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IS UNACCOUNTED FISHING MORTALITY A PROBLEM IN PURSE SEINING?

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INTRODUCTION

The total unaccounted fishing mortality in the Norwegian spring-spawning herring fishery for all gear categories has been estimated to 150,000 tons for the period 1985-1987 (Anon. 1989). It is claimed that one of the reasons for such unaccounted mortality is net bursts, which occures when a purse seine is torn by the fish itself. This winter, the Norwegian authorities closed daytime purse seining on Norwegian spring-spawning herring as a result of several net-bursts on large and dense spawning schools.

For the fishermen, the consequences of net bursts are unwanted expenses (up to 200,000 NOK) to repair the gear damages and reduced income as both catch and fishing time are lost. If net bursts result in instant or long term unaccounted fishing mortality, the consequences are biases in stock assessment based on fisheries statistics. To compensate such errors, reliable estimates of unaccounted fishing mortality must be based on knowledge of the total number of sets, frequency of net bursts, and instant and long term mortality.

There have also been reports of herring mortality during transfer and storing in net pens, but this problem will not be considered in this paper.

PURSE SEINE FISHING STATISTICS AND BEHAVIOUR OBSERVATIONS

Official, quantitative information on unaccounted fishing mortality, or the frequency of net bursts in the Norwegian purse seine fisheries, is scarce. We have collected some catch data directly from the log books of several purse seiners during the fishing seasons 1985 and 1986. A fishery organization recorded the net burst frequency during the herring fishery last winter. Data about the mortality caused by net burst do not exist, but our purse seine statistics can be used to estimate worst case figures of unaccounted fishing mortality.

Figure 1 shows the frequency distibution of catch size and time of catch for the Norwegian spring-spawning herring, North Sea herring and mackerel fisheries. The Norwegian spring-spawning herring were mainly caught during winter night-time, along the northwest coast of Norway, while the North Sea herring and mackerel were fished during the daylight and dusk hours in May-July and July-October, respectively. The catch size in these fisheries varied from 5 to 500 tons, but most catches were less than 100 tons. Average catch size was significantly different ($P<0.05$, Kruskal-Wallis test) in these fisheries, and the biggest average and maximum catch size were obtained during the Norwegian spring-spawning herring fishery (Table 1, Fig. 1).

Table 1. Average catch size (x) in Norwegian purse seine fisheries.
(SD = Standard deviation, n = number of catches.)

	x tons	SD tons	n
Norwegian spring-spawning herring	73.1	95.9	88
North Sea herring	57.9	49.9	192
North Sea mackerel	48.8	54.6	103

The distribution of catch size related to time of day for these fisheries, are given in Figure 2. There is a tendency to larger catches during the daylight hours in the Norwegian spring-spawning herring fishery, but one 500 tons catch was also obtained at night. One net-burst (in an evening trial) was reported in this material from the Norwegian spring-spawning herring fishery.

Number of net-bursts for parts of the 1989 fishing season on the traditional spawning grounds for Norwegian spring-spawning herring off the northwest coast of Norway, as recorded by a fishery organization, is given in Table 2. As mentioned in the introduction, daytime fishing was closed during this season (week no. 9). Prior to the closing of the daytime fishing, net bursts (and loss of the catch) occured in abouth half of the daytime sets (6

net-bursts in a total of 14 daytime sets). During evening and night-time, the number of net-bursts was 1 out of 35 sets. These data clearly demonstrate that net-bursts occur mostly during daytime, but the data contain no information of the school size or mortality caused by the net-bursts.

Table 2. Weekly numbers of sets and net-bursts in the 1989 fishing season for Norwegian spring-spawning herring.
E = net burst during the early phase of the net hauling
L = net burst during the late phase of the net hauling
* daytime fishing closed
Total number of sets in brackets

Week no.	6	7	8	Σ 6-8	9*
Daytime	1E + 2L (5)	2L (5)	1E (4)	2E + 4L (14)	-
Evening	(3)	1E (4)	(3)	1E (10)	5
Night	(2)	(2)	(21)	(25)	10

It is tempting to calculate a figure for the unaccounted fishing mortality during the Norwegian spring-spawning herring fishery on the basis of the described purse seine statistics. The total quota for the period 1985-1987 was about 180,000 tons for the purse seine fleet. Given an average catch size of 73 tons (Table 1), the total quota has been fished by 2465 sets. Only one evening net-burst, as recorded in the log-book data, is probably an underestimate when compared to the Table 2 data, which clearly show that net-bursts mainly occurs during daytime fishing. Assuming that the data in Figure 1 are representative, the frequency of daytime sets is 8/88, and the average daytime catch size 262.5 tons (SD = 136 tons, n = 8). This indicates that 58,800 tons have been fished during daytime. Further, assuming that the frequencies of daytime accounted and unaccounted fishing mortality are given by the Table 2 data (8/14 and 6/14), respectively, and that the average school size was the same (262.5 tons) both in the sets causing accounted and unaccounted fishing mortality. If it is assumed that a net-burst causes eighter instant or long term mortality to every fish involved, then there may have been a total unaccounted fishing mortality of 44,100 tons, or 168 sets with net-burst (each causing a mortality of 262.5 tons) for the period 1985 - 1987. If there is no mortality due to an early net-burst, the total unaccounted fishing mortality reduces to 29,400 tons, or 112 sets with late net-bursts in the period 1985 - 1987.

