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# Results of the 1991-92 herring acoustic surveys in NAFO Div. 4WX

by

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## ABSTRACT

Acoustic herring surveys were conducted in the Chedabucto Bay area in December 1991 and in January 1992. The herring were located outside Chedabucto Bay in the December surveys and the maximum abundance estimated was 55,000 t. In January, the herring were found in Chedabucto Bay and the maximum possible abundance was estimated to be less than 40,000 t. These estimates are a small fraction of the abundances estimated by surveys in the recent past and could indicate either a decline in the 4WX herring stock, or simply a change in migration pattern.

Results of two exploratory summer surveys of 4WX herring are described. One is a survey of the Scots Bay roe fishery area done in July/August 1991; the other is a survey in the SW Nova Scotia summer fishery area on German Bank done in September 1991. Both surveys were intended to focus on the areas of heaviest fishing effort but the timing for the Scots Bay survey, unfortunately, coincided with an unscheduled closure of the fishery. This survey found no significant quantities of herring. The German Bank survey was run in the active fishery area. This allowed testing of a new method of surveying in a concentrated and mobile fishery and was successful in estimating herring abundance. The quantity estimated in the fished areas, however, was small and the variance was high.

## RÉSUMÉ

On a procédé à des relevés acoustiques du hareng dans la baie de Chedabucto et ses environs en décembre 1991 et en janvier 1992. En décembre, le hareng se trouvait à l'extérieur de la baie et on a estimé son abondance maximale à 55 000 t. En janvier, le hareng était présent dans la baie de Chedabucto et on a chiffré son abondance maximale possible à 40 000 t. Ces estimations correspondent à une petite fraction des biomasses estimées lors de récents relevés acoustiques antérieurs et peuvent être le signe soit d'un déclin du stock de hareng de 4WX, soit d'un changement dans les habitudes migratoires.

On présente les résultats de deux études exploratoires du hareng de 4WX réalisées en été. L'une d'elle, effectuée en juillet-août 1991, portait sur la pêche pour la rogue dans la baie de Scot; l'autre, effectuée en septembre 1991, portait sur le pêche estivale pratiquée sur le banc German, dans le sud-ouest de la Nouvelle-Écosse. Ces deux études visaient des zones où l'effort de pêche est le plus intense, mais, malheureusement, celle qui a été effectuée dans la baie de Scot coïncidait avec une fermeture imprévue de la pêche. Au cours de cette étude, on n'a trouvé aucune quantité importante de hareng. Quant à l'étude ayant eu lieu sur le banc German, elle a été réalisée en pleine zone de pêche, ce qui a permis de mettre à l'essai une nouvelle méthode d'évaluation au sein d'une pêche concentrée et mobile et d'aboutir à une bonne estimation de l'abondance du hareng. La quantité de hareng estimée dans les zones exploitées s'est cependant avérée faible et les écarts élevés.

# A. WINTER SURVEYS

## INTRODUCTION

Results of annual winter acoustic surveys have described large aggregations of herring in Chedabucto Bay since 1984 (Buerkle 1985). The acoustic abundances estimated have corresponded to large proportions of the total 4WX herring stock as estimated by catch analysis. In 1989, an analytical assessment was considered unreliable and the winter acoustic survey results were used as an indication of minimum stock size (Stephenson and Power 1989).

It was recognized from the start that the usefulness of acoustic estimates of herring abundance in Chedabucto Bay, as an index of 4WX stock abundance, depends on two conditions. One is that a constant proportion of the stock migrates to Chedabucto Bay, and the other is that the surveys be timed to determine the peak abundance in the bay. In response to observations of herring moving out of the bay in the later parts of the surveys, and in an attempt to satisfy the second condition, the starting times of the surveys have moved over the years from mid-January to early January.

In 1985, the herring were driven out of the bay by ice cover in early February (Buerkle 1986). In 1986, they were observed moving out of the bay between January 25 and January 30, and in 1987, many moved out of the bay on January 19, but then moved back in and stayed to the end of the survey time on January 25 (Buerkle 1987). In 1989, there was a significant decline in biomass between January 7 and 23 (Buerkle 1989). In 1990, the bulk of herring left the bay on January 9 (Buerkle 1991).

The 1991 surveys found no large aggregations of herring in Chedabucto Bay at all between January 6 and 28. The largest abundance was found on January 6, and at about 30,000 t, was only about one-tenth of the abundance found in previous years.

The seiners fishing in Chedabucto Bay in January 1991 reported that there had been many more herring in the bay during December 1990 than there were in January 1991. On the basis of this information it was concluded that the January 1991 acoustic surveys missed the major aggregation period of the herring, and that the abundances estimated were not representative of the stock size.

To address the timing problem, the surveys for the 1991/92 winter season were carried out during two time periods. Survey N162 was done from December 7-13, 1991, and survey N163 was done from January 7-16, 1992.

## EQUIPMENT

The survey vessel was the ALFRED NEEDLER and the sampling gear was an IGYPT midwater trawl. The acoustic transducer was the dual beam Ametek Straza SP-268 for survey N162 and for survey N163 until January 8. For the rest of survey N163, the transducer was the Ametek Straza SP-187-LT-11 from Newfoundland. The source levels receive sensitivities and equivalent ideal beams were:

| Transducer | Source level dB re 1 upa | Receive sen. dB re 1v/upa | E.Q.I. beam steradians |
|---|---|---|---|
| SP-268 | 120.4 | -83.0 | .00757 |
| SP-187-LT-11 | 122.0 | -79.7 | .00941 |

The echo sounder used was the Simrad EK50 (#2); it was run at full power, 20 logR - 0 dB, 0.6 ms pulse and 3 kHz bandwidth. The acoustic data were recorded with the Femto Model J9001 Hydro Acoustic Data Processing System.

## BIOLOGICAL SAMPLING

One midwater tow sample was taken during survey N162, and three samples were obtained during survey N163. The herring size distributions are shown in Fig. 1. There is no clear indication that these samples represent the same or different groups of herring.

