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SCALE DAMAGE AND SURVIVAL OF COD AND HADDOCK ESCAPING FROM A DEMERSAL TRAWL

by

Aud Vold Soldal, Bjørnar Isaksen, Jon Einar Marteinsson* and Arill Engås
Institute of Marine Research,
Fish Capture Division,
P.O.Box 1870, N-5024 Bergen, Norway

*Norwegian College of Fishery Science, University of Tromsø,
Dramsvei 201,
N-9000 Tromsø, Norway

ABSTRACT

Cod *(Gadus morhua L.)* and haddock *(Melanogrammus aeglefinus L.)* escaping through the meshes of a cod-end (135 mm diamond meshes) or through a metal grid sorting device mounted in the foremost part of the cod-end, were withheld in cages (2x2x5m) covering the cod-end during trawling. The scale loss of the escaped fish was examined and compared to that of cod and haddock from a control group. On average, less than 1% of the total body surface of cod was injured, while haddock, particularly those smaller than 40 cm, showed substantial scale loss.

Cages containing escaped fish were released from the trawl by means of an acoustic releaser and kept for observation (UTV) at sea bottom for 12 to 16 days. No mortality was found for cod, and the mortality of mesh and grid selected haddock was less than 10 %. Methodological problems that may have lead to errors in the mortality estimates are discussed.

INTRODUCTION

Trawl and gillnet fisheries are usually regulated through minimum legal mesh sizes, and it is assumed that fishes escaping through the meshes of a fishing gear survive and add to the future spawning stock. However, the value of regulating catches by changing the mesh size has been questioned as there is no proof of the survival of fish struggling out through the meshes (Zaferman and Serebrov 1989). Investigations have shown that haddock *(Melanogrammus aeglefinus L.)* may suffer from heavy scale loss and skin damage after escapement through a trawl cod-end, and that this may lead to mortality (Main and Sangster 1990), while cod *(Gadus morhua L.)* seem to be less exposed to damage and mortality.

To investigate the importance of gear induced damage and mortality in the Norwegian demersal trawl fisheries for gadoid fishes, two field experiments were conducted. The investigation intended to serve two main purposes: 1) To observe scale loss and injury rate of gadoid fishes escaping from a commercial demersal trawl (the 1990 season). 2) To investigate the mortality rate of escaped fish (the 1991 season).

MATERIALS AND METHODS

The experiments were carried out off the coast of Finnmark, northern Norway, with a hired stern trawler (47m, 1250Hp). Trawling was performed at 30 to 60m bottom depth with a towing speed of 3.6 to 3.8 knots. Escaped fish were collected from 1) the cod-end of a commercial demersal trawl (Cotesi no. 3) with 135 mm diamond meshes ("mesh selection" group), 2) a metal grid sorting device (55 mm between ribs) mounted in the front part of the cod-end of an identical trawl ("grid selection" group), and 3) an open trawl without a cod-end ("control" group). During the trawl hauls the cod-end ("mesh selection", Fig. 1 and 2) or the opening of the grid ("grid selection", Fig. 3) were covered by a small meshed net kept open by aluminium rings. A net cage on aluminium frame (2x2x5m) was mounted at the end of the cover-net by single chain stitches ("monkeybraid", Fig. 4). Due to dense fish concentrations in the area, towing time was set to 10 minutes for the two selection groups and 5 minutes for the control group.

During the scale loss studies (Marteinsson 1991) the cages were heaved onbord the trawler, and the skin damage of individual fish was visually assessed as the % scale loss of each of 10 sections on each body side as proposed by Main and Sangster (1988 and 1989), and the scale loss in % of total body surface calculated. To study mortality the cages were released from the trawl by means of an acoustic releaser which caused the monkeybraid to unstitch. Simultaneously, the slack net in front of the cage was closed with two 11" floats attached to a closing rope (Fig. 4). A small assistant vessel then picked up the marking buoy of the cage and it was towed slowly (1.3 knots) along the bottom for one to two hours into a sheltered fjord area. The cages, three parallels in each experimental group, were left at sea bottom (20m depth) for observation for 12 to 16 days. The main species in the area were cod and haddock, but some cages also contained significant amounts of saithe *(Pollachius virens L.)* and plaice *(Pleuronectes platessa L.)*. The number of fish in the cages varied between 150 and 1000 (Table 2), dependent on fish distribution in the trawled area and catching success.

