodologies have tried to develop alternative methods for estimating the abundance of crabs. Trawl, traps, submersibles, video and photography have been tried. None of these methods are up to now reliable enough, and further attempts must be made to develop more reliable techniques.

The applicability of the trap and trawl surveys is largely dependent on the reliability of the conversion from relative abundance (CPUE x distribution area) to absolute stock strength numbers. The nominal trap catching areas and trawl catching efficiency coefficient applied in the present and previous assessments, derived from Russian studies, are most likely underestimating the crab abundance. Experiments to establish catchability coefficients directly relevant to the Barents Sea king crab should therefore receive high priority.

The present king crab stock assessment work is primarily aimed at the mature segment of the population and provides only incidental observations and data of immature crabs. Rational resource management also requires forecasts of future recruitment to the exploitable stock and efficient methods and routines to evaluate and monitor the abundance of immature crabs are therefore greatly needed.

Small, immature king crabs appear in dense clusters or pods believed to increase survival by minimising the vulnerability to predators (Powell and Nickerson, 1965; Dew, 1990). The most serious limitation in studying juvenile king crabs is the lack of suitable fishing gear selective for small crabs. A sausage-shaped artificial collector that passively collects young-of-year red king crabs has been tried (Blau and Byersdorfer, 1994). These collectors are being used in an attempt to estimate future recruitment to the commercial fishery by indexing young-of-year red king crabs with adult crabs from the same cohorts. This is, however, a long term approach, and can be highly inaccurate due to variable mortality. Numerous small king crabs can occasionally be caught in traps. Presently, no appropriate sampling device for these small crabs exists. To achieve an index of recruitment to legal size, a gear/method for sampling these crabs should be developed.

The reproduction cycle need to be studied in more detail, especially with regard to time of season in different sub-regions, and identification of possible special "nursery locations". Possibly, in the future we will have to close areas to protect important nursing and moulting/mating areas. Such locations have been located on the Russian coast and may well be identified also in the Norwegian zone. The traps/pots to be used in the commercial fishery should be covered with netting of a specified, minimum mesh size, e.g. 70 mm, to facilitate escapement of small crabs. Alternatively the traps/pots are to have installed escape rings of a specified diameter. In addition the traps/pots are to be provided with self-destructing escape panels to prevent ghost-fishing by lost traps. Traps used in research surveys might have smaller meshes for catching smaller crabs.

Further improvements are required, especially with regard to obtain advance information about the recruitment potentials (yearclass/cohort strengths), and to convert relative indices into absolute abundance by estimating a trap's catchability coefficient. Methods for fish behaviour studies and fish behaviour in relation to fishing gears are also important issues. Radio link telemetry positioning will be used for this purpose, and this will receive high priority in the future.

PINRO has developed and used an UW-TV system, combined with a computer and software, for their scallop surveys. This system and the towed underwater vehicle Focus 400 (IMR) should be tried out for estimation of crab density. It is advisable to carry out future experiments on the TV survey of crabs at some limited areas. TV observations can also be used for studies of crab behaviour and for evaluation of catching efficiency in trap and trawl surveys.

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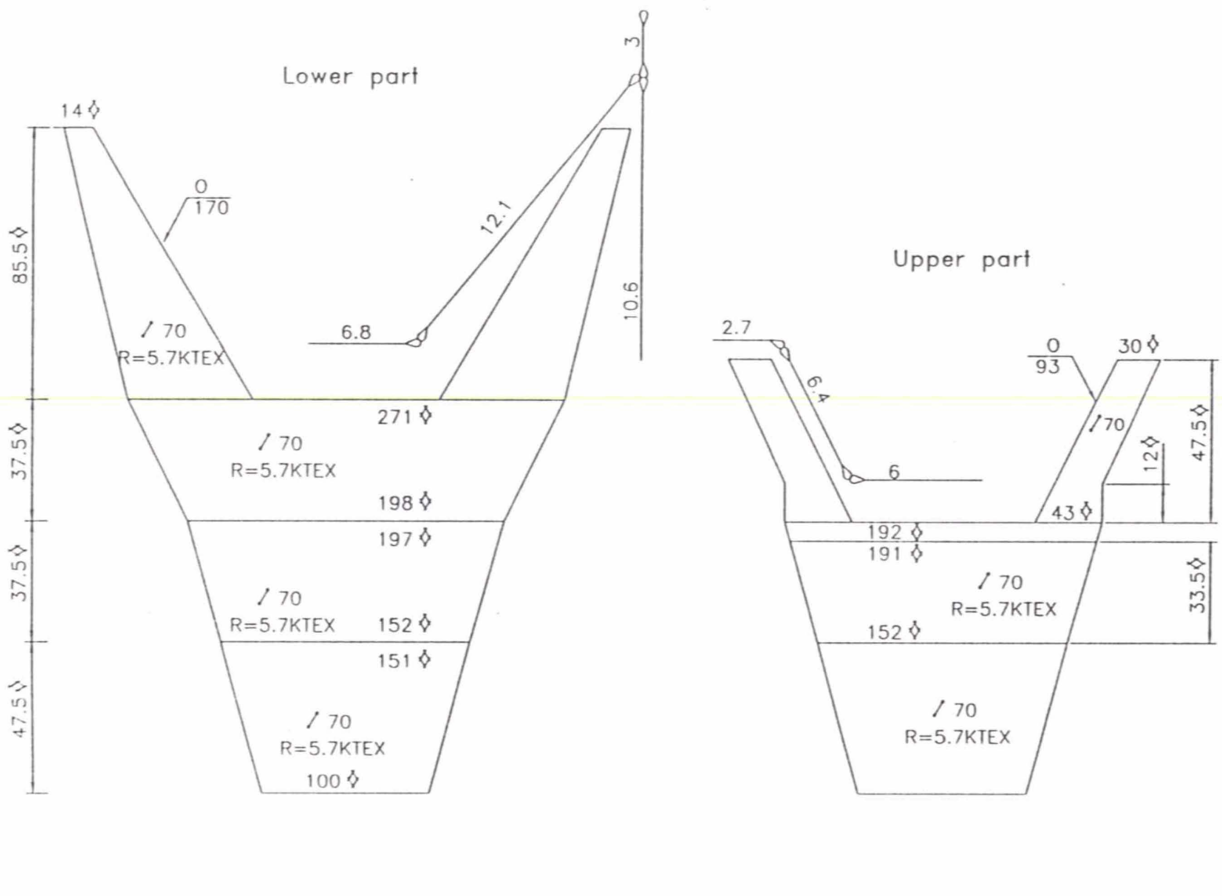

