

King crab

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Abstract

The distribution range of the red king crab in the Barents Sea continues to expand in eastern, northern and western directions. In autumn 2002 the recruitment to the legal size stock was good in the eastern part of the distribution area in the Russian Economic Zone (REZ) and in Tanafjorden in the Norwegian Economic Zone (NEZ). The total harvest of crab in 2002 was 400 000 individuals. In REZ the mean catch per day harvested by Japanese conical traps was 1.4 legal males, and 8.5 using American square traps. In NEZ the mean catch by Norwegian square traps increased considerably between 1999 and 2001. In REZ the bycatch of red king crab in the bottom trawl fisheries was steadily increasing, being estimated at 77 000 in 2001 and 417 000 in 2002. In NEZ, bycatch in the gillnet fishery for cod and lumpsucker has been observed to decline in the Varangerfjord and to increase in the Tanafjord in recent years.

Introduction

The red king crab was introduced to the Barents Sea by Russian researchers during the 1960s. By the mid-90s the crab sustained a self-reproducing population there (Bakanev et al., 1997; Gerasimova et al., 1997). However, the distribution area is continuously expanding westwards as new areas are invaded. In the light of this, scientists from both countries conduct regular research surveys to study the biology and distribution of the stock, and to assess it.

From 1994 onward, Russia and Norway have been conducting a research fishery on this introduced species, and the size of this fishery has been increasing with the growth of the stock size. Increased abundance and distribution have created a bycatch problem in other fisheries.

This paper reviews specific features of biology and distribution of the red king crab in Russian and Norwegian waters of the Barents Sea in 2001-2002. Its basis is a joint Russian-Norwegian research progress report for 2002 (Hjelset et al., 2002).

Materials and Methods

In 2002 the Russian research cruises for the red king crab were performed in April/May and August/September, while Norwegian cruises were carried out in August and September. Experimental tagging with external tags in the Norwegian zone was performed in order to study crab migration and as a complementary method for estimating stock size. In addition, tagging experiments with T-bar tags were carried out in Tanafjorden and Laksefjorden for studies of growth and moulting frequency.

Data from the research fishery were collected in September-December 2002 in the Norwegian zone in January-June, and in September-December 2002 in the Russian zone.

Two different types of traps are used to catch crabs in the Barents Sea. In the Russian exploratory fishery Japanese conical traps (standard gear) and American square traps are used, while square collapsible traps have been used in the Norwegian fishery since 1999. Square collapsible traps are used as a standard catching gear on Norwegian research cruises and both

conical and square collapsible traps are used on Russian research cruises. Stock assessment in the Russian and Norwegian zones of the Barents Sea in 2002 was carried out applying a swept area method, where a scientific bottom trawl was used by Russian scientists and an Agassiz trawl in the Norwegian zone.

For practical reasons Russian and Norwegian scientists have agreed on a number of definitions to describe different biological groups of the red king crab in the Barents Sea:

Total stock: All size-groups of the red king crab that are likely to be caught in representative numbers according to the stock, in the trawl devices used.

Legal males: All male crabs with carapace length greater than or equal to 132 mm, or carapace width larger than or equal to 150 mm.

Pre-recruits: Male crabs with a carapace length greater than or equal to 115 mm and carapace length smaller than or equal to 131 mm.

Mature crabs: All crabs with a carapace length greater than or equal to 110 mm. This is also the basis for the estimation of the stock of egg-carrying females, and for the calculation of the sex-composition in the stock from the research cruise data.

Results

Data from research fishery

For 2002 the quota was set to 400 000 individuals, with 300 000 allocated to Russia and 100 000 to Norway. In the NEZ the fishery started 21st of October and the number of participating vessels increased to 127.

In the REZ the fishery was conducted in January-March and September-December and 14 vessels participated.

During the Russian research fishery in 2002, crabs were harvested using Japanese conical traps (22 823 trap-days) and American square traps (29 852 trap-days). The total fishing effort in the REZ was estimated to be 52 675 trap-days.

Fishing area

In the Russian coastal zone in 2002, crabs were harvested from Varangerfjorden in the west to the Seven Islands Archipelago (40°E) in the east. Other fisheries took place at a considerable distance offshore along the northern slope of the Rybachaya Bank (70°20'N), in the East Coastal area and on the Murman Rise (70°N). The area of crab fishery in the REZ is tending to expand to the north and east of earlier crab fishing areas.

In 2001, the whole Varangerfjord area was exploited as fishing area, coastal waters close to Vardø and Kiberg included. Some vessels tried to take their quota in Tanafjorden and the area known as Østhavet. During the fishery in 2002, the same areas as in 2001 were utilized as fishing areas in the Norwegian fisheries.