For survey N162, the mean length of the herring was 27.8 cm and the length/weight relationship (M. Power, DFO, Biological Station, St. Andrews, N.B., pers. commun.) was:

$$W_{kg} = 5.65 \bullet L^{3.048} \bullet 10^{-06}.$$

With the target strength/length relationship of Foote (1987):

$$TS = 20 \text{ Log } L - 71.9,$$

the target strength per kilogram is calculated as:

$$TS_{kg} = -10.48 \text{ Log}(27.8) - 19.4 = -34.5 \text{ dB/kg}.$$

For survey N163, the mean length of the herring was 29.0 cm and the length/weight relationship was:

$$W_{kg} = 5.136 \cdot L^{3.07} \cdot 10^{-06}.$$

The target strength per kilogram in this case is calculated to be:

$$TS_{kg} = -10.7 \text{ Log}(29.0) - 19.0 = -34.6 \text{ dB/kg}.$$

## SURVEY RESULTS N162, DECEMBER 1991

The ALFRED NEEDLER arrived in the Chedabucto Bay area on December 7. The seiners reported that there were no herring in Chedabucto Bay and they were fishing off Little Dover. A survey area was chosen to cover the area of the fishery. The area extended from Carousse Bank to White Head Island and to about 6 mi off shore. It was about 70 $mi^2$ in area and the survey lines were spaced 1.3 mi apart.

The area was surveyed three times. Survey N7-8 during the night of December 7-8 estimated about 55,000 t of herring, and survey N8-9 during the night of December 8-9 estimated about 24,000 t (Table 1, 2). The third survey in the area was done during the night of December 11-12 and found no herring.

The south shore of Chedabucto Bay, where the herring have usually been found, was surveyed on December 8 and 9 by zig-zag surveys of a 30-$mi^2$ area. No herring were found.

The approaches to Chedabucto Bay, including Rocky Bay and the Green Island area, were surveyed on December 10-11 by a random line survey covering an area of about 125 $mi^2$. No herring were found.

After the disappearance of the herring from the Little Dover area on December 11-12, a survey extending from Cape Canso further southwest to New Harbour, covering an area of about 240 $mi^2$, also found no herring.

## SURVEY RESULTS N163, JANUARY 1992

The ALFRED NEEDLER arrived in Chedabucto Bay on January 7. The seiners reported herring in Chedabucto Bay off Queensport. The first night's survey (survey N7-8, Table 3) in the traditional Chedabucto Bay index area found herring on the inshore end of two survey lines. The abundance estimated was a mere 2500 t (Table 4). Two more nighttime surveys in the index area (N9-10, N13-14) showed the herring in the same place and produced estimates of about 2900 t and 1300 t, respectively.

A zig-zag survey through the fish during the night of January 9 showed the herring to occupy an area of about 1 $mi^2$. The average scattering was 0.00165/sr. The abundance estimated was about 16,000 t. The herring, however, were close to shore and the survey could not establish the inshore boundary of the herring aggregation. By assuming that the herring extended all the way to shore, the area occupied would be 2.5 $mi^2$. If the area scattering of 0.00165/sr applied to the whole area, the maximum total abundance in the aggregation would be about 40,000 t.

A zig-zag survey during daytime of January 9 showed the area occupied by the herring to be about the same as for the night survey, but the average scattering at 0.00395 was 2.4 times that at night. Since we still have no estimates of daytime target strengths, it is impossible to convert these estimates to herring abundance.

A one night survey on January 12-13 of about 80 $mi^2$ between Grime Shoals and White Head Island found no herring.

## CONCLUSION

The results of the acoustic surveys of the winter 1991/92 agree with the observations of purse seiners in 1990/91 that there were more herring in December than in the following January. The largest estimate of herring abundance in December 1991, however, was only about 55,000 t. This is far short of the several hundreds of thousands of tons these surveys used to estimate in the past.

The parallel line surveys in January 1992 estimated only about 2900 t. The herring were close to shore and the inshore portions were not surveyed. The results of a zig-zag mapping survey extrapolated to the shoreline showed that it is very unlikely that there were more than 40,000 t of herring in the area.

These low abundances, together with the low abundances reported in January 1991, indicate that the herring no longer aggregate in the Chedabucto Bay area in the numbers of the recent past. It is impossible to tell from these results whether the decline represents a decrease in the 4WX herring stock size, or whether it represents a change in behavior or migration pattern. Although two other stock abundance indices, the larval abundance index and the bottom trawl bycatch index, both show an increase in the 1991 abundance over 1990 (Stephenson et al. 1992), and variations in behavior and their effect on the usefulness of winter acoustic surveys as in index of stock abundance have been of concern for some time (Buerkle 1991), the decline in acoustic abundances nonetheless indicates a rapid and major change.

# B. SUMMER SURVEYS

## INTRODUCTION

The results of the recent winter acoustic surveys have indicated that, because of difficulties with timing the surveys to determine peak abundance, and because of the variability in herring behavior (Buerkle 1991), winter abundance estimates may not be reliable indicators of 4WX herring stock abundance. As an alternate option, summer surveys make good sense because herring stock assessments are based on discrete stocks and the 4WX herring aggregate to spawn off SW Nova Scotia.

Summer surveys have been attempted in the past, but have had little success. During August and September of 1979 and 1980, acoustic surveys with the J.L. HART showed that the herring could be detected only at night when they were generally concentrated in a small area at a different location each night. A large fishing effort of gillnetters and seiners gathered on the fish each night. Radar observations at one time showed 128 boats fishing in an area approximately 0.5 x 1.5 naut mi. No herring were detected outside of this area. Acoustic surveys were thought to be ineffective under such conditions.

A random parallel transect acoustic survey of the summer fishery area (excluding Scots Bay) was done in July 1981 (Shotton and Randall 1982). An area of 2400 naut $mi^2$ was surveyed by 27 transects. A total biomass of 201,000 t was reported. This was thought to be an underestimate because the herring in the survey area were on the inshore end of the transects, and because herring-like echo traces were reported from outside the survey area. (Another problem with the estimate is that more than 60% of it was based on the assumption that scattering in several large schools that were not recorded properly was the same as the scattering in the other schools.) Most of the herring (86%) were found on only three transects; this supports the conclusion of the work in 1979 and 1980, that the herring are aggregated in small areas, and it also shows that such a distribution is not amenable to line surveys with large spacing between lines.

The last attempt at acoustic evaluation of the SW N.S. herring during the summer fishery was made in 1984. The idea was that, since fish processors do not generally process fish on Sundays, there should be little fishing effort on Saturday nights, and it should be possible to survey areas of herring concentration on Saturday nights. Two seiners were chartered on alternate Saturday nights for nine surveys. These surveys were not a success for two reasons. There was an over-the-side market for herring, and there was enough fishing effort on Saturday nights to make the survey efforts difficult and ineffective. On the few occasions when no other boats were out, the charter seiners could not find significant concentrations of herring. Consistently finding the herring appears to require the searching effort of a fleet of fishing boats.

In recent years, the gillnet fishery has come to an end and the number of seiners has been reduced. That means a lot fewer boats are fishing, and again raises the question of the feasibility of summer surveys. With fewer boats concentrating on the herring, it was thought possible to run survey transects through the areas of fishing effort. The seiner fleet, in other words, would find the fish and the distribution of the seiners would determine the areas for acoustic surveys. Two acoustic surveys were done in 1991 to explore this issue further - one in the Scots Bay area in July, the other in the German Bank area in September.