The cages were regularly inspected by a small ROV and dead fish counted. Twice during the observation period selected cages were emptied by divers and the dead fish visually inspected for skin injuries. Due to technical problems, the ROV was not used the last 7 days of the observation period.

RESULTS

The scale loss and mortality studies showed that cod was highly resistant to gear damage. For cod larger than 30 cm the average scale loss was less than 1 % of the body surface both in the experiment and the control groups. Smaller cod seemed to have a somewhat higher scale loss (Table 1a), but only five specimens of this size were caught. Saithe showed an observed average scale loss of about 1 to 2 % for fish larger than 40 cm (Table 1b). Also for saithe there was a tendency of increased scale loss for smallest size groups.

The scale loss of haddock was substantially larger than for cod and saithe, and highly dependent of fish size (Fig. 6). A rapid increase in loss rate for haddock smaller than 30-35 cm was observed, with a loss of nearly 100 % for fish below 25 cm. Haddock larger than 40 cm was less damaged (below 5% of body surface). The scale loss of mesh selected haddock smaller than 40 cm was significantly higher than that of grid sorted fish. However, the smallest length groups of control fish also had a significant scale loss, and there was only small differences between controls and grid selected fish.

At the end of the 1990 observation period, the skin damage and scale loss of the fish remaining in the cages were assessed. The extent of injuries was smaller than for the corresponding group of newly escaped fish, probably because those with the heaviest wounds had died. However, nearly all fish with skin damage had developed heavy infections.

The fish caught in the cages consisted of a mixture of haddock, cod and saithe (Table 2). With two exceptions (cage 4 and 5), haddock was the most abundant species. No mortality of cod was observed during the observation period. The mortality of saithe also seemed to be low, but difficult to assess because of low numbers of saithe in the majority of the cages. The mortality of haddock was larger (Table 3): 0.9 and 6.5% in the mesh selected groups, 5.3 to 10.5 in the grid selected groups, and 8.9 to 32.2% in the control groups. The fish that died, mainly did so within the first 5 days of captivity, and after one week there was almost no mortality.

Use of underwater cameras outside and inside the cages during the different stages of the trawling, release, towing and anchoring phase of the cageing procedure revealed several methodological problems that most likely have added to the gear induced mortality and skin damage. Particularly two conditions were found to be of importance: 1) Small fish tended to rest against the rear net wall of the cage during trawling, probably because of exhaustion, and might loose scale by rubbing against the net. 2) As the cage was released from the trawl, the front end of the cage was lifted vertically in the sea for a short while. A lot of fish were seen rushing into the shutting funnel at this moment. As the cage was towed into the observation area, the funnel bent over the top of the cage, and fish standing within were trapped, squized and rubbed against each other and the net. When the cage was left on the seabed, they were gradually released and either fell dead on the cage floor or whired about heavily wounded. These fish could not be discriminated from those killed by the escapement process and may have lead to a significant overestimate of the mortality. Exceptionally large quantities of fish were trapped in cage 4 and 5, both "controls", and this is one reason for the high mortality rates found in the control groups. Another reason is cannibalism, as the fish in the control groups were not size selected. A number of large cod (>50 cm) were present in these cages. At the end of the observation period, their stomachs were opened and revealed several small haddock.

DISCUSSION

The vulnerability to gear damage clearly differs between the gadoid species studied in these experiments. While cod seems to manage the escapement from the trawl, both through the cod-end meshes and through a grid sorting device, with almost no visible damage, haddock was found to loose scale in the escapment process, particularly those smaller than 40 cm. Although the overall mortality of both species was low, it was higher for haddock than for cod. This is in agreement with similar experiments in Scotland (Main and Sangster 1991), and also with controlled tank experiments where scale were manually derived from the body surface of cod and haddock (Engås et al. 1990). The amount of saithe was too low in most cages to give reliable estimates of mortality, and further experiments have to be carried out to study this species.

