Effects of Seismic Activities on the Fisheries at the Faroe Islands

By

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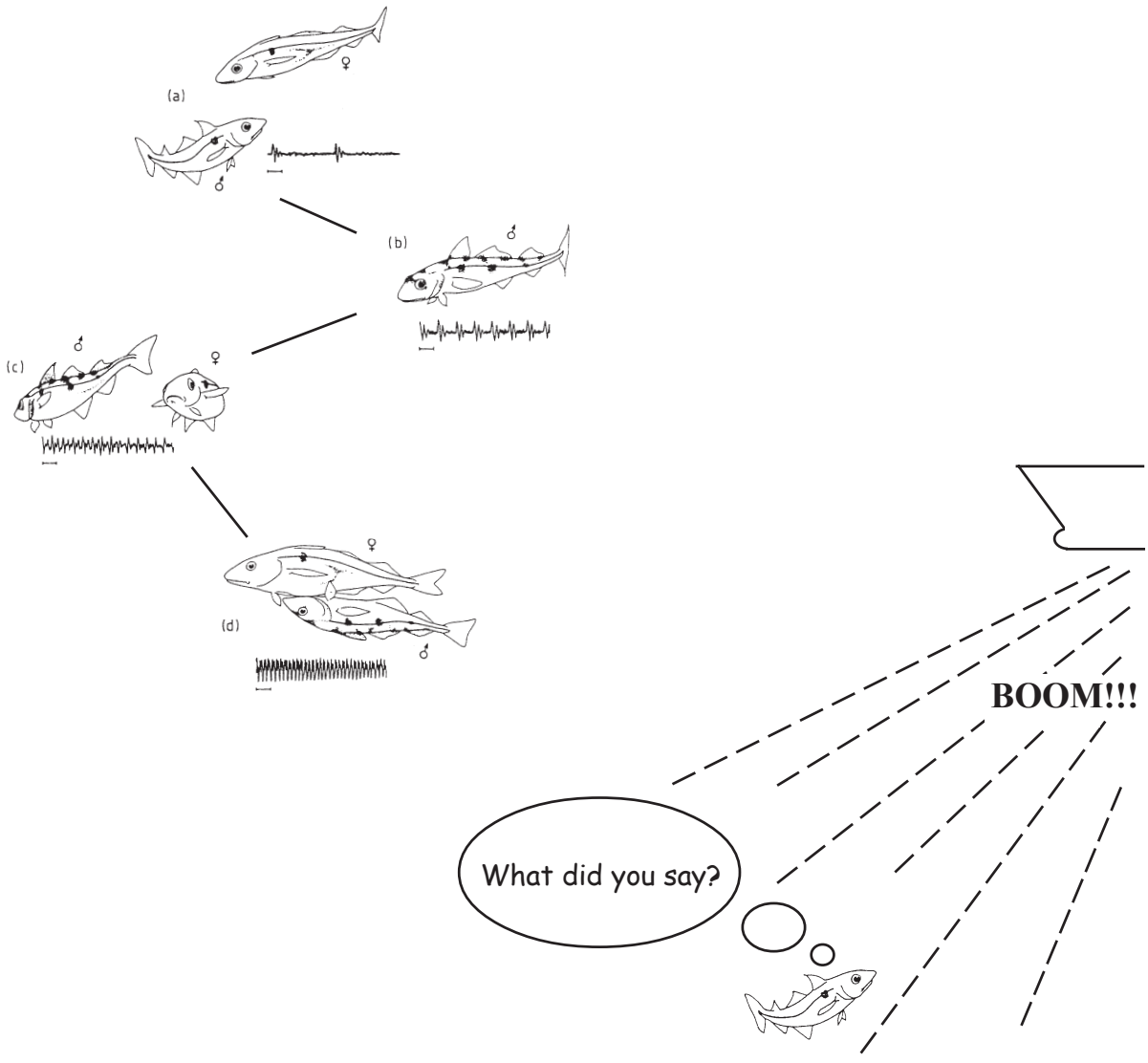

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Table of Contents

Front page drawing adapted from Hawkins (1993).

Executive Summary

To study the possible effects of seismic activity (SA) on the fisheries at the Faroe Islands, staff from the Faroese Fisheries Laboratory (Fiskirannsóknarstovan) conducted interviews of individual fishing boat skippers and analysed logbook data from selected fishing vessels. In addition to questions regarding the effects of SA on their fisheries, the skippers were also asked during the interview process a number of other questions related to their individual fishing success and to the fisheries in general at the Faroe Islands. The results of the study are presented in this report.

In order to obtain an unbiased population, all fishermen who had been at sea as skippers in week 10 of 1997 (3 - 9 March), a total of 207, were selected as potential interviewees. However, due to time constraints, logistics, and other practical reasons, only 168 were ultimately interviewed. In total, 95 skippers experienced SA while fishing and 71 (75%) of those skippers who experienced SA observed an effect on their fisheries.

The maintenance of fishing logbooks is obligatory for all larger Faroese fishing vessels. In the logbooks, a number of details regarding each fishing operation are recorded. For this particular project, logbooks for the year 1997 from 23 vessels in four different vessel categories were quality-checked and the data extracted. The distribution of the seismic activity in 1997 in time and space was obtained from the logbooks of the Fisheries Liaison Officers on the various seismic vessels. The combined data were plotted on maps and areas (Ø18nm) with the largest temporal and spatial coincidence between fishing and seismic activity were identified. The catch rates in the identified areas during and after SA were then analysed in relation to the time period just prior to SA and for the year as a whole. From the data, it was not possible to relate any changes in catch rates to seismic activity.

Thus, there is an apparent contradiction between the observations of fishermen regarding an effect on their fisheries by seismic activity and the lack of any recorded effect in the logbook data. Fishermen, however, are the first observers. The fact that 75% of the fishermen who experienced seismic activity while fishing observed an effect on their fisheries from seismic activity should be regarded as clear and convincing evidence of the existence of such an effect.

Due to a variety of reasons, the intrinsic variation in the catch rates is very large. The effects observed by the skippers, therefore, might easily be masked in the recorded averages. As there are no statistically significant differences in the catch rates recorded during and immediately after the seismic activity relative to the period immediately prior to the seismic activity or indeed to the whole year, the effects cannot have lasted very long and the fish were not totally herded from the areas studied.

The sound energy emitted during seismic shooting is so great that it can be distinguished above the ambient noise level by individual fish over considerable distance. One explanation for the short-lived effect might be that fish have adapted to seismic energy, and thus only react to it when very close to the source.

Further study, however, is indicated in that no systematic investigation has been conducted to validate the theoretical seismic sound spectrum and intensity at various horizontal distances from air gun emissions. The SOFAR layer in the Faroe-Shetland Channel is between 500 and 700 metres, which is a critical area for both large and small cetaceans who feed at the Faroe Islands. Thus, it is important to determine the sound levels in the entire water column and the SOFAR layer during seismic activity in the region in an effort to investigate the impact of seismic activity on significant cetacean species.

Introduction

The first seismic investigations in the Faroe area took place in the period 1975-1977. In 1993, some track lines from a seismic investigation in the UK part of the Faroe-Shetland Channel were extended into the Faroe area. With the increasing interest in oil exploration in Faroese waters, seismic investigations have been performed every year since 1993. The total seismic track line coverage (Figure 1) illustrates the extent and intensity of the activity.

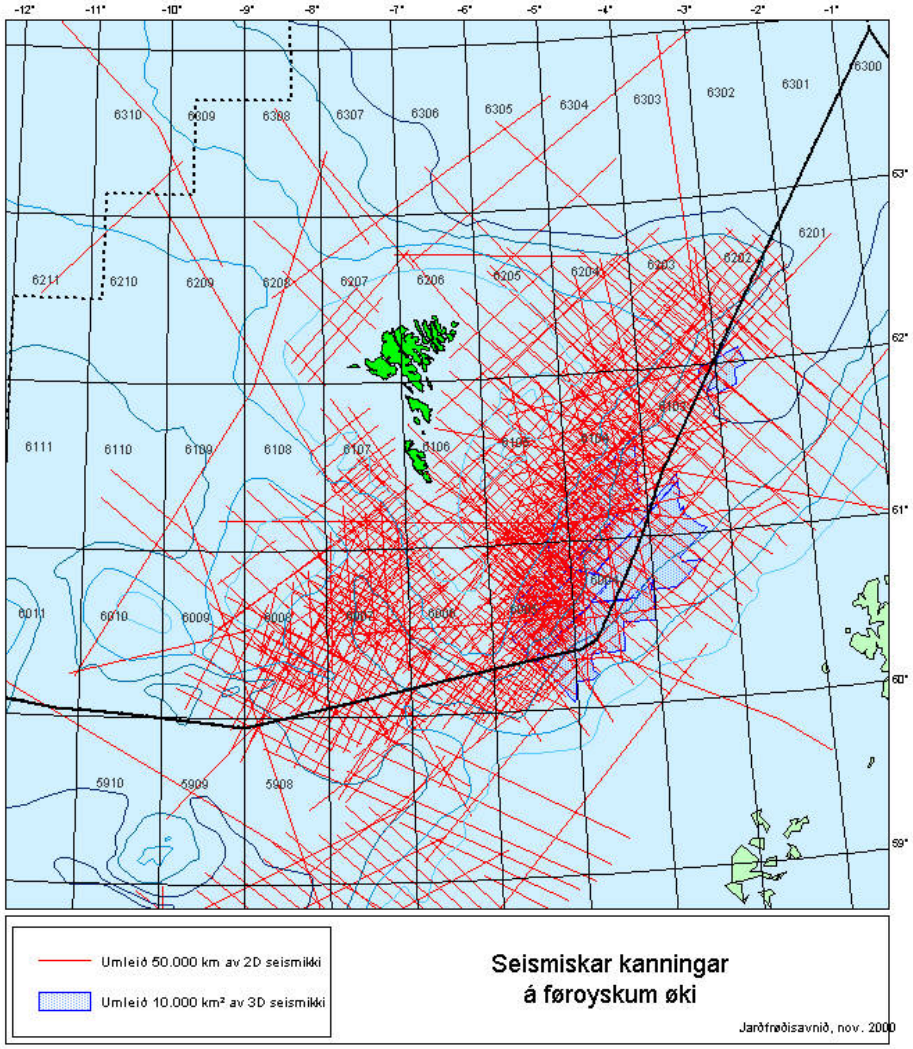


Figure 1. Total seismic coverage in Faroese waters 1973-2000.

In other areas, as in the North Sea and Norway, where there have been seismic investigations for many years, fishermen have claimed reduced catch rates due to seismic activity. Similarly, in the Faroe Islands a number of fishermen very soon after the intensified activity in 1994 complained about negative impacts from this activity on their fishing success.

The demersal fisheries at the Faroe Islands are regulated by limitations in effort (allowed number of days) and area restrictions. In this system, every fishing vessel is allowed a total number of fishing days in an area defined for each particular group of fishing vessel and gear type. Such a system requires that each day of fishing is a success, as there are no compensations for an unsuccessful day, and each fishing trip is therefore

planned carefully with regard to weather forecasts, lunar cycle, and any other factors that may interfere with the fishery. Any external and unforeseen factors that may have a negative impact on the catch rates are, therefore, viewed very badly. Beginning in 1998, the Faroese Coast Guard, as a mitigating effect, implemented a system where information on seismic activity (SA) can be obtained around the clock. Since then, the number of complaints have been significantly fewer.

Some studies on the effect of seismic investigations on fish and fisheries have demonstrated avoidance reactions by fish and consequently reduced catch rates.

Engaas *et al.* (1993) in the Barents Sea observed reduced catch rates of cod and haddock at a distance of up to 18 nautical miles from the sound source and Skalsi *et al.* (1992) found a 50% reduction in longline catches of redfish following air gun discharges.

Across the southern tip of the Faroe Plateau (*Munkagrunnur*), close to the most interesting areas for oil exploration, the width between the 200 m depth contours is less than 18 nm, and on either side a different temperature regime is found at approximately the 400 m depth. In a worst case scenario in which cod or any other fish species are herded off the shelf by intensive seismic research activity, they might enter quite a different environment. There is at present no knowledge on how the fish would react to these two contradicting negative impulses.

In the last two decades, the Faroe Islands has experienced great fluctuations in the stocks of cod and haddock. From a high level in the mid-eighties, the cod stock on the Faroe Plateau by the early nineties was reduced to an extremely low level. The stock, however, increased again rapidly to a very high level in the late nineties (Figure 2). The recovery was faster than predicted by fisheries scientists, and the reason for the large variations observed still puzzles both fisheries scientists and fishermen. Whereas the former mainly attributes the stock fluctuations to natural variations in recruitment and excessive fishing pressure, the fishermen mainly point to adverse climate in the late eighties as the main culprit. They claim this led to an emigration of cod from the Faroe area in the late eighties and early nineties, and an immigration in the mid- nineties when conditions improved.

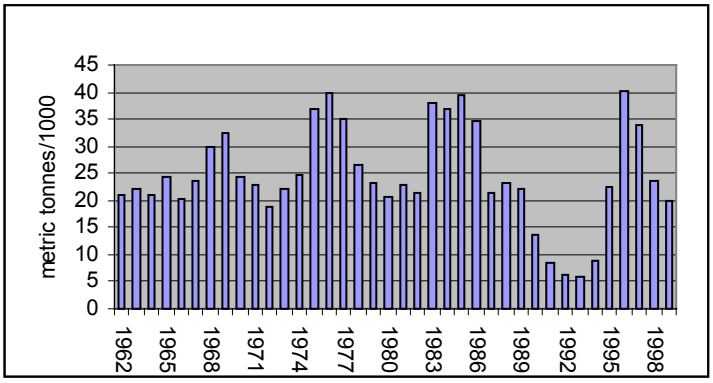


Figure 2. Landings of cod from the Faroe Plateau 1962-1999.

Given this background, the Faroese Fisheries Laboratory recognised a need for research into the effects of seismic activity on the fish and the fisheries in Faroese waters.

The fishing pressure on cod and haddock is still higher than the scientific advice would warrant, and, in a situation with several consecutive years of sub-average recruitment, this could led to a serious reduction in stock size.

In a situation with reduced catches, it would be necessary to know to what extent this was caused by excessive fishing or adverse climate or (as some people would claim) seismic activity. In this report are presented the results from this investigation, which was jointly funded by the Faroese Government and GEM.

Acknowledgements

The Faroese fishermen that were interviewed were both extremely helpful and positive about the project. In addition to the tabulated information, the Fisheries Laboratory obtained an enormous amount of unsolicited information on a number of topics. The Fisheries Laboratory is greatly indebted to them all.

The senior assistants that conducted the interviews were Kristian Zachariassen, Regin Kristiansen, Mourits Mohr Joensen, Arnold Henriksen, Sørin Sørensen, and Rógvi Mouritsen. They are indeed greatly acknowledged and applauded for a job well done.

The project was jointly funded by the Faroese Government and GEM. The consultancy firm, Develo, located in Stavanger, Norway was an external consultant.

Michael Reveal, from S/pf Reveal International, corrected the english text.

Fisheries at the Faroe Islands

The demersal fisheries on the Faroe Plateau are conducted by seven different groups of vessels, and in the section below is a brief description of each. A more thorough narrative is given in Jákupsstovu (1999). The group numbering is consistent with the Fisheries Act.

Group 1. Larger single trawlers

In total, 14 vessels in this group are licensed to fish within Faroese waters.

These are moderate to large trawlers with engine power in excess of 1,000 Hp, operating as single trawlers and fishing mainly on and off the shelf break targeting redfish, blue ling and saithe in addition to other deep water species. They are allowed a restricted bycatch of cod and haddock.

They have, on average, in the period 1985-1997 fished ca. 23,000 tonnes per year or 19% of the total amount of demersal fish fished by Faroese vessels in Faroese waters.

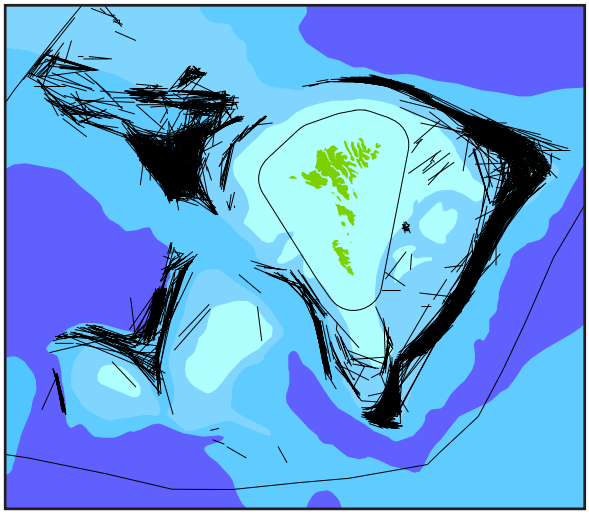


Figure 3. The distribution of the fishery by the larger single trawlers in 1997.

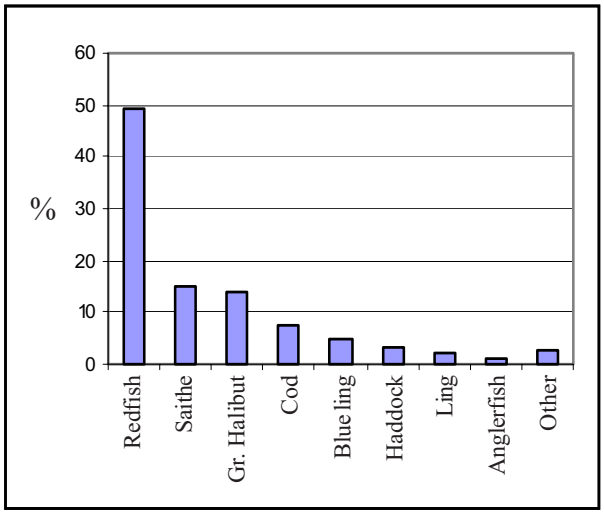


Figure 4. The main species caught by the larger single trawlers by percent of their total catch in 1997.

Group 2. Pair trawlers

Pair trawlers are the most numerous of the larger demersal fishing vessels. They use trawl that is towed between two vessels acting as a pair. Their main target specie is saithe, and in the period 1985-1997 saithe constituted ca. 70% of their total catch. However, depending on the availability, they also have significant bycatches of cod in some years, in addition to minor bycatches of a number of other species. The pair trawlers also in the period 1985-1999 landed 19% of the demersal fish caught at the Faroe Islands by Faroese vessels. Two pairs during the summer fish specifically for greater silver smelt (*Argentina silus*).

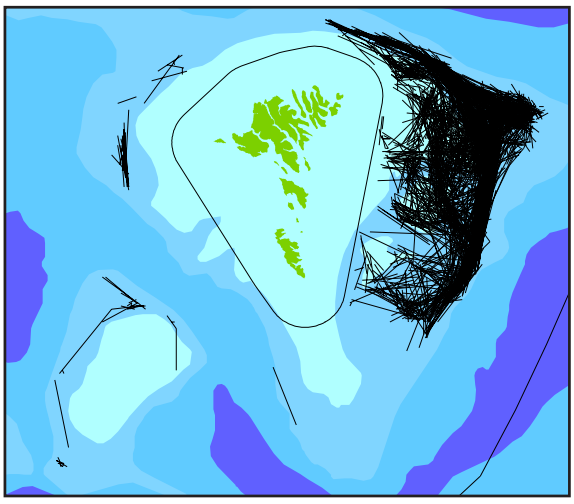


Figure 5. The distribution of the fishery by 8 pair trawlers in 1997.

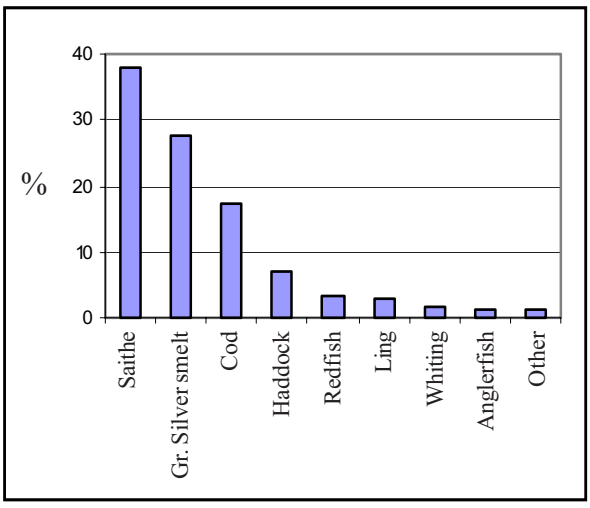


Figure 6. The main species caught by pair trawlers by percent of their total catch in 1997.

Group 3. Larger longliners

In this group are 20 vessels all larger then 100 feet in overall length and equipped with baiting machinery, which automatically baits the longline during the setting.

They are able to work in excess of 30,000 hooks every 24 hours. The main fishing areas are partly on the Plateau targeting cod and haddock, and partly on and off the shelf break targeting tusk and ling. In the period 1985-1997, their landings of demersal fish from the Faroe area constituted 7.5% of the total landings from the area.

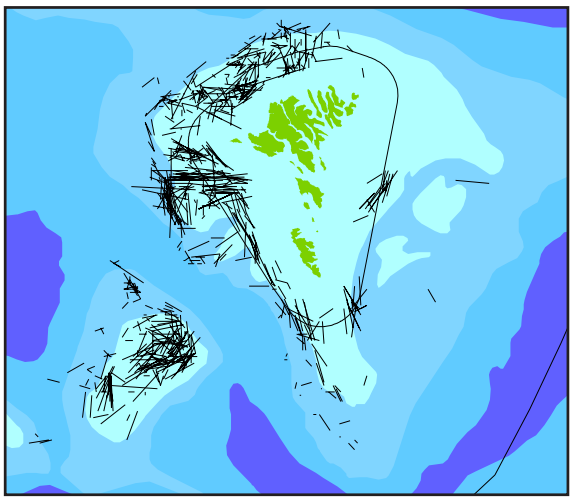


Figure 7. The distribution of the fishery by larger longline vessels in 1997.

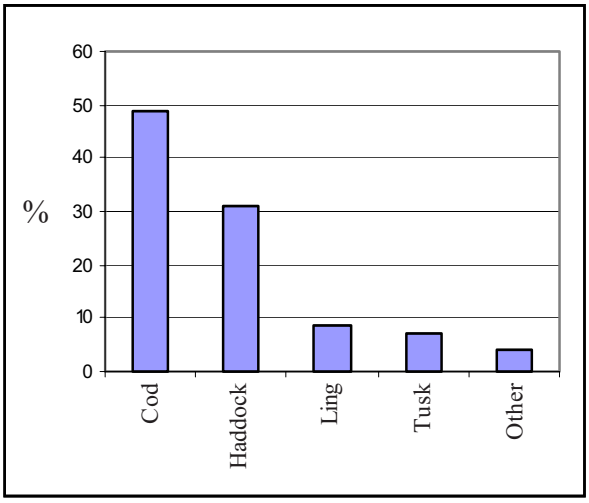


Figure 8. The main species caught by larger longline vessels in 1997.

Group 4. Larger coastal vessels

In this group are vessels up to 80-100 feet that fish for cod and haddock on the Plateau and occasionally on the Faroe Bank during the summer. They fish almost exclusively in depths less then 200 m, although some vessels from Suðuroy during summer may fish for tusk and ling in deeper water off the Islands. Some are equipped with automatic jigging machinery for saithe and cod fishing, some use longline for cod and haddock, and some are equipped for trawling. There are almost no area restrictions on vessels in this group when fishing with hook and line. Vessels using trawl have to fish outside the closed areas, where they target cod and haddock. During summer, some vessels are allowed to participate in a specially licensed fishery for "flatfishes" inside the 12 nm limit.

The overall bulk of their catch consists of cod and haddock. There is no obligation for these vessels to keep a log of their fishery, and, therefore, it is only possible to map their fishery and its success by relatively large statistical rectangles.

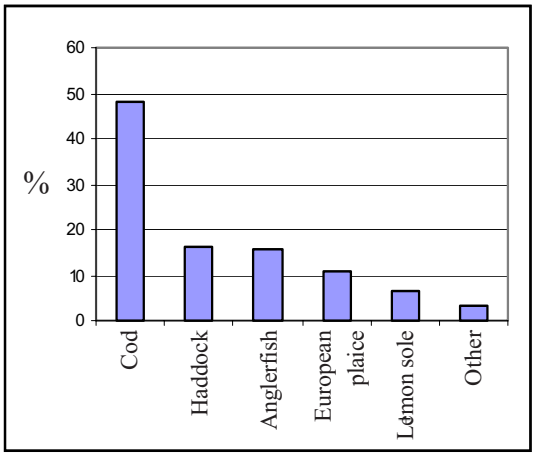


Figure 9. The main species caught by larger coastal vessels in 1997.

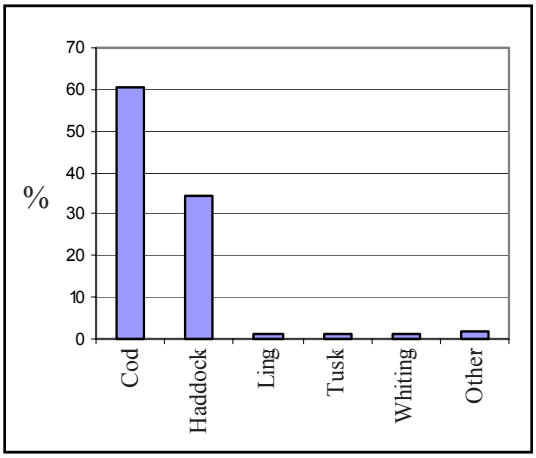


Figure 10. The main species caught by larger coastal jiggers and longliners in 1997.

