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Mortality and injuries of haddock (*Melanogrammus aeglefinus*) that are caught by pelagic longline

By

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ABSTRACT

By-catches of haddock *(Melanogrammus aeglefinus)* below legal size (44 cm total length) in the seasonal pelagic longline fisheries for haddock off the coast of Finnmark, northern Norway, are often high. The small fish are torn off the hook at the vessel side by means of a crucifier or a gaff and returned to the sea. It is generally thought that most of the discarded haddock die. An investigation to quantify this mortality was done in the season for this fishery in 1997. The undersized haddock that were torn off the longline hook were recaptured by gently catching them in a dip net as they reached the sea surface. Survival of haddock torn off by means of crucifier alone was compared to haddock torn of the hook by means of a gaff. The fish were transferred in tanks onboard a vessel to holding pens made of small meshed knotless netting floating at the surface. They were visually monitored for 7-11 days. The control group consisted of haddock fished with clean hooks without barbs and gently released by hand. At the end of the observation period the live and dead fish were examined for external damage. The experiment showed a total mortality of 39% for fish that had been torn off by means of a crucifier, and 53% mortality of fish released by means of a gaff. The mortality of the control group was 9%. The injuries of the fish were also analysed.

Keywords: mortality, haddock, longline, pelagic, crucifier, gaff

INTRODUCTION

Although the longline fisheries often are considered to be a “clean” fishery compared to bottom trawling (Løkkeborg and Bjordal, 1992), this is not always the case. The selectivity of the longline may to a certain degree be modified by changing hook and bait size, but the size and species composition of longline catches are highly dependent on the composition of the fish population in the fishing area (Huse et al., 2000). Bycatches of unwanted species and undersized fish may occur, and in two experiments, where longline and trawl fished simultaneously within the same area (Engås et al., 1994; Huse et al., 2000), it was found that longline was less size selective than trawl when fishing for haddock. In the pelagic longline fisheries for haddock *(Melanogrammus aeglefinus)* in the Barents Sea off the Norwegian coast, the discard rate of fish smaller than legal size (44 cm total length) is often high (Soldal and Huse, 1997) but varies with the strength of the recruiting year classes. Attempts have been done to improve the size selectivity in this fishery, but with limited success (Soldal and Huse, 1997, Huse and Soldal, 2000).

Haddock, although usually considered a bottom dwelling species (see e.g. Bergstad et al., 1987), may seasonally be found in pelagic concentrations. Along the North Norwegian coast haddock is shoaling at depths between 50 and 100 m during summer. These haddock concentrations give rise to annual pelagic longline fisheries where haddock are hunted with floating lines. During hauling small fish are torn off the hook at the vessel side by means of a crucifier or a gaff and thrown over board. The fate of these fish is not known, but it is generally believed that the mortality rate of the discards is high.

The last decades considerable effort has been put into the study of unaccounted mortality, including discard mortality, in various fisheries, particularly the trawl fisheries (see Breen, 2000). However, little work has been conducted on the study of discard mortality from commercial hook fisheries. Milliken et al. (1999) studied the mortality of cod (*Gadus morhua*) torn of circle hooks by crucifier, and found that 69% of the sub legal cod died. Pacific halibut (*Hippoglossus stenolepis*) removed from setlines by automated gear retrieval systems suffered severe injuries and a potential high mortality (Kaimmer, 1994).

Norwegian fishermen use several methods for dehooking unwanted fish. A common device is the “crucifier”, which is typically composed of to vertical steel rods where the fish is stopped during hauling, and the hook is torn from the fish as it is excluded from passing through the crucifier. This may inflict injuries to the mouth parts of the fish, including breaking and ripping the jaws. At some vessels the fish is gaffed and held along the vessel side while the hook is torn out of the mouth. In addition to the above mentioned injuries to the jaws, this method also inflicts puncture of the body wall and may cause serious damage to the abdomen and intestines. It is reason to believe that the survival of discarded fish is dependent on the release method used.