The scale loss studies showed a clear length dependency of injury rate. This was most evident for haddock, but seemed to be true for cod and saithe also. The Scottish experiments did not show this tendency (Main and Sangster 1988). Fish within the selection range of the mesh size studied (for 135 mm meshes, fish between 40 and 50 cm) should logically have to struggle hardest to wriggle through the cod-end meshes and thus get the largest wounds. However, fish within this length range had hardly any visible skin lesions at all. Use of underwater camera showed that the smallest fish got exhausted during trawling, and after having passed through the cod-end, they rested against the rear net wall as long as the towing speed (3.6 to 3.8 knots) was kept. Although the hauls were short (10 min.) and a small meshed, knotless net was used in the rear section to create a "bucket effect" with low water speed, the observed scale loss of small fish may, at least partially, be explained by these circumstances. In addition, the scale loss of all length groups may have been increased when the cages were heaved up the stern of the trawler. The fish were then thrown about within the cage, rubbing against the net wall and other fish. The scale loss rates obtained are therefore maximum estimates, and the bias is probably larger for small than for large fish.

That scale loss may be caused by other factors than the escapement process itself, is also demonstrated by the fact the level of injuries of the control groups were not significantly different from that of the grid selected fish. The control fish, which had passed through a normal trawl procedure except for the cod-end selection, may either have been damaged within the belly of the trawl, or by the handling after the capture process.

The mortality rates given in Table 3 must not be taken as accurate estimates of the amount of haddock dying from injuries caused by the escapement alone. They are rather maximum mortality rates caused by a set of factors including the capture-, escapement- and experimental procedure. Physical damage, exhaustion, cageing stress and infections due to hight density in cages may add to the mortality, and in the control groups cannibalism also may have been of importance. The relative importance of the different sets of factors may vary among hauls and give rise to a large variability within the experiment groups, but the mortality caused by the escapement process alone are probably minor in the majority of cages.

In spite of the many factors tending to reduce the survival, the total mortality of haddock was less than 10% in the two experiment groups, and it was even lower in the selection groups than in the control groups. The low mortality rates agree well with those reported by Main and Sangster (1991), and it seemed to be similar for the two different selection methods (mesh and metal grid selection) tested in the experiment. Most fish seem to survive the selection process, and for fisheries management purposes there seem to be no reason to leave the concept of saving small fish by using minimum mesh sizes or a sorting grid.

REFERENCES

Engås, A., Isaksen, B. and Soldal, A.V. 1990. Simulated gear injuries on cod and haddock. ICES Fish Capture Committee, FTFB Working Group Meeting, Rostock 23-25 April 1990.

Main, J. and Sangster, G.I. 1991. Do fish escaping from cod-ends survive? Scottish Fisheries Working Paper No 18/91.

Main, J. and Sangster, G.I. 1990. An assessment of the scale damage to and survival rates of young gadoid fish escaping from the cod-end of a demersal trawl. Scottish Fisheries Research Report No 46, 1990.

Main, J. and Sangster, G.I. 1989. Techniques for assessing fish damage and survival after escape from trawl cod-ends. Scottish Fisheries Working Paper No 9/89.

Main, J. and Sangster, G.I. 1988. A progress report on an investigation to assess the scale damage and survival of young gadoid fish escaping from the cod-end of a demersal trawl. Scottish Fisheries Working Paper No 3/88.

Marteinsson, J.E. 1991. Skader på fisk som sorteres ut i fiske med bunntrål. (Damage of fish which are sorted out in fisheries with demersal trawl). Thesis, University of Tromsø, May 1991, 81pp. In Norwegian.

Zaferman, M.L. and Serebrov, L.I. 1989. On fish injuring when escaping through the trwl mesh. Coun. Meet. int. Coun. Explor. Sea, 1989/B:18.

Table 1b. Average scale loss in % of total body surface of cod (*Gadus morhua* L.).

Length groups	Mesh selection		Grid selection		Control group	
	%	N	%	N	%	N
< 30 cm	43.7	5		0		0
30-90 cm	0.1	81	0.12	64	0.02	32

Table 1b. Average scale loss in % of total body surface of saithe (*Pollachius virens* L.).

Length groups	Mesh selection		Grid selection		Control group	
	%	N	%	N	%	N
31-40 cm	14	33		0		0
41-50 cm	5.9	56	1.4	6		0
51-60 cm	1.1	4		0	1.7	3
61-70 cm		0		0	1.1	20
71-80 cm		0		0	1	12

Table 2. Total number of fish and species composition in the cages used for mortality studies.

