# FISH COMMUNITY CHANGES IN AN EXPLOITED MARINE ECOSYSTEM: NEWFOUNDLAND SOUTHERN GRAND BANK AND ST. PIERRE BANK, 1951-1995



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0-612-54866-X

# Fish Community Changes in an Exploited Marine Ecosystem: Newfoundland Southern Grand Bank and St. Pierre Bank, 1951-1995

by

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A thesis submitted to the School of Graduate Studies
in partial fulfillment of the
requirements for the degree of
Master of Science

Department of Biology
Memorial University of Newfoundland
April 2000

St. John's Newfoundland

## Abstract

Longterm fish community changes on southern Grand and St. Pierre Banks were examined from dedicated research survey trawls conducted by the Canadian Department of Fisheries and Oceans from 1951-1995. These time series pre-date the arrival of factory-freezer-trawlers in the 1960's and 1970's, and thus provide insight into changes in the biomass and diversity of an exploited system. The time series were standardized by applying conversion factors for changes in vessel, diel changes in catchability, and relative catchability of selected species. Total biomass in the 1990's was reduced to 11% and 9% of that observed in the 1950's on southern Grand Bank and St. Pierre Bank, respectively, and largely resulted from the decline of the haddock population. Compensatory responses to this decline were visible with the flatfish on southern Grand Bank and skate on St. Pierre Bank but continued fisheries for flatfish and bycatch of skate ensured that total species biomass would remain at low levels. This study shows the importance of examining data on as long a time-scale as possible. Failure to examine such historical data has resulted in the largest skate in the northwest Atlantic, the barndoor skate, being driven to near extinction without anyone noticing.

## Acknowledgements

I would like to thank Dr. R. A. Myers for giving the opportunity to work on such an interesting and challenging Masters project, and for having such confidence in my ability to get the job done. I would also like to thank Dr. R. L. Haedrich, Dr. P. Snelgrove, and Dr. R. Knoechel for provided valuable criticism on this thesis.

The Canadian Department of Fisheries and Oceans Groundfish Division, St. John's, Newfoundland is thanked for providing data for this analysis. B. Atkinson, G. Lily, and S. Walsh provided much appreciated help in interpreting the data. Noel Cadigan is thanked for suggesting the form of model 2 in Chapter 1.

The Canadian Department of Fisheries and Oceans, Halifax, and the National Marine Fisheries Service at Woods Hole, MA are thanked for providing the data for Chapter 3. Also, B. Atkinson, K. Frank, J. E. Simon, M. Fogarty, S. Murawski and J. Hutchings are thanked for their helpful discussions of Chapter 3.

And last, but not least, I would like to thank my husband, Gavin Crutcher, for his patience and emotional support. I would also like to thank our son, Andrew, who showed me the benefits of applauding your own accomplishments no matter how small they might be.

*The story of this population is a very good example of how a fishery can disappear while being watched carefully by fisheries biologists and an international regulatory body* (Templeman 1978 - in reference to the haddock population on the southern Grand Bank).

# Contents

# List of Tables

# List of Figures

# Introduction and Overview

Fish populations have been exploited for centuries, with the expansion from simple food fisheries to extensive commercial fisheries (Sahrhage and Lundbeck 1992). At a time when many fish stocks around the world have been overexploited (Hilborn and Walters 1992; Larkin 1977) and the world's fishery harvest has reached one million metric tonnes (Pauly 1996), serious consideration must be given to the effect exploitation has, not only on commercial species, but on the marine community as a whole.

The natural variability observed in many fish populations (Caddy and Gulland 1983) may result from fishing pressure, changing environmental conditions, or from species interactions, such as competition and predation (Sissenwine 1984). The importance of species interactions are becoming better recognized, with multispecies studies rapidly replacing the single-species approach to fishery assessment (Kerr and Ryder 1989). Fisheries harvest more than the targeted species, as evidenced in by-catch statistics (Alverson et al. 1994), and thus are multispecies in nature. In the North Sea, however, a recent study has shown that non-targeted groundfish communities have remained stable in spite of intensive fishing (Greenstreet and Hall 1996). A similar result was observed for non-targeted deep-water fish assemblages in the Northwest Atlantic (Haedrich 1995).

Changes in species composition may occur as a result of competitive or predator-prey relationships which are precipitated by changes in environmental conditions or fishing pressure. One species may be better adapted to changing environmental conditions and thrive, thus out-competing the other species for food and space. In the Northeast Pacific, the sardine (*Sardinops caerulea*) was replaced by a competitor, the northern anchovy (*Engraulis mordax*), as a result of changes in the oceanographic environment that favoured the anchovy (?). A similar interaction was observed between the Atlantic herring (*Clupea harengus*) and Atlantic mackerel (*Scomber scombrus*) populations in the Northwest Atlantic (Skud 1982).

Fisheries tend to target the largest, most abundant species which are higher up the food chain (Deimling and Liss 1994). Removal of these larger species enables smaller species to expand their populations. Analysis of the Great Lakes' fish populations has shown a shift from large, long-lived species with higher commercial value, to small, short-lived species which are less preferred (Smith 1968; Steedman and Regier 1990). Intensive exploitation in the North Sea has resulted in the decrease in the number of fish from the larger length classes (Anon 1996). A similar result was observed on Georges Bank following the heavy exploitation of the 1960's and 1970's. Recently the proportion of fish from larger length classes has increased, due primarily to the increase in elasmobranchs (Murawski and Idoine 1992).

The distinction between the effects of exploitation and the environment is not easily made (Harris and Poiner 1991), and often effects due to changing environmental conditions may be further exacerbated by exploitation (Ludwig et al. 1993). Furthermore, environmental conditions, while being difficult to predict, cannot be controlled (Walters and Collie 1988). Alternatively, fishing effort is easily predicted and controlled.

In the Northwest Atlantic, commercial fisheries date back to the 1400's and over the following 500 years the fishery expanded from inshore to offshore. The inshore fishery had been more successful than the offshore until the mid-1950's when factory-freezer-trawlers first arrived on the Newfoundland Grand Banks (Hutchings and Myers 1995). The incredible increase in fishing effort, due to the power and storage capabilities of the factory freezer trawlers, was evidenced by the fact that the total amount of fish caught in two thirty-minute trawls was equal to the total amount of fish harvested in one year by the French in the 1500's (Warner

1983). The number of factory freezer trawlers fishing off the coast of Newfoundland increased into the 1960's and 1970's. In 1977, fishing by foreign fleets was reduced with the establishment of Canada's 200 mile limit (Pinhorn and Halliday 1990). This decrease in foreign fishing effort, however, was not matched by a decrease in effort from Canadian vessels, and in 1992 a moratorium was imposed in response to drastically depleted cod stocks off the coast of Newfoundland (Bishop et al. 1993).

Recent studies in the eastern North Atlantic (NAFO Divisions 2J3K) suggest that there has been a gradual decline in species abundance since 1978 (Gomes et al. 1995; Haedrich 1995; Villagarcia 1995). Total species abundance has remained fairly constant on the Newfoundland Grand Banks (Gomes et al. 1992) and Georges Bank (Fogarty and Murawski 1998) since 1971 and 1963, respectively. On Georges Bank this stability has resulted from an increase in the population size of elasmobranchs (Murawski and Idoine 1992). Both study periods began after the arrival the factory-freezer-trawlers, and thus may have missed the population maxima during the low exploitation period.

The main purpose of this study is to reconstruct the population history of fish species from the Southern Grand Bank and St. Pierre Bank back to the early 1950's, prior to the arrival of factory-freezer-trawlers. Research vessel survey data from the Department of Fisheries and Oceans will be examined to initially determine if the change in the timing of the surveys, from daylight hours to twenty-four hours a day, significantly effects the catchability of fish species (Chapter 1). Prior to 1972, research surveys in this region were primarily conducted during daylight hours. Without this correction, estimated abundance of species with variable patterns of diel catchability may be inaccurate.

In Chapter 2 this information will be used to calculate estimates of absolute abundance of groundfish species to determine if relative species abundance has been altered over the time period. The structure of the groundfish community will be examined in terms of changes in species diversity and dominance throughout this period of intense exploitation.

Finally, Chapter 3 concentrates on one species, the barndoor skate, and the effect that the fishery has had on this non-commercial species. This chapter shows the importance of assembling data on as long a time-scale as possible and as wide a spatial scale as possible. Failure to examine such historical data has allowed this species to disappear without anyone noticing.

# Co-authorship Statement

Chapter 1 was published in the Canadian Journal of Fisheries and Aquatic Science (1998) 55: 2329-2340 and Chapter 3 was published in Science (1998) 281: 690-692. Both studies were co-authored by Dr. R. A. Myers who suggested the proper analyses for each chapter. I researched the literature, manipulated the data, completed the analyses and wrote the text under Dr. Myers direct supervision.

# Chapter 1

# Diel variation in trawl catchability: Is it as clear as day and night?

## 1.1 Abstract

Diel variation in the catchability of over 50 species was examined using research vessel surveys conducted off the coast of Newfoundland and Labrador from 1972 to 1995. Catchability during the day and night was estimated for several seasons and geographic areas in the northwest Atlantic using two generalized linear models. In general, species exhibiting diel vertical migrations, such as redfish, northern sand lance and haddock, were caught in higher proportions during the day. Non-migrating species, such as flatfish, skate and scuplin, which rely on visibility of the trawl as a means of escapement, were caught in higher proportions during the night. Analysis of the effect of depth indicated that catchability during the day, relative to the night, increased significantly with depth for 21 species. This study

demonstrates that the accepted methods of estimating standard errors for generalized linear models are not valid for survey trawl data and suggest alternative methods.

## 1.2 Introduction

Many countries conduct bottom trawl surveys for the purpose of estimating abundance of commercial species. Determining the efficiency of survey gear, however, is a key component of estimating abundance and interpreting these survey results. The survey vessel, time of year and time of day affect the survey trawl efficiency. Fish behaviour in response to physical factors, such as light intensity, has been shown to affect the efficiency of the survey gear over a 24 hour period (Walsh 1991). Abundance of species exhibiting diel vertical migration would be overestimated during surveys conducted during the day as compared with surveys conducted at night, when these species would be out of the vertical range of the trawl (Michalsen et al. 1996). Increased visibility of the trawl during the day (Glass and Wardle 1989) could result in lower catches of non-migrating species and thus abundance would be underestimated. Consequently, estimated abundance of species with variable patterns of diel catchability may be inaccurate. Analysis must be carried out to determine if diel variability in catchability exists, and if so, to correct for this difference.

Several studies of diel catchability have made use of designed experiments in which a predetermined number of tows was carried out under controlled conditions (Walsh 1991; Walsh and Hickey 1993; Engås and Soldal 1996). While important information on fish behaviour in the vicinity of survey gear has been obtained, the number of tows completed has often been too few to give precise estimates. Furthermore, the results may not take into account regional or seasonal changes in catchability.

The purpose of this paper is to present a simple method that allows the relative efficiency of fishing gear during the day and night to be rigorously estimated using data routinely collected during research surveys. This approach combines data from many years and several geographic areas.

A further motivation for this work is to provide correction factors for older research surveys of the Canadian Department of Fisheries and Oceans, many of which were conducted almost exclusively during daylight hours. As data collected from commercial vessels are thought to be unreliable, more emphasis is being placed on research vessel surveys. Correction factors for diel variation in trawl catchability are essential in determining absolute abundances from these surveys.

## 1.3 Methods

### 1.3.1 Data

Research surveys have been conducted by the Canadian Department of Fisheries and Oceans off the coast of Newfoundland since 1946 (Templeman 1966). Prior to 1972, however, surveys were primarily conducted during daylight hours. We examined stratified random surveys conducted around the Island of Newfoundland and the coast of Labrador (Pitt et al. 1981) from 1972 (when both day and night surveys were conducted in roughly equal proportion) to 1995 during which time approximately 20,000 research tows were successfully made. Only tows with a duration of 30 minutes were selected for this analysis. Data from seven Northwest Atlantic Fisheries Organization (NAFO) subdivisions (Figure 1.1), each with different bottom topographies, were included in this study. Seasons of the surveys are given in Table 1.1.

Species were selected for analysis if they occurred in more than 100 tows, and only strata in which individual species were caught in more than five tows were included. Sunrise and sunset were determined using the day of year and latitude of the tows (Brock 1981). Tows which occurred within one hour of sunrise and sunset were excluded so that successive tows would not be compared (e.g. the last tow of the night and the first tow of the day).

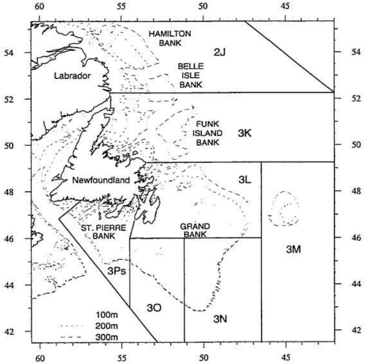


Figure 1.1: Map of NAFO areas around Newfoundland. The 100 (dotted line), 200 (narrow dash), and 300 (wide dash) meter isobaths are given for reference.

### 1.3.2 Model

#### Model 1

Consider a survey in year $y$, in which $C_{y,s,l}$ fish are caught in stratum $s$ during the time of day (i.e. day or night) $l$. The catchability associated with time of day $l$ is $S_l$, where the catchability will be scaled so that the catchability during the night will be 1. We construct a simple model in which an equal proportion of fish will be in each stratum in all years. The expected value of the catch, $E[C_{y,s,l}]$, is

$$E[C_{y,s,l}] = N_y P_s S_l$$

where $N_y$ is the number of fish in the population in year $y$, $P_s$ is the proportion of fish stratum $s$, and $S_l$ is the combined availability and vulnerability of each species to the survey gear (or catchability) associated with time of day, $l$. The simplest model for the probability of catching $C_{y,s,l}$ fish is a Poisson distribution. This is not a realistic model, however, because fish usually aggregate (i.e. in schools) and, as such, are not captured independently. Also, habitat within a stratum is not equally suitable. An over-dispersed, i.e. extra-Poisson model, is preferred in which over-dispersion is modeled using a scale factor for the variances (McCullagh and Nelder 1989). The scale factor only affects the variance, but not the parameter estimates. The data can be analyzed in terms of a generalized linear model (GLIM) with a log link.

The main assumption of this model is that an equal proportion of fish will be in each stratum in all years. This may not be a valid assumption, however, as it is unlikely that the distribution of fish will remain constant from year to year.

**Model 2**

To remove the assumption of a constant stratum and year effect, the data considered will be restricted to strata within years in which at least one day and night tow has occurred.

Let $C_{ysd}$ be the total catch in numbers during the day in a particular year and stratum, and $C_{ys}$ be the total catch for the day and the night in the same year and stratum. $T_{ysd}$ and $T_{ysn}$ will be the corresponding number of day and night tows, respectively. Let the probability that a fish caught in a year, $y$, and stratum, $s$, is caught during the day be $p_{ys}$, and $1-p_{ys}$ for night catches. If there is no difference between day and night catchability, then we would expect

$$\frac{p_{ys}}{1-p_{ys}} = \frac{T_{ysd}}{T_{ysn}}$$

We are interested, however, in whether or not a different proportion of fish are caught during the day and night, and so the catchability term, $S_d$, is multiplied to the right hand side of the above equation. After a log transformation we have

$$\log\left(\frac{p_{ys}}{1-p_{ys}}\right) = \log(S_d) + \log\left(\frac{T_{ysd}}{T_{ysn}}\right)$$

The left side of the equation represents the logit transformation $p_{ys}$. The term on the far right is the offset (McCullagh and Nelder 1989), a known quantitative variate, which will account for the number of day and night tows. The log of the catchability during the day, $S_d$, is the intercept and will be estimated. Positive estimates indicate higher daytime catchabilities, while negative estimates indicate higher catchabilities at night.

If fish of a given species are captured independently, and if the probability of catching a fish during the day is constant for individuals of that species, then the probability of catching a fish during the day in a particular year and stratum ($C_{ysd}$), given the total number of fish caught in that year and stratum ($C_{ys}$), is binomial. Over-dispersion must also be taken into account with Model 2. An extra-binomial model is preferred in which over-dispersion is modeled using a scale factor for the variances (McCullagh and Nelder 1989). A GLIM with a logit link and an offset is used to analyze the data. The method of programming is given in the Appendix A.

This model also makes a potentially unrealistic assumption that the same proportion of fish will remain in a stratum during the survey period for a given year. Many species make seasonal migrations which take them into and out of the arbitrarily assigned strata, and as such would not be expected to restrict their distribution during the year.

It is not clear that either of the above models is superior as both make assumptions that may not be valid for research survey data. For simplicity, Model 2 was chosen for this analysis, although reference will be made to the results of Model 1 as a method of comparison.

### 1.3.3 Regional and Seasonal Differences in Diel Catchability

Differences in bottom topographies associated with each NAFO area could possibly affect diel catchability. Banks within the study area range from 150-300m in depth surrounded by troughs of 450-500m in the north, to depths of 100m with 150-200m deep troughs in the south (Litvin and Rvachev 1963).

Seasonal changes in diel catchability have been suggested for various groundfish species (Beamish 1965). Since the degree of vertical migration within the water column may vary seasonally, research surveys conducted in different seasons were examined separately.

This analysis examines nine region and season combinations over which estimates of diel catchability will be compared.

### 1.3.4 Randomization Tests

The reliability of confidence limits and significance tests for the day/night effect was assessed using a randomization test (Manly 1991). For each area/season combination studied (Table 1.1), the catchability of day tows was estimated using Model 2 and the original data, with half of the data randomly assigned to the day and half to the night. Significance was determined by calculating the 95% confidence interval based on the standard errors of the GLIM estimates. The proportion of significant tests from 100 randomizations was then determined.

The randomization tests showed that the standard significance levels and standard errors of the parameter estimates were not reliable. Figure 1.2 shows the proportion of significant tests from the 100 randomizations for each species and region/season combination. With a significance level of 5%, the proportion of nominally significant tests should have been 0.05. For only 33% of the species and region/season combinations, however, was the proportion of significant tests less than or equal to 0.05.

Fish species which are known to school, such as capelin, redfish, Atlantic cod and arctic cod, tended to have a higher proportion of significant tests, while with solitary species, such as wolffish, the proportion of significant tests was closer to 0.05. In subdivision 3M, where the number of species and number of observations were the lowest for all subdivisions, the proportion of significant tests tended to be lower. In subdivisions with many observations, such as 3L and 3N O, the opposite was true.

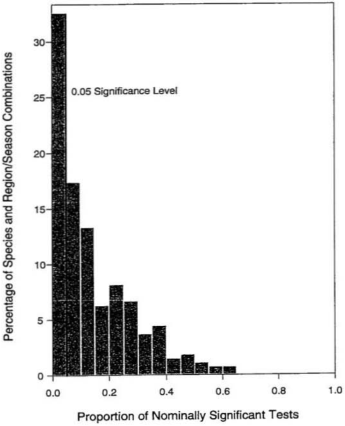


Figure 1.2: Frequency of the proportion of nominally significant tests obtained from the randomizations for all species and region/season combinations (as in Table 1.1). The frequency is given as the percentage of species and region/season combinations (n=266).

Alternative estimates of reliability were constructed as the standard deviation of the mean of the parameter estimates from the 100 randomizations. These estimates of reliability in Table 1.1 represent the standard errors under the null hypothesis (i.e. no difference between day and night catchability), and are used in hypothesis testing (Manly 1991). It was decided that 100 randomizations were sufficient as this study deals with many region/season combinations. The main interest of this study is to examine trends across all region and season combinations rather than the reliability of a single estimate.

### 1.3.5 Depth Effects

Depth, which has been thought to contribute to the variability in diel catchability (Pitt 1967), was examined using Model 2. Tows were categorized into approximately 100m depth classes that corresponded with the average depth of the strata included in this study (Bishop 1994). The model was run initially as a regression analysis with depth as a covariate. Since the standard significance tests are considered to be liberal, any species for which depth was not significant was eliminated. For the remaining species, estimates of reliability for the depth effect were then determined with the depth categories randomly assigned in the same proportion as would normally be observed for each species. For example, it would be unlikely that a species normally found at shallow depths would be caught in equal proportions at the greatest depths. The standard deviation of the estimates from 100 randomizations were used in hypothesis testing. Estimates of diel catchability in each depth class were then determined using Model 2.

## 1.4 Results

Estimates of diel catchability were obtained for all region/season combinations (Table 1.1 and Figure 1.3). Negative estimates indicated higher catchabilities at night. The summary refers to estimates determined over all regions and seasons. Of the 32 species with significant differences over all regions and seasons, 12 were caught significantly more during the day and 20 were caught significantly more at night.

Estimates for the family Gadidae differed among species. Arctic cod was caught significantly more during the day in subdivision 3L in both the fall and spring surveys, while the estimate for subdivision 3Ps indicated a higher night catchability. The estimates for Atlantic cod were also variable with higher day catchabilities in subdivisions 3M and 3NO and a higher night catchability in subdivision 2J. Haddock was caught significantly more during the day, while the opposite was true for longfin hake. Only longfin hake had significant results across all regions and seasons.

All of the flatfish species included in this analysis had significant differences in diel catchability, although no consistent pattern among the species could be found. Witch flounder was caught significantly more during the night in 3L (summer only) and 3NO. Higher daytime catchability for witch founder was found in subdivision 2J only. Atlantic halibut and Greenland halibut were caught significantly more during the day, while yellowtail flounder was caught significant more at night. Estimates for American plaice differed regionally with catchability in 3NO and 3Ps spring surveys higher at night. In the north, catches were higher during the day.

Table 1.1 Comparison of species catchability during day and night trawls. The number in parentheses refers to the standard errors computed using a randomization procedure (see text). Estimates for all regions and seasons (Summary) are provided with standards errors. Positive estimates indicate higher catches during the day relative to the night. Significant estimates are given in bold. For a list of order, family and species names see Table 2.1

| Species | 2J Fall | 3K Fall | 3L Fall | 3L Spring | 3L Summer | 3M Spring | 3NO Fall | 3NO Spring | 3Ps Spring | Summary |
|---|---|---|---|---|---|---|---|---|---|---|
| Herring | | | | | | | | **2.02**(0.53) | **0.81**(0.22) | **0.91**(0.22) |
| Arctic cod | 0.24(0.23) | -0.25(0.16) | **0.5**(0.14) | **0.38**(0.17) | -0.04(0.53) | | 0.95(1.22) | | **-1.12**(0.24) | 0.27(0.08) |
| Atlantic cod | **-0.23**(0.08) | -0.15(0.14) | -0.15(0.1) | -0.05(0.09) | 0.09(0.14) | **1.16**(0.43) | **0.26**(0.11) | **0.23**(0.09) | -0.26(0.15) | 0.05(0.05) |
| Greenland cod | -0.28(0.38) | | | | | | | | | -0.28(0.42) |
| Haddock | | | -1.29(1.08) | | 1(0.97) | | -1.32(0.83) | **0.87**(0.25) | **0.34**(0.17) | 0.51(0.2) |
| Silver hake | | | | | | | -0.99(0.66) | 0.02(0.24) | 0.37(0.2) | 0.26(0.18) |
| Pollock | | | | | | | | 0.99(0.75) | 0.11(0.36) | 0.2(0.32) |
| Longfin hake | | | | | | **-0.95**(0.16) | **-1.55**(0.73) | **-1.01**(0.26) | **-0.42**(0.11) | **-0.58**(0.09) |
| White hake | | | | | | | -0.18(0.46) | 0.24(0.15) | 0.01(0.09) | 0.04(0.07) |
| Roundnose grenadier | -0.9(0.65) | **-1.38**(0.59) | | | | | | | | **-1.3**(0.49) |
| Roughhead grenadier | 0.08(0.06) | 0.09(0.05) | **0.41**(0.13) | -0.12(0.09) | **0.35**(0.14) | 0.1(0.11) | 0.87(0.48) | 0.15(0.16) | | **0.19**(0.04) |
| Marlin-spike | 0.21(0.24) | -0.14(0.1) | 0.11(0.16) | 0.39(0.26) | -0.1(0.24) | **-0.27**(0.1) | -0.5(0.31) | **-0.39**(0.18) | 0.04(0.05) | -0.02(0.04) |
| Blue hake | -0.72(0.42) | -0.43(0.32) | | | | -0.14(0.18) | | | | -0.27(0.14) |
| Monkfish | | | | | | | | 1.12(1.33) | 0.19(0.12) | 0.14(0.12) |
| Lanternfishes | 0.12(0.22) | 0.78(0.49) | -0.25(0.27) | **3.56**(0.69) | 1.84(3.94) | -0.4(0.43) | | -1.22(1.07) | -0.6(0.43) | -0.18(0.18) |
| Barracudina | -0.35(0.54) | 0.09(0.3) | **1.07**(0.43) | 0.4(0.25) | 0.05(0.26) | | | | 0.43(0.3) | **0.48**(0.16) |
| Longnose eel | -0.16(0.44) | -0.28(0.5) | | | | | | | | -0.24(0.37) |
| Atlantic hagfish | | | | | | | | | **-0.65**(0.18) | **-0.65**(0.2) |
| Spiny eels | | -0.74(0.38) | 0.75(0.79) | 0.11(1.17) | 1.47(0.98) | -0.58(0.29) | | | | -0.19(0.24) |
| Northern alligatorfish | **-0.34**(0.14) | -0.15(0.11) | **-0.44**(0.15) | **-1**(0.2) | -0.2(0.6) | | | | | **-0.56**(0.11) |
| Common alligatorfish | **-2.69**(0.93) | | **-1.06**(0.27) | -0.81(0.48) | | | **-2.38**(0.98) | | | **-1.01**(0.21) |
| Northern sand lance | | | **1.09**(0.3) | **1.78**(0.42) | 1.91(2.34) | | **2.43**(0.38) | **2.7**(0.4) | 3.58(2) | **1.59**(0.19) |
| Broadhead wolffish | **-0.2**(0.05) | -0.02(0.08) | 0.16(0.12) | -0.11(0.23) | 0.01(0.18) | -0.14(0.19) | | | | **-0.11**(0.04) |
| Striped wolffish | -0.09(0.08) | -0(0.05) | **0.29**(0.11) | -0.03(0.1) | -0.12(0.16) | **-0.87**(0.09) | **-0.82**(0.32) | **-0.71**(0.12) | **-1.19**(0.19) | **-0.29**(0.04) |
| Spotted wolffish | -0.12(0.09) | **0.32**(0.15) | -0.17(0.14) | 0.07(0.13) | 0.09(0.25) | **-0.63**(0.12) | | **2**(0.77) | | -0.09(0.06) |
| Hookear sculpin | **-1.73**(0.59) | **-0.89**(0.13) | **-2.13**(0.24) | **-1.87**(0.55) | | | | | | **-2.02**(0.2) |
| Arctic Deepsea sculpin | **-0.63**(0.23) | 0.23(0.16) | -0.14(0.78) | 0.56(0.44) | | | | | | 0.01(0.11) |
| Sea Raven | | | | 0.25(0.3) | | | **-1.08**(0.26) | **-0.52**(0.08) | **-0.51**(0.08) | **-0.56**(0.06) |

Table 1.1 Continued.

| Species | 2J Fall | 3K Fall | 3L Fall | 3L Spring | 3L Summer | 3M Spring | 3NO Fall | 3NO Spring | 3Ps Spring | Summary |
|---|---|---|---|---|---|---|---|---|---|---|
| Longhorn sculpin | | | **-3.55**(1.06) | -0.56(0.55) | | | **-1.33**(0.24) | **-1.2**(0.31) | **-1.84**(0.44) | **-1.44**(0.19) |
| Shorthorn sculpin | | | **-0.78**(0.34) | **0.55**(0.26) | | | 0.43(0.6) | -0.05(0.25) | 0.2(0.15) | 0.19(0.1) |
| Mailed sculpin | **-1.96**(0.38) | **-1.39**(0.63) | **-0.83**(0.17) | **-0.78**(0.25) | **-1.82**(0.29) | | -0.52(0.27) | **-1.12**(0.29) | **-1.13**(0.33) | **-0.78**(0.14) |
| Common lumpfish | **1.29**(0.42) | 0.95(0.49) | **1.84**(0.67) | 0.45(0.27) | | | | **1.21**(0.24) | **0.56**(0.2) | **0.57**(0.14) |
| Spiny lumpfish | **-1.52**(0.23) | | **-1.21**(0.12) | -2(0.2) | **-2.13**(0.64) | | **-1.95**(0.54) | **-1.83**(0.33) | **-2.68**(0.28) | **-1.54**(0.08) |
| Seasnails | -1.17(0.87) | **-1.96**(0.65) | **-1.28**(0.16) | **-0.95**(0.25) | | | **-3.75**(1.59) | | | **-1.31**(0.14) |
| Redfish | **0.65**(0.26) | 0.28(0.38) | **0.59**(0.23) | 0.2(0.16) | **1.01**(0.37) | **0.94**(0.15) | **0.99**(0.3) | **1.24**(0.23) | **0.63**(0.08) | **0.8**(0.07) |
| Fourline snakeblenny | | | -1.37(0.7) | | | | | | | **-1.37**(0.62) |
| Snake blenny | | | 0.51(0.28) | | | | 0.36(0.44) | | | 0.43(0.27) |
| Shanny | | | 0.28(0.32) | -1.05(1.05) | | | | | | 0.12(0.25) |
| Arctic eelpout | **-0.26**(0.09) | **-0.46**(0.12) | **-0.7**(0.11) | **-0.38**(0.08) | **-0.44**(0.09) | | -0.12(0.39) | **-0.53**(0.15) | -0.27(0.18) | **-0.54**(0.06) |
| Eelpout (Lycodes sp.) | 0.28(0.21) | 0.19(0.29) | -0.86(0.68) | 0.13(0.07) | | | | -0.35(0.56) | | 0.1(0.07) |
| Vahl's eelpout | -0.18(0.13) | **-0.24**(0.06) | -0.19(0.1) | -0.1(0.11) | **-0.58**(0.16) | -0.06(0.16) | -1.79(1.48) | 0.42(0.27) | | **-0.21**(0.04) |
| Witch flounder | 0(0.1) | **0.25**(0.1) | 0.19(0.16) | 0(0.11) | **-0.32**(0.1) | 0.28(0.16) | **-0.59**(0.14) | **-0.62**(0.13) | -0.09(0.08) | **-0.1**(0.05) |
| American plaice | **0.3**(0.09) | **0.16**(0.05) | **0.38**(0.08) | **0.39**(0.05) | **0.23**(0.08) | 0.21(0.13) | 0.03(0.07) | **-0.38**(0.07) | **-0.29**(0.11) | **0.2**(0.03) |
| Atlantic halibut | | | | | | | | 0.26(0.13) | 0.41(0.16) | 0.34(0.12) |
| Yellowtail flounder | | | **-0.76**(0.19) | **-0.68**(0.23) | **-0.62**(0.28) | | **-1.02**(0.17) | **-1.06**(0.11) | -0.32(0.22) | **-1**(0.1) |
| Greenland halibut | -0.01(0.06) | -0.07(0.05) | **0.28**(0.07) | **0.32**(0.08) | -0.08(0.1) | -0.05(0.09) | **0.78**(0.15) | 0.1(0.11) | 0.02(0.08) | 0.02(0.03) |
| Thorny skate | **-1.07**(0.12) | **-0.64**(0.06) | **-0.8**(0.08) | **-0.75**(0.09) | **-0.77**(0.12) | **-1.19**(0.13) | **-0.74**(0.08) | **-0.98**(0.12) | **-1.15**(0.13) | **-0.87**(0.04) |
| Smooth skate | **-0.64**(0.24) | **-0.61**(0.1) | **-0.8**(0.36) | -0.13(0.29) | | **-1.49**(0.43) | **-1.54**(0.64) | **-1.03**(0.36) | **-0.43**(0.1) | **-0.62**(0.07) |
| Atlantic argentine | | | | | | | | **2.03**(0.64) | **0.83**(0.2) | **0.93**(0.19) |
| Capelin | 0.59(1.21) | 0.32(0.19) | 0.23(0.13) | **1.82**(0.2) | **1.33**(0.62) | | 1.16(0.78) | 0.34(0.36) | 1.4(0.74) | **0.95**(0.12) |
| Black dogfish | -0.03(0.25) | -0.66(0.85) | | | | -0.47(0.47) | | | 0.11(0.06) | 0.1(0.06) |
| Spiny dogfish | | | | | | | | 1.39(3.65) | -0.34(0.51) | -0.33(0.49) |

Higher catchabilities during the day were found for several deepwater species, such as Atlantic argentine and roughhead grenadier, and pelagic species, such as capelin and herring. Redfish and northern sand lance, which have higher daytime catchabilities, have a demersal existence during the day, but become pelagic feeders at night (Scott and Scott 1988).

