International Council for
the Exploration of the Sea

Fish Caputure Committe
C.M. 1991/B:40
Ref. Comm. D + G + J

EFFECTS OF A GEOPHYSICAL SURVEY ON CATCHING SUCCESS IN LONGLINE FISHING

by

Svein Løkkeborg

Institute of Marine Research
Department of Marine Resources
Fish Capture Division
P.O. Box 1870, N-5024 Bergen, Norway

ABSTRACT

The effects on longline catches of a geophysical survey conducted during the winter fishery for cod (*Gadus morhua*) were studied. Spatial extent of the effects was investigated by comparing the catch rates of longlines set at various distances from the survey tracklines, and duration of the effects was studied by analysing the catch rates of longlines soaked after the sound emissions ended. Catch reduction of 55-80% was observed for longlines set within the seismic survey area. The results indicated that the acoustic device used caused a 24-h duration and 5-miles spatial extent of reduced catches.

INTRODUCTION

Concerns have been raised by fishermen that sounds generated by acoustic devices used in seismic survey operations affect commercial fishing. In particular, Norwegian fishermen targeting demersal species and using longline, gillnet or trawl have reported significant reduced catch rates caused by the operations of seismic survey vessels.

Fish detect and respond to sounds (Tavolga et al. 1981), and air gun discharges have been reported to elicite startle and alarm responses in rockfish (*Sebastes* spp.) (Anon. 1987). Changes in the depth distribution of whiting (*Merlangius merlangus*) upon discharges of a single air gun have been reported (Chapman and Hawkins 1969), and a field study suggested changes in fish distribution along tracklines of a seismic survey vessel using an array of 40 air guns (Dalen and Raknes 1985). However, quantitative effects of seismic survey operations on catching success in commercial fishing have not been documented (but see Anon. 1987).

In 1990, during the winter fishery for cod (*Gadus morhua*) off the coast of Finnmark (northern Norway), a geophysical survey was conducted within the same area as several commercial longliners were fishing. The present study is based on catch data obtained from four longliners fishing in this area in the same period as the seismic operations were conducted. The catch rates of fleets of longlines set within and at various distances from the seismic tracklines were compared. The catching efficiency of longlines set at different periods of time after the seismic operations ended was also compared.

MATERIALS AND METHODS

The seismic survey was carried out in January 1990 off the coast of Finnmark (northern Norway) at about 185 m depth (Fig. 1). The seismic vessel used an array of four sleeve guns (40 $in.^3$, Texas Instruments) towed 0.5 m appart at 3 m depth. The survey tracklines were 2.5 nautical miles long, and the guns were discharged every 12.5 m (i.e. at intervals of about 5 s). A total of 32 tracklines were run during four periods (Table 1).

The locations of the fishing areas of the longliners from which catch data were obtained are shown in Fig. 1. For each fleet of longlines, the skipper normally notes the position, time of setting, and estimates the weight of the catch. Copies of these notes were obtained from the autoliners "Husby", "Førde", "Frøyanes" and "Værland". These data were related to the positions of the survey tracklines and the times of discharges of the guns.

RESULTS

The locations and catch rates of the fleets of the "Husby" are shown in Fig. 2. These fleets were soaked January 28 and 29 when the seismic vessel was operating, but the exact time of setting was not noted by the skipper. Three fleets of lines were set within the seismic survey area, and these caught 190 - 300 kg cod each. The other fleets were set 1 - 5 and 5 - 8 nautical miles from the survey area and caught 500 - 620 and 1100 - 1340 kg, respectively.

The catch data for the "Førde" are given in Table 2 and Fig. 3. Fleets 1 and 2 were set 3.5 and 1.75 h before sound emissions ended, respectively, and fleets 3 and 4 about 7 h after sound emissions ended. The catch rate of fleet 4, which was set within the seismic survey area, was 45% of the mean catch rate of fleets 1, 2 and 3 which were set about 1 - 6 nautical miles from this area. Fleets 5 - 8 were set about 24 h after sound emissions ended, and at increasing distances from the survey area. The catch rates for these fleets increased with increasing distance from the survey area.

The fleets of the "Frøyanes" were all set about 1.5 - 8.5 nautical miles from the seismic survey area (Table 2). The catch data obtained from this longliner show that fleets soaked prior to sound emissions caught 2000 - 2800 kg cod each (mean = 2500 kg). Fleets set during sound emissions and within 24 h after emissions ended caught 1200 - 2200 kg (mean = 1518 kg), which give a catch reduction of about 40%.