To study the survival of haddock discards in the pelagic longline fisheries using two different dehooking methods, a study was carried out in 1997 with commercial coastal longline vessels off the coast of northern Norway.

METHODS

A typical coastal longline vessel (“Tone Helen” N-92-VV, 14,9 m long) provided the samples of longline caught haddock during the period 1 to 7 July 1997. The vessel was using its own longline gear with Mustad wide gap hooks and manual baiting and setting, and fished as normally done during commercial fishing. The fish were caught at depths ranging from 50 to 70 m. During hauling, unwanted fish were dehooked using two different methods:

A. Dehooking using crucifier. The fish was stopped against two vertical steel rods during hauling, and the hook was torn from the fish as it was excluded from passing through the crucifier.
B. Dehooking by withholding the fish at the vessel side using a gaff while the hook is torn out of its mouth.

The dehooked fish were recaptured by gently catching them in a dip net as they reached the sea surface. The fish were transferred to tanks with circulating sea waters onboard a small fishing vessel and transported to net pens anchored in shallow protected waters. The holding pens were made of small meshed knotless netting floating at the surface. The fish were visually monitored for 7 to 11 days. A total of five identical holding pens were set up: Two containing fish dehooked by crucifier, two containing fish dehooked by gaff, and one control group consisting of haddock fished with barbless hooks gently released by hand. The control group was fished in an area close to the longline grounds, and the transportation was identical to the other groups.

Dead fish were removed from the holding pens daily, and examined for visual damage. At the end of the observation period the remaining live and dead fish were counted and external injuries investigated. Skin injuries were classified to the right or left body side, which were divided in 12 segments. Only sores in the skin was registered, while scale loss and injuries of the epidermis was not. The injuries of the fish were classified by a cause-related approach (Table 1).

Table 1. Classification of injuries

Class	Explanation
Hook	Injuries after the hook had been torn off the mouth. All injuries ranging from small sores to rupture and damage of jaws related to the dehooking process.
Gaff	Aperture visible in the skin of the fish, clearly from the gaffing. The internal damage of tissues and organs was not investigated.
Gas	Gas collection in or around eye caused by decompression
Bird	Injuries resulting from preying birds. Indicate that decompression problems were part of the death course.

RESULTS

The mortality of haddock was severe in this experiment. During the transport to the holding pens, a significant higher mortality was observed in the group of fish that was gaffed than in the crucifier and control groups (Table 2). However, the long term mortality showed less difference between the crucifier and the gaff groups.

Table 2. Number of haddock and mortality in the holding pens

Pen	Group	Number in pen	Dead during transportation	Total number dead	Transport mortality	Total mortality
1	Control	46	0	4	0	8,7
2	Crucifier	63	7	20	11,1	31,8
3	Gaff	113	24	53	21,2	46,9
4	Crucifier	96	8	43	8,3	44,8
5	Gaff	61	27	40	44,3	65,6

Table 3. Mean length of fish and number of observations

Group	Dead fish	Live fish	n
Control	43.3	50.4*	46
Crucifier	49.8	50.9	159
Gaff	50.1	50.4	174

* Mean length significantly lower in dead fish (Wilcoxon, p<0.005)

There was a slight difference in mean length between fish that survived the observation period and the ones that died (Table 3), but the difference was only significant for the control group.

Soars and damage of the tissue where the hook or gaff had penetrated the fish skin were registered as injuries to the fish. Damages that appeared to be caused by gaffing were observed also in the control group where no gaffing had occurred. In the crucifier group the gaff was incidentally used if the fish got stuck between the rolls. These fish are included in the sample, as they would have been gaffed in a normal fishery even if the gaff should not be used to tear the fish off the hook. The percentage of each type of injuries per group and status (dead or alive) shows that gaffing injuries is over-represented in the dead fish that was crucified (Figure 1).