Estimates for each species of lumpfish were consistent for all regions and seasons. Common lumpfish catches, however, were significantly higher during the day, while spiny lumpfish had a significantly higher catchability at night across all regions and seasons.

For species of wolffish, sculpin, skate and eelpout, catches were higher at night. Both striped and spotted wolffish, however, also exhibited higher day catchabilities in subdivision 3L (fall only) and 3K surveys, respectively.

Parameter estimates for catchability during the day were generally not different for Models 1 and 2 (Figure 1.4). The only exceptions were roundnose grenadier and northern sand lance. The fact that two models, using two variations on the same data set (Model 2 used a much smaller proportion of the Model 1 data set), would have such similar results, suggests that the results of this analysis are believable.

Significant estimates for the effect of depth on diel catchability were obtained for 24 species (Table 1.2). For the majority of these species, depth was positively associated with higher catchabilities during the day relative to the night. At shallow depths, these species were more likely to caught in greater proportions during night tows, but at greater depths, catchability was likely to be higher during the day. Only three species had a negative association with depth.

Catchability was not affected by the type of vessel used over the time period. Estimates of diel catchability obtained for each region, season, and vessel combination did not differ significantly from those obtained using only region and season combinations.

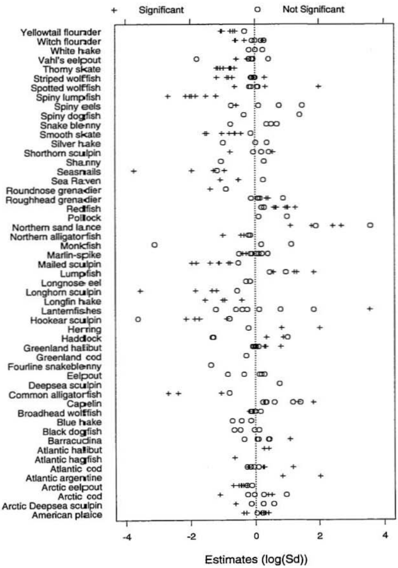


Figure 1.3: Estimates of the day/night effect for all region and season combinations (as in Table 1.1). Negative results indicate higher catchability at night. Significant (+) and non-significant (○) results are differentiated and a reference line at zero is provided for comparison.

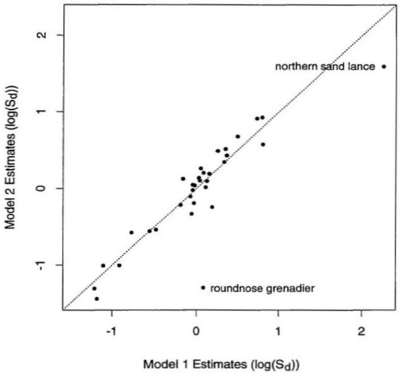


Figure 1.4: Comparison of the parameter estimates combined over all regions and seasons for Model 1 and Model 2. Each point represents an individual species. A one-to-one reference line is also given.

Table 1.2: Influence of depth on diel catchability. The second column is the estimate of the slope from the regression analysis, where positive estimates indicate higher catches during the day relative to the night as depth increases. The number in parentheses refers to the standard error under the null hypothesis (as in Table 1.1). Only those species with significant estimates are shown. Estimates of diel catchability in each depth zone, which correspond to average depths of the strata, are given for comparison. Significant estimates are given in bold.

| | | Depth Zone (in meters) | | | | |
|---|---|---|---|---|---|---|
| Species | Estimate of the depth effect | < 91 | 92-183 | 184-274 | 275-366 | 367-549 |
| American plaice | **0.39**(0.03) | **-0.28**(0.06) | **0.42**(0.06) | **0.51**(0.1) | **0.24**(0.11) | 0.28(0.28) |
| Arctic cod | **0.29**(0.12) | -0.47(0.32) | **0.35**(0.15) | 0.22(0.18) | **0.93**(0.43) | |
| Arctic eelpout | **0.38**(0.09) | **-1.09**(0.13) | **-0.58**(0.11) | -0.14(0.15) | **-0.38**(0.15) | |
| Atlantic hagfish | **0.99**(0.35) | | -3.33(19.1) | **-1.05**(0.48) | -0.13(0.4) | 0.21(21.91) |
| Barracudina | **0.56**(0.25) | | | -0.16(0.43) | 0.46(0.31) | **0.96**(0.26) |
| Capelin | **-0.44**(0.13) | **1.41**(0.44) | **1.12**(0.2) | 0.2(0.21) | 0.72(0.43) | 0.49(9.24) |
| Common alligatorfish | **1.06**(0.29) | **-3.41**(0.69) | **-1.25**(0.3) | -0.05(0.39) | -0.11(0.53) | |
| Common lumpfish | **-0.52**(0.21) | **1.28**(0.36) | 0.34(0.31) | 0.87(0.67) | -0.1(0.51) | 0.66(0.34) |
| Hookear sculpin | **0.84**(0.22) | **-2.38**(0.75) | **-2.18**(0.27) | -0.55(0.3) | -0.34(0.54) | |
| Longfin hake | **0.46**(0.14) | | | **-0.96**(0.32) | **-0.82**(0.16) | -0.12(0.12) |
| Longhorn sculpin | **0.89**(0.37) | **-1.48**(0.22) | -0.39(0.47) | -1.42(5.33) | | |
| Longnose eel | **-1.87**(0.52) | | | | 1.11(17.02) | -0.76(0.7) |
| Marlin-spike | **0.15**(0.07) | | -0.09(14.34) | 0.02(0.14) | -0.27(0.14) | 0.07(0.07) |
| Northern alligatorfish | **0.67**(0.22) | -1.52(3.84) | **-1.17**(0.21) | -0.39(0.31) | 0.15(0.28) | |
| Sea raven | **0.39**(0.11) | **-0.72**(0.08) | **-0.35(0.14)** | 0.13(0.47) | | |
| Seasnails | **0.79**(0.23) | **-4.05**(0.35) | **-1.22**(0.21) | **-0.84**(0.2) | -0.28(0.27) | |
| Shorthorn sculpin | **0.94**(0.29) | -0.22(0.17) | **0.72**(0.22) | | | |
| Smooth skate | **0.32**(0.09) | -1.33(9.36) | **-0.99**(0.12) | **-0.59**(0.13) | -0.3(0.18) | -0.06(0.23) |
| Spiny eels | **1.79**(0.35) | | | | **-1.46**(0.71) | 0.33(0.29) |
| Spiny lumpfish | **0.99**(0.18) | **-2.51**(0.18) | **-1.43**(0.12) | -0.55(0.41) | | |
| Striped wolffish | **0.22**(0.05) | **-0.77**(0.12) | **-0.37**(0.08) | -0.16(0.07) | 0.01(0.09) | -0.78(0.56) |
| Thorny skate | **0.14**(0.04) | **-0.93**(0.1) | **-0.99**(0.07) | **-0.82**(0.08) | **-0.44**(0.11) | -0.13(0.17) |
| Vahl's eelpout | **0.16**(0.06) | 0.09(6.55) | **-0.49**(0.17) | **-0.21**(0.08) | -0.06(0.1) | -0.06(0.14) |
| Witch flounder | **0.22**(0.06) | **-0.96**(0.17) | -0.24(0.17) | -0.11(0.1) | 0.1(0.13) | 0.17(0.11) |

## 1.5 Discussion

The observed diel variation in catchability may be attributed to patterns of vertical migration, and escapement associated with visibility of the trawl. Redfish and northern sand lance are known to migrate vertically at night in search of food high in the water column (Scott and Scott 1988). The high catchability during the day for both species is consistent with this type of diel vertical migration. Atkinson (1989) and Beamish (1965) found similar results for redfish in the northwest Atlantic.

Previous studies of Atlantic cod and haddock have shown that catches were higher during the day (Engås and Soldal 1996; Walsh and Hickey 1993; Michalsen et al. 1996). Using acoustic techniques Beamish (1965) found that both species were found in higher concentrations on the bottom during the day. Our results for haddock are consistent with these studies. For Atlantic cod, however, diel catchabilities were variable among regions. The previous studies considered surveys conducted over a small geographic area and a short period of time and thus may not represent the variability of these species over their entire range.

Visibility is important to the ability to escape the trawl during daylight hours for some species (Glass and Wardle 1989), e.g. underwater video cameras have shown that some flatfish are able to avoid the trawl during the day (Walsh 1988; Walsh and Hickey 1993). In this study, however, not all flatfish showed higher catchabilities during night tows. Atlantic halibut, a deepwater species, was caught significantly more during the day indicating that this species may be migrating up into the water column at night, a previously undocumented phenomenon. The same may be true for American plaice found in deep water. Walsh (1991) carried out experiments on the Grand Banks and found higher catchabilities of American plaice at night, while Beamish (1965), who examined data from the Scotian shelf and the Gulf of St. Lawrence, found the opposite. These regional differences, however, may be confounded by the effects of depth on diel catchability. In our analysis, estimates of diel catchability for American plaice were higher during the day in the northern regions which also have the deepest strata. In the south, where strata are shallower, catchabilities were higher at night.

Analysis of the influence of depth indicated that catchability during the day, relative to the night, increased significantly with depth for 21 species. When diel catchability was examined for each depth zone, the greatest differences were between the shallowest depth ($< 91$m) and the rest of the zones. If light does not penetrate farther than the shallowest depth, then the diel catchability should not necessarily differ beyond this depth. This increase in catchability during the day with depth may be the result of diel vertical migrations.

This study has shown that there are clear differences between day and night catchabilities for many species in the northwest Atlantic, and that depth and geography are also important factors. Size and abundance of species, although not considered in this analysis, may also be important in determining the diel variation in trawl catchability (Korsbrekke and Nakken 1997). These differences should be taken into account in the assessment of fish stocks to improve estimates of abundance.

Stratified random surveys are conducted annually for the purpose of estimating abundance of commercial species. Our analysis has shown that these data can be used to augment other studies which require the use of specified controlled experiments. Research surveys provide many replicates of data necessary for rigorous hypothesis testing and should not be overlooked as a source of valuable information. Our results will allow the time series of groundfish research surveys to be extended back 45 years which was previously not possible because the earlier surveys occurred mostly during the day. Such an analysis is crucial for resolving major ecological issues (Greenstreet and Hall 1996).

An important general statistical issue has been raised as a result of this analysis. The standard methods for dealing with extra-Poisson and extra-binomial variation in generalized linear models (GLIM's) do not appear to provide an adequate basis for inference and hypothesis testing when dealing with stratified random research survey data. Our randomization testing clearly demonstrated that the variation in both models could not be explained by the scale factor, which inflates the binomial and Poisson variances in GLIM's. We suggest that for research survey data, and perhaps for other highly variable fisheries data, that randomization testing be undertaken to demonstrate the reliability of inferences. We have demonstrated, however, that by examining data from many geographical areas, the reliability of inferences can often be determined.

# Chapter 2

# Fish Community Changes in an Exploited Marine Ecosystem: Newfoundland Southern Grand Bank and St. Pierre Bank, 1951-1995

## 2.1 Abstract

Longterm fish community changes on southern Grand and St. Pierre Banks were examined from dedicated research survey trawls conducted by the Canadian Department of Fisheries and Oceans from 1951-1995. These time series pre-date the arrival of factory-freezer-trawlers in the 1960's and 1970's, and thus provide insight into changes in the biomass and diversity of a heavily exploited system. The time series were standardized by applying conversion factors for changes in

vessel, diel changes in catchability, and relative catchability of selected species. Total biomass in the 1990's was reduced to 11% and 9% of that observed in the 1950's on southern Grand Bank and St. Pierre Bank, respectively, and largely resulted from the decline of the haddock population. Compensatory responses to this decline were visible with the flatfish on southern Grand Bank and skate on St. Pierre Bank but continued fisheries for flatfish and bycatch of skate kept total species biomass at low levels.

## 2.2 Introduction

At a time when many fish stocks around the world have been overexploited serious consideration must be given to the role that fisheries play in the structuring of marine communities. Fisheries often target the largest and most abundant species which are higher up on the food chain (Deimling and Liss 1994). The removal of these top predators enables species at lower trophic levels to compensate for this loss of fish biomass. Fisheries, however, have become quite adaptive and efforts have often concentrated on the next trophic level when the catch per unit effort at the highest trophic level declines. This phenomenon has recently been referred to as "fishing down marine food webs" (Pauly et al. 1998).

The concept that total fish biomass remains constant over time, through species compensation, is over 50 years old (Allee et al. 1949). Two widely known examples have lent credibility to this idea. In the Great Lakes, the total weight of the catch remained relatively constant over the last 150 years (Regier and Hartman 1973). This is a case of species compensation where large predators, such as lake trout, are replaced by smaller, often introduced, species. This finding, however, is based upon commercial catches, and not true abundance. Consequently, trends in absolute biomass are difficult to interpret. The second is the observation that the total biomass of demersal fish on Georges Bank remained relatively constant from 1963 to 1990, with sharks and skates compensating for the loss of gadoid and flatfish biomass (Fogarty and Murawski 1998). By 1963, however, the biomass of the most desirable species on Georges Bank, such as halibut, haddock and cod, had already been greatly reduced by fishing (Smith 1994).

A unique data set from two regions in the northwest Atlantic is examined and allows the abundance of groundfish species to be estimated from the early 1950's, before the arrival of factory-freezer-trawlers, to 1995. The structure of the groundfish community will be examined in terms of changes in species diversity and dominance throughout this period of intense exploitation.

## 2.3 Methods

### Data

From 1947 to 1970 a "fixed" location survey along line transects, designed to sample a range of depths, was used to estimate groundfish abundance off the coast of Newfoundland (Pitt et al. 1981). Stratified random surveys began in 1971 and 1972, on the southern Grand Bank and St. Pierre Bank, respectively. The data collected prior to 1971 was converted to the new stratification scheme using the latitude, longitude and depth of the survey locations (Figure 1). Strata were included in the analysis if fewer than 10 years of data were missing, which would allow for a more complete time series. Fourteen strata from the southern Grand Bank, with depths ranging from 57-183 meters, and eleven strata from the St. Pierre Bank, with depths ranging from 56-274 meters, were selected for analysis (see Appendix B). Six years of St. Pierre Bank data were excluded due to the stratum constraints.

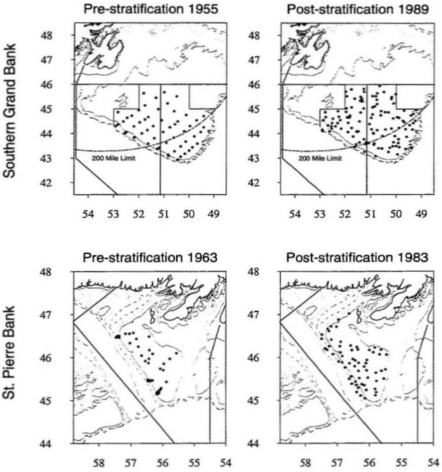


Figure 2.1: Map of research survey trawl locations on the southern Grand Bank and the St. Pierre Bank. Each (•) represents one trawl. The area of the southern Grand Bank used in this analysis is outlined and extends down to a depth of 183m. The Canadian 200 mile limit is provided as a reference on the southern Grand Bank. St. Pierre Bank strata considered are located on the bank and extend down to a depth of 366m west of 56° latitude. Years shown were selected arbitrarily.

Annual research surveys of the Southern Grand and St. Pierre Banks were conducted in the spring, but often extended into the summer and fall. For the purpose of this analysis, data was selected if the timing of the trawl occurred between January 1st and June 30th. Changes in the timing of the survey has consequences for species such as lumpfish (*Cyclopterus lumpus*) which migrate in-shore of the survey area in the spring to spawn (Scott and Scott 1988). Also, spiny dogfish (*Squalus acanthias*), which migrate from the south into the study area in the spring (Templeman 1963), may not be surveyed by trawls which occurred before the month of May. These species will not be considered.

The number of tows in which each species was caught was determined, and the common species were selected for analysis (Table 2.1). All redfish (*Sebastes* sp.) species were grouped because in the 1950's the distinction among species was not made as redfish species identification requires a dissection. Rare species and fish that were only identified to genus or family, but which occurred in the same family as the common species, were also selected and will be used to estimate biomass at the family level. Individual estimates of biomass are calculated for fish identified to species (see Appendices C and D).

## Standardization of the Data

### Vessels and Survey Gear

Dedicated groundfish research surveys were conducted using otter trawls with 29 or 30 mm mesh liners in all years (Table 2.2) in the study area. The *Investigator II* conducted research surveys from 1951-1960 and from 1963-1965 using a Yankee 36 otter trawl, while the *A.T. Cameron*, which replaced the *Investigator II*, conducted surveys from 1959-1982 using a Yankee 41.5 otter trawl. The *Wilfred Templeman*, which subsequently replaced the *A.T. Cameron*, conducted surveys from 1983-

present using the Engels 145 high-lift otter trawl.

Catches were standardized using correction factors determined from the area surveyed by each gear type relative to that of the *A.T. Cameron* (Table 2.2). The area surveyed was calculated as wingspread multiplied by the towing speed (Rijnsdorp et al. 1996). Paired tow comparisons, which were carried out in 1959-1960 between the *Investigator II* and the *A.T. Cameron* (Templeman et al. 1978), and in 1983 between the *A.T. Cameron* and the *Wilfred Templeman* (Gavaris and Brodie 1984), yielded similar results. It should be noted, however, that neither of the correction factors is large and is unlikely to have a profound effect on the observed trends in biomass.

### Diel variability in trawl catches

Prior to 1972, research surveys were primarily conducted during daylight hours. This may cause early estimates of abundance to be either underestimated, due to the increased visibility of the trawl during the day (Glass and Wardle 1989), or overestimated, if species exhibit diel vertical migrations that take them out of the vertical range of the trawl at night (Michalsen et al. 1996).

Conversion factors for the variation in diel catchability were calculated for over 50 species in the northwest Atlantic (Casey and Myers 1998a). Since the majority of the early research surveys were conducted during daylight hours, night catches for the entire period were adjusted by multiplying the weight by the appropriate conversion factor (Table 2.3).

Table 2.1: Number of research survey tows on St. Pierre Bank (3Ps) and southern Grand Bank (3NO) in which each species was caught. The ordering is alphabetical for the order, family and species. "Other" refers to any fish that was identified to family only. The habitat of each species, and the reported range relative to the study area are given for reference. D=demersal, P=pelagic, M=mesopelagic, C=coastal, DL=species found locally but usually at depths greater than that surveyed in the study area, L=local, LO=local species that migrates out of the area seasonally, MS=migrates into the area seasonally from the south, N=north of the study area, S=south of the study area, W=west of the study area.

| Species | 3Ps (n=1595) | 3NO (n=2678) | Habitat | Range |
|---|---|---|---|---|
| CLUPEIFORMES | 124 | 41 | | |
| **Clupeidae** | 124 | 41 | | |
| *Alosa pseudoharengus* (Alewife) | 3 | | P | S |
| *Clupea harengus* (Herring) | 123 | 41 | P | L |
| GADIFORMES | 1249 | 2238 | | |
| **Gadidae** | 1247 | 2237 | | |
| *Boreogadus saida* (Arctic cod) | 8 | 10 | P | N |
| *Enchelyopus cimbrius* (Fourbeard rockling) | 63 | 12 | D | L |
| *Gadus morhua* (Atlantic cod) | 1060 | 2108 | D | L |
| *Gadus ogac* (Greenland cod) | 1 | | D | N |
| *Gaidropsarus sp.* (Threebeard rockling) | 10 | 4 | D | DL |
| *Melanogrammus aeglefinus* (Haddock) | 585 | 851 | D | L |
| *Merluccius bilinearis* (Silver hake) | 385 | 135 | D | L |
| *Micromesistius poutassou* (Blue whiting) | 2 | 14 | M | S |
| *Pollachius virens* (Pollock) | 173 | 99 | P | L |
| *Urophycis chesteri* (Longfin hake) | 295 | 51 | D | DL |
| *Urophycis tenuis* (White hake) | 468 | 387 | D | L |
| **Macrouridae** | 294 | 76 | | |
| *Coryphaenoides rupestris* (Roundnose grenadier) | 1 | | D | DW |
| *Nezumia bairdi* (Marlin-spike) | 294 | 76 | D | S |
| LOPHIIFORMES | 375 | 128 | | |
| **Lophiidae** | 375 | 128 | | |
| *Lophius americanus* (Monkfish) | 375 | 128 | D | L |
| MYCTOPHIFORMES | 65 | 13 | | |
| **Paralepididae** | 65 | 13 | | |
| *Notolepis rissoi* (White barracudina) | 9 | | M | DL |
| *Notolepis sp.* (Barracudina) | 56 | 13 | | |
| MYXINIFORMES | 91 | 3 | | |
| **Myxinidae** | 91 | 3 | | |
| *Myxine glutinosa* (Atlantic hagfish) | 91 | 3 | D | L |
| PERCIFORMES | 1547 | 1891 | | |
| **Ammodytidae** | 95 | 492 | | |
| *Ammodytes dubius* (Northern sand lance) | 95 | 492 | D | L |
| **Anarhichadidae** | 268 | 577 | | |
| *Anarhichas denticulatus* (Broadhead wolffish) | 39 | 28 | D | N |
| *Anarhichas lupus* (Striped wolffish) | 241 | 538 | D | L |
| *Anarhichas minor* (Spotted wolffish) | 17 | 23 | D | N |
| **Cottidae** | 1018 | 1091 | | |
| *Artediellus sp.* (Hookear sculpin) | 17 | 42 | | |
| *Cottunculus microps* (Arctic deepsea sculpin) | 2 | | D | W |
| *Cottunculus sp.* (Deepsea sculpin) | 2 | | | |
| *Gymnocanthus tricuspis* (Arctic staghorn sculpin) | 1 | | D | N |
| *Hemitripterus americanus* (Sea raven) | 658 | 718 | D | L |

Table 2.1 (continued).

| Species | 3Ps (n=1595) | 3NO (n=2678) | Habitat | Range |
|---|---|---|---|---|
| PERCIFORMES | | | | |
| **Cottidae** | | | | |
| *Myoxocephalus octodecemspinosus* (Longhorn sculpin) | 654 | 656 | D | L |
| *Myoxocephalus quadricornis* (Fourhorn sculpin) | 1 | | D | N |
| *Myoxocephalus scorpius* (Shorthorn sculpin) | 213 | 35 | D | N |
| *Triglops sp.* (Mailed sculpin) | 87 | 130 | | |
| **Cyclopteridae** | 682 | 124 | | |
| *Cyclopterus lumpus* (Common lumpfish) | 655 | 59 | D | LO |
| *Eumicrotremus spinosus* (Spiny lumpfish) | 98 | 66 | D | N |
| **Scorpaenidae** | 631 | 491 | | |
| *Sebastes sp.* (Redfish) | 631 | 491 | D | L |
| **Zoarcidae** | 28 | 107 | | |
| *Gymnelus viridis* (Green ocean pout) | 2 | 3 | D | N |
| *Lycenchelys sp.* (Wolf eel) | 5 | 1 | | |
| *Lycenchelys verrilli* (Verrill's wolf eel) | 2 | | D | S |
| *Lycodes esmarki* (Esmark's eelpout) | 12 | 1 | D | DL |
| *Lycodes lavalaei* (Laval's eelpout) | 1 | 4 | D | L |
| *Lycodes reticulatus* (Arctic eelpout) | 27 | 94 | D | N |
| *Lycodes sp.* (Eelpout) | 7 | 74 | | |
| *Lycodes vahlii* (Vahl's eelpout) | 8 | 26 | D | DL |
| *Macrozoarces americanus* (Common ocean pout) | 7 | 27 | D | L |
| *Melanostigma altanticum* (Soft eelpout) | 3 | 1 | D | DL |
| Other (Eelpouts) | 2 | 2 | | |
| PLEURONECTIFORMES | 1387 | 2650 | | |
| **Pleuronectidae** | 1387 | 2650 | | |
| *Glyptocephalus cynoglossus* (Witch flounder) | 654 | 945 | D | L |
| *Hippoglossoides platessoides* (American plaice) | 1224 | 2576 | D | L |
| *Hippoglossus hippoglossus* (Atlantic halibut) | 190 | 280 | D | DL |
| *Limanda ferruginae* (Yellowtail flounder) | 492 | 1743 | D | L |
| *Pseudoplueronectes americanus* (Winter flounder) | 8 | 1 | D | L,C |
| *Reinhardtius hippoglossoides* (Greenland halibut) | 174 | 253 | D | DL |
| RAJIFORMES | 1277 | 2232 | | |
| **Rajidae** | 1277 | 2232 | | |
| *Raja fyllae* (Deepwater skate) | 1 | | D | DL |
| *Raja laevis* (Barndoor skate) | 23 | 18 | D | L |
| *Raja ocellata* (Winter skate) | 28 | | D | S |
| *Raja radiata* (Thorny skate) | 1228 | 2219 | D | L |
| *Raja senta* (Smooth skate) | 243 | 183 | D | L |
| *Raja spinicauda* (Spinytail skate) | 1 | | D | DL |
| SALMONIFORMES | 320 | 670 | | |
| **Argentinidae** | 242 | 90 | | |
| *Argentina silus* (Atlantic argentine) | 242 | 90 | D | DL |
| **Osmeridae** | 88 | 585 | | |
| *Mallotus villosus* (Capelin) | 88 | 585 | P | L |
| SQUALIFORMES | 298 | 25 | | |
| **Squalidae** | 298 | 25 | | |
| *Centroscyllium fabricii* (Black dogfish) | 81 | | P | DL |
| *Squalus acanthias* (Spiny dogfish) | 247 | 25 | P | MS |

Table 2.2: Comparison of research survey vessel and gear characteristics of the *Investigator II*, the *A.T. Cameron* and the *W. Templeman*.

| | *Investigator II* [1] | *A.T.Cameron* [2] | *W. Templeman* [3] |
|---|---|---|---|
| Vessel type | Stern trawler | Side trawler | Stern trawler |
| Tonnage | 124 | 753 | 925 |
| Length (m) | 24.6 | 53 | 50 |
| Speed of tow | 4 knots | 3.5 knots | 3.5 knots |
| Trawl | Yankee 36 | Yankee 41.5 | Engels 145 |
| Footrope (m) | 24.4 | 30.5 | 44.2 |
| Headrope (m) | 18.3 | 24.4 | 29.3 |
| Doors | | | |
| Weight (kg) | 362.9 | 589.7 | 1247.4 |
| Net opening (m) | | | |
| Wing spread | 10.7 | 13.4 | 18.3 |
| Headline height | 2.4-3.4 | 2.4-3.4 | 3.7-5.5 |
| Mesh size (mm) | | | |
| Codend liner | 29[4] | 30[3] | 30 |
| Area swept (1000 $m^2h^{-1}$) | 79.2 | 86.8 | 118.5 |
| Relative catchability | 1.1 | 1 | 0.73 |

[1](Templeman 1959)
[2](Gavaris and Brodie 1984)
[3](Walsh and McCallum 1995)
[4](Templeman et al. 1978)

Table 2.3: Conversion factors for diel catchability and the relative catchability of species. Conversions for diel catchability are applied to all night catches to make them comparable to that of the day. Conversions for relative species catchability are applied to biomass estimates to obtain estimates of absolute abundance (Edwards 1968).

| Species | Diel Catchability 3Ps | 3NO | Relative Species Catchability |
|---|---|---|---|
| American plaice | 0.75 | 0.68 | 0.28 |
| Atlantic cod | 1.00 | 1.26 | 0.28 |
| Atlantic halibut | 1.40 | 1.40 | 0.38 |
| Barndoor skate | 0.48 | 0.48 | 0.10 |
| Broadhead wolffish | 0.90 | 0.90 | 0.16 |
| Haddock | 1.40 | 2.39 | 0.48 |
| Longfin hake | 0.65 | 0.36 | 0.42 |
| Longhorn sculpin | 0.24 | 0.24 | 0.42 |
| Monkfish | 1.00 | 1.00 | 0.16 |
| Pollock | 1.00 | 1.00 | 0.08 |
| Redfish | 2.23 | 2.23 | 0.27 |
| Sea raven | 0.57 | 0.57 | 0.90 |
| Shorthorn sculpin | 1.00 | 1.00 | 0.42 |
| Silver hake | 1.00 | 1.00 | 0.04 |
| Smooth skate | 0.54 | 0.54 | 0.10 |
| Spotted wolffish | 0.91 | 0.91 | 0.16 |
| Striped wolffish | 0.75 | 0.75 | 0.16 |
| Thorny skate | 0.42 | 0.42 | 0.10 |
| White hake | 1.00 | 1.00 | 0.51 |
| Witch flounder | 0.90 | 0.90 | 0.49 |
| Yellowtail flounder | 0.36 | 0.36 | 0.39 |

### Biomass Estimates

The survey area is primarily stratified along depth zones. For the purpose of this analysis, strata of equal depths were combined within each region and then biomass estimates were calculated (Pinhorn 1971). All strata were not surveyed in all years and therefore by combining same-depth strata more years could be included in the analysis.

