

Assessment of the Shetland Sandeel Fishery - 1996

Donna Goodlad & Ian Napier

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Summary

In 1996 the North Atlantic Fisheries College conducted an assessment of sandeel stocks and the sandeel fishery (chiefly *Ammodytes marinus*) in Shetland waters, by sampling commercial landings to obtain information on the sandeel population composition and by carrying out a scientific survey of sandeel grounds. The results demonstrated the recruitment of 0-group sandeels to the fishery in June, and showed that the overall abundance of 0-group sandeels from all grounds combined was relatively high in 1996 as compared to previous years, presumably due to better than average recruitment. The results also indicated that bycatch made up only a very small proportion of commercial sandeel catches.



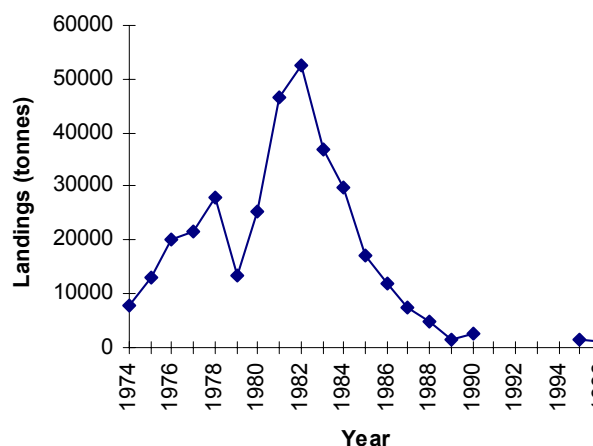
Lesser Sandeels, *Ammodytes marinus*. New 10 pence coin in centre indicates scale.

Introduction

Sandeels are numerically one of the most abundant fish species in the North Sea where they sustain a large industrial fishery. Fish from industrial fisheries are converted into fish meal, which is used in animal feed, and oil, which is used largely in the production of margarine. Five species of sandeel occur in the waters around Shetland although one, the lesser sandeel (*Ammodytes marinus*), is much more abundant than the others and accounts for over 90% of sandeel catches in both the North Sea and local Shetland fisheries. Sandeels are relatively short-lived (the maximum age reached is around 8 years) and the fishery is mainly composed of sandeels less than three years old. The size of sandeel stocks each year is strongly influenced, therefore, by the number of young sandeels born in that, and the previous, year.

The Shetland sandeel fishery consists of several inshore (less than 10 km from the coast) fishing grounds. Although this fishery occurs within the North Sea, the Shetland sandeel population is regarded as being a separate stock, mainly because the Shetland grounds are isolated from other grounds in the North Sea. The Shetland sandeel fishery has, therefore, been managed separately from other North Sea sandeel fisheries.

The Shetland sandeel fishery started in 1974 when 8,000 tonnes of sandeels were taken and reached a peak of 52,000 tonnes in 1982 (see graph below). From then on landings progressively declined until the fishery was closed in 1991. It reopened in 1995, but whereas the fishery had previously been largely unregulated, tight regulations were laid down, including a precautionary annual Total Allowable Catch of 3,000 tonnes, a licensing scheme with a maximum size limit on the vessels which were allowed to participate in the fishery, and a condition that all catches were landed at the Shetland Fish Products fish meal plant.



Catches from the Shetland sandeel fishery, 1974-1996. The fishery was closed from 1991 to 1994 inclusive.

In previous years, a scientific monitoring programme was conducted by the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) Marine Laboratory in Aberdeen to assess the status of the Shetland sandeel fishery. In 1996 this work was continued by the North Atlantic Fisheries College (NAFC), with the assistance of SOAEFD and with financial assistance from the European Commission. Samples of sandeels were collected from all commercial landings of sandeels in Shetland during 1996, and during a

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scientific survey cruise, and analysed to provide information on the size and composition of the Shetland sandeel stock.

Methods

Commercial Catch Sampling

Samples of sandeels were collected from every commercial landing made to the Shetland Fish Products plant by factory staff and frozen for transfer to the NAFC for analysis. Analysis of the samples involved measuring the lengths of the sandeels in each sample and removing otoliths from a proportion of them to enable their ages to be determined. (Otoliths are small "bones" present in the ears of fish in which annual growth rings, analogous to the rings of a tree, are formed as the fish grows). The growth rings in the sandeel otoliths were counted under a dissecting microscope at $\times 10$ -30 magnification. When ageing fish it is common to use a system of age- groups: fish below one year old are classified as 0-group, while a 1-group fish is in its second year (between 1 and 2 years old), and so on.