The notes obtained from the "Værland" do not specify the catch rate for each fleet of longlines, but give the total catch for each day of fishing. The catches for January 15 to 19 ranged from 6300 - 8250 kg (mean = 7100 kg), whereas 4000 kg were caught January 20

(sound emissions started 18:32 January 19, Table 1). From January 21 this vessel was fishing on other fishing grounds. These data have therefore limited value, but the results support those obtained from the other longliners.

DISCUSSION

The present results demonstrate effects of seismic survey operations on longline catch rates. Although uneven fish distribution may cause significant catch differences among longlines set on the same fishing ground, the catch data obtained from all longliners investigated in this study showed the same tendency. Thus, the reduced catch for the longlines set within or close to the survey area, and soaked under or shortly after sound emission is most likely explained by sounds generated by the acoustic device. Behaviour studies using ultrasonic tagging technique may reveal if such effects are due to changes in fish distribution or feeding motivation.

In hook and line fishing for rockfish, total CPUE was observed to decline by 50% under continuously sound emission from a single air gun (Anon. 1987). In the present study catch reductions of 55 - 80% were observed for longlines set within the seismic survey area. The results also indicated reduced catches for longlines set at a distance of about 5 nautical miles from the survey area. Furthermore, the duration of such effects seemed to be at least 24 h.

The spatial and temporal extents of effects of seismic survey operations might be greater under other conditions than those of the present study. In deep seismic surveys that are more common on the Norwegian continental shelf, the survey vessels are towing arrays of 40 - 50 air guns that are 300 $in.^3$ The peak pressures produced by such arrays are 100 - 200 bar-m compared to 8.4 bar-m for the present survey (T. Pedersen, A/S Geoteam, pers. comm.). In addition, as this survey was carried out when the cod undertake their seasonal migration towards spawning areas, fish not previously exposed to sound emissions will continuously move into the survey area. Therefore, spatial and temporal extents of reduced catch might be more pronounced for stationary fishes exposed to sounds generated by acoustic devices used in deep seismic surveys.

REFERENCES

Anon. 1987. Effects of sounds from a geophysical survey device on fishing success. *Battelle Memorial Institute, 1431 Spinnaker Drive, Ventura, CA 93001, USA.* 293 p.

Chapman, C.J. and A.D. Hawkins. 1969. The importance of sound in fish behaviour in relation to capture by trawls. *FAO Fish. Rep., 62(3)*: 717-729.

Dalen, J. and A. Raknes. 1985. Scaring effects on fish from three-dimensional seismic surveys. *Institute of Marine Research, Rep. No. FO 8504. Bergen, Norway.*

Tavolga, W.N., A.N. Popper and R.R. Fay. 1981. *Hearing and sound communication in fishes.* Springer-Verlag, New York, 608 p.

Table 1. Schedule of the seismic survey conducted off the coast of Finnmark (northern Norway) in 1990.

Period	Start sound emissions		End sound emissions		No. of survey tracklines
	Date	Time	Date	Time	
1	Jan. 19	18:32	Jan. 20	04:33	7
2	Jan. 21	16:43	Jan. 22	06:38	10
3	Jan. 28	09:14	Jan. 28	12:00	3
4	Jan. 29	03:44	Jan. 29	20:27	12

Table 2. Distance from the seismic survey area, time of setting relative to sound emissions and catch rate of longline fleets of the autoliners "Førde" and "Frøyanes". Distance from survey area is the distance (in nautical miles) between each end of the fleet and the nearest survey trackline. Time elapsed is the time elapsed between ending of sound emissions and setting of fleet. Fleets 11-15 of "Frøyanes" are related to Period 2 (see Table 1), the other fleets are related to Period 1.