Group 5. Smaller coastal vessels

In this group is a high number of small vessels, of which most are used only part of the year for supplemental income. The main gears are longline and automatic jigging machines for cod and haddock and to some extent saithe fishing. They fish almost exclusively in nearshore waters. However, during the summer some of the more experienced and professional skippers may explore a wider range occasionally fishing as far out as the Faroe Bank.

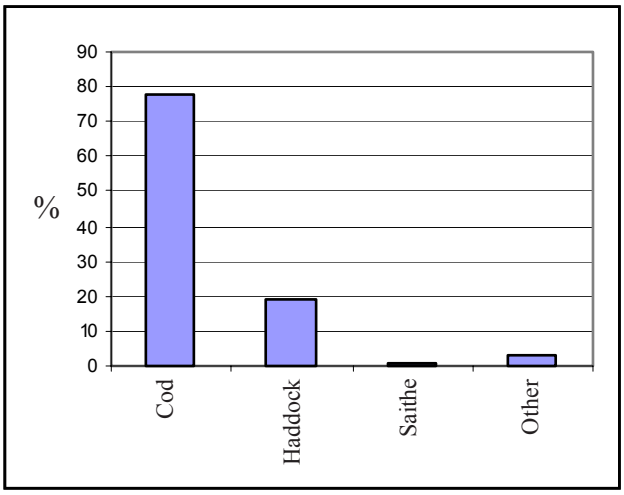


Figure11. The main species caught by smaller coastal vessels in 1997.

Gill-netting vessels

These vessels are all larger than 100 feet and have a special license to fish in deeper water using gill-net for either Greenland halibut or angler fish. The main fishing areas are off the shelf break down to 500-600 m.

The vessels essentially divide the fishable areas between themselves, and in a restricted area seismic activity will most likely affect only one of these vessels.

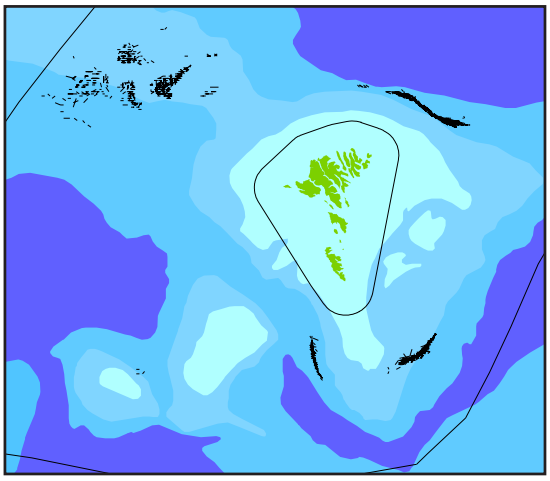


Figure 12. The distribution of the fishery by gill-netting vessels in 1997.

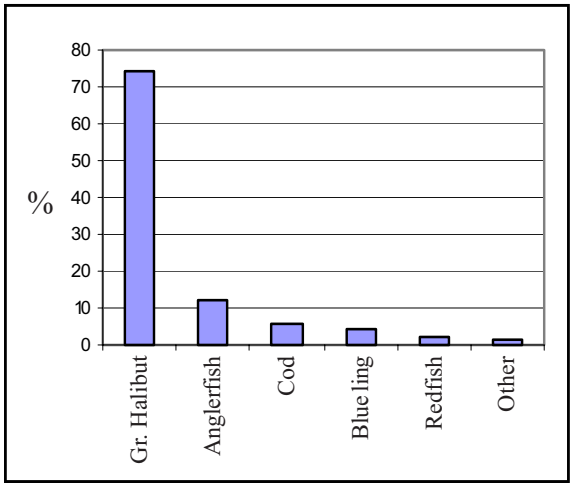


Figure 13. The main species caught by gill-netting vessels by percent of their total catch in 1997.

Pelagic trawl

In addition to the demersal fisheries, the pelagic fisheries for blue whiting may be affected by SA.

Blue whiting is fished off the Faroe Plateau by large vessels using pelagic trawl. The Faroese vessels are combined purser trawlers. The main fishing areas are in the Faroe-Shetland Channel and in the Faroe Bank Channel during the top season in late April to early June. However, the fishery for blue whiting in Faroese waters takes place throughout the year, especially by the Russian fleet, but in later years also by Faroese and Icelandic vessels. This fishery is mostly to the north of the Faroe Islands.

Fish and sound

Many fish species are sensitive to sound. They emit sound for communication during mating and during aggressive behaviour (Hawkins, 1993). They can be scared by the sound of approaching vessels (Olsen, 1971), and their adaptive behaviour my change due to other fish species, vessels, and perceived predators (Misund and Aglen, 1992). Fish can also be attracted by sound (Wahlberg, 1999) and conditioned to sound (Bjørnsson, 1999).

Based on the absence or presence of a swim-bladder, and the connection between the swim-bladder and the inner ear, fish can be grouped into three categories for sound pressure detection, which is based on sensitivity and sound frequency (Wahlberg, 1999). Non-specialist fish have no swim-bladder, generalist fish have a swim-bladder with no physical connection with the inner ear, and specialist fish have a swim-bladder that has a special connection to the inner ear.

The vast majority of teleost fish are generalist and among these are the most important demersal fish species at the Faroe Islands: cod, saithe, haddock, redfish, ling, tusk, blue ling, and many others. Blue whiting is also a generalist, whereas herring is a specialist.

The figure below shows the audiogram for various species taken from Wahlberg (1999), which indicates, e.g. that cod is most sensitive to sound in the range of 50-500 Hz.

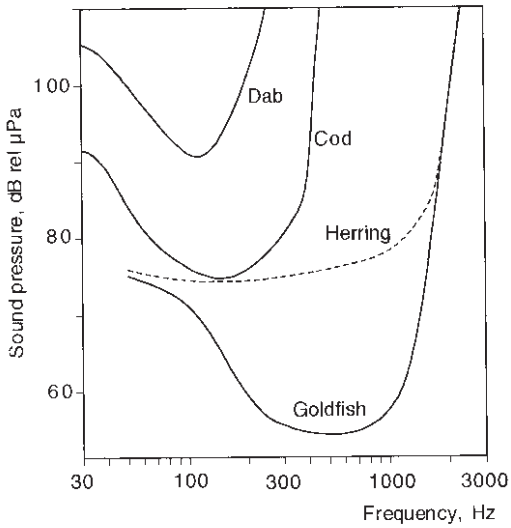


Figure 14. Audiogram for various fish species. (From Wahlberg,1999).

Sound emitted by SA

From the literature, Engås *et al.* (1993) cite that single air guns emit sound in the frequency range 5-200 Hz (-20 dB) and 5-150 Hz in arrays of air guns. Sound pressure varies dependent upon the frequency, with maximum levels at 10-80 Hz. Thus, there is a significant overlap within the hearing frequencies of fish.

Based on (1) a simplification of the sonar equation, (2) an assumption of the spheric distribution of emitted sound, (3) an ambient noise level of 80 dB re 1ì Pa/Hz, and (4) a detection threshold of 100 dB re 1ì Pa/Hz, Engås *et al.* (*loc cit*) further conclude that a fish would be able to hear an air gun array with a source level of 210 dB re 1ì Pa/Hz at a distance of more than 100 km.

Other sources of sound in the sea

There are a number of different sources of sound in the sea that constitute the ambient noise. Most of this "noise" is low frequency sound within the hearing window of fish. Some of the sound originates from natural sources, as from wave breaks on the surface or when waves meet land (surf) and from invertebrates and fish emitting sound. Some marine mammals communicate with low frequency sound in addition to emitting high frequency sound for navigational purposes. Vessel noise also adds to the sound spectrum in the sea, and there are a number of investigations documenting avoidance reactions of individual fish and fish schools in response to approaching vessels (Olsen, 1971; Misund and Aglen, 1992).

Fish reaction to sound from seismic activity

It has been demonstrated by experiments that lethal damage to fish from seismic activity is only found on fish larvae in close proximity to an air gun (Dalen *et al.*,1996). There is no evidence of any negative physical effects from seismic activity on juvenile and adult fish.

Any negative effect on fish and fisheries from SA, therefore, arises from the changed behaviour of the fish in response to emitted sound. According to Engås *et al.* (*loc cit*), the sound from an air gun array can be sensed by fish at a significant distance from the source. Assuming a reaction to sound to take place when the sound intensity is 20 dB above the detection level, the reaction distance could be 10 km, given a source level of 210 dB re 1mPa/Hz.

For SA in the area of the Faroe Islands, special air gun arrays have been used in order to obtain data from below the basalt layers. Such air gun arrays may have source levels up to 220 dB re 1mPa/Hz, and from these the reaction distance could be up to 32 km.

Avoidance reactions by fish to sound suggest that fish perceive sound as coming from a possible enemy. It is well known that fish can be adapted to sound, and, if sound is emitted for a long period, they will ignore it. In 1997, seismic surveys took place on the Faroe Plateau almost continuously from mid-May to mid-October. Assuming a source level of 220 dB re 1mPa/Hz and a detection level at 100 dB, fish like cod, saithe, and haddock would be able to hear the emitted sound at a distance of 300 km (Engås *et al., loc cit*) or 160 nm. This would imply that the sound from SA at any place on the Faroe Plateau would be detectable throughout the entire plateau. Thus, during the summer, all fish would have heard, with varying intensity, the regular emissions of sound from seismic activities.

Material and methods

The project was divided into two separate sub-projects:

a. Interviews with individual fishermen about their experiences regarding the effects of SA on their fishing success.
b. Statistical analysis of catch rates from logbook data in relation to SA.

Interviews

Construction of the questionnaire

As many fishermen had reported reduced catch rates as a consequence of seismic activity, it was decided to attempt to compile these observations in a systematic way.

Two problems had to be addressed in this context:

a. It was necessary to take into account the possibility that at least some of the fishermen had already formed an opinion about the effect of SA on their fishing success. The questionnaire, therefore, had to be constructed in such a way that biased answers were reduced as much as possible.
b. To select a representative population.

To our knowledge, there was no similar investigation to rely on and we, therefore, had to build the questionnaire from scratch.

The approach decided upon was to incorporate the seismic questions into a broader questionnaire embodying a broad suite of questions about the impact on the fishing success of a number of causal factors, both man-made and natural in origin. The basic idea was that through a process where the fishermen had to answer a number of "unloaded" questions, the responses would be less biased than if the seismic question stood alone.

The questionnaire (Appendix 1) was constructed via a process that involved a professional interview consultant and two test panels of professional fishermen. In addition to the types of questions mentioned above, a number of other questions of interest for the Fisheries Laboratory and the public-at-large were incorporated.

The final questionnaire was too elaborate for individual voluntary responses. Therefore, five senior assistants from the Fisheries Laboratory conducted individual interviews of the selected population of fishermen.

Selection of fishermen

Care had to be executed in the selection of fishermen to interview in order to avoid problems with representativity.

In the General Fisheries Act, the vessels licensed to fish demersal fish within the Faroese EEZ are divided into five groups according to gear and size. In addition, there are some smaller, specialised fisheries, e.g. gill-netting vessels fishing for Greenland halibut and angler fish that are regulated by separate Acts. Each group is not very numerous (Table 1) and they fish in different areas. In order to attempt an unbiased selection, it was decided to aim at interviewing a "total" population of fishermen. This was achieved by

Table 1. The groups of fishing vessels licensed to fish within the Faroese EEZ, the number licensed, selected, and interviewed.

	Group	Main target fish species	No. licensed	No. selected	No. interviewed
1	Larger single boat trawlers	Redfish Blue ling Gr. Halibut	14	14	13
2	Pair trawlers	Saithe Cod Gr. Silver smelt	33	32	31
3	Longliners	Cod Haddock Ling Tusk	20	20	16
4	Larger coastal fishing vessels - mainly <110 grt longlining, however, also some jiggers and trawlers	Cod Haddock Saithe Flatfish	75	75	57
5	Smaller coastal fishing vessels <15 grt, both longlining and jigging	Cod Haddock Saithe	119	55	41
	Gill-netting vessels	Gr. Halibut	7	7	6
	Purser/trawlers	Blue whiting	4	4	4
	Total			207	168

selecting those "professional" skippers who had been at sea in week 10 in 1999. The term "professional" was only valid for the smaller vessel groups and is defined below. Week 10 was chosen as being in the peak of the spawning fisheries.

The population selected contained all captains of the larger vessels, i.e. Groups 1-3; from Group 4, the skippers of all vessels that had fished for more than DKK 400,000. In addition, one skipper of a vessel within Group 4 was selected who did not meet the criteria. This was done because the skipper is a professional fisherman and the small catch in 1998 was due to the special problems encountered. From Group 5, 47 skippers from the best 60 boats in 1998 and the first 4 months of 1999 were selected. In addition, 8 extra skippers from boats from Suðuroy were selected, as these boats were the most likely to have encountered seismic activity while fishing.

The names of vessels and persons to question were obtained from the official census of fishing activity of the regulated demersal fish species.

In addition, all skippers of gill-netting vessels targeting Greenland halibut and angler fish were selected as well as four skippers from the purser/trawler vessels fishing for blue whiting.

As a result of this process, a total of 207 fishermen were selected for participation in the survey.

The senior assistants of the Fisheries Laboratory interviewed the selected fishermen. These individuals all have backgrounds either as fishermen or work experience in other sectors of the fishing industry. In addition,

through their work at the Fisheries Laboratory, they liase on a regular basis with fishermen. This background allowed them to explain the questions, where needed, and to communicate on an equal level with the fishermen and, thus, establish a neutral platform for the interview process.

Prior to conducting the interviews, all questions were thoroughly discussed and amended through discussion with the two test panels. Finally, the questions were defined in detail among the group of senior assistants in order to ensure that everyone had the same conception of what was to be asked. Before the interviews started, all were instructed in interview technique by a consultant.

During the interview, the interviewees were asked to write the answers to each question in the questionnaire with the interviewer only assisting in specifying the questions. In some instances, when specifically asked, the interviewer transcribed an individual's answers into the questionnaire, acting only as a secretary, however.

It was a difficult and time consuming task to arrange for the interviews with the fishermen. Given the time constraint, it was not possible to meet all possible candidates. In addition, some 11 did not wish to be interviewed or were not in the Faroe Islands during the interview period. In total, 168 fishermen were interviewed.

All data from the completed questionnaires have since been entered into an Access database.

Statistical analysis

Logbook data

Seismic investigations relative to oil exploration in the Faroe Islands have been conducted on a regular basis since 1994, and the activity has increased every year. Prior to 1998, no information was given to the fishing fleet on the temporal and spatial distribution of the SA. This lack of information did not allow the fishing fleet to take SA into account when planning their fishery and led to a lot of criticism. From 1998 onwards, however, information on SA has been available around the clock from the Faroese Coast Guard, and, judging from the reduced number of complaints since that time, the information system has been a success.

In order to have an "unbiased" set of data, it was decided to use the SA in 1997 to analyse the effects on the fisheries.

The larger Faroese fishing vessels are required to keep logbooks into which a number of relevant data on each fishing operation have to be entered. The obligatory data are: fishing operation position at beginning and end (e.g. trawl tow, longline set), duration of operation (hrs. and minutes), catch in weight by species, depth, and a number of climatic observations.

Although the quality of the logbooks returned have improved with time, the information cannot be used without a thorough quality check, a process that is both expensive and time consuming. For assessment purposes, the Faroese Fisheries Laboratory had selected subsets of vessels from two vessel groups (pair trawlers and longliners) and had quality checked the logbooks from these vessels for a number of years. For the purpose of this project, logbooks for the year 1997 from two more groups of vessels, the larger single trawlers and the gill-netting vessels, were quality checked. In total, data were available for 8 pair trawlers, 7 single trawlers, 5 longline vessels, and 3 gill-netting vessels.

From the logbook data, all successful fishing operations where sufficient information was available were plotted on a series of maps. The required data were date, time, position at beginning and end, effort, catch in kg by fish species, etc. These plots are depicted in Figures 3, 5, 7, and 12 for the four groups of fishing vessels.

For the smaller vessels (Group 4 and 5), no data were available that could be used in this context.

Mapping the seismic activity in time and space

It was technically difficult to extract the necessary information to plot the SA in time and space from the seismic logs given to the Faroese authorities. However, in the diary of the fisheries liaison officers responsible for communications between the seismic vessels and the fishing fleet, the geographic positions of the seismic vessels were noted at irregular intervals during the day. These data enabled the Fisheries Laboratory to plot as discrete points the distribution of the SA (Figure 15). These data did not contain information on the direction of vessel movements nor the track lines, however.

The Fisheries Laboratory has subsequently obtained the track lines of the SA in 1997 (Figure 16), but without any information on timing. As these data, to a large extent, mirror the distribution obtained from the fisheries liaison officers, the former have been used in this analysis.

Effect on the fisheries

In order to analyse the data to determine any causal effects on fishing success related to SA, the seismic data sets were combined with the fisheries data by category of vessel. When the data sets were plotted together on a map, it was possible to visually pinpoint areas with the highest coincident activity. In such areas, all data within a ring with a diameter of 18 nm were selected for closer scrutiny. Through a step-wise procedure, the encircling rings were drawn to contain the highest possible combined number of fishing operations and seismic points. The 18 nm diameter was based on an investigation by Dalen *et al.* (1996). Effects of SA on the catch rate of trawlers were observed up to 18 nm from the source. Both the single trawlers and the pair trawlers may tow up to 6 hours covering a distance of 18 nm. Only a few of the trawl hauls in the present analysis were totally contained within the ring. Only those hauls whose mid-point was inside the ring were included. By restricting the ring diameter to 18 nm, most of the hauls selected would be within 18 nm from the mid-point of the ring. The encircled areas are shown in Figures 17, 21, 26, and 28.

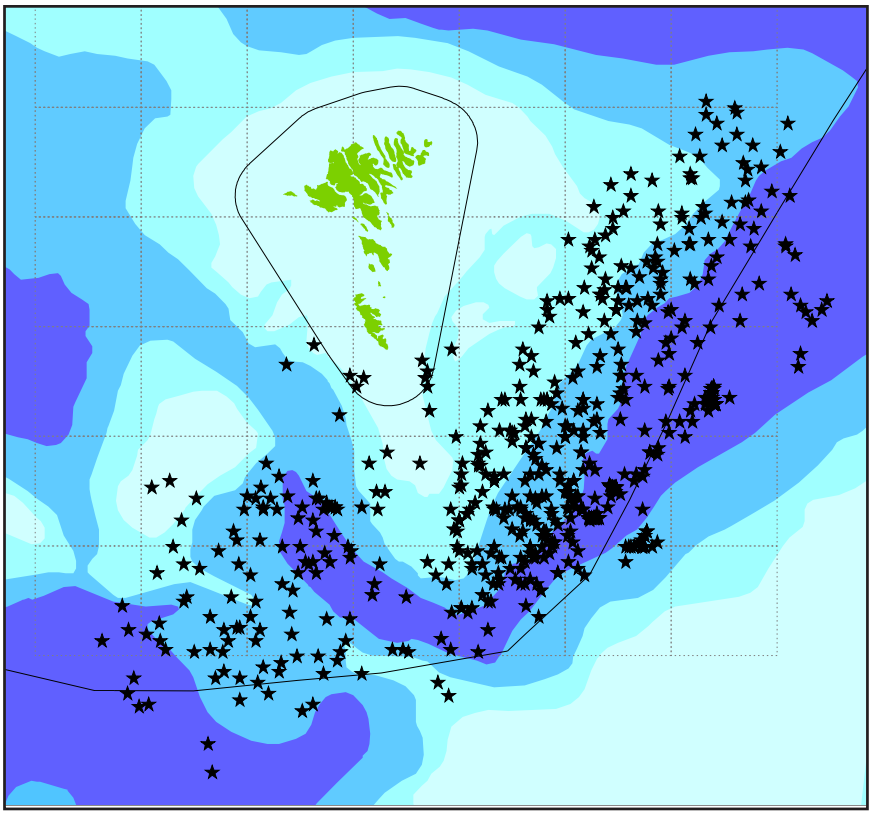


Figure 15. Seismic activity in 1997. For further explanation, see text.

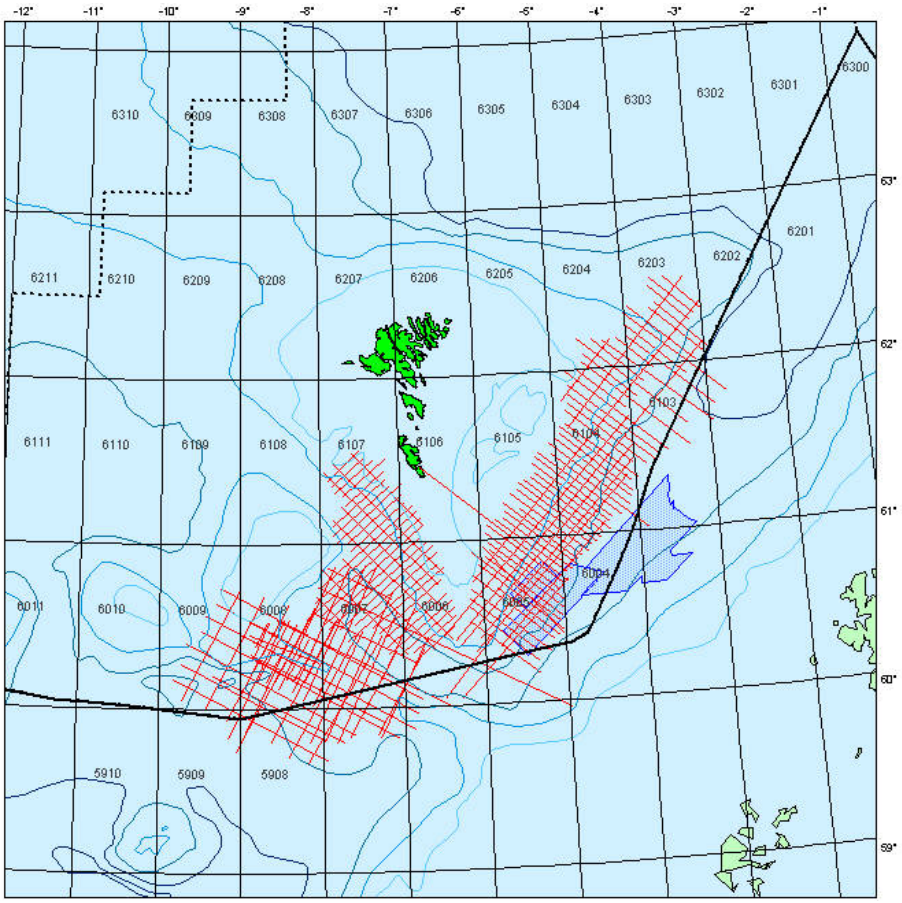


Figure 16. Track lines of the SA in 1997.

Results

Questionnaire

Effects on fisheries from seismic activity

The table below provides a summary of the answers to the main seismic questions.

Out of the 168 fishermen questioned, 95 experienced SA while they were fishing. Of these, 69 or 73% observed negative effects on their catch rate due to SA and two observed a positive effect. Of the remaining, 12 fishermen observed no effect and 12 did not know whether the SA had any effect or not.
The answers presented in Tables 2 - 7 are discussed in more detail in the appendices.

Table 2. Summary of the answers to the main seismic questions.

	Number Questioned	Number Experienced	Number of Effects			
Vessel Group			Pos	Neg	No effect	Don't know
1 Single trawl	13	10	0	5	3	2
2 Pair trawl	30	27	2	20	1	4
3 Longline	17	10	0	2	3	5
4A	22	9	0	7	2	0
4B Jigging	34	10	0	10	0	0
4B Trawl		6	0	4	2	0
5 Jigging	42	11	0	11	0	0
5 Longline		6	0	4	1	1
Gill-net	6	4	0	4	0	0
Pelagic Trawl	4	2	0	2	0	0
Total	**168**	**95**	**2**	**69**	**12**	**12**
Total %		56,5	0,0	72,6	12,6	12,6

The larger single trawlers (Group 1) with engines greater than 1,000 Hp target mainly deep water fish species like redfish, blue ling, and Greenland halibut and their catch is often a mixture of several species. In addition, they occasionally target saithe and during this fishery may have bycatches of cod and haddock. Ten captains commanding vessels in this group experienced SA while fishing. Five claimed that SA had a negative effect on their fishing success, three had not observed any effect, while two did not know.

Group 2 constitutes the pair trawlers fishing mainly for saithe in Faroese waters, yet with significant bycatches of cod and minor bycatches of a number of different demersal fish species. In addition, four vessels have a specific fishery for greater silver smelt (*Argentina silus*) during summer. In this group, 27 out of 31 skippers experienced SA while fishing. Twenty of these experienced negative effect from the SA, two a positive effect, one no effect, and four did not know. In the case of positive effect, the skippers observed their catches of cod to increase significantly. In both cases, it was claimed that the increased catch was "due to the herding effect of an approaching seismic vessel".

Only ten of the captains on the larger longliners (Group 3) experienced SA while fishing. Of these, only two claimed negative effects, whereas three observed no effect, and five did not know.

These vessels fish partly on the Faroe Plateau for cod and haddock and partly for ling and tusk off the Plateau.

The vessels in Groups 4 and 5 are quite numerous with a wide mixture of coastal vessels ranging from 80-100 feet (80-120 grt) in overall length to small open boats. These vessels target mainly cod and haddock and the main gear is longline and jigging. Some vessels, however, use trawl. In total, less then fifty percent of these vessels experienced SA while fishing, but of those the vast majority claimed negative effects on their fishing success. These vessels fish almost exclusively on the Faroe Plateau.

It is not easy to draw any definite conclusions from this data, except to state that 75 % of the fishermen (from all vessel categories that had experienced SA while fishing) observed an effect from SA on their catch rate.

There are great differences between the fishermen, however, regarding the magnitude of effect observed. Some of them experienced a 100 % reduction in immediate catch rate, or within 2-3 days following the SA. Others experienced a more moderate reduction of 10%.

