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FAROESE QUEST OF ORANGE ROUGHY IN THE NORTH ATLANTIC

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Abstract

In 1991 orange roughy *(Hoplostethus atlanticus)* entered the arena as a new commercial species in the European fresh fish market. Faroese experimental fishery for this species has been carried out since late 1992. Orange roughy has been found on deep-sea banks and pinnacles in the western and southern area in Faroese waters, in the Hatton Bank area and on the Mid-Atlantic-ridge between the EEZ's of Iceland and the Azores.

The total length of orange roughy ranged between 15 and 75 cm, with the majority between 50 and 70 cm. The diet consisted mainly of deep-sea fish species, shrimps and cephalopods.

In the fishery for orange roughy, large by-catches of deep-sea cardinal fish and roundnose grenadier have been taken. Other by-catch species are black scabbard fish, sharks, smooth-head, alfonsino and a few specimens of other species.

Commercial catch data indicate, that although the abundance of orange roughy on a deep-sea bank can be reduced considerably by a few months fishing, large catches can be taken in the spawning season in late January to early March.

Keywords

deep-sea, deep water fisheries, north atlantic, orange roughy

Introduction

Although orange roughy (*Hoplostethus atlanticus*, Collett 1889) is found and named in the North Atlantic, this species is better known from the areas around New Zealand. In this region, orange roughy has been fished since 1979 and catches that have reached more than 50,000 tonnes a year have made this species to one of the most valuable demersal species in this area (Robertson, 1990). Since mid 1980s orange roughy has been caught commercially in the waters south of Australia. In resent years a fishery for orange roughy has also developed off the cost of Namibia.

Since trawling commenced in the deep open areas of the North Atlantic, large hauls of orange roughy have occasionally been reported, but no continuous fishery has been going on. In 1991 increasing landings from French trawlers were reported and in 1992 the sale on the fresh fish market in Boulogne reached 3,244 tonnes. The French fishery took place on the slopes west of the British Isles, but it collapsed in 1993 (pers. comm. A. Newton, Marine Laboratory, Aberdeen).

In 1991 Icelandic trawlers began to fish orange roughy on the slope south of Iceland (Magnusson & Magnusson, 1995), but this fishery also has ceased.

In 1992 the Faroese Fisheries Laboratory initiated exploratory fishing for orange roughy in the North Atlantic. This paper summarises the results of this work and of the succeeding Faroese commercial fishery for orange roughy.

Materials and methods

From August 1992 to February 1998 a total of 28 exploratory cruises for orange roughy were conducted, see Table 1.

Table 1. Faroese exploratory cruises for orange roughy. The majority of the cruises were carried out with the research vessel Magnus Heinason (45m, 1800HP stern-trawler). The remaining by hired deep-sea trawlers (45-50m, 2000-2500HP).

No	Vessel name	Start date	No of days	No of tows	Kg or. roughy
1	Brestir	22/8-92	11	38	100
2	Magnus Heinason	18/9-92	12	36	800
3	Magnus Heinason	3/10-92	17	38	1,260
4	Magnus Heinason	13/1-93	7	10	3,876
5	Magnus Heinason	20/1-93	14	36	15,602
6	Brestir	9/2-93	15	74	17,915
7	Magnus Heinason	10/2-93	14	31	450
8	Brestir	9/3-93	15	44	6,523
9	Magnus Heinason	8/9-93	16	7	20
10	Magnus Heinason	24/10-93	10	34	4,125
11	Magnus Heinason	5/11-93	12	25	5,099
12	Magnus Heinason	5/2-94	17	45	2,657
13	Magnus Heinason	8/7-94	11	44	7,887
14	Oyrnafjall	8/11-94	14	61	57,286
15	Oyrnafjall	24/11-94	24	58	61,551
16	Magnus Heinason	27/1-95	19	40	817
17	Boðasteinur	1/9-95	14	76	90,981
18	Boðasteinur	15/9-95	19	89	99,677
19	Magnus Heinason	21/9-95	13	12	5,143
20	Phoenix	11/11-95	21	85	39,210
21	Magnus Heinason	25/1-96	21	64	16,000
22	Boðasteinur	24/4-96	16	76	80,700
23	Boðasteinur	11/5-96	13	68	39,307
24	Rankin	1/5-96	16	68	35,000
25	Phoenix	1/9-96	21	105	24,080
26	Magnus Heinason	27/9-96	26	73	12,000
27	Magnus Heinason	21/1-97	20	55	4,900
28	Magnus Heinason	21/1-98	10	23	67,040

On all cruises experiments have been made to find the most appropriate gear, learning the fishing technique, locate orange roughy grounds and to collect biological information.