A few (12) fish showed signs of stress-related wounds and bleedings in the skin, some with large parts of the body covered by skinless areas and open bleedings. These damages are not included in this analysis.

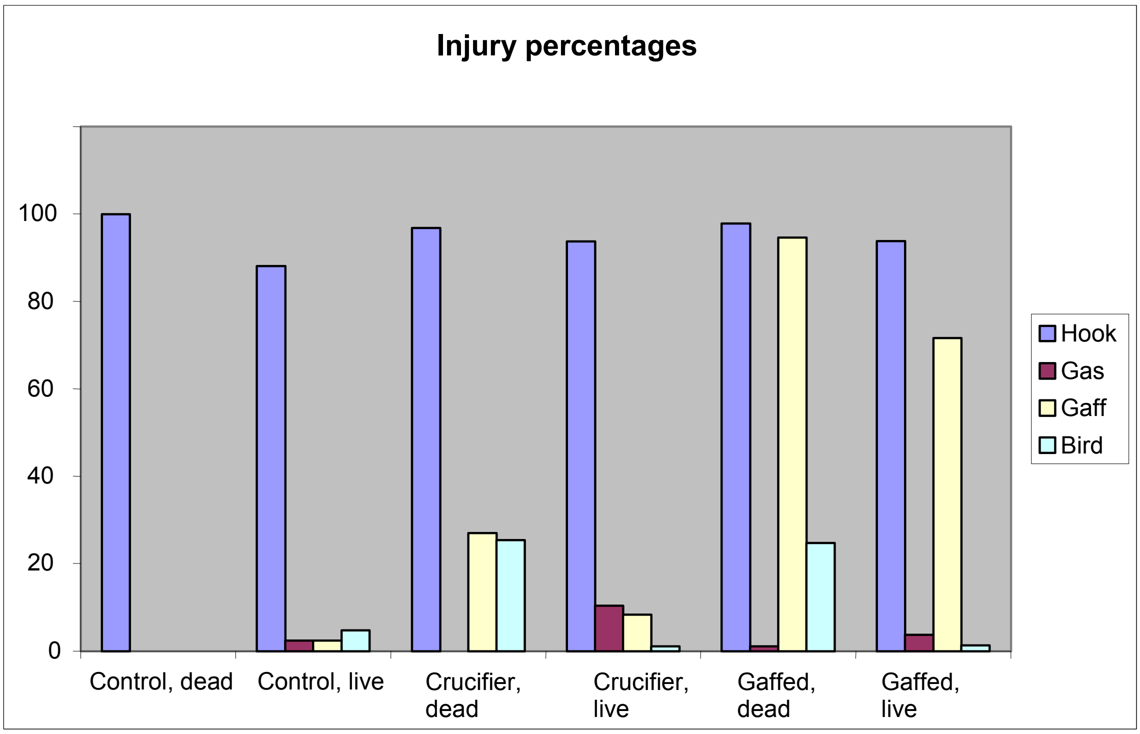

Figure 1. Percentage of visible injuries for each subgroup.

The flank area where the injuries were found is shown in figs 2-4. When adding up the percentages of gaffing injuries in the 4 anterior (2 upper and 2 lower areas) flank areas and compare this to the rest of the body sides, there is a difference between the gaffed and crucified group. In the gaffed group more 46.1 % of all gaffed fish had injuries in the posterior flank areas and 37,5% of the fish were injured in the 4 most anterior areas. For the crucified group 7.6% had visible gaff wounds in the posterior and 8.2% in the anterior body parts.