Biomass estimates, with standard errors, were determined for individual species using the standard calculations for stratified random methods (Cochran 1977). The estimation of standard error was modified when there was only one sample per stratum: the sample variances in the same stratum from the previous and following years were averaged. This correction was only used in one year for the southern Grand Bank data and in four years for the St. Pierre Bank data.

All species are not sampled equally by the survey gear, as the survey trawl used may be more efficient at catching certain species. With the use of research submarines, underwater cameras and acoustic surveys, Edwards (1968) determined the availability and vulnerability of species to the survey gear. More rigorous methods employed by Clark and Brown (1977), which considered commercial and research vessel surveys and weight at age data, yielded catchability coefficients comparable to those of Edwards' (1968). Correction factors for the relative catchability of species used in this analysis are listed in Table 2.3. Absolute indices of abundance are calculated by dividing the biomass estimates by these correction factors.

In order to visualize changes within the grounfish community, estimates of biomass were calculated at the family level. A "loess" was then used to graphically display the data (Cleveland 1979). This is a robust, local smooth using locally linear fits. A window, dependent on the fraction of the data selected to be analyzed, is placed around each x value; points inside the window are weighted so that nearby points get the most weight. A fraction equal to 0.25 was used for all families, except the Gadidae in the southern Grand Bank for which 0.45 of the data was used. The smoothing is used for graphical purposes only.

## Species Diversity

Two measures of species diversity were examined to identify changes within the groundfish community. Species richness is a simple measure of the total number of species in an given area (Gotelli and Graves 1996) and can provide information regarding the appearance or disappearance of species. Although changes in individual species are not identified with this summary measure, any changes in species richness over time can be further investigated. Species richness was calculated as the average number of species per tow in each year.

Evenness, a measure of the distribution of species abundances within the community, was chosen to examine changes in dominance within the groundfish community. Species evenness is negatively related to proportional abundances (Hill 1973). That is, low species evenness indicates that proportional abundances are high, and necessarily, that the community is dominated by only a few species.

Species evenness (E) was defined as $E = \frac{exp(H)}{N_o}$, where $H$ is the Shannon-Wiener function and $N_o$ is the corresponding species richness for each year (Hill 1973).

As a complement to the diversity indices, the cumulative biomass was calculated for each year. That is, biomass estimates were ranked from lowest to highest in each year and then the cumulative biomass was plotted against rank. A steeper rank abundance curve denotes dominance by only a few species.

## 2.4 Results

Large changes in the groundfish community occurred on both the southern Grand Bank (Figure 2.2) and St. Pierre Bank (Figure 2.3) where total biomass decreased by 70% and 80%, respectively, from the 1950's to the 1970's, and was largely representative of the family Gadidae. During the decrease in gadoid biomass on the southern Grand Bank, flatfish biomass increased and dominated through the 1960's, 1970's and into the 1980's, but was not nearly sufficient to compensate for the decrease in gadoid biomass. Flatfish biomass also increased on the St. Pierre Bank over the same time period, but the total biomass in this region was dominated by skate species which also increased as gadoids declined. Although gadoid biomass increased in both areas in the 1980's, by the 1990's the biomass of all species had decreased to its lowest level in at least 43 years. Only wolffish continued to increased in biomass into the 1990's on the southern Grand Bank.

Biomass of Atlantic cod, haddock and white hake, was greatest in the 1950's (Figures 2.4 and 2.5). While the biomass of cod peaked again in the mid 1980's, the biomass of the haddock and white hake remained low for the rest of the time period. On the southern Grand Bank, both cod and haddock had been equally abundant, while on the St. Pierre Bank, haddock had been twice as abundant as cod. Silver hake was abundant on the St. Pierre Bank where biomass was the greatest in the 1950's and peaked again in the mid 1980's.

Redfish biomass in both areas contributed to the high estimate of total biomass in the 1950's. Since redfish inhabit a range of depths from about 90m to over 350m (Templeman 1959), and the survey area being investigated only covers 50-80% of that range, these estimates represent only that portion of the population found at the upper limit of its vertical range. Redfish biomass, however, has declined since the 1950's, except for an increase on the southern Grand Bank in the 1980's.

Biomass estimates of American plaice, the dominant flatfish in this region, were greatest in the 1960's but gradually declined to the early 1990's. Yellowtail flounder biomass did not peak until the early 1970's and has decreased steadily since that time. The trends in biomass of Atlantic halibut and witch flounder more closely resemble that of the family Gadidae, with maximum estimates obtained in the 1950's and 1960's, and estimates remaining low since that time.

Skate biomass remained fairly stable over the time period. Biomass estimates of thorny skate, the dominant skate species in both regions, was greatest in the 1950's and 1960's on the southern Grand Bank but has decreased since the early 1970's. On the St. Pierre Bank thorny skate biomass did not peak until the mid 1960's and has been decreasing since that time. Smooth skate, one of the smallest skate species in the northwest Atlantic, was highly variable on the southern Grand Bank, but on the St. Pierre Bank, smooth skate biomass had been increasing until the 1980's. Barndoor skate and winter skate on the St. Pierre Bank had opposite trends in biomass over the time period. Barndoor skate biomass was greatest in the 1950's but decreased into the mid 1960's where it has remained at low levels ever since. Winter skate, however, was rarely caught until the mid 1980's when biomass estimates doubled. This may have resulted from a shift in distribution from the south.

Trends in biomass for wolffish, dominated by striped wolffish, differed for the southern Grand Bank and the St. Pierre Bank. On the St. Pierre Bank, wolffish biomass had been increasing until the mid 1970's when it peaked and subsequently declined. Estimates of wolffish biomass on the southern Grand Bank, however, have been increasing steadily.

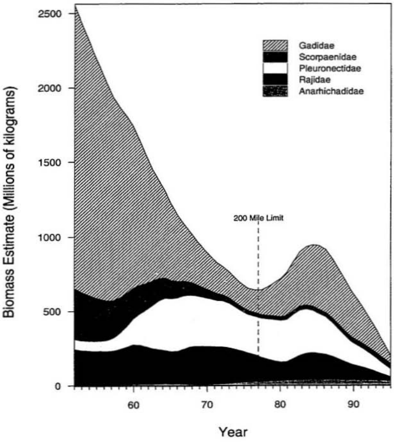


Figure 2.2: Estimate of total biomass from selected southern Grand Bank strata from 1952-1995. Loess curves are used to depict changes in family composition during the time series.

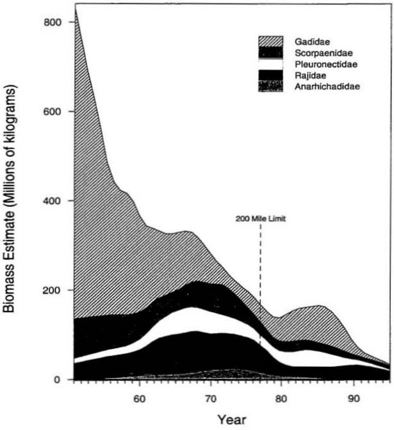


Figure 2.3: Estimate of total biomass from selected St. Pierre Bank strata from 1951-1995. Loess curves are used to depict changes in family composition during the time series.

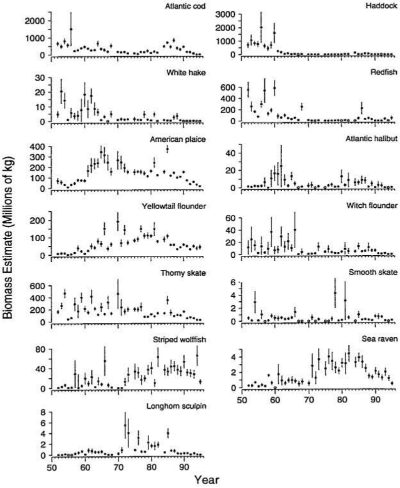


Figure 2.4: Estimates of biomass (with standard errors) for species in the selected region of the southern Grand Bank for the years 1952-1995.

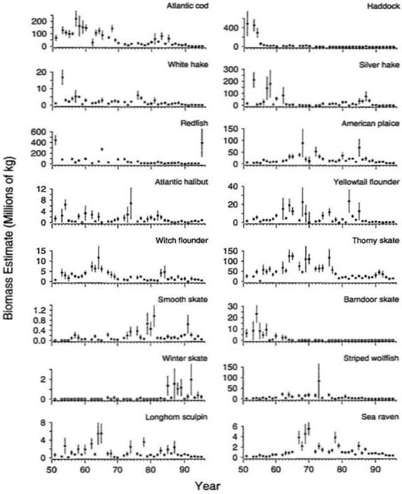


Figure 2.5: Estimates of biomass (with standard errors) for species in the selected region of the St. Pierre Bank for the years 1951-1995.

Other species, such as those in the family Cottidae, increased in biomass over time. Sea raven biomass peaked in the late 1960's on the St. Pierre Bank and the 1970's on the southern Grand Bank, and has since decreased in both areas. Trends in biomass for longhorn sculpin were similar to that of the sea raven, except on the St. Pierre Bank where estimates of biomass were highly variable.

Species richness (Figure 2.6) increased on both the southern Grand Bank and the St. Pierre Bank, although the results for the southern Grand Bank were more variable. On St. Pierre Bank, species richness increased sharply from about 18 species in the 1950's to about 24 species in the 1970's, at a time when the total number of individuals was actually in decline. To ensure that this result was not due to the research vessel, survey gear or survey location, species richness was recalculated with only one vessel and gear type, and a subset of survey locations. Each subset produced similar trends in species richness over that time period. Most of the new species encountered were deepwater species, such as Greenland halibut and eelpout, that had moved into shallower depths.

Species evenness (Figure 2.6) on the southern Grand bank increased from the 1950's to the 1970's and then remained fairly stable through the 1990's. On the St. Pierre Bank, however, species evenness continued to increase from the 1950's through the 1990's. These patterns are shown by the plot of rank abundance where the steepest curves for the southern Grand Bank (Figure 2.7) were found in the 1950's and 1960's, while on the St. Pierre Bank (Figure 2.7), the steepness of the rank abundance curves decreased gradually over the time period. The steep curve for 1995, however, is the result of a large catch of redfish on the St. Pierre Bank.

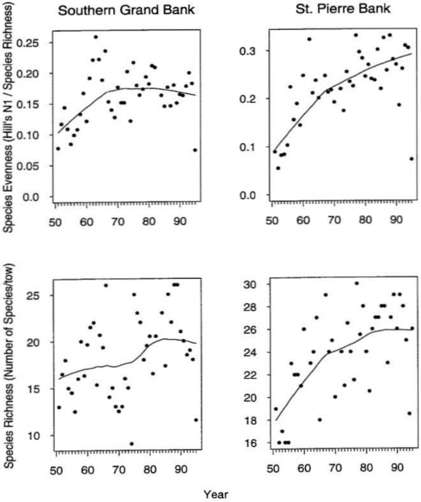


Figure 2.6: Species diversity. Two measures of species diversity, species evenness (Hill's $N_1$/species richenss) and species richness (mean number of species) are given for the southern Grand and St. Pierre Banks.

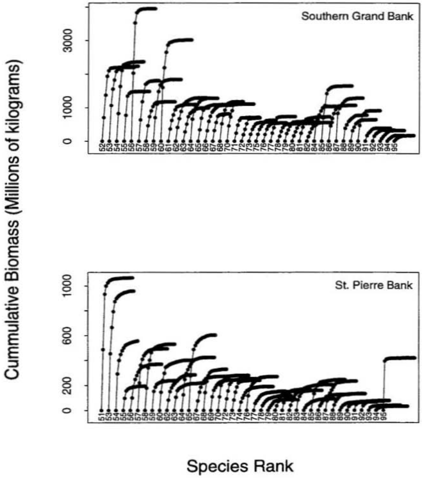


Figure 2.7: Cumulative species biomass for the southern Grand Bank from 1952-1995 and the St. Pierre Bank from 1951-1995.

## 2.5 Discussion

This study represents one of the first attempts to obtain longterm, absolute estimates of biomass without relying on data from commercial fish catches. Commercial catch data, which can produce absolute indices of abundance through virtual population analysis, can only give insight into commercially important species and thus fish community changes may not be detected (Gulland and Garcia 1984). Although attempts have been made to examine historical fisheries data (Greenstreet and Hall 1996), such studies have not assessed changes in survey design and research vessel, or diel variability of research surveys conducted 24 hours a day.

The reduction in the biomass of major species, namely cod and haddock, fundamentally changed the groundfish community structure and reduced total species biomass by 90% from the 1950's to the 1990's. The largest biomass decrease of an individual species was experienced by the haddock population. In the 1950's, haddock had been the most abundant species on the southern Grand and St. Pierre Banks. Intensive fishing effort, both foreign and domestic, combined with an unprecedented discard rate (50-80% of the haddock catch was discarded due to the small size of the fish (Templeman et al. 1978; Templeman and Bishop 1979)), drastically depleted the haddock population by the 1960's. Haddock biomass has not recovered since that time is likely due to the fact that it has been taken as by-catch in the Atlantic cod fishery.

The findings of this study do not support the concept that total fish biomass will remain constant over a period of intense exploitation through the mechanism of species compensation. Increases in flatfish biomass on the southern Grand Bank and flatfish and skate biomass on the St. Pierre Bank were not great enough to compensate for the decline of the gadoids in the 1950's and 1960's. The increase that did occur was probably due to functional complementarity within the groundfish community. The function of the gadoids, flatfish and skates can be considered in terms of prey preferences. Both haddock and yellowtail flounder feed primarily on crustaceans and polychaetes, while cod and American plaice share capelin as the preferred prey (Methven 1999). Thorny skate, the most abundant skate on the St. Pierre Bank, prey on crustaceans and polychaetes (Templeman 1982) and would have been able to increase in biomass in this region where yellowtail flounder was less abundant. American plaice and yellowtail flounder became the target of fisheries, however, preventing either species from attaining their potential maximum biomass level. Skate species, although not taken commercially until 1994, were taken as bycatch in major fisheries.

Whether or not pelagic fish species would have compensated for this loss of biomass is uncertain as surprisingly little published information is available for pelagics during this time period. Pelagic species, such as capelin and northern sand lance, are not well sampled in groundfish surveys as they tend to swim above the range of the trawl. For this reason no attempt was made in this study to compare estimates of biomass between demersal and pelagic species. For comparison, the proportion of trawls in which each pelagic species was caught (?) was calculated as an index of biomass (Figure 2.8). Trawls that were directed capelin surveys were excluded. It is assumed that biomass is high when the species is caught in a high proportion of tows. Only the southern Grand Bank data were used for this calculation as neither species is abundant on the St. Pierre Bank.

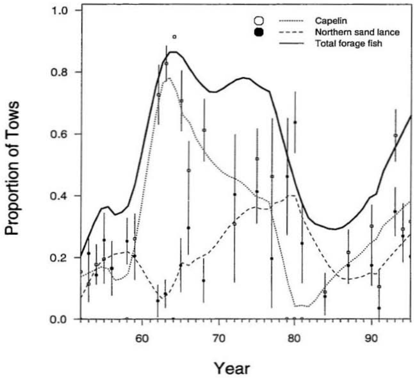


Figure 2.8: Proportion of tows in which capelin and northern sand lance were caught in research survey trawls of the southern Grand Bank, 1952-1995.

Pelagics were only caught in 20% of the tows in the 1950's, but with the decrease in gadid biomass into the 1960's, 80% of the tows contained forage fish. The increase in gadid biomass in the early 1980's was coincident with a decrease to about 30% of the tows contaning forage fish. In the early 1990's, when most of the demersal species had decreased in biomass, the proportion of tows in which forage fish were caught again increased to over 60%.

The increase in species evenness and richness with fishing pressure was not expected but can be explained using the intermediate disturbance hypothesis (Huston 1979). This hypothesis states that in the absence of environmental stress, such as fishing pressure, species diversity would be low as one or more species dominate the community. If the biomass of the dominant species is reduced (i.e. intermediate disturbance), more resources would be made available to other species thus increasing species diversity. In this case, the fishery acts as a keystone predator. Such predators actually facilitate the increase in species diversity by reducing competitive exclusion through species removal (Hacker and Gaines 1990). The removal of cod and haddock allowed flatfish on the southern Grand Bank, and flatfish and skate on the St. Pierre Bank to increase in biomass thus increasing species evenness. The release of resources into the groundfish community on the St. Pierre Bank may have allowed deepwater species, such as Greenland halibut and eelpout, to move into shallower depths, contributing to the increase in species richness.

This study differs dramatically from the analysis by Greenstreet and Hall (1996) of northern North Sea data from 1929 to 1993. They did not show this decline in absolute abundance and increase in diversity. The North Sea, however, was perhaps fully exploited at the time that survey began. Hislop (1996) showed that fishing mortality on haddock had already reached very high levels when the first world war began. By the 1930's hundreds of trawlers were operating in the

North Sea, while on the Grand Banks, only about 50 trawlers operated using large mesh nets to capture mainly large cod (Thompson 1939).

This is the only study of a demersal fish community that makes estimates of the long term impact of trawling on the biomass and diversity before the introduction of intensive industrial trawling. There are two other studies that examined changes in species composition and began close to the onset of industrial trawling. Pauly (1988) describes bottom trawl surveys from 1963 to 1982 in the Gulf of Thailand when trawling effort increased by a factor of 8, and virtually all species groups declined except squid. Jin and Tang (1996) describe demersal surveys from 1959 to 1986 in the Yellow Sea where the dominant demersal fish species were replaced by small pelagic fish species.

Examination of historical fisheries data allows current species biomass to be put into perspective. Recent estimates of species biomass are often considered to be normal and are used in comparison only with estimates of future years. This has been referred to by Pauly (1995) as the 'shifting baseline syndrome'. In these instances, current biomass estimates are often a fraction of that suggested by historical data. Such was the case with the barndoor skate in the northwest Atlantic (Casey and Myers 1998b). The historical data for this species was readily available but not examined and so this species was able to disappear without anyone taking notice. Haddock populations on the southern Grand and St. Pierre Banks, which are thought to be genetically distinct from other stocks in the northwest Atlantic (Zwanenburg et al. 1992), could be facing the same fate.

# Chapter 3

# Near Extinction of a Large, Widely Distributed Fish

## 3.1 Abstract

Are extinctions of marine vertebrates as rare and unlikely as current data indicate? Longterm research surveys on the continental shelf between the Grand Banks of Newfoundland and Southern New England reveal that one of the largest skates in the northwest Atlantic, the barndoor skate (*Raja laevis*), is close to extinction. Forty-five years ago, research surveys on St. Pierre Bank (off southern Newfoundland) recorded barndoor skates in 10% of their tows; in the last 20 years none has been caught and this pattern of decline is similar throughout the range of the species.

## 3.2 Introduction

Elasmobranchs tend to be very susceptible to the effects of fishing because they grow slowly, mature late in life and produce few offspring (Holden 1973). Species of the family Rajidae, while the most fecund of the elasmobranchs (Holden 1974), are known to experience varying degrees of resilience to exploitation (Walker and Hislop 1988) due to the large range in life history characteristics within this family. While shark fisheries usually cause a sharp decline in species abundance (Anderson 1990), dogfish and skate on Georges Bank have increased in biomass following the depletion of groundfish stocks (Murawski and Idoine 1992). It has been suggested that the energy released into the ecosystem by these depleted stocks provided resources for elasmobranch populations to increase. The recent introduction of a directed fishery for dogfish and skate on Georges Bank, however, has resulted in a marked decline of these species (Fogarty and Murawski 1998).

The barndoor skate, *Raja laevis*, is one of the largest skates in the northwest Atlantic (Bigelow and Schroeder 1953b), ranging from Cape Hatteras to the Grand Banks of Newfoundland (Figure 3.1). In May 1929 in the southern New England region, barndoor skates were captured at an average rate of 7 per tow (Bigelow and Schroeder 1953b). On Georges Bank in 1951 the average capture rate for barndoor skates was as high as 21 per tow (Bigelow and Schroeder 1953a). Once common, this distinctive species with a maximum body width of just over one meter, now appears to be near extinction. Although the extinction of marine species is thought to be rare (Huntsman 1994), the closely related "common" skate in the northeast Atlantic, *Raja batis*, was shown to be locally extinct in the Irish Sea (Brander 1981). If current population trends continue, however, the barndoor skate could become the first well-documented example of extinction in a marine fish species.

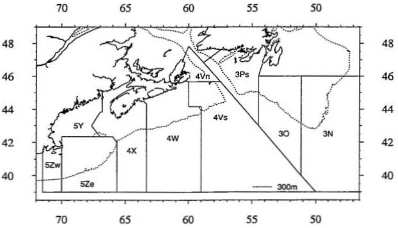


Figure 3.1: Map of the Northwest Atlantic Fisheries Organization. Subdivisions in which populations were assessed in this analysis are shown. The 300-m isobath (dotted line) is given for reference. 3N and 3O, southern Grand Bank; 3Ps, St. Pierre Bank; 4Vn, Sydney Bight; 4Vs, Banquereau Bank; 4W, Sable Island Bank; 4X, Browns Bank; 5Y, Gulf of Maine; 5Ze, Georges Bank; 5Zw, southern New England. The numbers on the axes are degrees of latitude and longitude.

## 3.3 Methods

Biomass (kg/km$^2$) of the barndoor skate was determined from research vessel survey data assembled from the southern Grank Bank, at the northern limit of the range, to southern New England. From 1971 in Canadian waters and 1963 in the United States, annual research surveys have been conducted using a stratified random survey design (Doubleday and Rivard 1981). These are systematic surveys, covering a range of depths from 50 to 400 m, which are designed to provide unbiased estimates of abundance.

Prior to 1971, a fixed location survey along line transects was used off the coasts of Newfoundland and Nova Scotia. These surveys were converted to the stratification scheme using the latitude, longitude and depth of the tow. The earlier surveys were conducted primarily during the day and, as skates are caught in significantly higher proportions at night, day catches would underestimate the true abundance (Casey and Myers 1998a). To account for this difference in diel catchability, half of the catches prior to 1970 were converted to the night using a factor of 2.08. These surveys would then be comparable to those after 1970 in which day and night tows were conducted in roughly equal proportion.

Biomass estimates are based upon the stratified random design (Cochran 1977). Estimates of absolute abundance were obtained by dividing the biomass estimates by a factor of 0.15, if 10% of the skates in the path of the trawl are caught during the day (Edwards 1968) and 20% of the population would be caught at night. Neither of these conversions affects the observed biomass trends. An exponential decay curve ($Ne^{-\delta t}$) was fit to the data using non-linear least squares, where $N$ is the population size in the first year of the surveys, and $t$ is the time since the first year.

If barndoor skate are rarely caught in recent surveys, then the statistical power of detecting individuals must be determined. On St. Pierre Bank, 504 of 1075 research survey tows were conducted over the past 25 years at depths where, historically, barndoor skate were commonly found (200-400 m). Assume that the number, $n$, of barndoor skate caught in one tow has a negative binomial distribution, with a probability of $\frac{\Gamma(k+n)}{\Gamma(k)n!}\frac{\mu^n k^k}{(\mu+k)^{k+n}}$, where $\mu$ is the mean catch per tow, and the constant, $k$, is the inverse of aggregation. Then, with a theoretical low mean abundance of 500 individuals in a 7368 $km^2$ area (with a tow sample area of 0.05 $km^2$, and the probability of catching a barndoor skate if encountered is 0.15), and $k$=0.5, the probability of not detecting a barndoor skate in 504 tows is 0.77. Greater aggregation (that is, lower $k$) results in only small changes in this number. If 1000 individuals remained, the probability of not detecting a barndoor skate decreases to 0.6.

## 3.4 Results

The population trend of the barndoor skate is similar for all regions (Figure 3.2), with biomass decreasing into the early 1970's, after which barndoor skate were caught only on Browns Bank and nearby Georges Bank. The estimated rate of population decline ($\hat{\delta}$) was lowest in the northern and highest in southern regions. If only data since 1960 are considered, the population decline on St. Pierre Bank, Sydney Bight and Banquereau Bank is similar to that in southernmost regions (that is, Gulf of Maine, Georges Bank, and southern New England).

The longest time-series available is for southern Grand Bank, at the species' northern limit on the continental shelf, and St. Pierre Bank, where barndoor skate were once commonly found. Compared with other skate species on St. Pierre Bank, the barndoor skate had been one of the most numerous skates, second in abundance only to the thorny skate *Raja radiata* (Templeman 1966). Considering the mean biomass of the barndoor skate in each decade and the corresponding mean weight of individuals on St. Pierre Bank, the average number of barndoor skates in the 1950's would have been on the order of 0.6 million. That number would decrease to about 0.2 million individuals in the 1960's, and to less than an estimated 500 individuals in the 1970's. The other smaller skate species, namely thorny skate and smooth skate (*Raja senta*), were actually increasing in biomass over this time period (see Figure 2.5 in the previous chapter).

## 3.5 Discussion

Direct biological information on skates in the northwest Atlantic is scarce. Sufficient comparative information, however, is available to estimate the mortality required to drive this species to extinction. The closest relative of the barndoor skate in the north Atlantic, the common skate (Bigelow and Schroeder 1953b), matures at approximately 11 years (Brander 1981). We should expect a similar age at maturity on Georges Bank, which has a similar temperature regime (Myers et al. 1997). Maximum egg production, which can be estimated from the inverse relationship with the weight of the young at hatching (The relationship between the weight of the young at hatching, $w$, and the maximum estimate of fecundity is $10.9w^{-0.45}$ (Holden 1973)) is approximately 47 eggs/year.

Considering the age at maturity and the annual fecundity of the barndoor skate, the instantaneous mortality rate required to drive this species to extinction is approximately 0.4, assuming that mature and immature mortalities are equal.

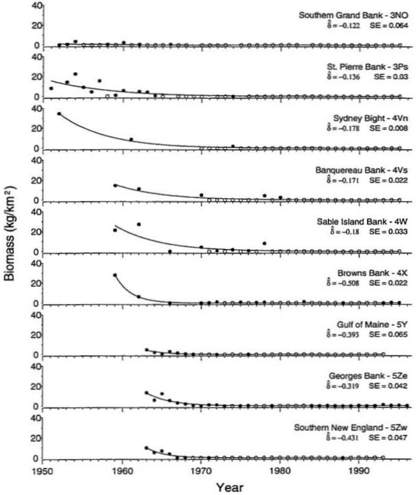


Figure 3.2: Estimates of absolute biomass for barndoor skate (*Raja laevis*) from the southern Grand Bank to southern New England. Open circles are zero catches. The estimated rate of population decline, $\hat{\delta}$, is provided with the standard error (SE).

In order for the barndoor skate population to be self-sustaining, the survival to age $x$, $l_x$, must be sufficient such that $\sum l_x m_x = 1$, where $m_x$ is the number of eggs developing into females from individuals at age $x$. If survival, $P$, is constant such that $l_x = P^x$, then $P^a m_o \sum_{i=0}^{\infty} P^i = 1$, where the survival to the age of maturity $a$, is $P^a$, and the fecundity in each year is $m_o$. Summing the geometric series, $P^a m_o(\frac{1}{1-P}) = 1$. The instantaneous mortality rate is $\log(P)$. If the mortality on juveniles is twice that of adults, the instantaneous mortality required to drive the barndoor skate to extinction is 0.45.

At the northern limit of the barndoor skate's range, where the bottom temperature averages 2.5°C, about 6°C colder than on Georges Bank (Myers et al. 1997), the age at maturity should be approximately double and the instantaneous mortality required to drive the species to extinction would be expected to be closer to 0.2. This is based on the relationship between somatic growth rate and temperature, and a comparison of age at maturity of cod which occurs at the same locations (Myers et al. 1997).

The fishing mortalities for cod (*Gadus morhua*) have been above 0.4, and often much greater, in these regions for more than 30 years (Myers et al. 1996). It is therefore not surprising that the barndoor skate population would be reduced to such extreme levels when taken as by-catch in major fisheries, for example cod and redfish (*Sebastes* sp.). For a species that matures at such a late age (at least 11 years), there is a greater probability that individuals will be caught before they are able to reproduce. This situation is amplified for populations at the northern limit of the range.

The only recent research survey catches of barndoor skate in the Newfoundland area have been very deep (greater than 1000 m) and in an area north of the reported range of this species, where surveys were conducted in support of a new fishery for Greenland halibut (*Reinhardtius hippoglossoides*). Whether or not barndoor skate were commonly found at this depth over the entire range is not known, as research surveys were rarely conducted at such depths. These great depths, however, may have represented one of the last refuges for this species.

Barndoor skate have survived on Browns Bank and Georges Bank probably because of a faster growth rate combined with the seasonal closure of parts of these banks to trawling (Shackell and Lien 1995). Perhaps the only hope for the longterm survival of this species is to designate an area protected from trawling on all the banks that is sufficiently large to allow for a self-sustaining population. A protected area would also provide a simple and effective means to conserve other species.

Failure to examine historical data has resulted in the largest skate in the northwest Atlantic being driven to near extinction without anyone noticing. If such a large, easily identified species, has been allowed to disappear in an area that is well surveyed, the fate of little known species is likely to be worse. This study shows the importance of assembling data on as long a time-scale as possible and as wide a spatial scale as possible; otherwise, the near extinction of a very apparent species may be missed.

A directed fishery for skate was initiated off the coasts of Newfoundland and Nova Scotia in 1994 as an attempt to utilize non-traditional groundfish species. Elasmobranchs experience low natural mortality when compared with teleost fish species, and, at low population levels, are not able to compensate, for example, with increased fecundity or reduced natural mortality (Anderson 1990). Consequently, the end result of increased mortality due to fishing pressure could be extinction. Consideration should be given to fact that species targeted in a commercial fishery are less likely to be driven to extinction for economic reasons. Non-target species, however, would continue to be taken as by-catch regardless of their commercial importance. As such, the extinction rate for non-target species, like the barndoor skate, would be far greater.

# Summary

Examination of large data sets presents many challenges due to the fact that the method of data collection changes over time with the introduction of new technology. Prior to 1972, research surveys of the southern Grand and St. Pierre Banks were conducted during daylight hours. This is a concern when determining absolute estimates of abundance. Species exhibiting diel vertical migrations, such as redfish and haddock, would be caught in greater proportions during the day. Non-migrating species, such as flatfish and skate, which rely on the visibility of the trawl as a means of escapement, would be caught in higher proportions during the night. Correction factors were determined for over 50 species and research surveys conducted at night were adjusted appropriately.

Total groundfish biomass in the 1990's was reduced to 11% and 9% of that observed in the 1950's on the southern Grand Bank and St. Pierre Bank, respectively. This trend largely resulted from the decline of the haddock population. Compensatory responses to this decline were visible with the flatfish on southern Grand Bank and skate on St. Pierre Bank. Continued fisheries for flatfish and bycatch of skate, however, ensured that total species biomass would remain at low levels.