These figures are unreliable, as they are based on few data and questionable assumptions, especially that every fish involved suffers either instant or long term mortality due to the net-bursts. However, these figures clearly indicate that net-bursts cannot be the cause of the unaccounted mortality in 1985-1987 of 150,000 tons, estimated by Anon (1988).

We have no exact information of mortality and school behaviour during and after a net-burst. During cruises onboard commercial fishing vessels to study and quantify the swimming behaviour of herring and mackerel schools during purse seining (Misund, 1988), we never observed net-bursts, but two incidental observations are relevant. One was made during daytime in a shallow fjord. A 150 tons school of Norwegian spring-spawning herring performed a behaviour which might have caused a net-burst (Fig. 3), but the net was strong enough to resist the pressure by the fish. This behaviour did not seem to have caused any instant mortality or damage to the herring, as the herring was visually observed to school around in the net until it was concentrated in the bag, and no damaged fish were recorded during brailing.

Figure 4 shows the Simrad SM 600 sonar recorded swimming behaviour of a 150 tons school of Norwegian spring-spawning herring during circling of the vessel and shooting of the net. Half on hour earlier this very same school caused a net-burst by another vessel. In the recorded situation, the school was caught, and there was no sign of damage on the herring.

These two observations clearly indicate that at least not all fish involved in a net-burst suffers instant fishing mortality.

UNCERTAINTIES AROUND THE NET-BURST PROBLEM

Modern fishery statistics and fishery management should not be based on uncertain and questionable assumptions, and the net-burst problem raises some important questions:

1. How large is the instant and long termed fishing mortality after a net burst?
2. What are the reasons for the instant and long term fishing mortality?
   a) Instant mortality:
      - The fish get squeezed against the net?
      - The fish get over-exhausted and die by swimming against the net?
      - The combined effects of high swimming activity, high density and low oxygen content within the school?
   b) Long term mortality:
      - Problems with osmo-regulation due to loss of scale?
      - Infection deceases due to wounds?
      - Reduced resistance against deceases and predators?
3. What causes contributes to net burst?
   a) The fish behaviour?
   b) Catching on large and dense schools?

c) Fishing operation during heavy sea?

d) To weak webbing in the nets?

e) Stops during hauling the net?

The Institute of Fishery Technology Research and the Institute of Marine Research, Bergen, have planned a project to verify and quantify the net burst problem, find reasons for the mortality, and improve the fishing operation with the aim to reduce the unaccounted fishing mortality.

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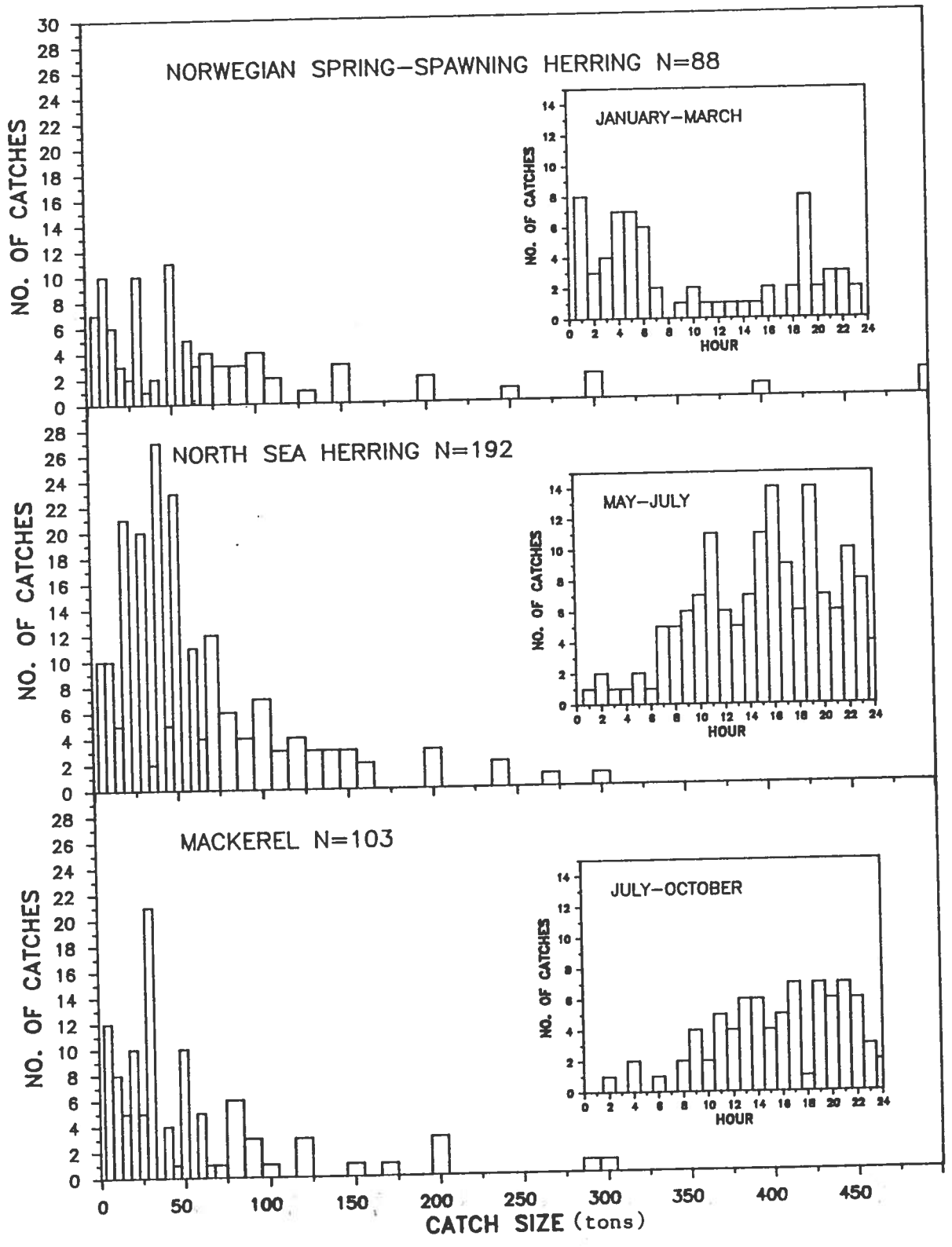