Vessel	Distance from survey area	Elapsed time	Catch rate (kg/fleet)
"Førde"			
Fleet 1	6.5-2.6	During[1]	1100
Fleet 2	0.7-4.1	During[1]	1000
Fleet 3	0.7-4.1	6h 30min	1200
Fleet 4	0-1.2	7h 10min	500
Fleet 5	0.8-1.8	24h 40min	600
Fleet 6	2.0-5.3	25h 20min	900
Fleet 7	5.7-9.7	25h 50min	1000
Fleet 8	9.9-13.7	26h 20min	1200
"Frøyanes"			
Fleet 1	5.1-7.2	Before[2]	2500
Fleet 2	6.1-8.3	Before[2]	2000
Fleet 3	4.1-6.7	Before[2]	2800
Fleet 4	6.7-8.4	Before[2]	2700
Fleet 5	3.4-5.9	– 4h 20min[3]	1800
Fleet 6	6.2-7.9	During[1]	1600
Fleet 7	2.0-5.7	1h 50min	1900
Fleet 8	5.0-7.2	9h 45min	1300
Fleet 9	1.5-6.3	17h 05min	1300
Fleet 10	3.3-6.5	24h 35min	2200
Fleet 11	2.3-5.0	– 4h 40min[3]	1200
Fleet 12	4.4-6.5	During[1]	1300
Fleet 13	5.5-6.6	During[1]	1500
Fleet 14	6.7-7.2	3h 30min	1400
Fleet 15	7.3-8.2	10h 25 min	1200

[1] The fleet was set during sound emissions.

[2] The fleet was set and hauled before sound emissions started.

[3] Time between setting of fleet and starting of sound emissions. The soak time for these fleets were about 9h.