Failure to examine such historical data has resulted in the largest skate in the northwest Atlantic, the barndoor skate, being driven to near extinction without

anyone noticing. If such a large, easily identified species, has been allowed to disappear in an area that is well surveyed, the fate of little known species is likely to be worse. This study shows the importance of assembling data on as long a time-scale as possible and as wide a spatial scale as possible; otherwise, the near extinction of a very apparent species may be missed.

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# Appendix A

# Estimation in SAS

This appendix demonstrates how to fit the proposed Model 2 (Chapter 1) to catch data from stratified random surveys.

Create a data set with seven variables per observation: species, region and season, number caught during the day ($Cysd$) in a particular year($y$) and stratum ($s$), total number caught ($Cys$) in a particular year and stratum, number of tows during the day ($Tysd$), number of tows during the night ($Tysn$), and time of day (daytime). A sample of what the data set should look like is given in Table A.1.

The following is a brief description of the method of programming in SAS:

```
data d1;
  infile survey;
  input species season Cysd Cys Tysd Tysn daytime;
  offset=Tysd/Tysn
proc sort; by species season;
proc genmod; by species season;
  class daytime;
  model Cysd/Cys = daytime / link=logit dist=binomial offset=offset
                             dscale noint;
```

Table A.1: Sample data set to be used with Model 2 (Chapter 1). The data represent Atlantic cod in subdivision 3NO from the spring research surveys.

| $y$ | $s$ | $C_{ysd}$ | $C_{ys}$ | $T_{ysd}$ | $T_{ysn}$ | Offset |
|---|---|---|---|---|---|---|
| 72 | 383 | 62 | 65 | 1 | 1 | 0 |
| 72 | 359 | 73 | 78 | 1 | 2 | -0.69 |
| 72 | 382 | 154 | 358 | 2 | 2 | 0 |
| 72 | 381 | 83 | 228 | 2 | 2 | 0 |
| 73 | 374 | 8 | 10 | 3 | 1 | 1.1 |
| 73 | 376 | 1 | 1 | 1 | 2 | -0.69 |
| 73 | 354 | 15 | 22 | 1 | 2 | -0.69 |
| 73 | 359 | 13 | 59 | 1 | 2 | -0.69 |
| 74 | 378 | 129 | 484 | 1 | 2 | -0.69 |
| 74 | 381 | 5 | 23 | 1 | 3 | -1.1 |
| 74 | 379 | 32 | 296 | 1 | 2 | -0.69 |
| 74 | 380 | 8 | 16 | 1 | 1 | 0 |
| 75 | 376 | 17 | 23 | 1 | 1 | 0 |
| 75 | 377 | 81 | 110 | 1 | 1 | 0 |
| 75 | 333 | 169 | 169 | 1 | 1 | 0 |
| 76 | 354 | 32 | 60 | 2 | 1 | 0.69 |
| 76 | 333 | 15 | 15 | 1 | 1 | 0 |
| 76 | 334 | 0 | 2 | 1 | 1 | 0 |

# Appendix B

# Research Survey Tows Per Stratum

Table B.1 Number of research survey tows completed in selected strata from the Southern Grand Bank during the years of 1951-1995.

| | Stratum Number | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 336 | 337 | 338 | 351 | 352 | 353 | 354 | 359 | 360 | 361 | 362 | 374 | 375 | 376 |
| 1951 | 0 | 8 | 4 | 0 | 9 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1952 | 5 | 6 | 3 | 3 | 3 | 3 | 7 | 6 | 6 | 3 | 1 | 0 | 3 | 1 |
| 1953 | 2 | 9 | 3 | 0 | 7 | 3 | 6 | 3 | 4 | 2 | 3 | 1 | 2 | 0 |
| 1954 | 0 | 3 | 5 | 1 | 9 | 1 | 2 | 0 | 5 | 5 | 4 | 2 | 2 | 1 |
| 1955 | 0 | 6 | 6 | 3 | 9 | 1 | 3 | 4 | 11 | 6 | 3 | 2 | 2 | 1 |
| 1956 | 0 | 4 | 4 | 2 | 3 | 0 | 1 | 0 | 5 | 2 | 2 | 2 | 1 | 1 |
| 1957 | 0 | 4 | 2 | 2 | 4 | 1 | 2 | 2 | 7 | 2 | 2 | 0 | 2 | 0 |
| 1958 | 0 | 4 | 2 | 3 | 4 | 0 | 2 | 2 | 7 | 1 | 0 | 2 | 1 | 0 |
| 1959 | 4 | 8 | 4 | 2 | 4 | 2 | 9 | 10 | 5 | 4 | 1 | 2 | 1 | 2 |
| 1960 | 8 | 6 | 6 | 6 | 3 | 1 | 3 | 3 | 5 | 7 | 1 | 2 | 0 | 4 |
| 1961 | 3 | 10 | 5 | 1 | 6 | 3 | 5 | 6 | 8 | 4 | 0 | 1 | 1 | 2 |
| 1962 | 13 | 14 | 7 | 3 | 3 | 2 | 12 | 6 | 5 | 3 | 0 | 0 | 2 | 3 |
| 1963 | 11 | 14 | 10 | 5 | 10 | 4 | 11 | 4 | 10 | 9 | 2 | 0 | 7 | 5 |
| 1964 | 11 | 22 | 13 | 3 | 8 | 4 | 10 | 3 | 3 | 3 | 1 | 0 | 3 | 6 |
| 1965 | 9 | 15 | 7 | 1 | 6 | 4 | 9 | 5 | 7 | 4 | 0 | 2 | 0 | 4 |
| 1966 | 7 | 8 | 4 | 0 | 5 | 2 | 10 | 3 | 5 | 1 | 0 | 0 | 1 | 4 |
| 1967 | 3 | 8 | 1 | 0 | 1 | 1 | 3 | 7 | 8 | 1 | 0 | 3 | 4 | 9 |
| 1968 | 5 | 4 | 3 | 2 | 3 | 1 | 3 | 4 | 4 | 3 | 2 | 1 | 2 | 4 |
| 1969 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 0 | 2 | 0 |
| 1970 | 1 | 3 | 0 | 2 | 0 | 0 | 3 | 1 | 4 | 0 | 6 | 2 | 4 | 4 |
| 1971 | 1 | 5 | 1 | 0 | 0 | 1 | 3 | 5 | 4 | 2 | 2 | 2 | 5 | 2 |
| 1972 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 10 | 8 | 4 | 5 | 7 | 5 |
| 1973 | 3 | 3 | 5 | 5 | 5 | 3 | 3 | 3 | 1 | 4 | 5 | 4 | 3 | 3 |
| 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 2 | 3 | 0 |
| 1975 | 2 | 3 | 2 | 4 | 4 | 3 | 0 | 0 | 4 | 4 | 3 | 2 | 3 | 2 |
| 1976 | 2 | 2 | 3 | 4 | 4 | 2 | 3 | 3 | 4 | 5 | 5 | 0 | 1 | 3 |
| 1977 | 2 | 2 | 4 | 5 | 5 | 3 | 2 | 2 | 4 | 3 | 5 | 3 | 4 | 3 |
| 1978 | 3 | 6 | 7 | 9 | 8 | 5 | 2 | 4 | 12 | 7 | 6 | 5 | 8 | 7 |
| 1979 | 4 | 4 | 7 | 11 | 12 | 5 | 4 | 3 | 9 | 8 | 12 | 4 | 5 | 4 |
| 1980 | 2 | 3 | 5 | 10 | 11 | 4 | 3 | 4 | 11 | 6 | 11 | 3 | 4 | 3 |
| 1981 | 4 | 5 | 2 | 4 | 0 | 1 | 8 | 6 | 14 | 6 | 13 | 7 | 9 | 7 |
| 1982 | 3 | 3 | 5 | 9 | 7 | 3 | 2 | 2 | 7 | 6 | 8 | 4 | 5 | 7 |
| 1984 | 2 | 2 | 5 | 6 | 7 | 2 | 2 | 2 | 7 | 5 | 7 | 2 | 5 | 4 |
| 1985 | 2 | 5 | 9 | 8 | 11 | 6 | 3 | 2 | 16 | 6 | 81 | 4 | 7 | 7 |
| 1986 | 2 | 5 | 9 | 14 | 14 | 7 | 3 | 2 | 13 | 10 | 14 | 6 | 8 | 8 |
| 1987 | 2 | 6 | 9 | 13 | 13 | 6 | 2 | 2 | 15 | 8 | 13 | 5 | 8 | 8 |
| 1988 | 2 | 4 | 8 | 10 | 11 | 5 | 2 | 2 | 12 | 7 | 10 | 5 | 6 | 6 |
| 1989 | 2 | 5 | 10 | 15 | 13 | 7 | 2 | 2 | 15 | 9 | 13 | 5 | 8 | 8 |
| 1990 | 5 | 10 | 16 | 22 | 23 | 8 | 4 | 4 | 28 | 17 | 21 | 10 | 14 | 13 |
| 1991 | 4 | 9 | 15 | 22 | 24 | 11 | 5 | 8 | 20 | 14 | 20 | 7 | 10 | 12 |
| 1992 | 4 | 6 | 10 | 16 | 14 | 7 | 4 | 4 | 20 | 12 | 14 | 5 | 6 | 10 |
| 1993 | 4 | 5 | 11 | 16 | 14 | 7 | 4 | 4 | 20 | 13 | 16 | 6 | 10 | 10 |
| 1994 | 3 | 5 | 10 | 16 | 14 | 6 | 4 | 4 | 16 | 11 | 15 | 5 | 9 | 8 |
| 1995 | 2 | 4 | 6 | 8 | 10 | 5 | 3 | 2 | 12 | 7 | 10 | 4 | 6 | 6 |

Table B.2 Number of research survey tows completed in selected strata from the St. Pierre Bank during the years of 1951-1995.

| | Stratum Number | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 320 | 321 | 705 | 706 |
| 1951 | 3 | 0 | 2 | 6 | 2 | 2 | 4 | 9 | 0 | 2 | 0 |
| 1952 | 3 | 1 | 0 | 4 | 4 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1953 | 3 | 3 | 0 | 3 | 5 | 1 | 2 | 8 | 3 | 1 | 0 |
| 1954 | 2 | 0 | 0 | 4 | 4 | 1 | 2 | 8 | 3 | 0 | 0 |
| 1955 | 1 | 1 | 1 | 3 | 5 | 1 | 2 | 10 | 2 | 0 | 0 |
| 1956 | 2 | 3 | 1 | 1 | 3 | 2 | 4 | 7 | 3 | 1 | 2 |
| 1957 | 2 | 1 | 1 | 4 | 3 | 2 | 3 | 6 | 4 | 1 | 2 |
| 1958 | 2 | 3 | 1 | 3 | 5 | 2 | 4 | 6 | 3 | 1 | 2 |
| 1959 | 2 | 0 | 0 | 6 | 2 | 4 | 4 | 6 | 4 | 0 | 0 |
| 1960 | 2 | 4 | 5 | 8 | 4 | 11 | 7 | 15 | 6 | 1 | 1 |
| 1962 | 0 | 0 | 0 | 3 | 1 | 2 | 2 | 3 | 0 | 0 | 1 |
| 1963 | 2 | 1 | 3 | 5 | 4 | 6 | 4 | 7 | 4 | 0 | 0 |
| 1964 | 2 | 2 | 1 | 3 | 3 | 4 | 5 | 6 | 1 | 0 | 1 |
| 1965 | 3 | 1 | 5 | 3 | 4 | 6 | 4 | 5 | 2 | 3 | 0 |
| 1967 | 5 | 3 | 6 | 2 | 2 | 6 | 4 | 2 | 0 | 2 | 1 |
| 1968 | 2 | 1 | 3 | 0 | 2 | 6 | 4 | 2 | 0 | 0 | 0 |
| 1969 | 3 | 1 | 6 | 1 | 1 | 6 | 4 | 2 | 0 | 0 | 0 |
| 1970 | 4 | 1 | 4 | 1 | 2 | 6 | 7 | 0 | 0 | 1 | 1 |
| 1972 | 4 | 2 | 2 | 2 | 2 | 2 | 4 | 0 | 2 | 2 | 2 |
| 1973 | 8 | 1 | 2 | 0 | 2 | 3 | 7 | 2 | 2 | 2 | 2 |
| 1974 | 8 | 2 | 12 | 2 | 2 | 14 | 8 | 1 | 1 | 11 | 15 |
| 1975 | 4 | 3 | 3 | 0 | 0 | 1 | 4 | 0 | 0 | 2 | 1 |
| 1976 | 6 | 5 | 6 | 2 | 2 | 4 | 4 | 1 | 2 | 5 | 4 |
| 1977 | 4 | 4 | 10 | 4 | 4 | 6 | 4 | 0 | 0 | 4 | 4 |
| 1978 | 8 | 2 | 5 | 3 | 0 | 6 | 4 | 0 | 3 | 5 | 2 |
| 1979 | 4 | 3 | 5 | 1 | 3 | 3 | 3 | 1 | 0 | 4 | 3 |
| 1980 | 2 | 1 | 2 | 1 | 4 | 2 | 2 | 6 | 5 | 2 | 2 |
| 1981 | 2 | 2 | 2 | 4 | 5 | 7 | 5 | 2 | 2 | 2 | 4 |
| 1982 | 3 | 2 | 2 | 5 | 3 | 1 | 3 | 4 | 4 | 2 | 4 |
| 1983 | 3 | 3 | 3 | 7 | 8 | 4 | 3 | 13 | 10 | 3 | 5 |
| 1984 | 2 | 2 | 2 | 4 | 5 | 2 | 2 | 7 | 6 | 2 | 2 |
| 1985 | 3 | 2 | 2 | 7 | 7 | 3 | 2 | 5 | 7 | 2 | 4 |
| 1986 | 3 | 2 | 2 | 7 | 6 | 2 | 2 | 9 | 10 | 2 | 4 |
| 1987 | 3 | 2 | 2 | 4 | 8 | 3 | 3 | 9 | 10 | 2 | 4 |
| 1988 | 4 | 2 | 2 | 7 | 6 | 3 | 2 | 11 | 11 | 2 | 4 |
| 1989 | 3 | 3 | 2 | 9 | 7 | 2 | 2 | 10 | 9 | 2 | 4 |
| 1990 | 3 | 2 | 2 | 6 | 1 | 2 | 2 | 5 | 8 | 2 | 4 |
| 1991 | 3 | 2 | 2 | 7 | 7 | 2 | 2 | 12 | 11 | 2 | 4 |
| 1992 | 2 | 2 | 2 | 5 | 7 | 2 | 2 | 8 | 9 | 2 | 5 |
| 1993 | 5 | 4 | 4 | 13 | 10 | 4 | 4 | 13 | 14 | 4 | 8 |
| 1994 | 4 | 2 | 2 | 9 | 6 | 2 | 2 | 8 | 10 | 3 | 4 |
| 1995 | 3 | 3 | 2 | 7 | 6 | 2 | 2 | 12 | 11 | 2 | 4 |