CPUE – index from traps

In January - March 2002 experimental fishing was conducted in the REZ in order to compare catch rates using conical, collapsible and American square traps. The average catch per day harvest by the first type was 1.7 ± 0.4 , by the second, 3.0 ± 0.39 and the third, 9.0 ± 0.49 legal males. Overall, the average catch per day harvest in the exploratory fishery in 2002 was 1.4 legal males by conical traps and 8.5 by American square traps.

There has been a general increase in catch per unit of effort (CPUE) of all sizes of males in the Norwegian research fishery (Table 1).

Table 1. CPUE (catch per unit effort) data from Varangerfjorden, Tanafjorden and Østhavet; 1999 – 2001. CPUE data from square collapsible traps.

CPUE value for males	1999	2000	2001
Varangerfjorden	3.8	6.4	14.6
Tanafjorden	0.4	1.3	12.4
Østhavet	1.1	2.0	3.7

Size of legal males

In the Russian zone, the mean weight of legal males was about 3.0 kg, according to information provided by research surveys in 2000 - 2002, while mean carapace width for crabs in the research fishery varied from 168 to 188 mm and the mean weight varied between 3.1 and 4.3 kg.

The mean individual weight of landed crabs in the Norwegian fishery decreased from 5.5 kg in 2000 to 4.3 kg in 2001. This was probably due to a higher exploitation rate in 2001. In 2002 the exploitation rate was at the same level as in 2001, and the mean individual weight of landed crabs was 4.1 kg.

Bycatch in other fisheries

Bycatches of red king crab in Russian waters are mainly taken during the trawl fishery for demersal fish. In 2001, the mean bycatch of crabs was 2.4 individuals per tonne of fish, and the total bycatch was estimated to be approximately 77 000 crabs (10 000 legal size males). In 2002, the average bycatch of the king crab was 10.88 individuals per tonne of fish, and the total bycatch was estimated to be approximately 417 000 crabs (175 000 legal size males).

The most serious bycatch problems of red king crabs in Norwegian waters are in the gillnet fishery for cod and lumpsucker during the winter and spring (Figure 1). The bycatch problem in the Varanger area has decreased, while it has increased in Tanafjorden. Bycatches of crab in the Norwegian trawl fishery offshore are so far poorly documented, but efforts to obtain such data will be increased in the future.

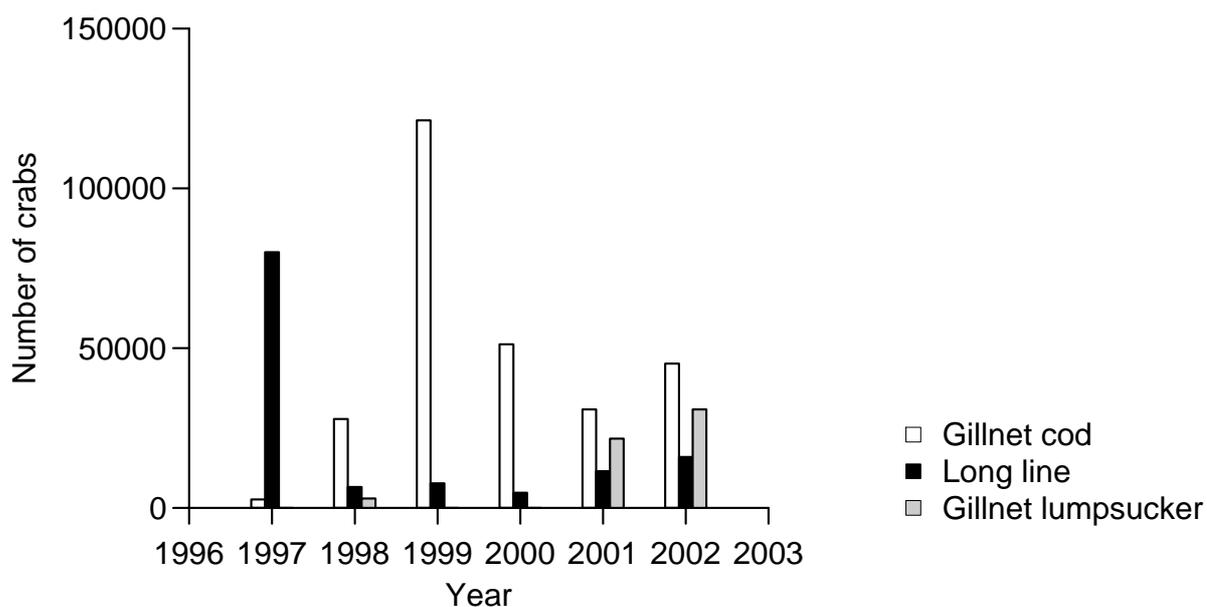


Figure 1. Estimated bycatches of red king crab; 1997 – 2002, for three types of fishing gear.

