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JOINT RUSSIAN-NORWEGIAN SELECTIVITY EXPERIMENTS ON COD (*GADUS MORHUA* L.) IN THE BARENTS SEA, 1995

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På oppfordring fra Den blandete norsk-russiske fiskerikommisjon (sesjon 23) ble det i september 1995 utført sammenlignende forsøk med to ristsorteringssystemer i torsketrål, det norske "Sort-X"-systemet og det russiske sorteringssystemet med enkel rist.

Feltforsøkene ble utført ombord i M/Tr "Anny Kræmer" og M/Tr "Bizon" på kysten av Øst-Finnmark og ved Bjørnøya. Resultatene viser at det norske sorteringssystemet isolert sett ga litt bedre seleksjon enn det russiske. Når sorteringssystemene ble brukt som under kommersielt fiske uten noen form for dekknett, ga norsk og russisk trål tilnærmet lik lengdefordeling av fisk.

Emneord - norsk:
1. Seleksjon
2. Sammenligning av ristsystemer
3. Torsketrål

Emneord - engelsk:
1. Selectivity
2. Comparison of grid systems
3. Bottom trawl

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## SUMMARY

With reference to point 4.3.2 in the protocol from the 23rd Session of the Mixed Norwegian-Russian Fisheries Commission, the parties agreed that necessary testing of sorting grids systems had to be performed during 1995 in order to enable the Fisheries Commission to reach a decision on the introduction of grid systems in the trawl fishery for cod in the Barents Sea.

During the period 15-27 September 1995, joint Russian-Norwegian selectivity experiments with sorting grid systems were carried out in the Barents Sea on board the Russian vessel "Bizon" and the Norwegian vessel "Anny Kræmer".

Two different grid systems were used, both with an inter-bar distance of 55 mm. The Norwegian vessel used predominantly the 4.5 m semi-rigid "Sort-X" system, while the Russian vessel used a 1.5 m single-grid system. In a few tows the Norwegian vessel used a single-grid system mounted in a two-panel Alfredo-type trawl.

The experiment were divided into four periods. By assistance from the Norwegian vessel during the first period, the Russian trawl was observed by an underwater vehicle carrying video camera. The single-grid system appeared to perform as anticipated. Underwater observations of the single-grid system in the Norwegian trawl revealed poor performance, and it was reinstalled to give a better performance.

Comparative fishing trials in the second period with covers and blinders gave almost similar 50% retention values for "Sort-X" used in the Norwegian trawl and the Russian single-grid system in the russian trawl, with $L_{50}$ of 50.3 and 49.7 cm, respectively. The "Sort-X" system gave a somewhat sharper selection, with a selection range of 11 cm compared to 15 cm for the single-grid system. Both systems had a very good release of small fish; with an escape rate for fish smaller than 42 cm of 93-94% and of fish smaller than 47 cm of 88-89%.

During the third period, single-grid systems were used on board both vessels. This system worked as before for the Russian trawl, but did not work properly with the Norwegian Alfredo-type trawl.

Although a good performance during UTV-observation, the selectivity experiments revealed that the single grid in the Norwegian trawl had a low angle of attack, and that far from all fish were brought into contact with the grid.

During the fourth and perhaps the most important stage of the experiments, the trawls were rigged as during commercial fishing, with a single-grid system and a 135 mm codend in the Russian trawl, and the "Sort-X" system and a 135 mm twin-codend in the Norwegian Alfredo-type trawl. The size distribution from the five parallel tows were not significantly different. Analysis of data from hauls with and without blinder revealed a slight codend selection in the Russian trawl aft of the single-grid system and minor or no codend size selection aft of the "Sort-X" system.

The two grid-systems tested during these experiments have both their benefits and drawbacks regarding selectivity, handling and expenditure aspects. The grid systems as used in the respective trawls with ordinary codends give a close to similar selectivity, and will undoubtedly improve the overall size selectivity of bottom trawls.

# INTRODUCTION

After an experiment- and development period of about two years for the "Sort-X" grid sorting system (Larsen and Isaksen 1993), a joint selectivity cruise with one Russian and one Norwegian trawler was performed in 1992 (Larsen *et al.*1992) with the goal of evaluating the efficiency of this selectivity device in bottom trawls normally used by Russian and Norwegian stern trawlers fishing for cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*). The main conclusion regarding selectivity was that the "Sort-X" selective device performed well in both the Russian and Norwegian trawls, and released a high proportion of small fish. The experiment gave slightly better selectivity results for the Russian trawl, most probably due to different gear construction and dimensions in the part of the trawl where the grid system was installed.

In the period 1992 -1995, the experiments have continued, with several cruises performed on board Norwegian trawlers to calculate size selectivity for different species when using the "Sort-X" system (Larsen 1993; Larsen and Schultz 1993; Larsen 1995a; Larsen and Gamst 1995a, b). In addition, some experiments on increased inter-bar distance when fishing for cod have been performed (Larsen 1995b). The basic construction of the "Sort-X" system has remained the same since May 1990, but small modifications have improved the system throughout the period. The use of the "Sort-X" has so far given few practical problems, but precautions should be taken during the use of the system to avoid damage, especially when the system is hauled up the stern-ramp, and during handling and storage on deck (Larsen and Gamst 1995a).

After the joint Norwegian-Russian selectivity cruise in July 1992 (Larsen *et al.* 1992), several experiments on board Russian vessels during autumn 1992 and spring 1993 confirmed the earlier selectivity results obtained with the "Sort-X" with good separation of small fish. However, the use the of "Sort-X" system on board Russian boats revealed some practical problems and inconvenience during normal fishing operations. A lot of Russian trawlers are equipped with gilson winches on the main trawl deck, and the "Sort-X" was exposed to heavier loads when hauled up the ramps, which are steeper than those found on board Norwegian sterntrawlers. Frame deformation was frequently observed, especially of the guiding and depressor frames. Twisting of trawl bags was also observed after turning maneuvers by the vessels. In addition the

Russian fishermen regarded the three-frame "Sort-X" system as heavy and inconvenient to handle on deck when compared to the single-grid system "Nordmøre-grid" used in shrimp trawls. During the period from 1992 to 1994, stainless steel (the normal material for the "Sort-X") was hardly obtainable in the Murmansk region, and at a very high price. With these background considerations, experiments were started in 1993 by PINRO with a single-grid system to determine the efficiency of this device in the Russian trawls. Results presented by Sakhnoe (1994), and later on during the annual meeting between scientists in Murmansk in March 1995, indicated that a single-grid system might be used in Russian trawls, giving roughly the same release of small fish as the "Sort-X" system. The results were evaluated during the 23rd Session of the Mixed Norwegian-Russian Fisheries Commission in November 1994, and it was stated that "necessary testing of sorting grid systems had to be performed during 1995 in order to enable the Fisheries Commission during its next meeting to make decisions upon the use of grid sorting systems in bottom trawl" (point 4.3.2 in the Protocol of the 23rd Session of the Mixed Russian-Norwegian Fisheries Commission). Accordingly, joint experiments were planned during spring 1995 and performed during September 1995.

# MATERIAL AND METHODS

## Planning of experiments

Rough plans for the experiments were made during the annual scientist meeting in Murmansk in March 1995, and further in more detail through fax correspondence. It was decided that the experiments should be divided into four periods:

### Period I: Underwater observations

The Norwegian vessel should be equipped with facilities for underwater observation, i.e. the towed underwater vehicle "Ocean Rover" and the self-recording unit "RS-400". The Russian single-grid system had not been observed earlier, and it was agreed that a Russian trawl equipped with the single-grid system should be transferred to the Norwegian vessel for underwater

observations. Furthermore the single-grid system in a two-panel trawl (Alfredo type), as commonly used in Norway, should be observed and modified if necessary.

**Period II: Comparative fishing; two different grid systems with covers and blinders**

During this period, the Norwegian vessel should use the "Sort-X" system while the Russian vessel should use the single-grid system. Both vessels should use small meshed covers attatched over the grids, and the codends should be blinded with an inside small-meshed netting. Preferably the hauls should be made as parallel hauls, but if this was not feasible, then the hauls should at least be conducted in the same area.

**Period III: Comparative fishing; single-grid system with covers and blinders**

During this period, both vessels should use the single-grid system to see if this system would perform equally well in the two types of trawl. The trawls should be equipped with covers and blinders as in period II.

**Period IV: Comparative fishing; commercial practice**

During this period, the Russian vessel should use the single-grid sorting system with an inter-bar distance of 55 mm, and a codend with a meshsize of 135 mm. The Norwegian vessel should use the "Sort-X" system with an inter-bar distance of 55 mm and a 135 mm twin-codend. Used in this way, the two trawls would give a size distribution of fish as during commercial fishing operations with grid(s) installed.

## Vessels and fishing gear

The characteristics of the Russian vessel "Bizon" and the Norwegian vessel "Anny Kræmer" and the gear used by the two boats during the joint selectivity experiments in the period 15 - 27 September 1995 are given in Table 1.

## Sorting grid systems

The Norwegian vessel "Anny Kræmer" was equipped with the "Sort-X" grid system consisting of two separate grids joined together with a third frame covered with pvc-canvas (guiding and depressor frame). The inter-bar distance used during the experiment was 55 mm. The "Sort-X" system has a width of 1.2 m, and total length of rigid (but hinged and collapsible) structure of 4.5 m. The weight of steel components (approximately 85 kg) is compensated by 35 8" floats. The location and working principle of the "Sort-X" is shown in Figure 1.

The vessel "Bizon" was equipped with the Russian single-grid system consisting of one sorting grid with an inter-bar distance of 55 mm. The dimensions of the Russian single-grid system are about the same as the front grid of the "Sort-X" system; 1.2 m wide and 1.5 m long, but made of steel tube yielding a weight of approximately 22 kg. The grid was equipped with 6 8" floats to give it neutral buyoancy in water. The working principle of the single-grid system is shown in Figure 2.

In addition to the two grid systems mentioned above, "Anny Kræmer" was equipped with a single-grid system, to see how this system would function in a two-panel trawl. The grid was installed according to specifications given by the Russian specialists.

## Covers and blinders

In order to evaluate the sorting efficiency of the two grid-sorting systems, specialized covers were used to "recapture" fish that had escaped through the grids. The working principles and shapes of the covers used on board "Anny Kræmer" and "Bizon" are shown in Figures 3 and 4. The covers were used in combination with codend blinders (small-meshed netting inside the codend to prevent escapement from the codend).

## Length measurements and data analysis

The lengths of fish from the codends and covers were measured to the nearest cm below for each haul. In hauls with large quantities of fish, subsamples of 800-1000 fish were measured, while the rest of the fish were counted yielding a scaling factor for estimating the total number of fish in each length group. Data analysis was performed by *Fortran IV*, *Excel* and *CC-Selectivity* programs. The figures are drawn by *Harvard Graphics.*

## Narrative of experimental operations

The two vessels "Anny Kræmer" and "Bizon" met late evening of 15 September, and due to rough sea conditions, a decision was made to go into a sheltered area in Varangerfjord for transfer of the Russian trawl to "Anny Kræmer" on 16 September. The trawl and single-grid system was observed at the Persfjord/Syltefjord area at 70-80 m depth during two hauls on 17 September and returned to "Bizon" during the evening (experimental period I). On 18 September, the single-grid system in the Norwegian trawl was re-installed to give a better angle of attack, and observed during the afternoon. The two vessels met on 19 September to start the comparative fishing experiments (period II-IV). Due to poor fishing conditions at the Norwegian coast with very small catches, it was decided to move to an area south of Bear Island, where good fishing and favourable size compositions were reported. During the stay in this area (approx. N 73°50', E 18°00') and an area further east (N 74°15', E 20°50') tasks allocated to experimental period II,III, and IV were carried out. Frequent meetings were held to discuss the progress and the results obtained by transferring scientist between the vessels.

The following specialists participated in the joint cruise:

*"Anny Kræmer":*

B. Isaksen, Institute of Marine Research, Fish Capture Division, Bergen

O. Chruickshank, Institute of Marine Research, Fish Capture Division, Bergen

R. B. Larsen, Norwegian College of Fisheries Science, University of Tromsø, Tromsø

K. Gamst, Directorate of Fisheries, Bergen

R. Misund, Directorate of Fisheries, Bergen

G. Langedal, Directorate of Fisheries, Bergen

B. Berthelsen, Selfi A/S, Tromsø

*"Bizon":*

S. Lisovsky, Knipovich Polar Research Institute of Marine Fisheries and Oceanography, Murmansk

V. Sakhnoe, Knipovich Polar Research Institute of Marine Fisheries and Oceanography, Murmansk

M. Sadokhin, Knipovich Polar Research Institute of Marine Fisheries and Oceanography, Murmansk

G. Zuikov, Knipovich Polar Research Institute of Marine Fisheries and Oceanography, Murmansk

# RESULTS

## Underwater observations

Underwater observations of the Russian single-grid system showed that the four-panel extension section had a somewhat square configuration. Although difficult to measure, it seemed that the grid had an angle of attack somewhat lower than the theoretical optimum installation angle of $30^{o}$. The leading panel in front of the grid was seen lifting away from the bottom panel. Fish passing through the belly extension piece in front of the grid seemed to have a slower speed than earlier observed in the shorter and more steeply-tapered two-panel trawls of Alfredo type. The underwater observations on the whole revealed that minor modifications of the grid system might improve the selectivity, first of all by cutting away more of the net panels right above the grid.