Experiment group	Cage no.	Total no. of gadoids	% haddock	% cod	% saithe
Mesh selection	2	398	84.6	14.1	1.3
	3	175	66.1	32.8	1.1
	10	999	98.4	1.4	0.2
Grid sorting	6	702	70.9	8.8	20.2
	7	155	71.9	5.5	22.6
	8	518	81.0	13.3	5.7
Control	4	575	29.0	43.7	27.2
	5	294	48.9	50.4	3.7
	9	170	80.7	17.5	1.8

Table 3. Total mortality of haddock during the observation period.

Experiment group	Cage no.	Observ. period (day)	Closing funnel problems*	No. of haddock	No. of deaths	% mortality	Average mortality
Mesh selection	2	16	+	340	22	6.5	
	3	15	–	116	1	0.9	3.7
	10	9	+	984	**		
Grid sorting	6	14	–	505	27	5.4	
	7	13	–	114	9	7.9	7.9
	8	13	+	428	45	10.5	
Control	4	15	++	127	41	32.2	
	5	14	++	131	26	19.8	20.3
	9	12	+	146	13	8.9	

* The amount of fish trapped in the shutting funnel, adding to mortality; – Few fish, + medium amounts, ++ large amounts
** Cage excluded due to technical problems with ROV during observation period

