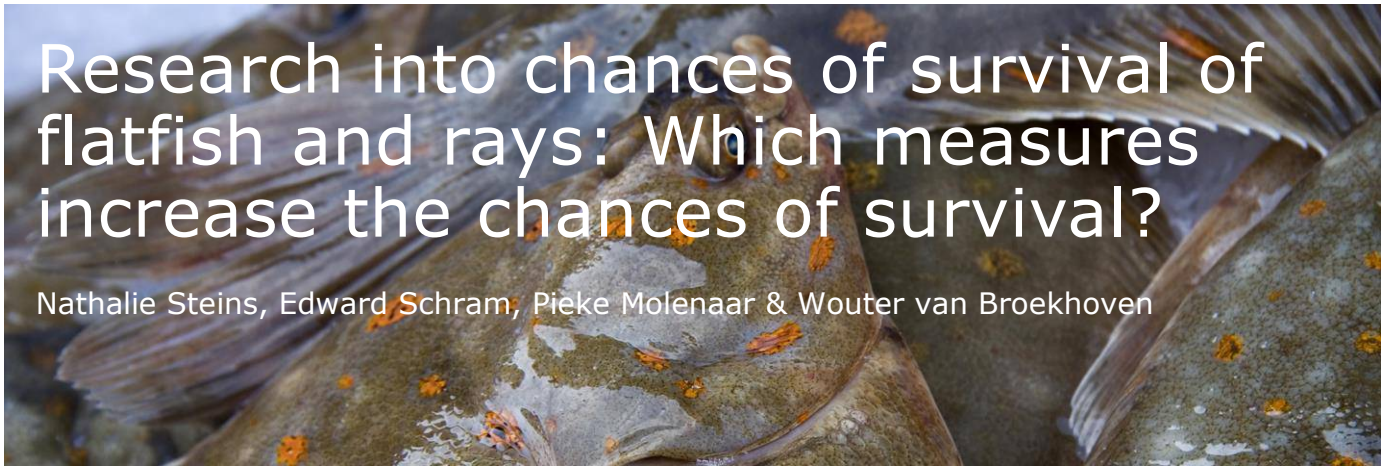

Research into chances of survival of flatfish and rays: Which measures increase the chances of survival?

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How many undersized fish actually survive the process of being discarded? This question is relevant because of the European landing obligation, which obliges fishers to land undersized fish that are subject to a quota. Wageningen Marine Research, together with the fishing industry, has investigated three measures to increase the chances of survival of plaice and sole in pulse fishing: a water-filled hopper, shorter hauls, and fishing with a knotless cod-end. What conclusions can be drawn from the research?

Why study the chances of survival of undersized fish?

As of 2019, the Common Fisheries Policy will oblige the fishing industry to land all undersized specimens of fish that are subject to a quota. Under the previous policy, fishers had to discard these fish back into the sea. Some of the undersized fish survive the process of discarding and can contribute to the fish stock. This is not the case if the fish has to be brought to shore; all fish are certain to perish. The discards policy therefore includes a provision that states that an exemption to the landing obligation may be made for fish species with a high chance of survival. For this reason, knowledge about the chances of survival of discarded fish is needed. This research project first determined how high the chances of survival of fish returned to sea actually are (see Table 1). The project subsequently examined whether adjustments to the nets or processing on board would increase the fish's chances of survival.

Research method

This research into the survival chances of plaice, common sole, turbot, brill, thornback ray, and spotted ray in the North Sea was carried out on board of three flatfish trawlers, each using a pulse trawl with 80mm meshes and 12m wide gears.

For plaice and common sole, the effects of measures aimed at improving survival were also studied. Scientists from Wageningen Marine Research collected the undersized fish during regular fishing. A total of nine fishing trips was made, spread over the entire year and the Southern North Sea. In this way, the final results are representative of the constantly changing conditions in which the fishing takes place, such as fluctuating water temperature, the type of fishing ground, and wind strength and direction. After examining the reflexes and external characteristics of the fish, they were put in special survival units and monitored daily. At the end of the fishing trip, the fish were brought to the laboratory for further monitoring until mortality ceased. Healthy control fish were also taken on board during the collection trips. Giving these control fish the same treatment allows for a differentiation between mortality caused by fishing and mortality caused by research activities.
The method used in this project follows the guidelines for survival research developed by the International Council for the Exploration of the Sea (ICES).