The first observation of the single-grid system in a Norwegian trawl clearly showed that the grid was operating at an inadequate angle of attack. The grid was re-installed in the same manner as

the Russian grid had been, and then it performed better. The single-grid system in the Alfredo trawl was not observed after attatching the grid cover.

## Comparative fishing experiments

The size compositon of the fish found at Bear Island was optimal for the selectivity experiments, with fish lengths ranging from 16 cm up to 120 cm. The dominant size groups were between 16 and 22 cm, and 35 to 82 cm. The catches varied from 500-600 kg to 8000 kg per haul, and varied between the two vessels fishing either parallel or in the same area. The average ratio of catch rates (kg/hour) between "Anny Kræmer" and "Bizon" was roughly 2:1. The haul specifications and pooled data from the comparative fishing conducted during the three periods II, III and IV are given in Tables 2a-b and 3a-f. The length distribution of fish caught during period II (22 - 24 Sept) is shown in Figure 5, and the corresponding selection curves drawn by the method of "3-point moving average" are given in Figure 6 (pooled data). The obtained 50% retention lengths for "Sort-X" in the two-panel trawl (Alfredo type) and the single-grid system ("Sort-V") in the Russian trawl are quite similar, with $L_{50}$ of 50.3 cm and 49.7 cm, respectively. The respective selection ranges (interval between 25 and 75% retention length) are 11 and 15 cm. Single haul calculation by *CC-Selectivity* (LOGIT function) gave an $L_{50}$ for the "Sort-X" ranging from 44.4 to 55.0 cm, with selection ranges between 9.0 and 13.0 cm, while the single-grid system in the Russian trawl gave $L_{50}$ ranging from 44.0 to 49.7 cm, with selection ranges from 8.4 to 13.1 cm. The calculation of the underlying selectivity curves for the "Sort-X" in the Alfredo-type trawl and the Russian single-grid system in the Russian trawl are given in Appendices I and II.

During period III, the hauls were made further east of Bear Island with more small fish in the size range 26-40 cm (Figure 8). The selection curves for the single-grid system show quite big differences, with an $L_{50}$ of 49.8 cm for the Russian trawl and 30.0 cm for the Norwegian trawl (Figure 7, pooled data). The corresponding selection ranges were 15 and 32 cm (!). The *CC-Selectivity* calculations are given in Appendices III and IV. During period III, three hauls were made by the Norwegian vessel with the "Sort-X" system in order to see if the different size

distribution had an impact on selectivity. The results obtained were similar to those obtained during period II for this system (Appendix V).

During the last and perhaps most important stage of the experiments; period IV, the trawls were rigged as during commercial fishing, with the single-grid system and 135 mm codend in the Russian trawl on board "Bizon" and the "Sort-X" and 135 mm twin-codend in the Norwegian trawl on board "Anny Kræmer". The comparisons were done as parallel trawl hauls, with simultaneous shooting and hauling of the trawls on the two vessels. The size distributions of fish caught and landed on the two vessels were very similar (Figure 9), with mean lenghts of the fish caught by "Anny Kræmer" and "Bizon" of 61.7 and 61.8 cm, respectively. No significant difference was found between the two length distributions using a Kolmogorov-Smirnov analysis. When comparing the size distribution of fish caught in the codend with blinder during period III and fish retained in the codend (without blinder) during period IV in the same area, it appears that there was almost no additional codend mesh selection aft of the "Sort-X" (Figure 10) in the Norwegian trawl, with mean lengths for cod of 62.5 and 61.7 cm, respectively. For the Russian trawl there is a codend mesh selection effect for fish between 30 and 47 cm (Figure 10), giving an increase from 58.9 to 61.8 cm in mean lengths of cod in codends with and without the small-meshed blinder.

## DISCUSSION

The results from a wide range of grid experiments in bottom trawls for both shrimp and fish have shown that grids in many cases are superior to meshes in terms of sorting out bycatch, either by species or size (Larsen and Isaksen 1993; Isaksen *et al.* 1992; Larsen *et al.* 1992; Sakhnoe 1994; and other). All grid systems are placed well in front of the codend, and in terms of escapee survival, it is a general supposition that bycatch organisms would benefit from an escape before ending up in the codend where they eventually could escape by codend mesh selection.

In the experiments performed in September this year, very good results were obtained for small fish (cod), with a grid release of 93-94% of fish smaller than 42 cm and 88-89% of fish smaller

than 47 cm. This is better than the results reported from earlier experiments with ordinary codends (Isaksen et al. 1989). The comparison of the well tested Norwegian "Sort-X" system (Patent NO 173162) in a Norwegian trawl (two-panel Alfredo type) and the Russian single-grid system (PINRO-construction, "Sort-V") in the Russian trawl, indicates a slightly better selectivity for the "Sort-X" when the two sorting systems were used with small-meshed covers attached above the grids and small-meshed blinders inserted in the codends. The underwater observations made in the first part of the cruise suggest that there may be possibilities for further improvements of the single-grid system.

But more importantly, when the same systems were compared and used as they will be during commercial, practical fishing, there was no significant difference in the size distribution of the fish brought on board the two ships. This was achieved mostly by grid selection and a minor codend mesh selection in the Russian trawl and by the grid system alone in the Norwegian trawl. No apparent mesh selection in the codend aft of the "Sort-X" may be due to the small amount of small fish, but may also be due to the wake/backwash aft of the guiding/depressor frame, affecting the water flow in and around the codend. In combination with the "Sort-X", Scanmar catch indicators often perform poorly. One explanation may be that disturbed or reduced water flows in the codend do not pack or accumulate the caught fish with enough force to yield the usual bulbous codend shape needed to activate the Scanmar sensors and to open the meshes comprising the normal "escape zone" for fish in front of the accumulated catch (Pope *et al.* 1975; Robertson and Ferro 1988; Engås *et al.* 1988; Zaperman and Serebrov 1989; Isaksen and Valdemarsen 1994). In the Russian system, the guiding panel aft of the grid is made of small-meshed netting, and the water speed behind the net will also be reduced, but most probably not to the same extent as would be seen with a canvas panel.

The few hauls with the single-grid systems in the Norwegian two-panel Alfredo type trawl gave poor results, with a lot of small fish ending up in the codend. The 100% retention length for cod was also relativly small in these tows. These results have earlier been attributed by Norwegian experts to a large gap developing between the aft and lower part of the grid and the trawl's bottom panel, and thus failing to bring all fish into physical contact with the grid (Anon 1992). A smaller retention length is most probably due to an inadequate angle of the grid. These findings were not in accordance with the underwater observations, which showed a satisfactory physical

configuration for the single-grid system. The grid cover designed for use on the longer and more rigid "Sort-X" system has most probably negatively affected the grids configuration. Since time was short and single-grid system refinement was not among the objectives, no modifications were done to improve the performance of the single-grid system in the Norwegian trawl.

From the experience achieved through numerous experiments performed on different grid systems since 1989, it can be seen that three conditions must be satisfied to get a grid working properly in terms of size selection, a process partly dependent on behaviour and partly on mechanical separation:

I The grid(s) should at least cover half the trawl's circumference in the area in which it is installed.

II The grid must be held at a constant, critical angle of attack throughout the haul (dependent on species).

III The animals must be brought into physical contact with the grid.

In the "Sort-X", the fixed angle of attack is achieved by connecting the front frame to the aft one by chains, yielding a semi-rigid structure; in the single-grid system, by mounting the grid over a panel whose stretched length is shorter than the grid (similar to the installation of a "Nordmøre" grid). The fish are brought into contact with the grid by a guiding panel in front of the single-grid system, while the "Sort-X" uses the lower panel as guiding panel; i.e. the aft canvas-covered frame not only acts as a guiding panel for released fish but also as a depressor, pressing the grids downwards against the lower panel. Both the "Sort-X" and single-grid systems are mounted over the upper half of the extention piece.

The two systems tested during these experiments have both their benefits and drawbacks. From a management point of view, the "Sort-X" shows excellent performance regarding selectivity. From a practical point of view there are such disadvantages as heavy, long, rigid construction, exposed to damage if no precautions are taken, and relatively high expense. The single-grid system gave acceptable selectivity performance (in the Russian trawl), and is easier to handle on deck, is shorter, and is relatively inexpensive compared to the "Sort-X". The fixed guiding panel

in front of the single-grid system, however, give rize to a piling up of stone and sponge, which may negatively affect the selectivity performance of the single grid system. Release holes in front of the fixed guiding panel, as often used with "Nordmøre" grids, would prevent any accumulation of stone/sponge. A newly developed flexible guiding panel used with grids in Danish seines (Isaksen 1995) may also be an alternative to the fixed guiding panel.

In contrast to the "Nordmøre" grid, where any tampering with system installation or structure will result in poorer catches for the fisherman, nearly any changes in the two grid systems tested here will give a poorer selection result. Consequently, the minimum codend mesh size should not be less than 135 mm, at least when fishing for cod and haddock using the braided Norwegian polyamide codend material.

Grid sorting systems in bottom trawl have so far only been used on a voluntary basis, and no tampering with the systems has been reported. A compulsory use of grid systems may change this attitude.

## CONCLUSION

Grid sorting systems like those tested in this experiments gave high escapement of small fish. The use of such separating devices will doubtless benefit fish stocks, especially when used in areas and at times with high occurrence of fish below the minimum landing size, or small, low-value fish.

The systems tested during this experiment; the "Sort-X" in Norwegian two-panel trawl (Alfredo type) and the single-grid system in Russian trawl, demonstrated an overall equal selectivity performance when tested under conditions presenting normal commercial fishing practice.

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Table 1. The main characteristics of vessels and gears used during the joint selectivity experiments in the Barents Sea, 15-27 Sept 1995.

| Vessel name and data | "Bizon" | "Anny Kræmer" |
|---|---|---|
| Gross tonnage, Brt | 2332,94 | 477 |
| Net tonnage, Nrt | 940,02 | 176 |
| Engine (B.h.p.) | 2.400 | 2.400 |
| Length (m) | 83.12 | 50.75 |
| Width (m) | 13.84 | 10.3 |
| Depth (m) | 5.4 | 4.7 |
| Gear and rigging | Russian trawl | Norwegian trawl |
| Trawl size | 45.3/47.0 m bottom trawl | Euronette: Alfredo-3, 453# x 150 mm |
| Materiale | Polyamide (kapron) | Polyethylene (courlene) |
| Vertical opening (m) | 6.0-8.0 | 4.0 |
| Horizontal opening (m) | 26.5 | 27.0 |
| Towing speed (knots) | 3.5-4.0 | 3.5-4.0 |
| Otterboards | Oval, plan | V-shaped, rectangular |
| area ($m^2$) | 6.5 | 7.3 |
| weight (kg) | 1650 | 2150 |
| Total sweep length (m) | 80 | 146,6 (2 x 40 fathoms) |
| Extension piece | | |
| Material | Polyamide (kapron) | Polyamide (nylon) |
| Construction/thickness | Twisted/2 x 3.1 mm | Plaited/2 x 5.0 mm |
| Codend | | |
| Material | Polyamide (nylon) | Polyamide (nylon) |
| Construction/thickness | Plaited/2 x 7.0 mm | Plaited/2 x 7.0 mm |
| Mesh size (mm) | 136.5 (mean) | 136.5 (mean) |

Table 2a. Hauls made by "Anny Kræmer" during the joint selectivity experiment, 22-27 Sept 1995.