Fig.1. Trawl used by PINRO for crab surveys.

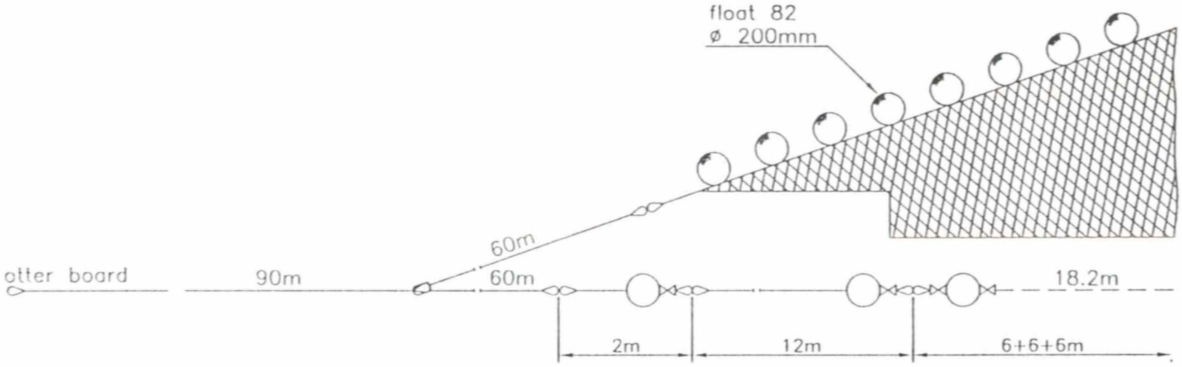

Fig. 2. Rigging of trawl used for king crab in the Barents Sea.

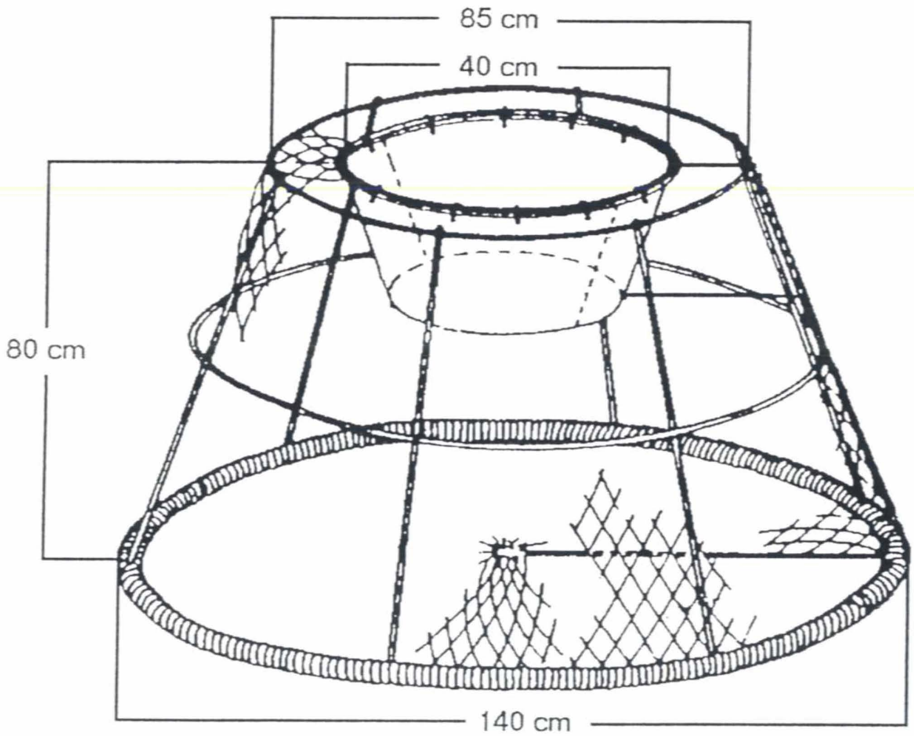

Fig. 3. Technical drawing of king crab trap used in the Barents Sea.