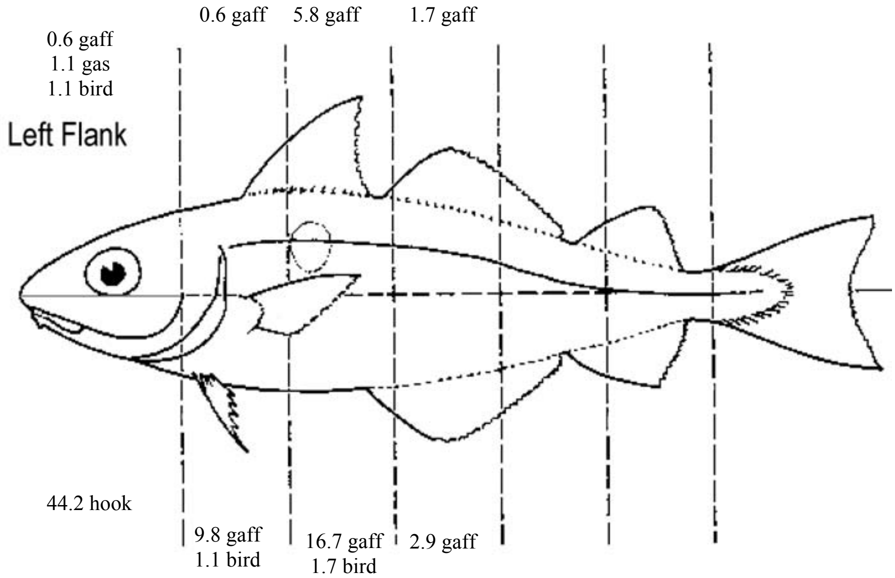

Fig 2a) Percentage of injuries in left flank areas for haddock (n=174) dehooked by gaff.

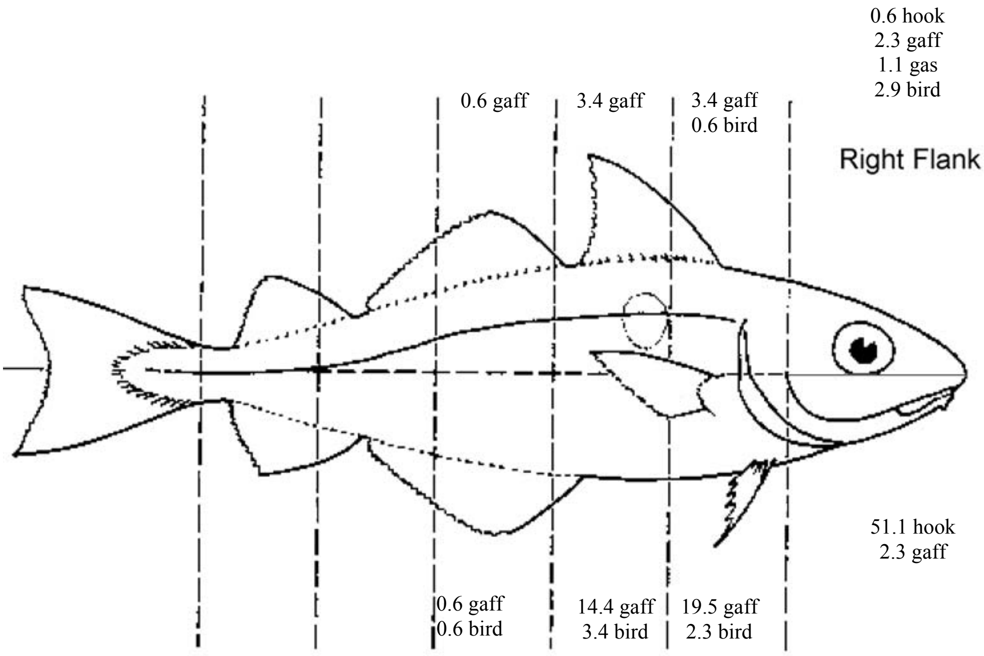

Fig 2b) Percentage of injuries in right flank areas for haddock (n=174) dehooked by gaff.