| Date | Haul no. | Start position | Start time* | Haul duration | Depth (m) | Catch (kg) | Research period |
|---|---|---|---|---|---|---|---|
| 220995 | 20 | 73°53'N 18°53'E | 0610 | 2 h 40 min | 190 | 3500 | II |
| | 21 | 73°53'N 17°48'E | 1055 | 3 h | 180 | 9000 | II |
| | 22 | 73°55'N 18°21'E | 2320 | 2 h | 190 | 750 | II |
| 230995 | 23 | 73°54'N 18°06'E | 0300 | 2 h | 205 | 1500 | II |
| | 24 | 73°49'N 17°54'E | 0550 | 2 h | 220 | 2300 | II |
| | 25 | 73°49'N 18°23'E | 0840 | 2 h | 255 | 4300 | II |
| | 26 | 73°42'N 17°59'E | 1130 | 2 h | 270 | 4500 | II |
| | 27 | 73°46'N 18°31'E | 1655 | 2 h | 270 | 384 | II |
| | 28 | 73°42'N 18°13'E | 1955 | 3 h | 280 | 840 | II |
| | 29 | 74°43'N 18°51'E | 2340 | 3 h | 280 | 560 | II |
| 240995 | 30 | 73°44'N 18°08'E | 0220 | 2 h 30 min | 280 | 700 | II |
| | 31 | 73°45'N 17°37'E | 0530 | 2 h | 260 | 1450 | II |
| | 32 | 74°02'N 19°27'E | 1130 | 1 h | 134 | 370 | II** |
| | 33 | 74°13'N 21°38'E | 1600 | 2 h | 220 | 1302 | IIIA |
| | 34 | 74°17'N 22°15'E | 1950 | 3 h | 180 | 1000 | III |
| | 35 | 74°22'N 21°29'E | 2345 | 3 h | 200 | 2150 | III |
| 250995 | 36 | 74°24'N 20°53'E | 0330 | 3 h 15 min | 180 | 4030 | III |
| | 37 | 74°16'N 21°31'E | 0910 | 3 h | 185 | 3472 | III |
| | 38 | 74°23'N 21°05'E | 1450 | 3 h | 170 | 1364 | IIIA |
| | 39 | 74°16'N 21°26'E | 1835 | 3 h | 175 | 1300 | III |
| | 40 | 74°21'N 20°30'E | 2250 | 3 h | 200 | 3350 | III |
| 260995 | 41 | 74°08'N 20°57'E | 0245 | 3 h | 210 | 3806 | IIIA |
| | 42 | 74°17'N 20°39'E | 0700 | 2h 30 min | 170 | 3500 | IV |
| | 43 | 74°10'N 20°47'E | 1015 | 3 h | 168 | 4836 | IV |
| | 44 | 74°17'N 20°36'E | 1445 | 3 h | 170 | 8600 | IV |
| | 45 | 74°07'N 20°49'E | 1930 | 3 h | 170 | 2790 | IV |
| | 46 | 74°17'N 20°22'E | 2335 | 3 h | 130 | 3596 | IV |
| 250995 | 47 | 74°07'N 20°50'E | 0345 | 3 h | 160 | 2300 | IV |

* Norwegian time, ** Excluded from comparison

Table 2b. Hauls made by "Bizon" during the joint selectivity experiment, 22-27 Sept 1995.

| Date | Haul no. | Start position | Start time* | Haul duration | Depth (m) | Catch (kg) | Research period |
|---|---|---|---|---|---|---|---|
| 220995 | 1 | 73°56'N 18°29'E | 1100 | 3 h | 195 | 2950 | II |
| | 2 | 73°52'N 18°29'E | 1830 | 3 h | 230 | 2800 | II |
| | 3 | 73°50'N 17°56'E | 2220 | 3 h 30 min | 225 | 1800 | II** |
| 230995 | 4 | 73°48'N 18°46'E | 0420 | 3 h | 245 | 1700 | II |
| | 5 | 73°44'N 18°02'E | 0900 | 3 h 30 min | 240 | 4300 | II |
| | 6 | 73°47'N 18°53'E | 1430 | 3 h | 240 | 1200 | II |
| | 7 | 73°43'N 18°03'E | 1920 | 3 h | 270 | 700 | II |
| | 8 | 73°47'N 18°49'E | 2350 | 2 h 10 min | 275 | 510 | II |
| 240995 | 9 | 73°43'N 1758'E | 0350 | 3 h | 280 | 650 | II |
| | 10 | 74°23'N 24°40'E | 1610 | 2 h | 260 | 690 | III |
| | 11 | 74°17'N 22°12'E | 2000 | 3 h | 240 | 1100 | III |
| 250995 | 12 | 74°17'N 21°23'E | 0020 | 3 h | 150 | 1200 | III |
| | 13 | 74°15'N 20°51'E | 0450 | 3 h | 190 | 2200 | III |
| | 14 | 74°15'N 21°27'E | 0920 | 3 h | 180 | 2050 | III |
| | 15 | 74°16'N 20°54'E | 1340 | 3 h | 180 | 850 | III |
| | 16 | 74°11'N 21°24'E | 1800 | 3 h | 175 | 1010 | III** |
| | 17 | 74°15'N 20°54'E | 2300 | 3 h | 195 | 2210 | III |
| 260995 | 18 | 74°04'N 21°18'E | 0430 | 3 h | 180 | 2100 | III |
| | 19 | 74°09'N 20°48'E | 1020 | 3 h | 160 | 1500 | IV |
| | 20 | 74°18'N 21°12'E | 1440 | 3 h | 180 | 1150 | IV |
| | 21 | 74°07'N 20°50'E | 1910 | 3 h | 190 | 2000 | IV |
| | 22 | 74°12'N 20°26'E | 2330 | 3 h | 130 | 2150 | IV |
| 270995 | 23 | 74°03'N 20°50'E | 0410 | 3 h | 150 | 1500 | IV |

* Converted to Norwegian time, ** Excluded from comparison

Table 3a. Pooled selectivity data for "Bizon", 22.-24.09.95. Hauls no. 1-9 (no. 3 excluded). Research period II. (Cover and codends with blinder.) Single-grid sorting system ("Sort-V").

| Length | Nos. in codend | Nos. in cover | % retained | 3-point moving average |
|---|---|---|---|---|
| 14.0 | 0. | 11. | 0. | 0. |
| 16.0 | 0. | 230. | 0. | 0. |
| 18.0 | 0. | 876. | 0. | 0. |
| 20.0 | 0. | 674. | 0. | 0. |
| 22.0 | 0. | 233. | 0. | 0. |
| 24.0 | 0. | 129. | 0. | 1. |
| 26.0 | 3. | 154. | 2. | 2. |
| 28.0 | 10. | 207. | 5. | 4. |
| 30.0 | 9. | 143. | 6. | 9. |
| 32.0 | 19. | 107. | 15. | 15. |
| 34.0 | 35. | 113. | 24. | 19. |
| 36.0 | 20. | 87. | 19. | 21. |
| 38.0 | 34. | 123. | 22. | 24. |
| 40.0 | 63. | 134. | 32. | 27. |
| 42.0 | 74. | 187. | 28. | 31. |
| 44.0 | 123. | 258. | 32. | 33. |
| 46.0 | 111. | 182. | 38. | 39. |
| 48.0 | 179. | 212. | 46. | 44. |
| 50.0 | 145. | 152. | 49. | 53. |
| 52.0 | 170. | 95. | 64. | 64. |
| 54.0 | 319. | 85. | 79. | 77. |
| 56.0 | 295. | 46. | 87. | 87. |
| 58.0 | 708. | 43. | 94. | 93. |
| 60.0 | 749. | 25. | 97. | 97. |
| 62.0 | 750. | 4. | 99. | 99. |
| 64.0 | 754. | 4. | 99. | 100. |
| 66.0 | 482. | 0. | 100. | 100. |
| 68.0 | 501. | 0. | 100. | 100. |
| 70.0 | 294. | 0. | 100. | 100. |
| 72.0 | 185. | 0. | 100. | 100. |
| 74.0 | 158. | 0. | 100. | 100. |
| 76.0 | 120. | 0. | 100. | 100. |
| 78.0 | 124. | 0. | 100. | 100. |
| 80.0 | 73. | 0. | 100. | 100. |
| 82.0 | 37. | 0. | 100. | 100. |
| 84.0 | 12. | 0. | 100. | 100. |
| 86.0 | 10. | 0. | 100. | 100. |
| 88.0 | 14. | 0. | 100. | 100. |
| 90.0 | 6. | 0. | 100. | 100. |
| 92.0 | 12. | 0. | 100. | 100. |
| 94.0 | 5. | 0. | 100. | 100. |
| 96.0 | 2. | 0. | 100. | 100. |
| 98.0 | 14. | 0. | 100. | 100. |
| 100.0 | 1. | 0. | 100. | 100. |
| 108.0 | 1. | 0. | 100. | 100. |
| 110.0 | 1. | 0. | 100. | 100. |
| 118.0 | 1. | 0. | 100. | 100. |

Escape of fish with the length of less than: 42 cm - 94%; 47 cm - 88%

Table 3b. Pooled selectivity data for "Bizon", 24.-26.09.95. Hauls no. 10-18 (no. 16 excluded). Research period III. (Cover and codend with blinder.) Single-grid sorting system ("Sort-V").

| Length | Nos. in codend | Nos. in cover | % retained | 3-point moving average |
|---|---|---|---|---|
| 16.0 | 0. | 59. | 0 | 0. |
| 18.0 | 0. | 419. | 0 | 0. |
| 20.0 | 0. | 336. | 0 | 0. |
| 22.0 | 2. | 197. | 1 | 2. |
| 24.0 | 10. | 220. | 4 | 3. |
| 26.0 | 9. | 303. | 3 | 4. |
| 28.0 | 30. | 466. | 6 | 6. |
| 30.0 | 55. | 472. | 10 | 10. |
| 32.0 | 84. | 534. | 14 | 14. |
| 34.0 | 102. | 459. | 18 | 17. |
| 36.0 | 86. | 361. | 19 | 22. |
| 38.0 | 147. | 354. | 29 | 26. |
| 40.0 | 142. | 344. | 29 | 31. |
| 42.0 | 127. | 258. | 33 | 32. |
| 44.0 | 132. | 258. | 34 | 33. |
| 46.0 | 97. | 202. | 32 | 36. |
| 48.0 | 127. | 178. | 42 | 42. |
| 50.0 | 146. | 139. | 51 | 52. |
| 52.0 | 151. | 86. | 64 | 65. |
| 54.0 | 218. | 63. | 80 | 77. |
| 56.0 | 317. | 48. | 87 | 87. |
| 58.0 | 671. | 36. | 95 | 93. |
| 60.0 | 683. | 18. | 97 | 97. |
| 62.0 | 535. | 5. | 99 | 99. |
| 64.0 | 597. | 4. | 99 | 99. |
| 66.0 | 403. | 0. | 100 | 100. |
| 68.0 | 400. | 0. | 100 | 100. |
| 70.0 | 276. | 0. | 100 | 100. |
| 72.0 | 131. | 0. | 100 | 100. |
| 74.0 | 151. | 0. | 100 | 100. |
| 76.0 | 112. | 0. | 100 | 100. |
| 78.0 | 100. | 0. | 100 | 100. |
| 80.0 | 79. | 0. | 100 | 100. |
| 82.0 | 31. | 0. | 100 | 100. |
| 84.0 | 27. | 0. | 100 | 100. |
| 86.0 | 11. | 0. | 100 | 100. |
| 88.0 | 12. | 0. | 100 | 100. |
| 90.0 | 6. | 0. | 100 | 100. |
| 92.0 | 8. | 0. | 100 | 100. |
| 94.0 | 2. | 0. | 100 | 100. |
| 96.0 | 6. | 0. | 100 | 100. |
| 98.0 | 1. | 0. | 100 | 100. |
| 108.0 | 1. | 0. | 100 | 100. |

Escape of fish with the length of less than: 42 cm - 86%; 47 cm - 84%

Table 3c. Pooled selectivity data for "Anny Kræmer", 22.-24.09.95. Hauls no. 20-31. Research period II. (Cover and codend with blinder.) Grid system: "Sort-X".