Apparently, there is some concensus on the effect of SA on the various fish species. Several fishermen claim that, following SA, saithe disperse up into the water column, and the catch rate of saithe, therefore, is reduced swiftly. On the other hand, cod are observed to seek the bottom and the catch rate, therefore, might increase following SA. The two observations on increased catch rate were both made while fishing for cod. The observations on other fish species are too few to make any general statements.

Several fishermen observed greater effects on the catch rate at shallower water depths compared to greater depths. This is to some extent supported by the observations by vessel group. Jiggers, which normally fish at the most shallow water depths, experienced a 100% negative effect, and, similarly, also the smaller longline vessels. On the other hand, only 50% of the larger single trawlers and 20% of the larger longline vessels experienced a negative effect on their catch rate following SA. All the gill-net vessels, which also fish in deep water, however, observed a negative impact on their fisheries from SA.

Logbooks

In 1997, by far the most seismic activity was in deeper waters outside the Plateau. Some survey tracks, however, extended onto the Plateau proper. As most of the fishery takes place on the Plateau and along the shelf break, this reduced the number of temporal and spatial coincidences between SA and the fishery of the various vessel groups, and for some (the larger longliners) no overlap was found.

The highest coincidence was found for the larger single trawlers, followed by pair trawlers and, to a minor extent, the gill-netting vessels.

From the respective databases, points of SA and fishery by vessel group were plotted in MapInfo, and from these it was possible to select and encircle some areas with the highest possible incidence in time and space. In this analysis, the catch rate (Kg/hour trawled, Kg/gill-net) prior to, during, and after the seismic activity was compared.

For each of the vessel categories -- larger single trawlers, pair trawlers, and gill-netting vessels -- the catch rate of the combined catch was calculated over time, as well as the catch rate of the main target species. For the pair trawlers, the catch rate of saithe and cod was plotted; for the larger single trawlers, redfish, Greenland halibut, saithe, and cod; and for the gill-netting vessels, Greenland halibut, and blue ling. The results are shown in Table 4, 5, and 6 as average catch rates (with standard deviations) prior to, during, and after the seismic activity. In order to have a visual overview, the data were plotted graphically. Sample plots are given in Figures 17, 21, and 28.

Pair trawlers

As stated earlier, the main seismic activity took place off the Faroe Plateau and, therefore, only to a limited extent coincided with the fisheries. This is illustrated in Figure 17, where all the trawl hauls by the so-called Cuba trawlers, a unique group of eight identical pair trawlers, in 1997 are plotted together with the SA points noted by the fisheries liaison officers. Also indicated are the three areas with the highest coincidence in 1997 ("N", "N2", and "E").

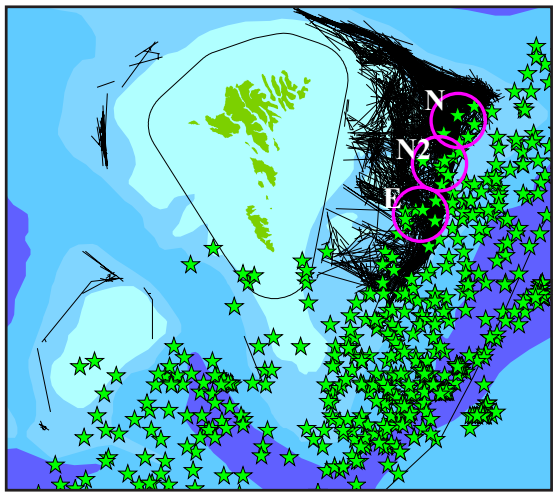


Figure 17. Areas encircled for analysis of the SA effects on the fisheries of the larger pair trawlers in 1997.

Within ring area N, the pair trawlers fished throughout the year, but not every day. Seismic activity was recorded within the ring on six days during the period 25 June to 10 July. The average daily catch rates (kg/hr) for all species combined (Figure 18) show a great variation throughout the year with no clear seasonal signal, and the catch rates during and after seismic activity do not differ from the general picture.

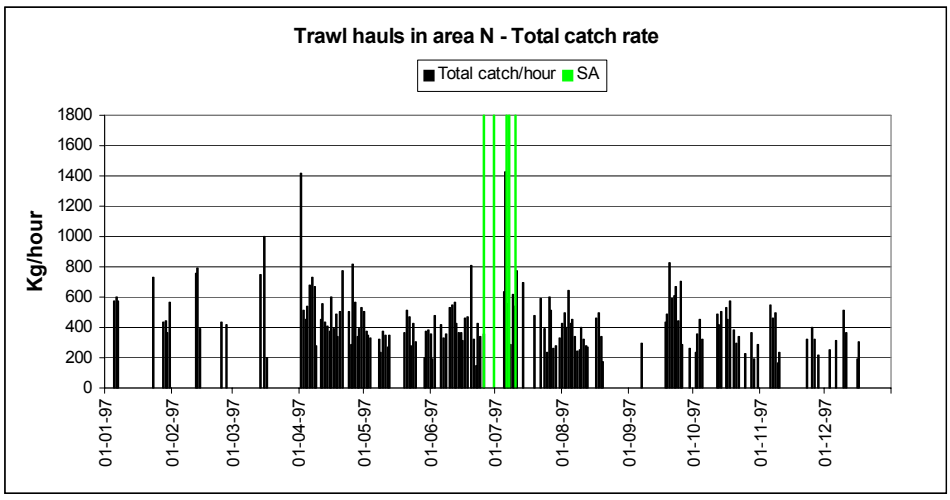


Figure 18. Total catch rate in ring area N for pair trawlers in 1997.

There was no fishery in area N in the days immediately after the start of SA, however, in the latter part of the period with SA, the average catch rate was of the same order of magnitude as immediately prior to SA. Analysis of the catch rates of the target species, saithe and haddock, yielded the same picture.

Table 4 shows the main statistics for the fishery of the pair trawlers in area N.

In ring area N2, fishery was also conducted throughout the year, but not as intensively as in area N. The average daily catch rate during the year (Figure 19) indicates a seasonal signal, with the highest catch rates in the spring. SA was recorded on five specific days during the period 26 June to 13 August.

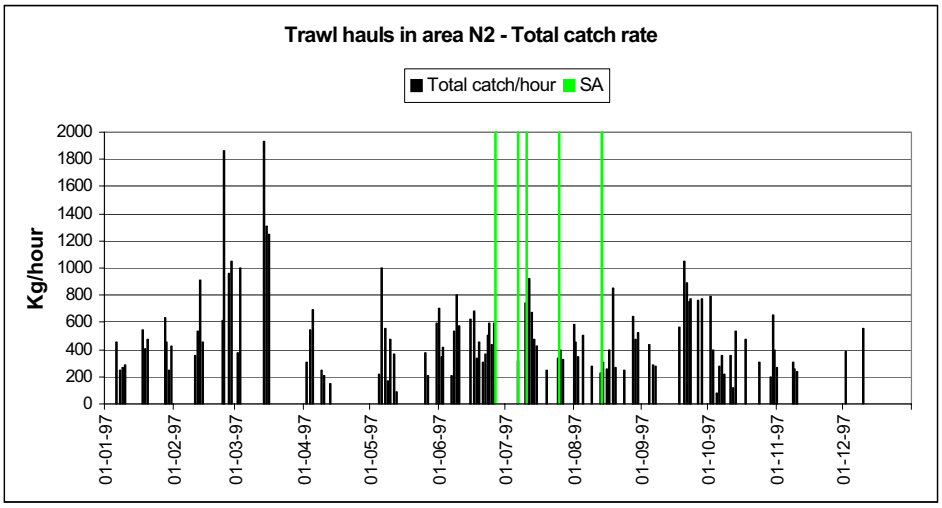


Figure 19. Total catch rate in ring area N2 for pair trawlers in 1997.

As in area N, there are no apparent effects of SA on the total catch rates of all species combined. There are similarly no significant differences in the catch rates of cod and saithe. (See main statistics below).

In ring area E, the pair trawlers did not fish as intensively as in areas N and N2. The fishery, however, is year round. The average daily catch rates were very variable without any seasonal signal (Figure 20). Seismic activity was recorded within the area on six days during the period 12 July to 8 October.

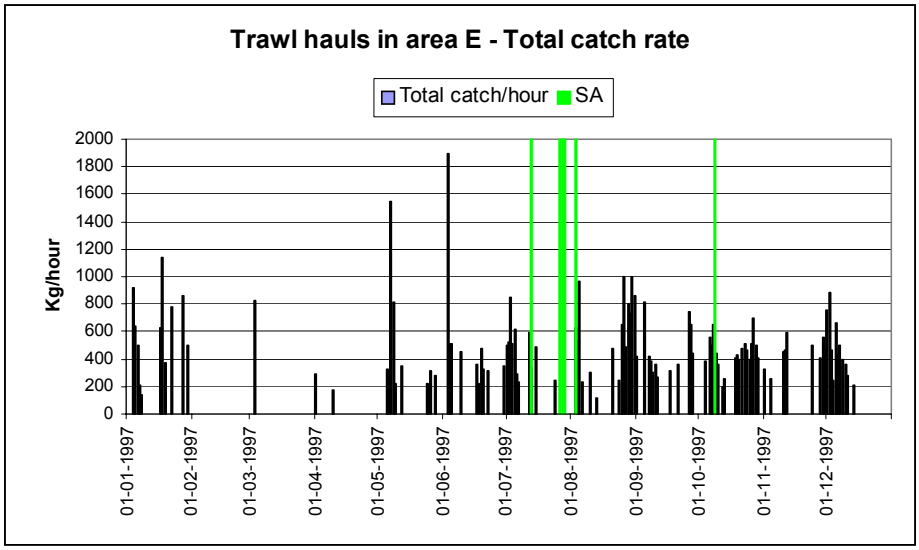


Figure 20. Total catch rate in ring area E for pair trawlers in 1997.

As in the other areas, the daily variation in the catch rate is large and it is not possible to discern any effects from SA on these catch rates. See Table 4.

Table 4. The pair trawlers catch rates by encircled area.

Ring	14 days prior		During		14 days after		In between		14 days prior		During		14 days after	
	Mid. kg/h	Std.dev.	Mid. kg/h	Std.dev.	Mid. kg/h	Std.dev.	Mid. kg/h	Std.dev.	Mid. kg/h	Std.dev.	Mid. kg/h	Std.dev.	Mid. kg/h	Std.dev.
N (Total)	439	*194*	583	*362*	597	*712*								
N (Saithe)	212	*146*	385	*347*	421	*704*								
N (Cod)	114	*55*	133	*79*	90	*64*								
N2 (Total)	492	*181*	585	*329*	389	*216*								
N2 (Saithe)	237	*134*	373	*264*	171	*131*								
N2 (Cod)	149	*84*	108	*58*	101	*35*								
E (Total)	531	*343*	407	*157*	482	*480*	556	*789*	541	*312*	655	*176*	361	*112*
E (Saithe)	334	*338*	261	*109*	173	*136*	401	*762*	292	*225*	375	*122*	168	*83*
E (Cod)	81	*51*	30	*12*	90	*39*	79	*59*	109	*88*	150	*10*	98	*56*

Larger single trawlers

The larger single trawlers fish in deeper waters as compared to the pair trawlers and consequently there appeared a larger spatial overlap with the seismic activities as compared to the latter. See Figure 21.

There are fairly good coincidences between the fishing activity for the single trawlers and the SA in four encircled areas *viz*. N, N2, E2, and S2. The single trawlers have a much wider fishing area compared with the Cuba trawlers. The temporal coincidence is, therefore, not as good.

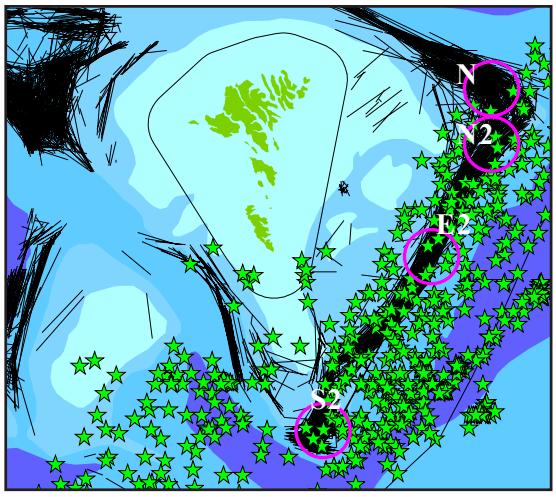


Figure 21. Areas encircled for analysis of the SA effects on the fisheries of the larger single trawlers in 1997.

The single trawlers differ in size and engine capacity. In order to compare the catch rates by the various vessels, the individual catch rate was standardised relative to the horsepower output. The average catch rate by ring area, together with the standard deviations, for the combined catches and by individual species are shown in Table 5.

Table 5. The single trawlers catch rates by encircled area.

Ring	14 days prior		During		14 days after	
	Mid. kg/h	Std.dev.	Mid. kg/h	Std.dev.	Mid. kg/h	Std.dev.
N (Total)	449	*266*	282	*111*	216	*73*
N (G. halibut)	50	*104*	53	*90*	32	*54*
N (Red fish)	301	*242*	114	*79*	120	*101*
N (Saithe)	62	*74*	77	*72*	33	*36*
N (Cod)	20	*17*	24	*12*	16	*8*
N2 (Total)	288		240	*161*	193	*72*
N2 (G. halibut)	155		137	*89*	56	*54*
N2 (Red fish)	64		76	*136*	120	*68*
N2 (Saithe)	0		10	*27*	5	*8*
N2 (Cod)	57		11	*12*	9	*5*
E2 (Total)	195	*92*	240	*132*	181	*80*
E2 (G. halibut)	117	*82*	32	*48*	35	*112*
E2 (Red fish)	53	*30*	126	*119*	93	*29*
E2 (Saithe)	6	*8*	36	*58*	12	*9*
E2 (Cod)	16	*22*	30	*28*	24	*18*
S2 (Total)	195	*92*	240	*132*	181	*80*
S2 (G. halibut)	117	*82*	32	*48*	35	*112*
S2 (Red fish)	53	*30*	126	*119*	93	*29*
S2 (Saithe)	6	*8*	36	*58*	12	*9*
S2 (Cod)	16	*22*	30	*28*	24	*18*

Similarly, as with pair trawlers, the daily catch rate varied significantly throughout the year, both by season and target species, and also within the four selected areas. In some cases, catch rate increased following SA and in other cases it was reduced. This is the case both for the combined catch rate as well as for the catch rate by individual fish species. The differences, however, are not statistically significant in any instance.

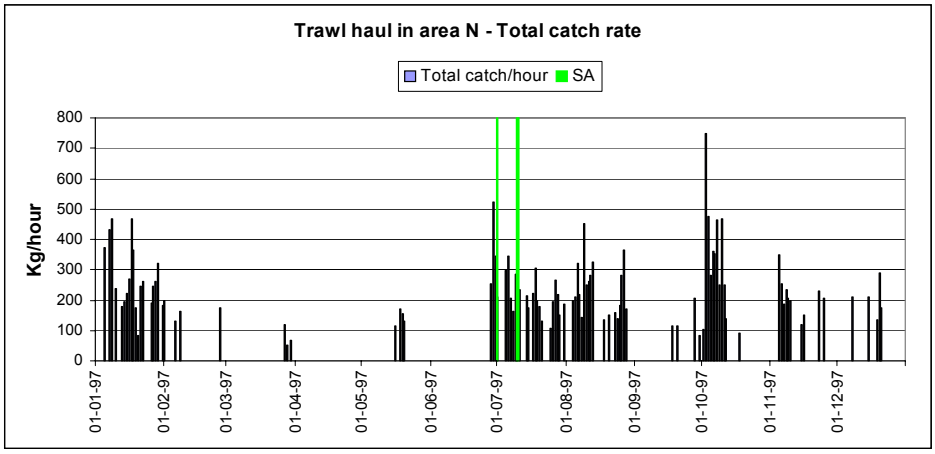


Figure 22. Total catch rate in area N for larger single trawlers in 1997.

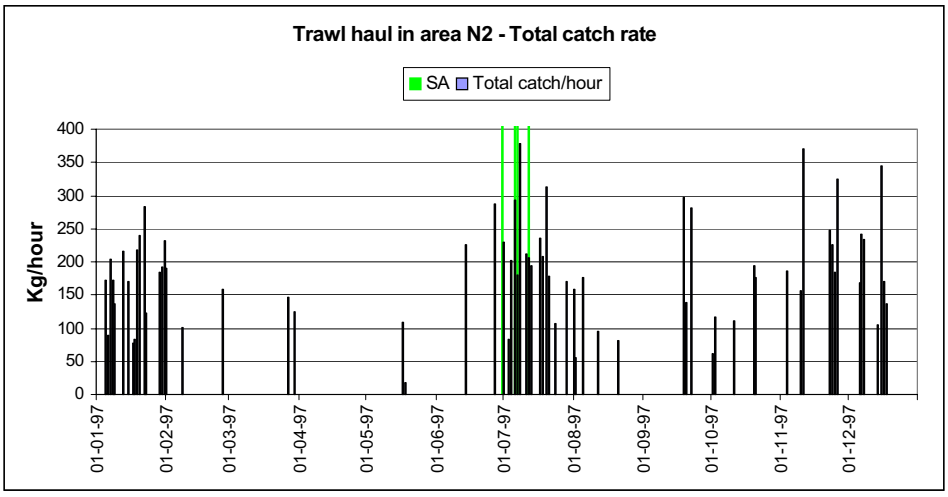


Figure 23. Total catch rate in area N2 for larger single trawlers in 1997.

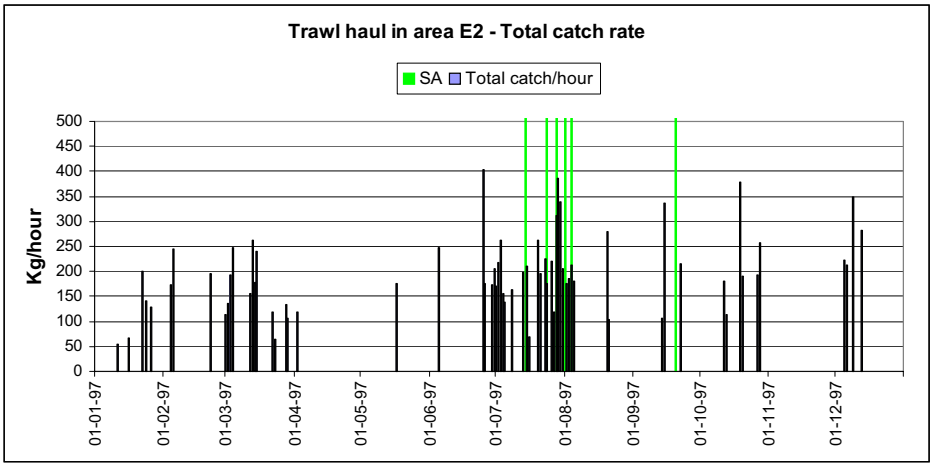


Figure 24. Total catch rate in area E2 for larger single trawlers in 1997.

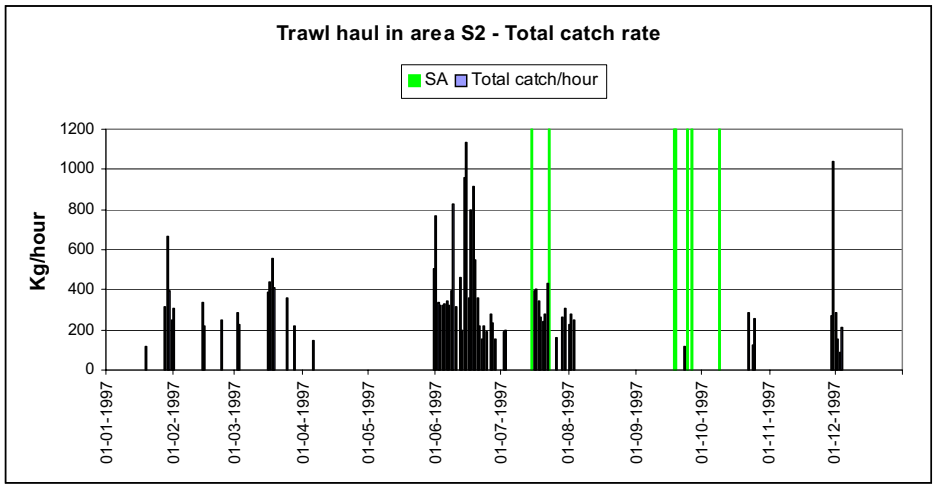


Figure 25. Total catch rate in area S2 for larger single trawlers in 1997.

In addition to the rings, a boxed area covering a much larger area was analysed (Figure 26). The trend for this region was nevertheless the same as for the individual rings: no significant differences in catch rates.

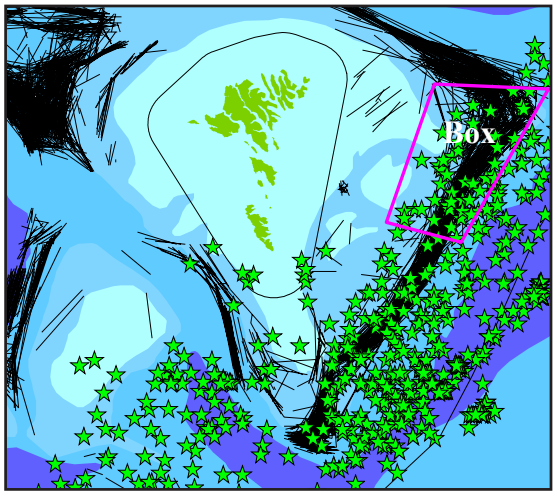


Figure 26. Boxed area for analysis of the SA effects on the fisheries of the larger single trawlers in 1997.

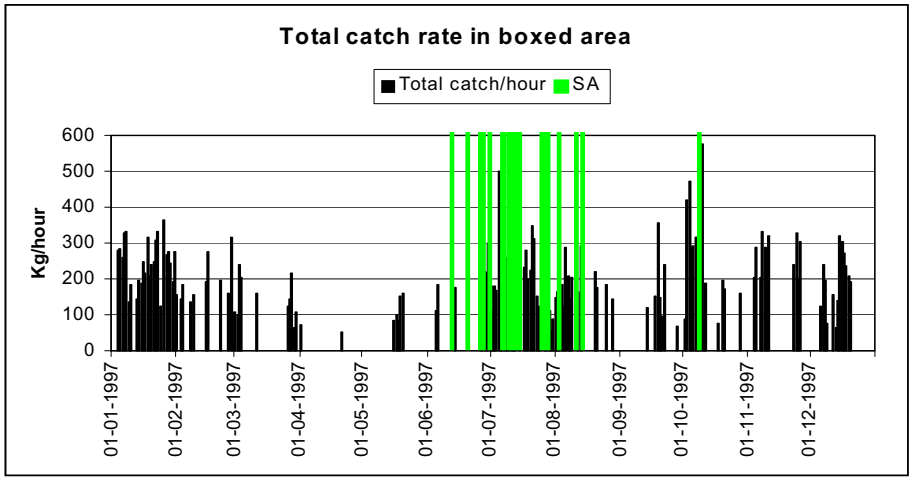


Figure 27. Total catch rate in the boxed area for larger single trawlers in 1997.

Gill-netting vessels

Only one gill-netting vessel fished in the area with SA in 1997. There was a fair coincidence between the fishing activity and the SA in three areas (E, E2, and V). See Figure 28.

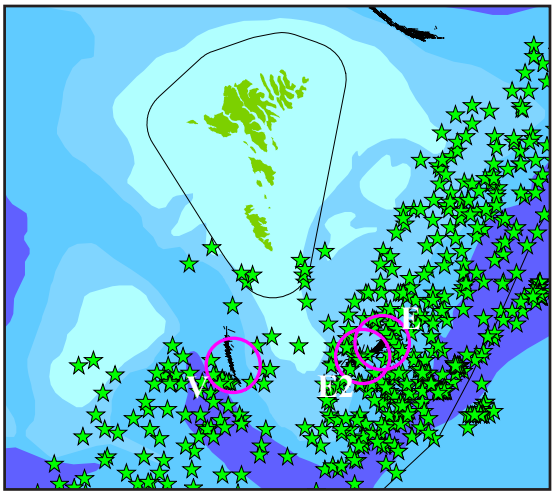


Figure 28. Areas encircled for analysis of the SA effects on the fisheries of the gill-netting vessels.

In general, when fishing for Greenland halibut with gill-nets, the nets are in the sea for four days in a row before they are hauled back in. In this analysis, this time delay was taken into account. The result of the various analyses presented in Table 6 shows the same picture as for the two other groups of vessels. In some cases, the average catch rate increases, in others it decreases.

Table 6. The gill-netters catch rates by encircled area.