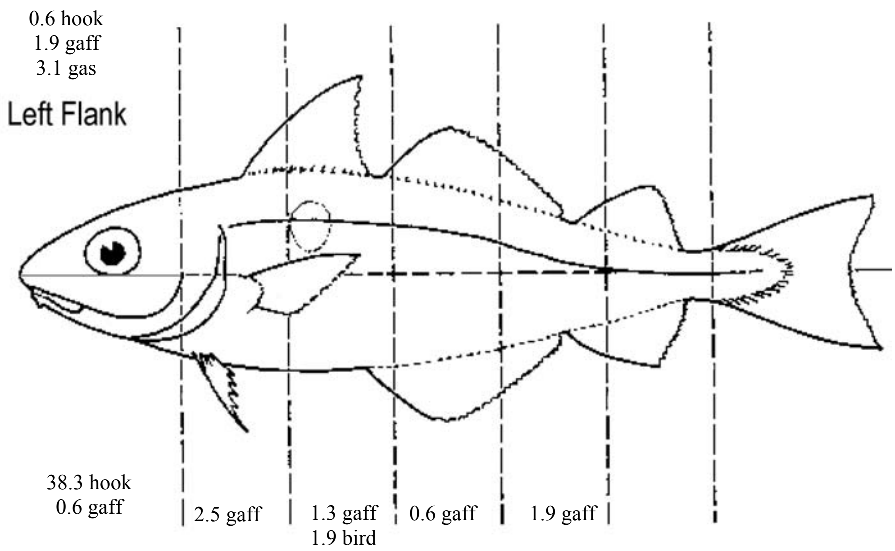

Fig 3a) Percentage of injuries in left flank areas for haddock (n=159) dehooked by crucifier.

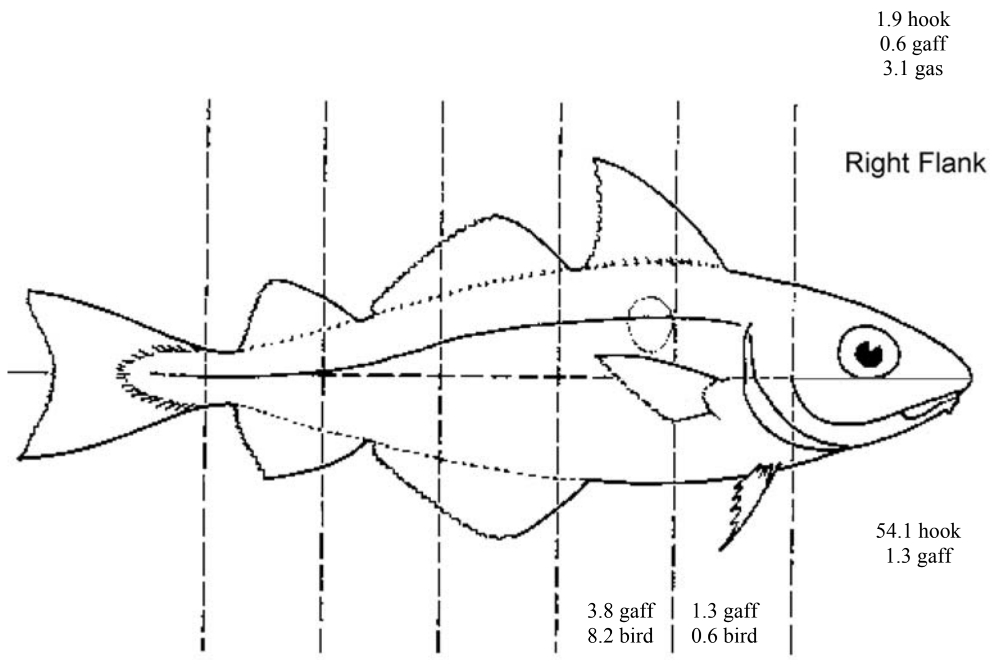

Fig 3b) Percentage of injuries in right flank areas for haddock (n=159) dehooked by crucifier.