Data from research cruises

Distribution area

According to Russian data from 2001, the densest concentrations of legal size males were found west and east of the Rybachy Peninsula. In 2002 a large area of dense concentrations developed in the eastern part of the crab habitat (Figure 1). In 2001, egg-carrying females were distributed over the entire area surveyed, while in 2002 they were only found in the near-coastal region (Figure 2).

The red king crab is continuously invading new areas along the coast of Finnmark as well as along deeper slopes 10 – 12 nm offshore. The crab has been recorded in Tanafjorden for many years now, and its stock appears to be well established there. A survey carried out in autumn 2000, together with the research cruise in September 2002 and the research fishery in 2001, showed that the species is quite abundant in several places along the eastern side of Laksefjorden. Østhavet could not be examined sufficiently in 2002 due to bad weather conditions and loss of equipment during the cruise. In the winter of 2001/2002 there were additional cases of crab bycatches in the gillnet fishery for cod, west of the North Cape.

Stock structure

Analysis of the size distribution of red king crab in 1998-2002 in Russian waters showed that in 2002 a strong year-class recruited to the commercial stock (Figure 3). Males were most abundant in the size group from 150 to 180 mm carapace width (CW), while females were mainly 120 - 140 mm CW.

The size distribution of the crab stock in Varangerfjorden in 2002 showed that the abundant year-classes recorded for the first time in 1997 are now dominating the stock of legal males. Only a few small crabs were caught during the cruise in 2002. The absence of strong year classes means that recruitment to the legal male component of the stock will be negligible in the next few years (Figure 4).

In Tanafjorden the size distribution is different from that of the Varangerfjord area. Legal males with carapace length larger than 132 mm are quite abundant, while pre-recruits are found in only small numbers. A new year class of crabs with a carapace length of about 90 mm is abundant in the Tana stock, and will contribute significantly to the fishery within a few years.

The size distribution in Østhavet is unknown due to crab cruise failure in 2002.

Total stock index

Estimates of the total red king crab stock for the two national zones in the Barents Sea are presented in Table 2. However, the smallest size groups are not fully represented in the trawl catches, which provide the basis for the estimates. The smallest size groups (<50 – 60 mm carapace lengths) inhabit water depths that are not fully covered during trawl surveys. Therefore it was found necessary to agree upon a precise definition of what is meant by the term “total stock”.