## SCOTS BAY SURVEY

### Methods

The survey was done with the E.E. PRINCE from July 25-August 2, 1991. The acoustic equipment was a Simrad EK50 echosounder and the Ametek Straza SP268 dual beam transducer operated on the narrow beam in a Fathom towed body. Digitizing, data recording and data editing was done with the Femto Model J9001 system. Data processing was done by the St. Andrews Marine Fish Division integration software.

The intent of the survey was to survey the area of active fishing effort. Unfortunately, the fishery was interrupted by an unscheduled closure during the week of the survey because of poor roe condition. The initial survey plan was to survey replicate sets of equally spaced transects in a 10 x 11 naut mi area where the fishery has reported the highest catches from 1988-90. This plan was modified during the survey to include a much larger part of the Bay of Fundy.

### Results

Four transects run in the survey area during the night July 26-27 showed only light fish markings on the echograms in the western corner of the area. Nine transects run during the following day showed even lighter markings. A midwater tow in the area of fish caught two baskets of dogfish, 1 L brit and a few gaspereau.

The lack of herring in the survey area led to the decision to search a larger area. Zig-zag lines were surveyed all over Scots Bay and south along the N.S. shore as far as Long Island, and along the N.B. shore from Quaco Head to Alma (Fig. 2). A total of about 650 naut mi of survey was done. Various light echo traces were detected. Five more midwater tow samples produced mainly brit, sardines and dogfish, but very few roe herring.

On July 31, a larger concentration of herring was detected 5 naut mi SE of Ile Haute. A midwater tow sample caught large (mean length = 33 cm) herring that yielded 8% roe.

To quantify the acoustic abundance in this concentration, a 2 naut $mi^2$ area was centred on the position of the fish and sampled by four random transects. No fish were detected; the fish had obviously moved. Continued attempts to relocate the fish with echosounder and sonar were not successful.

The echogram recorded during the sample tow showed fish for about 200 m. The area scattering coefficient was about 0.017/sr. If the fish school is assumed to be circular and the transect passed through its center, it would have contained about 2000 t of herring.

## Conclusion

This survey found only one concentration of herring in Scots Bay in 650 naut mi of survey. The concentration was mobile and could not be properly surveyed and quantified, but is thought to have contained approximately 2000 t of fish. The week following this survey, the fishery was opened again and seiners caught many times this quantity of herring. That could indicate that the fish were not in the area during the survey, but more likely it indicates that the survey was not successful in locating them. It was concluded that if future survey efforts are to be made, they must be coordinated with active fishing effort.

# GERMAN BANK SURVEY

## Methods

This survey was done with the E.E. PRINCE from September 3-13. For easy access to German Bank and to facilitate scientific staff changes, the survey was run from Yarmouth. The acoustic equipment and data processing was the same as for the Scotts Bay survey.

The aim of this was to survey areas of concentrated fishing effort by the seiner fleet at the time the fishing was done. The strategy was to observe the seiners on the radar of the E.E. PRINCE as they find and fish the herring, to then define a small area that covers the area of major fishing effort, and to survey the area with equidistant transects. The process was to be repeated several times a night when possible.

To create a flexible system for defining survey areas, two types of transparent overlay were made to position on the radar screen. One was an 8.4-cm square, the other was an 8.4 x 16.8 cm rectangle. Depending on the range setting of the radar, the square could cover an area representing 1, or 2, or 4, etc. naut mi$^2$, and the rectangle could cover an area representing 2, or 8, or 32, etc. naut mi$^2$. Associated with each type of overlay was another overlay with four equally spaced survey lines on it. The lines for the square were 2.1 cm apart, those for the rectangle were 4.2 cm apart and were parallel to the short side of the rectangle. The line overlays also had an offset scale drawn perpendicular to the lines. The scale was marked in 10 units of one-tenth of the line separation and was used to position the survey lines randomly in the survey area for each survey.

In use, when the seiners were suitably aggregated, a radar range and overlay combination, that best suited the boat distribution, was selected. The overlay was taped to the radar screen so that the survey area included most of the boats. A random number was selected to position the survey lines in the area using the offset scale. The line overlay was then also taped to the radar screen. The variable range ring and course marker of the radar were then used to determine the start and end position of each of the four survey lines using a pocket calculator program that calculates the Lat/Long position of a point that is a given distance and course from a given Lat/Long position.

## Biological Sampling

The herring length frequencies used to calculate target strength were obtained from five samples collected by port technicians in Yarmouth from boats fishing in the German Bank, Seal Island area between Sept. 6 and 13. The mean length of the herring was 29.3 cm.

The length/weight relationship was calculated from samples taken in the 1991 summer fishery:

$$W_{kg} = 2.719 \cdot L^{3.309} \cdot 10^{-6}.$$

With the Foote (1987) target strength relationship:

$$TS = 20 \text{ Log } L - 71.9,$$

the target strength was calculated to be -35.4 dB per kilogram.

## Results

Fourteen small area surveys were done between Sept. 5 and 13. Eleven of the survey were done at night, three were done during daylight. The areas surveyed ranged in size from 1-90 naut mi$^2$. Survey results by transect are shown in Table 5, and are summarized by survey in Table 6. Survey names in the tables refer to night (N) or day (D), and the date (eg. N05 is a night survey started on Sept. 5).

During the first survey (N05), the fleet fished in the Seal Island area, not German Bank. A four-transect survey of a 32 naut mi$^2$ area on the boat distribution found no herring. Up to 21 boats were counted within the 3-mi range on the radar during the survey. This number included an unknown number of carriers standing by to receive fish. It proved impossible to determine which boats were seiners actually fishing, which were seiners searching, and which were carriers. The survey could not be aimed at only the fishing effort as envisaged; it had to be aimed at all the boats present. This has the effect of increasing the size of the area surveyed and reduces the chance of encountering fish. This problem applied to all subsequent attempts to survey fishing effort as well.

The second and third night worked were a Friday and Saturday, and the fleet did not fish. Surveys N06 and N07 surveyed a 7.5 x 12.0 naut mi area on German Bank where recent catches had been reported (Fig. 2). The Sept. 6 survey found no fish; the Sept. 7 survey found two small patches of herring with very high scattering in the NE quarter of the survey area. The scattering (in transect 15) was high enough to trigger the bottom pulse of the echosounder with the discriminator set at 6, as normal for winter surveys. The first repeat pass over the transect apparently missed the herring. The second pass found the herring and showed that the discriminator needed to be set to 2 to avoid triggering in the herring. The abundance reported for transect 15 is the result of the second replicate pass. The total scattering for this transect is almost five times higher than the next highest transect (no. 74) in all surveys.