Figure 1. Distributions of catch size and time of catch for the Norwegian purse seine fisheries for Norwegian spring-spawning herring, North Sea herring, and mackerel, 1985-1986.

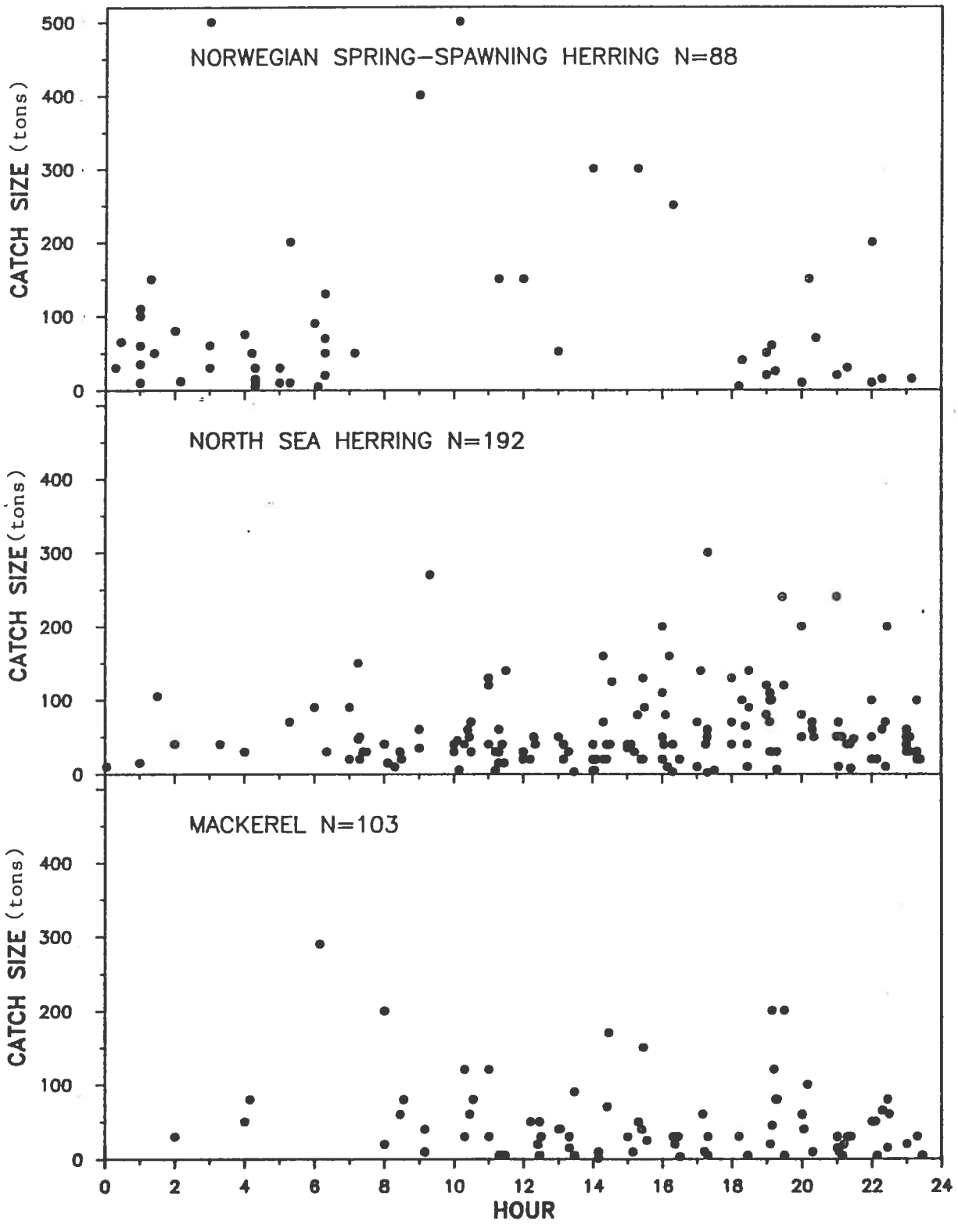


Figure 2. Distribution of catch size to time of day for the Norwegian purse seine fisheries