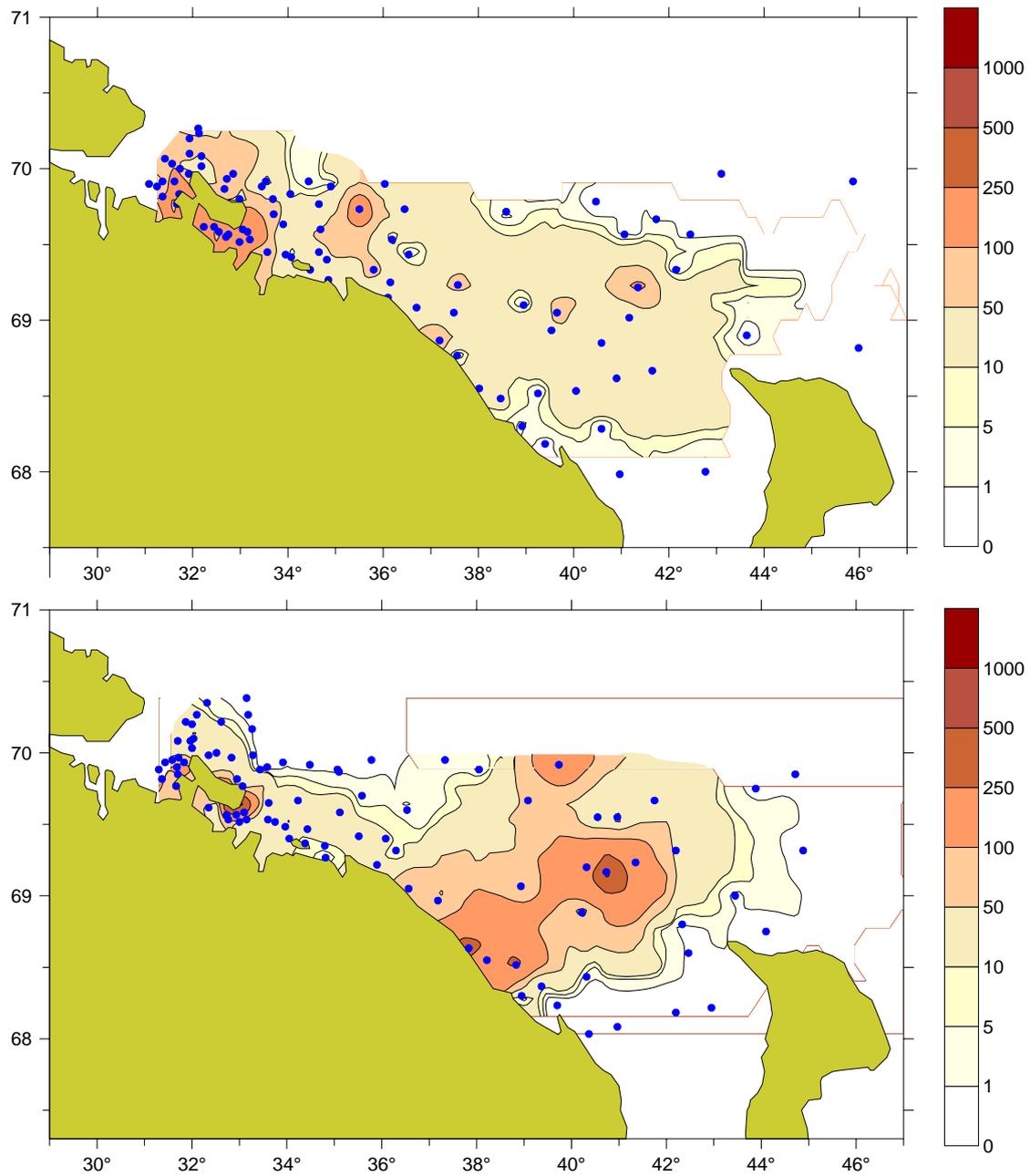


Figure 2. Distribution of legal males (spec/square km) in REZ in autumn 2001 (top) and in autumn 2002 (bottom).

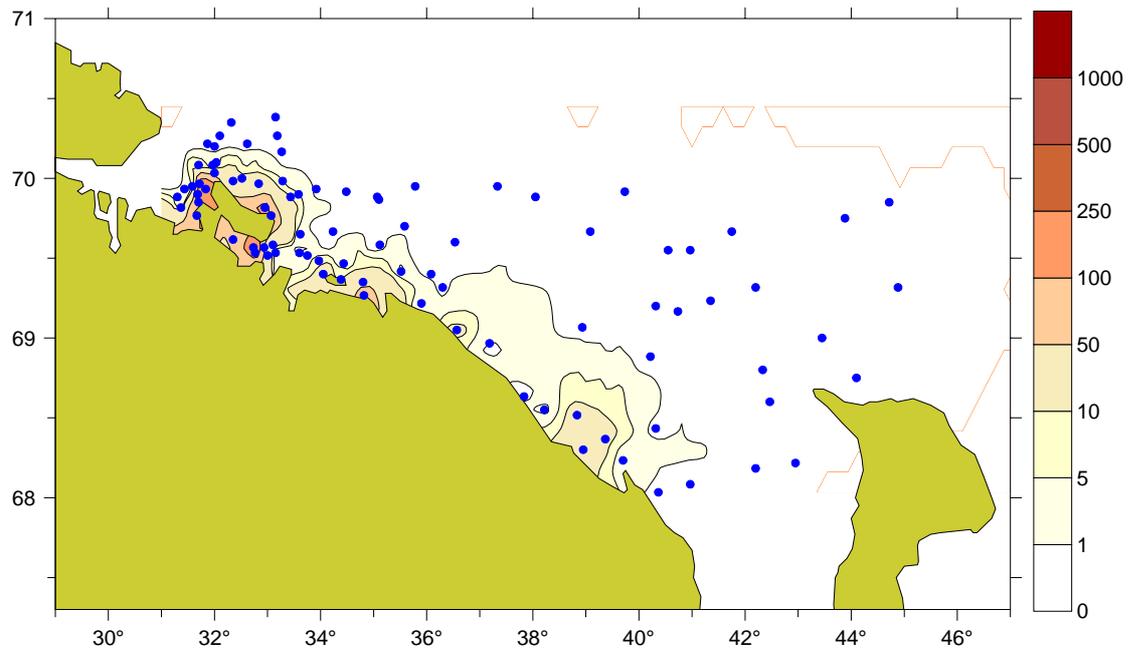
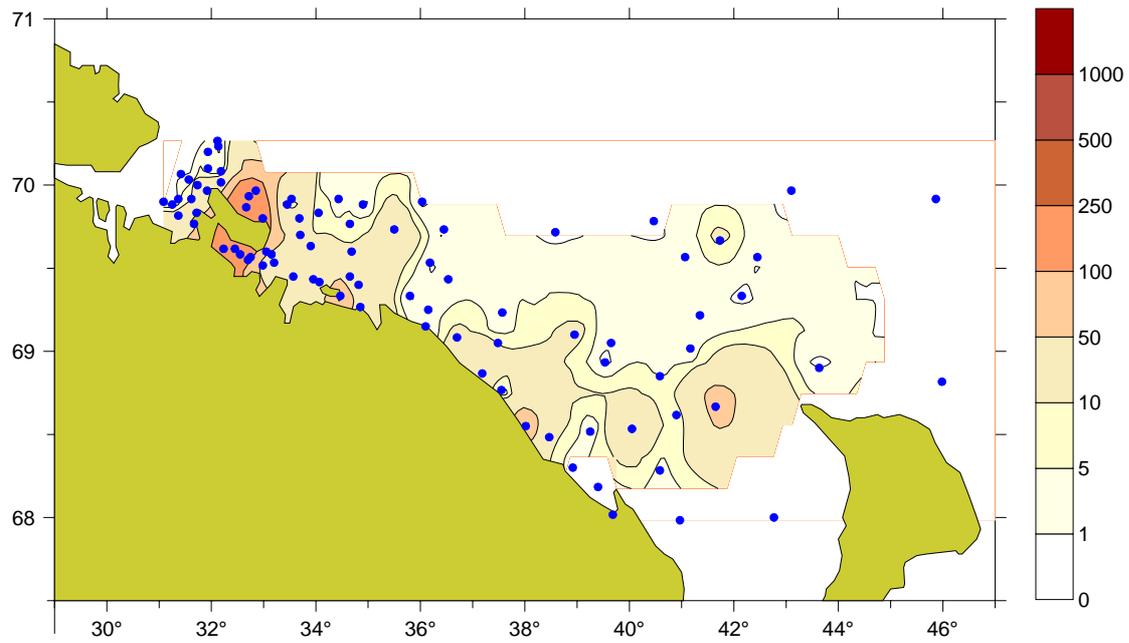