# Appendix C

# Southern Grand Bank Data Used in Chapter 2

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| American plaice | 1951 | 103.31 | 26 | 1973 | 1870.63 | 50 |
| American plaice | 1952 | 1859.69 | 50 | 1974 | 478.99 | 13 |
| American plaice | 1953 | 504.83 | 45 | 1975 | 1368.03 | 36 |
| American plaice | 1954 | 317.05 | 40 | 1976 | 1791.72 | 41 |
| American plaice | 1955 | 179.97 | 57 | 1977 | 2045.76 | 47 |
| American plaice | 1956 | 431.22 | 27 | 1978 | 3943.79 | 89 |
| American plaice | 1957 | 594.35 | 30 | 1979 | 2999.55 | 92 |
| American plaice | 1958 | 418.56 | 28 | 1980 | 3731 | 80 |
| American plaice | 1959 | 1613.44 | 52 | 1981 | 2579.5 | 49 |
| American plaice | 1960 | 930.32 | 54 | 1982 | 2255.8 | 71 |
| American plaice | 1961 | 3123.02 | 55 | 1984 | 2474.64 | 58 |
| American plaice | 1962 | 4743.28 | 64 | 1985 | 11741.18 | 167 |
| American plaice | 1963 | 2922.42 | 56 | 1986 | 3829.29 | 115 |
| American plaice | 1964 | 3763.52 | 90 | 1987 | 3794.14 | 110 |
| American plaice | 1965 | 6138.58 | 66 | 1988 | 2550.84 | 90 |
| American plaice | 1966 | 2670.32 | 50 | 1989 | 3033.01 | 112 |
| American plaice | 1967 | 851.87 | 19 | 1990 | 2946.01 | 104 |
| American plaice | 1968 | 1191.6 | 40 | 1991 | 1753.6 | 103 |
| American plaice | 1969 | 406.42 | 8 | 1992 | 871.67 | 89 |
| American plaice | 1970 | 1394.12 | 28 | 1993 | 1090.75 | 77 |
| American plaice | 1971 | 2245.56 | 30 | 1994 | 487.52 | 64 |
| American plaice | 1972 | 1076.84 | 21 | 1995 | 426.5 | 85 |
| Arctic cod | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Arctic cod | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Arctic cod | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Arctic cod | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Arctic cod | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Arctic cod | 1956 | 0 | 27 | 1978 | 0 | 89 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Arctic cod | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Arctic cod | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Arctic cod | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Arctic cod | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Arctic cod | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Arctic cod | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Arctic cod | 1963 | 0 | 56 | 1986 | 0.04 | 115 |
| Arctic cod | 1964 | 0 | 90 | 1987 | 0.08 | 110 |
| Arctic cod | 1965 | 0 | 66 | 1988 | 0.01 | 90 |
| Arctic cod | 1966 | 0 | 50 | 1989 | 0.04 | 112 |
| Arctic cod | 1967 | 0 | 19 | 1990 | 0.01 | 104 |
| Arctic cod | 1968 | 0 | 40 | 1991 | 0.02 | 103 |
| Arctic cod | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Arctic cod | 1970 | 0 | 28 | 1993 | 0.02 | 77 |
| Arctic cod | 1971 | 0 | 30 | 1994 | 0.01 | 64 |
| Arctic cod | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Arctic eelpout | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Arctic eelpout | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Arctic eelpout | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Arctic eelpout | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Arctic eelpout | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Arctic eelpout | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Arctic eelpout | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Arctic eelpout | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Arctic eelpout | 1959 | 0 | 52 | 1981 | 10.75 | 49 |
| Arctic eelpout | 1960 | 0 | 54 | 1982 | 12.4 | 71 |
| Arctic eelpout | 1961 | 0 | 55 | 1984 | 1.91 | 58 |
| Arctic eelpout | 1962 | 0 | 64 | 1985 | 28.1 | 167 |
| Arctic eelpout | 1963 | 0 | 56 | 1986 | 12.12 | 115 |
| Arctic eelpout | 1964 | 0 | 90 | 1987 | 10 | 110 |
| Arctic eelpout | 1965 | 0 | 66 | 1988 | 3.07 | 90 |
| Arctic eelpout | 1966 | 0 | 50 | 1989 | 7.39 | 112 |
| Arctic eelpout | 1967 | 0 | 19 | 1990 | 16.7 | 104 |
| Arctic eelpout | 1968 | 0 | 40 | 1991 | 9.45 | 103 |
| Arctic eelpout | 1969 | 0 | 8 | 1992 | 4.56 | 89 |
| Arctic eelpout | 1970 | 0 | 28 | 1993 | 2.95 | 77 |
| Arctic eelpout | 1971 | 0 | 30 | 1994 | 1.11 | 64 |
| Arctic eelpout | 1972 | 5.45 | 21 | 1995 | 2.81 | 85 |
| Atlantic argentine | 1951 | 0 | 52 | 1973 | 0.23 | 100 |
| Atlantic argentine | 1952 | 6.88 | 100 | 1974 | 0 | 26 |
| Atlantic argentine | 1953 | 1.81 | 90 | 1975 | 2.49 | 72 |
| Atlantic argentine | 1954 | 0 | 80 | 1976 | 0.05 | 82 |
| Atlantic argentine | 1955 | 0 | 114 | 1977 | 0.23 | 94 |
| Atlantic argentine | 1956 | 0 | 54 | 1978 | 6.43 | 178 |
| Atlantic argentine | 1957 | 0 | 60 | 1979 | 23.16 | 184 |
| Atlantic argentine | 1958 | 0 | 56 | 1980 | 0.7 | 160 |
| Atlantic argentine | 1959 | 5.13 | 104 | 1981 | 0 | 98 |
| Atlantic argentine | 1960 | 52.03 | 108 | 1982 | 0 | 142 |
| Atlantic argentine | 1961 | 2.18 | 110 | 1984 | 1.33 | 116 |
| Atlantic argentine | 1962 | 4.54 | 128 | 1985 | 0.42 | 334 |
| Atlantic argentine | 1963 | 313.59 | 112 | 1986 | 29.46 | 230 |
| Atlantic argentine | 1964 | 34.18 | 180 | 1987 | 0 | 220 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Atlantic argentine | 1965 | 4.27 | 132 | 1988 | 0 | 180 |
| Atlantic argentine | 1966 | 59.64 | 100 | 1989 | 0 | 224 |
| Atlantic argentine | 1967 | 0 | 38 | 1990 | 0.35 | 208 |
| Atlantic argentine | 1968 | 70.76 | 80 | 1991 | 0 | 206 |
| Atlantic argentine | 1969 | 0 | 16 | 1992 | 1.25 | 178 |
| Atlantic argentine | 1970 | 0 | 56 | 1993 | 0.98 | 154 |
| Atlantic argentine | 1971 | 0 | 60 | 1994 | 0.18 | 128 |
| Atlantic argentine | 1972 | 0 | 42 | 1995 | 1.41 | 170 |
| Atlantic cod | 1951 | 1621.82 | 26 | 1973 | 714.44 | 50 |
| Atlantic cod | 1952 | 4227.76 | 50 | 1974 | 81.18 | 13 |
| Atlantic cod | 1953 | 3277.31 | 45 | 1975 | 587.29 | 36 |
| Atlantic cod | 1954 | 7118.99 | 40 | 1976 | 367.13 | 41 |
| Atlantic cod | 1955 | 6849.32 | 57 | 1977 | 1510 | 47 |
| Atlantic cod | 1956 | 7912.11 | 27 | 1978 | 2506.76 | 89 |
| Atlantic cod | 1957 | 1530.45 | 30 | 1979 | 3937.41 | 92 |
| Atlantic cod | 1958 | 1295.98 | 28 | 1980 | 1549.15 | 80 |
| Atlantic cod | 1959 | 5912.23 | 52 | 1981 | 1577.7 | 49 |
| Atlantic cod | 1960 | 4008.15 | 54 | 1982 | 1639.32 | 71 |
| Atlantic cod | 1961 | 5091.08 | 55 | 1984 | 5111.14 | 58 |
| Atlantic cod | 1962 | 3598.3 | 64 | 1985 | 17672.87 | 167 |
| Atlantic cod | 1963 | 3865.55 | 56 | 1986 | 9854.82 | 115 |
| Atlantic cod | 1964 | 8020.83 | 90 | 1987 | 13897.56 | 110 |
| Atlantic cod | 1965 | 5070.13 | 66 | 1988 | 6272.14 | 90 |
| Atlantic cod | 1966 | 2237.81 | 50 | 1989 | 6613.15 | 112 |
| Atlantic cod | 1967 | 1285.36 | 19 | 1990 | 6693.52 | 104 |
| Atlantic cod | 1968 | 2913.44 | 40 | 1991 | 2730.1 | 103 |
| Atlantic cod | 1969 | 1094.8 | 8 | 1992 | 1736.21 | 89 |
| Atlantic cod | 1970 | 1253.99 | 28 | 1993 | 1024 | 77 |
| Atlantic cod | 1971 | 2687.79 | 30 | 1994 | 136.47 | 64 |
| Atlantic cod | 1972 | 652.02 | 21 | 1995 | 217.7 | 85 |
| Atlantic hagfish | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Atlantic hagfish | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Atlantic hagfish | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Atlantic hagfish | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Atlantic hagfish | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Atlantic hagfish | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Atlantic hagfish | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Atlantic hagfish | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Atlantic hagfish | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Atlantic hagfish | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Atlantic hagfish | 1961 | 0.46 | 55 | 1984 | 0 | 58 |
| Atlantic hagfish | 1962 | 0.23 | 64 | 1985 | 0 | 167 |
| Atlantic hagfish | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Atlantic hagfish | 1964 | 0 | 90 | 1987 | 0 | 110 |
| Atlantic hagfish | 1965 | 0 | 66 | 1988 | 0 | 90 |
| Atlantic hagfish | 1966 | 0.23 | 50 | 1989 | 0 | 112 |
| Atlantic hagfish | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Atlantic hagfish | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Atlantic hagfish | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Atlantic hagfish | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Atlantic hagfish | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Atlantic hagfish | 1972 | 0 | 21 | 1995 | 0 | 85 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Atlantic halibut | 1951 | 0 | 26 | 1973 | 15.42 | 50 |
| Atlantic halibut | 1952 | 48.47 | 50 | 1974 | 0 | 13 |
| Atlantic halibut | 1953 | 41.91 | 45 | 1975 | 7.94 | 36 |
| Atlantic halibut | 1954 | 32.33 | 40 | 1976 | 68.04 | 41 |
| Atlantic halibut | 1955 | 30.93 | 57 | 1977 | 43.55 | 47 |
| Atlantic halibut | 1956 | 21.45 | 27 | 1978 | 42.25 | 89 |
| Atlantic halibut | 1957 | 59.86 | 30 | 1979 | 30.42 | 92 |
| Atlantic halibut | 1958 | 4.99 | 28 | 1980 | 245.8 | 80 |
| Atlantic halibut | 1959 | 173.54 | 52 | 1981 | 81 | 49 |
| Atlantic halibut | 1960 | 372.74 | 54 | 1982 | 140.9 | 71 |
| Atlantic halibut | 1961 | 541.36 | 55 | 1984 | 92.96 | 58 |
| Atlantic halibut | 1962 | 588.03 | 64 | 1985 | 283.44 | 167 |
| Atlantic halibut | 1963 | 150.88 | 56 | 1986 | 239.46 | 115 |
| Atlantic halibut | 1964 | 173.08 | 90 | 1987 | 220.32 | 110 |
| Atlantic halibut | 1965 | 335.59 | 66 | 1988 | 23.22 | 90 |
| Atlantic halibut | 1966 | 115.53 | 50 | 1989 | 132.8 | 112 |
| Atlantic halibut | 1967 | 0 | 19 | 1990 | 20.43 | 104 |
| Atlantic halibut | 1968 | 29.48 | 40 | 1991 | 81.13 | 103 |
| Atlantic halibut | 1969 | 41.28 | 8 | 1992 | 58.1 | 89 |
| Atlantic halibut | 1970 | 8.62 | 28 | 1993 | 8.01 | 77 |
| Atlantic halibut | 1971 | 38.1 | 30 | 1994 | 3.78 | 64 |
| Atlantic halibut | 1972 | 0 | 21 | 1995 | 15.98 | 85 |
| Barndoor skate | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Barndoor skate | 1952 | 15.54 | 50 | 1974 | 0 | 13 |
| Barndoor skate | 1953 | 44.91 | 45 | 1975 | 0 | 36 |
| Barndoor skate | 1954 | 31.08 | 40 | 1976 | 0 | 41 |
| Barndoor skate | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Barndoor skate | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Barndoor skate | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Barndoor skate | 1958 | 15.54 | 28 | 1980 | 0 | 80 |
| Barndoor skate | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Barndoor skate | 1960 | 110.68 | 54 | 1982 | 0 | 71 |
| Barndoor skate | 1961 | 90.72 | 55 | 1984 | 0 | 58 |
| Barndoor skate | 1962 | 61.23 | 64 | 1985 | 0 | 167 |
| Barndoor skate | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Barndoor skate | 1964 | 9.98 | 90 | 1987 | 0 | 110 |
| Barndoor skate | 1965 | 0 | 66 | 1988 | 0 | 90 |
| Barndoor skate | 1966 | 27.21 | 50 | 1989 | 0 | 112 |
| Barndoor skate | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Barndoor skate | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Barndoor skate | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Barndoor skate | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Barndoor skate | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Barndoor skate | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Blue whiting | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Blue whiting | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Blue whiting | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Blue whiting | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Blue whiting | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Blue whiting | 1956 | 0 | 27 | 1978 | 0.2 | 89 |
| Blue whiting | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Blue whiting | 1958 | 0 | 28 | 1980 | 0 | 80 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Blue whiting | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Blue whiting | 1960 | 0.18 | 54 | 1982 | 0 | 71 |
| Blue whiting | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Blue whiting | 1962 | 0 | 64 | 1985 | 0.83 | 167 |
| Blue whiting | 1963 | 0.79 | 56 | 1986 | 0.17 | 115 |
| Blue whiting | 1964 | 0.54 | 90 | 1987 | 0 | 110 |
| Blue whiting | 1965 | 0.18 | 66 | 1988 | 0 | 90 |
| Blue whiting | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Blue whiting | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Blue whiting | 1968 | 4.31 | 40 | 1991 | 0 | 103 |
| Blue whiting | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Blue whiting | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Blue whiting | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Blue whiting | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Broadhead wolffish | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Broadhead wolffish | 1952 | 8.66 | 50 | 1974 | 0 | 13 |
| Broadhead wolffish | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Broadhead wolffish | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Broadhead wolffish | 1955 | 0 | 57 | 1977 | 7.26 | 47 |
| Broadhead wolffish | 1956 | 0 | 27 | 1978 | 15.5 | 89 |
| Broadhead wolffish | 1957 | 0 | 30 | 1979 | 35.41 | 92 |
| Broadhead wolffish | 1958 | 0 | 28 | 1980 | 15.1 | 80 |
| Broadhead wolffish | 1959 | 4.99 | 52 | 1981 | 73 | 49 |
| Broadhead wolffish | 1960 | 10.89 | 54 | 1982 | 0 | 71 |
| Broadhead wolffish | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Broadhead wolffish | 1962 | 0 | 64 | 1985 | 4.15 | 167 |
| Broadhead wolffish | 1963 | 0 | 56 | 1986 | 12.45 | 115 |
| Broadhead wolffish | 1964 | 0 | 90 | 1987 | 0 | 110 |
| Broadhead wolffish | 1965 | 44.27 | 66 | 1988 | 0 | 90 |
| Broadhead wolffish | 1966 | 21.33 | 50 | 1989 | 0 | 112 |
| Broadhead wolffish | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Broadhead wolffish | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Broadhead wolffish | 1969 | 19.05 | 8 | 1992 | 15.85 | 89 |
| Broadhead wolffish | 1970 | 22.68 | 28 | 1993 | 24.61 | 77 |
| Broadhead wolffish | 1971 | 13.61 | 30 | 1994 | 0 | 64 |
| Broadhead wolffish | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Capelin | 1951 | 15.27 | 26 | 1973 | 1.96 | 50 |
| Capelin | 1952 | 1.3 | 50 | 1974 | 0 | 13 |
| Capelin | 1953 | 24.9 | 45 | 1975 | 1500.59 | 36 |
| Capelin | 1954 | 2.65 | 40 | 1976 | 0.28 | 41 |
| Capelin | 1955 | 4.9 | 57 | 1977 | 42.63 | 47 |
| Capelin | 1956 | 0.3 | 27 | 1978 | 16.61 | 89 |
| Capelin | 1957 | 0.05 | 30 | 1979 | 211.14 | 92 |
| Capelin | 1958 | 0.55 | 28 | 1980 | 0.7 | 80 |
| Capelin | 1959 | 31.64 | 52 | 1981 | 147 | 49 |
| Capelin | 1960 | 6.54 | 54 | 1982 | 31.65 | 71 |
| Capelin | 1961 | 12.61 | 55 | 1984 | 2.24 | 58 |
| Capelin | 1962 | 265.32 | 64 | 1985 | 52.23 | 167 |
| Capelin | 1963 | 1511.98 | 56 | 1986 | 12.54 | 115 |
| Capelin | 1964 | 811.66 | 90 | 1987 | 325.77 | 110 |
| Capelin | 1965 | 636.23 | 66 | 1988 | 5.98 | 90 |
| Capelin | 1966 | 96.74 | 50 | 1989 | 43.94 | 112 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Capelin | 1967 | 249.8 | 19 | 1990 | 28 | 104 |
| Capelin | 1968 | 381.73 | 40 | 1991 | 84.5 | 103 |
| Capelin | 1969 | 30.09 | 8 | 1992 | 16.4 | 89 |
| Capelin | 1970 | 220.24 | 28 | 1993 | 408.9 | 77 |
| Capelin | 1971 | 11.37 | 30 | 1994 | 9.42 | 64 |
| Capelin | 1972 | 60.88 | 21 | 1995 | 35.6 | 85 |
| Common ocean pout | 1951 | 0 | 26 | 1973 | 16.33 | 50 |
| Common ocean pout | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Common ocean pout | 1953 | 0 | 45 | 1975 | 6.8 | 36 |
| Common ocean pout | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Common ocean pout | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Common ocean pout | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Common ocean pout | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Common ocean pout | 1958 | 0 | 28 | 1980 | 0.8 | 80 |
| Common ocean pout | 1959 | 1.54 | 52 | 1981 | 4.25 | 49 |
| Common ocean pout | 1960 | 0.75 | 54 | 1982 | 6.4 | 71 |
| Common ocean pout | 1961 | 0 | 55 | 1984 | 4.81 | 58 |
| Common ocean pout | 1962 | 0.91 | 64 | 1985 | 5.6 | 167 |
| Common ocean pout | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Common ocean pout | 1964 | 0.45 | 90 | 1987 | 2.49 | 110 |
| Common ocean pout | 1965 | 1.54 | 66 | 1988 | 1 | 90 |
| Common ocean pout | 1966 | 0.91 | 50 | 1989 | 1.83 | 112 |
| Common ocean pout | 1967 | 0 | 19 | 1990 | 7.74 | 104 |
| Common ocean pout | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Common ocean pout | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Common ocean pout | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Common ocean pout | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Common ocean pout | 1972 | 23.36 | 21 | 1995 | 0 | 85 |
| Deepsea sculpin | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Deepsea sculpin | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Deepsea sculpin | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Deepsea sculpin | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Deepsea sculpin | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Deepsea sculpin | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Deepsea sculpin | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Deepsea sculpin | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Deepsea sculpin | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Deepsea sculpin | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Deepsea sculpin | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Deepsea sculpin | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Deepsea sculpin | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Deepsea sculpin | 1964 | 0 | 90 | 1987 | 0 | 110 |
| Deepsea sculpin | 1965 | 0 | 66 | 1988 | 0 | 90 |
| Deepsea sculpin | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Deepsea sculpin | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Deepsea sculpin | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Deepsea sculpin | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Deepsea sculpin | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Deepsea sculpin | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Deepsea sculpin | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Eelpout | 1951 | 0 | 26 | 1973 | 3.17 | 50 |
| Eelpout | 1952 | 0 | 50 | 1974 | 1.36 | 13 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Eelpout | 1953 | 0 | 45 | 1975 | 4.08 | 36 |
| Eelpout | 1954 | 0 | 40 | 1976 | 3.18 | 41 |
| Eelpout | 1955 | 0 | 57 | 1977 | 33.34 | 47 |
| Eelpout | 1956 | 0 | 27 | 1978 | 50.53 | 89 |
| Eelpout | 1957 | 0 | 30 | 1979 | 12.93 | 92 |
| Eelpout | 1958 | 0 | 28 | 1980 | 12.85 | 80 |
| Eelpout | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Eelpout | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Eelpout | 1961 | 19.74 | 55 | 1984 | 0 | 58 |
| Eelpout | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Eelpout | 1963 | 18.14 | 56 | 1986 | 0 | 115 |
| Eelpout | 1964 | 0.9 | 90 | 1987 | 0 | 110 |
| Eelpout | 1965 | 14.51 | 66 | 1988 | 0 | 90 |
| Eelpout | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Eelpout | 1967 | 34.02 | 19 | 1990 | 0 | 104 |
| Eelpout | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Eelpout | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Eelpout | 1970 | 7.94 | 28 | 1993 | 0 | 77 |
| Eelpout | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Eelpout | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Esmark's eelpout | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Esmark's eelpout | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Esmark's eelpout | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Esmark's eelpout | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Esmark's eelpout | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Esmark's eelpout | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Esmark's eelpout | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Esmark's eelpout | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Esmark's eelpout | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Esmark's eelpout | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Esmark's eelpout | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Esmark's eelpout | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Esmark's eelpout | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Esmark's eelpout | 1964 | 0 | 90 | 1987 | 0 | 110 |
| Esmark's eelpout | 1965 | 0 | 66 | 1988 | 0 | 90 |
| Esmark's eelpout | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Esmark's eelpout | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Esmark's eelpout | 1968 | 1.13 | 40 | 1991 | 0 | 103 |
| Esmark's eelpout | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Esmark's eelpout | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Esmark's eelpout | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Esmark's eelpout | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Fourbeard rockling | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Fourbeard rockling | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Fourbeard rockling | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Fourbeard rockling | 1954 | 0 | 40 | 1976 | 0.05 | 41 |
| Fourbeard rockling | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Fourbeard rockling | 1956 | 0 | 27 | 1978 | 0.14 | 89 |
| Fourbeard rockling | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Fourbeard rockling | 1958 | 0 | 28 | 1980 | 0.02 | 80 |
| Fourbeard rockling | 1959 | 0.14 | 52 | 1981 | 0 | 49 |
| Fourbeard rockling | 1960 | 0 | 54 | 1982 | 0 | 71 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Fourbeard rockling | 1961 | 0.14 | 55 | 1984 | 0 | 58 |
| Fourbeard rockling | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Fourbeard rockling | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Fourbeard rockling | 1964 | 0.28 | 90 | 1987 | 0 | 110 |
| Fourbeard rockling | 1965 | 0.28 | 66 | 1988 | 0 | 90 |
| Fourbeard rockling | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Fourbeard rockling | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Fourbeard rockling | 1968 | 0.14 | 40 | 1991 | 0 | 103 |
| Fourbeard rockling | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Fourbeard rockling | 1970 | 0.23 | 28 | 1993 | 0 | 77 |
| Fourbeard rockling | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Fourbeard rockling | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Greenland halibut | 1951 | 0 | 26 | 1973 | 1.05 | 50 |
| Greenland halibut | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Greenland halibut | 1953 | 0 | 45 | 1975 | 0.78 | 36 |
| Greenland halibut | 1954 | 0 | 40 | 1976 | 3.09 | 41 |
| Greenland halibut | 1955 | 0 | 57 | 1977 | 6.79 | 47 |
| Greenland halibut | 1956 | 0 | 27 | 1978 | 10.62 | 89 |
| Greenland halibut | 1957 | 0.67 | 30 | 1979 | 42.62 | 92 |
| Greenland halibut | 1958 | 2.67 | 28 | 1980 | 14.6 | 80 |
| Greenland halibut | 1959 | 4.98 | 52 | 1981 | 11.5 | 49 |
| Greenland halibut | 1960 | 1.87 | 54 | 1982 | 3.8 | 71 |
| Greenland halibut | 1961 | 3.63 | 55 | 1984 | 0.17 | 58 |
| Greenland halibut | 1962 | 2.97 | 64 | 1985 | 0.54 | 167 |
| Greenland halibut | 1963 | 22.44 | 56 | 1986 | 4.52 | 115 |
| Greenland halibut | 1964 | 33.32 | 90 | 1987 | 4.96 | 110 |
| Greenland halibut | 1965 | 46 | 66 | 1988 | 3.78 | 90 |
| Greenland halibut | 1966 | 20.41 | 50 | 1989 | 1.18 | 112 |
| Greenland halibut | 1967 | 53.98 | 19 | 1990 | 3.69 | 104 |
| Greenland halibut | 1968 | 4.41 | 40 | 1991 | 4.43 | 103 |
| Greenland halibut | 1969 | 0 | 8 | 1992 | 3.71 | 89 |
| Greenland halibut | 1970 | 3.77 | 28 | 1993 | 7.29 | 77 |
| Greenland halibut | 1971 | 4.98 | 30 | 1994 | 1.42 | 64 |
| Greenland halibut | 1972 | 0 | 21 | 1995 | 12.62 | 85 |
| Haddock | 1951 | 6886.19 | 26 | 1973 | 29.4 | 50 |
| Haddock | 1952 | 5295.16 | 50 | 1974 | 0 | 13 |
| Haddock | 1953 | 11176.23 | 45 | 1975 | 6.35 | 36 |
| Haddock | 1954 | 11628.28 | 40 | 1976 | 6.8 | 41 |
| Haddock | 1955 | 11543.03 | 57 | 1977 | 11.1 | 47 |
| Haddock | 1956 | 12396.57 | 27 | 1978 | 31.27 | 89 |
| Haddock | 1957 | 5506.08 | 30 | 1979 | 35.19 | 92 |
| Haddock | 1958 | 4217.07 | 28 | 1980 | 76 | 80 |
| Haddock | 1959 | 8398.19 | 52 | 1981 | 119.95 | 49 |
| Haddock | 1960 | 11649.92 | 54 | 1982 | 502.38 | 71 |
| Haddock | 1961 | 7773.31 | 55 | 1984 | 1179.6 | 58 |
| Haddock | 1962 | 5762.97 | 64 | 1985 | 1063.25 | 167 |
| Haddock | 1963 | 1507.25 | 56 | 1986 | 265.85 | 115 |
| Haddock | 1964 | 1856.81 | 90 | 1987 | 1289.07 | 110 |
| Haddock | 1965 | 644.56 | 66 | 1988 | 1739.51 | 90 |
| Haddock | 1966 | 1017.64 | 50 | 1989 | 142.26 | 112 |
| Haddock | 1967 | 0.45 | 19 | 1990 | 170.94 | 104 |
| Haddock | 1968 | 183.39 | 40 | 1991 | 102.61 | 103 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Haddock | 1969 | 1.82 | 8 | 1992 | 27.35 | 89 |
| Haddock | 1970 | 7.39 | 28 | 1993 | 75.07 | 77 |
| Haddock | 1971 | 187.1 | 30 | 1994 | 68.81 | 64 |
| Haddock | 1972 | 5.21 | 21 | 1995 | 37.06 | 85 |
| Hookear sculpin | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Hookear sculpin | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Hookear sculpin | 1953 | 0 | 45 | 1975 | 0.14 | 36 |
| Hookear sculpin | 1954 | 0 | 40 | 1976 | 0.05 | 41 |
| Hookear sculpin | 1955 | 0 | 57 | 1977 | 0.23 | 47 |
| Hookear sculpin | 1956 | 0 | 27 | 1978 | 0.12 | 89 |
| Hookear sculpin | 1957 | 0 | 30 | 1979 | 0.06 | 92 |
| Hookear sculpin | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Hookear sculpin | 1959 | 0.07 | 52 | 1981 | 0 | 49 |
| Hookear sculpin | 1960 | 0.06 | 54 | 1982 | 0 | 71 |
| Hookear sculpin | 1961 | 0.14 | 55 | 1984 | 0 | 58 |
| Hookear sculpin | 1962 | 0.03 | 64 | 1985 | 0 | 167 |
| Hookear sculpin | 1963 | 0.01 | 56 | 1986 | 0 | 115 |
| Hookear sculpin | 1964 | 0.01 | 90 | 1987 | 0.01 | 110 |
| Hookear sculpin | 1965 | 0.35 | 66 | 1988 | 0 | 90 |
| Hookear sculpin | 1966 | 0.1 | 50 | 1989 | 0 | 112 |
| Hookear sculpin | 1967 | 0 | 19 | 1990 | 0.01 | 104 |
| Hookear sculpin | 1968 | 0 | 40 | 1991 | 0.01 | 103 |
| Hookear sculpin | 1969 | 0 | 8 | 1992 | 0.02 | 89 |
| Hookear sculpin | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Hookear sculpin | 1971 | 0 | 30 | 1994 | 0.02 | 64 |
| Hookear sculpin | 1972 | 0 | 21 | 1995 | 0.01 | 85 |
| Longfin hake | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Longfin hake | 1952 | 16.77 | 50 | 1974 | 0 | 13 |
| Longfin hake | 1953 | 0 | 45 | 1975 | 1.14 | 36 |
| Longfin hake | 1954 | 0 | 40 | 1976 | 0.96 | 41 |
| Longfin hake | 1955 | 0 | 57 | 1977 | 0.68 | 47 |
| Longfin hake | 1956 | 0 | 27 | 1978 | 17.3 | 89 |
| Longfin hake | 1957 | 0 | 30 | 1979 | 5.72 | 92 |
| Longfin hake | 1958 | 0 | 28 | 1980 | 4 | 80 |
| Longfin hake | 1959 | 0.9 | 52 | 1981 | 0 | 49 |
| Longfin hake | 1960 | 2.74 | 54 | 1982 | 0.1 | 71 |
| Longfin hake | 1961 | 0 | 55 | 1984 | 0.66 | 58 |
| Longfin hake | 1962 | 0 | 64 | 1985 | 0.83 | 167 |
| Longfin hake | 1963 | 3.05 | 56 | 1986 | 0 | 115 |
| Longfin hake | 1964 | 29.49 | 90 | 1987 | 0.5 | 110 |
| Longfin hake | 1965 | 2.72 | 66 | 1988 | 0 | 90 |
| Longfin hake | 1966 | 6.94 | 50 | 1989 | 0.66 | 112 |
| Longfin hake | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Longfin hake | 1968 | 1.81 | 40 | 1991 | 0.11 | 103 |
| Longfin hake | 1969 | 0 | 8 | 1992 | 0.12 | 89 |
| Longfin hake | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Longfin hake | 1971 | 0 | 30 | 1994 | 0.05 | 64 |
| Longfin hake | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Longhorn sculpin | 1951 | 0 | 26 | 1973 | 72.63 | 50 |
| Longhorn sculpin | 1952 | 1.77 | 50 | 1974 | 74.02 | 13 |
| Longhorn sculpin | 1953 | 1.06 | 45 | 1975 | 28.34 | 36 |
| Longhorn sculpin | 1954 | 2.48 | 40 | 1976 | 97.09 | 41 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Longhorn sculpin | 1955 | 0 | 57 | 1977 | 23.8 | 47 |
| Longhorn sculpin | 1956 | 0.79 | 27 | 1978 | 33.7 | 89 |
| Longhorn sculpin | 1957 | 2.83 | 30 | 1979 | 117.51 | 92 |
| Longhorn sculpin | 1958 | 3.95 | 28 | 1980 | 108.25 | 80 |
| Longhorn sculpin | 1959 | 11.32 | 52 | 1981 | 16.1 | 49 |
| Longhorn sculpin | 1960 | 3.66 | 54 | 1982 | 114.5 | 71 |
| Longhorn sculpin | 1961 | 15.09 | 55 | 1984 | 32.29 | 58 |
| Longhorn sculpin | 1962 | 11.17 | 64 | 1985 | 314.57 | 167 |
| Longhorn sculpin | 1963 | 9.48 | 56 | 1986 | 83.37 | 115 |
| Longhorn sculpin | 1964 | 27.23 | 90 | 1987 | 100.1 | 110 |
| Longhorn sculpin | 1965 | 14.12 | 66 | 1988 | 20.92 | 90 |
| Longhorn sculpin | 1966 | 3.05 | 50 | 1989 | 24.27 | 112 |
| Longhorn sculpin | 1967 | 1.49 | 19 | 1990 | 29.68 | 104 |
| Longhorn sculpin | 1968 | 1.83 | 40 | 1991 | 26.39 | 103 |
| Longhorn sculpin | 1969 | 1.99 | 8 | 1992 | 3.82 | 89 |
| Longhorn sculpin | 1970 | 1.13 | 28 | 1993 | 12.08 | 77 |
| Longhorn sculpin | 1971 | 9.31 | 30 | 1994 | 2.33 | 64 |
| Longhorn sculpin | 1972 | 125.41 | 21 | 1995 | 4.67 | 85 |
| Mailed sculpin | 1951 | 0 | 52 | 1973 | 0.1 | 100 |
| Mailed sculpin | 1952 | 0 | 100 | 1974 | 0.24 | 26 |
| Mailed sculpin | 1953 | 0 | 90 | 1975 | 0.43 | 72 |
| Mailed sculpin | 1954 | 0 | 80 | 1976 | 0.43 | 82 |
| Mailed sculpin | 1955 | 0 | 114 | 1977 | 0.09 | 94 |
| Mailed sculpin | 1956 | 0.03 | 54 | 1978 | 1.29 | 178 |
| Mailed sculpin | 1957 | 0 | 60 | 1979 | 0.56 | 184 |
| Mailed sculpin | 1958 | 0 | 56 | 1980 | 0.3 | 160 |
| Mailed sculpin | 1959 | 0.1 | 104 | 1981 | 1.6 | 98 |
| Mailed sculpin | 1960 | 0.09 | 108 | 1982 | 0.01 | 142 |
| Mailed sculpin | 1961 | 0.3 | 110 | 1984 | 0 | 116 |
| Mailed sculpin | 1962 | 0 | 128 | 1985 | 0.02 | 334 |
| Mailed sculpin | 1963 | 0.39 | 112 | 1986 | 0.08 | 230 |
| Mailed sculpin | 1964 | 0.26 | 180 | 1987 | 0.12 | 220 |
| Mailed sculpin | 1965 | 0.7 | 132 | 1988 | 0.03 | 180 |
| Mailed sculpin | 1966 | 0.03 | 100 | 1989 | 0.23 | 224 |
| Mailed sculpin | 1967 | 0 | 38 | 1990 | 0.16 | 208 |
| Mailed sculpin | 1968 | 0.03 | 80 | 1991 | 0.22 | 206 |
| Mailed sculpin | 1969 | 0 | 16 | 1992 | 0.57 | 178 |
| Mailed sculpin | 1970 | 0.03 | 56 | 1993 | 0.02 | 154 |
| Mailed sculpin | 1971 | 0 | 60 | 1994 | 0.07 | 128 |
| Mailed sculpin | 1972 | 0.68 | 42 | 1995 | 0 | 170 |
| Marlin-spike | 1951 | 0 | 26 | 1973 | 0.09 | 50 |
| Marlin-spike | 1952 | 8.28 | 50 | 1974 | 0 | 13 |
| Marlin-spike | 1953 | 0 | 45 | 1975 | 0.37 | 36 |
| Marlin-spike | 1954 | 0 | 40 | 1976 | 0.1 | 41 |
| Marlin-spike | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Marlin-spike | 1956 | 0 | 27 | 1978 | 0.45 | 89 |
| Marlin-spike | 1957 | 0 | 30 | 1979 | 0.23 | 92 |
| Marlin-spike | 1958 | 0 | 28 | 1980 | 1.4 | 80 |
| Marlin-spike | 1959 | 5.43 | 52 | 1981 | 0 | 49 |
| Marlin-spike | 1960 | 5.9 | 54 | 1982 | 0.1 | 71 |
| Marlin-spike | 1961 | 0.68 | 55 | 1984 | 0.08 | 58 |
| Marlin-spike | 1962 | 7.12 | 64 | 1985 | 0.02 | 167 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Marlin-spike | 1963 | 40.1 | 56 | 1986 | 0 | 115 |
| Marlin-spike | 1964 | 44.03 | 90 | 1987 | 0.59 | 110 |
| Marlin-spike | 1965 | 16.02 | 66 | 1988 | 0.17 | 90 |
| Marlin-spike | 1966 | 12.64 | 50 | 1989 | 0.07 | 112 |
| Marlin-spike | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Marlin-spike | 1968 | 3.4 | 40 | 1991 | 0.27 | 103 |
| Marlin-spike | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Marlin-spike | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Marlin-spike | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Marlin-spike | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Monkfish | 1951 | 0 | 26 | 1973 | 27.44 | 50 |
| Monkfish | 1952 | 52.46 | 50 | 1974 | 0 | 13 |
| Monkfish | 1953 | 22.08 | 45 | 1975 | 5.44 | 36 |
| Monkfish | 1954 | 6.56 | 40 | 1976 | 13.61 | 41 |
| Monkfish | 1955 | 5.98 | 57 | 1977 | 0.95 | 47 |
| Monkfish | 1956 | 1 | 27 | 1978 | 22.13 | 89 |
| Monkfish | 1957 | 0.5 | 30 | 1979 | 2.95 | 92 |
| Monkfish | 1958 | 13.97 | 28 | 1980 | 45 | 80 |
| Monkfish | 1959 | 89.36 | 52 | 1981 | 22 | 49 |
| Monkfish | 1960 | 44.58 | 54 | 1982 | 2.95 | 71 |
| Monkfish | 1961 | 142.87 | 55 | 1984 | 0 | 58 |
| Monkfish | 1962 | 148.66 | 64 | 1985 | 36.94 | 167 |
| Monkfish | 1963 | 68.6 | 56 | 1986 | 25.73 | 115 |
| Monkfish | 1964 | 39.47 | 90 | 1987 | 47.72 | 110 |
| Monkfish | 1965 | 39.82 | 66 | 1988 | 46.48 | 90 |
| Monkfish | 1966 | 23.59 | 50 | 1989 | 12.95 | 112 |
| Monkfish | 1967 | 0 | 19 | 1990 | 13.07 | 104 |
| Monkfish | 1968 | 13.6 | 40 | 1991 | 18.9 | 103 |
| Monkfish | 1969 | 0 | 8 | 1992 | 0.62 | 89 |
| Monkfish | 1970 | 0 | 28 | 1993 | 4.65 | 77 |
| Monkfish | 1971 | 0 | 30 | 1994 | 9.54 | 64 |
| Monkfish | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Northern sand lance | 1951 | 0 | 26 | 1973 | 41.29 | 50 |
| Northern sand lance | 1952 | 1.05 | 50 | 1974 | 34.02 | 13 |
| Northern sand lance | 1953 | 0.7 | 45 | 1975 | 252.19 | 36 |
| Northern sand lance | 1954 | 0.22 | 40 | 1976 | 26.07 | 41 |
| Northern sand lance | 1955 | 7.48 | 57 | 1977 | 70.99 | 47 |
| Northern sand lance | 1956 | 0.62 | 27 | 1978 | 483.3 | 89 |
| Northern sand lance | 1957 | 1.05 | 30 | 1979 | 469.83 | 92 |
| Northern sand lance | 1958 | 52.88 | 28 | 1980 | 528.55 | 80 |
| Northern sand lance | 1959 | 1.14 | 52 | 1981 | 89.15 | 49 |
| Northern sand lance | 1960 | 27.39 | 54 | 1982 | 182.36 | 71 |
| Northern sand lance | 1961 | 1.2 | 55 | 1984 | 1.66 | 58 |
| Northern sand lance | 1962 | 0.12 | 64 | 1985 | 3.54 | 167 |
| Northern sand lance | 1963 | 0.18 | 56 | 1986 | 0.24 | 115 |
| Northern sand lance | 1964 | 3.15 | 90 | 1987 | 1.19 | 110 |
| Northern sand lance | 1965 | 1.85 | 66 | 1988 | 0.8 | 90 |
| Northern sand lance | 1966 | 1.02 | 50 | 1989 | 3.57 | 112 |
| Northern sand lance | 1967 | 2.66 | 19 | 1990 | 0.42 | 104 |
| Northern sand lance | 1968 | 0.32 | 40 | 1991 | 1.45 | 103 |
| Northern sand lance | 1969 | 3.18 | 8 | 1992 | 0.58 | 89 |
| Northern sand lance | 1970 | 91.56 | 28 | 1993 | 0.75 | 77 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Northern sand lance | 1971 | 36.35 | 30 | 1994 | 0.89 | 64 |
| Northern sand lance | 1972 | 35.38 | 21 | 1995 | 0.47 | 85 |
| Pollock | 1951 | 66.53 | 26 | 1973 | 0 | 50 |
| Pollock | 1952 | 123.03 | 50 | 1974 | 0 | 13 |
| Pollock | 1953 | 12.47 | 45 | 1975 | 0 | 36 |
| Pollock | 1954 | 14.46 | 40 | 1976 | 0.91 | 41 |
| Pollock | 1955 | 10.48 | 57 | 1977 | 0 | 47 |
| Pollock | 1956 | 602.49 | 27 | 1978 | 1.82 | 89 |
| Pollock | 1957 | 7.48 | 30 | 1979 | 7.49 | 92 |
| Pollock | 1958 | 3.99 | 28 | 1980 | 0 | 80 |
| Pollock | 1959 | 47.66 | 52 | 1981 | 0 | 49 |
| Pollock | 1960 | 219.07 | 54 | 1982 | 0.7 | 71 |
| Pollock | 1961 | 20.41 | 55 | 1984 | 0 | 58 |
| Pollock | 1962 | 19.05 | 64 | 1985 | 1.7 | 167 |
| Pollock | 1963 | 156.66 | 56 | 1986 | 1.25 | 115 |
| Pollock | 1964 | 120.21 | 90 | 1987 | 16.43 | 110 |
| Pollock | 1965 | 13.39 | 66 | 1988 | 0.5 | 90 |
| Pollock | 1966 | 37.87 | 50 | 1989 | 13.7 | 112 |
| Pollock | 1967 | 0 | 19 | 1990 | 15.13 | 104 |
| Pollock | 1968 | 0 | 40 | 1991 | 15.44 | 103 |
| Pollock | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Pollock | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Pollock | 1971 | 103.65 | 30 | 1994 | 0 | 64 |
| Pollock | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Redfish | 1951 | 174.89 | 78 | 1973 | 639.61 | 150 |
| Redfish | 1952 | 18936.93 | 150 | 1974 | 0 | 39 |
| Redfish | 1953 | 10132.08 | 135 | 1975 | 694.78 | 108 |
| Redfish | 1954 | 2116.6 | 120 | 1976 | 176.41 | 123 |
| Redfish | 1955 | 1896.92 | 171 | 1977 | 3683.8 | 141 |
| Redfish | 1956 | 3016.57 | 81 | 1978 | 126.7 | 267 |
| Redfish | 1957 | 7910.48 | 90 | 1979 | 1222.65 | 276 |
| Redfish | 1958 | 2247.04 | 84 | 1980 | 194.36 | 240 |
| Redfish | 1959 | 6552.77 | 156 | 1981 | 241 | 147 |
| Redfish | 1960 | 19059.76 | 162 | 1982 | 4340.5 | 213 |
| Redfish | 1961 | 4061.4 | 165 | 1984 | 299.55 | 174 |
| Redfish | 1962 | 7739.65 | 192 | 1985 | 563.49 | 501 |
| Redfish | 1963 | 3376.8 | 168 | 1986 | 4024.09 | 345 |
| Redfish | 1964 | 5108.69 | 270 | 1987 | 463.85 | 330 |
| Redfish | 1965 | 2704.55 | 198 | 1988 | 651.53 | 270 |
| Redfish | 1966 | 3679.19 | 150 | 1989 | 368.85 | 336 |
| Redfish | 1967 | 69.85 | 57 | 1990 | 1513.05 | 312 |
| Redfish | 1968 | 6609.13 | 120 | 1991 | 29.9 | 309 |
| Redfish | 1969 | 0 | 24 | 1992 | 107.14 | 267 |
| Redfish | 1970 | 375.82 | 84 | 1993 | 1295.73 | 231 |
| Redfish | 1971 | 460.4 | 90 | 1994 | 1162.21 | 192 |
| Redfish | 1972 | 0.6 | 63 | 1995 | 9282.72 | 255 |
| Sea raven | 1951 | 0 | 26 | 1973 | 157.39 | 50 |
| Sea raven | 1952 | 8.73 | 50 | 1974 | 62.58 | 13 |
| Sea raven | 1953 | 8.73 | 45 | 1975 | 78.71 | 36 |
| Sea raven | 1954 | 15.71 | 40 | 1976 | 158.98 | 41 |
| Sea raven | 1955 | 4.99 | 57 | 1977 | 115.65 | 47 |
| Sea raven | 1956 | 12.48 | 27 | 1978 | 189.4 | 89 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Sea raven | 1957 | 3.49 | 30 | 1979 | 176.42 | 92 |
| Sea raven | 1958 | 13.48 | 28 | 1980 | 238.35 | 80 |
| Sea raven | 1959 | 17.45 | 52 | 1981 | 89.5 | 49 |
| Sea raven | 1960 | 0 | 54 | 1982 | 279 | 71 |
| Sea raven | 1961 | 47.21 | 55 | 1984 | 177.04 | 58 |
| Sea raven | 1962 | 31.98 | 64 | 1985 | 392.96 | 167 |
| Sea raven | 1963 | 16.25 | 56 | 1986 | 370.68 | 115 |
| Sea raven | 1964 | 45.29 | 90 | 1987 | 259.22 | 110 |
| Sea raven | 1965 | 35.57 | 66 | 1988 | 115.83 | 90 |
| Sea raven | 1966 | 17.9 | 50 | 1989 | 137.2 | 112 |
| Sea raven | 1967 | 13.61 | 19 | 1990 | 159.15 | 104 |
| Sea raven | 1968 | 29.94 | 40 | 1991 | 126.05 | 103 |
| Sea raven | 1969 | 26.31 | 8 | 1992 | 89.34 | 89 |
| Sea raven | 1970 | 23.14 | 28 | 1993 | 126.21 | 77 |
| Sea raven | 1971 | 30.38 | 30 | 1994 | 59.76 | 64 |
| Sea raven | 1972 | 26.08 | 21 | 1995 | 41.63 | 85 |
| Shorthorn sculpin | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Shorthorn sculpin | 1952 | 0.75 | 50 | 1974 | 0.91 | 13 |
| Shorthorn sculpin | 1953 | 1.5 | 45 | 1975 | 0.23 | 36 |
| Shorthorn sculpin | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Shorthorn sculpin | 1955 | 0 | 57 | 1977 | 0.32 | 47 |
| Shorthorn sculpin | 1956 | 0 | 27 | 1978 | 0.91 | 89 |
| Shorthorn sculpin | 1957 | 0 | 30 | 1979 | 0.45 | 92 |
| Shorthorn sculpin | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Shorthorn sculpin | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Shorthorn sculpin | 1960 | 0 | 54 | 1982 | 0.9 | 71 |
| Shorthorn sculpin | 1961 | 0 | 55 | 1984 | 2.49 | 58 |
| Shorthorn sculpin | 1962 | 0.68 | 64 | 1985 | 2.32 | 167 |
| Shorthorn sculpin | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Shorthorn sculpin | 1964 | 0 | 90 | 1987 | 2.57 | 110 |
| Shorthorn sculpin | 1965 | 0 | 66 | 1988 | 0.25 | 90 |
| Shorthorn sculpin | 1966 | 0 | 50 | 1989 | 1 | 112 |
| Shorthorn sculpin | 1967 | 0 | 19 | 1990 | 3.29 | 104 |
| Shorthorn sculpin | 1968 | 0 | 40 | 1991 | 0.84 | 103 |
| Shorthorn sculpin | 1969 | 0 | 8 | 1992 | 5.38 | 89 |
| Shorthorn sculpin | 1970 | 0 | 28 | 1993 | 1.09 | 77 |
| Shorthorn sculpin | 1971 | 0 | 30 | 1994 | 0.33 | 64 |
| Shorthorn sculpin | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Silver hake | 1951 | 0.94 | 26 | 1973 | 0 | 50 |
| Silver hake | 1952 | 3.78 | 50 | 1974 | 0 | 13 |
| Silver hake | 1953 | 2334.62 | 45 | 1975 | 1.36 | 36 |
| Silver hake | 1954 | 14.64 | 40 | 1976 | 1.59 | 41 |
| Silver hake | 1955 | 14.34 | 57 | 1977 | 0.45 | 47 |
| Silver hake | 1956 | 6.24 | 27 | 1978 | 56.56 | 89 |
| Silver hake | 1957 | 1 | 30 | 1979 | 29.78 | 92 |
| Silver hake | 1958 | 4.88 | 28 | 1980 | 10.1 | 80 |
| Silver hake | 1959 | 2.06 | 52 | 1981 | 318.55 | 49 |
| Silver hake | 1960 | 34.38 | 54 | 1982 | 0.1 | 71 |
| Silver hake | 1961 | 31.97 | 55 | 1984 | 0 | 58 |
| Silver hake | 1962 | 9.07 | 64 | 1985 | 35.28 | 167 |
| Silver hake | 1963 | 0 | 56 | 1986 | 123.75 | 115 |
| Silver hake | 1964 | 0 | 90 | 1987 | 25.07 | 110 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Silver hake | 1965 | 0.23 | 66 | 1988 | 0.42 | 90 |
| Silver hake | 1966 | 0 | 50 | 1989 | 1.08 | 112 |
| Silver hake | 1967 | 0 | 19 | 1990 | 1.45 | 104 |
| Silver hake | 1968 | 0.43 | 40 | 1991 | 1.35 | 103 |
| Silver hake | 1969 | 0 | 8 | 1992 | 0.91 | 89 |
| Silver hake | 1970 | 1.36 | 28 | 1993 | 0.09 | 77 |
| Silver hake | 1971 | 0 | 30 | 1994 | 1.04 | 64 |
| Silver hake | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Smooth skate | 1951 | 0.75 | 26 | 1973 | 4.98 | 50 |
| Smooth skate | 1952 | 12.75 | 50 | 1974 | 0 | 13 |
| Smooth skate | 1953 | 3.75 | 45 | 1975 | 0.45 | 36 |
| Smooth skate | 1954 | 9.75 | 40 | 1976 | 0 | 41 |
| Smooth skate | 1955 | 1.5 | 57 | 1977 | 2.26 | 47 |
| Smooth skate | 1956 | 4.74 | 27 | 1978 | 37.13 | 89 |
| Smooth skate | 1957 | 0.99 | 30 | 1979 | 3.17 | 92 |
| Smooth skate | 1958 | 2.66 | 28 | 1980 | 5 | 80 |
| Smooth skate | 1959 | 10.58 | 52 | 1981 | 8 | 49 |
| Smooth skate | 1960 | 9.66 | 54 | 1982 | 4 | 71 |
| Smooth skate | 1961 | 2.27 | 55 | 1984 | 1.41 | 58 |
| Smooth skate | 1962 | 11.57 | 64 | 1985 | 9.84 | 167 |
| Smooth skate | 1963 | 14.21 | 56 | 1986 | 2.9 | 115 |
| Smooth skate | 1964 | 37.69 | 90 | 1987 | 2.99 | 110 |
| Smooth skate | 1965 | 13.06 | 66 | 1988 | 2.08 | 90 |
| Smooth skate | 1966 | 13.84 | 50 | 1989 | 0.66 | 112 |
| Smooth skate | 1967 | 0 | 19 | 1990 | 8.13 | 104 |
| Smooth skate | 1968 | 0.23 | 40 | 1991 | 9.94 | 103 |
| Smooth skate | 1969 | 0 | 8 | 1992 | 4.47 | 89 |
| Smooth skate | 1970 | 0 | 28 | 1993 | 0.83 | 77 |
| Smooth skate | 1971 | 6.36 | 30 | 1994 | 0.79 | 64 |
| Smooth skate | 1972 | 0 | 21 | 1995 | 1.99 | 85 |
| Spiny lumpfish | 1951 | 0 | 52 | 1973 | 0 | 100 |
| Spiny lumpfish | 1952 | 0 | 100 | 1974 | 0 | 26 |
| Spiny lumpfish | 1953 | 0 | 90 | 1975 | 0.14 | 72 |
| Spiny lumpfish | 1954 | 0 | 80 | 1976 | 0 | 82 |
| Spiny lumpfish | 1955 | 0 | 114 | 1977 | 0 | 94 |
| Spiny lumpfish | 1956 | 0 | 54 | 1978 | 0.08 | 178 |
| Spiny lumpfish | 1957 | 0 | 60 | 1979 | 0.2 | 184 |
| Spiny lumpfish | 1958 | 0 | 56 | 1980 | 0.11 | 160 |
| Spiny lumpfish | 1959 | 0 | 104 | 1981 | 0 | 98 |
| Spiny lumpfish | 1960 | 0 | 108 | 1982 | 0.15 | 142 |
| Spiny lumpfish | 1961 | 0.08 | 110 | 1984 | 0 | 116 |
| Spiny lumpfish | 1962 | 0 | 128 | 1985 | 0 | 334 |
| Spiny lumpfish | 1963 | 0.04 | 112 | 1986 | 0.12 | 230 |
| Spiny lumpfish | 1964 | 0.04 | 180 | 1987 | 0.2 | 220 |
| Spiny lumpfish | 1965 | 0.12 | 132 | 1988 | 0.12 | 180 |
| Spiny lumpfish | 1966 | 0 | 100 | 1989 | 0.26 | 224 |
| Spiny lumpfish | 1967 | 0 | 38 | 1990 | 0.24 | 208 |
| Spiny lumpfish | 1968 | 0 | 80 | 1991 | 0.06 | 206 |
| Spiny lumpfish | 1969 | 0 | 16 | 1992 | 0.66 | 178 |
| Spiny lumpfish | 1970 | 0 | 56 | 1993 | 0.25 | 154 |
| Spiny lumpfish | 1971 | 0 | 60 | 1994 | 0.19 | 128 |
| Spiny lumpfish | 1972 | 0.23 | 42 | 1995 | 0.57 | 170 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Spotted wolffish | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Spotted wolffish | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Spotted wolffish | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Spotted wolffish | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Spotted wolffish | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Spotted wolffish | 1956 | 0 | 27 | 1978 | 16.86 | 89 |
| Spotted wolffish | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Spotted wolffish | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Spotted wolffish | 1959 | 0 | 52 | 1981 | 7.5 | 49 |
| Spotted wolffish | 1960 | 0 | 54 | 1982 | 4.1 | 71 |
| Spotted wolffish | 1961 | 3.63 | 55 | 1984 | 17.02 | 58 |
| Spotted wolffish | 1962 | 7.71 | 64 | 1985 | 0 | 167 |
| Spotted wolffish | 1963 | 7.53 | 56 | 1986 | 0 | 115 |
| Spotted wolffish | 1964 | 13.61 | 90 | 1987 | 0 | 110 |
| Spotted wolffish | 1965 | 15.25 | 66 | 1988 | 11.62 | 90 |
| Spotted wolffish | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Spotted wolffish | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Spotted wolffish | 1968 | 30.84 | 40 | 1991 | 9.34 | 103 |
| Spotted wolffish | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Spotted wolffish | 1970 | 9.53 | 28 | 1993 | 0 | 77 |
| Spotted wolffish | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Spotted wolffish | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Striped wolffish | 1951 | 6.95 | 26 | 1973 | 180.99 | 50 |
| Striped wolffish | 1952 | 39.91 | 50 | 1974 | 87.55 | 13 |
| Striped wolffish | 1953 | 25.86 | 45 | 1975 | 186.66 | 36 |
| Striped wolffish | 1954 | 37.42 | 40 | 1976 | 195.52 | 41 |
| Striped wolffish | 1955 | 14.96 | 57 | 1977 | 86.18 | 47 |
| Striped wolffish | 1956 | 7.99 | 27 | 1978 | 228.47 | 89 |
| Striped wolffish | 1957 | 66.36 | 30 | 1979 | 442.27 | 92 |
| Striped wolffish | 1958 | 1.99 | 28 | 1980 | 462.65 | 80 |
| Striped wolffish | 1959 | 61.28 | 52 | 1981 | 65 | 49 |
| Striped wolffish | 1960 | 157.3 | 54 | 1982 | 630.5 | 71 |
| Striped wolffish | 1961 | 64.41 | 55 | 1984 | 305.02 | 58 |
| Striped wolffish | 1962 | 151.94 | 64 | 1985 | 575.19 | 167 |
| Striped wolffish | 1963 | 55.42 | 56 | 1986 | 751.15 | 115 |
| Striped wolffish | 1964 | 154.24 | 90 | 1987 | 739.7 | 110 |
| Striped wolffish | 1965 | 59.68 | 66 | 1988 | 497.67 | 90 |
| Striped wolffish | 1966 | 282.26 | 50 | 1989 | 547.55 | 112 |
| Striped wolffish | 1967 | 18.83 | 19 | 1990 | 697.04 | 104 |
| Striped wolffish | 1968 | 18.36 | 40 | 1991 | 388.83 | 103 |
| Striped wolffish | 1969 | 15.88 | 8 | 1992 | 355.12 | 89 |
| Striped wolffish | 1970 | 1.36 | 28 | 1993 | 304.65 | 77 |
| Striped wolffish | 1971 | 5.44 | 30 | 1994 | 435.12 | 64 |
| Striped wolffish | 1972 | 36.29 | 21 | 1995 | 153.57 | 85 |
| Thorny skate | 1951 | 104.43 | 26 | 1973 | 1394.59 | 50 |
| Thorny skate | 1952 | 1094.72 | 50 | 1974 | 172.51 | 13 |
| Thorny skate | 1953 | 1328.45 | 45 | 1975 | 816.29 | 36 |
| Thorny skate | 1954 | 1351.48 | 40 | 1976 | 1264.39 | 41 |
| Thorny skate | 1955 | 239.15 | 57 | 1977 | 1164.86 | 47 |
| Thorny skate | 1956 | 177.87 | 27 | 1978 | 906.59 | 89 |
| Thorny skate | 1957 | 651.52 | 30 | 1979 | 939.82 | 92 |
| Thorny skate | 1958 | 421.18 | 28 | 1980 | 1395.6 | 80 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Thorny skate | 1959 | 2275.78 | 52 | 1981 | 493.4 | 49 |
| Thorny skate | 1960 | 1491.5 | 54 | 1982 | 1233.6 | 71 |
| Thorny skate | 1961 | 1600.89 | 55 | 1984 | 926.86 | 58 |
| Thorny skate | 1962 | 2659.96 | 64 | 1985 | 3740.85 | 167 |
| Thorny skate | 1963 | 2065.85 | 56 | 1986 | 2631.39 | 115 |
| Thorny skate | 1964 | 2380.83 | 90 | 1987 | 1379.21 | 110 |
| Thorny skate | 1965 | 1709.92 | 66 | 1988 | 1346.97 | 90 |
| Thorny skate | 1966 | 805.15 | 50 | 1989 | 1261.72 | 112 |
| Thorny skate | 1967 | 655.9 | 19 | 1990 | 1656.61 | 104 |
| Thorny skate | 1968 | 467.45 | 40 | 1991 | 670.69 | 103 |
| Thorny skate | 1969 | 238.15 | 8 | 1992 | 786.32 | 89 |
| Thorny skate | 1970 | 940.78 | 28 | 1993 | 455.89 | 77 |
| Thorny skate | 1971 | 550.88 | 30 | 1994 | 234.05 | 64 |
| Thorny skate | 1972 | 555.88 | 21 | 1995 | 370.47 | 85 |
| Threebeard rockling | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Threebeard rockling | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Threebeard rockling | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Threebeard rockling | 1954 | 0 | 40 | 1976 | 0.05 | 41 |
| Threebeard rockling | 1955 | 0 | 57 | 1977 | 0.09 | 47 |
| Threebeard rockling | 1956 | 0 | 27 | 1978 | 0.1 | 89 |
| Threebeard rockling | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Threebeard rockling | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Threebeard rockling | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Threebeard rockling | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Threebeard rockling | 1961 | 0.09 | 55 | 1984 | 0 | 58 |
| Threebeard rockling | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Threebeard rockling | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Threebeard rockling | 1964 | 0 | 90 | 1987 | 0 | 110 |
| Threebeard rockling | 1965 | 0 | 66 | 1988 | 0 | 90 |
| Threebeard rockling | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Threebeard rockling | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Threebeard rockling | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Threebeard rockling | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Threebeard rockling | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Threebeard rockling | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Threebeard rockling | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Vahl's eelpout | 1951 | 0 | 26 | 1973 | 0.23 | 50 |
| Vahl's eelpout | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Vahl's eelpout | 1953 | 0 | 45 | 1975 | 0.18 | 36 |
| Vahl's eelpout | 1954 | 0 | 40 | 1976 | 0.45 | 41 |
| Vahl's eelpout | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Vahl's eelpout | 1956 | 0 | 27 | 1978 | 25.56 | 89 |
| Vahl's eelpout | 1957 | 0 | 30 | 1979 | 1.13 | 92 |
| Vahl's eelpout | 1958 | 0 | 28 | 1980 | 0.5 | 80 |
| Vahl's eelpout | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Vahl's eelpout | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Vahl's eelpout | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Vahl's eelpout | 1962 | 1.29 | 64 | 1985 | 0.66 | 167 |
| Vahl's eelpout | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Vahl's eelpout | 1964 | 2.26 | 90 | 1987 | 0 | 110 |
| Vahl's eelpout | 1965 | 0.23 | 66 | 1988 | 0 | 90 |
| Vahl's eelpout | 1966 | 0.42 | 50 | 1989 | 0 | 112 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Vahl's eelpout | 1967 | 7.71 | 19 | 1990 | 0.04 | 104 |
| Vahl's eelpout | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Vahl's eelpout | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Vahl's eelpout | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Vahl's eelpout | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Vahl's eelpout | 1972 | 0 | 21 | 1995 | 0 | 85 |
| White hake | 1951 | 608.73 | 26 | 1973 | 116.35 | 50 |
| White hake | 1952 | 1635.18 | 50 | 1974 | 0 | 13 |
| White hake | 1953 | 1139.15 | 45 | 1975 | 24.04 | 36 |
| White hake | 1954 | 328.44 | 40 | 1976 | 95.93 | 41 |
| White hake | 1955 | 59.39 | 57 | 1977 | 24.94 | 47 |
| White hake | 1956 | 88.81 | 27 | 1978 | 472.67 | 89 |
| White hake | 1957 | 86.81 | 30 | 1979 | 220.65 | 92 |
| White hake | 1958 | 51.85 | 28 | 1980 | 57.5 | 80 |
| White hake | 1959 | 696.8 | 52 | 1981 | 331.3 | 49 |
| White hake | 1960 | 1079.53 | 54 | 1982 | 0.1 | 71 |
| White hake | 1961 | 1741.57 | 55 | 1984 | 28.64 | 58 |
| White hake | 1962 | 1936.75 | 64 | 1985 | 61.42 | 167 |
| White hake | 1963 | 1484.39 | 56 | 1986 | 21.58 | 115 |
| White hake | 1964 | 7725.97 | 90 | 1987 | 157.66 | 110 |
| White hake | 1965 | 116.68 | 66 | 1988 | 126.12 | 90 |
| White hake | 1966 | 949.07 | 50 | 1989 | 28.3 | 112 |
| White hake | 1967 | 0 | 19 | 1990 | 6.89 | 104 |
| White hake | 1968 | 181.89 | 40 | 1991 | 15.27 | 103 |
| White hake | 1969 | 0 | 8 | 1992 | 10.79 | 89 |
| White hake | 1970 | 31.98 | 28 | 1993 | 18.05 | 77 |
| White hake | 1971 | 43.37 | 30 | 1994 | 52.37 | 64 |
| White hake | 1972 | 16.33 | 21 | 1995 | 2.41 | 85 |
| Witch flounder | 1951 | 144.21 | 26 | 1973 | 286.23 | 50 |
| Witch flounder | 1952 | 205.21 | 50 | 1974 | 0 | 13 |
| Witch flounder | 1953 | 352.15 | 45 | 1975 | 58.96 | 36 |
| Witch flounder | 1954 | 241.99 | 40 | 1976 | 278.64 | 41 |
| Witch flounder | 1955 | 78.88 | 57 | 1977 | 74.62 | 47 |
| Witch flounder | 1956 | 132.37 | 27 | 1978 | 77.08 | 89 |
| Witch flounder | 1957 | 91.3 | 30 | 1979 | 73.33 | 92 |
| Witch flounder | 1958 | 135.23 | 28 | 1980 | 173.5 | 80 |
| Witch flounder | 1959 | 814.13 | 52 | 1981 | 105 | 49 |
| Witch flounder | 1960 | 163.9 | 54 | 1982 | 167 | 71 |
| Witch flounder | 1961 | 329.99 | 55 | 1984 | 111.05 | 58 |
| Witch flounder | 1962 | 1161.2 | 64 | 1985 | 489.37 | 167 |
| Witch flounder | 1963 | 342.87 | 56 | 1986 | 229 | 115 |
| Witch flounder | 1964 | 841.63 | 90 | 1987 | 250.7 | 110 |
| Witch flounder | 1965 | 286.03 | 66 | 1988 | 419.4 | 90 |
| Witch flounder | 1966 | 517.23 | 50 | 1989 | 265.56 | 112 |
| Witch flounder | 1967 | 4.54 | 19 | 1990 | 192.54 | 104 |
| Witch flounder | 1968 | 136.76 | 40 | 1991 | 99.99 | 103 |
| Witch flounder | 1969 | 7.48 | 8 | 1992 | 154.16 | 89 |
| Witch flounder | 1970 | 8.75 | 28 | 1993 | 50.7 | 77 |
| Witch flounder | 1971 | 18.15 | 30 | 1994 | 85.74 | 64 |
| Witch flounder | 1972 | 25.85 | 21 | 1995 | 29.63 | 85 |
| Yellowtail flounder | 1951 | 2.99 | 26 | 1973 | 1906.37 | 50 |
| Yellowtail flounder | 1952 | 75.49 | 51 | 1974 | 1077.28 | 13 |