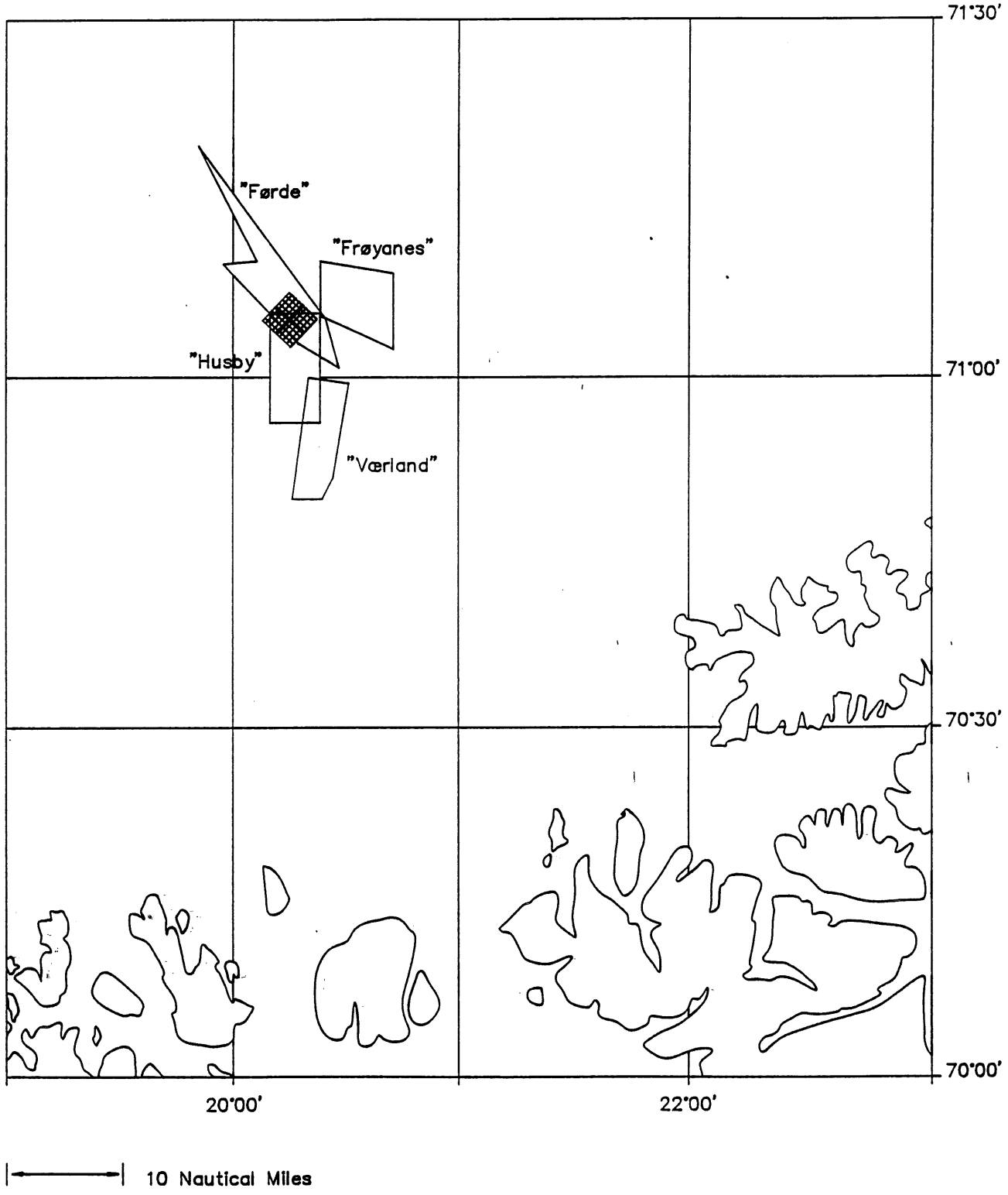

Figure 1. Locations of the seismic survey area (hatched) and the fishing areas (open) of the longliners from which catch data were obtained.

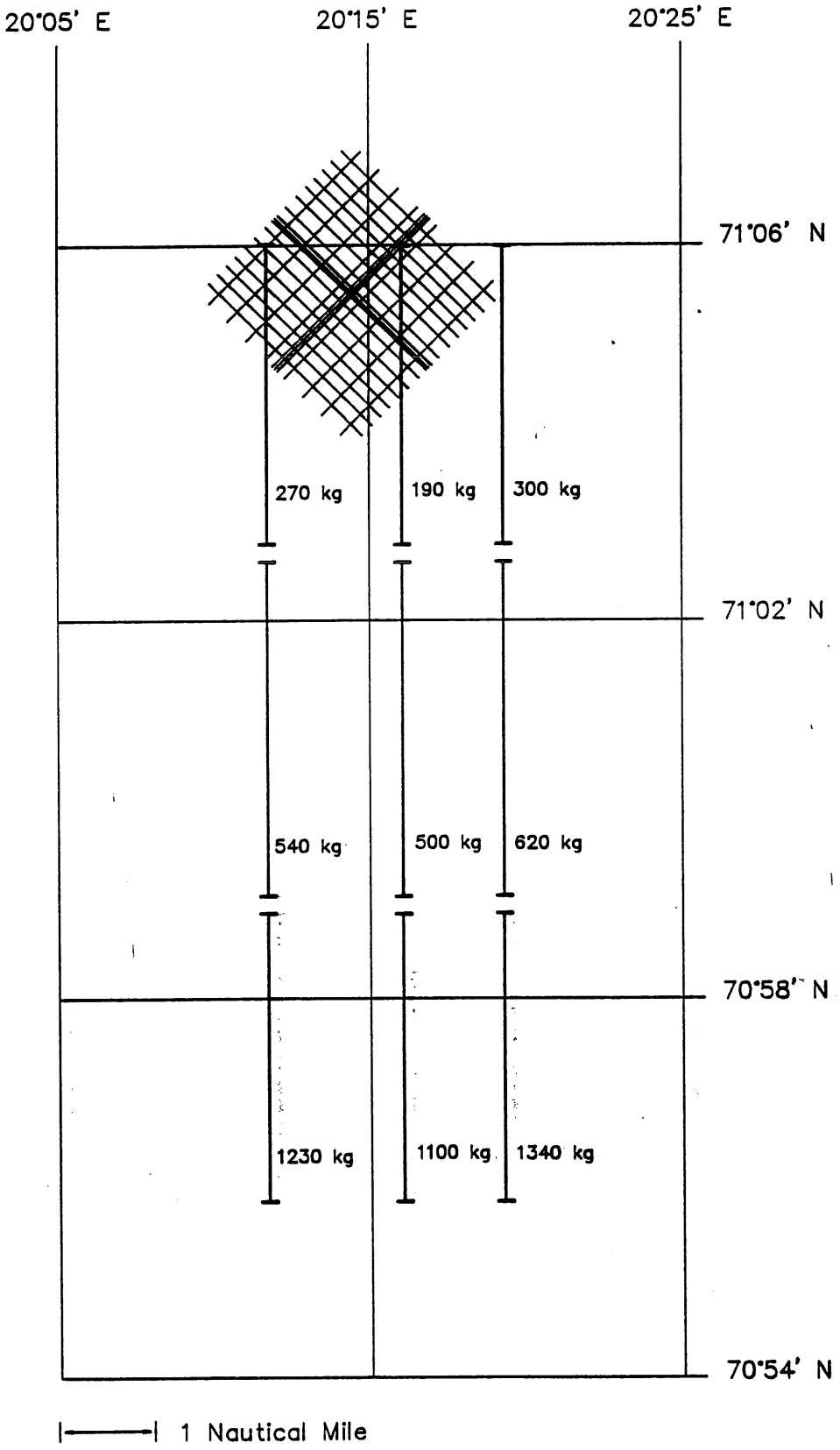

Figure 2. Locations of the seismic tracklines, and locations and catch rates of the fleets of the "Husby".