Figure 3. Distribution (spec/square km) of egg-carrying females in REZ in autumn 2001 (top) and autumn 2002 (bottom).

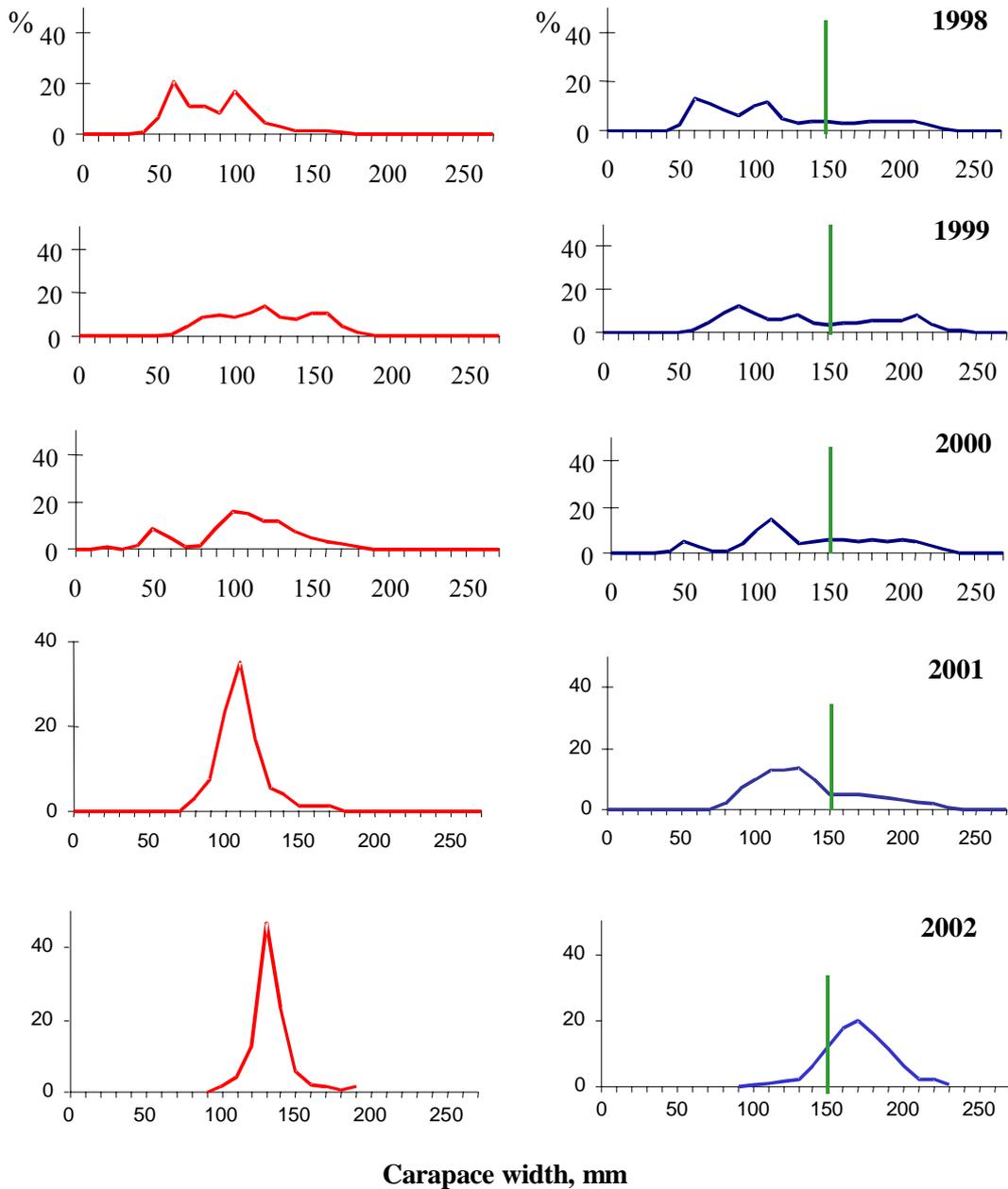


Figure 4. Carapace width distribution of red king crab in REZ from research cruises; 1998-2002. Red line – female; blue line – male; green bar – legal size limit.

the total stock index in the REZ in 2002 was 4 315 900 individuals and 12 100 000 in 2001. This reduction is probably related to underestimation of females and young crabs due to their mainly coastal distribution (see Figure 2); areas that are impossible to survey with a trawl.