Any bycatch (i.e. non-sandeel species and sandeel species other than *A. marinus*) found within the samples were also recorded. A computer programme was used to calculate the relative abundance of each year class of sandeels in the commercial catches. The raw data was also passed to the SOAEFD Marine Laboratory for incorporation into national and international sandeel stock assessment programmes.

Survey Cruise

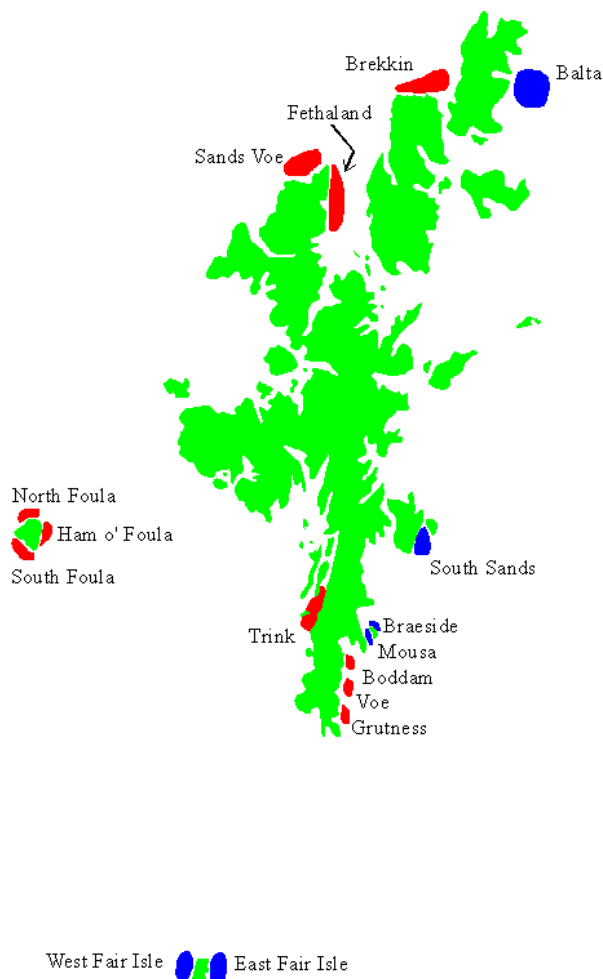
A scientific survey of the Shetland sandeel stock was carried out using FRV *Clupea* in August 1996, continuing a series of such surveys carried out by SOAEFD between 1984 and 1994. The aim of this survey was to obtain information on the distribution and relative abundance of sandeels at 16 different fishing grounds around Shetland (see map below). More grounds were sampled than were fished commercially to provide population distribution data from a wider geographical area. The sampling methods used in this survey were the same as those used by SOAEFD in previous years, to allow direct comparisons of the data collected. Each ground was fished three times at different times of day using a conventional sandeel trawl. Each tow was of standard duration (30 mins) and was taken along a similar track. The quantity of sandeels caught during each tow was assessed, and samples taken for analyses of size and age. The method of analysis was similar to that described for the samples taken from the commercial landings.

Results

Commercial Catch Samples

Eight fishing vessels under 18m in length were granted licences to fish for sandeels in 1996 but only seven of these boats actually fished. Fishing started in the second week of April and continued until the last day of June when the season closed, but throughout the season the fishery was interrupted by bad weather. Six grounds were fished commercially (see map below) but fishing effort was primarily directed at Mousa, Braeside and South Sands where about 90% of all the sandeels taken during 1996 were caught. In April and May total landings amounted to 428 and 515

tonnes respectively, and fell to 99 tonnes in June (see table below). Correspondingly, in April and May, the total number of landings equalled 45 and 47 respectively whereas in June the number of landings fell to 15.



Shetland sandeel grounds in 1996:

- - fished commercially and surveyed
- - surveyed but not fished commercially

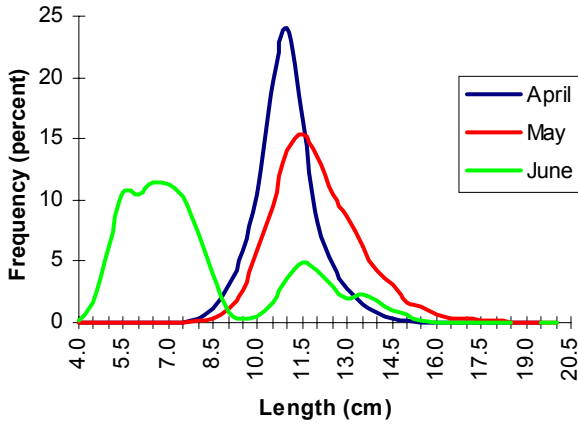
	April	May	June	Total
No. vessels fishing	7	6	2	-
No. landings made	45	47	15	107
Total weight landed (tonnes)	428	515	99	1042
Total weight of samples (kg)	99	124	27	250
No. sandeels measured	12,211	13,682	4,372	30,265
No. otoliths read	217	297	234	748

Summary of sandeel landings and samples in 1996.