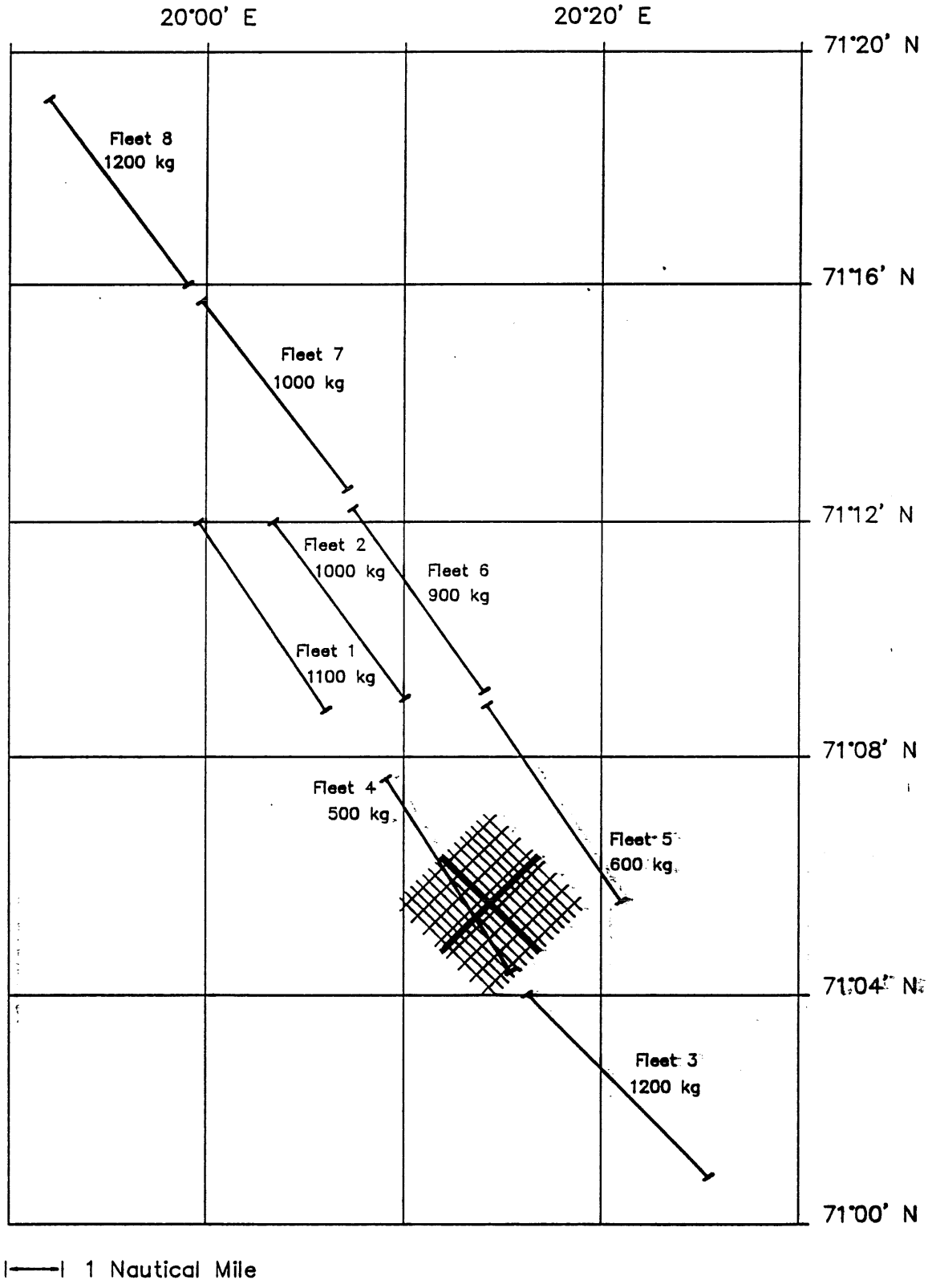

Figure 3. Locations of the seismic tracklines, and locations and catch rates of the fleets of the "Førde".