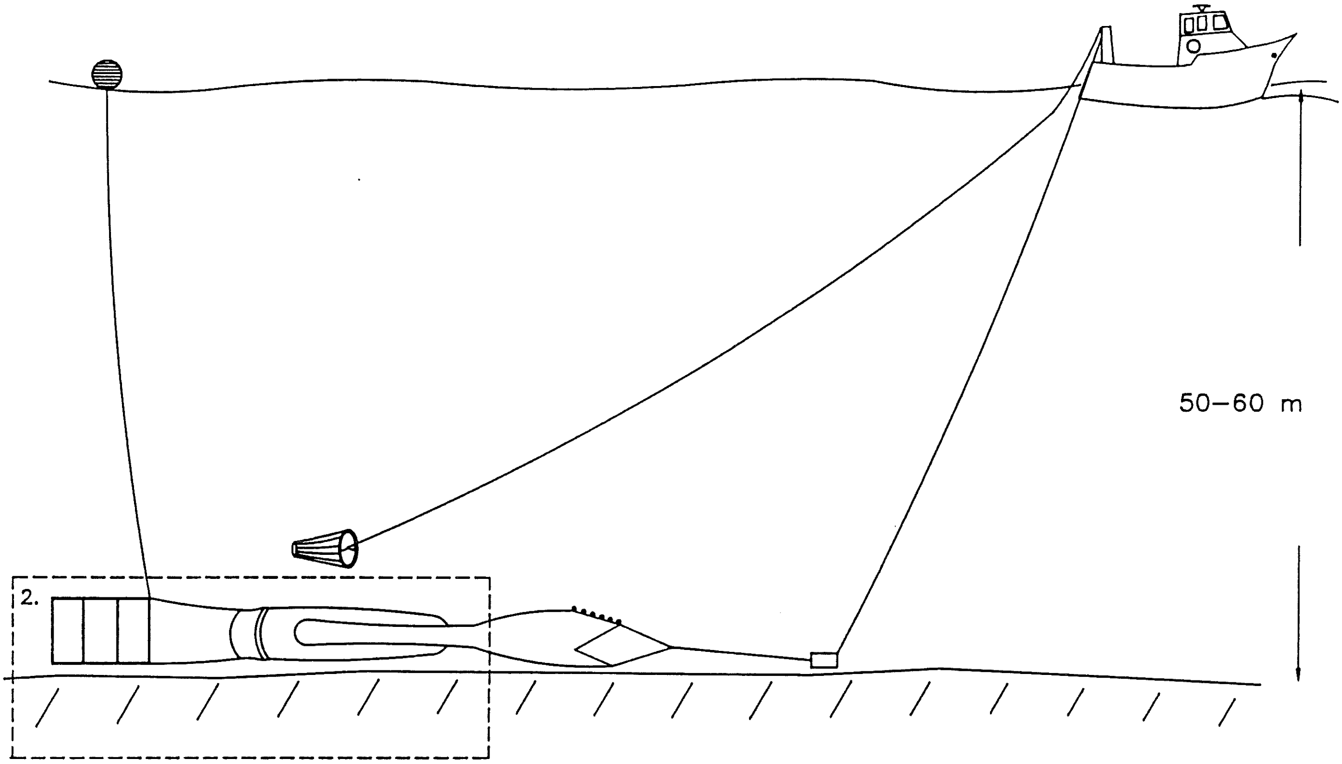

Figure 1. Experimental set up during trawling with the demersal trawl Cotesi no. 3. The cod-end is covered by a small meshed cover net. The trawling procedure is inspected with the towed ROV "Ocean Rover".

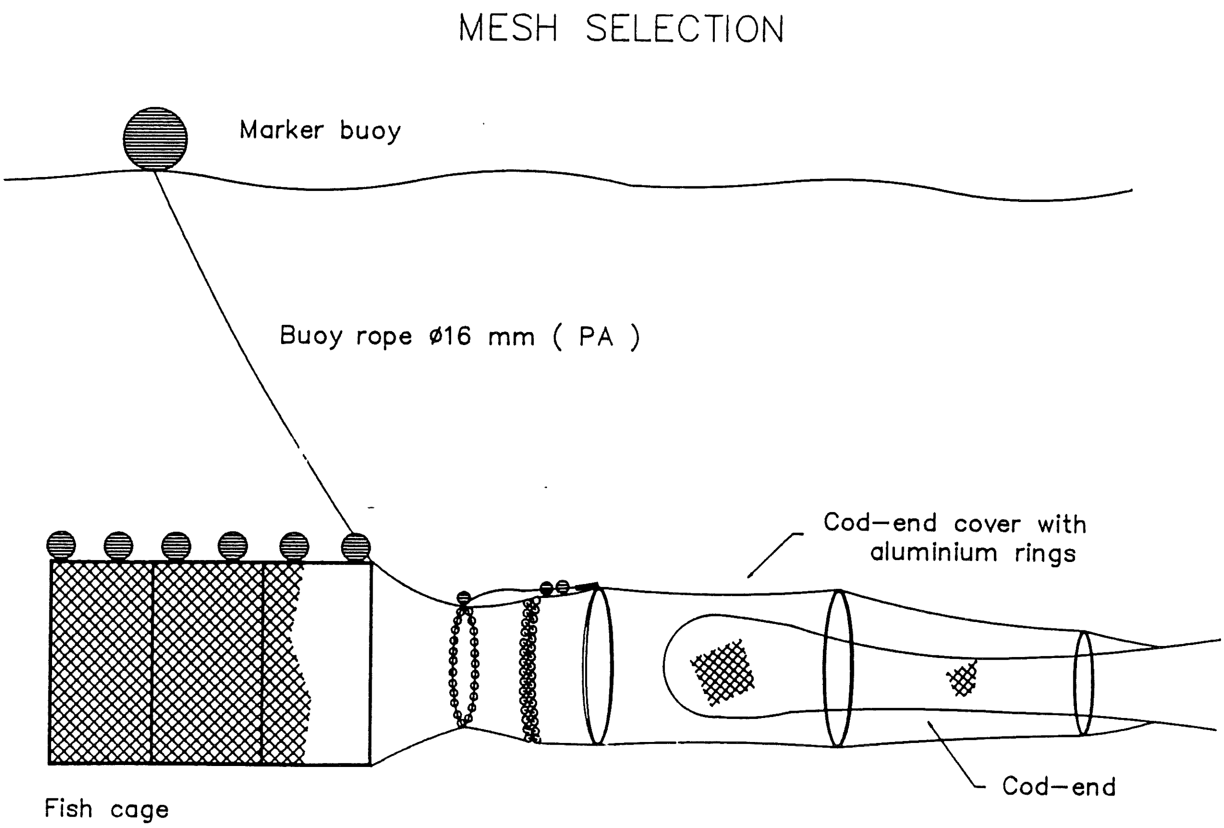

Figure 2. Rigging of cage and cod-end cover for catching fish escaping through the cod-end meshes (135 mm).