Fishing gear and fishing technique

From the New Zealand fishery it was known, that orange roughy was found on difficult trawling grounds, usually on or near irregularities in the seabed such as deep-sea banks or pinnacles and on hills and drop-offs. Fishing on these grounds necessitates special trawling technique and skill. For the Faroese exploratory experiments much effort was made to be as close to the New Zealand fishing gear and technique as possible. Existing literature was consulted, e.g. Greening (1988) and a New Zealand skipper was hired as a supervisor on one cruise.

Area

In New Zealand the main attributes for the orange roughy habitat were depths of 700 to 1500m and temperatures of 4 to 9°C. It was assumed that this was also applicable in the North Atlantic.

Although no information could be obtained from the French and Icelandic fishery for orange roughy, some clues could be found in existing literature, e.g. Bridger (1978), Gordon & Hunter (1994), Hareide et al. (1993) and Troyanovsky & Lisovsky (1995).

From available charts all areas in Faroese and international waters with suitable depths were located and this was compared to available information on temperatures. In areas with matching depth and temperature trawling was performed and more detailed information was obtained on depth (from echo sounder) and temperature (from net sounder and CTD). Where underwater deep-sea banks, ridges and pinnacles were found, these were thoroughly mapped.

The surveyed areas are shown on Figure 1. The experiments began in southern and western part of Faroese waters (1) and then continued in the Hatton Bank area (2). Only few cruises have been on the Reykjanes ridge (3) while the most effort since late 1994 has been used on the ridge north of the Azores (4).

Biological data

For each haul, parameters as date, time, position, depth, temperature etc. was recorded both on beginning and end of tow. From each haul the catch of each species was estimated or weighed if possible. For orange roughy the total length, total round weight and sex was determined. The maturity stage was determined according to Table 2. It is known that some specimens fail to spawn in some years (Bell et al., 1992), therefore stage 8 was included.

Figure 1. The four areas investigated for orange roughy grounds: 1) Faroe area, 2) Hatton Bank area, 3) Reykjanes ridge area and 4) the ridge north of the Azores.

Table 2. Maturity stages used for orange roughy.

	Female	Male
0	Immature	Immature
1	Small developing gonads (immature)	Small developing gonads (immature)
2	Small eggs	Black hard [1)]
3	Large orange roe	Brindled hard [1)]
4	Starting hyaline	White hard [1)]
5	Hyaline	White soft
6	Running	Running
7	Spent	Spent
8	Not spawning	Not spawning

[1)] The black colour on male gonad is caused by a fungus and is not an expression of a maturity stage.

In a few specimens of orange roughies the stomach content was determined.
For age-determination an experienced otolith reader counted the rings in the otoliths, which are believed to be laid down annually.
Biological information on other species than orange roughy was only collected scarcely and only length of some fish species has been sampled on a few occasions.

Commercial catches
Following the success of the exploratory fishing several commercial deep-sea trawlers began to exploit the new fishing grounds found. Official landing statistic from this fishery is available. Most vessels had only moderate catches and made only few fishing trips.
Only one vessel, M/S Boðasteinur, has been fishing for orange roughy continuously since late 1994. On this vessel, fortunately the number of orange roughies has been counted for every single haul and reported daily to the vessel home office. This information has been compared to the logbook and every haul with information on number of fish has been designated to the respective bank or pinnacle.
Fishing gear and fishing technique used is as copied from New Zealand. Hauls are very short, typical duration is 10 to 20 minutes.

Results
Although the North Atlantic covers a wide area, only a small fraction has bottom depths suitable for bottom trawling, see Figure 1.
But all over this area, from the Faroese waters in the north and to the Azores area in the south, suitable temperature for orange roughy has been found, see Figure 2.