Ring	14 days prior		During		14 days after		In between		14 days prior		During		14 days after	
	Mid. kg/net	Std.dev.	Mid. kg/net	Std.dev.	Mid. kg/net	Std.dev.	Mid. kg/net	Std.dev.	Mid. kg/net	Std.dev.	Mid. kg/net	Std.dev.	Mid. kg/net	Std.dev.
V (Total)			5,3	*0,8*	14,1	*7,8*			9,5	*7,0*	9,2	*2,4*	11,4	*3,3*
V (G. halibut)			4,1	*0,8*	12,3	*5,5*			9,2	*6,8*	8,8	*2,6*	10,6	*3,4*
V (Blue ling)			0,6	*0,0*	1,9	*2,9*			0,3	*0,4*	0,3	*0,3*	0,5	*0,7*
E (Total)	4,0	*1,7*	5,4	*2,1*			8,2	*1,4*			5,1	*3,1*	4,8	*2,6*
E (G. halibut)	4,0	*1,7*	5,3	*2,2*			8,0	*1,3*			4,9	*3,0*	4,6	*2,5*
E (Blue ling)	0,0	*0,0*	0,1	*0,3*			0,2	*0,3*			0,1	*0,2*	0,2	*0,3*
E2 (Total)	4,2	*1,4*	5,3	*1,7*			8,7	*2,6*			5,7	*3,2*	5,1	*2,5*
E2 (G. halibut)	4,1	*1,4*	5,0	*1,9*			7,9	*1,5*			5,1	*2,8*	4,7	*2,3*
E2 (Blue ling)	0,1	*0,3*	0,2	*0,3*			0,7	*1,3*			0,4	*1,5*	0,3	*0,4*

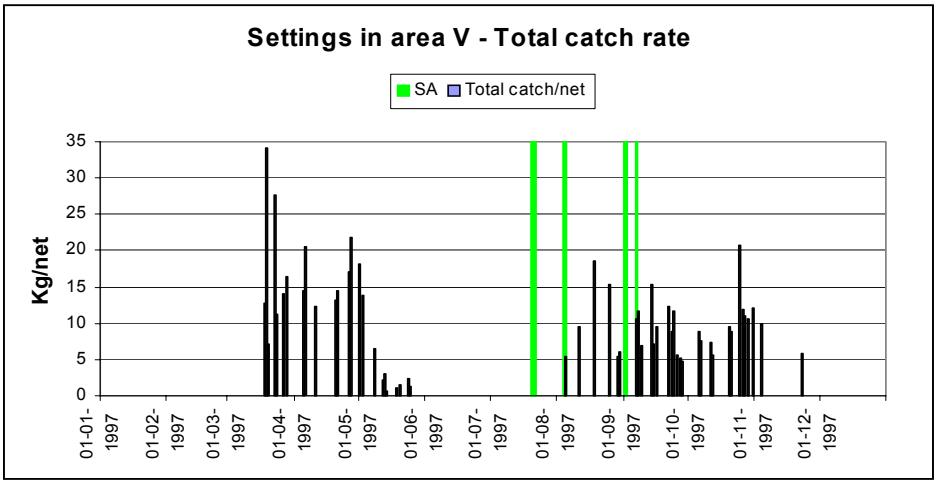


Figure 29. Total catch rate in ring area V for gill-net vessels in 1997.

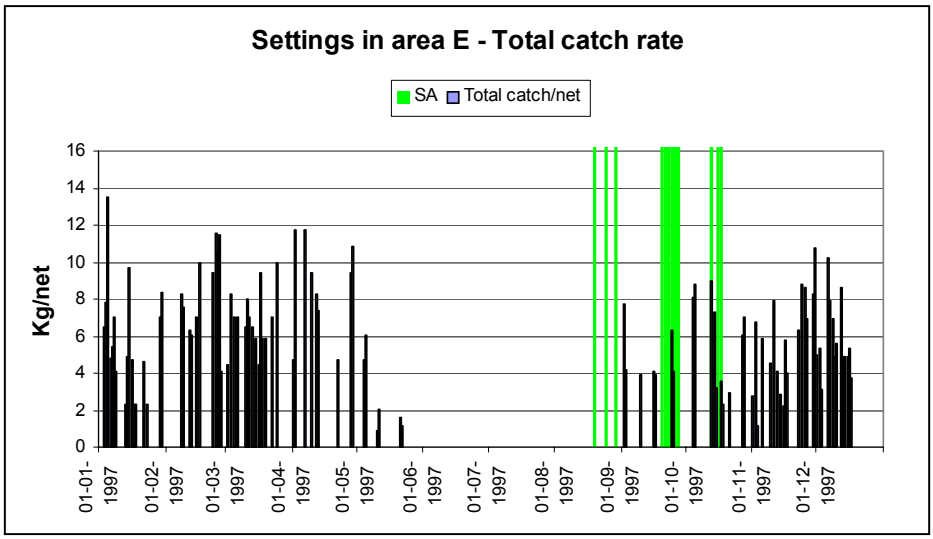


Figure 30. Total catch rate in ring area E for gill-net vessels in 1997.

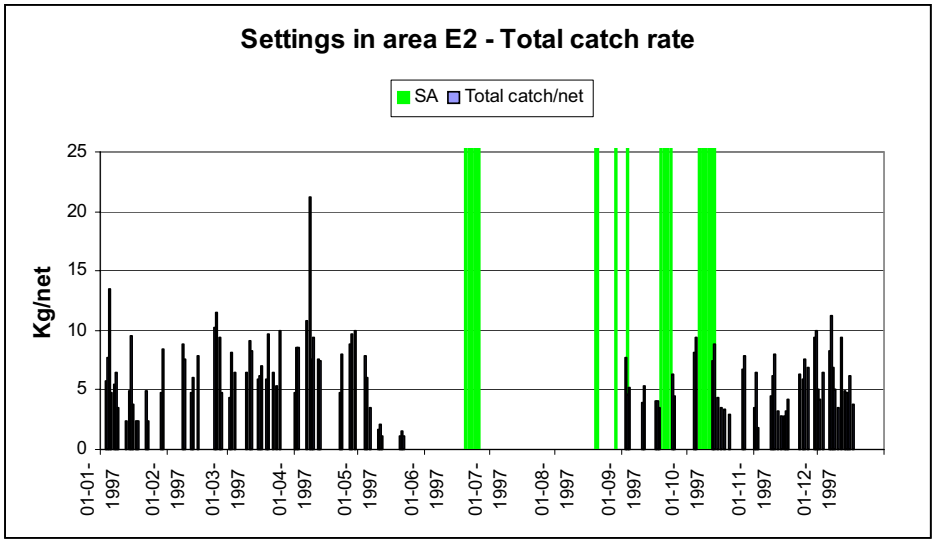


Figure 31. Total catch rate in ring area E2 for gill-net vessels in 1997.

Additional questions from the questionnaire

Under normal conditions, the catch rate varies quite significantly. The reasons for this are many and complicated and are both of natural and man-made origin. In order to elucidate this phenomena, three groups of questions were incorporated into the questionnaire. The first group relates to natural phenomena, the second to the influence of other fishing vessels, and the third to the construction of the fishing gear. The following chart tabulates the answers as averages. The answers regarding the influences from natural phenomena are presented graphically.

Table 7. The influences of natural phenomena on catch rate.

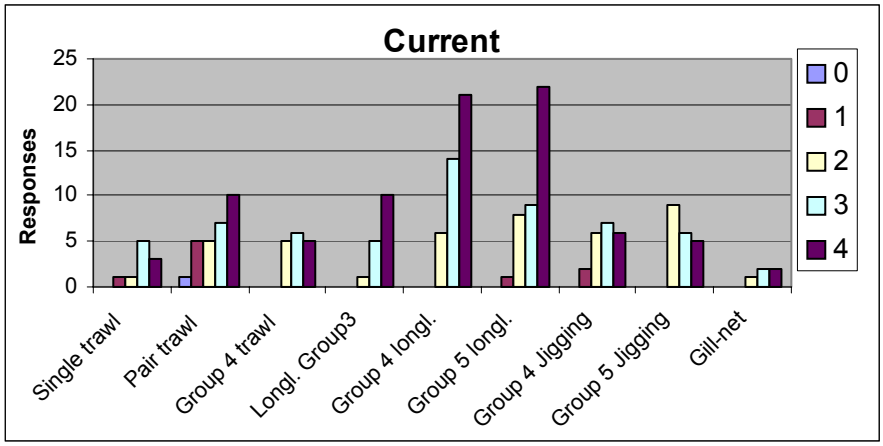
Question: "*Listed below are a number of phenomena that, in one way or another, may affect the fishing success. We would like you to grade these effects using a scale between 0 and 4 (0 = no effect and 4 = very great effect). If necessary, briefly comment on how the phenomena affect success.*"

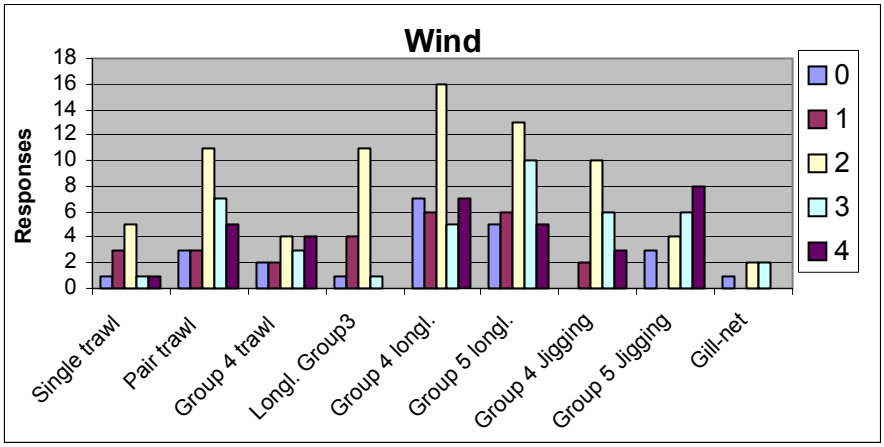
Phenomena		Effect				Comment
1. Natural phenomena						
		T	**L**	**J**	**G**	
Current		2.9	3.4	2.8	3.2	
Wind		2.2	2.0	2.6	2.0	
Wind direction		2.6	1.9	2.2	2.0	
*Surface temperature		1.2	1.9	1.4		
*Temperature at fishing depth		3.5	3.0	3.1		
Sea visibility		2.2	2.1	2.8	2.3	
Light		2.1	2.1	2.0	0.5	
Time of day		3.0	2.9	3.1	0.4	
Bottom quality		2.2	2.8	1.9	3.5	
Food availability		3.1	3.0	3.5	3.0	
Season		2.8	3.1	2.8	3.2	
Maturity		2.9	2.5	3.0	1.8	
Bycatches		1.4	0.6	0.4	1.3	
Marine mammals in the area		1.2	0.6	1.3	0.2	
Sea birds		1.6	1.2	2.0	0.2	
Stock size		2.7	3.2	3.4	2.3	
Size of target fish specie	Many juve-niles	2.5	2.6	2.8	1.8	
	Many large fish	2.0	2.2	2.4	2.0	

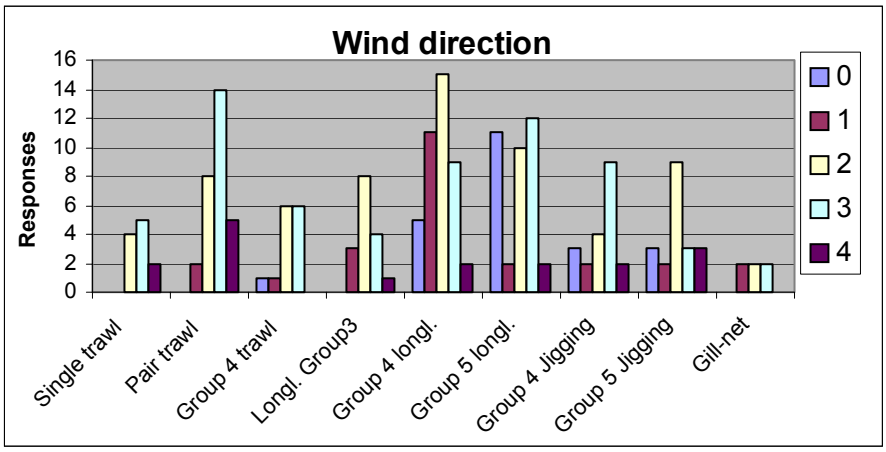
*** Comment if you use equipment to measure the temperature.**

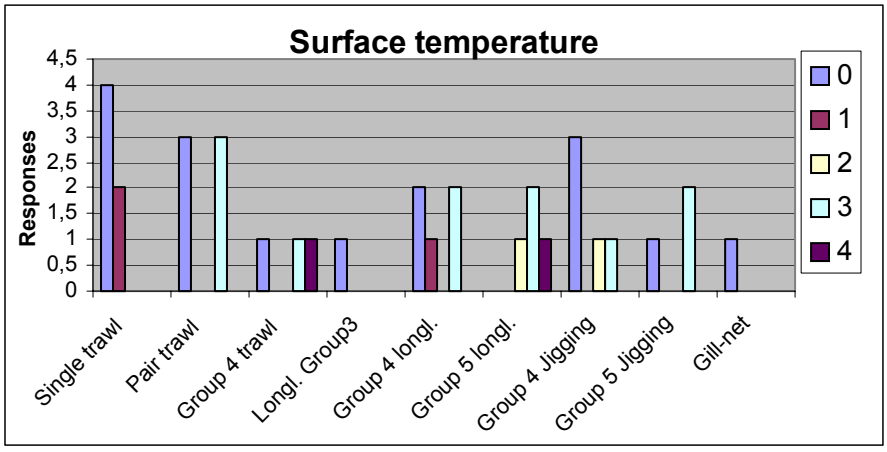
T = Trawl
L = Longline
J = Jigging
G = Gill-net

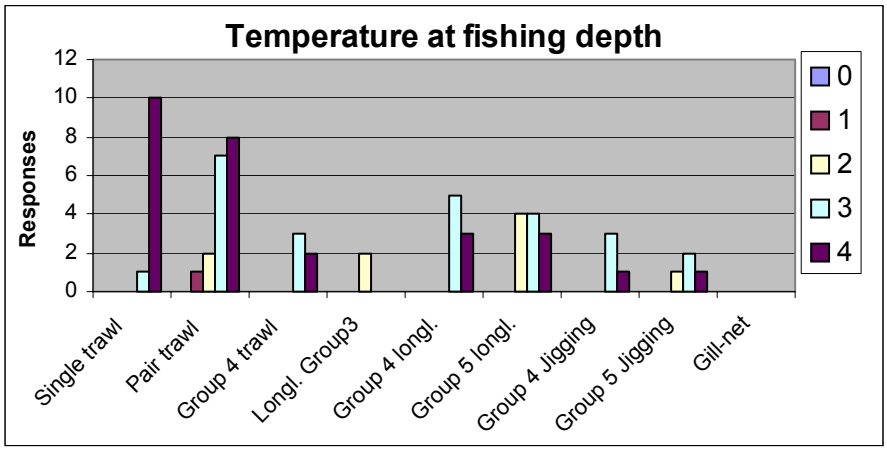
The results are also illustrated on the following pages. The graphs show the effects from the natural phenomena by fleet group.

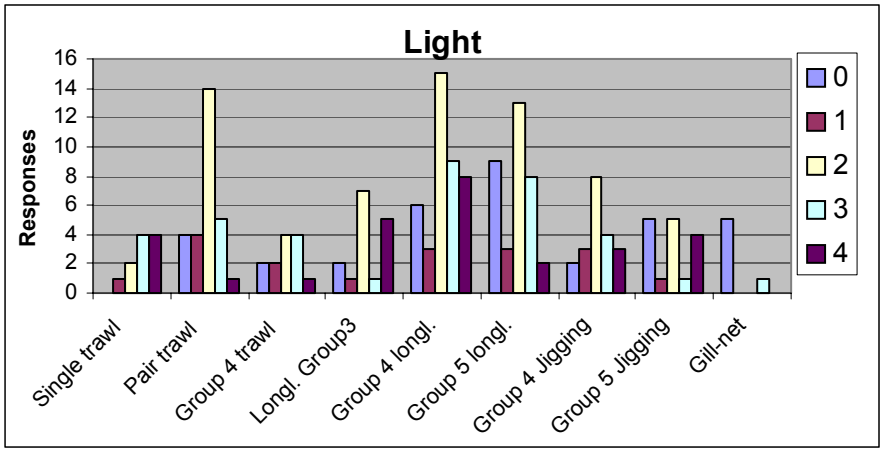

Current
Responses
25
20
15
10
5
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

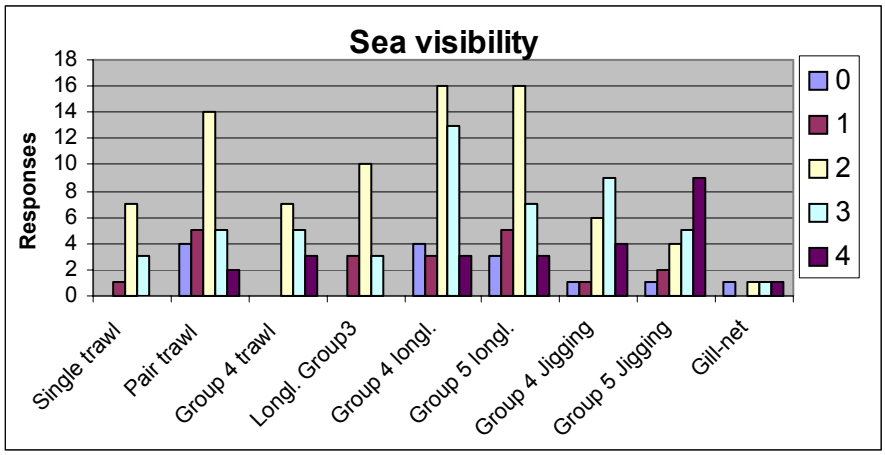

Wind
Responses
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

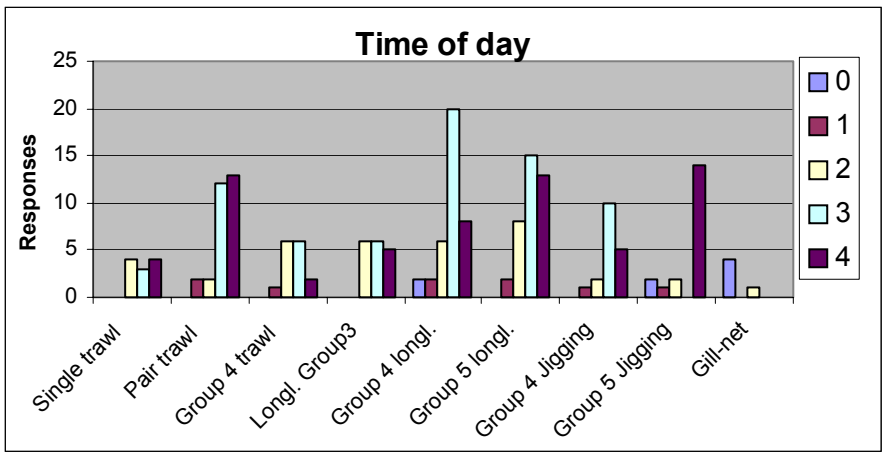

Wind direction
Responses
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

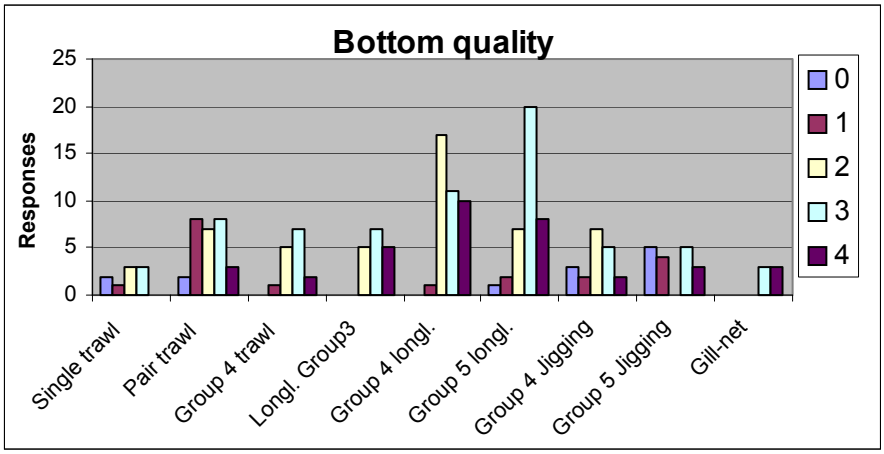

Surface temperature
Responses
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

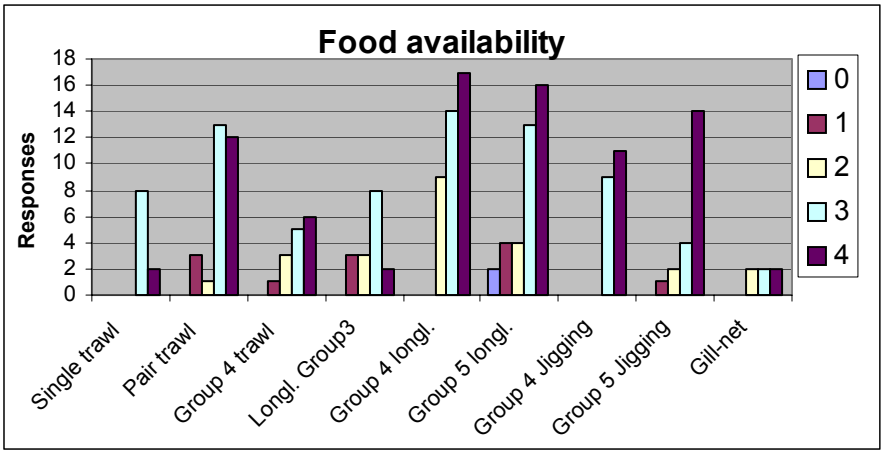

Temperature at fishing depth
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

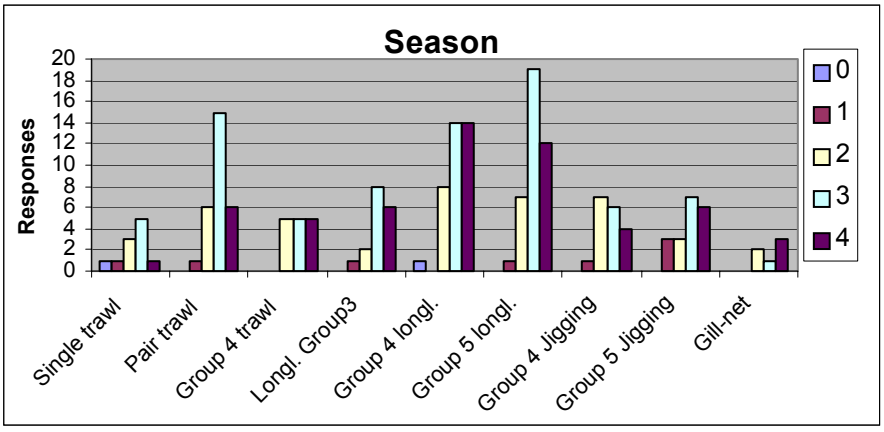

Light
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

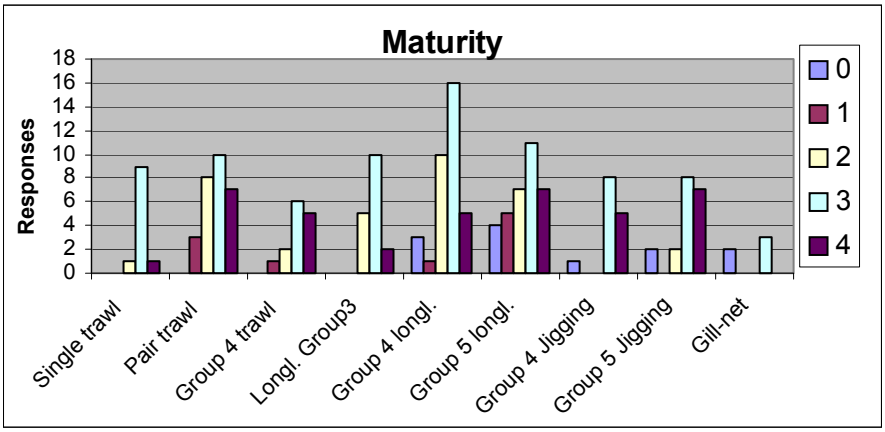

Sea visibility
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

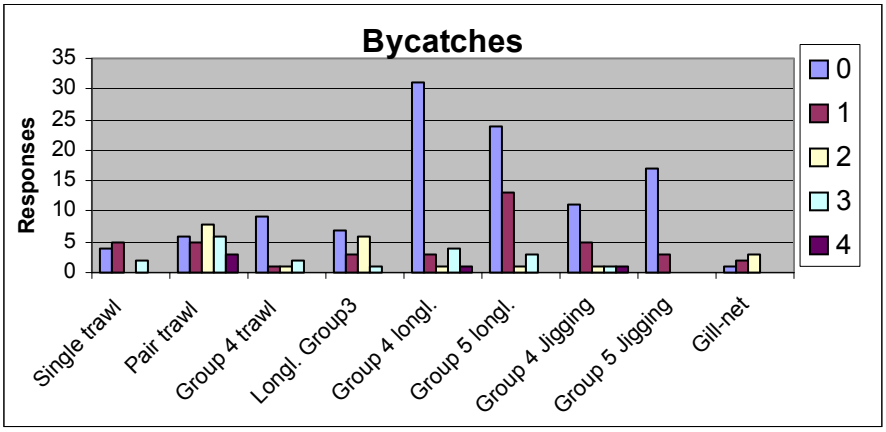

Time of day
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

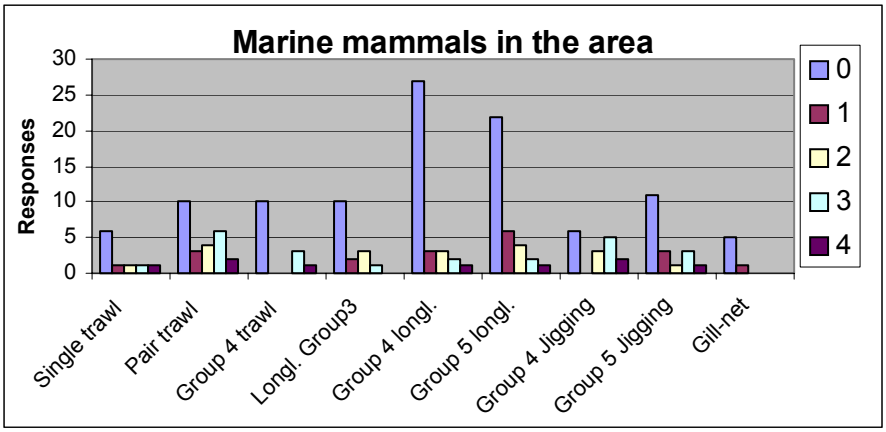

Bottom quality
Responses
25
20
15
10
5
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