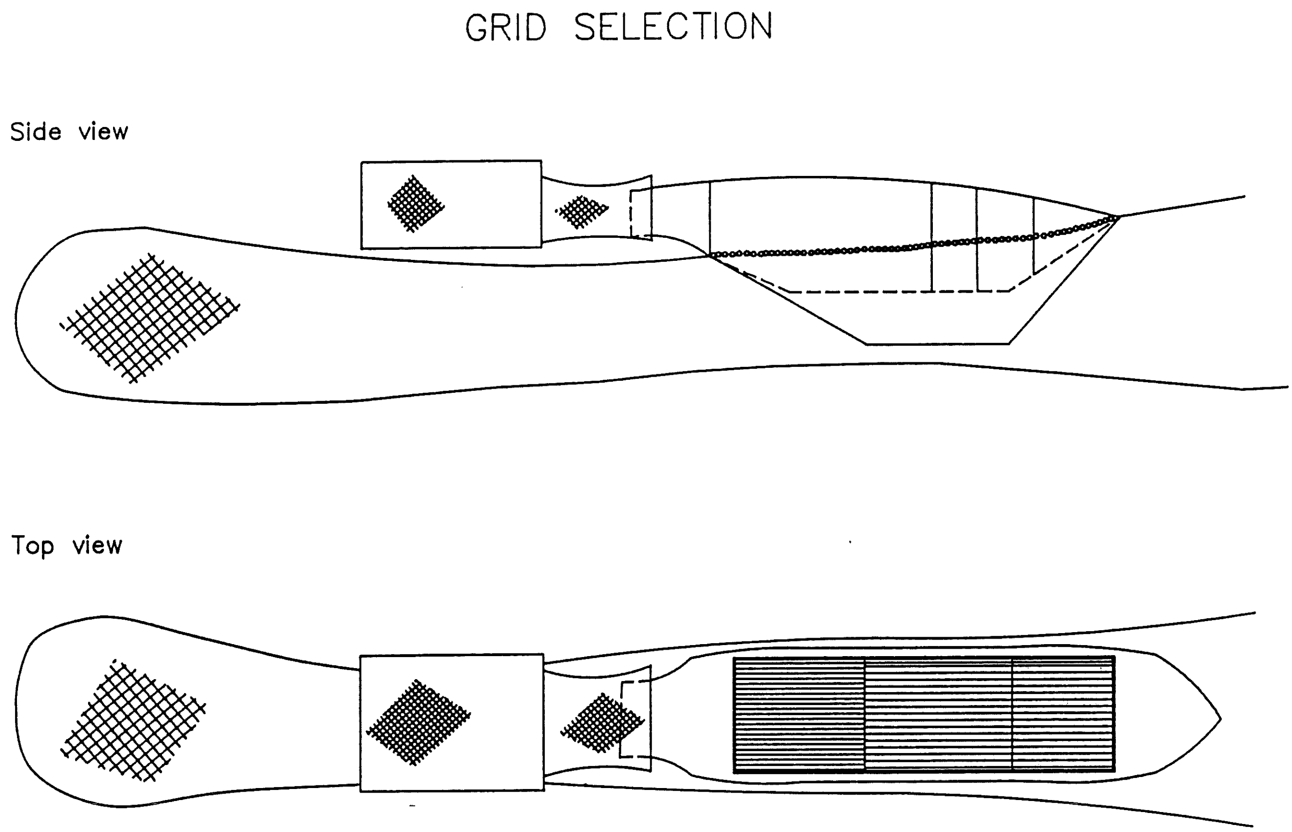

Figure 3. Rigging of the equipment for catching fish escaping through the metal grid sorting device.