for Norwegian spring-spawning herring, North Sea herring, and mackerel, 1985-1986.

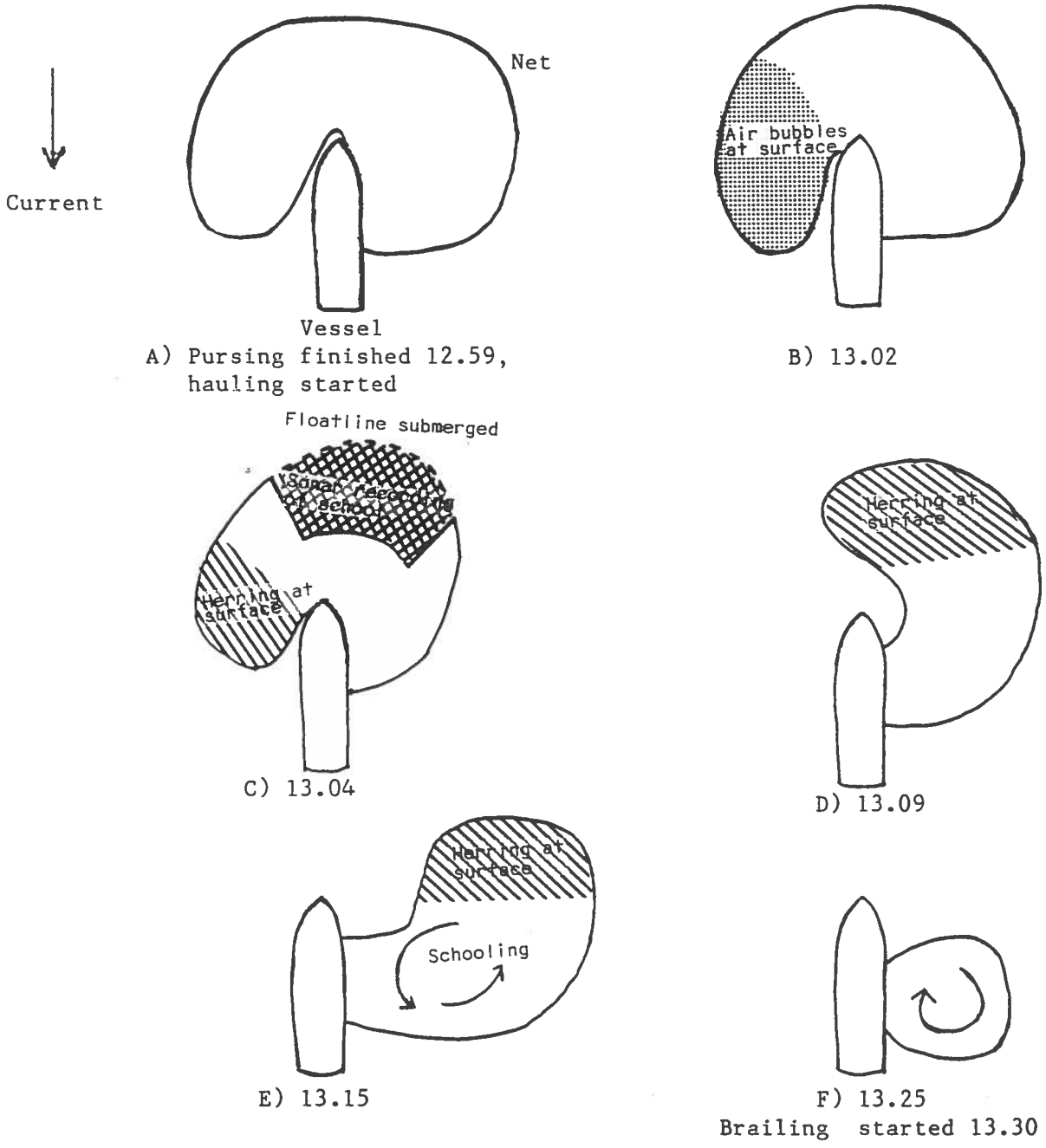


Figure 3. Visual observations and sonar recording of a 150 tons Norwegian spring-spawning herring school during purse seining in Solemsundet, Northwest Norway, January 14, 1985.