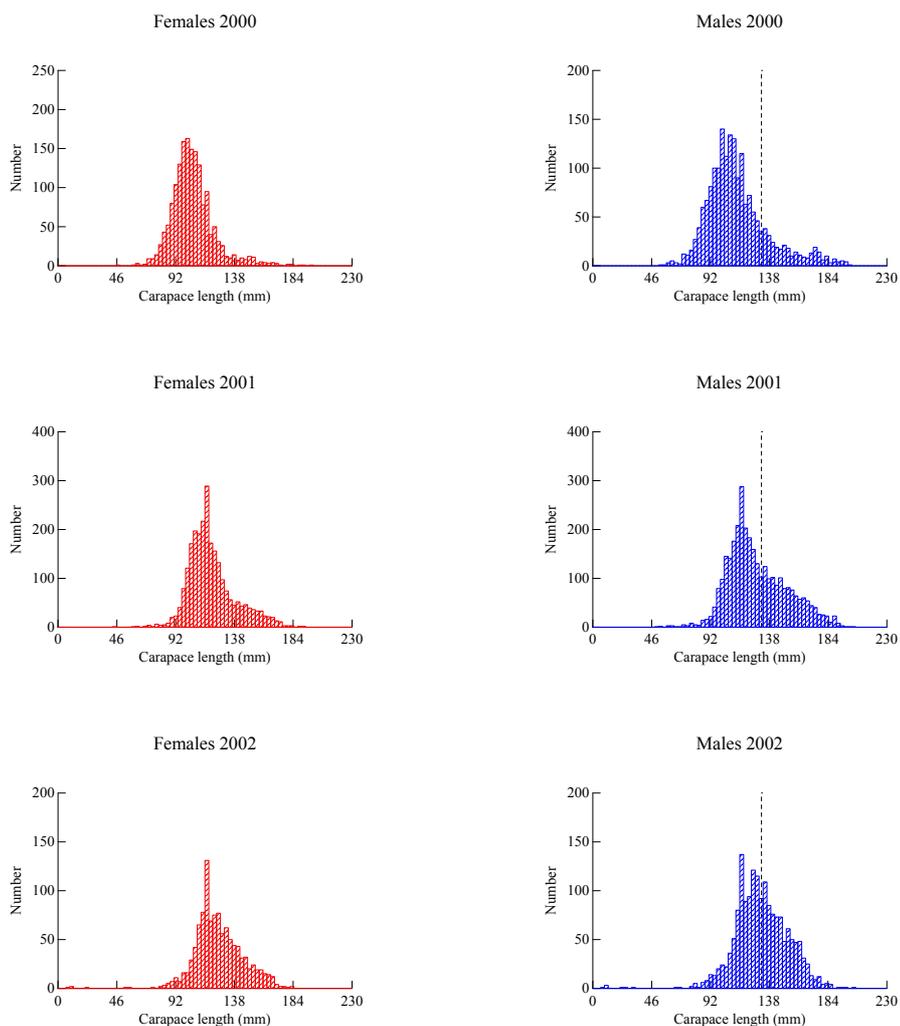


Figure 5. Carapace length distribution of red king crab caught in the Norwegian part of Varanger, in the period 2000 – 2002. Right-hand part of the figure - males and left-hand part - females. Dotted line indicates minimum legal size for males.

Table 2. Total red king crab stock index in the Russian economic zone (REZ) and Norwegian economic zone (NEZ), 2001 and 2002; swept area method.

Economic Zone	Year	Total stock index
REZ	2001	12 210 000
	2002	4 316 000
NEZ	2001	2 970 000
	2002	3 180 000

Stock index of legal males

A considerable recruitment to the legal males stock in REZ in 2002 led to an increase of the stock (Table 3).

The stock index of the legal males in the NEZ in 2002 was estimated only for the Varangerfjorden and Tanafjord. Only areas deeper than 100 m were included, since legal males rarely occurred in samples taken at depths of less than 100 m. The stock index estimate is based on a total of 81 trawl hauls in Varangerfjorden and 23 trawl hauls in Tanafjorden (Table 3).

Table 3. Estimates stock of legal males (CaWi \geq 150 mm or CaLe \geq 132 mm) for 1995 – 2002 in REZ and NEZ.

Year	REZ	NEZ	REZ + NEZ
1995	250 000	54000	304 000
1996	155 000	87000	242 000
1997	316 000	110000	426 000
1998	801 000	150000	951 000
1999	1 508 000	not estimated	
2000	1 513 000	676 000	2 189 000
2001	1 494 000	446 000	1 940 000
2002	3 271 000	799 000	4 070 000

Stock index of pre-recruits

The pre-recruit component of the crab stock was estimated for the first time in 2001. In the REZ the pre-recruit abundance in 2001 was estimated to be 2 220 000 crabs. In 2002, it decreased to 488 000 crabs. In West Murmansk waters - in the Russian part of the Varangerfjorden and Motovsky Bay - the stock index for pre-recruits remained almost unchanged from 2001 to 2002 at 109 400 and 95 300 crabs, respectively. On the northern slope of the Rybachy Peninsula and in the East Murmansk region the total abundance of pre-recruits was estimated to be 1 220 900 crabs in 2001 and 392 600 in 2002. The stock index of pre-recruits decreased 2-14 times in various areas (northern part of the Rybachaya bank, Kildin bank, West and East Coastal areas, Murmansk Shallows).

As seen in the length distribution figure (see Figure 3) the pre-recruits make up a large proportion of the immature component of the male crab stock in the Norwegian part of Varanger, while they were almost absent in the Tanafjord in 2002. In NEZ the mean stock index of pre-recruits in 2002 was 445 572.

Recruitment to the crab stock

Juvenile red king crabs inhabit shallow waters during the first years of their life. This means that these year-classes do not appear in trawl catches before they migrate to deeper areas. Indices of the recruitment to the crab stock may therefore not be obtained before crabs reach about 50 – 70 mm in carapace length, when they begin to be caught in the trawl samples.

In Russian and Norwegian areas, high abundance of these age groups was observed only in 1997. Since then, there has been no evidence of good recruitment to the crab stock in these waters.

In Tanafjorden, there will probably be a good recruitment to the stock within about three to five years, since a large group of the stock was around 90 mm carapace length in 2002.

Moulting frequency of male red king crab

Male red king crabs skip moulting as they become older. The moulting frequency in each size-group depends on food availability, temperature etc., and may vary between years and areas. In the Norwegian investigations we use two different methods to reveal moulting; tagging experiments with T-bar tags in the isthmus, and a subjective judgment of the carapace age.

During the period from 1997 to 2001 the rate of moulting in the pre-recruit group varied between 70 and 90% in the Norwegian part of Varanger. Based on the subjective judgment of carapace age, the moult rate rose to about 94% in 2002. It may therefore be concluded that most of the pre-recruits will become legal males within the next year.