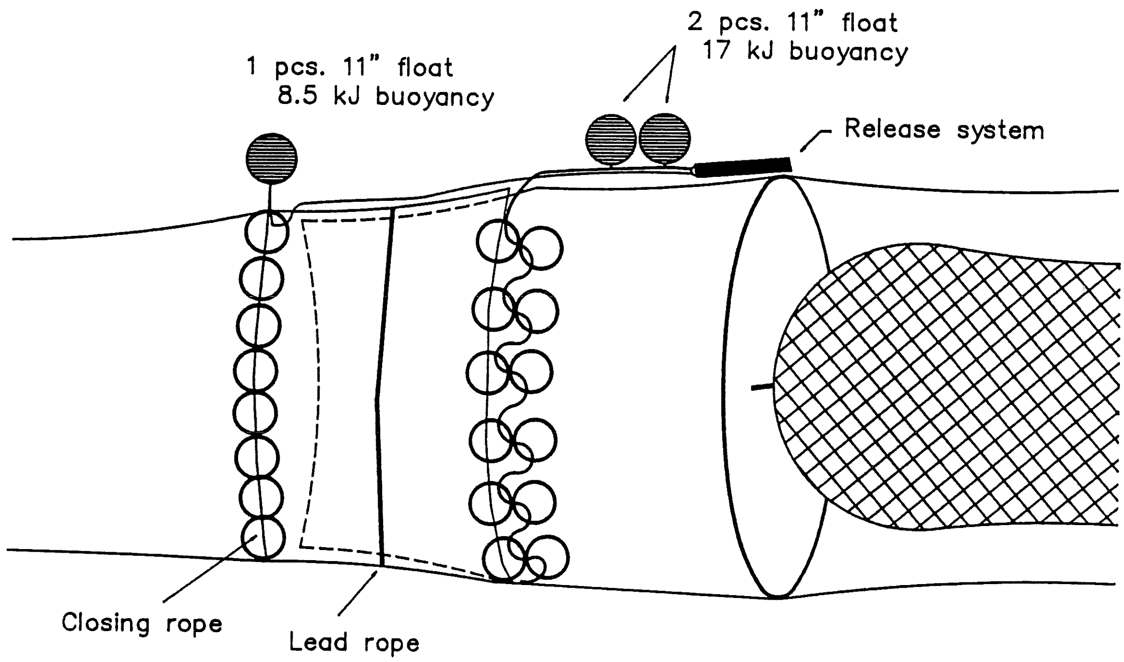

Figure 4. Mounting of the shutting funnel of the cage to the cod-end cover. The attachment was done by single chain stitches ("monkeybraid"). An acoustic releaser made the "monkeybraid" unstitch at a given acoustic signal, and the cage was left at sea bottom.