From Sept. 8-12, the fleet fished on German Bank near the area where the herring were found during survey N07. Eight nighttime surveys were done in the areas of fishing (Fig. 2), all of them recording fish along at least one transect. Six of the night surveys are the randomized four transect surveys described in the methods. Surveys N08 and N10 surveyed larger areas with more transects because we were a little timid about surveying in the fleet.

The average abundance of herring for all 10 nighttime surveys on German Bank was 20,735 t; the standard deviation was 33,374 t. Such large variance inspires little confidence in the mean. These estimates, however, include the two surveys, N06 and N07, that were not aimed at the fleet. The abundance estimates from these surveys are at the extreme ends of the range of estimates - N06 estimated 0 t, N07 estimated 109,929 t - that is almost three times higher than the next highest estimate.

Excluding the estimates from surveys N06 and N07 from the mean results in the mean abundance for eight surveys on the fishing fleet of 12,178 t and a standard deviation of 12,266 t. The variance is still very high; the 95% confidence interval for the mean is from about 1900-22,000 t.

Such large variability leads to questions about the survey design. If the herring were distributed more widely than the fishing effort, one could expect large variation among the estimates because the larger survey areas would include more total herring. Figure 3 shows no relationship between the estimates of herring abundance and size of survey area and appears to validate the earlier experience that few herring can be found outside the area being fished.

## Conclusions

It has been demonstrated in the past that a single boat on its own can have difficulties locating concentrations of herring in the summer. This summer's experience has shown that by working with the fishing fleet, it is possible to survey concentrations of herring. Eight surveys aimed at the fishing effort on German Bank during September 1991 estimated a mean abundance of 12,178 t and a standard deviation of 12,266 t. This mean is disappointingly low and the variance is disappointingly high. It must be recognized, however, that spawning herring come and go, and this series of experimental surveys represents a very short time span in the spawning cycle. Further efforts to obtain accurate and precise estimates of spawning herring abundance would require a much longer time series of surveys, and would also have to address the question of different fish spawning at different times, and the question of spawning in other areas such as Trinity, Lurcher, and Seal Island.

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TABLE 1.1 Backscatter and biomass for transects.
Herring survey N162 December 1991

| Survey | Transect Number | Transect Length (m) | Transect Area (km²) | Target Strength (dB/kg) | Sa - Area Scattering (sr⁻¹) | Total Scattering (m²/sr) | Biomass Density (kg/m²) | Total Biomass (t/transect) | Set Number |
|---|---|---|---|---|---|---|---|---|---|
| N7-8 | 2 | 9355 | 18.42 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 3 | 9343 | 18.39 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 4 | 1 | 0.00 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 5 | 8433 | 16.60 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 6 | 7907 | 15.57 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 7 | 4518 | 8.90 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 8 | 7112 | 14.00 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 9 | 6998 | 13.78 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 10 | 6372 | 12.55 | -34.5 | 0.000018 | 226 | 0.0507 | 636.433 | |
| N7-8 | 11 | 6811 | 13.41 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 12 | 8351 | 16.44 | -34.5 | 0.000182 | 2992 | 0.5129 | 8433.624 | |
| N7-8 | 13 | 1 | 0.00 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 14 | 1 | 0.00 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 15 | 8221 | 16.19 | -34.5 | 0.000520 | 8417 | 1.4656 | 23720.965 | |
| N7-8 | 16 | 10310 | 20.30 | -34.5 | 0.000037 | 751 | 0.1043 | 2116.727 | |
| N7-8 | 17 | 10865 | 21.39 | -34.5 | 0.000254 | 5433 | 0.7159 | 15313.265 | |
| N7-8 | 18 | 12086 | 23.80 | -34.5 | 0.000028 | 666 | 0.0789 | 1877.781 | 1 |
| N7-8 | 19 | 6146 | 12.10 | -34.5 | 0.000060 | 726 | 0.1691 | 2046.200 | |
| N7-8 | 20 | 2805 | 5.52 | -34.5 | 0.000059 | 326 | 0.1663 | 918.310 | |
| N7-8 | 21 | 2988 | 5.88 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 38 | 6998 | 16.21 | -34.5 | 0.000006 | 97 | 0.0169 | 274.101 | |
| N8-9 | 39 | 7144 | 16.55 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 40 | 7074 | 16.39 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 41 | 4682 | 10.84 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 42 | 7183 | 16.64 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 43 | 6523 | 15.11 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 44 | 5893 | 13.65 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 45 | 6920 | 16.03 | -34.5 | 0.000455 | 7293 | 1.2824 | 20554.311 | |
| N8-9 | 46 | 7596 | 17.59 | -34.5 | 0.000051 | 897 | 0.1437 | 2528.952 | |
| N8-9 | 47 | 7238 | 16.77 | -34.5 | 0.000004 | 67 | 0.0113 | 189.001 | |
| N8-9 | 48 | 5247 | 12.15 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 49 | 5516 | 12.78 | -34.5 | 0.000003 | 38 | 0.0085 | 108.027 | |
| N8-9 | 50 | 5454 | 12.63 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 51 | 5442 | 12.61 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 52 | 5401 | 12.51 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N8-9 | 53 | 5211 | 12.07 | -34.5 | 0.000000 | 0 | 0.0000 | 0.000 | |

TABLE 2 Backscatter and biomass for surveys.
Herring survey N162 December 1991

| Survey | Target Strength (dB/kg) | Stratum Area (km²) | Area Scattering (sr⁻¹) | Total Scattering (m²/sr) Total | S.E. | Biomass Density (kg/m²) | Total Biomass (t/stratum) Total | S.E. |
|---|---|---|---|---|---|---|---|---|
| N7-8 | -34.5 | 253.24 | 0.000077 | 19537 | 9837 | 0.2174 | 55063 | 27723 |
| N8-9 | -34.5 | 230.52 | 0.000036 | 8393 | 7274 | 0.1026 | 23654 | 20501 |