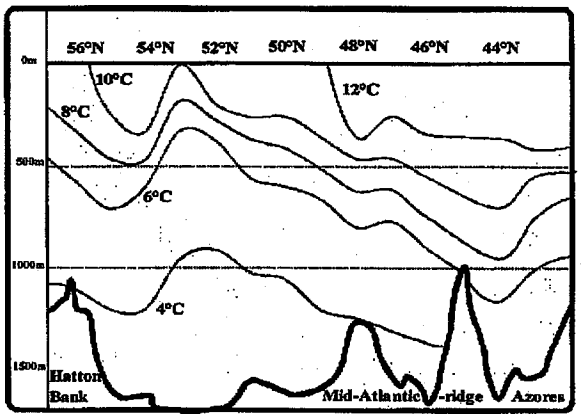

Figure 2. Temperature measured with CTD on a section from Hatton Bank (56°N, 21°W) to the Mid-Atlantic-ridge north of the Azores (43°N, 28°W)

And orange roughy has been found in several locations in Faroese waters, on Hatton Bank and on the Mid-Atlantic-ridge between the EEZ's of Iceland and Azores, especially in

areas, where deep-sea banks or pinnacles reach up into waters of suitable temperature, see Figure 2.

The first two years the findings of orange roughy were not in quantities to sustain a commercial fishery, but since the breakthrough in November 1994 (Table 1) there has been a continuos Faroese fishery for orange roughy.

Biological information

The size of orange roughy caught is mainly between 50 and 70 cm. Few small specimens have been found, and no specimen less than 15 cm. Difference in size of orange roughy can be seen between areas, see Table 3 and Figure 3.

Table 3. Average size (cm) and weight (kg) of orange roughy by area.

	Female		Male	
Area	Size	Weight	Size	Weight
Faroe Island	61.4	4.4	58.6	3.7
Hatton Bank	64.6	4.9	62.8	4.3
Reykjanesridge	58.9	3.6	56.4	3.0
Azores	60.6	3.9	59.7	3.7

The observed relationship between weight and length is shown on Figure 4. The largest specimens, usually females, can reach a total length of 75 cm and a body weight of 7 kg.

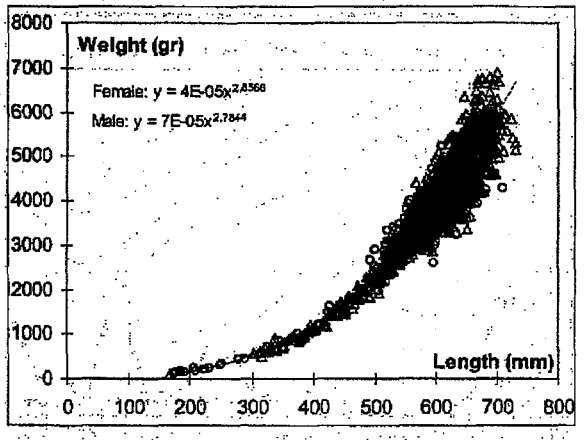

Figure 4. Weight-length relationship (Δ=female, o=male).

The results from age-determinations are shown on Figure 5. Age rings in the otoliths could only be counted in small specimens (up to maturity). Orange roughy of 55 cm is found to be more than 30 years of age. This corresponds to information, that this species is believed to reach more than 100 years of age (Fenton et al., 1991).