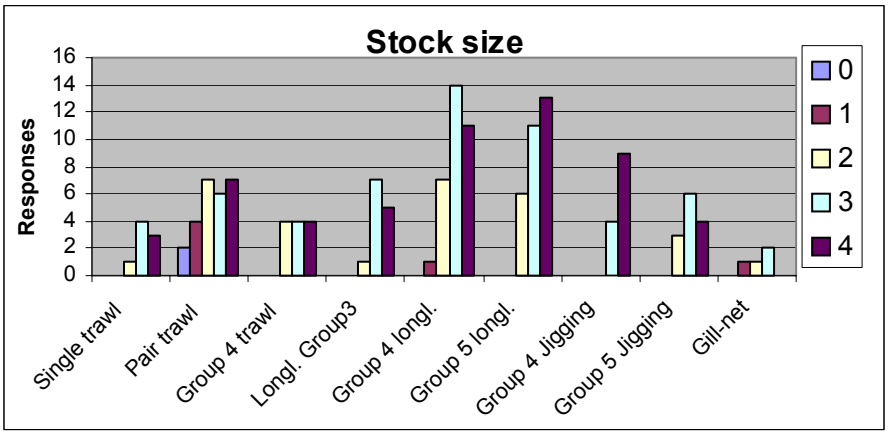

Food availability
Responses
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

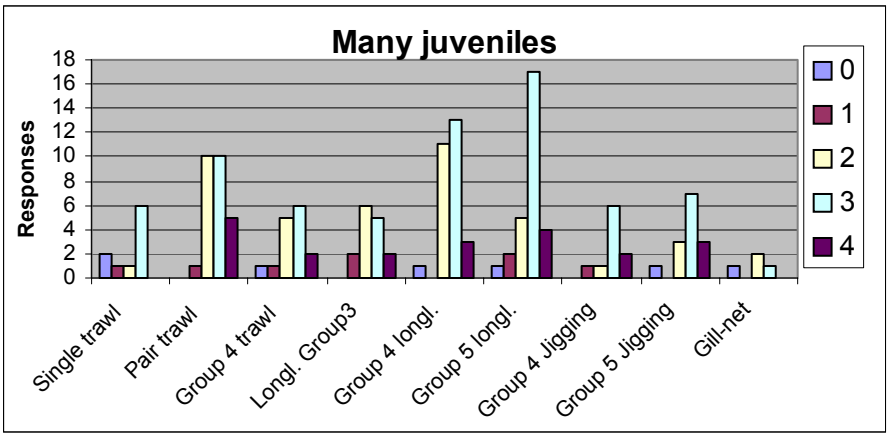

Season
Responses
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

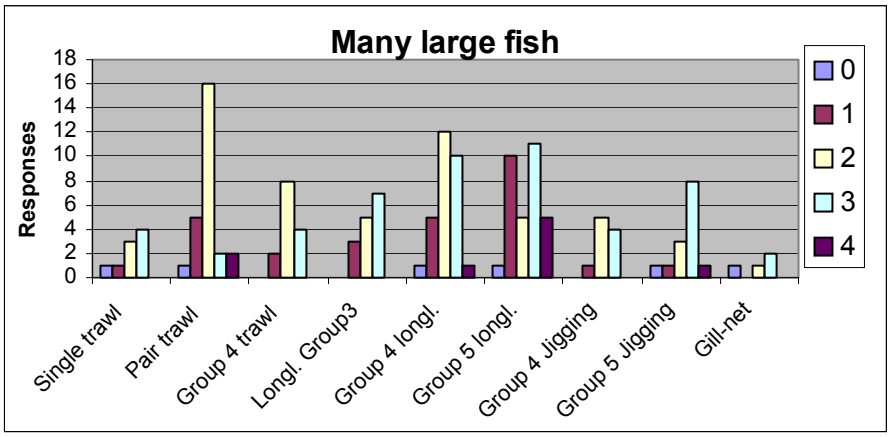

Maturity
Responses
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net


Bycatches
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net


Marine mammals in the area
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net


Stock size
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net


Many juveniles
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net


Many large fish
Responses
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

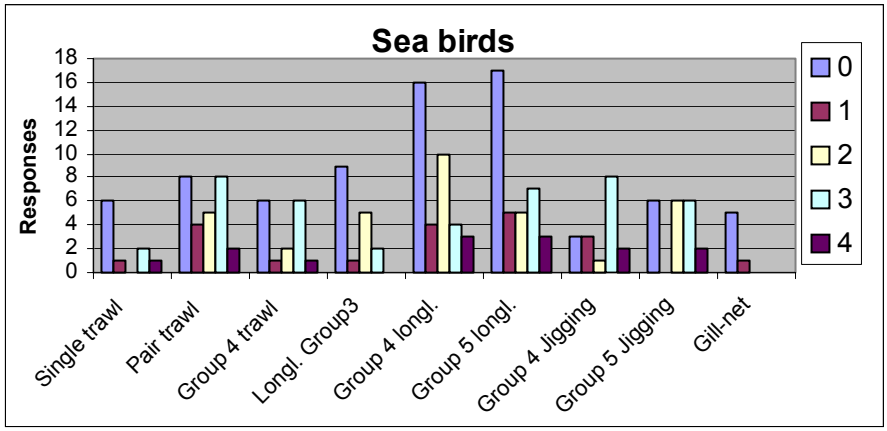

Sea birds
Responses
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

Table 8. The influence of other vessels and gear on the fishery.

Question: "*How much does the fishing gear of others disturb your fishing gear."*

Other fisheries in the same area	**Your fishing gear**	*Trawl*	*Long line*	*Jigging*	*gillnet*	*Pair trawl*
	Trawl					
	Longline					
	Jigging					
	Gill-net					
	Pair trawl					

Your fishing gear: TRAWL

	0	**1**	**2**	**3**	**4**	**Total**	**Average**
Trawl	20	10	4	2	1	37	0.8
Longline	27	8	7	1	9	52	1.2
Jigging	33	0	1	1	3	38	0.4
Gill-net	16	2	3	5	6	32	1.5
Pair trawl	3	4	4	2	9	22	2.5

Your fishing gear: LONGLINE

	0	**1**	**2**	**3**	**4**	**Total**	**Average**
Trawl	14	6	17	16	27	80	2.5
Longline	18	25	36	15	4	98	1.6
Jigging	78	3	3	2	0	86	0.2
Gill-net	30	9	12	5	8	64	1.3
Pair trawl	24	11	11	7	14	67	1.6

Your fishing gear: JIGGING

	0	**1**	**2**	**3**	**4**	**Total**	**Average**
Trawl	7	0	2	11	31	51	3.2
Longline	22	7	10	15	8	62	1.7
Jigging	32	6	7	3	1	49	0.7
Gill-net	17	6	6	5	5	39	1.4
Pair trawl	5	0	3	6	28	42	3.2

Your fishing gear: GILL-NET

	0	**1**	**2**	**3**	**4**	**Total**	**Average**
Trawl	6	2	2	0	8	18	2.1
Longline	19	3	3	3	2	30	0.9
Jigging	16	0	0	2	0	18	0.3
Gill-net	10	1	5	0	0	16	0.7
Pair trawl	6	2	1	0	6	15	1.9

Your fishing gear: PAIR TRAWL

	0	**1**	**2**	**3**	**4**	**Total**	**Average**
Trawl	23	2	3	1	2	31	0.6
Longline	20	4	11	7	4	46	1.4
Jigging	27	1	0	1	3	32	0.5
Gill-net	18	2	4	2	2	28	0.9
Pair trawl	23	1	1	1	1	27	0.4

Table 9. The importance and consequent influence of different parts of the gear on the fishery success.

Question: "*How important is each part of the gear in the different fisheries. Please grade each part with a number between 0 and 4.*"

		0	***1***	***2***	***3***	***4***	**Total**	**Avg.**
Single trawl Group 1	Otter boards	*0*	*0*	*0*	*1*	*10*	11	**3.9**
	Ground gear	*0*	*0*	*3*	*4*	*4*	11	**3.1**
	Trawl type	*0*	*1*	*5*	*2*	*3*	11	**2.6**
	Mesh size cod-end	*0*	*0*	*0*	*0*	*11*	11	**4.0**
	Mesh size trawl	*1*	*2*	*4*	*4*	*0*	11	**2.0**
	Towing speed	*0*	*0*	*3*	*2*	*6*	11	**3.3**
	Synchronised winches	*0*	*0*	*0*	*4*	*6*	10	**3.6**
	Other	*0*	*0*	*2*	*1*	*3*	6	**3.2**
Pair trawl	Weights	*0*	*0*	*4*	*5*	*6*	15	**3.1**
	Ground gear	*0*	*1*	*7*	*10*	*11*	29	**3.1**
	Trawl type	*0*	*1*	*14*	*5*	*8*	28	**2.7**
	Mesh size cod-end	*1*	*6*	*9*	*5*	*6*	27	**2.3**
	Mesh size trawl	*0*	*1*	*1*	*8*	*20*	30	**3.6**
	Towing speed	*0*	*1*	*3*	*10*	*13*	27	**3.3**
	Synchronised winches	*2*	*1*	*3*	*4*	*9*	19	**2.9**
	Other	*0*	*0*	*5*	*6*	*6*	17	**3.1**
Single trawl Group 4	Otter boards	*0*	*0*	*0*	*2*	*12*	14	**3.9**
	Ground gear	*0*	*0*	*0*	*4*	*10*	14	**3.7**
	Trawl type	*0*	*0*	*4*	*3*	*6*	13	**3.2**
	Mesh size cod-end	*2*	*3*	*4*	*1*	*3*	13	**2.0**
	Mesh size trawl	*0*	*0*	*0*	*3*	*10*	13	**3.8**
	Towing speed	*0*	*0*	*3*	*5*	*5*	13	**3.2**
	Synchronised winches	*1*	*1*	*2*	*3*	*0*	7	**2.0**
	Other	*0*	*0*	*0*	*0*	*2*	2	**4.0**
Longline Group 3	Bait	*0*	*0*	*0*	*2*	*14*	16	**3.9**
	Hook type	*0*	*1*	*5*	*6*	*4*	16	**2.8**
	Snood	*0*	*3*	*9*	*3*	*1*	16	**2.1**
	Line type	*0*	*3*	*9*	*3*	*1*	16	**2.1**
	Swivel line	*0*	*0*	*0*	*7*	*9*	16	**3.6**
	Other	*0*	*2*	*1*	*1*	*4*	8	**2.9**
Longline Group 4	Bait	*0*	*0*	*0*	*5*	*36*	41	**3.9**
	Hook type	*1*	*4*	*12*	*10*	*11*	38	**2.7**
	Snood	*3*	*12*	*12*	*8*	*4*	39	**1.9**
	Line type	*3*	*5*	*13*	*8*	*10*	39	**2.4**
	Swivel line	*1*	*0*	*10*	*6*	*19*	36	**3.2**
	Other	*0*	*2*	*5*	*1*	*4*	12	**2.6**

Longline Group 5	Bait	*0*	*0*	*2*	*7*	*32*	41	**3.7**
	Hook type	*2*	*9*	*14*	*9*	*5*	39	**2.2**
	Snood	*5*	*13*	*14*	*5*	*3*	40	**1.7**
	Line type	*4*	*9*	*10*	*12*	*6*	41	**2.2**
	Swivel line	*3*	*2*	*12*	*11*	*10*	38	**2.6**
	Other	*1*	*1*	*2*	*1*	*1*	6	**2.0**
Jigging Group 4	Hooks	*3*	*3*	*10*	*1*	*7*	24	**2.3**
	Bait	*7*	*5*	*4*	*7*	*1*	24	**1.6**
	Nylon	*1*	*2*	*7*	*6*	*8*	24	**2.8**
	Noise	*0*	*0*	*0*	*1*	*25*	26	**4.0**
	Other	*0*	*0*	*1*	*0*	*3*	4	**3.5**
Jigging Group 5	Hooks	*2*	*3*	*9*	*6*	*6*	26	**2.4**
	Bait	*5*	*4*	*10*	*5*	*3*	27	**1.9**
	Nylon	*3*	*4*	*11*	*1*	*7*	26	**2.2**
	Noise	*1*	*1*	*3*	*5*	*17*	27	**3.3**
	Other	*0*	*0*	*2*	*1*	*3*	6	**3.2**
Gill-net	Net material	*0*	*0*	*1*	*2*	*2*	5	**3.2**
	Mesh size	*0*	*0*	*0*	*3*	*2*	5	**3.4**
	Net type	*0*	*0*	*0*	*0*	*4*	4	**4.0**
	Hanging ratio	*0*	*0*	*2*	*1*	*3*	6	**3.2**
	Other	*0*	*0*	*0*	*0*	*3*	3	**4.0**
Pelagic trawl	Trawl type	*3*	*1*	*1*	*1*	*1*	7	**1.4**
	Height	*0*	*1*	*0*	*4*	*2*	7	**3.0**
	Width	*0*	*1*	*0*	*4*	*2*	7	**3.0**
	Mesh size cod-end	*0*	*0*	*1*	*3*	*2*	6	**3.2**
	Mesh size trawl	*0*	*2*	*2*	*2*	*1*	7	**2.3**
	Tow speed	*0*	*1*	*1*	*4*	*1*	7	**2.7**
	Otter boards	*0*	*0*	*2*	*3*	*2*	7	**3.0**
	Other	*0*	*0*	*2*	*1*	*2*	5	**3.0**
Purse seine	Depth	*0*	*0*	*1*	*2*	*1*	4	**3.0**
	Length	*0*	*0*	*2*	*1*	*1*	4	**2.8**
	Mesh size	*0*	*2*	*0*	*0*	*2*	4	**2.5**
	Sonar	*0*	*0*	*0*	*0*	*4*	4	**4.0**
	Shape	*0*	*0*	*0*	*3*	*1*	4	**3.3**
	Other	*0*	*0*	*1*	*0*	*1*	2	**3.0**

Discussion and concluding remarks

From the logbook data, it is not possible to document any effects of SA on the fishing success. However, 75 % of the fishermen that experienced SA while fishing claim they observed an effect. The fishermen who had observed an effect came from all the vessel groups, both the larger vessel groups with a logbook obligation, and the smaller vessel groups with no obligation. It should be noted here that while the skippers claim they observed an effect, it is not possible to find references to the observed effects in the logbook data.

From media coverage, anecdotal evidence, and observations by other fishermen, a certain residual prejudice towards SA has to be anticipated. Thus, it is very difficult through an interview process to have unbiased responses, even though great effort had been taken to formulate the questions in order to minimize the problem. The number of observations, nevertheless, are not only numerous, but also represent the whole range of demersal fisheries at the Faroe Islands. Thus, it has to be accepted as a fact from the interview responses, that SA affects the fisheries, although we have not been able to verify this fact from the logbook data. Nevertheless, it is important to acknowledge that the fishermen are the first-hand observers and their observations must be taken as a reality. It is not possible to assess the quantitative impact on the fishery, neither from the logbook data nor the questionnaire. It is most likely, however, very variable, depending on target species, season, depth, and fishing gear.

The natural variations in catch rate that can be observed in the logbook data are a result of a number of factors affecting the fishery. How the interviewees graded the effect of these factors on the fisheries is presented in Table 7. Fishing success was also graded by stock specifics (size and age) and vessel and gear specifics.

It is not possible from the logbook data to distinguish any long or short term change in the catch rate that could be linked to SA in the same area in time and place. From this, however, it is not possible to conclude that there are no effects from SA. It is possible only to state that the natural variations in the catch rate are so large that they mask any SA effects that might exist.

The magnitude of the effects, if any, was within the "ambient noise" level and no long-term changes in the average catch rate were observed. From this, it is possible to state that the seismic activity in Faroese territorial waters in 1997 did not have any lasting effect on success in the demersal fisheries nor on the fish stocks.

Variance by vessel group

The most confident responses on the effects of SA came from the fishermen connected with the smaller-sized vessel groups that traditionally fish for cod and haddock in shallow waters. There are a number of possible reasons for this:

a. The intensity of sound in the sea reduces rapidly with distance from the source (20logR). Assuming the scaring effect to be proportional to intensity, the effects on fish at the bottom would be inversely proportional with bottom depth. Thus, the concentrations fished by the smaller vessel group would to be more vulnerable than those in deeper water.
b. Sensitivity to sound differs among the fish species, and is, in general, not well understood. A number of experiments and observations on the behaviour of cod and haddock have been made. This information clearly indicates that both species are sensitive to sound, not only in that they react to it, but that it is used as a means of communication. For fish living at greater depths, far less information is available.

c. On the smaller vessels, the individual fisherman is closer to the sea surface compared to the larger vessels and the catch rate with some of their gear, e.g. jigging, is very sensitive to fish behaviour. These fishermen, therefore, might have a better platform from which to observe than the fishermen on the larger vessels.

Along the Faroe Shelf, large changes in the hydrography can be observed over short vertical distances. Therefore, the distance fish need to migrate in order to escape SA is limited to the extent that they will suffer an unfavourable environment compared to an unfavourable noise level. On the Faroe Plateau proper, the environment is homogenous and any escape migration is, therefore, not limited by counteracting phenomena. This could explain the very much increased catches of cod observed by one pair trawler skipper, which, in his opinion, were herded into the area in which he fished by SA.

It is also important to note, that in 1997 only 2D seismic investigations were performed, and that our findings do not relate to 3D seismic investigations in which a small area is investigated through a dense net of closely spaced cruise lines.

Although there are immediate reactions in behaviour by fish to SA, there is no apparent long-lasting change. In general, the fishery tends to be unaffected by the seismic activities. In the logbook data sets, there are several examples of non-fishing in the days following SA, indicating that the fishing vessels diverted their fishing to other areas, possibly in an anticipation of a reduced fishery caused by SA. This anticipation of a reduced fishery is supported by the significantly reduced number of complaints since information on SA in time and space is continuously relayed through a call up system. This would indicate that the fishermen avoid fishery in these areas.

As mentioned in the section on fish and sound, the high intensity of the sound emitted by the air guns allows the sound, at least in theory, to be above the ambient level of noise throughout the Faroe Plateau. With seismic investigations being performed every year since 1993 this prolonged period of SA might have resulted in the fish adapting to the sound pattern, and any avoidance reaction would only be temporary at very close range. A very interesting project would be to measure the sound pressure and intensity at various distances from a seismic vessel under operation.

The SOFAR layer

Of special interest in respect to sound in the sea is the phenomena that occurs at a point, the so-called "SOFAR layer", in which low frequency sound is transmitted over very long distances. The sofar layer is a point where the speed of sound, following a decrease due to reduced temperature and/or salinity, starts to increase again due to pressure. In the Faroe-Shetland Channel, this layer is at the 500-700 m depth. See Figure 32. It would also be of interest to investigate to what extent sound from seismic activity is trapped in this layer.

There are, to our knowledge, no systematic observations on the sound spectrum and intensity at various horizontal distances from airgun emissions of sound in the sea. And the theoretical distances calculated where the sound level will be above the ambient noise level have thus not been validated. As it might not be valid to look only at the spherical scattering of sound from a source only 5 meter below the surface, there is clearly a need for further investigations into this matter.

The sofar layer in the Faroe Shetland Channel is 500-700 m below the seismic sound emitted, and in addition to the very much-reduced energy, which will reach that depth, only a fraction will be trapped in the layer. The Faroe Shetland Channel, the area of most interest for oil exploration, is a very important area for

both larger and smaller cetaceans to feed in and migrate trough (Bloch *et al.*, 2000). And it is therefore of importance to make sound recordings there throughout the water column and in the sofar layer in order to measure the sound level during seismic activity in the area.

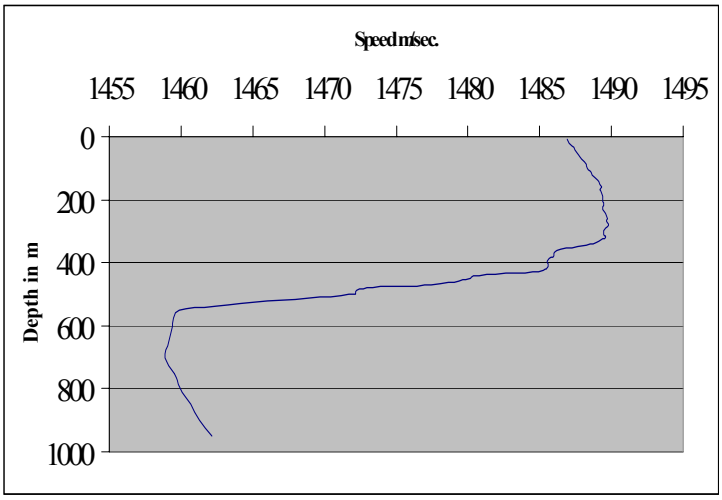


Figure 32. Sound speed at 60°21'N, 5°11'W in May 1997.

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Appendix 1

Questionnaire

Information

The fishery fleet in the Faroe Islands is divided into five groups. Each group consists of a specific ship type or a specific ship size.

In this questionnaire, you will often see tables and figures where the answers are divided into groups.

The groups are:

Group 1: Larger single trawlers, mostly fishing in deep waters, normally between 200m – 1200m .

Group 2: Pair trawlers, mostly fishing between 150m – 400m

Group 3: Longliners >110 GRT using automatic baiters, mostly fishing between 150m – 600m

Group 4: Larger coastal fishing vessels. Group 4 can be divided into 3 groups: Trawlers, longline vessels, and jigging vessels.

Group 5: Smaller coastal fishing vessels < 15 GRT. Group 5 can be divided into 2 groups: Longline vessels and jigging vessels

1. Changes in the fishery

1. *A subject that often is talked about is changes in the fishery. These changes could be both present and past.*
   Have you, in your time as a fisherman, observed any changes in the fishery.

   Yes/No **155/13**

   If yes, could you please explain this and could you give your opinion of what could explain these changes. It could, e.g., be natural or other reasons.

   The comments are widespread. The skippers discuss, for example, reduced fishing areas, improved fishery, changed fishstocks, automation of fishing gear.

2. Effects on the fisheries

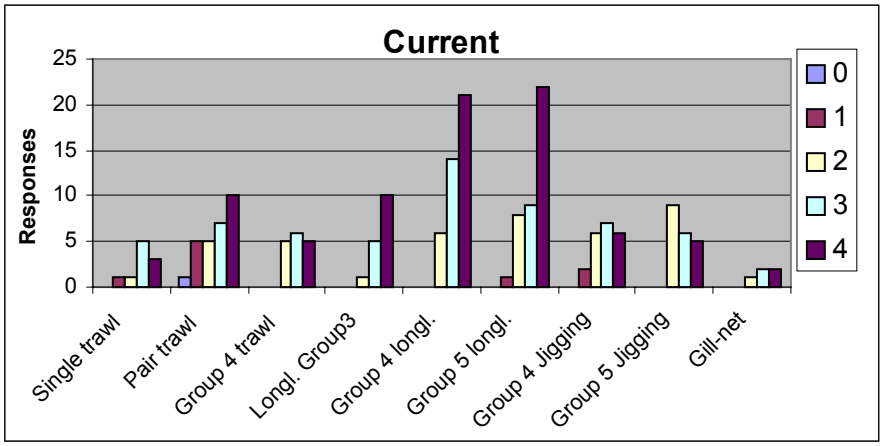
The table below lists a number of phenomena that in one way or the other may affect fishing success. We would like you to grade these effects using a scale between 0 and 4 (0 = no effect and 4 = very great effect). If necessary, briefly comment on how the phenomena affect your fishing success.