| Length | Nos. in codend | Nos. in cover | % retained | 3-point moving average |
|---|---|---|---|---|
| 10.0 | 0. | 6. | 0. | 0. |
| 12.0 | 0. | 13. | 0. | 0. |
| 14.0 | 0. | 92. | 0. | 1. |
| 16.0 | 11. | 614. | 2. | 1. |
| 18.0 | 12. | 1143. | 1. | 1. |
| 20.0 | 6. | 723. | 1. | 2. |
| 22.0 | 7. | 182. | 4. | 2. |
| 24.0 | 5. | 188. | 3. | 4. |
| 26.0 | 16. | 260. | 6. | 7. |
| 28.0 | 25. | 198. | 11. | 9. |
| 30.0 | 21. | 187. | 10. | 12. |
| 32.0 | 29. | 168. | 15. | 11. |
| 34.0 | 13. | 139. | 9. | 12. |
| 36.0 | 24. | 164. | 13. | 14. |
| 38.0 | 49. | 198. | 20. | 19. |
| 40.0 | 103. | 326. | 24. | 21. |
| 42.0 | 104. | 461. | 18. | 22. |
| 44.0 | 173. | 534. | 24. | 24. |
| 46.0 | 198. | 457. | 30. | 30. |
| 48.0 | 186. | 352. | 35. | 37. |
| 50.0 | 258. | 313. | 45. | 47. |
| 52.0 | 342. | 205. | 63. | 59. |
| 54.0 | 451. | 192. | 70. | 71. |
| 56.0 | 770. | 188. | 80. | 80. |
| 58.0 | 1286. | 160. | 89. | 87. |
| 60.0 | 1764. | 135. | 93. | 92. |
| 62.0 | 2058. | 95. | 96. | 95. |
| 64.0 | 1934. | 42. | 98. | 97. |
| 66.0 | 1361. | 25. | 98. | 99. |
| 68.0 | 1348. | 6. | 100. | 99. |
| 70.0 | 783. | 7. | 99. | 99. |
| 72.0 | 559. | 2. | 100. | 100. |
| 74.0 | 534. | 0. | 100. | 100. |
| 76.0 | 381. | 2. | 99. | 100. |
| 78.0 | 287. | 0. | 100. | 100. |
| 80.0 | 185. | 0. | 100. | 100. |
| 82.0 | 137. | 0. | 100. | 100. |
| 84.0 | 62. | 0. | 100. | 100. |
| 86.0 | 61. | 0. | 100. | 100. |
| 88.0 | 26. | 0. | 100. | 100. |
| 90.0 | 25. | 0. | 100. | 100. |
| 92.0 | 14. | 0. | 100. | 100. |
| 94.0 | 36. | 0. | 100. | 100. |
| 96.0 | 9. | 0. | 100. | 100. |
| 100.0 | 4. | 0. | 100. | 100. |
| 102.0 | 12. | 0. | 100. | 100. |
| 104.0 | 7. | 0. | 100. | 100. |
| 106.0 | 7. | 0. | 100. | 100. |
| 108.0 | 7. | 0. | 100. | 100. |
| 110.0 | 3. | 0. | 100. | 100. |
| 112.0 | 2. | 0. | 100. | 100. |
| 114.0 | 1. | 0. | 100. | 100. |
| 120.0 | 2. | 0. | 100. | 100. |

Escape of fish with the length of less than: 42 cm - 93%; 47 cm - 88%

Table 3d. Pooled selectivity data for "Anny Kræmer", 24.-26.09.95. Hauls no. 34-37 and 39-40. Research period III. (Cover and codend with blinder.) Norwegian single-grid system.

| Length | Nos. in codend | Nos. in cover | % retained | 3-point moving aerage |
|---|---|---|---|---|
| 10.0 | 4. | 1. | 80. | 0. |
| 12.0 | 4. | 1. | 80. | 53. |
| 14.0 | 0. | 4. | 0. | 41. |
| 16.0 | 28. | 39. | 42. | 26. |
| 18.0 | 60. | 102. | 37. | 34. |
| 20.0 | 22. | 75. | 23. | 31. |
| 22.0 | 40. | 77. | 34. | 32. |
| 24.0 | 97. | 153. | 59. | 39. |
| 26.0 | 192. | 233. | 45. | 44. |
| 28.0 | 279. | 320. | 47. | 48. |
| 30.0 | 425. | 409. | 51. | 50. |
| 32.0 | 398. | 375. | 51. | 53. |
| 34.0 | 459. | 333. | 58. | 57. |
| 36.0 | 335. | 212. | 61. | 61. |
| 38.0 | 414. | 236. | 64. | 63. |
| 40.0 | 433. | 228. | 66. | 65. |
| 42.0 | 393. | 196. | 67. | 67. |
| 44.0 | 319. | 150. | 62. | 67. |
| 46.0 | 192. | 104. | 65. | 69. |
| 48.0 | 226. | 77. | 75. | 75. |
| 50.0 | 229. | 41. | 85. | 83. |
| 52.0 | 279. | 33. | 89. | 90. |
| 54.0 | 302. | 16. | 95. | 94. |
| 56.0 | 456. | 11. | 98. | 97. |
| 58.0 | 629. | 6. | 99. | 99. |
| 60.0 | 783. | 2. | 100. | 100. |
| 62.0 | 942. | 2. | 100. | 100. |
| 64.0 | 801. | 1. | 100. | 100. |
| 66.0 | 571. | 0. | 100. | 100. |
| 68.0 | 539. | 0. | 100. | 100. |
| 70.0 | 324. | 0. | 100. | 100. |
| 72.0 | 224. | 0. | 100. | 100. |
| 74.0 | 179. | 0. | 100. | 100. |
| 76.0 | 164. | 0. | 100. | 100. |
| 78.0 | 150. | 0. | 100. | 100. |
| 80.0 | 110. | 0. | 100. | 100. |
| 82.0 | 91. | 0. | 100. | 100. |
| 84.0 | 62. | 0. | 100. | 100. |
| 86.0 | 36. | 0. | 100. | 100. |
| 88.0 | 22. | 0. | 100. | 100. |
| 90.0 | 3. | 0. | 100. | 100. |
| 94.0 | 5. | 0. | 100. | 100. |
| 96.0 | 2. | 0. | 100. | 100. |
| 98.0 | 5. | 0. | 100. | 100. |
| 100.0 | 3. | 0. | 100. | 100. |
| 102.0 | 5. | 0. | 100. | 100. |
| 108.0 | 3. | 0. | 100. | 100. |
| 110.0 | 3. | 0. | 100. | 100. |
| 118.0 | 1. | 0. | 100. | 100. |

Escape of fish with the length of less than: 42 cm - 46%; 47 cm - 44%

Table 3e. Pooled selectivity data for "Anny Kræmer", 24.-26.09.95. Hauls no. 33, 38, 41 (additional hauls with "Sort-X"). Research period IIIA.

| Length | Nos. in codend | Nos. in cover | % retained | 3-point moving average |
|---|---|---|---|---|
| 10.0 | 0. | 3. | 0. | 0 |
| 12.0 | 0. | 5. | 0. | 0 |
| 14.0 | 0. | 31. | 0. | 0 |
| 16.0 | 0. | 182. | 0. | 0 |
| 18.0 | 4. | 399. | 1. | 1 |
| 20.0 | 2. | 183. | 1. | 1 |
| 22.0 | 0. | 54. | 0. | 0 |
| 24.0 | 0. | 112. | 0. | 1 |
| 26.0 | 3. | 129. | 2. | 2 |
| 28.0 | 3. | 126. | 2. | 2 |
| 30.0 | 5. | 184. | 3. | 2 |
| 32.0 | 5. | 211. | 2. | 3 |
| 34.0 | 11. | 213. | 5. | 4 |
| 36.0 | 11. | 172. | 6. | 6 |
| 38.0 | 15. | 176. | 8. | 8 |
| 40.0 | 17. | 154. | 10. | 10 |
| 42.0 | 22. | 182. | 11. | 14 |
| 44.0 | 41. | 152. | 21. | 20 |
| 46.0 | 45. | 122. | 27. | 25 |
| 48.0 | 44. | 115. | 28. | 35 |
| 50.0 | 64. | 65. | 50. | 47 |
| 52.0 | 80. | 48. | 63. | 58 |
| 54.0 | 112. | 67. | 63. | 68 |
| 56.0 | 168. | 48. | 78. | 76 |
| 58.0 | 276. | 38. | 22. | 87 |
| 60.0 | 312. | 19. | 94. | 93 |
| 62.0 | 350. | 16. | 96. | 95 |
| 64.0 | 350. | 17. | 95. | 97 |
| 66.0 | 280. | 4. | 99. | 98 |
| 68.0 | 246. | 3. | 99. | 99 |
| 70.0 | 161. | 2. | 99. | 99 |
| 72.0 | 121. | 0. | 100. | 99 |
| 74.0 | 71. | 1. | 99. | 100 |
| 76.0 | 55. | 0. | 100. | 100 |
| 78.0 | 60. | 0. | 100. | 100 |
| 80.0 | 27. | 0. | 100. | 100 |
| 82.0 | 34. | 0. | 100. | 100 |
| 84.0 | 20. | 0. | 100. | 100 |
| 86.0 | 12. | 0. | 100. | 100 |
| 88.0 | 9. | 0. | 100. | 100 |
| 90.0 | 10. | 0. | 100. | 100 |
| 92.0 | 3. | 0. | 100. | 100 |
| 96.0 | 3. | 0. | 100. | 100 |
| 98.0 | 2. | 0. | 100. | 100 |
| 102.0 | 2. | 0. | 100. | 100 |
| 104.0 | 4. | 0. | 100. | 100 |
| 106.0 | 4. | 0. | 100. | 100 |
| 108.0 | 1. | 0. | 100. | 100 |

Escape of fish with the length of less than: 42 cm - 96%; 47 cm - 94%

Table 3f. Pooled selectivity data from experiments without cover and blinder during research period IV (= commercial fishing practice with grid system installed).

| Length | "Anny Kræmer" | | "Bizon" | |
|---|---|---|---|---|
| | Nos. | % | Nos. | % |
| 26.0 | 9. | + | 0. | 0 |
| 28.0 | 0. | 0 | 0. | 0 |
| 30.0 | 0. | 0 | 0. | 0 |
| 32.0 | 13. | 0.1 | 2. | + |
| 34.0 | 26. | 0.2 | 2. | + |
| 36.0 | 12. | 0.1 | 4. | 0.1 |
| 38.0 | 96. | 0.7 | 14. | 0.3 |
| 40.0 | 150. | 1.1 | 30. | 0.7 |
| 42.0 | 123. | 0.9 | 30. | 0.7 |
| 44.0 | 192. | 1.3 | 29. | 0.6 |
| 46.0 | 214. | 1.5 | 36. | 0.8 |
| 48.0 | 238. | 1.7 | 96. | 2.1 |
| 50.0 | 351. | 2.5 | 112. | 2.4 |
| 52.0 | 519. | 3.6 | 143. | 3.1 |
| 54.0 | 500. | 3.5 | 204. | 4.4 |
| 56.0 | 887. | 6.2 | 329. | 7.2 |
| 58.0 | 1475. | 10.3 | 639. | 13.9 |
| 60.0 | 1681. | 11.8 | 630. | 13.7 |
| 62.0 | 1907. | 13.4 | 493. | 10.7 |
| 64.0 | 1506. | 10.6 | 509. | 11.1 |
| 66.0 | 1393. | 9.8 | 316. | 6.9 |
| 68.0 | 868. | 6.1 | 278. | 6.1 |
| 70.0 | 481. | 3.4 | 185. | 4.1 |
| 72.0 | 395. | 2.8 | 127. | 2.8 |
| 74.0 | 297. | 2.1 | 73. | 1.6 |
| 76.0 | 291. | 2.0 | 87. | 1.9 |
| 78.0 | 212. | 1.5 | 72. | 1.6 |
| 80.0 | 125. | 0.9 | 50. | 1.1 |
| 82.0 | 81. | 0.6 | 30. | 0.7 |
| 84.0 | 42. | 0.4 | 24. | 0.5 |
| 86.0 | 67. | 0.5 | 71. | 0.4 |
| 88.0 | 23. | 0.2 | 11. | 0.2 |
| 90.0 | 19. | 0.1 | 1. | + |
| 92.0 | 10. | 0.1 | 4. | + |
| 94.0 | 2. | + | 2. | + |
| 96.0 | 0. | 0 | 0. | 0 |
| 98.0 | 0. | 0 | 2. | + |
| 100.0 | 4. | + | 2. | + |
| 102.0 | 9. | 0.1 | 0. | 0 |
| 104.0 | 10. | 0.1 | 0. | 0 |
| 106.0 | 2. | + | 0. | 0 |
| 108.0 | 3. | + | 1. | + |
| 110.0 | 5. | + | 3. | + |
| 112.0 | 18. | 0.1 | 2. | + |
| 114.0 | 5. | + | 0. | 0 |
| 116.0 | 3. | + | 0. | 0 |
| 118.0 | 0. | 0 | 2. | + |