Research improvement measures through port-starboard comparison

The aforementioned research method was followed when testing the measures to increase the chances of survival. The research was done through a port-starboard comparison. On one side of the ship the fishery and processing took place according to normal practice (conventional fishing), while on the other side the improvement measure was tested.

Established chances of survival for plaice and sole in the 80mm pulse fishery

The determined chances of survival for undersized plaice and sole, along with the indicative chances of survival for turbot, brill, stingray, and spotted ray in the 80mm pulse fishery are summarized in Table 1.

Table 1 Chances of survival and 95% confidence intervals (95%CI) for six fish species (undersized) in 80mm pulse fishing (gear width 12m) in the North Sea

Species	Chances of survival	95% CI
Plaice	14%[1]	11-18%
Common sole	19%[1]	13-28%
Turbot	30%[2]	20-43%
Brill	13%[2]	7-23%
Thornback ray	53%[2]	40-65%
Spotted ray	21 and 67%[2]	N.A. due to small sample

Status calculated chances of survival: [1] determined, [2] indicative

Source: Schram & Molenaar (2018)

The percentages in this table give the average chances of survival in conventional fishing methods (i.e., without improvement measures) with confidence intervals over 9 voyages for six species. The confidence interval (95% CI) simply indicates that there is a 95% probability that the actual chance of survival lies between the specified percentages.

Increasing the chances of survival

Fishermen proposed a number of measures to increase the chances of survival of undersized fish:

1. A water-filled hopper
2. Shorter hauls
3. Fishing with a knotless cod-end

The tests initially only focused on plaice, but sole was additionally included.

Results: Water-filled hopper

After a haul, the nets are emptied into hoppers on the starboard and port sides of the ship. From there, the fish enter the processing belt to be sorted and gutted. In this study, one of these hoppers was adapted and filled with water before emptying the nets to make a so-called water-filled hopper, allowing the fish to stay in water while awaiting processing.

The water-filled hopper was tested for plaice during 8 trips. Sole was also included in 2 of these trips. A total of 478 plaice and 60 sole individuals from the water-filled hopper were tested and compared to 476 plaice and 60 sole individuals from the conventional processing (i.e., a waterless hopper). The total number of control fish was 277 plaice and 30 sole.

For all research trips combined, the chances of survival for plaice with the water-filled hopper was 20% (95% CI 15-25%), compared to 16% (95% CI 12-19%) in the conventional waterless hopper. This difference is not statistically significant.

When the trips were analyzed *individually*, there was a higher chance of survival for plaice in 5 out of 8 fishing trips when using the water-filled hopper. This higher chance of survival was significant for 3 of these 5 trips.

In the other research trips (3 out of 8), the chance of survival in the water-filled hopper was smaller than in the conventional waterless hopper, but not significant.

The conclusion is that the use of the water-filled hopper does lead to a better condition of the undersized plaice, but that this does not lead to a significant improvement in the survival of plaice during year-round pulse fishing. In other words, during individual fishing trips, the water-filled hopper can contribute to a higher chance of survival of plaice but it appears that this is only the case under specific circumstances. What those circumstances are could not yet be determined.

Water-filled hopper

Photo: Edward Schram

For the two trips in which sole was also tested, the chance of survival was higher when using the water-filled hopper (14%, 95% CI 10-21%) compared to the conventional waterless hopper (5%, 95%CI 2-10%). Even though an increase in survival of sole was measured when using the water-filled hopper, the number of test trips (2) is too limited to draw conclusions. The higher survival may be due to specific circumstances during the trip.

Results: Shorter hauls

A normal haul in the 80mm pulse fishery takes an average of 120 minutes. During four fishing trips, the haul duration was reduced to 90 minutes. In this case, no port-starboard comparison could be made because it is not possible to lift one net continuing to drag the other one. The fish from the shorter haul period were compared to the fish from a normal haul immediately before or immediately after the shorter hauls. In total, 200 plaice from shorter hauls were compared with 239 plaice from the conventional haul duration. The number of control fish was 125.