The drop in landings in June was caused by a reduction in the number of boats fishing. Seven boats fished in April and six fished in May, but in June only two vessels remained in the fishery. This decline was primarily the result of fishermen transferring to other fisheries, such as scallops. In total 1,042 tonnes of sandeels were landed in 1996, just over one third of

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the total allowable catch. From this a total of 250 kg of sandeels were sampled, with over 30,000 individual sandeels being measured and 748 otoliths analysed. The graph above shows the length-frequency distribution - the proportion of sandeels in each size class - for each month.



The size-frequency distributions of sandeels (*A. marinus*) in commercial catches in April, May and June 1996.

In April, a few sandeels as small as 7.0 cm were present, but the majority were between 10.0 and 12.0 cm in length. A similar distribution was observed in May, but compared to April the peak had shifted slightly to the right due to the growth of the sandeels. Very small sandeels (down to 5.0 cm) also appeared in May indicating the start of recruitment of young 0-group sandeels, spawned during the previous winter, to the fishery. In June, the length-frequency distribution showed a bimodal distribution, i.e. there are two peaks in the graph. The majority of the sandeels were relatively small (69% were between 4.0 and 8.5 cm in length), whereas in May only a very small proportion had been less than 8.5 cm. The first peak in June represents 0-group sandeels which had just joined the fishery, while the second represents the same (older) sandeels which were present in April and May.

Age	April	May	June
0	0	0.1	73.5
1	82.4	60.6	21.4
2	16.3	31.8	4.2
3	0.9	2.8	0.3
4	0.1	2	0.3
5	0.2	2.6	0.3
6	0	0.2	0

The age-frequency composition (%) of sandeels (*A. marinus*) in April, May and June 1996.

There were differences in the age composition of the *A. marinus* populations in the three months of the fishery, as can be seen in the table above. In April, no 0-group *A. marinus* were present, the majority of the sandeels belonging to the 1-group (i.e. 1-2 years old) and the 2-group

(2-3 years old). A very small number of 0-group sandeels were present in catches taken during May, but again the majority of the population belonged to the 1-group and 2-group. By June, however, the age composition of the catches had shifted significantly, with the 0-group dominating, indicating the recruitment of sandeels spawned the previous winter.

Bycatch

Fish species other than sandeels were rare in the samples collected from commercial catches, as indicated in the table below. The lesser sandeel, *A. marinus*, accounted for 99.4% by weight of the samples analysed, while two other sandeel species (*Gymnammodytes semisquamatus* and the greater sandeel *Hyperoplus lanceolatus*) accounted for 0.2%. Non-sandeel species made up less than 0.2% of the samples analysed. Only 4 commercially important species were encountered: whiting (*Merlangus merlangus*), lemon sole (*Microstomus kitt*), dab (*Limanda limanda*) and plaice (*Pleuronectes platessa*), which together accounted for less than 0.07% of the samples analysed. "Others" represented organisms such as hermit crabs, sponges, gurnards, starfish and crabs. Low levels of bycatch were also observed during trips aboard sandeel vessels.

Species	April	May	June	Total
<i>A. marinus</i> - lesser sandeel	99.7	99.4	97.6	99.4
Other sandeel species	0.2	0.3	0.5	0.2
Whiting	0	0.01	0	<0.01
Lemon sole	<0.01	0	0	<0.01
Dab	0.04	0.23	0.61	0.02
Plaice	0.03	0.06	0.05	0.04
Others (non-commercial species)	0.08	0	1.12	0.14

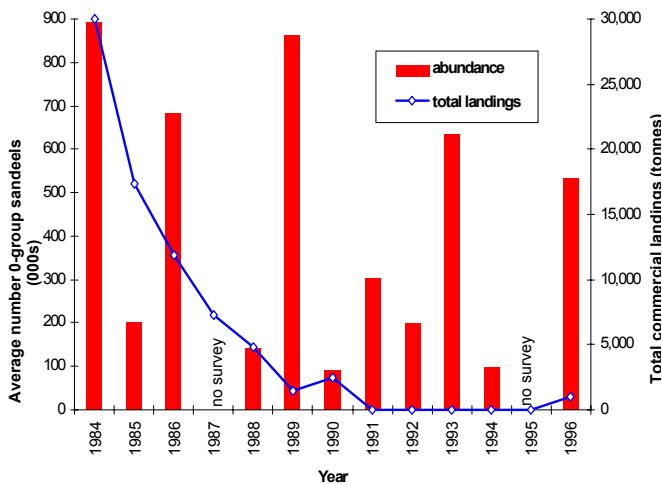
Species composition (%) of commercial sandeel catches in Shetland 1996.