TABLE 3.1 Backscatter and biomass for transects.
Herring survey N163 January 1992

| Survey | Transect Number | Transect Length (m) | Transect Area (km²) | Target Strength (dB/kg) | Sa - Area Scattering (sr⁻¹) | Total Scattering (m²/sr) | Biomass Density (kg/m²) | Total Biomass (t/transect) | Set Number |
|---|---|---|---|---|---|---|---|---|---|
| N7-8 | 1 | 5126 | 14.25 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 2 | 5283 | 14.68 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 3 | 5628 | 15.64 | -34.6 | 0.000047 | 735 | 0.1355 | 2120.404 | |
| N7-8 | 4 | 5842 | 16.24 | -34.6 | 0.000009 | 146 | 0.0260 | 421.474 | 1 |
| N7-8 | 5 | 6030 | 16.76 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 6 | 5631 | 15.65 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 7 | 6449 | 17.92 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 8 | 6114 | 16.99 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 9 | 6469 | 17.98 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 10 | 5961 | 16.57 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 11 | 5969 | 16.59 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 12 | 6011 | 16.71 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 13 | 6357 | 17.67 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 14 | 6962 | 19.35 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 15 | 6740 | 18.73 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N7-8 | 16 | 7289 | 20.26 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 44 | 6310 | 14.03 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 45 | 6237 | 13.87 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 46 | 6704 | 14.91 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 47 | 5623 | 12.50 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 48 | 5675 | 12.62 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 49 | 5394 | 11.99 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 50 | 5134 | 11.42 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 51 | 5349 | 11.89 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 52 | 5395 | 12.00 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 53 | 5547 | 12.33 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 54 | 5165 | 11.48 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 55 | 5028 | 11.18 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 56 | 5566 | 12.38 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 57 | 5217 | 11.60 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 58 | 5731 | 12.74 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 59 | 5673 | 12.61 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 60 | 5534 | 12.31 | -34.6 | 0.000010 | 123 | 0.0288 | 354.892 | |
| N9-10 | 61 | 6239 | 13.87 | -34.6 | 0.000063 | 874 | 0.1817 | 2520.648 | 2 |
| N9-10 | 62 | 5564 | 12.37 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N9-10 | 63 | 5422 | 12.06 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 87 | 6827 | 15.18 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 88 | 6447 | 14.34 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 89 | 6461 | 14.37 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 90 | 6196 | 13.78 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 91 | 5719 | 12.72 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 92 | 5827 | 12.96 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 93 | 5291 | 11.77 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 94 | 5604 | 12.46 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 95 | 5538 | 12.31 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |

TABLE 3.2 Backscatter and biomass for transects.
Herring survey N163 January 1992

| Survey | Transect Number | Transect Length (m) | Transect Area (km²) | Target Strength (dB/kg) | Sa - Area Scattering (sr⁻¹) | Total Scattering (m²/sr) | Biomass Density (kg/m²) | Total Biomass (t/transect) | Set Number |
|---|---|---|---|---|---|---|---|---|---|
| N13-14 | 96 | 5809 | 12.92 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 97 | 5129 | 11.40 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 98 | 5232 | 11.63 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 99 | 5908 | 13.14 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 100 | 4690 | 10.43 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 101 | 5739 | 12.76 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 102 | 5732 | 12.75 | -34.6 | 0.000035 | 446 | 0.1009 | 1286.563 | 3 |
| N13-14 | 103 | 6022 | 13.39 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 104 | 6083 | 13.53 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 105 | 5874 | 13.06 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N13-14 | 106 | 5926 | 13.18 | -34.6 | 0.000000 | 0 | 0.0000 | 0.000 | |

TABLE 4 Backscatter and biomass for surveys.
Herring survey N163 January 1992

| Survey | Target Strength (dB/kg) | Stratum Area (km²) | Area Scattering (sr⁻¹) | Total Scattering (m²/sr) | | Biomass Density (kg/m²) | Total Biomass (t/stratum) | |
|---|---|---|---|---|---|---|---|---|
| | | | | Total | S.E. | | Total | S.E. |
| N7-8 | -34.6 | 272.00 | 0.000003 | 881 | 740 | 0.0093 | 2542 | 2134 |
| N9-10 | -34.6 | 250.17 | 0.000004 | 997 | 876 | 0.0115 | 2876 | 2527 |
| N13-14 | -34.6 | 258.06 | 0.000002 | 446 | 446 | 0.0050 | 1287 | 1287 |

TABLE 5.1 Backscatter and biomass for transects.
German Bank September 1991

| Survey | Transect Number | Transect Length (m) | Transect Area (km²) | Target Strength (dB/kg) | Sa - Area Scattering (sr⁻¹) | Total Scattering (m²/sr) | Biomass Density (kg/m²) | Total Biomass (t/transect) | Set Number |
|---|---|---|---|---|---|---|---|---|---|
| N05 | 2 | 6660 | 24.68 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N05 | 3 | 6942 | 25.73 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N05 | 4 | 7148 | 26.49 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N05 | 5 | 7551 | 27.98 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N06 | 6 | 13962 | 38.81 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N06 | 7 | 13923 | 38.70 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N06 | 8 | 13719 | 38.13 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N06 | 9 | 13938 | 38.74 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N06 | 10 | 13809 | 38.38 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N06 | 11 | 13829 | 38.44 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N06 | 12 | 14033 | 39.00 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N06 | 13 | 14081 | 39.14 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N07 | 14 | 13331 | 37.05 | -35.2 | 0.000019 | 704 | 0.0629 | 2331.219 | |
| N07 | 15 | 1128 | 3.14 | -35.2 | 0.010364 | 32494 | 34.3184 | 107597.748 | |
| N07 | 16 | 13282 | 36.92 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N07 | 17 | 13266 | 36.87 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N07 | 18 | 13380 | 37.19 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N07 | 19 | 13492 | 37.50 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N07 | 20 | 13422 | 37.31 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N07 | 21 | 13243 | 36.81 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N08 | 23 | 13307 | 36.99 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N08 | 24 | 10372 | 28.83 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N08 | 25 | 13306 | 36.98 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N08 | 26 | 13204 | 36.70 | -35.2 | 0.000013 | 477 | 0.0430 | 1579.849 | |
| N08 | 27 | 13414 | 37.28 | -35.2 | 0.000001 | 37 | 0.0033 | 123.460 | |
| N08 | 28 | 13402 | 37.25 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N08 | 29 | 13514 | 37.56 | -35.2 | 0.000015 | 563 | 0.0497 | 1865.700 | |
| N08 | 30 | 13427 | 37.32 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D09 | 31 | 7157 | 6.63 | -35.2 | 0.000001 | 7 | 0.0033 | 21.957 | |
| D09 | 32 | 7241 | 6.71 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D09 | 33 | 7228 | 6.70 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D09 | 34 | 7109 | 6.59 | -35.2 | 0.000011 | 72 | 0.0364 | 239.909 | |
| D09 | 35 | 7278 | 6.74 | -35.2 | 0.000002 | 13 | 0.0066 | 44.657 | |
| D09 | 36 | 7147 | 6.62 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D09 | 37 | 7043 | 6.53 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D09 | 38 | 7246 | 6.71 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D09 | 39 | 7315 | 6.78 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D09 | 40 | 7188 | 6.66 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D09 | 41 | 6805 | 6.30 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N09a | 42 | 6836 | 25.33 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N09a | 43 | 6855 | 25.40 | -35.2 | 0.000031 | 788 | 0.1027 | 2607.802 | |
| N09a | 44 | 6947 | 25.75 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |