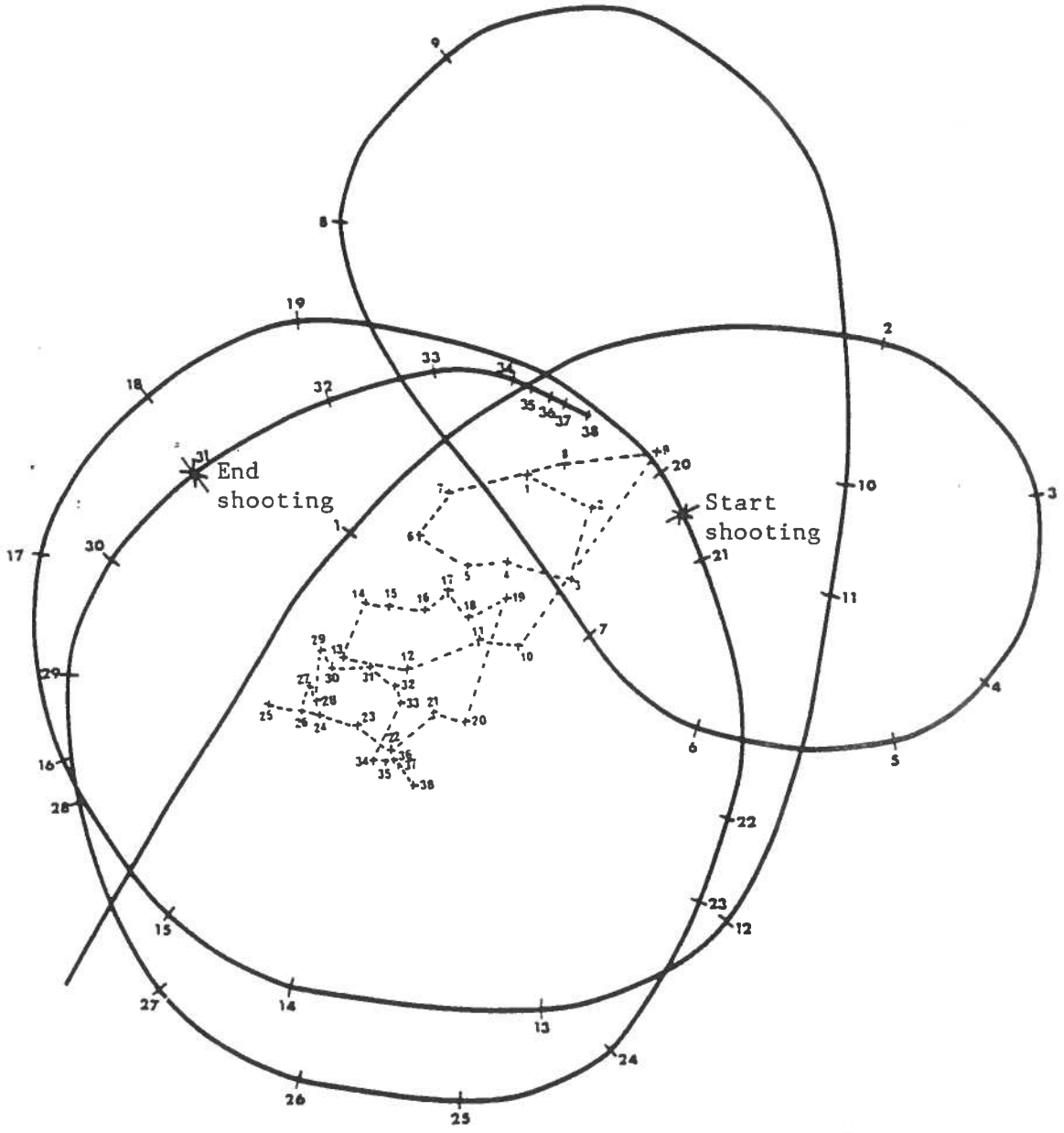
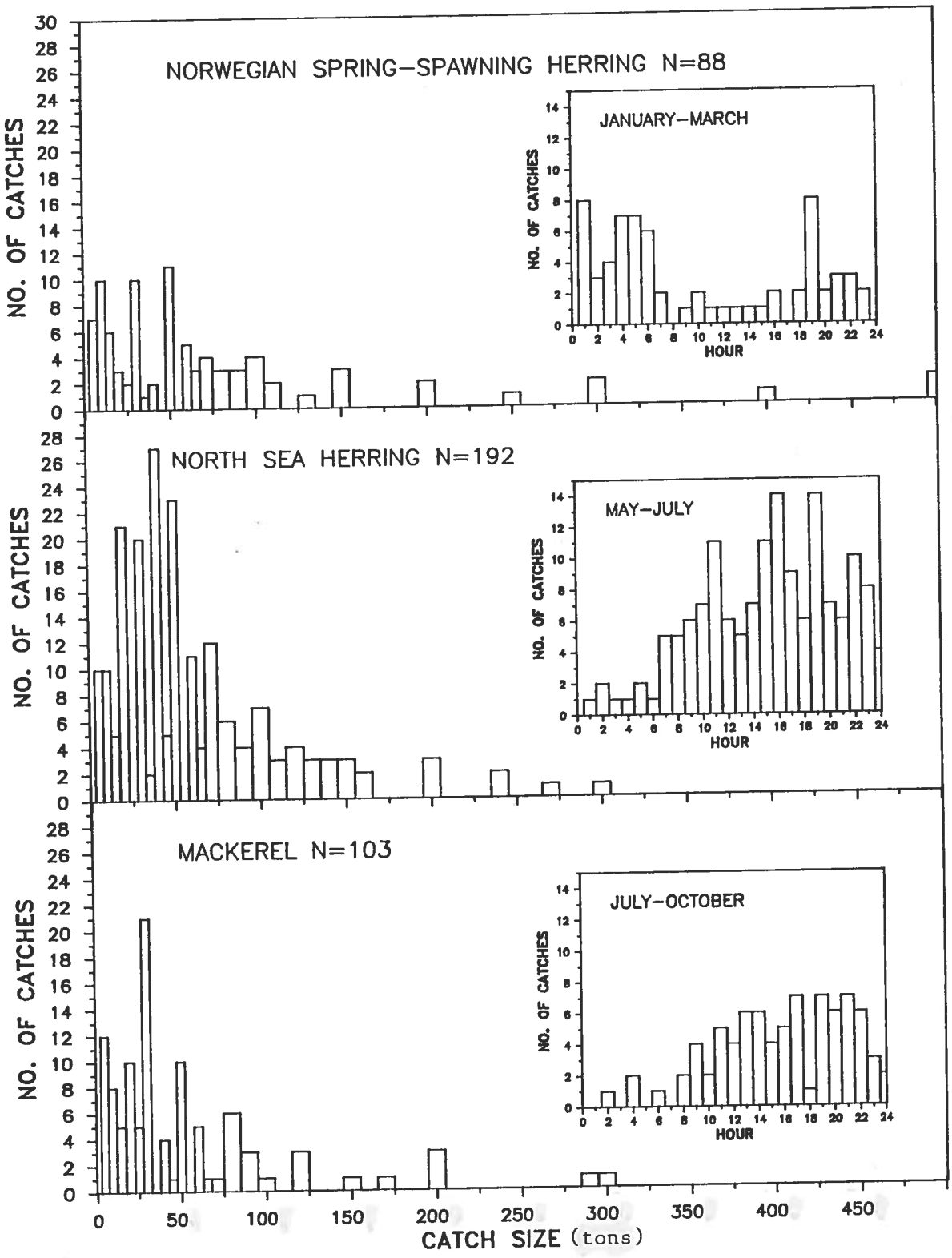