FRV *Clupea* survey

A total of 16 different grounds were surveyed by the *Clupea* in August 1996 (see map above) with the sizes of catches varying markedly between different grounds. Two grounds gave significantly higher catches than the others; Braeside gave the highest yield of almost 15 tonnes per 30 minute tow while nearly 10.5 tonnes per 30 min. tow was taken at Mousa. (These two sites were popular fishing grounds with the commercial fishermen). The majority of sandeels taken from these grounds were 0-group (Braeside 97%; Mousa 99%). Relatively high catches were also taken from three other grounds; South Sands, Sands Voe and Ham o' Foula, where catches varied between 6 and 8 tonnes per 30 min. tow. All other catches were significantly smaller with the smallest catch, from West Fair Isle, weighing only a few kgs.

The average numbers of 0-group sandeels caught per 30 minute tow at all sites in 1996 is shown on the graph below, together with the data from surveys carried out in previous years by SOAEFD, and the total landings in each year.

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Average number of sandeels caught per 30 minute tow at all Shetland sandeel grounds during FRV *Clupea* surveys, and total landings from Shetland sandeel fishery. Note: there were no surveys in 1987 and 1995; and the fishery was closed from 1991 to 1994 inclusive.

As can be seen, the average catches of 0-group sandeels have varied from a minimum of 90,000 per 30 minute tow in 1990 to a maximum of 892,000 in 1984. The abundance of 0-group *A. marinus* was relatively high in 1996 as compared to previous years, particularly at Mousa, Braeside and South Sands, being the second highest ever recorded at each of these sites. These three sites were fished most frequently during the commercial fishery.

There appears to be no pattern in the fluctuation of 0-group sandeel abundance, and there appears to be no relationship between the abundance of 0-group sandeels during the scientific surveys and the weight of sandeels caught either in the same year or in the following year. The total landings show a steady decline, leading up to the closure of the fishery in 1991 whereas the abundance indices fluctuate with no apparent pattern.

Discussion

The data collected from commercial sandeel catches in 1996 clearly demonstrates the entry of small numbers of 0-group sandeels to the fishery in May 1996, followed by a larger recruitment in June, when 0-group sandeels accounted for almost 75% of commercial catches. By August 0-group sandeels accounted for about 94% of the *Clupea's* catches. As the sandeel stocks are composed primarily of young sandeels (0-2 years), the size of the stocks in any year will be strongly influenced by the level of recruitment in that, and the previous few, years. As there is little relationship between the size of the sandeel spawning stock and the level of recruitment it is difficult to make predictions about future stock sizes. Nevertheless, it is important to monitor the state of these stocks in relation to catch levels as this provides the best basis for the sustainable management of the fishery.

Analyses of the commercial samples indicates that bycatch made up a very small proportion of sandeel catches, suggesting that the Shetland sandeel fishery is unlikely to have direct adverse effects on stocks of other fish species.

However, the level of bycatch may depend on the grounds fished and the distribution of fish stocks in relation to the sandeel fishing grounds.

The fact that no relationship is apparent between sandeel landings each year and the abundance of 0-group sandeels during the FRV *Clupea* surveys suggests that there may not be a simple direct relationship between the level of fishing effort and the size of the sandeel stock and/or commercial catches. It is possible that the decline in commercial catches which occurred during the 1980s, and the concurrent lack of availability of sandeels to breeding seabirds, were not wholly a result of over-fishing.

Research carried out by the SOAEFD Marine Laboratory indicates that a large proportion of the sandeels in Shetland waters are actually spawned further south, on grounds to the west of Orkney, with the eggs and larvae being carried into Shetland waters by ocean currents. If this is correct then the size of Shetland sandeel stocks could be strongly affected by factors which influence this immigration of 0-group sandeels from outside Shetland waters, particularly changes in the pattern of ocean circulation. It is known that the patterns of ocean currents around Shetland do vary over time.

However, little is known about the precise factors which affect recruitment of 0-group sandeels to Shetland sandeel stocks, so at this stage it is not possible to draw any definite conclusions on the exact causes of the apparent increase in 0-group sandeel abundance seen in 1996, or of the fluctuations in their abundance which have been observed since surveys started.

Acknowledgements

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Editor: Dr. Ian R. Napier.

North Atlantic Fisheries College,
Port Arthur,
Scalloway,
Shetland,
Scotland ZE1 0UN.

Tel: +44 (0)1595 880328

Fax: +44 (0)1595 880549

Email: admin@nafc.ac.uk

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