Table B.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Yellowtail flounder | 1953 | 108.78 | 45 | 1975 | 1606.39 | 36 |
| Yellowtail flounder | 1954 | 135.37 | 40 | 1976 | 2094.24 | 41 |
| Yellowtail flounder | 1955 | 34.33 | 57 | 1977 | 2542.19 | 47 |
| Yellowtail flounder | 1956 | 49.7 | 27 | 1978 | 4463.43 | 89 |
| Yellowtail flounder | 1957 | 121.69 | 30 | 1979 | 4790.51 | 92 |
| Yellowtail flounder | 1958 | 257.3 | 28 | 1980 | 4651.87 | 80 |
| Yellowtail flounder | 1959 | 241.27 | 52 | 1981 | 2114.5 | 49 |
| Yellowtail flounder | 1960 | 144.23 | 54 | 1982 | 2780.4 | 71 |
| Yellowtail flounder | 1961 | 298.25 | 55 | 1984 | 3214.53 | 58 |
| Yellowtail flounder | 1962 | 743.44 | 64 | 1985 | 6815.42 | 167 |
| Yellowtail flounder | 1963 | 684.93 | 56 | 1986 | 4435.6 | 115 |
| Yellowtail flounder | 1964 | 1677.53 | 90 | 1987 | 3800.03 | 110 |
| Yellowtail flounder | 1965 | 1377.25 | 66 | 1988 | 1968.05 | 90 |
| Yellowtail flounder | 1966 | 1278.44 | 50 | 1989 | 2337.58 | 112 |
| Yellowtail flounder | 1967 | 493.73 | 19 | 1990 | 2991.73 | 104 |
| Yellowtail flounder | 1968 | 1104.52 | 40 | 1991 | 2563.03 | 103 |
| Yellowtail flounder | 1969 | 365.15 | 8 | 1992 | 1533.83 | 89 |
| Yellowtail flounder | 1970 | 1089.1 | 28 | 1993 | 2217.12 | 77 |
| Yellowtail flounder | 1971 | 728.24 | 30 | 1994 | 1093.41 | 64 |
| Yellowtail flounder | 1972 | 1494.15 | 21 | 1995 | 1894.17 | 85 |