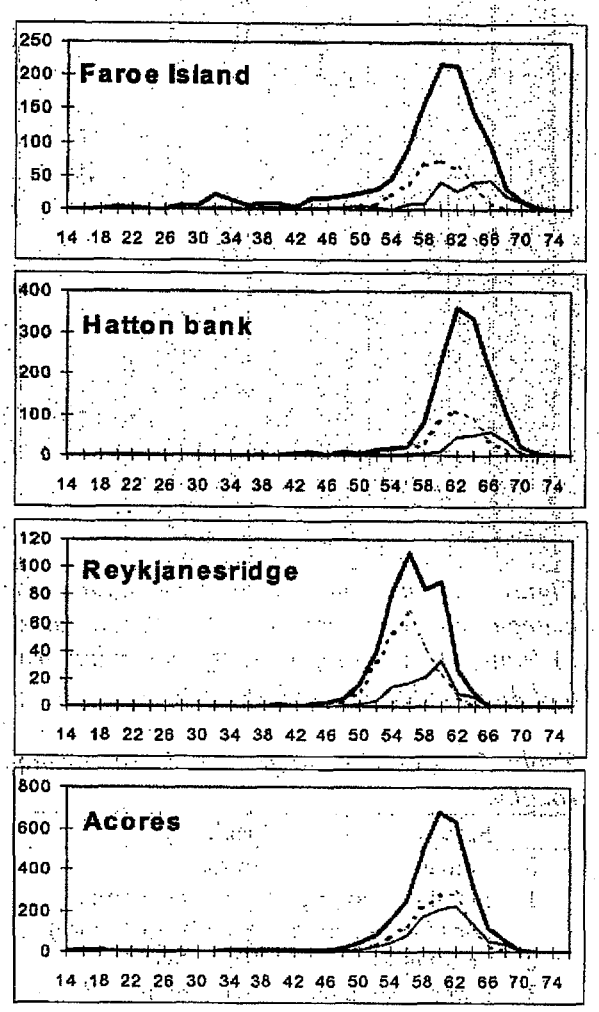

Figure 3. Length distribution (number in 2 cm groups) from the four areas investigated. Lower lines are male (dotted) and female.

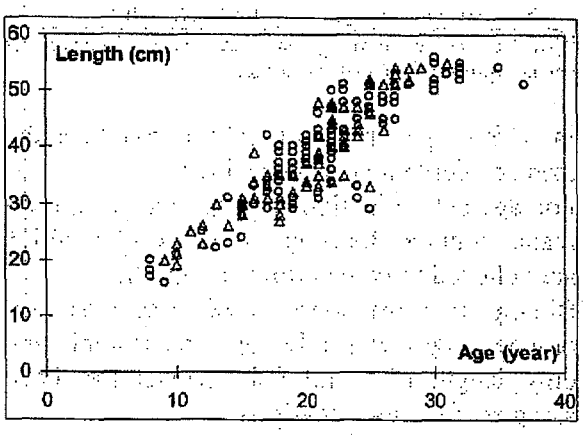

Figure 5. Length at age for orange roughy (Δ=female, o=male).

Development in gonads depending on length is shown on Figure 6.

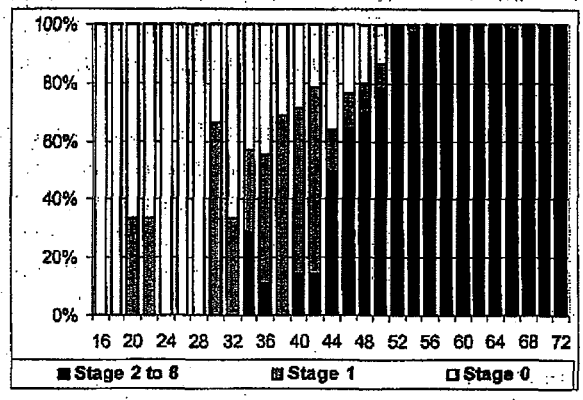

Figure 6. Maturity in % at length (cm). See Table 2 for description of maturity stages.

No development in gonads is seen in fish of a total length of less than 20 cm and fish with no development in the gonads can be found even at 50 cm total length. Very few specimens reach maturity before a length of 44-45 cm, and 50% maturity is not reached until 48-49 cm length, i.e. at 25 years of age (Figure 5).
Although large gonads and also a few specimens with hyaline eggs can be found during winter (i.e. from September) the main spawning season is in late January to early March. This is also verified by the large commercial hauls taken in this period, see Figure 7.
Up to spawning a substantial number of fish have been seen with small gonads. These have been regarded as none spawner, but as this is difficult to discriminate from newly spent gonads only a rough estimate of 5-15% can be given.
The stomach content of orange roughy reveals a great variation in the diet. This includes a broad selection of small deep-sea fish species, shrimps and cephalopods.

By-catch.
A great number of fish species have been found in the investigated area. Through all the area a large number of shark species are found although not in great numbers. Named in descending order of occurrence these have been: *Etmopterus spp., Centroscymnus coelolepis, Deania calceus, Lepidorhinus squamosus, Galeus melastomus, Centrophorus fabricii, Hexanchus griseus, Pseudotriakis microdon.* Huge schools of roundnose grenadier *(Corypaenoides rupestris)* and deep-sea cardinal fish *(Epigonus telescopus)* have been seen and sometimes several tonnes have been taken in a few minutes haul. Also black scabbard fish *(Aphanopus carbo)* and smooth-head *(Alepocephalus bairdii)* are found through all the area.
In the northern part blue ling *(Molva dypterygia)* and Greenland halibut *(Reinhardtius hippoglossoides)* have been taken and in the southern part alfonsino *(Beryx spp.), Hoplostethus mediterraneus* and wreckfish *(Polyprion americanus)* have been taken.