TABLE 5.2 Backscatter and biomass for transects.
German Bank September 1991

| Survey | Transect Number | Transect Length (m) | Transect Area (km²) | Target Strength (dB/kg) | Sa - Area Scattering (sr⁻¹) | Total Scattering (m²/sr) | Biomass Density (kg/m²) | Total Biomass (t/transect) | Set Number |
|---|---|---|---|---|---|---|---|---|---|
| N09a | 45 | 6956 | 25.78 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| | | | | | | | | | |
| N09b | 46 | 6972 | 12.92 | -35.2 | 0.000015 | 194 | 0.0497 | 641.688 | |
| N09b | 47 | 7008 | 12.99 | -35.2 | 0.000011 | 143 | 0.0364 | 473.001 | |
| N09b | 48 | 7239 | 13.41 | -35.2 | 0.000229 | 3072 | 0.7583 | 10171.605 | |
| N09b | 49 | 8660 | 16.05 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| | | | | | | | | | |
| N10 | 51 | 11168 | 22.76 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N10 | 52 | 11255 | 22.94 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N10 | 53 | 11165 | 22.76 | -35.2 | 0.000057 | 1297 | 0.1887 | 4295.381 | |
| N10 | 54 | 11309 | 23.05 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N10 | 55 | 11266 | 22.96 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N10 | 56 | 11259 | 22.95 | -35.2 | 0.000023 | 528 | 0.0762 | 1747.816 | |
| N10 | 57 | 11859 | 24.17 | -35.2 | 0.000061 | 1475 | 0.2020 | 4882.542 | |
| N10 | 58 | 10843 | 22.10 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N10 | 59 | 6897 | 14.06 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N10 | 60 | 9471 | 19.30 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| | | | | | | | | | |
| D11 | 61 | 13320 | 6.35 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D11 | 62 | 14558 | 6.94 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D11 | 63 | 13263 | 6.32 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D11 | 64 | 14467 | 6.89 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D11 | 65 | 8449 | 4.03 | -35.2 | 0.000129 | 519 | 0.4272 | 1719.669 | |
| D11 | 66 | 2597 | 1.24 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D11 | 67 | 2577 | 1.23 | -35.2 | 0.000476 | 584 | 1.5762 | 1935.402 | |
| | | | | | | | | | |
| N11a | 70 | 1597 | 0.74 | -35.2 | 0.003399 | 2515 | 11.2551 | 8326.673 | |
| N11a | 71 | 1594 | 0.74 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N11a | 72 | 1895 | 0.88 | -35.2 | 0.000018 | 16 | 0.0596 | 52.324 | |
| N11a | 73 | 1706 | 0.79 | -35.2 | 0.000172 | 136 | 0.5695 | 450.114 | |
| | | | | | | | | | |
| N11b | 74 | 7041 | 13.05 | -35.2 | 0.000520 | 6784 | 1.7219 | 22465.346 | |
| N11b | 75 | 6359 | 11.78 | -35.2 | 0.000367 | 4324 | 1.2153 | 14319.581 | |
| N11b | 76 | 6931 | 12.84 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N11b | 77 | 7054 | 13.07 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| | | | | | | | | | |
| N11c | 78 | 7248 | 13.43 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N11c | 79 | 7137 | 13.22 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N11c | 80 | 7405 | 13.72 | -35.2 | 0.000003 | 41 | 0.0099 | 136.308 | |
| N11c | 81 | 6264 | 11.61 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| | | | | | | | | | |
| D12 | 83 | 776 | 1.08 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D12 | 84 | 8435 | 11.72 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D12 | 85 | 9323 | 12.96 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D12 | 86 | 9461 | 13.15 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D12 | 87 | 9360 | 13.01 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D12 | 88 | 1 | 0.00 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |

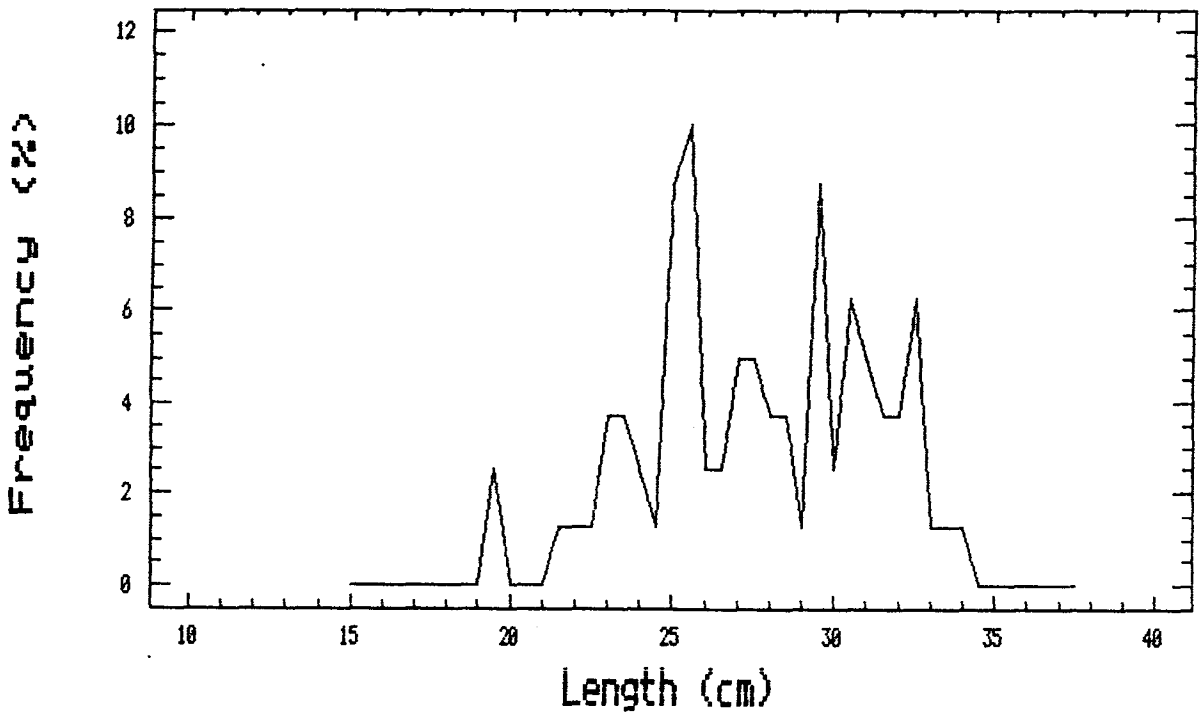
TABLE 5.3 Backscatter and biomass for transects.
German Bank September 1991