# Appendix D

# St. Pierre Bank Data Used in Chapter 2

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| American plaice | 1951 | 103.31 | 26 | 1973 | 1870.63 | 50 |
| American plaice | 1952 | 1859.69 | 50 | 1974 | 478.99 | 13 |
| American plaice | 1953 | 504.83 | 45 | 1975 | 1368.03 | 36 |
| American plaice | 1954 | 317.05 | 40 | 1976 | 1791.72 | 41 |
| American plaice | 1955 | 179.97 | 57 | 1977 | 2045.76 | 47 |
| American plaice | 1956 | 431.22 | 27 | 1978 | 3943.79 | 89 |
| American plaice | 1957 | 594.35 | 30 | 1979 | 2999.55 | 92 |
| American plaice | 1958 | 418.56 | 28 | 1980 | 3731 | 80 |
| American plaice | 1959 | 1613.44 | 52 | 1981 | 2579.5 | 49 |
| American plaice | 1960 | 930.32 | 54 | 1982 | 2255.8 | 71 |
| American plaice | 1961 | 3123.02 | 55 | 1984 | 2474.64 | 58 |
| American plaice | 1962 | 4743.28 | 64 | 1985 | 11741.18 | 167 |
| American plaice | 1963 | 2922.42 | 56 | 1986 | 3829.29 | 115 |
| American plaice | 1964 | 3763.52 | 90 | 1987 | 3794.14 | 110 |
| American plaice | 1965 | 6138.58 | 66 | 1988 | 2550.84 | 90 |
| American plaice | 1966 | 2670.32 | 50 | 1989 | 3033.01 | 112 |
| American plaice | 1967 | 851.87 | 19 | 1990 | 2946.01 | 104 |
| American plaice | 1968 | 1191.6 | 40 | 1991 | 1753.6 | 103 |
| American plaice | 1969 | 406.42 | 8 | 1992 | 871.67 | 89 |
| American plaice | 1970 | 1394.12 | 28 | 1993 | 1090.75 | 77 |
| American plaice | 1971 | 2245.56 | 30 | 1994 | 487.52 | 64 |
| American plaice | 1972 | 1076.84 | 21 | 1995 | 426.5 | 85 |
| Arctic cod | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Arctic cod | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Arctic cod | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Arctic cod | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Arctic cod | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Arctic cod | 1956 | 0 | 27 | 1978 | 0 | 89 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Arctic cod | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Arctic cod | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Arctic cod | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Arctic cod | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Arctic cod | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Arctic cod | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Arctic cod | 1963 | 0 | 56 | 1986 | 0.04 | 115 |
| Arctic cod | 1964 | 0 | 90 | 1987 | 0.08 | 110 |
| Arctic cod | 1965 | 0 | 66 | 1988 | 0.01 | 90 |
| Arctic cod | 1966 | 0 | 50 | 1989 | 0.04 | 112 |
| Arctic cod | 1967 | 0 | 19 | 1990 | 0.01 | 104 |
| Arctic cod | 1968 | 0 | 40 | 1991 | 0.02 | 103 |
| Arctic cod | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Arctic cod | 1970 | 0 | 28 | 1993 | 0.02 | 77 |
| Arctic cod | 1971 | 0 | 30 | 1994 | 0.01 | 64 |
| Arctic cod | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Arctic eelpout | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Arctic eelpout | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Arctic eelpout | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Arctic eelpout | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Arctic eelpout | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Arctic eelpout | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Arctic eelpout | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Arctic eelpout | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Arctic eelpout | 1959 | 0 | 52 | 1981 | 10.75 | 49 |
| Arctic eelpout | 1960 | 0 | 54 | 1982 | 12.4 | 71 |
| Arctic eelpout | 1961 | 0 | 55 | 1984 | 1.91 | 58 |
| Arctic eelpout | 1962 | 0 | 64 | 1985 | 28.1 | 167 |
| Arctic eelpout | 1963 | 0 | 56 | 1986 | 12.12 | 115 |
| Arctic eelpout | 1964 | 0 | 90 | 1987 | 10 | 110 |
| Arctic eelpout | 1965 | 0 | 66 | 1988 | 3.07 | 90 |
| Arctic eelpout | 1966 | 0 | 50 | 1989 | 7.39 | 112 |
| Arctic eelpout | 1967 | 0 | 19 | 1990 | 16.7 | 104 |
| Arctic eelpout | 1968 | 0 | 40 | 1991 | 9.45 | 103 |
| Arctic eelpout | 1969 | 0 | 8 | 1992 | 4.56 | 89 |
| Arctic eelpout | 1970 | 0 | 28 | 1993 | 2.95 | 77 |
| Arctic eelpout | 1971 | 0 | 30 | 1994 | 1.11 | 64 |
| Arctic eelpout | 1972 | 5.45 | 21 | 1995 | 2.81 | 85 |
| Atlantic argentine | 1951 | 0 | 52 | 1973 | 0.23 | 100 |
| Atlantic argentine | 1952 | 6.88 | 100 | 1974 | 0 | 26 |
| Atlantic argentine | 1953 | 1.81 | 90 | 1975 | 2.49 | 72 |
| Atlantic argentine | 1954 | 0 | 80 | 1976 | 0.05 | 82 |
| Atlantic argentine | 1955 | 0 | 114 | 1977 | 0.23 | 94 |
| Atlantic argentine | 1956 | 0 | 54 | 1978 | 6.43 | 178 |
| Atlantic argentine | 1957 | 0 | 60 | 1979 | 23.16 | 184 |
| Atlantic argentine | 1958 | 0 | 56 | 1980 | 0.7 | 160 |
| Atlantic argentine | 1959 | 5.13 | 104 | 1981 | 0 | 98 |
| Atlantic argentine | 1960 | 52.03 | 108 | 1982 | 0 | 142 |
| Atlantic argentine | 1961 | 2.18 | 110 | 1984 | 1.33 | 116 |
| Atlantic argentine | 1962 | 4.54 | 128 | 1985 | 0.42 | 334 |
| Atlantic argentine | 1963 | 313.59 | 112 | 1986 | 29.46 | 230 |
| Atlantic argentine | 1964 | 34.18 | 180 | 1987 | 0 | 220 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Atlantic argentine | 1965 | 4.27 | 132 | 1988 | 0 | 180 |
| Atlantic argentine | 1966 | 59.64 | 100 | 1989 | 0 | 224 |
| Atlantic argentine | 1967 | 0 | 38 | 1990 | 0.35 | 208 |
| Atlantic argentine | 1968 | 70.76 | 80 | 1991 | 0 | 206 |
| Atlantic argentine | 1969 | 0 | 16 | 1992 | 1.25 | 178 |
| Atlantic argentine | 1970 | 0 | 56 | 1993 | 0.98 | 154 |
| Atlantic argentine | 1971 | 0 | 60 | 1994 | 0.18 | 128 |
| Atlantic argentine | 1972 | 0 | 42 | 1995 | 1.41 | 170 |
| Atlantic cod | 1951 | 1621.82 | 26 | 1973 | 714.44 | 50 |
| Atlantic cod | 1952 | 4227.76 | 50 | 1974 | 81.18 | 13 |
| Atlantic cod | 1953 | 3277.31 | 45 | 1975 | 587.29 | 36 |
| Atlantic cod | 1954 | 7118.99 | 40 | 1976 | 367.13 | 41 |
| Atlantic cod | 1955 | 6849.32 | 57 | 1977 | 1510 | 47 |
| Atlantic cod | 1956 | 7912.11 | 27 | 1978 | 2506.76 | 89 |
| Atlantic cod | 1957 | 1530.45 | 30 | 1979 | 3937.41 | 92 |
| Atlantic cod | 1958 | 1295.98 | 28 | 1980 | 1549.15 | 80 |
| Atlantic cod | 1959 | 5912.23 | 52 | 1981 | 1577.7 | 49 |
| Atlantic cod | 1960 | 4008.15 | 54 | 1982 | 1639.32 | 71 |
| Atlantic cod | 1961 | 5091.08 | 55 | 1984 | 5111.14 | 58 |
| Atlantic cod | 1962 | 3598.3 | 64 | 1985 | 17672.87 | 167 |
| Atlantic cod | 1963 | 3865.55 | 56 | 1986 | 9854.82 | 115 |
| Atlantic cod | 1964 | 8020.83 | 90 | 1987 | 13897.56 | 110 |
| Atlantic cod | 1965 | 5070.13 | 66 | 1988 | 6272.14 | 90 |
| Atlantic cod | 1966 | 2237.81 | 50 | 1989 | 6613.15 | 112 |
| Atlantic cod | 1967 | 1285.36 | 19 | 1990 | 6693.52 | 104 |
| Atlantic cod | 1968 | 2913.44 | 40 | 1991 | 2730.1 | 103 |
| Atlantic cod | 1969 | 1094.8 | 8 | 1992 | 1736.21 | 89 |
| Atlantic cod | 1970 | 1253.99 | 28 | 1993 | 1024 | 77 |
| Atlantic cod | 1971 | 2687.79 | 30 | 1994 | 136.47 | 64 |
| Atlantic cod | 1972 | 652.02 | 21 | 1995 | 217.7 | 85 |
| Atlantic hagfish | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Atlantic hagfish | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Atlantic hagfish | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Atlantic hagfish | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Atlantic hagfish | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Atlantic hagfish | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Atlantic hagfish | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Atlantic hagfish | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Atlantic hagfish | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Atlantic hagfish | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Atlantic hagfish | 1961 | 0.46 | 55 | 1984 | 0 | 58 |
| Atlantic hagfish | 1962 | 0.23 | 64 | 1985 | 0 | 167 |
| Atlantic hagfish | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Atlantic hagfish | 1964 | 0 | 90 | 1987 | 0 | 110 |
| Atlantic hagfish | 1965 | 0 | 66 | 1988 | 0 | 90 |
| Atlantic hagfish | 1966 | 0.23 | 50 | 1989 | 0 | 112 |
| Atlantic hagfish | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Atlantic hagfish | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Atlantic hagfish | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Atlantic hagfish | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Atlantic hagfish | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Atlantic hagfish | 1972 | 0 | 21 | 1995 | 0 | 85 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Atlantic halibut | 1951 | 0 | 26 | 1973 | 15.42 | 50 |
| Atlantic halibut | 1952 | 48.47 | 50 | 1974 | 0 | 13 |
| Atlantic halibut | 1953 | 41.91 | 45 | 1975 | 7.94 | 36 |
| Atlantic halibut | 1954 | 32.33 | 40 | 1976 | 68.04 | 41 |
| Atlantic halibut | 1955 | 30.93 | 57 | 1977 | 43.55 | 47 |
| Atlantic halibut | 1956 | 21.45 | 27 | 1978 | 42.25 | 89 |
| Atlantic halibut | 1957 | 59.86 | 30 | 1979 | 30.42 | 92 |
| Atlantic halibut | 1958 | 4.99 | 28 | 1980 | 245.8 | 80 |
| Atlantic halibut | 1959 | 173.54 | 52 | 1981 | 81 | 49 |
| Atlantic halibut | 1960 | 372.74 | 54 | 1982 | 140.9 | 71 |
| Atlantic halibut | 1961 | 541.36 | 55 | 1984 | 92.96 | 58 |
| Atlantic halibut | 1962 | 588.03 | 64 | 1985 | 283.44 | 167 |
| Atlantic halibut | 1963 | 150.88 | 56 | 1986 | 239.46 | 115 |
| Atlantic halibut | 1964 | 173.08 | 90 | 1987 | 220.32 | 110 |
| Atlantic halibut | 1965 | 335.59 | 66 | 1988 | 23.22 | 90 |
| Atlantic halibut | 1966 | 115.53 | 50 | 1989 | 132.8 | 112 |
| Atlantic halibut | 1967 | 0 | 19 | 1990 | 20.43 | 104 |
| Atlantic halibut | 1968 | 29.48 | 40 | 1991 | 81.13 | 103 |
| Atlantic halibut | 1969 | 41.28 | 8 | 1992 | 58.1 | 89 |
| Atlantic halibut | 1970 | 8.62 | 28 | 1993 | 8.01 | 77 |
| Atlantic halibut | 1971 | 38.1 | 30 | 1994 | 3.78 | 64 |
| Atlantic halibut | 1972 | 0 | 21 | 1995 | 15.98 | 85 |
| Barndoor skate | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Barndoor skate | 1952 | 15.54 | 50 | 1974 | 0 | 13 |
| Barndoor skate | 1953 | 44.91 | 45 | 1975 | 0 | 36 |
| Barndoor skate | 1954 | 31.08 | 40 | 1976 | 0 | 41 |
| Barndoor skate | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Barndoor skate | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Barndoor skate | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Barndoor skate | 1958 | 15.54 | 28 | 1980 | 0 | 80 |
| Barndoor skate | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Barndoor skate | 1960 | 110.68 | 54 | 1982 | 0 | 71 |
| Barndoor skate | 1961 | 90.72 | 55 | 1984 | 0 | 58 |
| Barndoor skate | 1962 | 61.23 | 64 | 1985 | 0 | 167 |
| Barndoor skate | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Barndoor skate | 1964 | 9.98 | 90 | 1987 | 0 | 110 |
| Barndoor skate | 1965 | 0 | 66 | 1988 | 0 | 90 |
| Barndoor skate | 1966 | 27.21 | 50 | 1989 | 0 | 112 |
| Barndoor skate | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Barndoor skate | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Barndoor skate | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Barndoor skate | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Barndoor skate | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Barndoor skate | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Blue whiting | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Blue whiting | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Blue whiting | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Blue whiting | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Blue whiting | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Blue whiting | 1956 | 0 | 27 | 1978 | 0.2 | 89 |
| Blue whiting | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Blue whiting | 1958 | 0 | 28 | 1980 | 0 | 80 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Blue whiting | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Blue whiting | 1960 | 0.18 | 54 | 1982 | 0 | 71 |
| Blue whiting | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Blue whiting | 1962 | 0 | 64 | 1985 | 0.83 | 167 |
| Blue whiting | 1963 | 0.79 | 56 | 1986 | 0.17 | 115 |
| Blue whiting | 1964 | 0.54 | 90 | 1987 | 0 | 110 |
| Blue whiting | 1965 | 0.18 | 66 | 1988 | 0 | 90 |
| Blue whiting | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Blue whiting | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Blue whiting | 1968 | 4.31 | 40 | 1991 | 0 | 103 |
| Blue whiting | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Blue whiting | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Blue whiting | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Blue whiting | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Broadhead wolffish | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Broadhead wolffish | 1952 | 8.66 | 50 | 1974 | 0 | 13 |
| Broadhead wolffish | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Broadhead wolffish | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Broadhead wolffish | 1955 | 0 | 57 | 1977 | 7.26 | 47 |
| Broadhead wolffish | 1956 | 0 | 27 | 1978 | 15.5 | 89 |
| Broadhead wolffish | 1957 | 0 | 30 | 1979 | 35.41 | 92 |
| Broadhead wolffish | 1958 | 0 | 28 | 1980 | 15.1 | 80 |
| Broadhead wolffish | 1959 | 4.99 | 52 | 1981 | 73 | 49 |
| Broadhead wolffish | 1960 | 10.89 | 54 | 1982 | 0 | 71 |
| Broadhead wolffish | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Broadhead wolffish | 1962 | 0 | 64 | 1985 | 4.15 | 167 |
| Broadhead wolffish | 1963 | 0 | 56 | 1986 | 12.45 | 115 |
| Broadhead wolffish | 1964 | 0 | 90 | 1987 | 0 | 110 |
| Broadhead wolffish | 1965 | 44.27 | 66 | 1988 | 0 | 90 |
| Broadhead wolffish | 1966 | 21.33 | 50 | 1989 | 0 | 112 |
| Broadhead wolffish | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Broadhead wolffish | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Broadhead wolffish | 1969 | 19.05 | 8 | 1992 | 15.85 | 89 |
| Broadhead wolffish | 1970 | 22.68 | 28 | 1993 | 24.61 | 77 |
| Broadhead wolffish | 1971 | 13.61 | 30 | 1994 | 0 | 64 |
| Broadhead wolffish | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Capelin | 1951 | 15.27 | 26 | 1973 | 1.96 | 50 |
| Capelin | 1952 | 1.3 | 50 | 1974 | 0 | 13 |
| Capelin | 1953 | 24.9 | 45 | 1975 | 1500.59 | 36 |
| Capelin | 1954 | 2.65 | 40 | 1976 | 0.28 | 41 |
| Capelin | 1955 | 4.9 | 57 | 1977 | 42.63 | 47 |
| Capelin | 1956 | 0.3 | 27 | 1978 | 16.61 | 89 |
| Capelin | 1957 | 0.05 | 30 | 1979 | 211.14 | 92 |
| Capelin | 1958 | 0.55 | 28 | 1980 | 0.7 | 80 |
| Capelin | 1959 | 31.64 | 52 | 1981 | 147 | 49 |
| Capelin | 1960 | 6.54 | 54 | 1982 | 31.65 | 71 |
| Capelin | 1961 | 12.61 | 55 | 1984 | 2.24 | 58 |
| Capelin | 1962 | 265.32 | 64 | 1985 | 52.23 | 167 |
| Capelin | 1963 | 1511.98 | 56 | 1986 | 12.54 | 115 |
| Capelin | 1964 | 811.66 | 90 | 1987 | 325.77 | 110 |
| Capelin | 1965 | 636.23 | 66 | 1988 | 5.98 | 90 |
| Capelin | 1966 | 96.74 | 50 | 1989 | 43.94 | 112 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Capelin | 1967 | 249.8 | 19 | 1990 | 28 | 104 |
| Capelin | 1968 | 381.73 | 40 | 1991 | 84.5 | 103 |
| Capelin | 1969 | 30.09 | 8 | 1992 | 16.4 | 89 |
| Capelin | 1970 | 220.24 | 28 | 1993 | 408.9 | 77 |
| Capelin | 1971 | 11.37 | 30 | 1994 | 9.42 | 64 |
| Capelin | 1972 | 60.88 | 21 | 1995 | 35.6 | 85 |
| Common ocean pout | 1951 | 0 | 26 | 1973 | 16.33 | 50 |
| Common ocean pout | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Common ocean pout | 1953 | 0 | 45 | 1975 | 6.8 | 36 |
| Common ocean pout | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Common ocean pout | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Common ocean pout | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Common ocean pout | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Common ocean pout | 1958 | 0 | 28 | 1980 | 0.8 | 80 |
| Common ocean pout | 1959 | 1.54 | 52 | 1981 | 4.25 | 49 |
| Common ocean pout | 1960 | 0.75 | 54 | 1982 | 6.4 | 71 |
| Common ocean pout | 1961 | 0 | 55 | 1984 | 4.81 | 58 |
| Common ocean pout | 1962 | 0.91 | 64 | 1985 | 5.6 | 167 |
| Common ocean pout | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Common ocean pout | 1964 | 0.45 | 90 | 1987 | 2.49 | 110 |
| Common ocean pout | 1965 | 1.54 | 66 | 1988 | 1 | 90 |
| Common ocean pout | 1966 | 0.91 | 50 | 1989 | 1.83 | 112 |
| Common ocean pout | 1967 | 0 | 19 | 1990 | 7.74 | 104 |
| Common ocean pout | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Common ocean pout | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Common ocean pout | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Common ocean pout | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Common ocean pout | 1972 | 23.36 | 21 | 1995 | 0 | 85 |
| Deepsea sculpin | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Deepsea sculpin | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Deepsea sculpin | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Deepsea sculpin | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Deepsea sculpin | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Deepsea sculpin | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Deepsea sculpin | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Deepsea sculpin | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Deepsea sculpin | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Deepsea sculpin | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Deepsea sculpin | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Deepsea sculpin | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Deepsea sculpin | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Deepsea sculpin | 1964 | 0 | 90 | 1987 | 0 | 110 |
| Deepsea sculpin | 1965 | 0 | 66 | 1988 | 0 | 90 |
| Deepsea sculpin | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Deepsea sculpin | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Deepsea sculpin | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Deepsea sculpin | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Deepsea sculpin | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Deepsea sculpin | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Deepsea sculpin | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Eelpout | 1951 | 0 | 26 | 1973 | 3.17 | 50 |
| Eelpout | 1952 | 0 | 50 | 1974 | 1.36 | 13 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Eelpout | 1953 | 0 | 45 | 1975 | 4.08 | 36 |
| Eelpout | 1954 | 0 | 40 | 1976 | 3.18 | 41 |
| Eelpout | 1955 | 0 | 57 | 1977 | 33.34 | 47 |
| Eelpout | 1956 | 0 | 27 | 1978 | 50.53 | 89 |
| Eelpout | 1957 | 0 | 30 | 1979 | 12.93 | 92 |
| Eelpout | 1958 | 0 | 28 | 1980 | 12.85 | 80 |
| Eelpout | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Eelpout | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Eelpout | 1961 | 19.74 | 55 | 1984 | 0 | 58 |
| Eelpout | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Eelpout | 1963 | 18.14 | 56 | 1986 | 0 | 115 |
| Eelpout | 1964 | 0.9 | 90 | 1987 | 0 | 110 |
| Eelpout | 1965 | 14.51 | 66 | 1988 | 0 | 90 |
| Eelpout | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Eelpout | 1967 | 34.02 | 19 | 1990 | 0 | 104 |
| Eelpout | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Eelpout | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Eelpout | 1970 | 7.94 | 28 | 1993 | 0 | 77 |
| Eelpout | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Eelpout | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Esmark's eelpout | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Esmark's eelpout | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Esmark's eelpout | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Esmark's eelpout | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Esmark's eelpout | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Esmark's eelpout | 1956 | 0 | 27 | 1978 | 0 | 89 |
| Esmark's eelpout | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Esmark's eelpout | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Esmark's eelpout | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Esmark's eelpout | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Esmark's eelpout | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Esmark's eelpout | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Esmark's eelpout | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Esmark's eelpout | 1964 | 0 | 90 | 1987 | 0 | 110 |
| Esmark's eelpout | 1965 | 0 | 66 | 1988 | 0 | 90 |
| Esmark's eelpout | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Esmark's eelpout | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Esmark's eelpout | 1968 | 1.13 | 40 | 1991 | 0 | 103 |
| Esmark's eelpout | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Esmark's eelpout | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Esmark's eelpout | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Esmark's eelpout | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Fourbeard rockling | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Fourbeard rockling | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Fourbeard rockling | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Fourbeard rockling | 1954 | 0 | 40 | 1976 | 0.05 | 41 |
| Fourbeard rockling | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Fourbeard rockling | 1956 | 0 | 27 | 1978 | 0.14 | 89 |
| Fourbeard rockling | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Fourbeard rockling | 1958 | 0 | 28 | 1980 | 0.02 | 80 |
| Fourbeard rockling | 1959 | 0.14 | 52 | 1981 | 0 | 49 |
| Fourbeard rockling | 1960 | 0 | 54 | 1982 | 0 | 71 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Fourbeard rockling | 1961 | 0.14 | 55 | 1984 | 0 | 58 |
| Fourbeard rockling | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Fourbeard rockling | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Fourbeard rockling | 1964 | 0.28 | 90 | 1987 | 0 | 110 |
| Fourbeard rockling | 1965 | 0.28 | 66 | 1988 | 0 | 90 |
| Fourbeard rockling | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Fourbeard rockling | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Fourbeard rockling | 1968 | 0.14 | 40 | 1991 | 0 | 103 |
| Fourbeard rockling | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Fourbeard rockling | 1970 | 0.23 | 28 | 1993 | 0 | 77 |
| Fourbeard rockling | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Fourbeard rockling | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Greenland halibut | 1951 | 0 | 26 | 1973 | 1.05 | 50 |
| Greenland halibut | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Greenland halibut | 1953 | 0 | 45 | 1975 | 0.78 | 36 |
| Greenland halibut | 1954 | 0 | 40 | 1976 | 3.09 | 41 |
| Greenland halibut | 1955 | 0 | 57 | 1977 | 6.79 | 47 |
| Greenland halibut | 1956 | 0 | 27 | 1978 | 10.62 | 89 |
| Greenland halibut | 1957 | 0.67 | 30 | 1979 | 42.62 | 92 |
| Greenland halibut | 1958 | 2.67 | 28 | 1980 | 14.6 | 80 |
| Greenland halibut | 1959 | 4.98 | 52 | 1981 | 11.5 | 49 |
| Greenland halibut | 1960 | 1.87 | 54 | 1982 | 3.8 | 71 |
| Greenland halibut | 1961 | 3.63 | 55 | 1984 | 0.17 | 58 |
| Greenland halibut | 1962 | 2.97 | 64 | 1985 | 0.54 | 167 |
| Greenland halibut | 1963 | 22.44 | 56 | 1986 | 4.52 | 115 |
| Greenland halibut | 1964 | 33.32 | 90 | 1987 | 4.96 | 110 |
| Greenland halibut | 1965 | 46 | 66 | 1988 | 3.78 | 90 |
| Greenland halibut | 1966 | 20.41 | 50 | 1989 | 1.18 | 112 |
| Greenland halibut | 1967 | 53.98 | 19 | 1990 | 3.69 | 104 |
| Greenland halibut | 1968 | 4.41 | 40 | 1991 | 4.43 | 103 |
| Greenland halibut | 1969 | 0 | 8 | 1992 | 3.71 | 89 |
| Greenland halibut | 1970 | 3.77 | 28 | 1993 | 7.29 | 77 |
| Greenland halibut | 1971 | 4.98 | 30 | 1994 | 1.42 | 64 |
| Greenland halibut | 1972 | 0 | 21 | 1995 | 12.62 | 85 |
| Haddock | 1951 | 6886.19 | 26 | 1973 | 29.4 | 50 |
| Haddock | 1952 | 5295.16 | 50 | 1974 | 0 | 13 |
| Haddock | 1953 | 11176.23 | 45 | 1975 | 6.35 | 36 |
| Haddock | 1954 | 11628.28 | 40 | 1976 | 6.8 | 41 |
| Haddock | 1955 | 11543.03 | 57 | 1977 | 11.1 | 47 |
| Haddock | 1956 | 12396.57 | 27 | 1978 | 31.27 | 89 |
| Haddock | 1957 | 5506.08 | 30 | 1979 | 35.19 | 92 |
| Haddock | 1958 | 4217.07 | 28 | 1980 | 76 | 80 |
| Haddock | 1959 | 8398.19 | 52 | 1981 | 119.95 | 49 |
| Haddock | 1960 | 11649.92 | 54 | 1982 | 502.38 | 71 |
| Haddock | 1961 | 7773.31 | 55 | 1984 | 1179.6 | 58 |
| Haddock | 1962 | 5762.97 | 64 | 1985 | 1063.25 | 167 |
| Haddock | 1963 | 1507.25 | 56 | 1986 | 265.85 | 115 |
| Haddock | 1964 | 1856.81 | 90 | 1987 | 1289.07 | 110 |
| Haddock | 1965 | 644.56 | 66 | 1988 | 1739.51 | 90 |
| Haddock | 1966 | 1017.64 | 50 | 1989 | 142.26 | 112 |
| Haddock | 1967 | 0.45 | 19 | 1990 | 170.94 | 104 |
| Haddock | 1968 | 183.39 | 40 | 1991 | 102.61 | 103 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Haddock | 1969 | 1.82 | 8 | 1992 | 27.35 | 89 |
| Haddock | 1970 | 7.39 | 28 | 1993 | 75.07 | 77 |
| Haddock | 1971 | 187.1 | 30 | 1994 | 68.81 | 64 |
| Haddock | 1972 | 5.21 | 21 | 1995 | 37.06 | 85 |
| Hookear sculpin | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Hookear sculpin | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Hookear sculpin | 1953 | 0 | 45 | 1975 | 0.14 | 36 |
| Hookear sculpin | 1954 | 0 | 40 | 1976 | 0.05 | 41 |
| Hookear sculpin | 1955 | 0 | 57 | 1977 | 0.23 | 47 |
| Hookear sculpin | 1956 | 0 | 27 | 1978 | 0.12 | 89 |
| Hookear sculpin | 1957 | 0 | 30 | 1979 | 0.06 | 92 |
| Hookear sculpin | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Hookear sculpin | 1959 | 0.07 | 52 | 1981 | 0 | 49 |
| Hookear sculpin | 1960 | 0.06 | 54 | 1982 | 0 | 71 |
| Hookear sculpin | 1961 | 0.14 | 55 | 1984 | 0 | 58 |
| Hookear sculpin | 1962 | 0.03 | 64 | 1985 | 0 | 167 |
| Hookear sculpin | 1963 | 0.01 | 56 | 1986 | 0 | 115 |
| Hookear sculpin | 1964 | 0.01 | 90 | 1987 | 0.01 | 110 |
| Hookear sculpin | 1965 | 0.35 | 66 | 1988 | 0 | 90 |
| Hookear sculpin | 1966 | 0.1 | 50 | 1989 | 0 | 112 |
| Hookear sculpin | 1967 | 0 | 19 | 1990 | 0.01 | 104 |
| Hookear sculpin | 1968 | 0 | 40 | 1991 | 0.01 | 103 |
| Hookear sculpin | 1969 | 0 | 8 | 1992 | 0.02 | 89 |
| Hookear sculpin | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Hookear sculpin | 1971 | 0 | 30 | 1994 | 0.02 | 64 |
| Hookear sculpin | 1972 | 0 | 21 | 1995 | 0.01 | 85 |
| Longfin hake | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Longfin hake | 1952 | 16.77 | 50 | 1974 | 0 | 13 |
| Longfin hake | 1953 | 0 | 45 | 1975 | 1.14 | 36 |
| Longfin hake | 1954 | 0 | 40 | 1976 | 0.96 | 41 |
| Longfin hake | 1955 | 0 | 57 | 1977 | 0.68 | 47 |
| Longfin hake | 1956 | 0 | 27 | 1978 | 17.3 | 89 |
| Longfin hake | 1957 | 0 | 30 | 1979 | 5.72 | 92 |
| Longfin hake | 1958 | 0 | 28 | 1980 | 4 | 80 |
| Longfin hake | 1959 | 0.9 | 52 | 1981 | 0 | 49 |
| Longfin hake | 1960 | 2.74 | 54 | 1982 | 0.1 | 71 |
| Longfin hake | 1961 | 0 | 55 | 1984 | 0.66 | 58 |
| Longfin hake | 1962 | 0 | 64 | 1985 | 0.83 | 167 |
| Longfin hake | 1963 | 3.05 | 56 | 1986 | 0 | 115 |
| Longfin hake | 1964 | 29.49 | 90 | 1987 | 0.5 | 110 |
| Longfin hake | 1965 | 2.72 | 66 | 1988 | 0 | 90 |
| Longfin hake | 1966 | 6.94 | 50 | 1989 | 0.66 | 112 |
| Longfin hake | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Longfin hake | 1968 | 1.81 | 40 | 1991 | 0.11 | 103 |
| Longfin hake | 1969 | 0 | 8 | 1992 | 0.12 | 89 |
| Longfin hake | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Longfin hake | 1971 | 0 | 30 | 1994 | 0.05 | 64 |
| Longfin hake | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Longhorn sculpin | 1951 | 0 | 26 | 1973 | 72.63 | 50 |
| Longhorn sculpin | 1952 | 1.77 | 50 | 1974 | 74.02 | 13 |
| Longhorn sculpin | 1953 | 1.06 | 45 | 1975 | 28.34 | 36 |
| Longhorn sculpin | 1954 | 2.48 | 40 | 1976 | 97.09 | 41 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Longhorn sculpin | 1955 | 0 | 57 | 1977 | 23.8 | 47 |
| Longhorn sculpin | 1956 | 0.79 | 27 | 1978 | 33.7 | 89 |
| Longhorn sculpin | 1957 | 2.83 | 30 | 1979 | 117.51 | 92 |
| Longhorn sculpin | 1958 | 3.95 | 28 | 1980 | 108.25 | 80 |
| Longhorn sculpin | 1959 | 11.32 | 52 | 1981 | 16.1 | 49 |
| Longhorn sculpin | 1960 | 3.66 | 54 | 1982 | 114.5 | 71 |
| Longhorn sculpin | 1961 | 15.09 | 55 | 1984 | 32.29 | 58 |
| Longhorn sculpin | 1962 | 11.17 | 64 | 1985 | 314.57 | 167 |
| Longhorn sculpin | 1963 | 9.48 | 56 | 1986 | 83.37 | 115 |
| Longhorn sculpin | 1964 | 27.23 | 90 | 1987 | 100.1 | 110 |
| Longhorn sculpin | 1965 | 14.12 | 66 | 1988 | 20.92 | 90 |
| Longhorn sculpin | 1966 | 3.05 | 50 | 1989 | 24.27 | 112 |
| Longhorn sculpin | 1967 | 1.49 | 19 | 1990 | 29.68 | 104 |
| Longhorn sculpin | 1968 | 1.83 | 40 | 1991 | 26.39 | 103 |
| Longhorn sculpin | 1969 | 1.99 | 8 | 1992 | 3.82 | 89 |
| Longhorn sculpin | 1970 | 1.13 | 28 | 1993 | 12.08 | 77 |
| Longhorn sculpin | 1971 | 9.31 | 30 | 1994 | 2.33 | 64 |
| Longhorn sculpin | 1972 | 125.41 | 21 | 1995 | 4.67 | 85 |
| Mailed sculpin | 1951 | 0 | 52 | 1973 | 0.1 | 100 |
| Mailed sculpin | 1952 | 0 | 100 | 1974 | 0.24 | 26 |
| Mailed sculpin | 1953 | 0 | 90 | 1975 | 0.43 | 72 |
| Mailed sculpin | 1954 | 0 | 80 | 1976 | 0.43 | 82 |
| Mailed sculpin | 1955 | 0 | 114 | 1977 | 0.09 | 94 |
| Mailed sculpin | 1956 | 0.03 | 54 | 1978 | 1.29 | 178 |
| Mailed sculpin | 1957 | 0 | 60 | 1979 | 0.56 | 184 |
| Mailed sculpin | 1958 | 0 | 56 | 1980 | 0.3 | 160 |
| Mailed sculpin | 1959 | 0.1 | 104 | 1981 | 1.6 | 98 |
| Mailed sculpin | 1960 | 0.09 | 108 | 1982 | 0.01 | 142 |
| Mailed sculpin | 1961 | 0.3 | 110 | 1984 | 0 | 116 |
| Mailed sculpin | 1962 | 0 | 128 | 1985 | 0.02 | 334 |
| Mailed sculpin | 1963 | 0.39 | 112 | 1986 | 0.08 | 230 |
| Mailed sculpin | 1964 | 0.26 | 180 | 1987 | 0.12 | 220 |
| Mailed sculpin | 1965 | 0.7 | 132 | 1988 | 0.03 | 180 |
| Mailed sculpin | 1966 | 0.03 | 100 | 1989 | 0.23 | 224 |
| Mailed sculpin | 1967 | 0 | 38 | 1990 | 0.16 | 208 |
| Mailed sculpin | 1968 | 0.03 | 80 | 1991 | 0.22 | 206 |
| Mailed sculpin | 1969 | 0 | 16 | 1992 | 0.57 | 178 |
| Mailed sculpin | 1970 | 0.03 | 56 | 1993 | 0.02 | 154 |
| Mailed sculpin | 1971 | 0 | 60 | 1994 | 0.07 | 128 |
| Mailed sculpin | 1972 | 0.68 | 42 | 1995 | 0 | 170 |
| Marlin-spike | 1951 | 0 | 26 | 1973 | 0.09 | 50 |
| Marlin-spike | 1952 | 8.28 | 50 | 1974 | 0 | 13 |
| Marlin-spike | 1953 | 0 | 45 | 1975 | 0.37 | 36 |
| Marlin-spike | 1954 | 0 | 40 | 1976 | 0.1 | 41 |
| Marlin-spike | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Marlin-spike | 1956 | 0 | 27 | 1978 | 0.45 | 89 |
| Marlin-spike | 1957 | 0 | 30 | 1979 | 0.23 | 92 |
| Marlin-spike | 1958 | 0 | 28 | 1980 | 1.4 | 80 |
| Marlin-spike | 1959 | 5.43 | 52 | 1981 | 0 | 49 |
| Marlin-spike | 1960 | 5.9 | 54 | 1982 | 0.1 | 71 |
| Marlin-spike | 1961 | 0.68 | 55 | 1984 | 0.08 | 58 |
| Marlin-spike | 1962 | 7.12 | 64 | 1985 | 0.02 | 167 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Marlin-spike | 1963 | 40.1 | 56 | 1986 | 0 | 115 |
| Marlin-spike | 1964 | 44.03 | 90 | 1987 | 0.59 | 110 |
| Marlin-spike | 1965 | 16.02 | 66 | 1988 | 0.17 | 90 |
| Marlin-spike | 1966 | 12.64 | 50 | 1989 | 0.07 | 112 |
| Marlin-spike | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Marlin-spike | 1968 | 3.4 | 40 | 1991 | 0.27 | 103 |
| Marlin-spike | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Marlin-spike | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Marlin-spike | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Marlin-spike | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Monkfish | 1951 | 0 | 26 | 1973 | 27.44 | 50 |
| Monkfish | 1952 | 52.46 | 50 | 1974 | 0 | 13 |
| Monkfish | 1953 | 22.08 | 45 | 1975 | 5.44 | 36 |
| Monkfish | 1954 | 6.56 | 40 | 1976 | 13.61 | 41 |
| Monkfish | 1955 | 5.98 | 57 | 1977 | 0.95 | 47 |
| Monkfish | 1956 | 1 | 27 | 1978 | 22.13 | 89 |
| Monkfish | 1957 | 0.5 | 30 | 1979 | 2.95 | 92 |
| Monkfish | 1958 | 13.97 | 28 | 1980 | 45 | 80 |
| Monkfish | 1959 | 89.36 | 52 | 1981 | 22 | 49 |
| Monkfish | 1960 | 44.58 | 54 | 1982 | 2.95 | 71 |
| Monkfish | 1961 | 142.87 | 55 | 1984 | 0 | 58 |
| Monkfish | 1962 | 148.66 | 64 | 1985 | 36.94 | 167 |
| Monkfish | 1963 | 68.6 | 56 | 1986 | 25.73 | 115 |
| Monkfish | 1964 | 39.47 | 90 | 1987 | 47.72 | 110 |
| Monkfish | 1965 | 39.82 | 66 | 1988 | 46.48 | 90 |
| Monkfish | 1966 | 23.59 | 50 | 1989 | 12.95 | 112 |
| Monkfish | 1967 | 0 | 19 | 1990 | 13.07 | 104 |
| Monkfish | 1968 | 13.6 | 40 | 1991 | 18.9 | 103 |
| Monkfish | 1969 | 0 | 8 | 1992 | 0.62 | 89 |
| Monkfish | 1970 | 0 | 28 | 1993 | 4.65 | 77 |
| Monkfish | 1971 | 0 | 30 | 1994 | 9.54 | 64 |
| Monkfish | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Northern sand lance | 1951 | 0 | 26 | 1973 | 41.29 | 50 |
| Northern sand lance | 1952 | 1.05 | 50 | 1974 | 34.02 | 13 |
| Northern sand lance | 1953 | 0.7 | 45 | 1975 | 252.19 | 36 |
| Northern sand lance | 1954 | 0.22 | 40 | 1976 | 26.07 | 41 |
| Northern sand lance | 1955 | 7.48 | 57 | 1977 | 70.99 | 47 |
| Northern sand lance | 1956 | 0.62 | 27 | 1978 | 483.3 | 89 |
| Northern sand lance | 1957 | 1.05 | 30 | 1979 | 469.83 | 92 |
| Northern sand lance | 1958 | 52.88 | 28 | 1980 | 528.55 | 80 |
| Northern sand lance | 1959 | 1.14 | 52 | 1981 | 89.15 | 49 |
| Northern sand lance | 1960 | 27.39 | 54 | 1982 | 182.36 | 71 |
| Northern sand lance | 1961 | 1.2 | 55 | 1984 | 1.66 | 58 |
| Northern sand lance | 1962 | 0.12 | 64 | 1985 | 3.54 | 167 |
| Northern sand lance | 1963 | 0.18 | 56 | 1986 | 0.24 | 115 |
| Northern sand lance | 1964 | 3.15 | 90 | 1987 | 1.19 | 110 |
| Northern sand lance | 1965 | 1.85 | 66 | 1988 | 0.8 | 90 |
| Northern sand lance | 1966 | 1.02 | 50 | 1989 | 3.57 | 112 |
| Northern sand lance | 1967 | 2.66 | 19 | 1990 | 0.42 | 104 |
| Northern sand lance | 1968 | 0.32 | 40 | 1991 | 1.45 | 103 |
| Northern sand lance | 1969 | 3.18 | 8 | 1992 | 0.58 | 89 |
| Northern sand lance | 1970 | 91.56 | 28 | 1993 | 0.75 | 77 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Northern sand lance | 1971 | 36.35 | 30 | 1994 | 0.89 | 64 |
| Northern sand lance | 1972 | 35.38 | 21 | 1995 | 0.47 | 85 |
| Pollock | 1951 | 66.53 | 26 | 1973 | 0 | 50 |
| Pollock | 1952 | 123.03 | 50 | 1974 | 0 | 13 |
| Pollock | 1953 | 12.47 | 45 | 1975 | 0 | 36 |
| Pollock | 1954 | 14.46 | 40 | 1976 | 0.91 | 41 |
| Pollock | 1955 | 10.48 | 57 | 1977 | 0 | 47 |
| Pollock | 1956 | 602.49 | 27 | 1978 | 1.82 | 89 |
| Pollock | 1957 | 7.48 | 30 | 1979 | 7.49 | 92 |
| Pollock | 1958 | 3.99 | 28 | 1980 | 0 | 80 |
| Pollock | 1959 | 47.66 | 52 | 1981 | 0 | 49 |
| Pollock | 1960 | 219.07 | 54 | 1982 | 0.7 | 71 |
| Pollock | 1961 | 20.41 | 55 | 1984 | 0 | 58 |
| Pollock | 1962 | 19.05 | 64 | 1985 | 1.7 | 167 |
| Pollock | 1963 | 156.66 | 56 | 1986 | 1.25 | 115 |
| Pollock | 1964 | 120.21 | 90 | 1987 | 16.43 | 110 |
| Pollock | 1965 | 13.39 | 66 | 1988 | 0.5 | 90 |
| Pollock | 1966 | 37.87 | 50 | 1989 | 13.7 | 112 |
| Pollock | 1967 | 0 | 19 | 1990 | 15.13 | 104 |
| Pollock | 1968 | 0 | 40 | 1991 | 15.44 | 103 |
| Pollock | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Pollock | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Pollock | 1971 | 103.65 | 30 | 1994 | 0 | 64 |
| Pollock | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Redfish | 1951 | 174.89 | 78 | 1973 | 639.61 | 150 |
| Redfish | 1952 | 18936.93 | 150 | 1974 | 0 | 39 |
| Redfish | 1953 | 10132.08 | 135 | 1975 | 694.78 | 108 |
| Redfish | 1954 | 2116.6 | 120 | 1976 | 176.41 | 123 |
| Redfish | 1955 | 1896.92 | 171 | 1977 | 3683.8 | 141 |
| Redfish | 1956 | 3016.57 | 81 | 1978 | 126.7 | 267 |
| Redfish | 1957 | 7910.48 | 90 | 1979 | 1222.65 | 276 |
| Redfish | 1958 | 2247.04 | 84 | 1980 | 194.36 | 240 |
| Redfish | 1959 | 6552.77 | 156 | 1981 | 241 | 147 |
| Redfish | 1960 | 19059.76 | 162 | 1982 | 4340.5 | 213 |
| Redfish | 1961 | 4061.4 | 165 | 1984 | 299.55 | 174 |
| Redfish | 1962 | 7739.65 | 192 | 1985 | 563.49 | 501 |
| Redfish | 1963 | 3376.8 | 168 | 1986 | 4024.09 | 345 |
| Redfish | 1964 | 5108.69 | 270 | 1987 | 463.85 | 330 |
| Redfish | 1965 | 2704.55 | 198 | 1988 | 651.53 | 270 |
| Redfish | 1966 | 3679.19 | 150 | 1989 | 368.85 | 336 |
| Redfish | 1967 | 69.85 | 57 | 1990 | 1513.05 | 312 |
| Redfish | 1968 | 6609.13 | 120 | 1991 | 29.9 | 309 |
| Redfish | 1969 | 0 | 24 | 1992 | 107.14 | 267 |
| Redfish | 1970 | 375.82 | 84 | 1993 | 1295.73 | 231 |
| Redfish | 1971 | 460.4 | 90 | 1994 | 1162.21 | 192 |
| Redfish | 1972 | 0.6 | 63 | 1995 | 9282.72 | 255 |
| Sea raven | 1951 | 0 | 26 | 1973 | 157.39 | 50 |
| Sea raven | 1952 | 8.73 | 50 | 1974 | 62.58 | 13 |
| Sea raven | 1953 | 8.73 | 45 | 1975 | 78.71 | 36 |
| Sea raven | 1954 | 15.71 | 40 | 1976 | 158.98 | 41 |
| Sea raven | 1955 | 4.99 | 57 | 1977 | 115.65 | 47 |
| Sea raven | 1956 | 12.48 | 27 | 1978 | 189.4 | 89 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Sea raven | 1957 | 3.49 | 30 | 1979 | 176.42 | 92 |
| Sea raven | 1958 | 13.48 | 28 | 1980 | 238.35 | 80 |
| Sea raven | 1959 | 17.45 | 52 | 1981 | 89.5 | 49 |
| Sea raven | 1960 | 0 | 54 | 1982 | 279 | 71 |
| Sea raven | 1961 | 47.21 | 55 | 1984 | 177.04 | 58 |
| Sea raven | 1962 | 31.98 | 64 | 1985 | 392.96 | 167 |
| Sea raven | 1963 | 16.25 | 56 | 1986 | 370.68 | 115 |
| Sea raven | 1964 | 45.29 | 90 | 1987 | 259.22 | 110 |
| Sea raven | 1965 | 35.57 | 66 | 1988 | 115.83 | 90 |
| Sea raven | 1966 | 17.9 | 50 | 1989 | 137.2 | 112 |
| Sea raven | 1967 | 13.61 | 19 | 1990 | 159.15 | 104 |
| Sea raven | 1968 | 29.94 | 40 | 1991 | 126.05 | 103 |
| Sea raven | 1969 | 26.31 | 8 | 1992 | 89.34 | 89 |
| Sea raven | 1970 | 23.14 | 28 | 1993 | 126.21 | 77 |
| Sea raven | 1971 | 30.38 | 30 | 1994 | 59.76 | 64 |
| Sea raven | 1972 | 26.08 | 21 | 1995 | 41.63 | 85 |
| Shorthorn sculpin | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Shorthorn sculpin | 1952 | 0.75 | 50 | 1974 | 0.91 | 13 |
| Shorthorn sculpin | 1953 | 1.5 | 45 | 1975 | 0.23 | 36 |
| Shorthorn sculpin | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Shorthorn sculpin | 1955 | 0 | 57 | 1977 | 0.32 | 47 |
| Shorthorn sculpin | 1956 | 0 | 27 | 1978 | 0.91 | 89 |
| Shorthorn sculpin | 1957 | 0 | 30 | 1979 | 0.45 | 92 |
| Shorthorn sculpin | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Shorthorn sculpin | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Shorthorn sculpin | 1960 | 0 | 54 | 1982 | 0.9 | 71 |
| Shorthorn sculpin | 1961 | 0 | 55 | 1984 | 2.49 | 58 |
| Shorthorn sculpin | 1962 | 0.68 | 64 | 1985 | 2.32 | 167 |
| Shorthorn sculpin | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Shorthorn sculpin | 1964 | 0 | 90 | 1987 | 2.57 | 110 |
| Shorthorn sculpin | 1965 | 0 | 66 | 1988 | 0.25 | 90 |
| Shorthorn sculpin | 1966 | 0 | 50 | 1989 | 1 | 112 |
| Shorthorn sculpin | 1967 | 0 | 19 | 1990 | 3.29 | 104 |
| Shorthorn sculpin | 1968 | 0 | 40 | 1991 | 0.84 | 103 |
| Shorthorn sculpin | 1969 | 0 | 8 | 1992 | 5.38 | 89 |
| Shorthorn sculpin | 1970 | 0 | 28 | 1993 | 1.09 | 77 |
| Shorthorn sculpin | 1971 | 0 | 30 | 1994 | 0.33 | 64 |
| Shorthorn sculpin | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Silver hake | 1951 | 0.94 | 26 | 1973 | 0 | 50 |
| Silver hake | 1952 | 3.78 | 50 | 1974 | 0 | 13 |
| Silver hake | 1953 | 2334.62 | 45 | 1975 | 1.36 | 36 |
| Silver hake | 1954 | 14.64 | 40 | 1976 | 1.59 | 41 |
| Silver hake | 1955 | 14.34 | 57 | 1977 | 0.45 | 47 |
| Silver hake | 1956 | 6.24 | 27 | 1978 | 56.56 | 89 |
| Silver hake | 1957 | 1 | 30 | 1979 | 29.78 | 92 |
| Silver hake | 1958 | 4.88 | 28 | 1980 | 10.1 | 80 |
| Silver hake | 1959 | 2.06 | 52 | 1981 | 318.55 | 49 |
| Silver hake | 1960 | 34.38 | 54 | 1982 | 0.1 | 71 |
| Silver hake | 1961 | 31.97 | 55 | 1984 | 0 | 58 |
| Silver hake | 1962 | 9.07 | 64 | 1985 | 35.28 | 167 |
| Silver hake | 1963 | 0 | 56 | 1986 | 123.75 | 115 |
| Silver hake | 1964 | 0 | 90 | 1987 | 25.07 | 110 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Silver hake | 1965 | 0.23 | 66 | 1988 | 0.42 | 90 |
| Silver hake | 1966 | 0 | 50 | 1989 | 1.08 | 112 |
| Silver hake | 1967 | 0 | 19 | 1990 | 1.45 | 104 |
| Silver hake | 1968 | 0.43 | 40 | 1991 | 1.35 | 103 |
| Silver hake | 1969 | 0 | 8 | 1992 | 0.91 | 89 |
| Silver hake | 1970 | 1.36 | 28 | 1993 | 0.09 | 77 |
| Silver hake | 1971 | 0 | 30 | 1994 | 1.04 | 64 |
| Silver hake | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Smooth skate | 1951 | 0.75 | 26 | 1973 | 4.98 | 50 |
| Smooth skate | 1952 | 12.75 | 50 | 1974 | 0 | 13 |
| Smooth skate | 1953 | 3.75 | 45 | 1975 | 0.45 | 36 |
| Smooth skate | 1954 | 9.75 | 40 | 1976 | 0 | 41 |
| Smooth skate | 1955 | 1.5 | 57 | 1977 | 2.26 | 47 |
| Smooth skate | 1956 | 4.74 | 27 | 1978 | 37.13 | 89 |
| Smooth skate | 1957 | 0.99 | 30 | 1979 | 3.17 | 92 |
| Smooth skate | 1958 | 2.66 | 28 | 1980 | 5 | 80 |
| Smooth skate | 1959 | 10.58 | 52 | 1981 | 8 | 49 |
| Smooth skate | 1960 | 9.66 | 54 | 1982 | 4 | 71 |
| Smooth skate | 1961 | 2.27 | 55 | 1984 | 1.41 | 58 |
| Smooth skate | 1962 | 11.57 | 64 | 1985 | 9.84 | 167 |
| Smooth skate | 1963 | 14.21 | 56 | 1986 | 2.9 | 115 |
| Smooth skate | 1964 | 37.69 | 90 | 1987 | 2.99 | 110 |
| Smooth skate | 1965 | 13.06 | 66 | 1988 | 2.08 | 90 |
| Smooth skate | 1966 | 13.84 | 50 | 1989 | 0.66 | 112 |
| Smooth skate | 1967 | 0 | 19 | 1990 | 8.13 | 104 |
| Smooth skate | 1968 | 0.23 | 40 | 1991 | 9.94 | 103 |
| Smooth skate | 1969 | 0 | 8 | 1992 | 4.47 | 89 |
| Smooth skate | 1970 | 0 | 28 | 1993 | 0.83 | 77 |
| Smooth skate | 1971 | 6.36 | 30 | 1994 | 0.79 | 64 |
| Smooth skate | 1972 | 0 | 21 | 1995 | 1.99 | 85 |
| Spiny lumpfish | 1951 | 0 | 52 | 1973 | 0 | 100 |
| Spiny lumpfish | 1952 | 0 | 100 | 1974 | 0 | 26 |
| Spiny lumpfish | 1953 | 0 | 90 | 1975 | 0.14 | 72 |
| Spiny lumpfish | 1954 | 0 | 80 | 1976 | 0 | 82 |
| Spiny lumpfish | 1955 | 0 | 114 | 1977 | 0 | 94 |
| Spiny lumpfish | 1956 | 0 | 54 | 1978 | 0.08 | 178 |
| Spiny lumpfish | 1957 | 0 | 60 | 1979 | 0.2 | 184 |
| Spiny lumpfish | 1958 | 0 | 56 | 1980 | 0.11 | 160 |
| Spiny lumpfish | 1959 | 0 | 104 | 1981 | 0 | 98 |
| Spiny lumpfish | 1960 | 0 | 108 | 1982 | 0.15 | 142 |
| Spiny lumpfish | 1961 | 0.08 | 110 | 1984 | 0 | 116 |
| Spiny lumpfish | 1962 | 0 | 128 | 1985 | 0 | 334 |
| Spiny lumpfish | 1963 | 0.04 | 112 | 1986 | 0.12 | 230 |
| Spiny lumpfish | 1964 | 0.04 | 180 | 1987 | 0.2 | 220 |
| Spiny lumpfish | 1965 | 0.12 | 132 | 1988 | 0.12 | 180 |
| Spiny lumpfish | 1966 | 0 | 100 | 1989 | 0.26 | 224 |
| Spiny lumpfish | 1967 | 0 | 38 | 1990 | 0.24 | 208 |
| Spiny lumpfish | 1968 | 0 | 80 | 1991 | 0.06 | 206 |
| Spiny lumpfish | 1969 | 0 | 16 | 1992 | 0.66 | 178 |
| Spiny lumpfish | 1970 | 0 | 56 | 1993 | 0.25 | 154 |
| Spiny lumpfish | 1971 | 0 | 60 | 1994 | 0.19 | 128 |
| Spiny lumpfish | 1972 | 0.23 | 42 | 1995 | 0.57 | 170 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Spotted wolffish | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Spotted wolffish | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Spotted wolffish | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Spotted wolffish | 1954 | 0 | 40 | 1976 | 0 | 41 |
| Spotted wolffish | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Spotted wolffish | 1956 | 0 | 27 | 1978 | 16.86 | 89 |
| Spotted wolffish | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Spotted wolffish | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Spotted wolffish | 1959 | 0 | 52 | 1981 | 7.5 | 49 |
| Spotted wolffish | 1960 | 0 | 54 | 1982 | 4.1 | 71 |
| Spotted wolffish | 1961 | 3.63 | 55 | 1984 | 17.02 | 58 |
| Spotted wolffish | 1962 | 7.71 | 64 | 1985 | 0 | 167 |
| Spotted wolffish | 1963 | 7.53 | 56 | 1986 | 0 | 115 |
| Spotted wolffish | 1964 | 13.61 | 90 | 1987 | 0 | 110 |
| Spotted wolffish | 1965 | 15.25 | 66 | 1988 | 11.62 | 90 |
| Spotted wolffish | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Spotted wolffish | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Spotted wolffish | 1968 | 30.84 | 40 | 1991 | 9.34 | 103 |
| Spotted wolffish | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Spotted wolffish | 1970 | 9.53 | 28 | 1993 | 0 | 77 |
| Spotted wolffish | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Spotted wolffish | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Striped wolffish | 1951 | 6.95 | 26 | 1973 | 180.99 | 50 |
| Striped wolffish | 1952 | 39.91 | 50 | 1974 | 87.55 | 13 |
| Striped wolffish | 1953 | 25.86 | 45 | 1975 | 186.66 | 36 |
| Striped wolffish | 1954 | 37.42 | 40 | 1976 | 195.52 | 41 |
| Striped wolffish | 1955 | 14.96 | 57 | 1977 | 86.18 | 47 |
| Striped wolffish | 1956 | 7.99 | 27 | 1978 | 228.47 | 89 |
| Striped wolffish | 1957 | 66.36 | 30 | 1979 | 442.27 | 92 |
| Striped wolffish | 1958 | 1.99 | 28 | 1980 | 462.65 | 80 |
| Striped wolffish | 1959 | 61.28 | 52 | 1981 | 65 | 49 |
| Striped wolffish | 1960 | 157.3 | 54 | 1982 | 630.5 | 71 |
| Striped wolffish | 1961 | 64.41 | 55 | 1984 | 305.02 | 58 |
| Striped wolffish | 1962 | 151.94 | 64 | 1985 | 575.19 | 167 |
| Striped wolffish | 1963 | 55.42 | 56 | 1986 | 751.15 | 115 |
| Striped wolffish | 1964 | 154.24 | 90 | 1987 | 739.7 | 110 |
| Striped wolffish | 1965 | 59.68 | 66 | 1988 | 497.67 | 90 |
| Striped wolffish | 1966 | 282.26 | 50 | 1989 | 547.55 | 112 |
| Striped wolffish | 1967 | 18.83 | 19 | 1990 | 697.04 | 104 |
| Striped wolffish | 1968 | 18.36 | 40 | 1991 | 388.83 | 103 |
| Striped wolffish | 1969 | 15.88 | 8 | 1992 | 355.12 | 89 |
| Striped wolffish | 1970 | 1.36 | 28 | 1993 | 304.65 | 77 |
| Striped wolffish | 1971 | 5.44 | 30 | 1994 | 435.12 | 64 |
| Striped wolffish | 1972 | 36.29 | 21 | 1995 | 153.57 | 85 |
| Thorny skate | 1951 | 104.43 | 26 | 1973 | 1394.59 | 50 |
| Thorny skate | 1952 | 1094.72 | 50 | 1974 | 172.51 | 13 |
| Thorny skate | 1953 | 1328.45 | 45 | 1975 | 816.29 | 36 |
| Thorny skate | 1954 | 1351.48 | 40 | 1976 | 1264.39 | 41 |
| Thorny skate | 1955 | 239.15 | 57 | 1977 | 1164.86 | 47 |
| Thorny skate | 1956 | 177.87 | 27 | 1978 | 906.59 | 89 |
| Thorny skate | 1957 | 651.52 | 30 | 1979 | 939.82 | 92 |
| Thorny skate | 1958 | 421.18 | 28 | 1980 | 1395.6 | 80 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Thorny skate | 1959 | 2275.78 | 52 | 1981 | 493.4 | 49 |
| Thorny skate | 1960 | 1491.5 | 54 | 1982 | 1233.6 | 71 |
| Thorny skate | 1961 | 1600.89 | 55 | 1984 | 926.86 | 58 |
| Thorny skate | 1962 | 2659.96 | 64 | 1985 | 3740.85 | 167 |
| Thorny skate | 1963 | 2065.85 | 56 | 1986 | 2631.39 | 115 |
| Thorny skate | 1964 | 2380.83 | 90 | 1987 | 1379.21 | 110 |
| Thorny skate | 1965 | 1709.92 | 66 | 1988 | 1346.97 | 90 |
| Thorny skate | 1966 | 805.15 | 50 | 1989 | 1261.72 | 112 |
| Thorny skate | 1967 | 655.9 | 19 | 1990 | 1656.61 | 104 |
| Thorny skate | 1968 | 467.45 | 40 | 1991 | 670.69 | 103 |
| Thorny skate | 1969 | 238.15 | 8 | 1992 | 786.32 | 89 |
| Thorny skate | 1970 | 940.78 | 28 | 1993 | 455.89 | 77 |
| Thorny skate | 1971 | 550.88 | 30 | 1994 | 234.05 | 64 |
| Thorny skate | 1972 | 555.88 | 21 | 1995 | 370.47 | 85 |
| Threebeard rockling | 1951 | 0 | 26 | 1973 | 0 | 50 |
| Threebeard rockling | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Threebeard rockling | 1953 | 0 | 45 | 1975 | 0 | 36 |
| Threebeard rockling | 1954 | 0 | 40 | 1976 | 0.05 | 41 |
| Threebeard rockling | 1955 | 0 | 57 | 1977 | 0.09 | 47 |
| Threebeard rockling | 1956 | 0 | 27 | 1978 | 0.1 | 89 |
| Threebeard rockling | 1957 | 0 | 30 | 1979 | 0 | 92 |
| Threebeard rockling | 1958 | 0 | 28 | 1980 | 0 | 80 |
| Threebeard rockling | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Threebeard rockling | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Threebeard rockling | 1961 | 0.09 | 55 | 1984 | 0 | 58 |
| Threebeard rockling | 1962 | 0 | 64 | 1985 | 0 | 167 |
| Threebeard rockling | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Threebeard rockling | 1964 | 0 | 90 | 1987 | 0 | 110 |
| Threebeard rockling | 1965 | 0 | 66 | 1988 | 0 | 90 |
| Threebeard rockling | 1966 | 0 | 50 | 1989 | 0 | 112 |
| Threebeard rockling | 1967 | 0 | 19 | 1990 | 0 | 104 |
| Threebeard rockling | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Threebeard rockling | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Threebeard rockling | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Threebeard rockling | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Threebeard rockling | 1972 | 0 | 21 | 1995 | 0 | 85 |
| Vahl's eelpout | 1951 | 0 | 26 | 1973 | 0.23 | 50 |
| Vahl's eelpout | 1952 | 0 | 50 | 1974 | 0 | 13 |
| Vahl's eelpout | 1953 | 0 | 45 | 1975 | 0.18 | 36 |
| Vahl's eelpout | 1954 | 0 | 40 | 1976 | 0.45 | 41 |
| Vahl's eelpout | 1955 | 0 | 57 | 1977 | 0 | 47 |
| Vahl's eelpout | 1956 | 0 | 27 | 1978 | 25.56 | 89 |
| Vahl's eelpout | 1957 | 0 | 30 | 1979 | 1.13 | 92 |
| Vahl's eelpout | 1958 | 0 | 28 | 1980 | 0.5 | 80 |
| Vahl's eelpout | 1959 | 0 | 52 | 1981 | 0 | 49 |
| Vahl's eelpout | 1960 | 0 | 54 | 1982 | 0 | 71 |
| Vahl's eelpout | 1961 | 0 | 55 | 1984 | 0 | 58 |
| Vahl's eelpout | 1962 | 1.29 | 64 | 1985 | 0.66 | 167 |
| Vahl's eelpout | 1963 | 0 | 56 | 1986 | 0 | 115 |
| Vahl's eelpout | 1964 | 2.26 | 90 | 1987 | 0 | 110 |
| Vahl's eelpout | 1965 | 0.23 | 66 | 1988 | 0 | 90 |
| Vahl's eelpout | 1966 | 0.42 | 50 | 1989 | 0 | 112 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Vahl's eelpout | 1967 | 7.71 | 19 | 1990 | 0.04 | 104 |
| Vahl's eelpout | 1968 | 0 | 40 | 1991 | 0 | 103 |
| Vahl's eelpout | 1969 | 0 | 8 | 1992 | 0 | 89 |
| Vahl's eelpout | 1970 | 0 | 28 | 1993 | 0 | 77 |
| Vahl's eelpout | 1971 | 0 | 30 | 1994 | 0 | 64 |
| Vahl's eelpout | 1972 | 0 | 21 | 1995 | 0 | 85 |
| White hake | 1951 | 608.73 | 26 | 1973 | 116.35 | 50 |
| White hake | 1952 | 1635.18 | 50 | 1974 | 0 | 13 |
| White hake | 1953 | 1139.15 | 45 | 1975 | 24.04 | 36 |
| White hake | 1954 | 328.44 | 40 | 1976 | 95.93 | 41 |
| White hake | 1955 | 59.39 | 57 | 1977 | 24.94 | 47 |
| White hake | 1956 | 88.81 | 27 | 1978 | 472.67 | 89 |
| White hake | 1957 | 86.81 | 30 | 1979 | 220.65 | 92 |
| White hake | 1958 | 51.85 | 28 | 1980 | 57.5 | 80 |
| White hake | 1959 | 696.8 | 52 | 1981 | 331.3 | 49 |
| White hake | 1960 | 1079.53 | 54 | 1982 | 0.1 | 71 |
| White hake | 1961 | 1741.57 | 55 | 1984 | 28.64 | 58 |
| White hake | 1962 | 1936.75 | 64 | 1985 | 61.42 | 167 |
| White hake | 1963 | 1484.39 | 56 | 1986 | 21.58 | 115 |
| White hake | 1964 | 7725.97 | 90 | 1987 | 157.66 | 110 |
| White hake | 1965 | 116.68 | 66 | 1988 | 126.12 | 90 |
| White hake | 1966 | 949.07 | 50 | 1989 | 28.3 | 112 |
| White hake | 1967 | 0 | 19 | 1990 | 6.89 | 104 |
| White hake | 1968 | 181.89 | 40 | 1991 | 15.27 | 103 |
| White hake | 1969 | 0 | 8 | 1992 | 10.79 | 89 |
| White hake | 1970 | 31.98 | 28 | 1993 | 18.05 | 77 |
| White hake | 1971 | 43.37 | 30 | 1994 | 52.37 | 64 |
| White hake | 1972 | 16.33 | 21 | 1995 | 2.41 | 85 |
| Witch flounder | 1951 | 144.21 | 26 | 1973 | 286.23 | 50 |
| Witch flounder | 1952 | 205.21 | 50 | 1974 | 0 | 13 |
| Witch flounder | 1953 | 352.15 | 45 | 1975 | 58.96 | 36 |
| Witch flounder | 1954 | 241.99 | 40 | 1976 | 278.64 | 41 |
| Witch flounder | 1955 | 78.88 | 57 | 1977 | 74.62 | 47 |
| Witch flounder | 1956 | 132.37 | 27 | 1978 | 77.08 | 89 |
| Witch flounder | 1957 | 91.3 | 30 | 1979 | 73.33 | 92 |
| Witch flounder | 1958 | 135.23 | 28 | 1980 | 173.5 | 80 |
| Witch flounder | 1959 | 814.13 | 52 | 1981 | 105 | 49 |
| Witch flounder | 1960 | 163.9 | 54 | 1982 | 167 | 71 |
| Witch flounder | 1961 | 329.99 | 55 | 1984 | 111.05 | 58 |
| Witch flounder | 1962 | 1161.2 | 64 | 1985 | 489.37 | 167 |
| Witch flounder | 1963 | 342.87 | 56 | 1986 | 229 | 115 |
| Witch flounder | 1964 | 841.63 | 90 | 1987 | 250.7 | 110 |
| Witch flounder | 1965 | 286.03 | 66 | 1988 | 419.4 | 90 |
| Witch flounder | 1966 | 517.23 | 50 | 1989 | 265.56 | 112 |
| Witch flounder | 1967 | 4.54 | 19 | 1990 | 192.54 | 104 |
| Witch flounder | 1968 | 136.76 | 40 | 1991 | 99.99 | 103 |
| Witch flounder | 1969 | 7.48 | 8 | 1992 | 154.16 | 89 |
| Witch flounder | 1970 | 8.75 | 28 | 1993 | 50.7 | 77 |
| Witch flounder | 1971 | 18.15 | 30 | 1994 | 85.74 | 64 |
| Witch flounder | 1972 | 25.85 | 21 | 1995 | 29.63 | 85 |
| Yellowtail flounder | 1951 | 2.99 | 26 | 1973 | 1906.37 | 50 |
| Yellowtail flounder | 1952 | 75.49 | 51 | 1974 | 1077.28 | 13 |