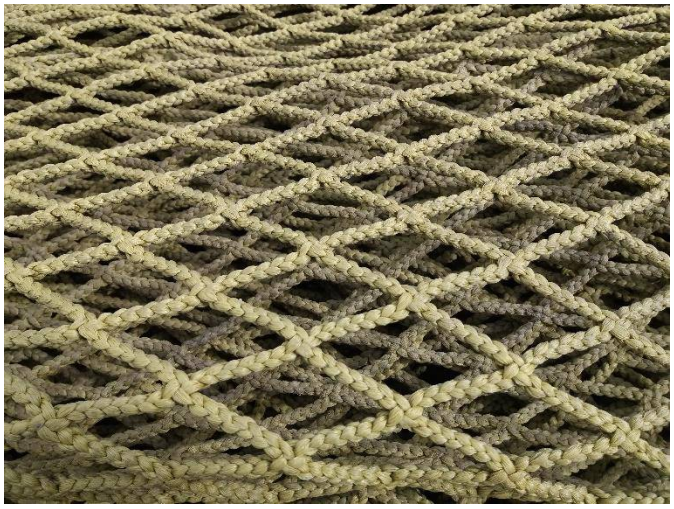
The study shows that the chances of survival for plaice using shorter hauls was identical to those in the conventional hauls: 11% (95% CI 8-15%). The reduction of the haul duration by half an hour therefore does not contribute to increasing the chances of survival.

Earlier research in the 80mm pulse fishery showed that a 60-minute haul duration did lead to increased chances of survival of plaice (Van der Reijden et al., 2017). However, reducing the haul duration to 60 minutes is not realistic in practice. The effective fishing time will decrease by approximately 17%. Reducing the haul duration will also lead to lower catches and less income, while the workload for the crew almost doubles.

Hauling the net (80mm pulse fishery)
Photo: Nathalie Steins

Results: Knotless cod-end

In conventional nets, yarn is knotted to form a mesh. A knotless cod-end is made of a specially woven mesh-work that does not contain knots.
The effects of a knotless cod-end on the chances of survival of plaice and sole were tested during one fishing trip. In total, 59 plaice and 31 sole from the knotless cod-end were compared with 80 plaice and 33 sole from the conventional cod-end, respectively. The number of control fish was 33 plaice and 10 sole.



Knotless mesh-work
Photo: Edward Schram

During the test trip, the chances of survival of all undersized fish from the conventional cod-end and the knotless cod-end were poor. The catch composition and the bad weather conditions during this research trip may have played a role in the result.
Based on the limited results of this first test with the knotless cod-end, it can be concluded that a knotless cod-end is not a breakthrough in improving chances of survival for undersized fish. The decision was therefore made to not pursue any further testing with this cod-end.

Condition of fish immediately after the haul as an indicator of survival chances

The research shows that the condition of the fish at the moment they come on board strongly predicts the chances of survival. This insight can be used as an indicator to quickly and easily identify promising improvement measures in future research.

Taking the focus underwater

If the conditions during the hauls damage the fish too much, measures taken on board to improve the condition and increase the chances of survival of undersized fish have a very limited effect. The recommendation is therefore to give priority to measures to improve the condition of the fish during the hauls (i.e., while they are underwater in the net).

In summary

Of the three measures proposed to increase the chances of survival of undersized plaice and sole in pulse fishing, the reduction of the hauling time to 90 minutes and fishing with a knotless cod-end do not lead to any improvements.
The use of the water-filled hopper leads to a better condition of the fish. However, this does not always translate into a significantly increased chance of survival. Under specific circumstances, the water-filled hopper could contribute to improving the chances of survival. Which circumstances these are has yet to be determined. The condition in which the fish comes on board is decisive for the chances of survival. The priority should lie in the search for measures during the haul, before the net is taken on board.

Series of factsheets into fish survival research

This factsheet is part of a series that discusses research into the chances of survival of flatfish and rays in pulse fishing. Other factsheets discuss how research into the chances of survival of flatfish and rays is done; the results of the research into the chances of survival of flatfish and rays; and the effects of the conditions under which fishing takes place on the survivability of flatfish and rays.

Animal Experimentation Act

The treatment of the fish in this research project was in accordance with the Dutch Animal Experimentation Act, as approved by ethical committees (Experiment 2017 D0012.002).

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More info: www.wur.eu/fishsurvival