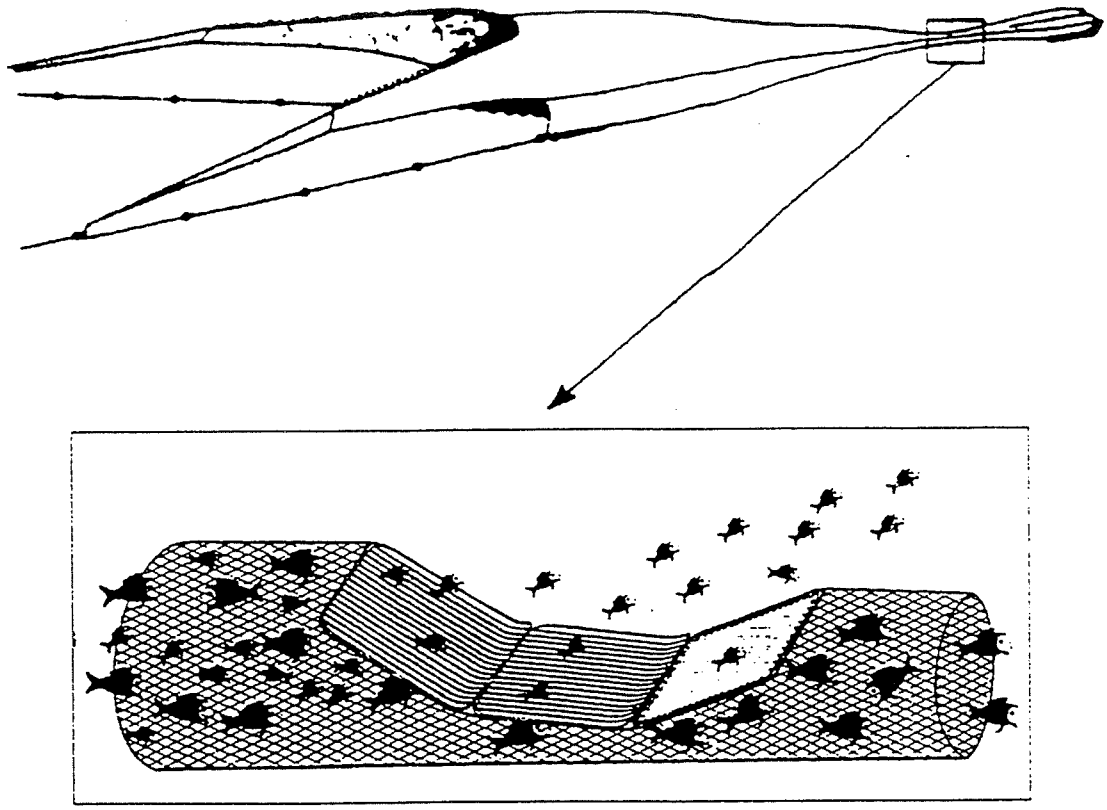


Figure 1. Illustration of the location and working principle of the sorting grid system "Sort-X" in a bottom trawl.

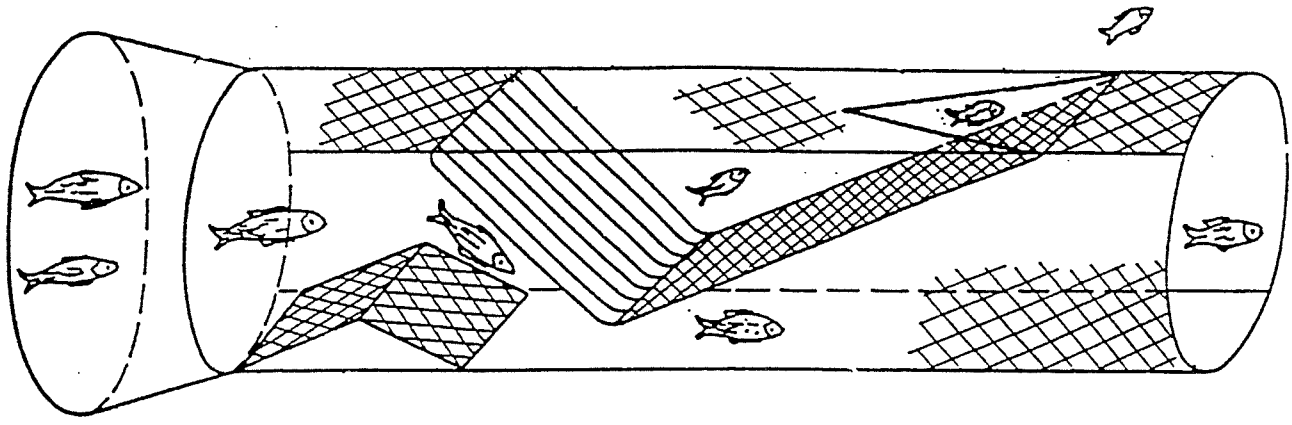


Figure 2. Illustration of the working principle of the single-grid system ("Sort-V", PINRO construction) in a bottom trawl.

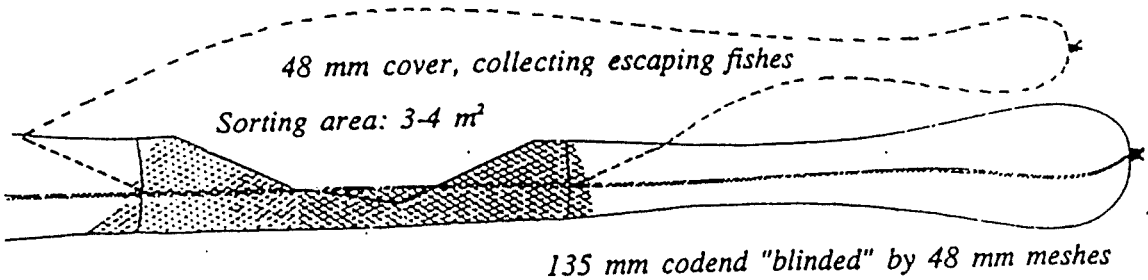



Figure 3. Illustration of cover used to collect fish that have escaped through the "Sort-X" grid-sorting system.

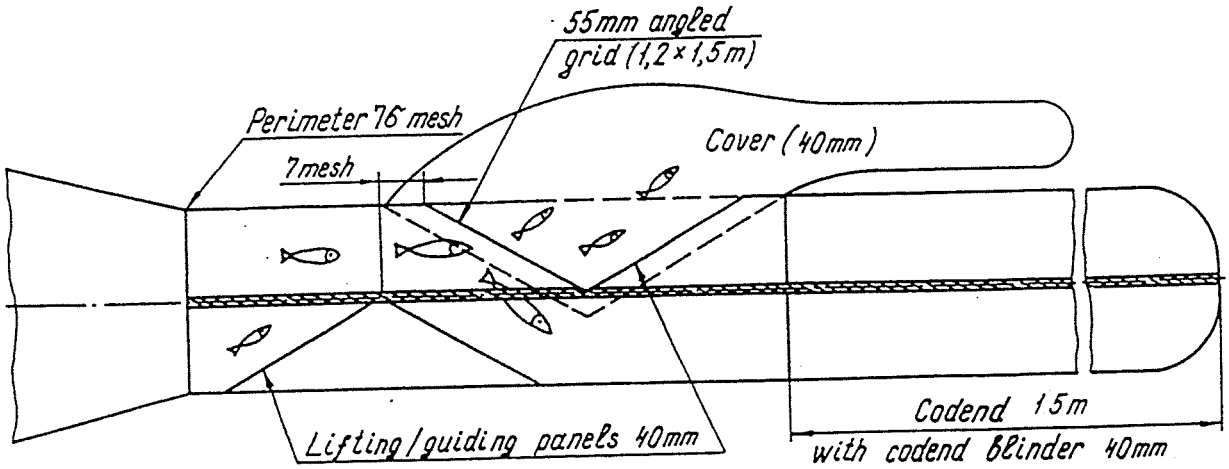



Figure 4. Illustration of cover used to collect fish that have escaped through the "Sort-V" single-grid sorting system.

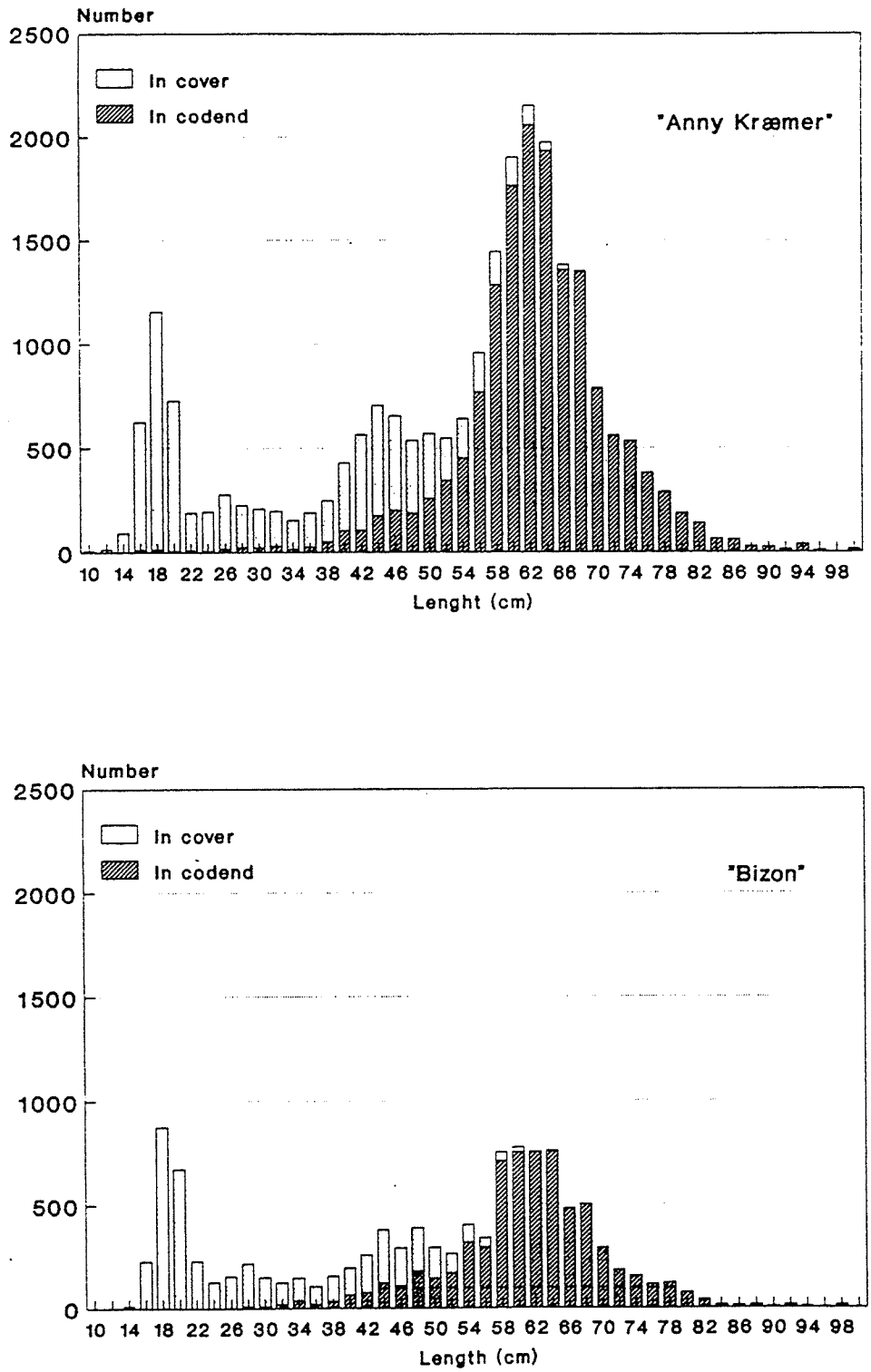



Figure 5. Length distribution of cod caught during comparative fishing period II, 22-24 Sept 1995, south of Bear Island.