Figure 4. Simrad SM 600 sonar recording of a 150 tons school of Norwegian spring-spawning herring in Freifjorden, Northwest Norway, January 18, 1985 (observation interval: 30 sec.).



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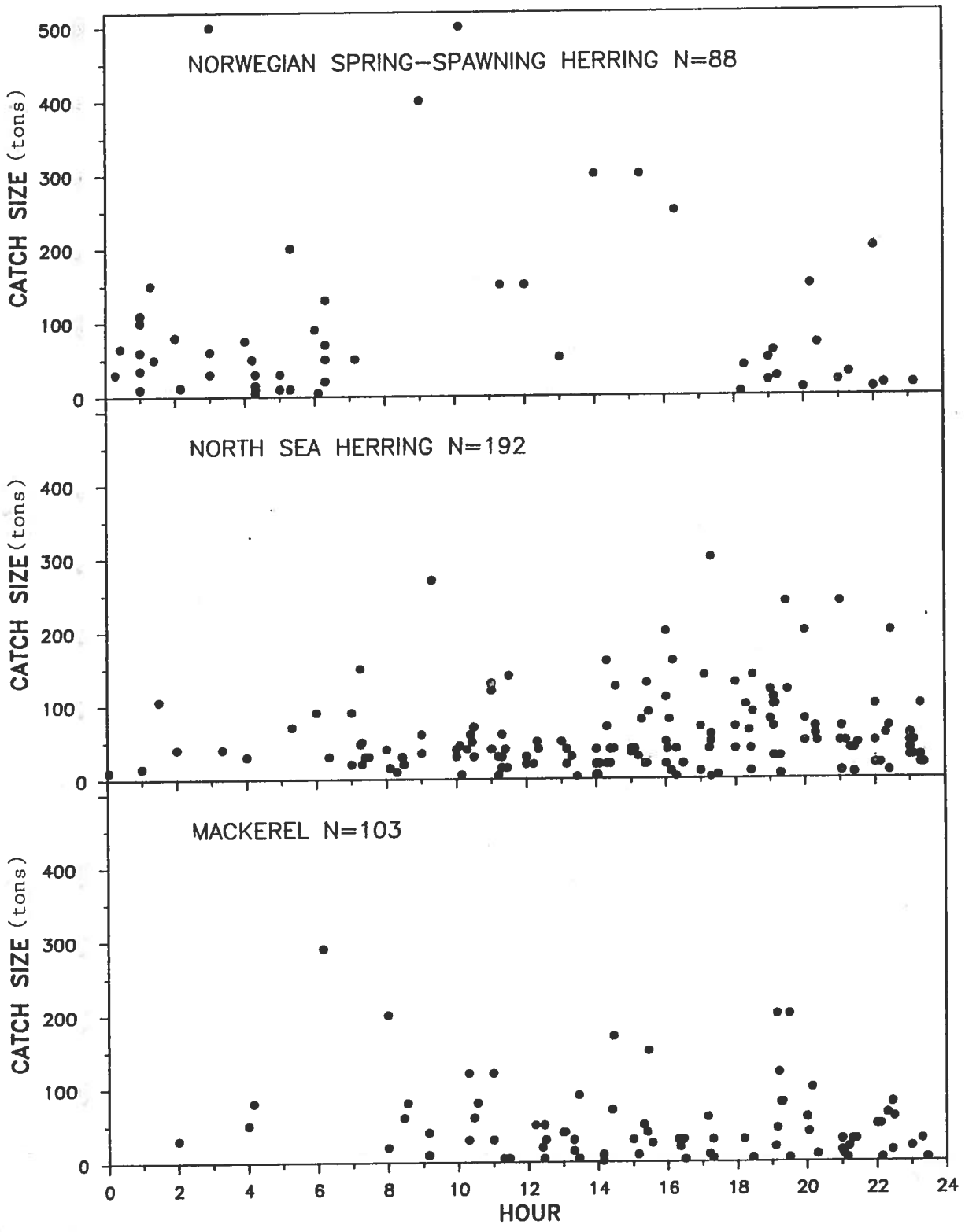

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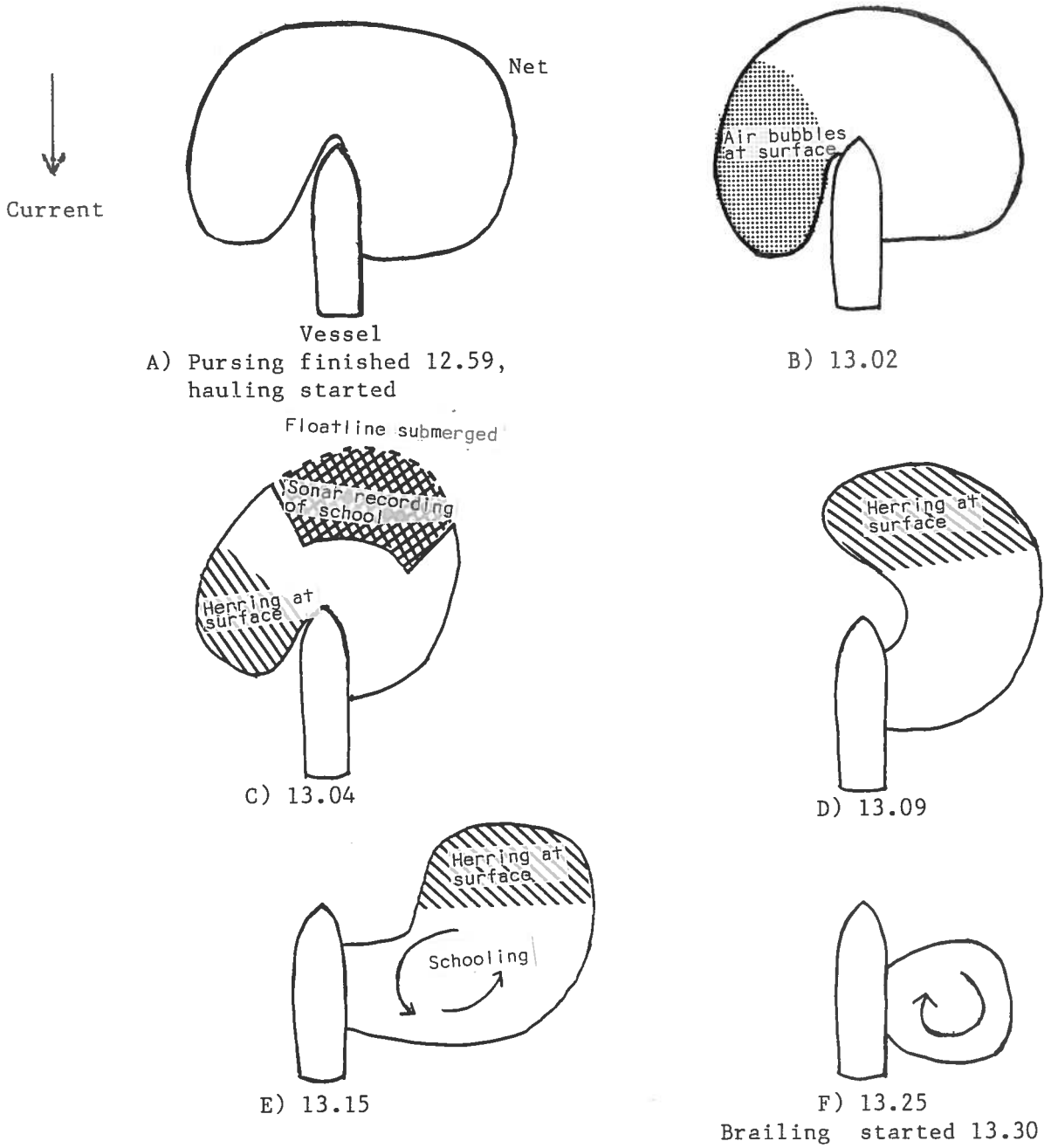