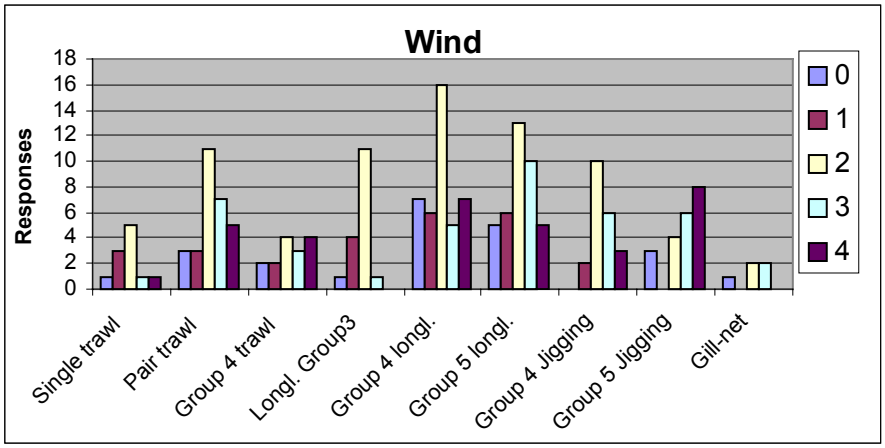
Phenomena		Effect				Comment
1. Natural phenomena						
		T	**L**	**J**	**G**	
Current		2.9	3.4	2.8	3.2	
Wind		2.2	2.0	2.6	2.0	
Wind direction		2.6	1.9	2.2	2.0	
*Surface temperature		1.2	1.9	1.4		
*Temperature at fishing depth		3.5	3.0	3.1		
Sea visibility		2.2	2.1	2.8	2.3	
Light		2.1	2.1	2.0	0.5	
Time of day		3.0	2.9	3.1	0.4	
Bottom quality		2.2	2.8	1.9	3.5	
Food availability		3.1	3.0	3.5	3.0	
Season		2.8	3.1	2.8	3.2	
Maturity		2.9	2.5	3.0	1.8	
Bycatches		1.4	0.6	0.4	1.3	
Marine mammals in the area		1.2	0.6	1.3	0.2	
Sea birds		1.6	1.2	2.0	0.2	
Stock size		2.7	3.2	3.4	2.3	
Size of target fish specie	Many juve-niles	2.5	2.6	2.8	1.8	
	Many large fish	2.0	2.2	2.4	2.0	

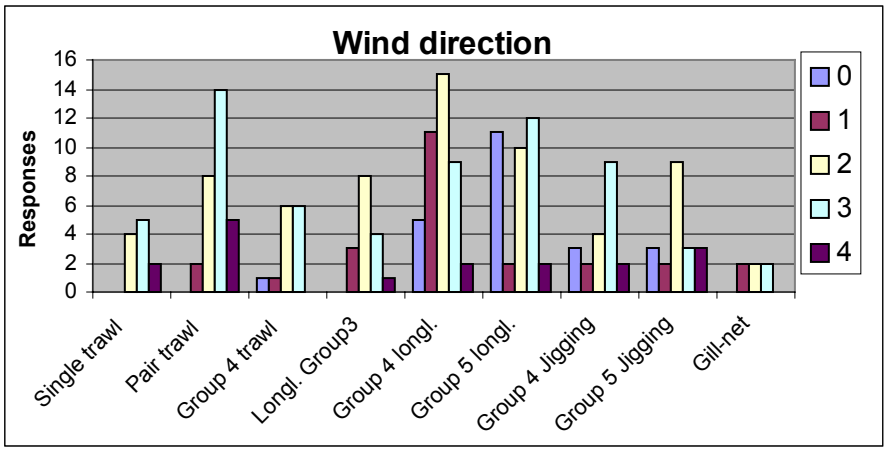
*** Comment if you use equipment to measure the temperature.**

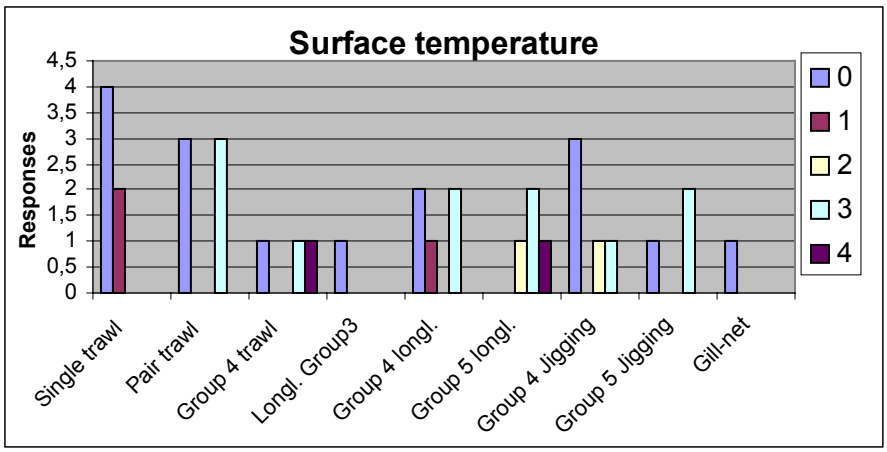
T = Trawl
L = Longline
J = Jigging
G = Gill-net

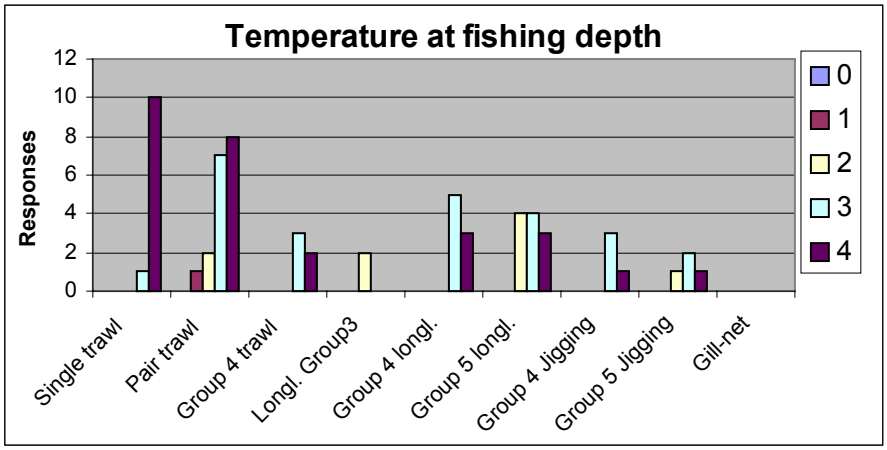
The results are also illustrated in the graphs on pages 6 – 10. These graphs show the effects from natural phenomena by fleet groups.

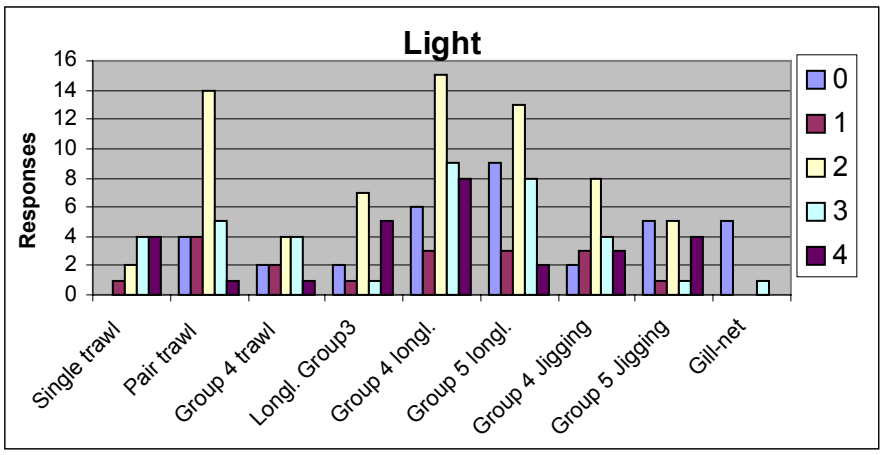

Current
Responses
25
20
15
10
5
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

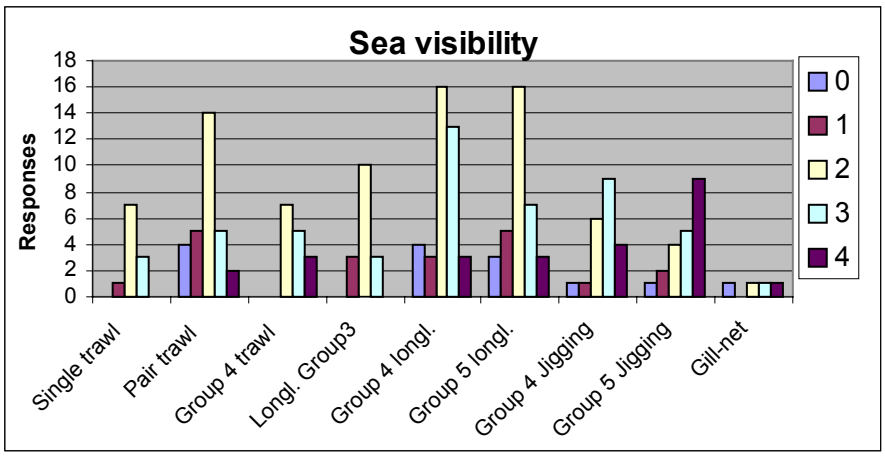

Wind
Responses
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

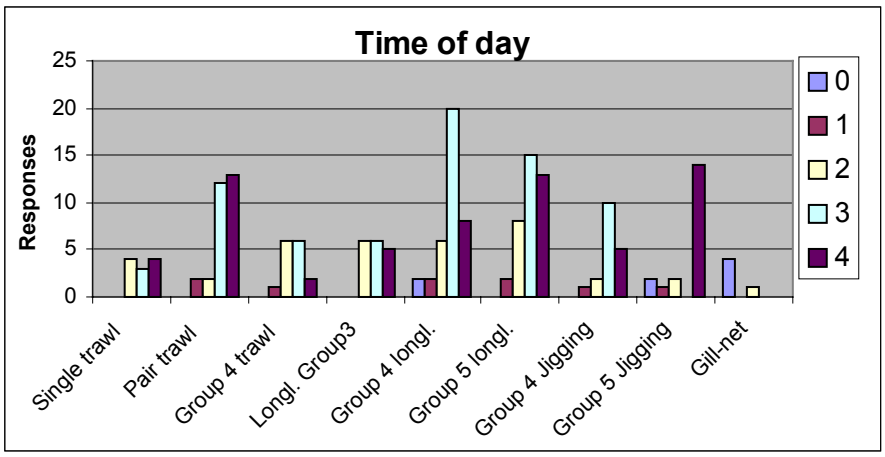

Wind direction
Responses
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

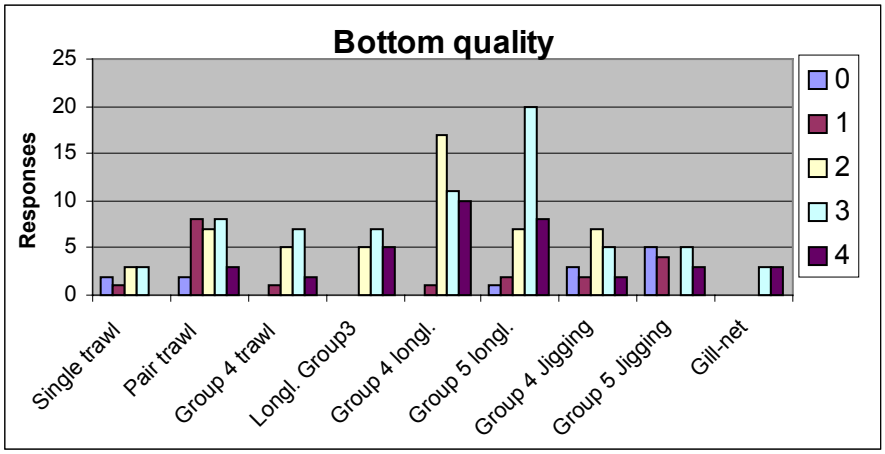

Surface temperature
Responses
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

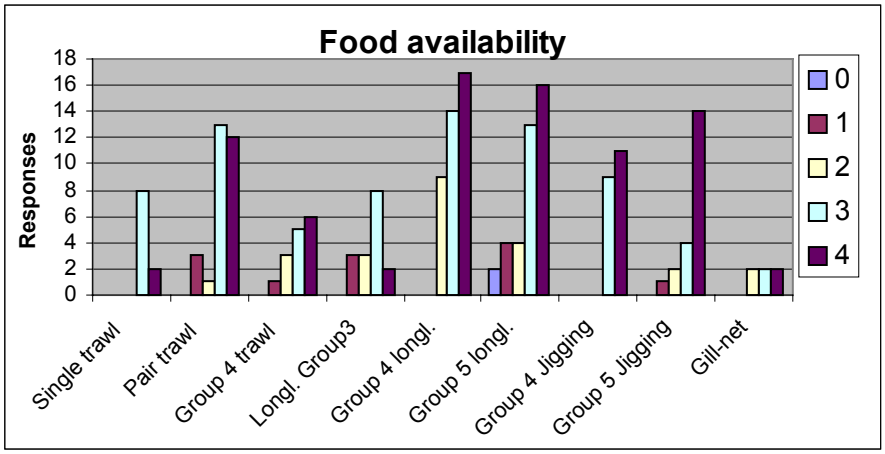

Temperature at fishing depth
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

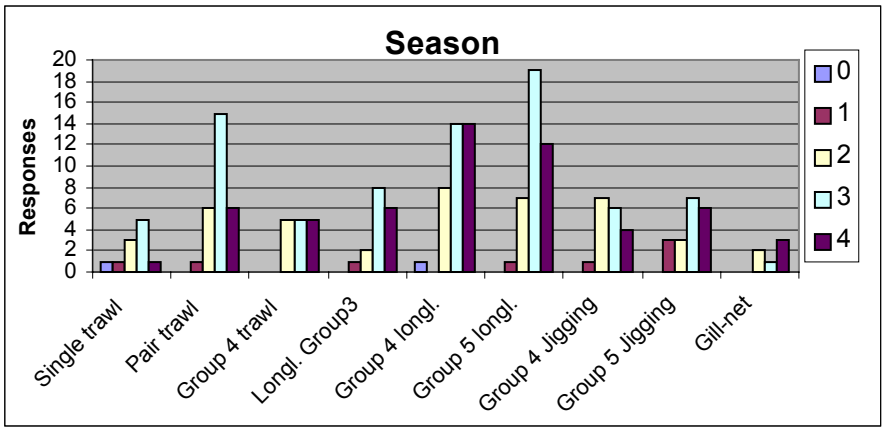

Light
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

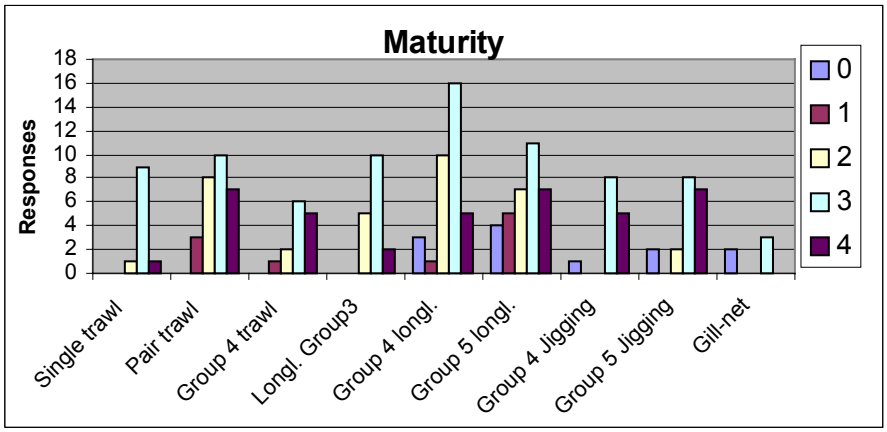

Sea visibility
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

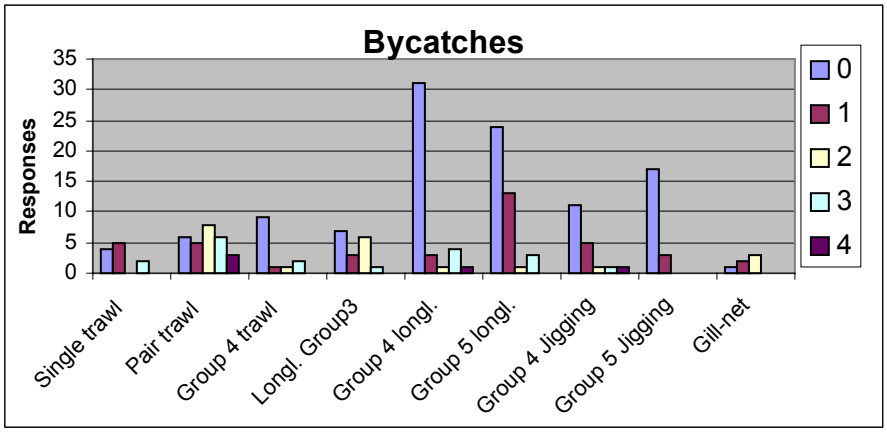

Time of day
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

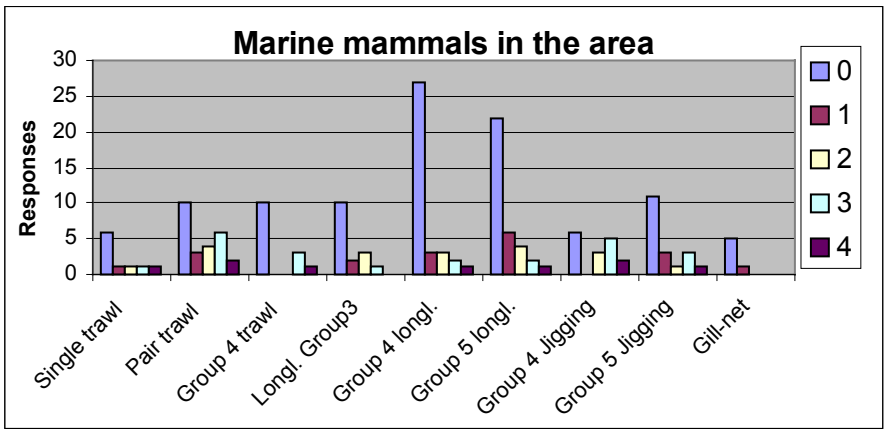

Bottom quality
Responses
25
20
15
10
5
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

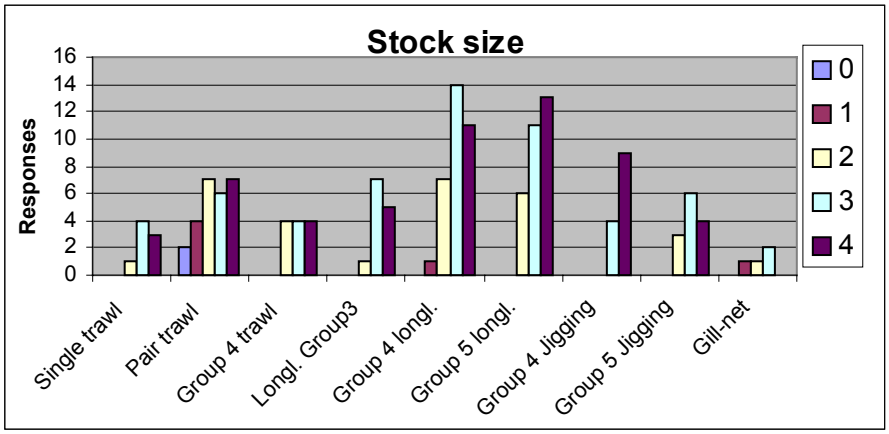

Food availability
Responses
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

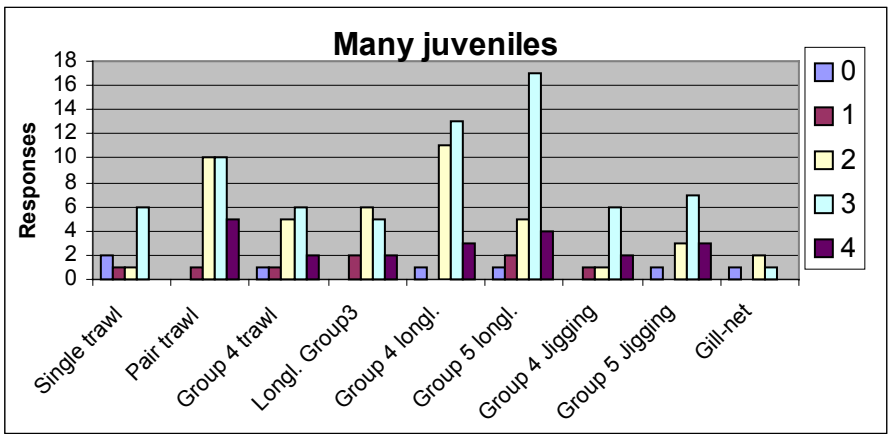

Season
Responses
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

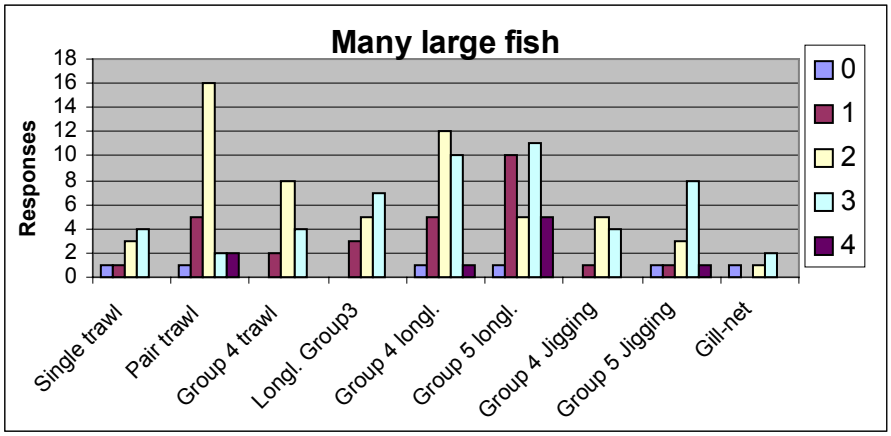

Maturity
Responses
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

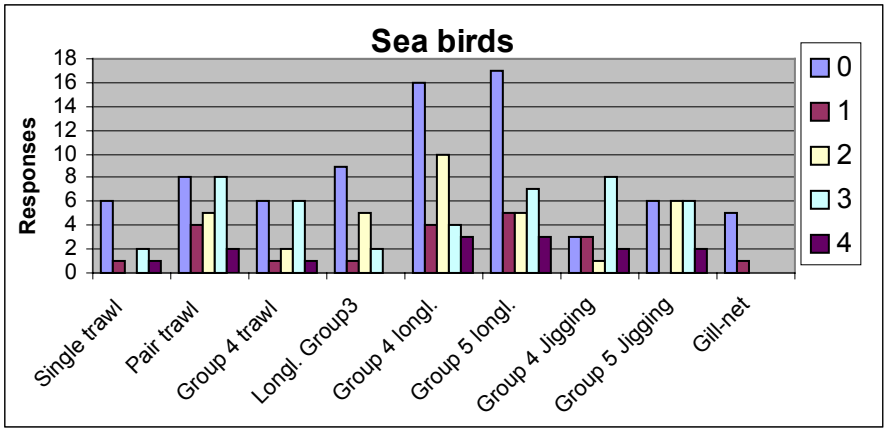

Bycatches
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net


Marine mammals in the area
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net


Stock size
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net


Many juveniles
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net


Many large fish
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net


Sea birds
Responses
0
1
2
3
4
Single trawl
Pair trawl
Group 4 trawl
Longl. Group3
Group 4 longl.
Group 5 longl.
Group 4 Jigging
Group 5 Jigging
Gill-net

2.2 Gear and handling. How much does the fishing gear of others disturb your fishing gear.						
		Fishing gear of others				
Other fisheries in the same area	**Your fishing gear**	*Trawl*	*Long line*	*Jigging*	*Gil-net*	*Pair trawl*
	Trawl					
	Longline					
	Jigging					
	Gill-net					
	Pair trawl					

Answers:

Your fishing gear: TRAWL

	0	**1**	**2**	**3**	**4**	**Total**	**Average**
Trawl	20	10	4	2	1	37	0.8
Longline	27	8	7	1	9	52	1.2
Jigging	33	0	1	1	3	38	0.4
Gill-net	16	2	3	5	6	32	1.5
Pair trawl	3	4	4	2	9	22	2.5

Your fishing gear: LONGLINE

	0	**1**	**2**	**3**	**4**	**Total**	**Average**
Trawl	14	6	17	16	27	80	2.5
Longline	18	25	36	15	4	98	1.6
Jigging	78	3	3	2	0	86	0.2
Gill-net	30	9	12	5	8	64	1.3
Pair trawl	24	11	11	7	14	67	1.6

Your fishing gear: JIGGING

	0	**1**	**2**	**3**	**4**	**Total**	**Average**
Trawl	7	0	2	11	31	51	3.2
Longline	22	7	10	15	8	62	1.7
Jigging	32	6	7	3	1	49	0.7
Gill-net	17	6	6	5	5	39	1.4
Pair trawl	5	0	3	6	28	42	3.2

Your fishing gear: GILL-NET

	0	**1**	**2**	**3**	**4**	**Total**	**Average**
Trawl	6	2	2	0	8	18	2.1
Longline	19	3	3	3	2	30	0.9
Jigging	16	0	0	2	0	18	0.3
Gill-net	10	1	5	0	0	16	0.7
Pair trawl	6	2	1	0	6	15	1.9

Your fishing gear: PAIR TRAWL

	0	**1**	**2**	**3**	**4**	**Total**	**Average**
Trawl	23	2	3	1	2	31	0.6
Longline	20	4	11	7	4	46	1.4
Jigging	27	1	0	1	3	32	0.5
Gill-net	18	2	4	2	2	28	0.9
Pair trawl	23	1	1	1	1	27	0.4

2.3 Question: *How important is each part of the gear in the different fisheries. Please grade each part with a number between 0 and 4.*

Answers

		0	***1***	***2***	***3***	***4***	**Total**	**Avg.**
Single trawl Group 1	Otter boards	*0*	*0*	*0*	*1*	*10*	11	**3.9**
	Ground gear	*0*	*0*	*3*	*4*	*4*	11	**3.1**
	Trawl type	*0*	*1*	*5*	*2*	*3*	11	**2.6**
	Mesh size cod-end	*0*	*0*	*0*	*0*	*11*	11	**4.0**
	Mesh size trawl	*1*	*2*	*4*	*4*	*0*	11	**2.0**
	Towing speed	*0*	*0*	*3*	*2*	*6*	11	**3.3**
	Synchronised winches	*0*	*0*	*0*	*4*	*6*	10	**3.6**
	Other	*0*	*0*	*2*	*1*	*3*	6	**3.2**
Pair trawl	Weights	*0*	*0*	*4*	*5*	*6*	15	**3.1**
	Ground gear	*0*	*1*	*7*	*10*	*11*	29	**3.1**
	Trawl type	*0*	*1*	*14*	*5*	*8*	28	**2.7**
	Mesh size cod-end	*1*	*6*	*9*	*5*	*6*	27	**2.3**
	Mesh size trawl	*0*	*1*	*1*	*8*	*20*	30	**3.6**
	Towing speed	*0*	*1*	*3*	*10*	*13*	27	**3.3**
	Synchronised winches	*2*	*1*	*3*	*4*	*9*	19	**2.9**
	Other	*0*	*0*	*5*	*6*	*6*	17	**3.1**
Single trawl Group 4	Otter boards	*0*	*0*	*0*	*2*	*12*	14	**3.9**
	Ground gear	*0*	*0*	*0*	*4*	*10*	14	**3.7**
	Trawl type	*0*	*0*	*4*	*3*	*6*	13	**3.2**
	Mesh size cod-end	*2*	*3*	*4*	*1*	*3*	13	**2.0**
	Mesh size trawl	*0*	*0*	*0*	*3*	*10*	13	**3.8**
	Towing speed	*0*	*0*	*3*	*5*	*5*	13	**3.2**
	Synchronised winches	*1*	*1*	*2*	*3*	*0*	7	**2.0**
	Other	*0*	*0*	*0*	*0*	*2*	2	**4.0**
Longline	Bait	*0*	*0*	*0*	*2*	*14*	16	**3.9**
Group 3	Hook type	*0*	*1*	*5*	*6*	*4*	16	**2.8**
	Snood	*0*	*3*	*9*	*3*	*1*	16	**2.1**
	Linetype	*0*	*3*	*9*	*3*	*1*	16	**2.1**
	Swivel line	*0*	*0*	*0*	*7*	*9*	16	**3.6**
	Other	*0*	*2*	*1*	*1*	*4*	8	**2.9**
Longline	Bait	*0*	*0*	*0*	*5*	*36*	41	**3.9**
Group 4	Hook type	*1*	*4*	*12*	*10*	*11*	38	**2.7**
	Snood	*3*	*12*	*12*	*8*	*4*	39	**1.9**
	Linetype	*3*	*5*	*13*	*8*	*10*	39	**2.4**
	Swivel line	*1*	*0*	*10*	*6*	*19*	36	**3.2**
	Other	*0*	*2*	*5*	*1*	*4*	12	**2.6**