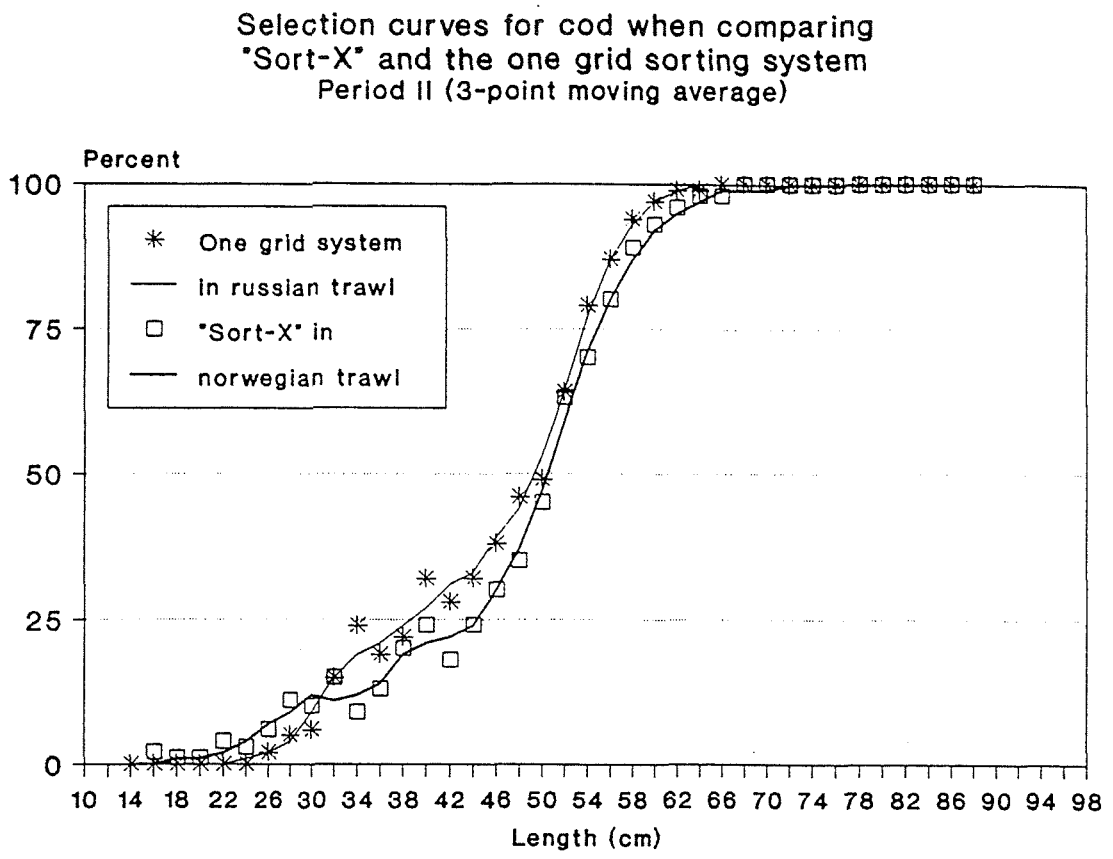



Figure 6. Selection curves for cod when using the "Sort-X" system in Norwegian trawl (Alfredo type) and the single-grid system in the Russian trawl.

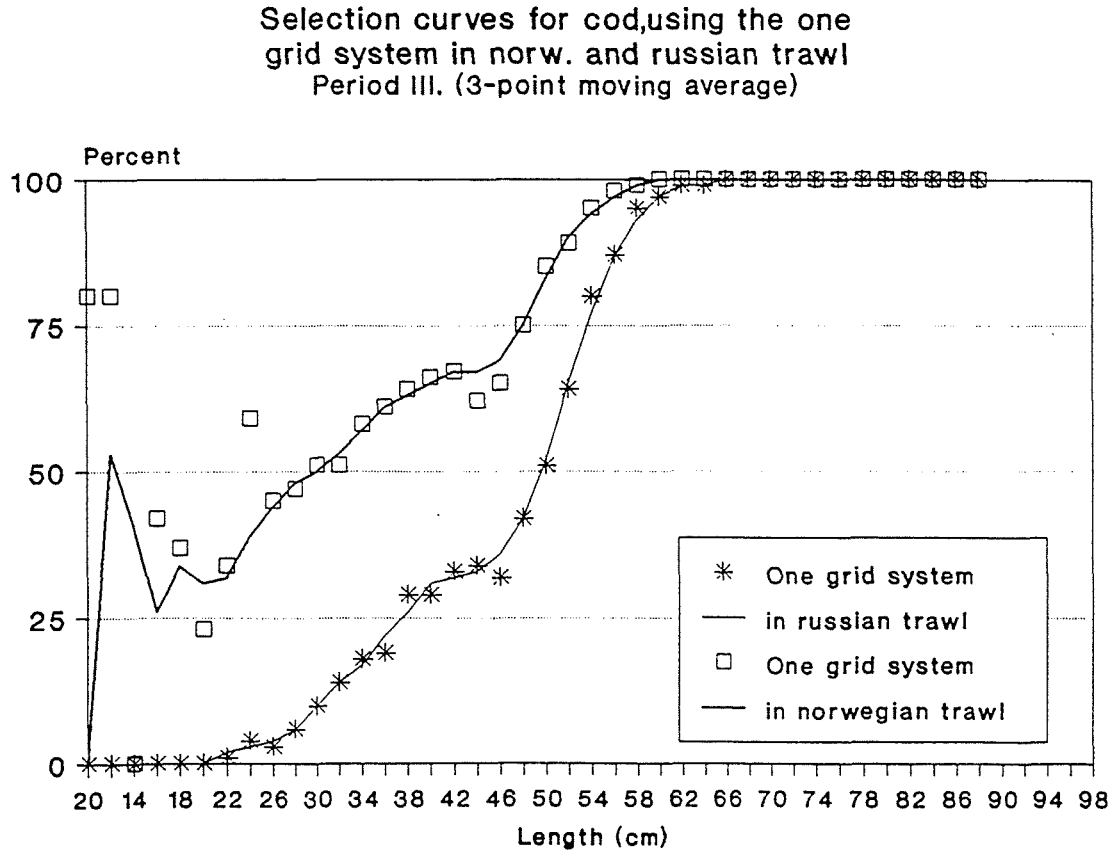



Figure 7. Selection curves for cod when using the one-grid sorting system in both the Norwegian and the Russian types of trawl.

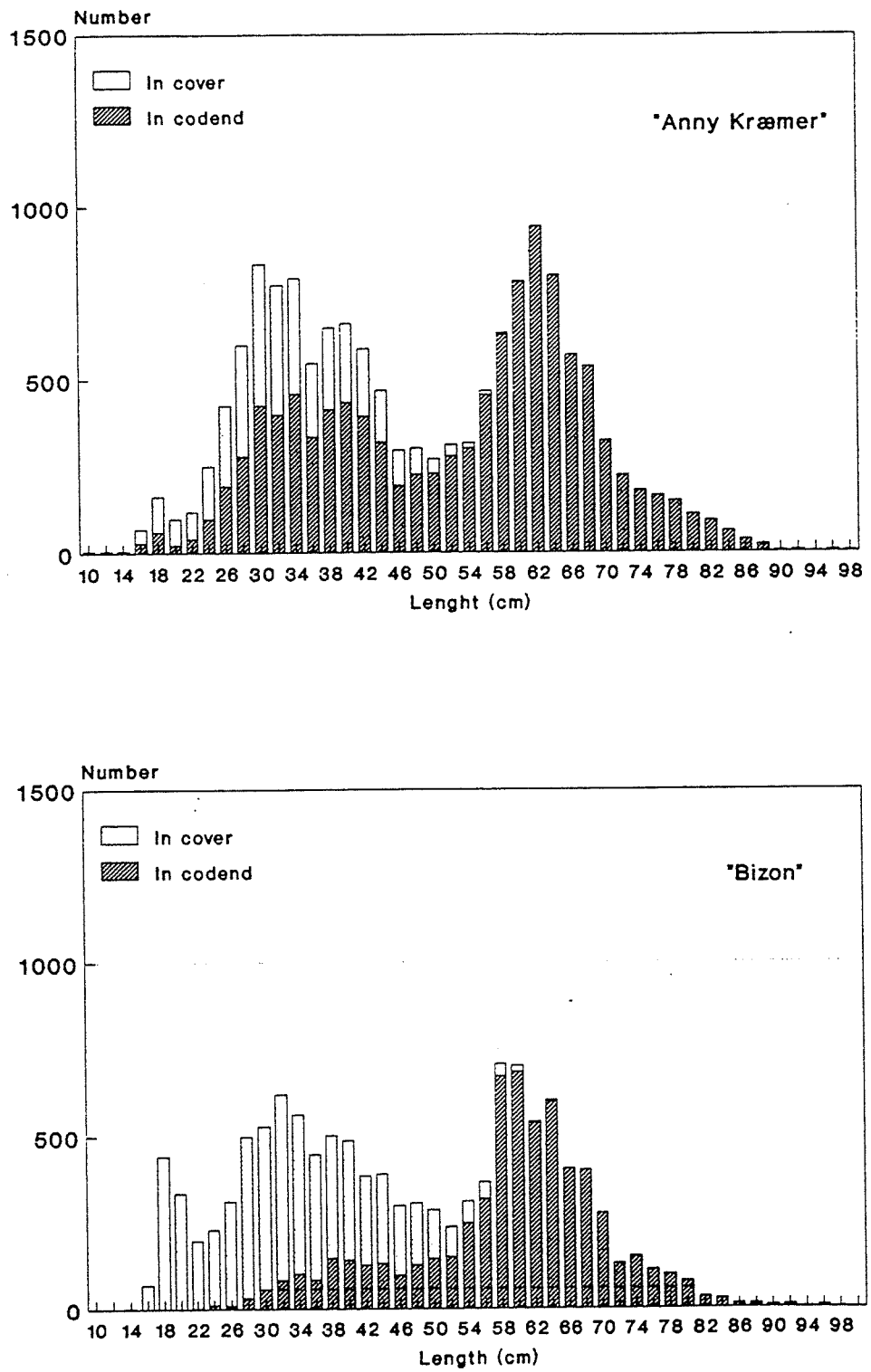



Figure 8. Length distribution of cod caught during comparative fishing period III, 24-26 Sept 1995, east of Bear Island (single-grid sorting system in both Norwegian and Russian trawls).

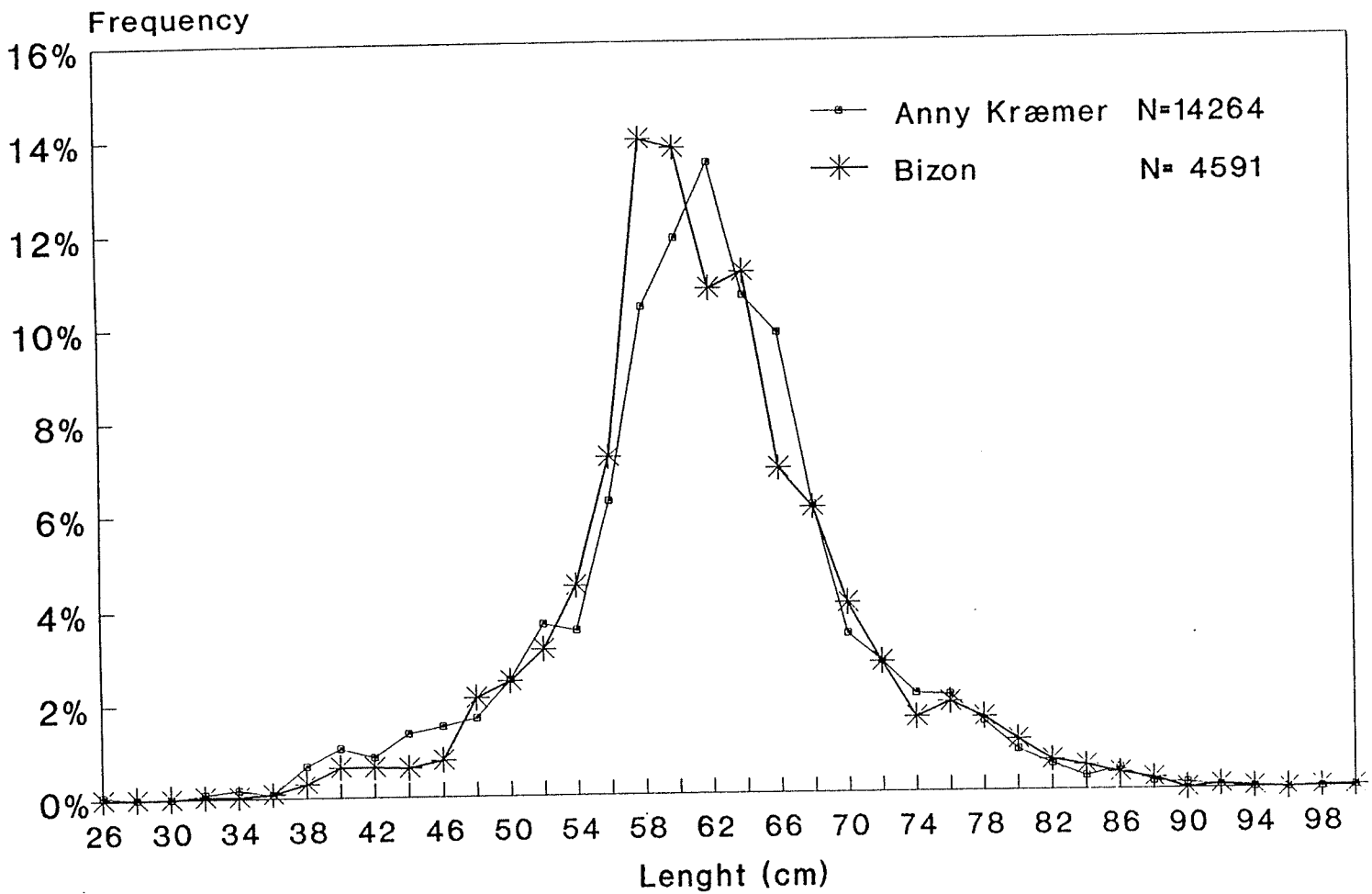



Figure 9. Length frequency distribution of cod caught during comparative fishing period IV. "Anny Kræmer" with "Sort-X", inter-bar distance 55 mm and codend mesh size 137 mm, "Bizon" with single-grid system, inter-bar distance 55 mm and codend mesh size 137 mm.