| Survey | Transect Number | Transect Length (m) | Transect Area (km²) | Target Strength (dB/kg) | Sa - Area Scattering (sr⁻¹) | Total Scattering (m²/sr) | Biomass Density (kg/m²) | Total Biomass (t/transect) | Set Number |
|---|---|---|---|---|---|---|---|---|---|
| D12 | 89 | 9842 | 13.68 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| D12 | 90 | 9624 | 13.37 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N12 | 99 | 7490 | 13.88 | -35.2 | 0.000468 | 6495 | 1.5497 | 21508.152 | |
| N12 | 100 | 7259 | 13.45 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N12 | 101 | 7164 | 13.27 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N12 | 102 | 7057 | 13.08 | -35.2 | 0.000041 | 536 | 0.1358 | 1775.331 | |
| N12 | 103 | 7461 | 13.83 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |
| N12 | 104 | 7705 | 14.28 | -35.2 | 0.000000 | 0 | 0.0000 | 0.000 | |

TABLE 6 Backscatter and biomass for surveys.
German Bank September 1991

| Survey | Target Strength (dB/kg) | Stratum Area (km²) | Area Scattering (sr⁻¹) | Total Scattering (m²/sr) Total | Total Scattering (m²/sr) S.E. | Biomass Density (kg/m²) | Total Biomass (t/stratum) Total | Total Biomass (t/stratum) S.E. |
|---|---|---|---|---|---|---|---|---|
| N05 | 0.0 | 104.88 | 0.000000 | 0 | 0 | 0.0000 | 0 | 0 |
| N06 | 0.0 | 309.34 | 0.000000 | 0 | 0 | 0.0000 | 0 | 0 |
| N07 | -35.2 | 262.79 | 0.000126 | 33198 | 32401 | 0.4183 | 109929 | 107290 |
| N08 | -35.2 | 288.92 | 0.000004 | 1078 | 677 | 0.0124 | 3569 | 2242 |
| D09 | -35.2 | 72.97 | 0.000001 | 93 | 72 | 0.0042 | 307 | 238 |
| N09a | -35.2 | 102.26 | 0.000008 | 788 | 788 | 0.0255 | 2608 | 2608 |
| N09b | -35.2 | 55.37 | 0.000062 | 3408 | 2964 | 0.2038 | 11286 | 9815 |
| N10 | -35.2 | 217.06 | 0.000015 | 3300 | 1840 | 0.0503 | 10926 | 6093 |
| D11 | -35.2 | 32.99 | 0.000033 | 1104 | 714 | 0.1108 | 3655 | 2365 |
| N11a | -35.2 | 3.15 | 0.000847 | 2666 | 2467 | 2.8061 | 8829 | 8169 |
| N11b | -35.2 | 50.74 | 0.000219 | 11109 | 6721 | 0.7249 | 36785 | 22255 |
| N11c | -35.2 | 51.98 | 0.000001 | 41 | 41 | 0.0026 | 136 | 136 |
| D12 | 0.0 | 78.97 | 0.000000 | 0 | 0 | 0.0000 | 0 | 0 |
| N12 | -35.2 | 81.78 | 0.000086 | 7031 | 6410 | 0.2847 | 23283 | 21224 |

N162




N163

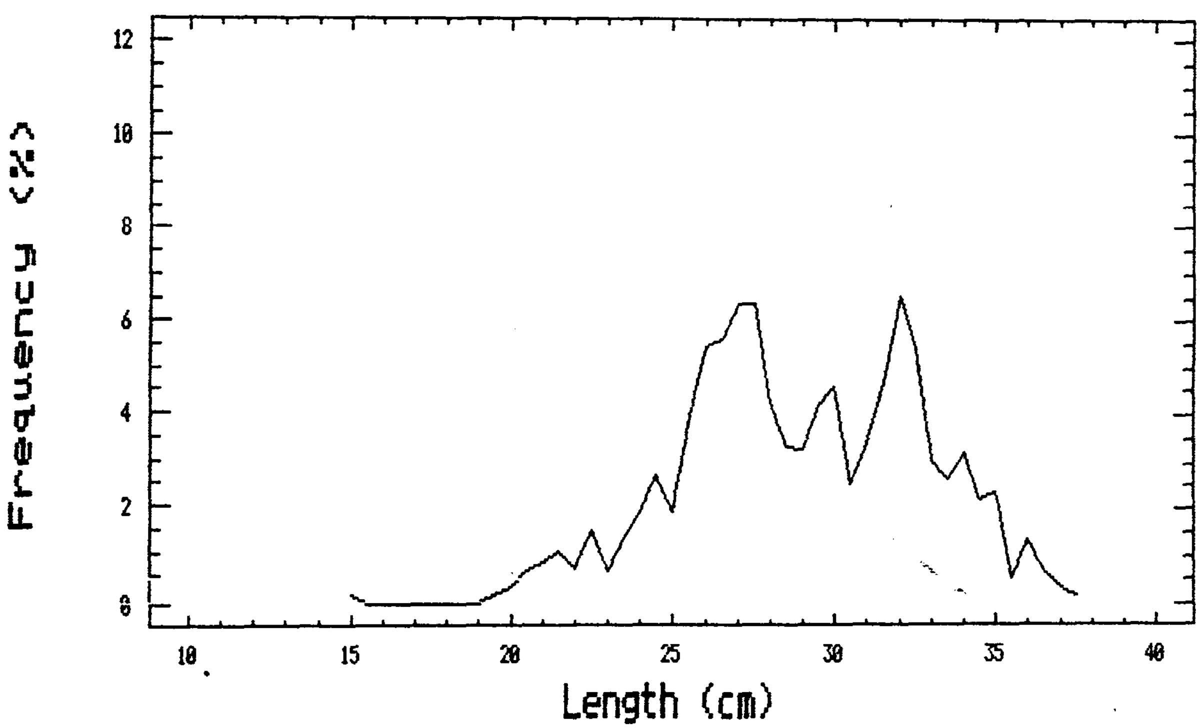



Fig. 1. Herring length/frequencies for survey N162 (December 1991) and for survey N163 (January 1992).