Table C.1 Total weight for each species and year surveyed on southern Grand Bank. The ordering of the species is alphabetical. The total number of tows (N) is given for reference.

| Species | Year | Total Weight (kg) | N | Year | Total Weight (kg) | N |
|---|---|---|---|---|---|---|
| Yellowtail flounder | 1953 | 108.78 | 45 | 1975 | 1606.39 | 36 |
| Yellowtail flounder | 1954 | 135.37 | 40 | 1976 | 2094.24 | 41 |
| Yellowtail flounder | 1955 | 34.33 | 57 | 1977 | 2542.19 | 47 |
| Yellowtail flounder | 1956 | 49.7 | 27 | 1978 | 4463.43 | 89 |
| Yellowtail flounder | 1957 | 121.69 | 30 | 1979 | 4790.51 | 92 |
| Yellowtail flounder | 1958 | 257.3 | 28 | 1980 | 4651.87 | 80 |
| Yellowtail flounder | 1959 | 241.27 | 52 | 1981 | 2114.5 | 49 |
| Yellowtail flounder | 1960 | 144.23 | 54 | 1982 | 2780.4 | 71 |
| Yellowtail flounder | 1961 | 298.25 | 55 | 1984 | 3214.53 | 58 |
| Yellowtail flounder | 1962 | 743.44 | 64 | 1985 | 6815.42 | 167 |
| Yellowtail flounder | 1963 | 684.93 | 56 | 1986 | 4435.6 | 115 |
| Yellowtail flounder | 1964 | 1677.53 | 90 | 1987 | 3800.03 | 110 |
| Yellowtail flounder | 1965 | 1377.25 | 66 | 1988 | 1968.05 | 90 |
| Yellowtail flounder | 1966 | 1278.44 | 50 | 1989 | 2337.58 | 112 |
| Yellowtail flounder | 1967 | 493.73 | 19 | 1990 | 2991.73 | 104 |
| Yellowtail flounder | 1968 | 1104.52 | 40 | 1991 | 2563.03 | 103 |
| Yellowtail flounder | 1969 | 365.15 | 8 | 1992 | 1533.83 | 89 |
| Yellowtail flounder | 1970 | 1089.1 | 28 | 1993 | 2217.12 | 77 |
| Yellowtail flounder | 1971 | 728.24 | 30 | 1994 | 1093.41 | 64 |
| Yellowtail flounder | 1972 | 1494.15 | 21 | 1995 | 1894.17 | 85 |