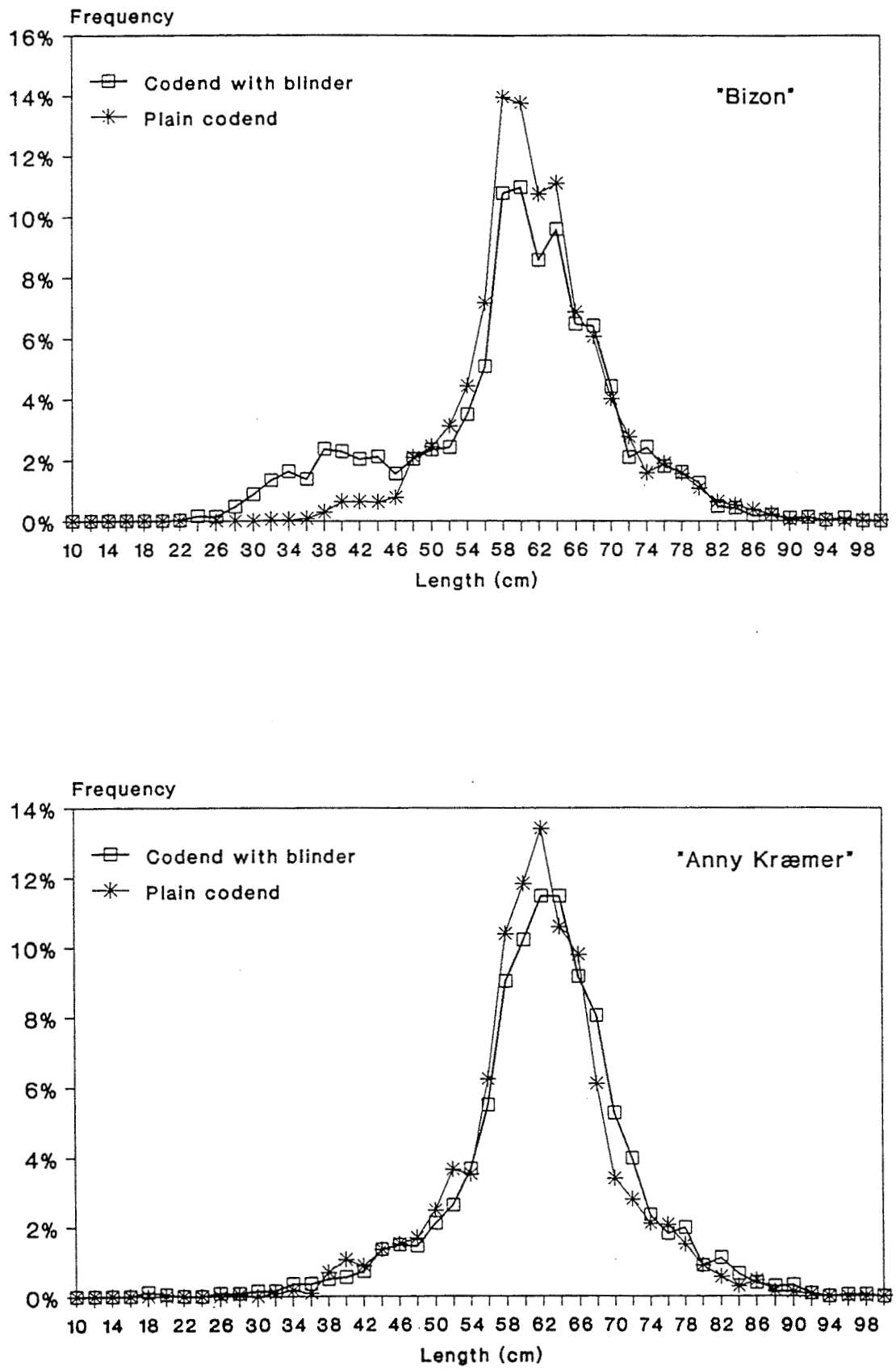



Figure 10. Length frequency distribution of cod when fishing with 55 mm inter-bar distance and codend with or without blinder. ("Anny Kræmer" with "Sort-X" and 52 mm codend blinder or plain 137 mm codend, "Bizon" with single-grid sorting system and 60 mm codend blinder or plain 137 mm codend, both boats with Norwegian type codend material, see Table 1).

APPENDIX 1

# ANALYSE REPORT FOR HAULS MADE BY "ANNY KRÆMER" DURING FISHING PERIOD II (*CC-SELECTIVITY*)

## HAUL INFORMATION

Date : 10/17/95 Reg. No : Hauls 20-31
Vessel : Anny-Kræmer Fishery Ground : Bear Island
Gear : Euronette

Name : B.Isaksen
Institute : IMR, Bergen,Norway

Experimental Type : Covered Codend

| FILES : | NAME | RESULT |
|---|---|---|
| | NRTO20.SEL | [1] |
| | NRTO21.SEL | [1] |
| | NRTO22.SEL | [1] |
| | NRTO23.SEL | [1] |
| | NRTO24.SEL | [1] |
| | NRTO25.SEL | [1] |
| | NRTO26.SEL | [1] |
| | NRTO27.SEL | [1] |
| | NRTO28.SEL | [1] |
| | NRTO29.SEL | [1] |
| | NRTO30.SEL | [1] |
| | NRTO31.SEL | [1] |

## ANALYSIS REPORT VARIANCE COMPONENT MODEL

ANALYSIS METHOD : MLE

LINK FUNCTION : LOGIT

Parameters

| | |
|---|---|
| Intercept | -10.25642 |
| Slope | 0.20527 |

Variance of Parameters

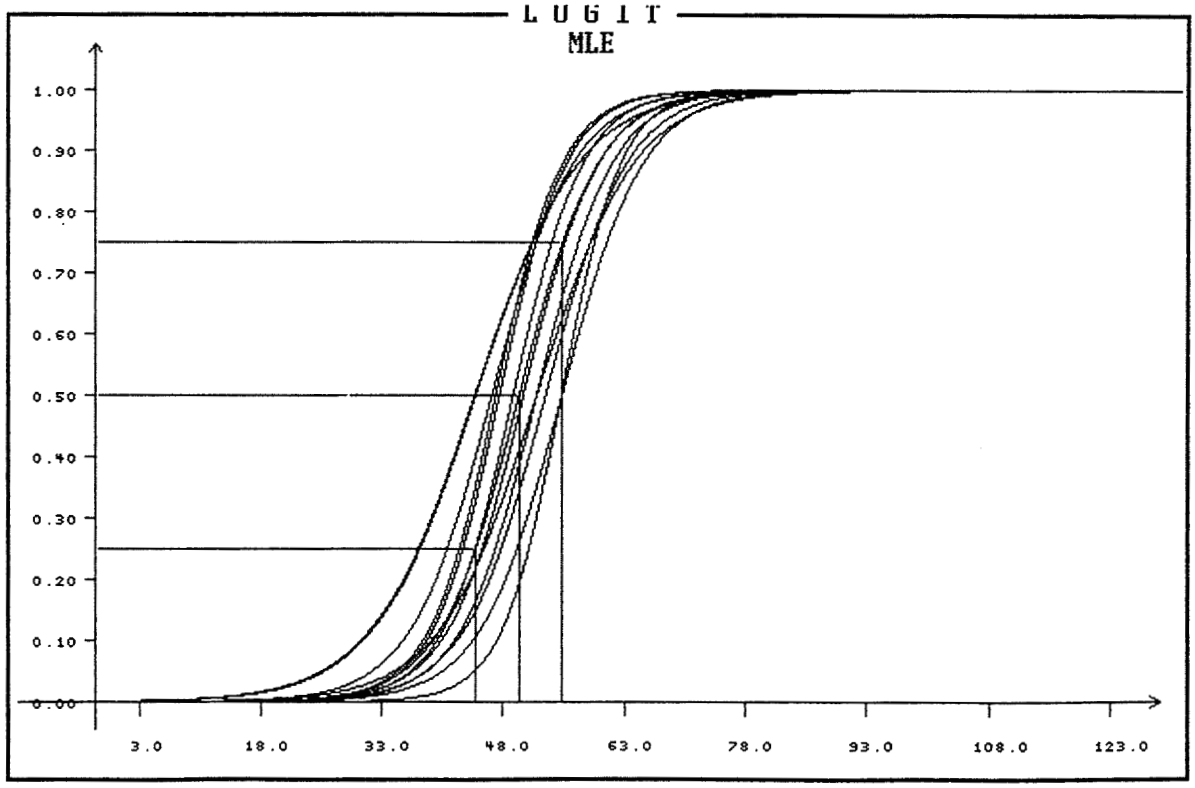
$$\begin{bmatrix} 0.34993 & -0.00549 \\ -0.00549 & 0.00010 \end{bmatrix}$$

Variance Component

$$\begin{bmatrix} 3.52629 & -0.05368 \\ -0.05368 & 0.00094 \end{bmatrix}$$

Calibration-points with 95.000 % confidence limits

| | | | | |
|---|---|---|---|---|
| L-25% | 44.613 | 38.688 | - | 50.325 |
| L-50% | 49.964 | 47.890 | - | 51.923 |
| L-75% | 55.316 | 49.597 | - | 61.016 |
| SR | 10.704 | 9.696 | - | 11.711 |



APPENDIX II

# ANALYSE REPORT FOR HAULS MADE BY "BIZON" DURING FISHING PERIOD II (*CC-SELECTIVITY*)

## HAUL INFORMATION

Date : 10/17/95
Reg. No : Haul 1-9 (ex3)
Vessel : Bizon
Fishery Ground : Bear Island
Gear : 45.3/47.0

Name : S.Lisovsky
Institute : PINRO

Experimental Type : Covered Codend

| FILES : | NAME | RESULT |
|---|---|---|
| | T1.SEL | 1___ |
| | T2.SEL | 1___ |
| | T4.SEL | 1___ |
| | T5.SEL | 1___ |
| | T6.SEL | 1___ |
| | T7.SEL | 1___ |
| | T8.SEL | 1___ |
| | T9.SEL | 1___ |

## ANALYSIS REPORT
## VARIANCE COMPONENT MODEL

ANALYSIS METHOD : MLE

LINK FUNCTION : LOGIT

Parameters

| | |
|---|---|
| Intercept | -9.76675 |
| Slope | 0.21178 |

Variance of Parameters

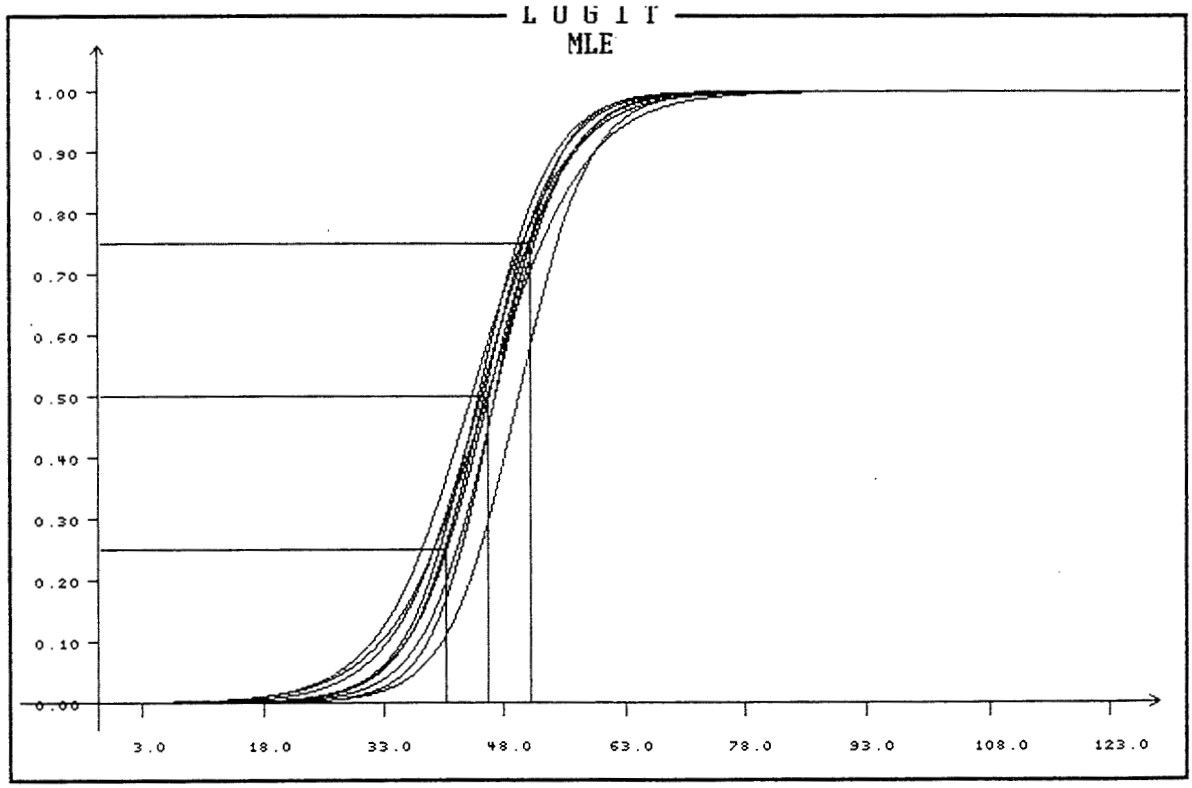
$$\begin{bmatrix} 0.32472 & -0.00619 \\ -0.00619 & 0.00012 \end{bmatrix}$$