		0	*1*	*2*	*3*	*4*	**Total**	**Avg.**
Longline	Bait	*0*	*0*	*2*	*7*	*32*	41	**3.7**
Group 5	Hook type	*2*	*9*	*14*	*9*	*5*	39	**2.2**
	Snood	*5*	*13*	*14*	*5*	*3*	40	**1.7**
	Linetype	*4*	*9*	*10*	*12*	*6*	41	**2.2**
	Sviwelline	*3*	*2*	*12*	*11*	*10*	38	**2.6**
	Other	*1*	*1*	*2*	*1*	*1*	6	**2.0**
Jigging	Hooks	*3*	*3*	*10*	*1*	*7*	24	**2.3**
Group 4	Bait	*7*	*5*	*4*	*7*	*1*	24	**1.6**
	Nylon	*1*	*2*	*7*	*6*	*8*	24	**2.8**
	Noise	*0*	*0*	*0*	*1*	*25*	26	**4.0**
	Other	*0*	*0*	*1*	*0*	*3*	4	**3.5**
Jigging	Hooks	*2*	*3*	*9*	*6*	*6*	26	**2.4**
Group 5	Bait	*5*	*4*	*10*	*5*	*3*	27	**1.9**
	Nylon	*3*	*4*	*11*	*1*	*7*	26	**2.2**
	Noise	*1*	*1*	*3*	*5*	*17*	27	**3.3**
	Other	*0*	*0*	*2*	*1*	*3*	6	**3.2**
Gill-net	Netmaterial	*0*	*0*	*1*	*2*	*2*	5	**3.2**
	Mesh size	*0*	*0*	*0*	*3*	*2*	5	**3.4**
	Net type	*0*	*0*	*0*	*0*	*4*	4	**4.0**
	Hanging ratio	*0*	*0*	*2*	*1*	*3*	6	**3.2**
	Other	*0*	*0*	*0*	*0*	*3*	3	**4.0**
Pelagic trawl	Trawl type	*3*	*1*	*1*	*1*	*1*	7	**1.4**
	Height	*0*	*1*	*0*	*4*	*2*	7	**3.0**
	Width	*0*	*1*	*0*	*4*	*2*	7	**3.0**
	Mesh size cod-end	*0*	*0*	*1*	*3*	*2*	6	**3.2**
	Mesh size trawl	*0*	*2*	*2*	*2*	*1*	7	**2.3**
	Tow speed	*0*	*1*	*1*	*4*	*1*	7	**2.7**
	Otter boards	*0*	*0*	*2*	*3*	*2*	7	**3.0**
	Other	*0*	*0*	*2*	*1*	*2*	5	**3.0**
Purse seine	Depth	*0*	*0*	*1*	*2*	*1*	4	**3.0**
	Length	*0*	*0*	*2*	*1*	*1*	4	**2.8**
	Mesh size	*0*	*2*	*0*	*0*	*2*	4	**2.5**
	Sonar	*0*	*0*	*0*	*0*	*4*	4	**4.0**
	Shape	*0*	*0*	*0*	*3*	*1*	4	**3.3**
	Other	*0*	*0*	*1*	*0*	*1*	2	**3.0**

2.4 In your opinion, if there is anything missing or anything you would like to explain, please write it below.

85 had comments
83 had no comments

3. Anthropogenic effects.

3.1 *On the attached map, please draw the areas where at present deep-water corals are found in concentrations that prevent fishery.*
In your opinion, have these areas changed over time? If yes, could you also draw the previous location and indicate how many years ago this change took place.

The following answers are from the questionnaire. Some skippers made comments on the attached map.

Drawn areas

	Yes	No
Single trawlers	12	1
Pair trawlers	28	2
Long line Group 3	14	3
Group 4	34	22
Group 5	22	20
Gill-net	5	0

Have these areas changed

	Yes	No	Don't know
Single trawlers	4	0	0
Pair trawlers	9	4	3
Long line Group 3	5	0	2
Group 4	17	0	7
Group 5	6	0	10
Gill-net	0	0	0

3.2 *On the attached map, please draw the areas where at present deep-water sponges are found in concentrations that prevent fishery.*
In your opinion, have these areas changed over time? If yes, could you also draw the previous location and indicate how many years ago this change took place.

Drawn areas

	Yes	No
Single trawlers	12	1
Pair trawlers	30	0
Long line Group 3	5	11
Group 4	15	40
Group 5	7	35
Gill-net	4	2

Have these areas changed

	Yes	No	Don't know
Single trawlers	4	2	1
Pair trawlers	17	3	3
Long line Group 3	2	0	1
Group 4	4	0	2
Group 5	3	0	3
Gill-net	1	0	0

3.3 *On the attached map, please draw the areas where there is difficult or unsuitable seabed.*
In your opinion, have these areas changed over time? If yes, could you also draw the previous location and indicate how many years ago this change took place.

Drawn areas

	Yes	No
Single trawlers	7	6
Pair trawlers	0	30
Long line Group 3	16	1
Group 4	41	15
Group 5	34	8
Gill-net	5	1

Have these areas changed

	Yes	No	Don't know
Single trawlers	0	0	3
Pair trawlers	0	0	0
Long line Group 3	7	1	1
Group 4	7	2	8
Group 5	7	1	6
Gill-net	3	0	1

3.4 *On the attached map, please draw the areas where there are concentrations of worms. In your opinion, have these areas changed over time? If yes, could you also draw the previous location and indicate how many years ago this change took place.*

Drawn areas

	Yes	No
Single trawlers	6	7
Pair trawlers	0	30
Long line Group 3	16	1
Group 4	42	14
Group 5	37	5
Gill-net	6	0

Have these areas changed

	Yes	No	Don't know
Single trawlers	0	0	3
Pair trawlers	0	0	0
Long line Group 3	1	0	0
Group 4	9	1	3
Group 5	13	2	0
Gill-net	0	0	0

3.5 *Have the fishing areas changed over time.*
Yes/No **105/58**

If yes, how much: a little (1) – some (2) – considerable (3) – very much (4)
Please comment whether this has had a positive or negative influence.

	No	**Yes**		**Yes - positive**					**Yes - negative**			
				1	**2**	**3**	**4**		**1**	**2**	**3**	**4**
Single trawlers	6	7		0	1	4	1		0	0	1	2
Pair trawlers	0	30		5	9	3	4		1	4	2	2
Long line Group 3	7	11		3	2	1	1		3	3	0	0
Group 4	21	35		2	16	4	1		1	10	4	3
Group 5	22	20		3	4	3	2		0	6	1	2
Gill-net	4	2		0	1	0	0		0	1	0	0

If yes, is this due to:	**Answers:**	**Avg.**
a. *Better knowledge of the area.*		1.9
b. *The vessels are bigger and better.*		1.6
c. *Better gear (e.g. rock hoppers).*		2.5
d. *Better navigational instrumentation.*		2.5
e. *Reduced areas with corals.*		0.6
f. *Reduced areas with deep water sponges.*		0.8
g. *Closed areas.*		2.6
h. *Other reasons (please specify).*		0.6

If the changes can be attributed to two or more of the above causes, please grade them by significance using a scale 0 - 4. (0 = no effect; 4 = very high effect).
If you think it is necessary, please make a comment.

3.6 *Could you draw on the attached map the fishing areas today and in the past?*

Yes/ No **134/34**

3.7 *Has the seabed changed due to ground friction by bottom trawling compared to the past?*

Yes/No/ Don't know **107/43/14**

	Yes	No	Don´t know	**Total**
Group 1	12	1	0	**13**
Group 2	19	11	1	**31**
Group 3	15	2	0	**17**
Group 4	33	18	5	**56**
Group 5	24	9	8	**41**
Gill-net	4	2	0	**6**
Total	**107**	**43**	**14**	**164**

3.8 *Are there other types of gear which change the seabed?*

Yes/No/ Don't know **53/94/11**

	Yes	No	Don´t know	**Total**
Group 1	6	4	1	**11**
Group 2	8	20	1	**29**
Group 3	7	8	1	**16**
Group 4	19	34	2	**55**
Group 5	12	25	4	**41**
Gill-net	1	3	2	**6**
Total	**53**	**94**	**11**	**158**

If yes, could you please explain this.

24 answered: Dredging for scallops. Dredging for scallops is like actively trawling.
19 answered: Gill-net. Dead fish fall from the nets down onto the bottom. These fish make an abnormal putrefaction on the bottom.
1 answered other reasons.
3 had no comments

3.9 *Have you observed any differences in the behaviour of fish at present compared to previously?*

Yes/No/ Don't know **91/61/11**

	Yes	No	Don´t know	**Total**
Group 1	8	4	1	**13**
Group 2	13	15	2	**30**
Group 3	12	4	1	**17**
Group 4	32	20	4	**56**
Group 5	21	17	3	**41**
Gill-net	5	1	0	**6**
Total	**91**	**61**	**11**	**163**

If yes, can you explain how.

Answers:
31 answered: Different distribution pattern.
10 answered: The fish show more avoidance reactions.
15 answered: Always different from year to year.
5 answered: Other reasons.

6 had no comments

3.10 *How does different gear affect the seabed. Could you grade the affect using a scale between 0 and 4. (0 = no effect; 4 = very high effect) Please make a comment, if necessary.*

Question

	Sand bottom	**Hard bottom**	**Mud bottom**	**Sponges**	**Deep sea corals**	**Notes**
Singel trawl						
Longline						
Jigging						
Gill-net						
Pair trawl						

Answers

Single trawl

	0	1	2	3	4	Total
Sand bottom	53	7	11	10	6	87
Hard bottom	35	9	18	19	8	89
Mud bottom	49	9	15	6	4	83
Sponges	9	7	13	18	29	76
Deep sea corals	2	2	12	19	51	86

Longline

	0	1	2	3	4	Total
Sand bottom	103	0	0	0	0	103
Hard bottom	101	1	0	0	0	102
Mud bottom	101	1	0	0	0	102
Sponges	88	3	0	0	0	91
Deep sea corals	88	2	1	0	0	91

Jigging

	0	1	2	3	4	Total
Sand bottom	92	0	0	0	0	92
Hard bottom	91	0	0	0	0	91
Mud bottom	90	0	0	0	0	90
Sponges	81	0	0	0	0	81
Deep sea corals	81	0	0	0	0	81

Gill-net

	0	1	2	3	4	Total
Sand bottom	50	1	1	3	0	55
Hard bottom	48	4	2	2	0	56
Mud bottom	49	2	2	3	0	56
Sponges	47	1	2	2	0	52
Deep sea corals	45	3	2	2	1	53

Pair trawl

	0	1	2	3	4	Total
Sand bottom	47	4	10	6	4	71
Hard bottom	39	6	13	5	6	69
Mud bottom	46	5	9	4	5	69
Sponges	10	7	12	16	25	70
Deep sea corals	4	3	13	18	39	77

3.9.1 *Do you observe lost fishing gear, such as longline, trawl, and gill-nets, on the seabed?*

Yes/No **153/11**

If yes, is this:

a. *A common experience or only a very rare incident?*

b. *What type of fishing gear do you observe?*

c. *Have you observed any newly caught fish in such nets?*

Answers:

	3,11			3.11a (if yes)	
	Yes	No	Total	Common	Rare incident
Group 1	11	2	13	5	6
Group 2	30	0	30	2	23
Group 3	17	0	17	11	6
Group 4	52	4	56	22	27
Group 5	39	3	42	14	25
Gill-net	4	2	6	1	3
Total	**153**	**11**	**164**	**55**	**90**

	3.11b (if yes)			3.11c (if yes)	
	Trawl	Longline	Gill-net	Yes	No
Group 1	7	8	7	6	5
Group 2	17	27	10	1	29
Group 3	11	17	5	1	16
Group 4	8	45	14	3	46
Group 5	6	37	1	0	38
Gill-net	2	4	1	0	4
Total	**51**	**138**	**38**	**11**	**138**

Please, could you elaborate a little.
Lost gillnets: New and old gill-nets.
Lost trawl: Whole trawls, part of trawls, or only net from trawls.

3.12 *Have you observed debris on the bottom from fishing and other marine activities, for instance, old wire, barrels, fishing gear (longlines, gill-nets, trawls, etc.)?*

Yes/No **119/45**

If yes, how much: a little (1) – considerable (2) – much (3) – very much (4)?

	3,12			3.12 (if yes how much)			
	Yes	No	Total	1	2	3	4
Group 1	10	3	13	3	4	1	0
Group 2	25	5	30	20	2	2	1
Group 3	15	2	17	10	5	0	0
Group 4	36	20	56	23	9	2	1
Group 5	28	14	42	10	12	3	3
Gill-net	5	1	6	3	2	0	0
Total	**119**	**45**	**164**	**70**	**36**	**11**	**9**

3.13 *From satellite tagging of seals, it is known that a high number of these animals on a regular basis migrate into the Faroese area. Have you experienced bycatches of seals and marine mammals? If yes, is this a common feature, and if so can you indicate which species?*

	Yes	No	Total
Group 1	8	5	13
Group 2	10	20	30
Group 3	15	2	17
Group 4	26	30	56
Group 5	15	27	42
Gill-net	5	1	6
Total	**79**	**85**	**164**

This is not a common feature except in longline fishery for salmon north of the Faroes.
The species are Harp Seal and Grey Seal.
The seals are caught very widely in the Faroese area.

3.14 *Is there anything else you would like to add? Please write it below.*

60 had some comments.
108 had no comments.

4. Innovation

4.1 *In any fishery, it is an ongoing process to make changes in the gear and the handling of the gear with the aim to improve fishing efficiency. Fish-finding equipment and other electronic equipment are also continuously improved. In the table below, could you please list some of the more recent innovations by main gear type and indicate when these innovations were introduced on the vessels you were on and to what extent they improved the efficiency (%).*

Gear	***Innovation***	***Year***	***Improvement %***

Answers:

Larger single trawlers (Group 1)

Innovation	Answered *	Year	Impr. %	Avg. Impr. %	Comments
Trawl sonde	12 (8)	89 - 92	0 - 50	18	
Scanmar	9 (6)	81 - 91	0 - 50	13	
Rock hopper	12 (7)	89 – 92	0 - 50	36	
Doors sensors	1 (1)	99	5	5	
Doors	1 (0)	99			
Double trawl**	2 (2)	94 - 95	50 - 100	50	

* The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give a percentage. The reason is that the fishery is affected by too many factors.

**Double trawl is not used in the Faroese area. Double trawl is used in the shrimp fishery.

Pair trawlers (Group 2)

Innovation	Answered *	Year	Imp. %	Avg. Impr. %	Comments
Trawl sonde	13 (6)	92 – 98	0 - 40	14	
Scanmar	16 (6)	85 - 94	10 - 40	23	
Rock hopper	31 (14)	90 - 95	1 - 50	15	
Double trawl	2 (2)	98	50-90	70	Used for 2 months
Better trawls	2 (1)	97	10	10	
Kitler chain	1 (0)				
Symmetry sensor	2 (1)	96	10	10	
Others	5 (1)	97	10	10	

* The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give a percentage. The reason is that the fishery is affected by too many factors.

Smaller single trawlers (Group 4)

Innovation	Answered *	Year	Impr. %	Avg. Impr. %	Comments
Trawl sonde	2 (1)	89 - 97	0	0	
Rock hopper	10 (6)	88 - 98	10 - 40	23	
Kitler chain	1 (1)	92	100	100	For monkfish
GPS	1 (0)				Nav. instrument
Trawl doors	1 (0)				

* The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give a percentage. The reason is that the fishery is affected by too many factors.

Larger longline vessels (Group 3)

Innovation	Answered *	Year	Impr. %	Avg. Impr. %	Comments
Automatic baiter	18 (9)	78 - 93	0 - 30	16	Per vessel
Skewed hooks	17 (14)	90 - 96	5 - 50	21	
Stability tanks	10 (5)	91 - 99	5 - 30	13	
Swivel line	17 (14)	92 - 96	10 - 50	34	Better for e.g. haddock
Snood line	5 (3)	92 - 96	10 - 20	13	
Line tec	3 (0)	97 - 99			
Others	1 (0)	91			

* The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give a percentage. The reason is that the fishery is affected by too many factors.

Smaller longline vessels (Group 4)

Innovation	Answered *	Year	Impr. %	Avg. Impr. %	Comments
Automatic baiter	6 (0)	96 - 98			Per vessel
Skewed hooks	23 (15)	93 - 98	3 - 40	17	Better for e.g. haddock
Swivel line	29 (23)	10 - 50	10 - 50	28	
Snood line	7 (3)	98 - 99	0 - 10	3	
Others	2 (0)	90			

* The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give percentages. The reason is that the fishery is affected by too many factors.

Smaller longline vessels (Group 5)

Innovation	Answered *	Year	Impr. %	Avg. Impr. %	Comments
Automatic baiter	7(4)	90 - 99	0 - 50	22	Per vessel
Skewed hooks	19 (15)	87 - 99	0 - 50	16	
Swivel line	32 (26)	94 - 99	0 - 50	19	
Snood line	6 (2)	89 - 96	0 - 5	3	
Others	5 (0)	97			

* The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give percentages. The reason is that the fishery is affected by too many factors.

Jigging vessels (Group 4)

Innovation	Answered *	Year	Impr. %	Avg. Impr. %	Comments
Automatic Jiggers	17 (11)	82 - 88	0 - 50	35	
Electric Jiggers	2 (2)	96 - 97	40	40	
Skewed hooks	9 (4)	94 -96	10 - 15	12	
Nav. equipment	1 (0)				GPS and plotter
Others	1 (1)	97	20	20	

* The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give percentages. The reason is that the fishery is affected by too many factors.

Jigging vessels (Group 5)

Innovation	Answered *	Year	Impr. %	Avg. Impr. %	Comments
Aut. Jiggers	20 (11)	87 - 98	0 – 50	33	
Electric Jiggers	5 (4)	95 – 97	20 - 50	38	
Skewed hooks	10 (5)	92 - 95	10 - 50	18	

* The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give percentages. The reason is that the fishery is affected by too many factors.

Gill-net vessels

Innovation	Answered *	Year	Impr. %	Avg. Impr. %	Comments
Smaller meshes	1 (0)				
Floating line	1 (1)	97	20	20	For monkfish
New gear	1 (1)		100	100	same type

*The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give percentages. The reason is that the fishery is affected by too many factors.

Pelagic trawlers

Innovation	Answered *	Year	Impr. %	Avg. Impr. %	Comments
Lighter material	2 (1)		20	20	
Bigger trawl	2 (2)	70 – 99	35 - 100	68	
Bigger engine	2 (2)	77 - 99	100 - 150	125	
Trawl sonde	1 (0)	89			

* The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give percentages. The reason is that the fishery is affected by too many factors.

Purse seine vessels

Innovation	Answered *	Year	Impr. %	Avg. Impr. %	Comments
Better asdic	3 (1)	87 – 99	5	5	
Bigger seine	3 (1)	- 99	100	100	
Bigger meshes	1 (1)	93	10	10	
Others	1 (0)				

* The numbers in brackets indicate the number of answers indicating improvement in %. Some of the skippers say that it is impossible to give percentages. The reason is that the fishery is affected by too many factors.

4.2 *Have there been any changes in the planning of the fishery since the fishing-day regulation was introduced, e.g., planning the trips differently, using more longline, more concern about weather conditions, etc?*

Yes/No **98/45**

Please, could you elaborate a little.

Group 1.
Group 1 is not regulated by fishing days, but by a quota system.

Group 2. Yes/no **27/2**
The "yes" answers specified:

23 answered: In bad weather, they do not wait for better weather at sea, but return to the harbour to land the catch in order to save fishing days.
16 answered: Do not have any dead time at sea.
3 answered: Buy fishing days from others.
6 answered: Try to do some trips in the outer fishing areas, which yields 3 days of fishing for 1 "fishing day".

The two respondents who answered "no" stated that they buy days if they have problems.

Group 3. Yes/no **15/1**
The "yes" answers specified:
11 answered: Do not fish in bad current conditions.
11 answered: In bad weather, they do not wait for better weather at sea, but return to the harbour to land the catch in order to save fishing days.
2 answered: Fish in worse weather than previously.
15 answered: Do not have any dead time at sea.
1 answered: Save days. They have gone from 295 fishing days down to 240 fishing days.

Group 4. Trawl. Yes/no **12/0**
The "yes" answers specified:
1 answered: Fish in worse weather than previously.
8 answered: Do not have any dead time at sea.
2 answered: Only start a trip if the weather forecast is favourable for more than two days.
8 answered: Are aware of trying to use their fishing days optimally.

Group 4. Longline and jigging. Yes/no **33/11**
The "yes" answers specified:
26 answered: Are aware of trying to use their fishing days optimally.
19 answered: Use more longline.
21 answered: Are more aware of weather and current conditions.
19 answered: Try not to have any dead time at sea.
1 answered: Buy and sell fishing days.
33 answered: Are generally more aware of the fishing days.

Of the 11 "no" answers, many are skippers on jigging vessels. The jigging vessels get two days at sea for one "fishing day"

Group 5. Longline and jigging. Yes/no **11/31**
The "yes" answers specified:
2 answered: Are more aware of weather and current conditions.
8 answered: Do not have any dead time at sea.
6 answered: Use more longline
6 answered: Save fishing days.

4.5 *If there is something else you would like to add, or if some of the questions need a comment, please write it below.*

46 had comments and 122 had no comments.

6. Other questions.

Below are some questions that are not related to seismic, innovation, or fishing gear.

6.1 *If you have any questions related to the fishery, environment, or anything similar, where do you get your information from?*

Answers:

From other fishermen:	135
The Fisheries Laboratory:	20
From the Internet:	6
From the inspection service:	20
Do not ask anyone:	11
Others:	34

6.2 *What could be done to improve the communication between the Fisheries Laboratory and the fishing industry?*

Answers:

More information:	46
Go out more to work and talk to fishermen:	31
Better dialog:	41
Do more work with the aim of finding new fishing areas:	3
Better and bigger research vessel:	2
Don’t know:	37
Communication is good enough:	18

Seismic activity and fisheries

In order to understand how seismic shooting affects the behaviour of fish and the fisheries, we would like you to answer the following questions as precisely as possible.

Group 1. The larger single boat trawlers

Number of respondents: 13

1. *Have you experienced seismic shooting in the same area as you were fishing at the time?* Yes/no **12/1**

   If Yes:

   A: When. Please give the date/dates as precisely as possible

   B: Where. Please give the area/areas fished as exactly as possible
   No information: 1
   North Sea: 2 (these were discounted in the further analysis)
   East and south of the Faroes: 9

   C: What gear were you using? **Bottomtrawl**

   D. What species were you targeting? **redfish, Greenland halibut, saithe, cod, haddock.**

2. *Did the seismic activity affect your fishing success?* Yes/no **7/3**

   If yes:

   A. Did your catch rate increase or decrease? Please quantify the changes.
   The catch rate reduction > 50%: 3
   Catch rate reduced, no percentage: 2
   Don't know: 2

   B. When did you observe the reaction from the seismic activity on your catch rates?
   Don't know: 1

   i. At some distance from your fishing position. If so, how far away?
   A gradual reduction as the vessel approached: 1

   ii. When the seismic vessel was within a short distance from your fishing position.
   Close to or at the trawling position: 2
   Before the vessel arrived, as they had to leave the area: 1

   iii. At some distance after the vessel had passed your fishing position. If so, how far?

If you answered "yes" to the first questions, please answer the next questions.

3. *After the seismic shooting, how long was the fishery in a non-normal state?*

   Please could you elaborate a little.
   Don't know: 3
   Don't know because you leave the area: 1
   Difficult to say, but for a few days: 2
   Same fishery after a week: 1

4. *Apart from the altered catch rates, did you observe any changes in the behaviour of the fish?*
   Yes/no/don't know **1/5/4**

   If yes, could you please describe the changes.
   The fish migrated up into the water column and dispersed.

5. *Have you observed any differences in the behaviour among the fish specie?*
   Yes/no/don't know **1/2/7**

   If yes, could you please describe the differences.
   Cod, haddock, and saithe are mostly affected

6. *Are there any differences in effect by geographical area?*
   Yes/no/don't know **1/3/6**

   If yes, could you please describe these.
   Largest effects in shallow waters

7. *Are there any seasonal differences?*
   Yes/no/don't know **2/1/7**

   If yes, could you please describe these.
   The question is not answerable as the SA is only in the summer.

8. *Are there any differences with depth?*
   Yes/no/don't know **1/3/6**

   If yes, could you please describe these.
   Largest effects in shallower waters

9. *Are there any differences in response related to the weather conditions?*
   Yes/no/don't know **0/2/8**

   If yes, could you please describe these.