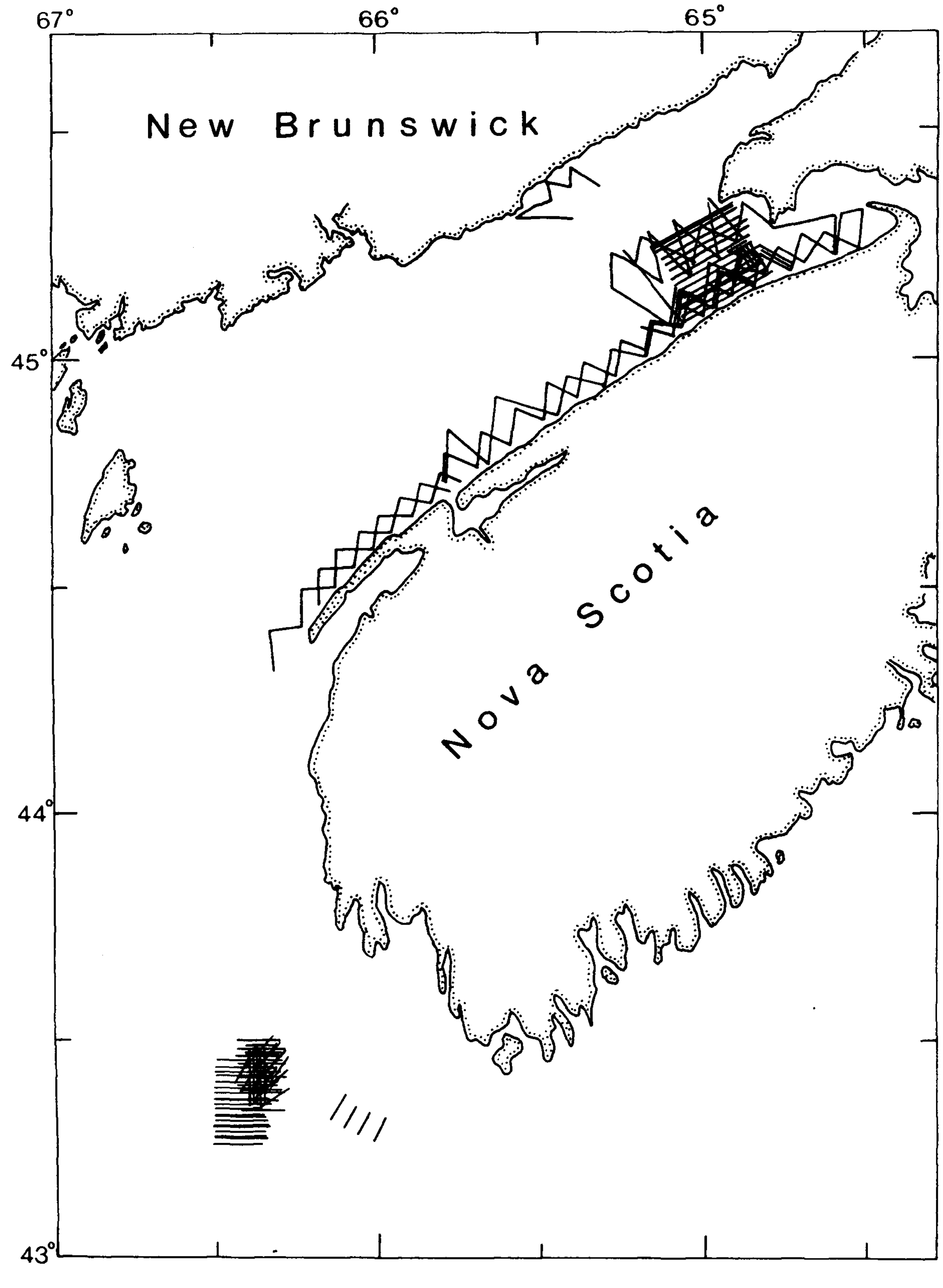



Fig. 2. Distribution of summer survey effort.

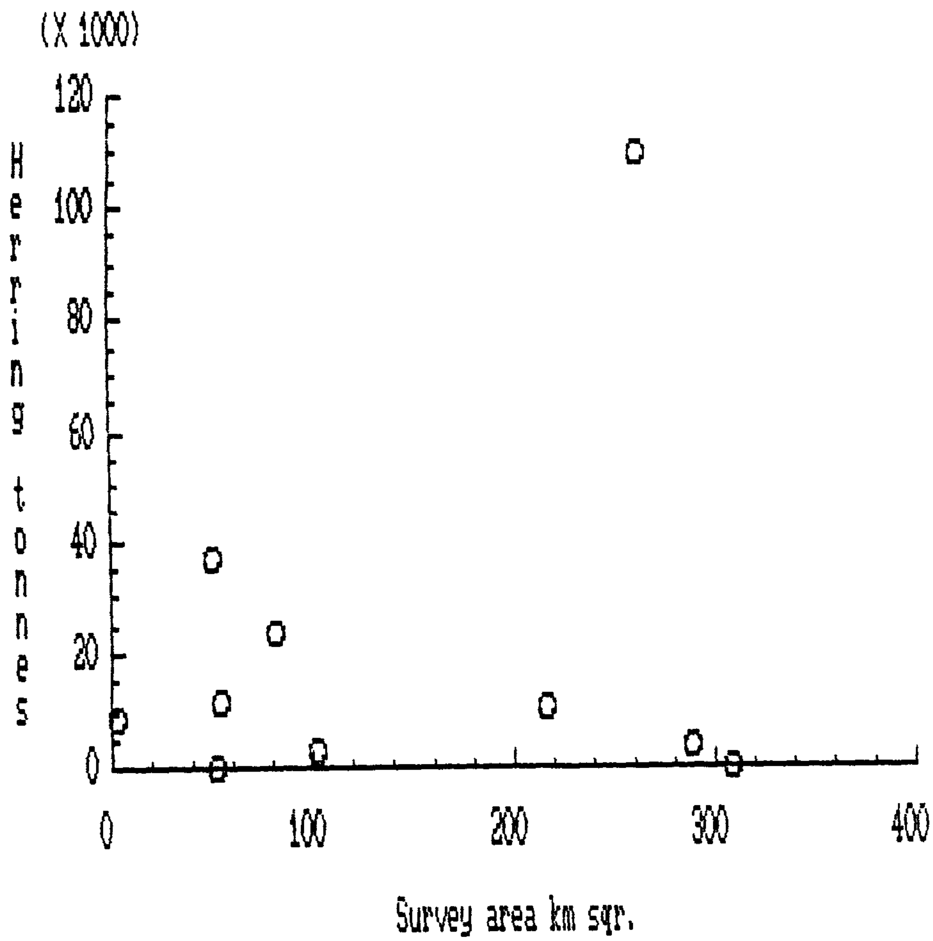



Fig. 3. Herring abundance estimates on German Bank in relation to size of survey areas.