Variance Component

$$\begin{bmatrix} 2.12023 & -0.04000 \\ -0.04000 & 0.00078 \end{bmatrix}$$

Calibration-points with 95.000 % confidence limits

| | | | | |
|---|---|---|---|---|
| L-25% | 40.930 | 35.426 | - | 46.229 |
| L-50% | 46.118 | 44.981 | - | 47.158 |
| L-75% | 51.305 | 46.005 | - | 56.618 |
| SR | 10.375 | 9.315 | - | 11.436 |



APPENDIX III

# ANALYSE REPORT FROM HAULS MADE BY "BIZON" DURING FISHING PERIOD III (*CC-SELECTIVITY*)

## HAUL INFORMATION

Date : 10/17/95
Vessel : Bizon
Gear : 45.3/47.0

Reg. No : Hauls 10-18
Fishery Ground : Bear Island

Name : S.Lisovsky
Institute : PINRO, Murmansk, Russia

Experimental Type : Covered Codend

| FILES : | NAME | RESULT |
|---|---|---|
| | T10.SEL | 1___ |
| | T11.SEL | 1___ |
| | T12.SEL | 1___ |
| | T13.SEL | 1___ |
| | T14.SEL | 1___ |
| | T15.SEL | 1___ |
| | T17.SEL | 1___ |
| | T18.SEL | 1___ |

## ANALYSIS REPORT VARIANCE COMPONENT MODEL

ANALYSIS METHOD : MLE

LINK FUNCTION : LOGIT

Parameters

| | |
|---|---|
| Intercept | -8.63412 |
| Slope | 0.19009 |

Variance of Parameters

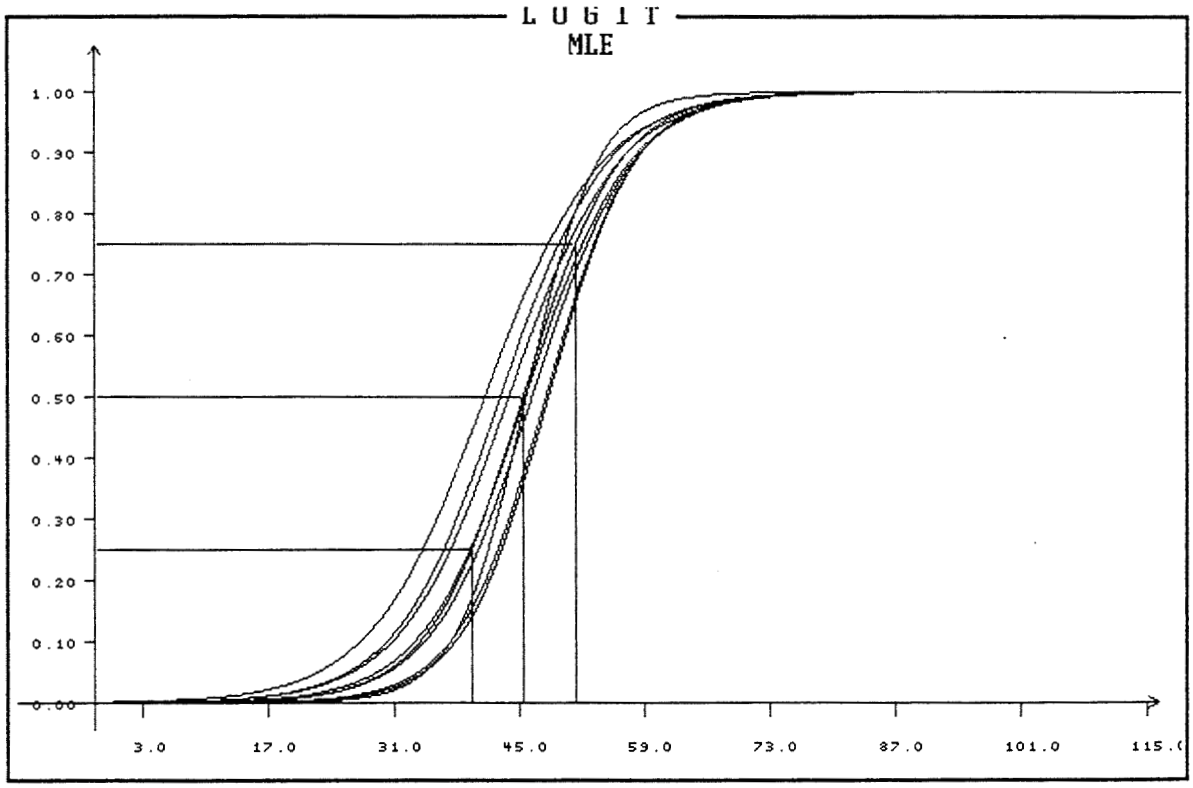
$$\begin{bmatrix} 0.33128 & -0.00588 \\ -0.00588 & 0.00011 \end{bmatrix}$$

Variance Component

$$\begin{bmatrix} 2.38803 & -0.04157 \\ -0.04157 & 0.00075 \end{bmatrix}$$

Calibration-points with 95.000 % confidence limits

| | | | | |
|---|---|---|---|---|
| L-25% | 39.643 | 33.334 | - | 45.615 |
| L-50% | 45.422 | 43.792 | - | 46.851 |
| L-75% | 51.202 | 45.223 | - | 57.115 |
| SR | 11.559 | 10.315 | - | 12.803 |



APPENDIX IV

# ANALYSE REPORT FROM HAULS MADE BY "ANNY KRÆMER" DURING FISHING PERIOD III (*CC-SELECTIVITY*)

## HAUL INFORMATION

Date : 10/17/95 Reg. No :
Vessel : Anny Kræmer Fishery Ground : Bear island
Gear : Euronette

Name : B.Isaksen
Institute : IMR,Bergen

Experimental Type : Covered Codend

| FILES : | NAME | RESULT |
|---|---|---|
| | NRTO34.SEL | [1]___ |
| | NRTO35.SEL | [1]___ |
| | NRTO36.SEL | [1]___ |
| | NRTO37.SEL | [1]___ |
| | NRTO39.SEL | [1]___ |
| | NRTO40.SEL | [1]___ |

## ANALYSIS REPORT VARIANCE COMPONENT MODEL

ANALYSIS METHOD : MLE

LINK FUNCTION : LOGIT

Parameters

| | |
|---|---|
| Intercept | -3.54067 |
| Slope | 0.11272 |

Variance of Parameters

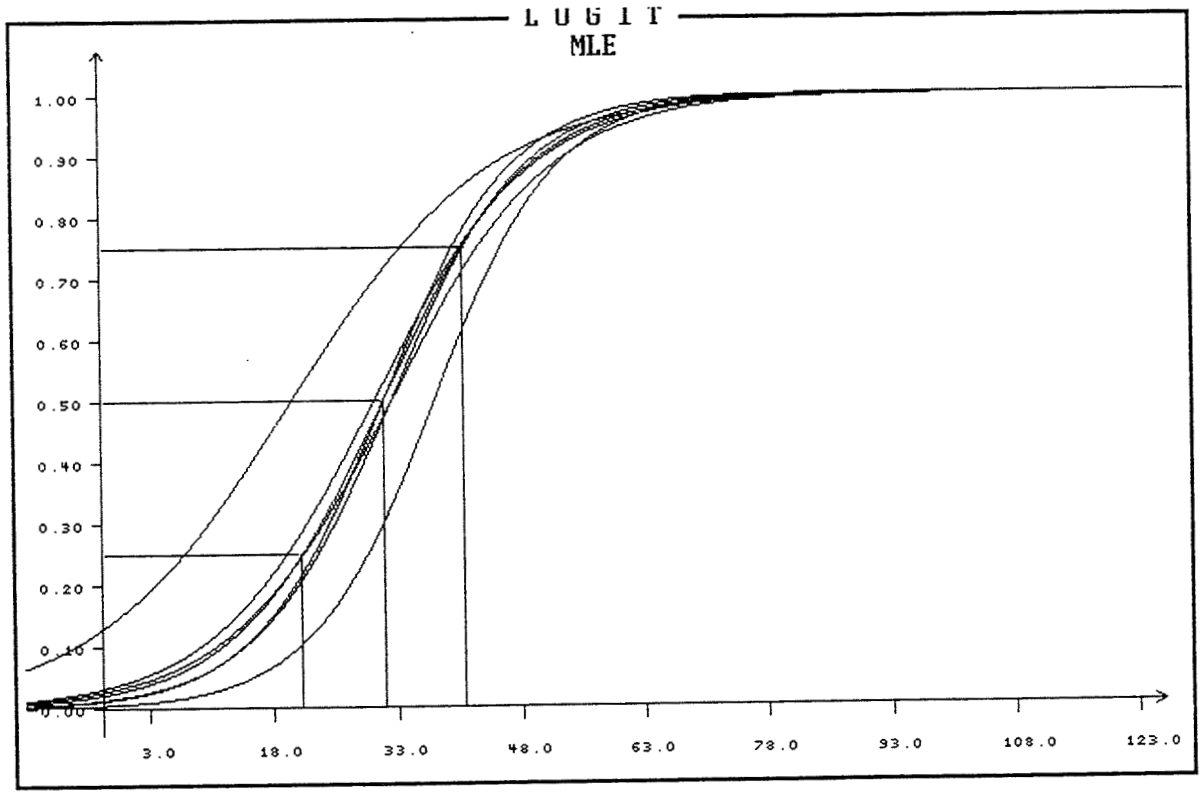
$$\begin{bmatrix} 0.18090 & -0.00301 \\ -0.00301 & 0.00005 \end{bmatrix}$$

Variance Component

$$\begin{bmatrix} 1.00840 & -0.01621 \\ -0.01621 & 0.00027 \end{bmatrix}$$

Calibration-points with 95.000 % confidence limits

| | | | | |
|---|---|---|---|---|
| L-25% | 21.664 | 10.137 | - | 32.055 |
| L-50% | 31.410 | 27.278 | - | 34.727 |
| L-75% | 41.157 | 30.715 | - | 51.105 |
| SR | 19.492 | 17.008 | - | 21.976 |



APPENDIX V

# ANALYSE REPORT FROM ADDITIONAL HAULS MADE BY "ANNY KRÆMER" DURING PERIOD III (= IIIA) (*CC-SELECTIVITY*)

# HAUL INFORMATION

Date : 10/17/95 Reg. No : Hauls,33,38,41
Vessel : Anny-Kræmer Fishery Ground : Bear Island
Gear : Euronette

Name : B.Isaksen
Institute : IMR, Bergen, Norway

Experimental Type : Covered Codend

FILES : NAME RESULT

NRTO33.SEL [1]___
NRTO38.SEL [1]___
NRTO41.SEL [1]___

# ANALYSIS REPORT VARIANCE COMPONENT MODEL

ANALYSIS METHOD : MLE

LINK FUNCTION : LOGIT

Parameters

| | |
|---|---|
| Intercept | -10.89821 |
| Slope | 0.21931 |

Variance of Parameters

$$\begin{bmatrix} 0.25588 & -0.00393 \\ -0.00393 & 0.00006 \end{bmatrix}$$

Variance Component

$$\begin{bmatrix} 0.48145 & -0.00630 \\ -0.00630 & 0.00008 \end{bmatrix}$$

Calibration-points with 95.000 % confidence limits

| | | | | |
|---|---|---|---|---|
| L-25% | 44.684 | 39.326 | - | 49.868 |
| L-50% | 49.694 | 48.287 | - | 50.977 |
| L-75% | 54.703 | 49.516 | - | 59.819 |
| SR | 10.019 | 9.305 | - | 10.733 |