Commercial catches
Total catch of orange roughy by Faroese vessels is shown in Table 4.

Table 4. Total Faroese catch of orange roughy by ICES statistical area.

Year	V	VI	X	XII	Total
1992	1	0	0	0	1
1993	26	34	0	0	60
1994	19	179	62	0	260
1995	86	34	444	131	694
1996	40	20	689	175	925
1997	30	11	479	272	792
1998*	1	12	91	534	637

(* 1998 only January-July)

In the years 1992-94 the first orange roughy occurrences were found and fished in the Faroese area and on Hatton Bank, ICES area V and VI. Since late 1994 most catches have been taken on the Mid-Atlantic-ridge, ICES area X and XII.
When the first banks were found in late 1994 and early 1995, several Faroese deep-sea trawlers began to exploit these new fishing grounds. However these grounds appeared to be difficult to fish and together with difficult weather conditions and long distance from home and from market this was reason for several unsuccessful trips and the fishing activity faded away during the spring of 1995. Only one vessel, M/S Boðasteinur, managed to

have continuously success and has been in this fishery since.

Although orange roughy has been found on many deep-sea banks and pinnacles in the North Atlantic, the commercial fishery has been based on only few locations. This can be seen on Figure 7, where number of fish (orange roughy) in all hauls of vessel M/S Boðasteinur since the fishery started in late 1994, are shown, split into different fishing places. Almost all hauls have been taken on five banks named A to E. A few small hauls have been taken in other places (O).

The fishery began on bank A in December 1994 with several hauls up to 500 fish (2 tonnes) and a single haul of 2,500 fish (10 tonnes). Since these early catches very few reasonable hauls have later been taken on this bank, although it has been visited frequently.

In early 1995 the fishing commenced on the new bank B. On the first trip very large hauls were taken, but the size of hauls were reduced considerably during the following three months. Large hauls were again taken on this bank during spawning season in January and February 1996 and again in February 1997. In November 1996, after a period with no fishing, reasonable hauls were also made on this bank.

In September 1995, M/T Boðasteinur was hired for exploratory fishing and the two banks C and D were investigated. On bank C large hauls were taken during the first three trips, but although this bank was visited frequently during 1996, very few large hauls were taken. In February 1997 a spawning aggregation was found on bank C resulting in very large catches. Again in February 1998 a spawning aggregation on the same spot gave huge catches. Several large hauls were also taken on bank D the first trips after discovery. This bank was also fished heavily in April to June 1997 with several large hauls.

Despite continuos effort on all four banks A to D in August to December 1997 no large hauls were taken.

On an exploratory cruise in late January 1998 (Table 1) a spawning aggregation was found on a new bank E. This aggregation was fished in early February 1998, resulting in several large hauls. Also in July 1998 large hauls have been taken on bank E.

When large hauls of orange roughy have been taken, these are usually short and without any by-catch. When the quantities of orange roughy are small, the tows tend to be longer and into greater depth resulting in catch of several by-catch species.

On some trips, when the fishery for orange roughy has failed, M/S Boðasteinur has been targeting other species on the same grounds. These are mainly black scabbard fish, roundnose grenadier and deep-sea cardinal fish.

Discussion

The Faroese experimental fishery for orange roughy has revealed that this species is widely distributed in the North Atlantic.

Orange roughy in the North Atlantic seems to seek the same habitat as in the New Zealand/Australia area and the diet seems to be comparable (Bulman & Koslow, 1992). Also the spawning seems to be seasonal as in New Zealand (Pankhurst et al., 1987).

Although other similarities are found, e.g. in DNA tests (Elliot et al., 1995) also differences can be seen. Most obvious is the average weight that in the North Atlantic is more or less twice the weight in New Zealand.

In New Zealand it has been seen that fishery over a 5-6 years period can reduce an orange roughy stock to 15-20% of the virgin stock (Clark, 1995). Present work shows that fishing during a few months on a single deep-sea bank can reduce the abundance of orange roughy considerably.

Although this reduction in abundance has been seen, dense schools of fish can be found during the spawning season and large hauls can be taken.

The best catches are taken during spawning season, which is in wintertime. At this time of the year the North Atlantic is a difficult area to operate in due to bad weather conditions. This will partly act as a natural prevention for depletion of this stock.