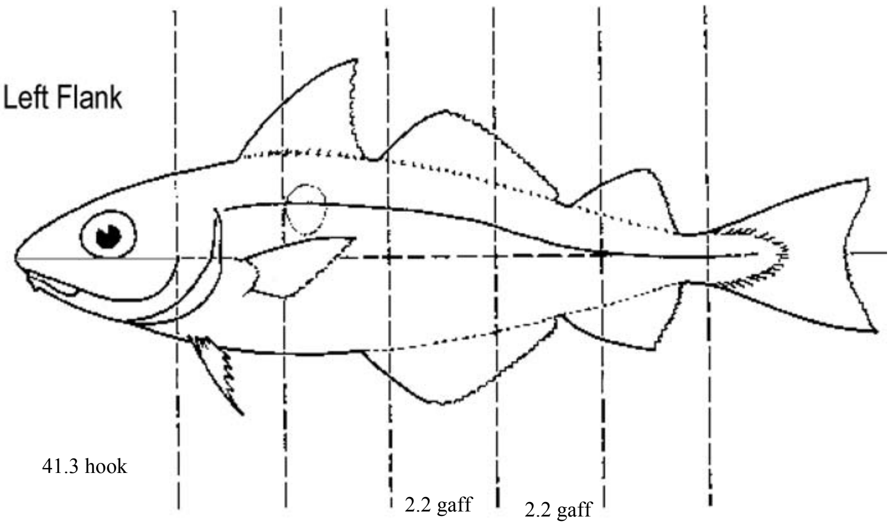

Fig 4a) Percentage of injuries in left flank areas for haddock (n=46) in the control group.

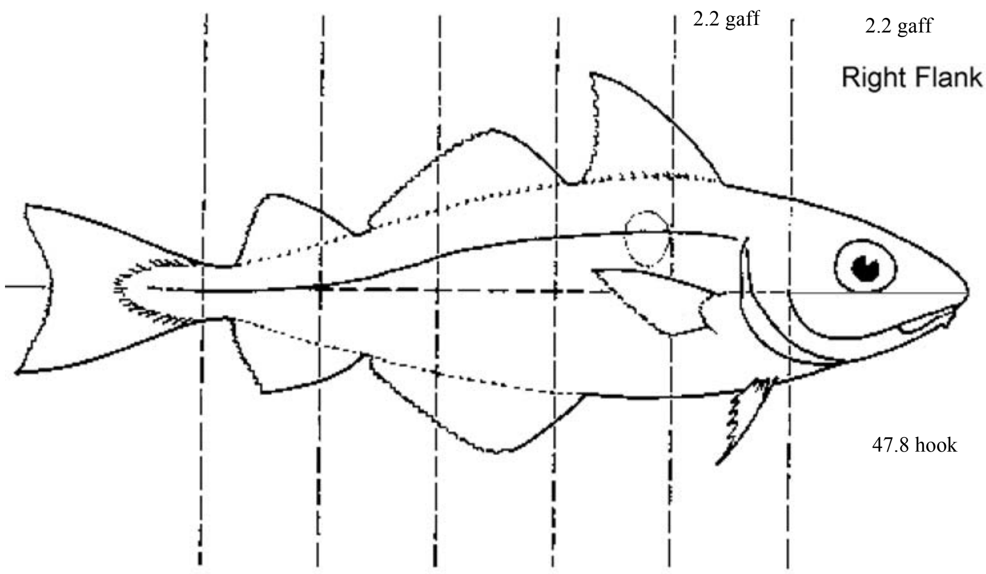

Fig 4b) Percentage of injuries in right flank areas for haddock (n=46) in the control group.