10. *Are there any differences related to the light condition?*
Yes/no/don't now **0/3/7**

If yes, could you please describe these.

11. *Is there any difference in the effect of seismic shooting among the different fishing gears?*
Yes/no/don't know **0/3/7**

If yes, could you please describe this.

12. *For further seismic activity, what time of year is most favourable?*

Don't know: 3
No preference: 2
April-June- A period with reduced fishery anyway: 2
Not during the summer on the Suðuroy Banks: 1
Not during the spawning period: 1
During the summer: 1

Seismic activity and fisheries

In order to understand how seismic shooting affects the behaviour of fish and the fisheries, we would like you to answer the following questions as precisely as possible.

Group 2. Pair trawlers

Number of respondents: 30

1. *Have you experienced seismic shooting in the same area as you were fishing at the time?*
   Yes/no **27/3**

   If yes:

   A: When? Please give the date/dates as precisely as possible
   Can not recall the time of the year: 1
   No answer - don't know: 2
   During the summer (May-July): 24

   B: Where? Please give the area/areas fished as exactly as possible
   27 responses -
   East of the Faroes - Munkagrunnin - to the west of Suðuroy

   C: What gear were you using?
   Pair trawl: 24
   Single trawl: 2
   Semi-pelagic trawl: 1

   D. What species were you targeting?
   Saithe: 21
   Saithe + Greater silver smelt: 1
   Greater silver smelt: 1
   Saithe + Cod: 3
   Cod + Angler fish: 1

2. *Did the seismic activity affect your fishing success?*
   Yes/no **26/1**

   If yes:

   A. Did your catch rate increase or decrease? Please quantify the changes.
   Saithe - 23 responses
   The catch rate was very much reduced: 13
   Reduced catch rates: 6
   Don't know - mainly because the fishery was poor in the first place: 4
   Cod - 7 responses
   The catch rate was reduced by 10%: 1
   Same fishery: 2
   Increased catch rates: 3
   Don't know: 1

One skipper argued that the cod were herded out of the areas closed for fisheries with trawl and thus increased the availability of cod outside these areas. The same skipper was of the opinion that the cod fled dangers by swimming horisontally, whereas the saithe fled vertically, i.e. up into the water column

Greater silver smelt - 1 response
No effect

.

B. When did you observe the reaction from the seismic activity on your catch rates?

1. At some distance from your fishing position. If so, how far away?
   1 - 10 nm: 14
   Very long distance: 4

2. When the seismic vessel was within a short distance from your fishing position: **3**

3. At some distance after the vessel had passed your fishing position? If so, how far?
   When the seismic vessel had passed: 3
   Somewhat later: 2
   The next day: 1

If you have answered "yes" to the first questions, please answer the next questions.

3. *How long after the seismic shooting was the fishery in a non-normal state.*

2 - 3 weeks, however, on the Suðuroy Banks up to 3 months: 1
Don't know: 13
1 - 7 days; 7
7 - 21 days: 2*
Some considerable time: 2

* One said 24 hours during which the fish concentrations were good, otherwise 7-14 days.

Please could you elaborate a little.

4. *Apart from the altered catch rates, did you observe any changes in the behaviour of the fish?* Yes/no/don't know **3/20/3**

If yes, could you please describe the changes.

The saithe became more wild and difficult to catch: 1
The cod migrated to deeper water, the saithe up into the water column: 2
The haddock dispersed into the water column: 1

5. *Have you observed any differences in the behaviour among the fish species?*
   Yes/no/don't know **13/6/7**

   If yes, could you please describe the differences.
   Saithe were more affected than cod
   Cod seek the bottom, and may therefore be more available for trawling
   Two repondents observed that haddock behave the same way as cod

6. *Are there any differences in effect by geographical area?*
   Yes/no/don't know **3/12/11**

   If yes, could you please describe these.
   Mainly in shallower waters: 1
   Mainly east of the Islands: 1
   Mostly on the Suðuroy Banks, where most SA is: 1

7. *Are there any seasonal differences?*
   Yes/no/Don't know **1/1/24**

   If yes, could you please describe these.
   May - September

8. *Are there any differences by depth?*
   Yes/no/don't know **3/5/18**

   If yes, could you please describe these.
   Mostly in shallow water

9. *Are there any differences in response related to the weather conditions?*
   Yes/no/don't know **1/2/23**

   If yes, could you please describe these.
   Most effect in very calm weather

10. *Are there any differences related to the light conditions?*
    Yes/no/don't know **0/32/23**

    If yes, could you please describe these.

11. *Is there any difference in the effect of seismic shooting among the different fishing gears?*
    Yes/no/don't know **1/3/22**

    If yes, could you please describe this.
    Probably most jigging fishery

12. *For further seismic activity, what time of year is most favourable?*

23 answers. No definite trend; all seasons mentioned.

13. *Regarding seismic activities in fishing areas, we will use the logbooks in our work. Because of this, we would like to ask you these questions.*

a) Is it easy or difficult to record data in the logbook?
b) Is it possible to be accurate when you keep the logbook?

14. *If you have any further observations, please write them below.*

A list of comments can be made available, if necessary.

Seismic activity and fisheries
In order to understand how seismic shooting affects the behaviour of fish and the fisheries, we would like you to answer the following questions as precisely as possible.

Group 3. Longliners

Number of respondents: 17

1. *Have you experienced SA in the same area as you were fishing at the time?*
   Yes/no **10/7**

   If Yes:

   A: When? Please give the date/dates as precisely as possible
   June - July - August: 6
   Can not recall: 1
   1995 - 1999: 1
   1997: 1
   1995 - May 1996: 1

   B: Where? Please give the area/areas fished as exactly as possible
   To the east of the Islands - East and west of Munkagrinninum - South of the Faroe Bank

   C: What gear were you using?
   Longline

   D. What species were you targeting?
   Ling and Tusk: 9
   Ling and Cod: 1

2. *Did the seismic activity affect your fishing success?*
   Yes/no/don't know **2/3/5**

   If yes:

   A. Did your catch rate increase or decrease? Please quantify the changes.
   Tusk and ling disappeared: 1
   For four days had 8,000 kg/day, then reduction
   Day one 50% reduction
   Day two 75% reduction
   Day three 100 % reduction

   B. When did you observe the reaction from the SA on your catch rates?
   1. At some distance from your fishing position. If so, how far away?
      Ca. 5 nm: 1
      The fish disappeared in a wide area.
   2. When the seismic vessel was within a short distance from your fishing position.
   3. At some distance, after the vessel had passed your fishing position. If so, how far?

If you have answered "yes" to the first questions, please answer the next questions.

3. *How long after the seismic shooting was the fishery in a non-normal state?*

   Please could you elaborate a little.
   The fishery was affected for at least 2 months

4. *Apart from the altered catch rate, did you observe any changes in the behaviour of the fish?*
   Yes/no/don't know **1/3/3**

   If yes, could you please describe the changes.
   The fish disappeared

5. *Have you observed any differences in the behaviour among the fish species?*
   Yes/no/don't know **0/3/4**

   If yes, could you please describe the differences.

6. *Are there any differences in effect by geographical areas?*
   Yes/no/don't know **1/2/4**

   If yes, could you please describe these.
   The fishery was less affected close to the Plateau

7. *Are there any seasonal differences?*
   Yes/no/don't know **0/2/5**

   If yes, could you please describe these.

8. *Are there any differences with depth?*
   Yes/no/don't know **0/2/5**

   If yes, could you please describe these.

9. *Are there any differences in response related to the weather conditions?*
   Yes/no/don't know **0/2/5**

   If yes, could you please describe these.

10. *Are there any differences related to the light conditions?*
    Yes/no/don't know **0/2/5**

    If yes, could you please describe these.

11. *Is there any difference in the effect of seismic shooting among the different fishing gears?*
Yes/no/don't know **0/3/4**

If yes, could you please describe this.

12. *For further seismic activity, what time of year is most favourable?*

Don't know: 2
During the winter: 2
During the summer: 2
For longline, it is most favourable to have the SA in deeper water during the winter and in shallower depths during the summer: 1

13. *Regarding seismic activities in fishing areas, we will use the logbooks in our work. Because of this, we would like to ask you these questions.*

a) Is is easy or difficult to maintain or record data in the logbook?
b) Is it possible to be accurate when you keep the logbook?

14. *If you have any further observations, please write them below.*

The comments can be made available, if necessary.

Seismic activity and fisheries

In order to understand how seismic shooting affects the behaviour of fish and the fisheries, we would like you to answer the following questions as precisely as possible.

Group 4A. Larger coastal fishing vessels

Number of respondents: 22

1. *Have you experienced SA in the same area as you were fishing at the time?*
   Yes/no **9/13**

   If yes:

   A: When? Please give the date/dates as precisely as possible.
   - **During the summer in 1994 or 1995: 2**
   - **Ca. 1996 - 1997: 1**
   - **1997: 1**
   - **September 1997: 1**
   - **Every year, except the last two: 1**
   - **June - July - August 1996 - 1998: 1**
   - **Latter half of the summer: 1**
   - **Summer 1997: 1**

   B: Where? Please give the area/areas fished as exactly as possible
   - **All areas around the Islands**

   C: What gear were you using?
   - **Jigging: 4**
   - **Longline: 4**
   - **Halibut longline: 1**

   D: What species were you targeting?

   Jiggers
   - **Saithe: 2**
   - **Cod and saithe: 1**
   - **Cod: 1**

   Longline
   - **Tusk and ling: 2**
   - **Tusk, cod, and haddock: 1**
   - **Cod and haddock: 1**
   - **Halibut: 1**

2. *Did the seismic activity affect your fishing success?*
   Yes/no **7/2**

   No
   Longlining for halibut: 1
   Longlining for cod and haddock: 1

If yes:

A. Did your catch rate increase or decrease? Please quantify the changes.
Longlining for tusk and ling: 2 (The catch rate was 100% reduced.)
Longlining for cod, haddock, and tusk: 1 (The catch rate was reduced 50%.)
Jigging for cod and saithe: 1 (The catch rate was very much reduced.)
Jigging for cod: 1 (The catch rate was reduced.)
Jigging for saithe: 1 (The catch rate was very much reduced, especially for saithe.)

B. When did you observe the reaction from the seismic activity on your catch rates? **Don't know: 1**

1. At some distance from your fishing position. If so, how far away?
   8 - 10 nm: 2
   20 - 30 nm: 2

2. When the seismic vessel was within a short distance from your fishing position.

3. At some distance after the vessel had passed your fishing position. If so, how far?

If you have answered "yes" to the first questions, please answer the next questions.

3. *How long after the seismic shooting was the fishery in a non-normal state?*

Please could you elaborate a little.

Don't know:	**3**
The rest of the year:	**1**
Two weeks:	**2**
Several weeks:	**1**

4. *Apart from the altered catch rate, did you observe any changes in the behaviour of the fish?*
Yes/no/don't know **0/5/2**

If yes, could you please describe the changes.

5. *Have you observed any differences in the behaviour among the fish species?*
Yes/no/Don't know **2/2/3**

If yes, could you please describe the differences.

Think tusk is least affected:	**1**
Saithe is more affected than cod:	**1**

6. *Are there any differences in effect by geographical area?*
Yes/no/Don't know **1/3/3**

If yes, could you please describe these.
Jigging fishery is more affected by SA when the bottom substrate is hard

7. *Are there any seasonal differences?*
Yes/no/Don't know **1/0/6**

If yes, could you please describe these.
When there is SA

8. *Are there any differences by depth?*
Yes/no/Don't know **0/3/4**

If yes, could you please describe these.

9. *Are there any differences in response related to the weather conditions?*
Yes/no/Don't know **0/1/6**

If yes, could you please describe these.

10. *Are there any differences related to the light conditions?*
Yes/no/Don't know **0/1/6**

If yes, could you please describe these.

11. *Is there any difference in the effect of seismic shooting among the different fishing gears?*
Yes/no/Don't know **0/2/5**

If yes, could you please describe this.

12. *For further seismic activity, what time of year is most favourable?*
Don't know: 2
Summer: 3
Not during the spring and autumn: 1
Not in the Spring

13. *Regarding seismic activities in fishing areas, we will use the logbooks in our work. Because of this, we would like to ask you these questions.*

a) Is is easy or difficult to maintain or record data in the logbook?.
b) Is it possible to be accurate when you keep the logbook?

14. *If you have any further observations, please write them below.*

Seismic activity and fisheries

In order to understand how seismic shooting affects the behaviour of fish and the fisheries, we would like you to answer the following questions as precisely as possible.

Group 4B. Larger coastal vessels

Number of respondents: 34

1. *Have you experienced SA in the same area as you were fishing at the time?*
   Yes/no **16/18**

Of those that answered "yes", ten were jigging vessels and six were trawlers. These two groups are dealt with separately below.

2. *Regarding seismic activities in fishing areas, we will use the logbooks in our work. Because of this, we would like to ask you these questions.*

   a) Is it easy or difficult to maintain or record data in the logbook?.
   b) Is it possible to be accurate when you keep the logbook?

3. *If you have any further observations, please write them below.*

Jigging vessels (10)

I. *Have you experienced SA in the same area as you were fishing at the time?*

If yes:

A: When? Please give the date/dates as precisely as possible

Ca. 1994 - 1995:	**2**
August 1995:	**2**
1996 - 1997:	**1**
Summer 1996:	**2**
August - September 1997:	**1**
August 1998:	**1**
Can not recall:	**1**

B: Where? Please give the area/areas fished as exactly as possible

To the west of the Islands: 5
Munkagrunnurin + Faroe Bank: 1

Munkagrunnurin:	**1**
Sandoy Bank:	**1**
To the east of the Islands:	**1**

$60^0$30 N - $6^0$18 W + Faroe Bank and west of Suðuroy

C: What gear were you using? **Jigging (10)**

D. What species were you targeting?

Cod:	**6**
Saithe:	**1**

II. *Did the seismic activity affect your fishing success?* Yes/no **10/0**

If yes:

A. Did your catch rate increase or decrease? Please quantify the changes.

The catch rate of cod was reduced 100%:	**5**
No difference to the catch rate of cod:	**1**
The catch rate of saithe was reduced 200%:	**5**

B. When did you observe the reaction from the SA on your catch rates?

1. At some distance from your fishing position. If so, how far away?

Don't know:	**3**
8 - 10 nm:	**4**
1 - 4 nm:	**3**

1. When the seismic vessel was within a short distance from your fishing position.

2. At some distance after the vessel had passed your fishing position. If so how far.

If you have answered "yes" to the first questions, please answer the next questions.

III. *How long after the seismic shooting was the fishery in a non-normal state?*

Cod

One day:	**1**
Two days:	**2**
Several days:	**2**
Several months:	**1**

Saithe

Don't know:	**2**
Differed by place and time:	**1**
Several days:	**2**

Please could you elaborate a little.

IV. *Apart from the altered catch rate, did you observe any change in the behaviour of the fish.?*
Yes/no/Don't know **1/8/1**

If yes, could you please describe the changes.
The acoustic signals on the echo sounder disappeared

V. *Have you observed any differences in the behaviour among the fish species?*
Yes/no/Don't know **1/2/7**

If yes, could you please describe the differences.
Saithe is very much affected, cod not

VI. *Are there any differences in effect by geographical area?*
Yes/no/Don't know **0/2/8**

If yes, could you please describe these.

VII. *Are there any seasonal differences?*
Yes/no/Don't know **1/0/9**

If yes, could you please describe these.

VIII. *Are there any differences by depth?*
Yes/no/Don't know **0/0/10**

If yes, could you please describe these.

IX. *Are there any differences in response related to the weather conditions?*
Yes/no/Don't know **0/0/10**

If yes, could you please describe these.

X. *Are there any differences related to the light conditions?*
Yes/no/Don't know **1/0/9**

If yes, could you please describe these.

XI. *Is there any difference in the effect of seismic shooting among the different fishing gears?*
Yes/no/Don't Know **0/0/10**

If yes, could you please describe this.

XII. *For further seismic activity, what time of year is most favourable?*

Don't know:	**5**
Not before May 15th:	**1**
During the summer:	**2**
During the winter:	**2**

Trawlers (6)

I. *Have you experienced SA in the same area as you were fishing at the time?*

If yes:

A: When? Please give the date/dates as precisely as possible
B: Where? Please give the area/areas fished as exactly as possible
C: What gear were you using? **Trawl**
D. What species were you targeting?

2. *Did the seismic activity affect your fishing success?*
Yes/no **4/2**

If yes:

A. Did your catch rate increase or decrease? Please quantify the changes.

Cod and haddock - catch rates reduced 50%:	**1**
Cod - haddock - flatfish - catch rates reduced 30-40 %:	**1**
Cod - catch rates reduced 100%:	**1**
Flatfish - catch rates very much reduced:	**1**

B. When did you observe the reaction from the SA on your catch rates?

1. At some distance from your fishing position. If so, how far away?

Before 8 - 10 nm:	**2**
Before 4 nm:	**1**
At the position:	**1**

2. When the seismic vessel was within a short distance from your fishing position.

3. At some distance after the vessel had passed your fishing position. If so how far.

If you have answered "yes" to the first questions, please answer the next questions.

3. *How long after the seismic shooting was the fishery in a non-normal state?*

3 - 7 days:	**3**
Don't know:	**1**

Please could you elaborate a little.

4. *Apart from the altered catch rate, did you observe any changes in the behaviour of the fish?*
Yes/no **0/4**

If yes, could you please describe the changes.

5. *Have you observed any differences in the behaviour among the fish species?*
   Yes/no **0/4**

   If yes, could you please describe the differences.
   Flatfish are less affected compared to round fish

6. *Are there any differences in effect by geographical area?*
   Yes/no/don't know **1/1/2**

   If yes, could you please describe these.

7. *Are there any seasonal differences?*
   Yes/no/ Don't know **0/0/4**

   If yes, could you please describe these.

8. *Are there any differences by depth?*
   Yes/no/don't know **0/0/4**

   If yes, could you please describe these.

9. *Are there any differences in response related to the weather conditions?*
   Yes/no/don't know **0/0/4**

   If yes, could you please describe these.

10. *Are there any differences related to the light conditions?*
    Yes/no/don't know **0/1/3**

    If yes, could you please describe these.

11. *Is there any difference in the effect of seismic shooting among the different fishing gears?*
    Yes/no/don't know **0/0/4**

    If yes, could you please describe this.

12. *For further seismic activity, what time of year is most favourable?*

Not during the spawning time:	**1**
Don't know:	**1**
When no fish are in the area:	**1**
During the winter:	**1**

Seismic activity and fisheries

In order to understand how seismic shooting affects the behaviour of fish and the fisheries, we would like you to answer the following questions as precisely as possible.

<u>Group 5. Smaller coastal vessels < 15 GRT</u>

Number of respondents: 42

1. *Have you experienced seismic shooting in the same area as you were fishing at the time?*
   Yes/no **16/26**

   Of those that answered "yes", nine were jigging vessels, six were longliners, and one was a halibut longliner. One of the longlining vessels and the halibut longliner also experienced SA when jigging. The vessels that were jigging (11) and the longliners (6) are dealt with separately below.

2. *In relation to seismic activities in fishing areas, we will use the logbooks in our work. Because of this we would like to ask you these questions.*

   a) Is it easy or difficult to maintain or record data in the logbook?
   b) Is it possible to be accurate when you keep the logbook?

3. *If you have any further observations, please write them below.*

Jigging (11)

I. *Have you experienced seismic shooting in the same area as you were fishing at the time?*

If yes:

A: When? Please give the date/dates as precisely as possible

1995 or 1996:	**2**
Every summer, the last three years:	**3**
Summer 1996:	**1**
Summer 1997:	**1**
Summer 1994:	**1**
Summer, the first years:	**1**
Several times:	**1**
1997:	**1**

B: Where? Please give the area/areas fished as exactly as possible

No answer:	**1**
$62^0$02 N, $8^0$06 W (ca.):	**2**
East, west and south of Suðuroy:	**7**
To the west of Sandoy, $61^0$45 N, $7^0$15W:	**1**

C: What gear were you using?

Jigging

D. What species were you targeting?

Cod and saithe:	**4**
Cod, saithe, and haddock:	**1**
Cod and haddock:	**1**
Cod:	**5**

II. *Did the seismic activity affect your fishing success?*

Yes/no **11/0**

If yes:

A. Did your catch rate increase or decrease? Please quantify the changes.

Catch rates reduced 80-100%:	**8**
Catch rates very much reduced:	**1**
Catch rates reduced:	**1**
Catch rates reduced 80-100%, although not for tusk:	**1**

B. When did you observe the reaction from the SA on your catch rate?

1. At some distance from your fishing position. If so, how far away?

At or very close:	**1**
2 - 3 nm away:	**3**
More than 5 nm:	**3**
Don't know:	**1**

2. When the seismic vessel was within a short distance from your fishing position.

3. At some distance after the vessel had passed your fishing position. If so, how far?

If you have answered "yes" to the first questions, please answer the next questions.

III. *How long after the seismic shooting was the fishery in a non-normal state?*

Don't know: 5
7 - 14 days: 3
At least two weeks: 1
Several months: 2
Two make the additional remark that this is dependent on the magnitude and duration of the SA.

Please could you elaborate a little.

IV. *Apart from the altered catch rate, did you observe any changes in the behaviour of the fish?*
Yes/no/Don't know **4/5/2**

If yes, could you please describe the changes.
Difficult to explain: 1
The fish became more agitated: 1
The fish didn't take the bait after the SA: 1
There were more fish in the fjords following the SA: 1

V. *Have you observed any differences in the behaviour among the fish species?*
Yes/no/Don't know **3/3/5**

If yes, could you please describe the differences.
Halibut is less affected than saithe: 1
Cod is less affected than saithe: 1
Think tusk is less affected than other fish species
The halibut disappears: 1

VI. *Are there any differences in effect by geographical area?*
Yes/no/Don't know **0/7/4**

If yes, could you please describe these.

VII. *Are there any seasonal differences?*
Yes/no/Don't know **4/2/5**

If yes, could you please describe these.

During summer:	**1**
No comment:	**3**

VIII. *Are there any differences by depth?*
Yes/no/Don't know **0/6/5**

If yes, could you please describe these.

IX. *Are there any differences in response related to the weather conditions?*
Yes/no/Don't know **0/5/6**

If yes, could you please describe these.

X. *Are there any differences related to the light conditions?*
Yes/no/Don't know **0/4/7**

If yes, could you please describe these.

XI. *Is there any difference in the effect of seismic shooting among the different fishing gears?*
Yes/no/Don't know **1/4/6**

If yes, could you please describe this.
Longline possibly less affected compared to jigging

XII. *For further seismic activity, what time of year is most favourable?*

No preference:	**2**
During the winter:	**1**
During the summer - no way during spawning:	**1**
Difficult to answer as the different places have different times:	**3**
Don't know:	**2**

Longlining (6)

I. *Have you experienced SA in the same area as you were fishing at the time?*

If yes:

A: When? Please give the date/dates as precisely as possible

During the summer, for several years:	**2**
During the summer of 1997, 1998, and only little in 1999:	**1**
During summer, 1996:	**1**
Autumn 1996:	**1**
September 1997:	**1**

B: Where? Please give the area/areas fished as exact as possible

South of Nolsoy:	**1**
East of Akraberg (fishing place for ling):	**1**
East and west of Suðuroy - very close to land:	**1**
At Munkagrunnur and around Suðuroy:	**1**
East of Sandoy (Skálhøvda):	**1**
East, south, and west of Suðuroy, 1/2 nm from land:	**1**

C: What gear were you using?

Longline

D. What species were you targeting?

Cod and haddock	**4**
Ling	**1**

II. *Did the seismic activity affect your fishing success?*

Yes/no **5/1**

If yes:

A. Did your catch rate increase or decrease? Please quantify the changes.

No effect:	**1**
Don't know:	**1**
Reduced 50% in shallow waters:	**1**
Reduced 100%:	**2**
Reduced 100%, except tusk:	**1**

B. When did you observe the reaction from the SA on your catch rate?

1. At some distance from your fishing position. If so, how far away?

At or close to the position:	**1**
The following day:	**1**
Don't know:	**1**

2. When the seismic vessel was within a short distance from your fishing position.

3. At some distance after the vessel had passed your fishing position. If so, how far?

If you have answered "yes" to the first questions, please answer the next questions.

III. *How long after the seismic shooting was the fishery in a non-normal state?*

Please could you elaborate a little.

Don't know:	**2**
Several months:	**2**
Some weeks:	**1**

IV. *Apart from the altered catch rates, did you observe any changes in the behaviour of the fish?* Yes/no/Don't know **0/2/3**

If yes, could you please describe the changes.

V. *Have you observed any differences in the behaviour among the fish species?*
Yes/no/Don't know **1/4/1**

Think that tusk is less affected than other fish species: 1
Halibut disappears

If yes, could you please describe the differences.

VI. *Are there any differences in effect by geographical area?*
Yes/no/Don't know **0/3/2**

If yes, could you please describe these.

VII. *Are there any seasonal differences?*
Yes/no/Don't know **2/0/4**

If yes, could you please describe these.

Summer and autumn:	**1**
Yes:	**1**

VIII. *Are there any differences by depth?*
Yes/no/Don't know **1/2/2**

If yes, could you please describe these.
Most effects in shallow waters

IX. *Are there any differences in response related to the weather conditions?*
Yes/no/Don't know **0/0/5**

If yes, could you please describe these.

X. *Are there any differences related to the light conditions?*
Yes/no/Don't know **0/0/5**

If yes, could you please describe these.

XI. *Is there any difference in the effect of SA among the different fishing gears?*
Yes/no Don't know **1/1/3**

If yes, could you please describe this.
Jigging fishery mostly affected

XII. *For further seismic activity, what time of year is most favourable?*

No preferences:	**2**
Summer:	**2**
Don't know:	**1**