The meat content of harvested males was low in the Norwegian research fishery in 1999. This was assumed to be a result of a high moult rate of about 36 % among legal males that year. In 2000 this fell to about 21%, while it increased again to about 43% in 2001. In 2002 a total of 65 % of the legal male stock had moulted. Low meat content in catches during autumn 2002 was therefore also a significant problem. However, the fishermen seem to be able to sort out crabs with low meat content from the catch.

According to Russian research, mature females moult once a year. Mature males with a carapace width of less than 150 mm moult once a year, among males with a carapace widths of more than 150 mm individuals are found which moult every second year, and among those with a 170 mm carapace width, every third year. Crabs with a carapace width of more than 190 mm moult only every fourth year. According to research surveys, the moulting frequency of legal males in Russian waters was close to that in Norwegian waters. In 1999 the number was 50%, in 2000 48%, in 2001 68% and 86% in 2002. A considerably higher proportion of moulted legal males appeared in 2002 than in 2001, probably due to increased recruitment to the legal stock.

Ecological effects

So far, there have been no reports of any ecological effects of the red king crab on the ecosystem in the Norwegian zone. Some people, however, maintain that the crab ruins scallop beds in its areas of distribution and that it affects the habitat of flatfishes. In co-operation with the Norwegian College of Fisheries, a project was launched in 2001 with the main aim of studying possible impacts of the crab on the species diversity associated with scallop beds.

Studies of various aspects of red king crab feeding in the REZ suggest that competition between the crab and benthos-eating fish is insignificant. The crab feeds, primarily, on benthos and offal from the fisheries. In 2003, the Institute of Marine Research (IMR) launched a comprehensive research and surveillance programme to study any ecological effects. This is planned to be carried out in cooperation with other research institutions and will last for at least ten years.

Marine climate

Marine climate data such as temperature and salinity have been recorded in the Norwegian part of Varanger since 1994, but no main changes in these parameters have been found during this period.

In the past two years bottom water temperature in the REZ exceeded the long-term mean level by 0.5-1.0° C in 2001 and by 1-3°C in 2002.

Perspectives for the fishery

The red king crab fishery in both the Russian and Norwegian zones of the Barents Sea has been organized as an exploratory fishery, where the fishermen were subject to instructions from the research institutions in charge until 2001. In 2002 the fishery became an ordinary commercial fishery in Norway as decided by the RNFC (Joint Russian-Norwegian Fisheries Commission) in 2001. However it was decided to ensure that fishery and biological data would be collected from the fishery under the new fishing regime.

It is also necessary to increase scientific efforts to study the role of the red king crab in the Barents Sea ecosystem as an introduced species.

The decision regarding the TAC in the Barents Sea king crab fishery is made in late autumn (November) every year. Choosing this particular time of the year means that data from the fishery to be used in the stock assessment will be one year old, since the crab fishery takes place in the autumn. We therefore recommend that the time of year to decide upon a TAC be changed to spring of the following year, so that all the data from the latest fishery can be used in the crab assessment.

Stock status

The red king crab stock in the NEZ is still growing in numbers particularly in areas outside Varanger, such as Tanafjorden. Most of the abundant year classes, which in recent years have made up a large part of the stock, have now recruited to the legal size stock. Recruitment to the legal size stock was high in the NEZ also in 2002, but will decline in 2003 and the following years. No new recruitment to the crab stock in Varanger has been recorded since 1997 in the NEZ. In Tana, recruitment to the legal male stock will be negligible in 2003, but will increase again in 2004. There are no indications of any effects of the male-only harvest strategy in Norwegian zone.

The total crab stock index in the REZ in 2002 was low because of considerable underestimation of females and young crabs. The legal male stock increased to more than twice the 2001 level. We have no data available on recruitment of younger crabs.

Conclusions

The distribution area of red king crab in the Barents Sea is tending to expand westwards in Norwegian waters and northwards and eastwards in Russian waters.

Stock of legal males in Russian and Norwegian waters nearly doubled in 2002 compared to the previous year. Catch per unit of effort in the Norwegian crab fishery in 1999-2002 increased considerably. Bycatches of crabs in the trawl fishery in Russian waters increased from 2.4 to 10.9 crabs per tonne of fish from 2001 to 2002. In 2003 and subsequent years recruitment to the legal size stock is anticipated to decline.

The fishery management of this stock should ensure maximum long-term sustainable yield via a rational multi-species fishery over a long period of time. However, there is a need for continuous evaluation of king crab management due to the crab being an introduced species. Knowledge of any serious impacts of the crab on the ecosystem should trigger a new discussion on how this species should be managed.

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J. V. Tagart: Red king crab in Alaskan waters

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