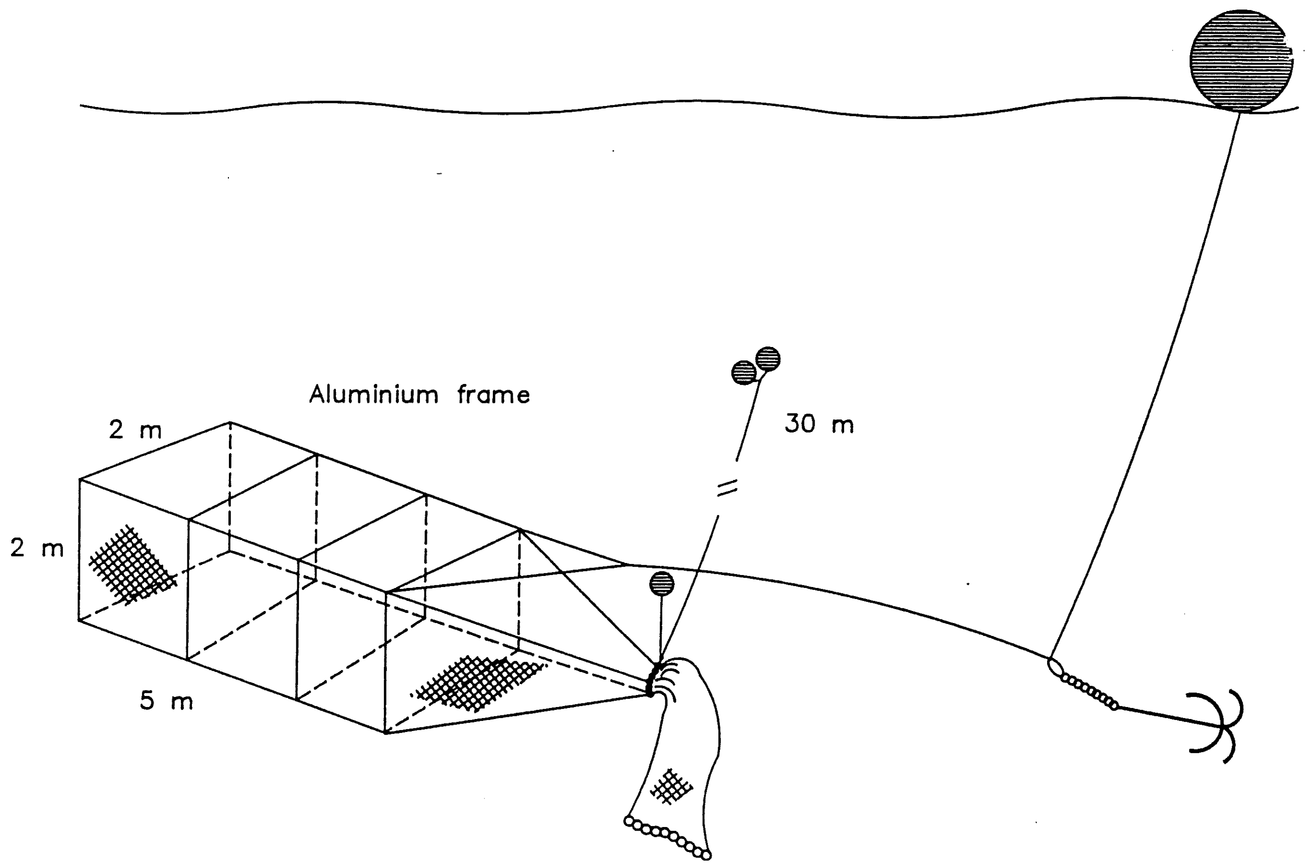

Figure 5. Anchoring of the fish cages at sea bottom during the observation period

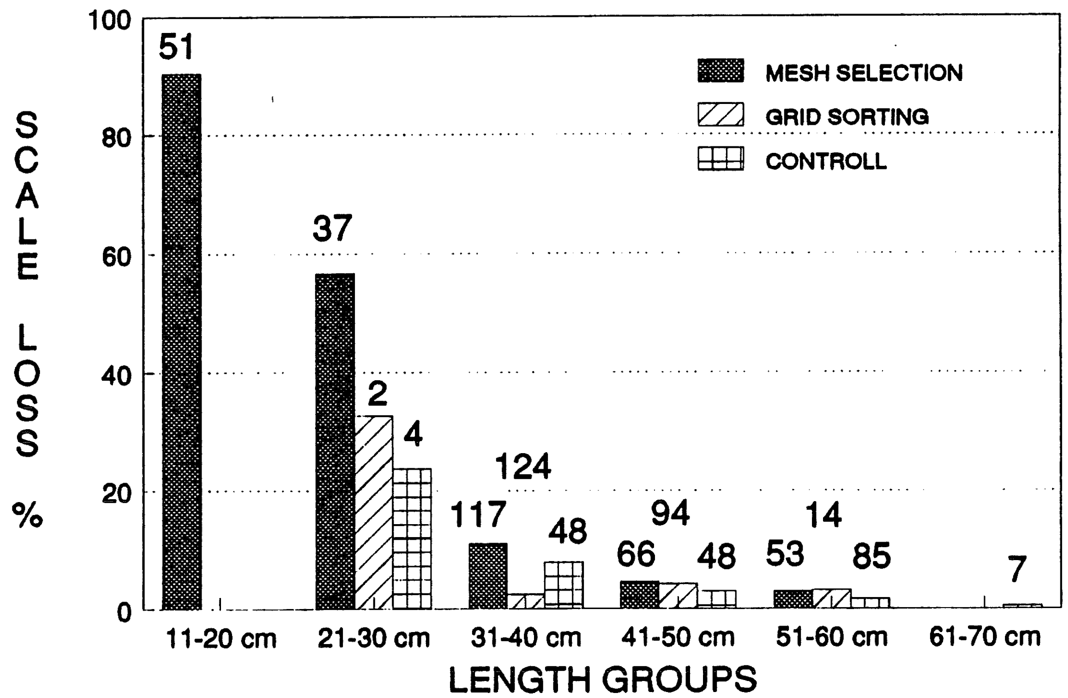

Figure 6. Average scale loss in percent of body surface of haddock *(Melanogrammus aeglefinus)* from the different experimental and length groups. Numbers of fish investigated in each group is given above each bar.