DISCUSSION

The survival experiments in this study confirm the general assumption that the mortality of haddock discarded in the longline fisheries is high. As in most other fisheries, the discard rate in the pelagic longline fisheries for haddock varies with the strength of the recruiting year classes, and may occasionally be high (Huse and Soldal, 2000). Although illegal, it is common practice that fish below legal size (44 cm) is torn off the hook at the vessel side and discarded. In years when small fish make up a large fraction of the stock, the unaccounted mortality of haddock may be high. The number of experiments carried out to study the mortality of fish discarded from longlines is low. Milliken et al. (1999) found high mortality rates for Atlantic cod (56-78%) in the longline fisheries at the east coast of USA. A study of the survival of Pacific halibut showed similar results (about 50% mortality) (Kaimmer, 1994), while 23% of Atlantic halibut released from longlines died in a short term (48 h) survival experiment (Neilson et al., 1989).

The number of fish in each experiment group in this experiment was rather small: two parallels of 63 and 96 fish released by crucifier, two parallels of 113 and 61 fish released by gaff, and one parallel with 46 fish caught by barbless hooks and gently released by hand (control). Still, there was a clear and significant difference in mortality rates between the different release methods used. While only 9% of the control group died, the mortalities of the crucifier and gaff groups were 39% and 53% respectively.

Some of the fish that was supposed to get torn off the hook at the crucifier, got stuck in the rollers and was released from it by means of a gaff. This lead to injuries from the gaff at, or near, the head also in some fish from the group that was supposed to be released by crucifier alone. These fish are over-represented among the deaths from the crucifier group (Figure 1), and the overall mortality would have been lower if they were omitted. However, using gaff is common practice during commercial fishing, and we chose to include fish with gaff wounds in the mortality and injury analyses of the crucifier group to get a realistic estimate of the mortality during normal fishing operations. It is also clear that the fish that has been stuck in the crucifier has a larger probability of having internal head injuries.

The results clearly show that dehooking method has a significant effect on the mortality rate of haddock, ranging from 9% among fish gently released from barbless hooks to more than 50% of fish torn off Mustad wide gap hooks by using a gaff. Similar results have been document for other species. Milliken et al. (1999) reported that cod carefully removed from circle hooks had a higher survival rate than cod released by crucifier, but the survival was low in all groups (22-44%). By using tagging technique Kaimmer (1994) showed that the mortality rate of Pacific halibut released by crucifier was nine-fold increased relative to fish released carefully by hand, and that fish receiving sub lethal injuries as a result of automated hook removal experience a significantly reduced growth rate in subsequent years.

Several studies (Neilson et al., 1989; Kaimmer, 1994; Milliken et al., 1999) showed that the mortality rate was related to fish size (length), in that the highest mortality was found among the smallest fish. Our study did only confirm the size dependence in the control group with fish hand released from barbless hooks. The samples of fish provided for the experiments by the commercial longliner were adequate regarding methods of dehooking. However, unlike during commercial fishing, fish from all length groups were discarded and recaptured, to ensure that the sampling was done as time efficient as possible. The average size of the recaptured haddock was therefor larger that of normal discards. If there is a length dependency in mortality, as suggested in table 3, the true mortality may have been underestimated.

The injury examinations in this experiment were not detailed enough to give a clear answer to the cause of mortality. In all experiment groups more than 90% of the fish had hook wounds in the mouth and jaw parts. The main difference in visible wounds between the groups was the frequency of gaff wounds. These were significantly different between groups, and also significantly more frequent among dead than live fish. The frequency of gaff wounds was related to mortality rate. The gaff inflicts puncture of the body wall and may cause lethal damage to the abdomen and internal organs.

After dehooking the fish had to be retrieved at sea surface by using a dip net and were transferred in seawater tanks onboard a research vessel to the monitoring net pens. This may have added to the capture stress and mortality. External evidence of stress symptoms such as skin bleedings is not visible until after several days, and the visible traces of stress could not be distinguished in the group that died during transportation. For a more detailed and precise determination of death cause, blood samples should be taken.

The fish were kept in floating net pens at the surface during the monitoring period. As the fish were caught at depths between 50 and 70 m, this was a change in environmental conditions that may have added to the general stress level and mortality. On the other hand, fish were protected against predators during a phase of energetic exhaustion and often severe physical damage, decreasing the potential risk of mortality.

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