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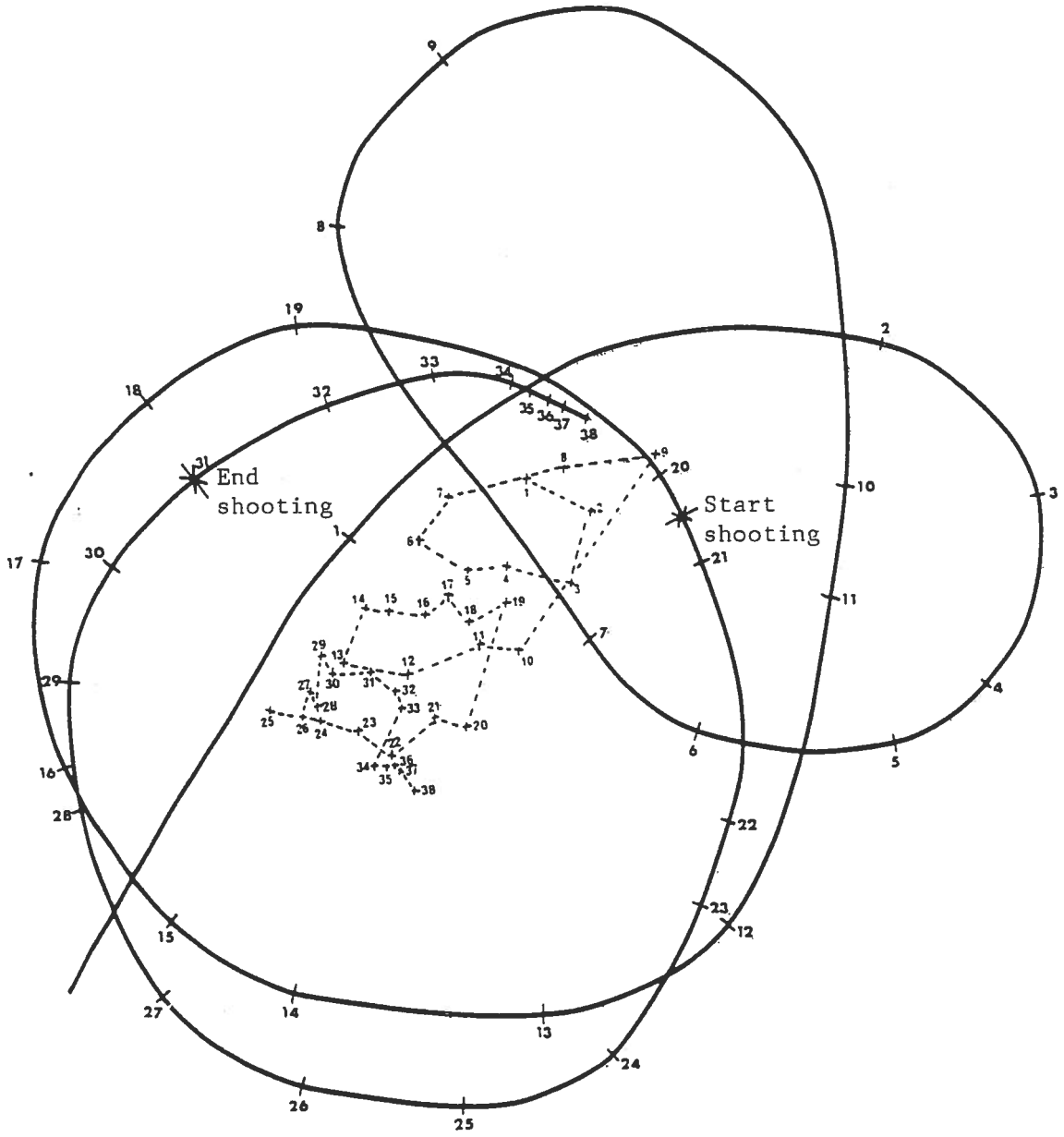

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