

# The Potential Short Term Economic Impacts of Square-Mesh Panels on the Shetland Inshore Fishing Fleet

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## Summary

The North Atlantic Fisheries College has completed a series of trials to assess the effects which various proposed Technical Conservation Measures could have on the catches and earnings of the Shetland inshore fishing fleet (trawlers and seine netters). The trials compared catch rates, discard levels, species composition and earnings during normal fishing operations using 80mm, 90mm and 110mm diamond mesh cod-ends fitted with square mesh panels of a corresponding mesh size, and standard 100mm diamond mesh cod-ends, on both trawl and seine nets. The results of these trials have highlighted several key points: Square-mesh panels do increase the selectivity of the fishing gear, substantially reducing catches of under-sized fish. However, the larger meshed cod-ends also significantly reduced commercial landings by allowing legally sized fish to escape. This would have a significant impact on the short-term viability of the inshore fishing fleet.



The fishing vessel Harmony used in the trials.

## Introduction

One of the major problems facing the fishing industry today is the over-exploitation of fish stocks - too many fish are being caught and, in particular, too many small immature fish, which are caught before they have the opportunity to reproduce. Simply increasing mesh-sizes has done little to improve the selectivity of fishing gear (trawl nets in particular) so that more juveniles can escape, and considerable interest has developed in recent years in the potential of other modifications to the design of fishing gear to improve their selectivity. These modifications include features such as separator panels, escape grids, and square-mesh panels, and are collectively referred to as "Technical Conservation Measures" (or TCMs).

A substantial amount of research has been carried out on the effects of various TCMs on fish catches. Although the resulting data have been of considerable interest and value, the links between these studies and commercial fishing operations have tended to be somewhat tenuous, as a result of factors such as non-commercial fishing protocols, heavily modified fishing gear, etc. In addition, little attempt has been made to assess the effects of TCMs in actual economic terms, i.e. to answer the question "what effects would this TCM have on the earnings of the fishing fleet?".

To address these short-comings the North Atlantic Fisheries College, at the request of Shetland Fishermen's Association, undertook a series of trials to assess in a commercial context the short-term effects which various cod-end and square-mesh panel mesh sizes would have on the catches and earnings of inshore fishing vessels using both trawl and seine nets.

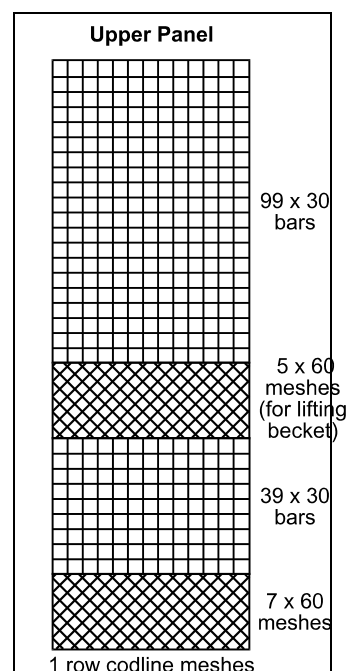
## Methods

The trials were conducted onboard the Shetland inshore fishing vessel *Harmony* (LK63), a 23 m (75 ft), 400hp vessel equipped for both bottom trawling and seine netting, between 11 and 22 August 1997.

### Cod-end Design

The square-mesh fitted cod-ends were constructed to the same design used during trials carried out onboard the fishing vessel *Sunbeam* (LK335) by the Marine Laboratory Aberdeen in 1989, as illustrated at right for the 80/80mm cod-end.

Three different cod-end/square-mesh panel designs were tested on both the trawl net and seine net: an 80mm diamond mesh cod-end fitted with an 80mm square mesh panel (80/80mm); a 90mm cod-end with a 90mm panel (90/90mm); and a 110mm cod-end with a 110mm panel (110/110mm). The lower panels of the cod-ends were of



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all diamond mesh. These cod-ends were compared to the *Harmony's* standard 100mm diamond mesh cod-end.

## Fishing Trials

During the trials successive tows were made on similar tracks using the different cod-ends. The fishing operations were under the control of the *Harmony's* skipper who followed normal commercial fishing protocols, so far as possible. All trials were conducted on fishing grounds west of Fitful Head at an average depth of about 110m (60fm).

It is recognised that fish populations are not wholly homogenous in composition along the path of the gear, or in time, and that this may introduce variability into the data collected during successive tows. This variability was reduced as far as possible, however, by undertaking a large number of replicate comparative tows along the same fishing tracks.

## Data Collection.

Each haul was sorted by the *Harmony's* crew and the total quantity of fish, and the quantities of haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangius merlangus*), the main commercial species caught, in both the

retained and discarded portions of the catch were measured. The weight of each component was estimated by weighing sub-samples. The numbers of boxes and weights of fish in each size category to be landed were also recorded.

A random sub-sample (approximately 200 fish each) of haddock and whiting from the retained and discarded components of each haul was analysed by measuring each individual fish to provide a length-frequency distribution.

All data from the trawls was converted to landings and discards per 2 hour tow, while those from the seine net were recorded as landings and discards per seine shot.