On the other hand the orange roughy is an extremely slow growing and long living species and this resource should be exploited with care.

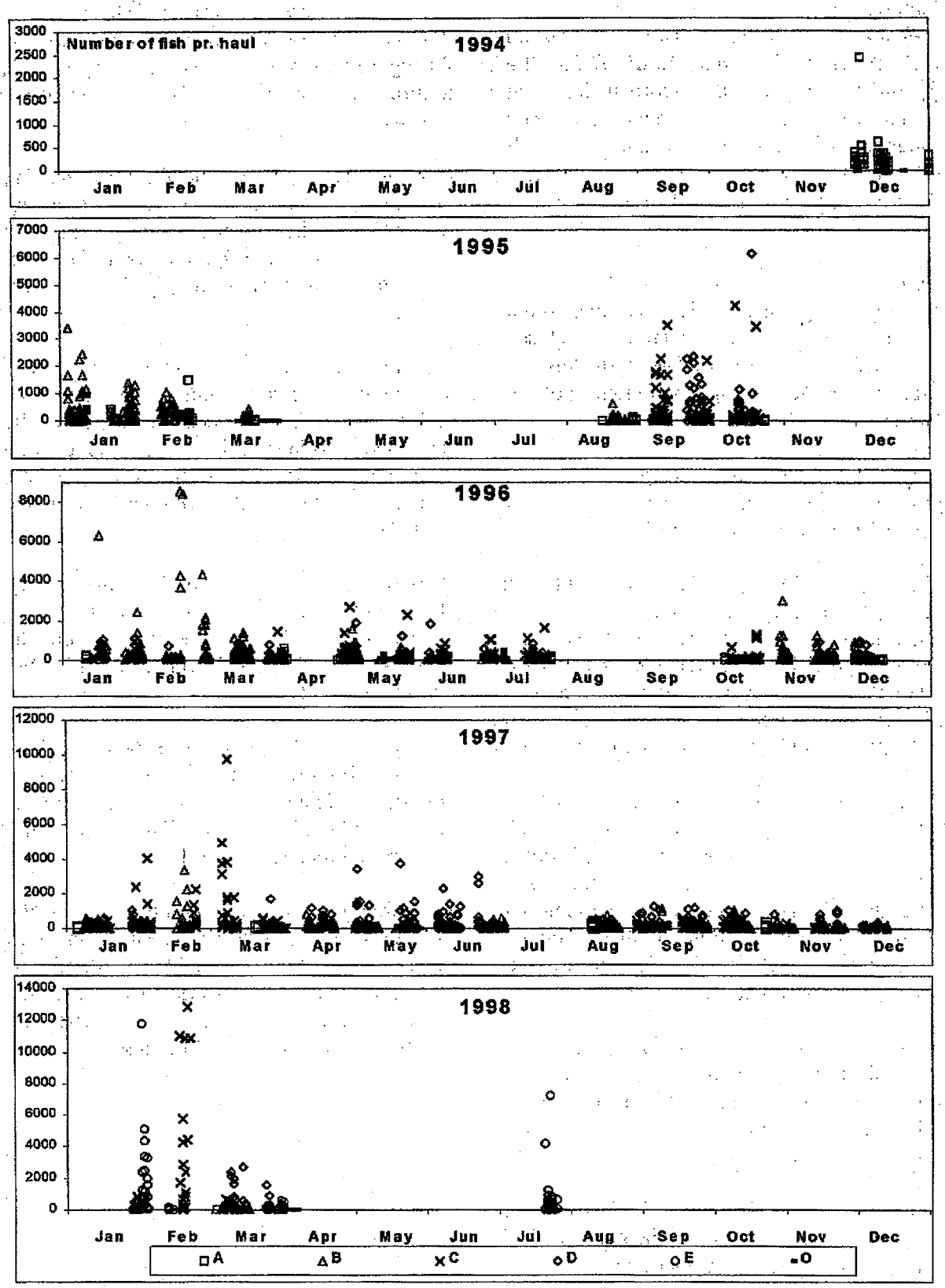

Figure 7. Commercial catches of orange roughy (number of fish per haul) by M/S Boðasteinur on five different banks (A to E) and other places (O) from December 1994 to July 1998. Each cluster of marks represents one commercial trip of 10-20 days. In periods with no marks (e.g. April-July 1995) the vessel has not been fishing for orange roughy.

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