## Results & Discussion

A total of 48 hauls comprising 23 comparative 2 hour trawls, 4 comparative 4 hour trawls, and 21 comparative seine net hauls were completed during 8 full days of fishing. The tables below show for the trawl net and seine net (as the number of 41kg boxes) the average total catches, and catches of haddock, whiting, and other fish species with each of cod-ends tested. They also show the percentage change in the average catches with each cod-end relative to the standard

Trawl Net (per 2 hour tow)	100mm		80mm / 80mm		90mm / 90mm		110mm / 110mm	
	landings	discards	landings	discards	landings	discards	landings	discards
<b>Whiting</b>								
Average No. of Boxes ± SE	6.7 ± 1.5	3.8 ± 1.2	4.4 ± 1.0	1.5 ± 0.5	0.4 ± 0.1	0.1 ± 0.0	0.2 ± 0.1	0.1 ± 0.0
% change relative to 100mm	—	—	- 34%	- 61%	- 95%	- 98%	- 97%	- 99%
<b>Haddock</b>								
Average No. of Boxes ± SE	5.0 ± 0.7	1.9 ± 0.3	5.9 ± 1.2	1.6 ± 0.4	1.8 ± 0.4	0.2 ± 0.0	0.1 ± 0.0	0.0 ± 0.0
% change relative to 100mm	—	—	+ 15%	- 16%	- 65%	- 89%	- 100%	- 99%
<b>Others</b>								
Average No. of Boxes ± SE	0.2 ± 0.1	2.0 ± 0.5	0.4 ± 0.1	2.2 ± 0.3	0.5 ± 0.1	1.2 ± 0.2	0.3 ± 0.1	0.5 ± 0.1
% change relative to 100mm	—	—	+ 47%	+ 10%	+ 58%	- 41%	+ 32%	- 73%
<b>Total</b>								
Average No. of Boxes ± SE	11.9 ± 1.8	7.7 ± 1.4	10.7 ± 1.9	5.3 ± 1.1	2.5 ± 0.5	2.0 ± 0.6	0.4 ± 0.1	0.6 ± 0.5
% change relative to 100mm	—	—	- 10%	- 31%	- 97%	- 74%	- 97%	- 92%

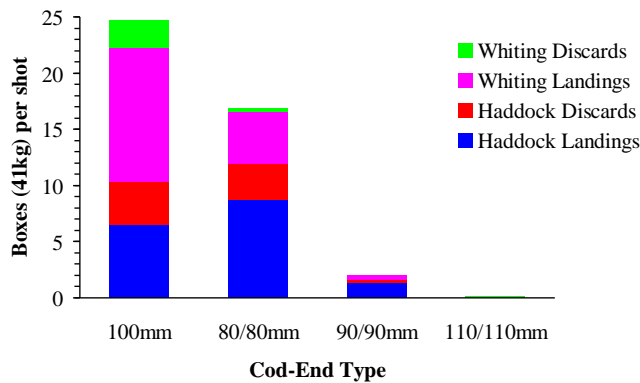
Average catches (no. of 41kg boxes) of haddock, whiting, and other fish species per 2 hour trawl tow (mean ± standard error of mean), and percentage change in catches relative to 100mm.

Seine Net (per shot)	100mm		80mm / 80mm		90mm / 90mm		110mm / 110mm	
	landings	discards	landings	discards	landings	discards	landings	discards
<b>Whiting</b>								
Average No. of Boxes ± SE	12.0 ± 2.0	2.4 ± 1.0	4.6 ± 1.5	0.3 ± 0.1	0.4 ± 0.1	0.0 ± 0.0	0.1 ± 0.0	0.1 ± 0.1
% change relative to 100mm	—	—	- 60%	- 89%	- 96%	- 99%	- 99%	- 100%
<b>Haddock</b>								
Average No. of Boxes ± SE	6.5 ± 1.4	3.8 ± 0.8	8.7 ± 3.0	3.2 ± 1.2	1.4 ± 0.5	0.2 ± 0.1	0.0 ± 0.0	0.0 ± 0.0
% change relative to 100mm	—	—	+25%	-16%	-79%	-95%	-99%	-100%
<b>Others</b>								
Average No. of Boxes ± SE	1.8 ± 0.5	1.8 ± 0.4	1.3 ± 0.3	2.1 ± 0.4	1.7 ± 0.2	3.3 ± 0.8	1.8 ± 0.4	1.1 ± 0.2
% change relative to 100mm	—	—	-31%	+12%	-3%	+44%	+1.6%	-38%
<b>Total</b>								
Average No. of Boxes ± SE	20.4 ± 2.7	8.0 ± 1.3	14.5 ± 4.2	5.5 ± 1.5	3.5 ± 0.6	3.5 ± 0.8	2.0 ± 0.3	1.2 ± 0.2
% change relative to 100mm	—	—	-29%	-31%	-83%	-56%	-90%	-86%

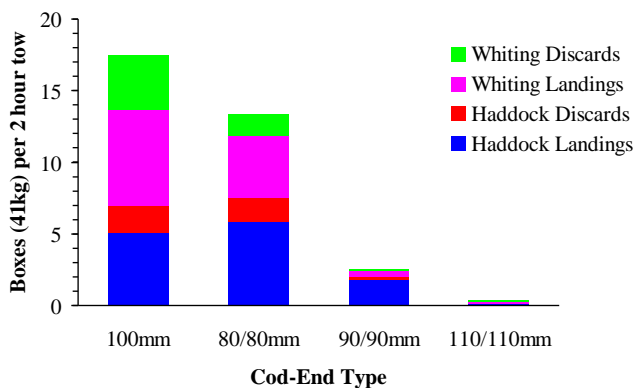
Average catches (no. of 41kg boxes) of haddock, whiting, and other fish species per seine shot (mean ± standard error of mean), and percentage change in catches relative to 100mm.

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100mm diamond mesh cod-end. The results for haddock and whiting are also illustrated graphically below. Despite the fact that the data is based on successive tows with different cod-end types the variability in the data (expressed as the standard error of the mean) is relatively low.



*Landings and Discards (41kg boxes) per seine shot with the various cod-ends tested.*



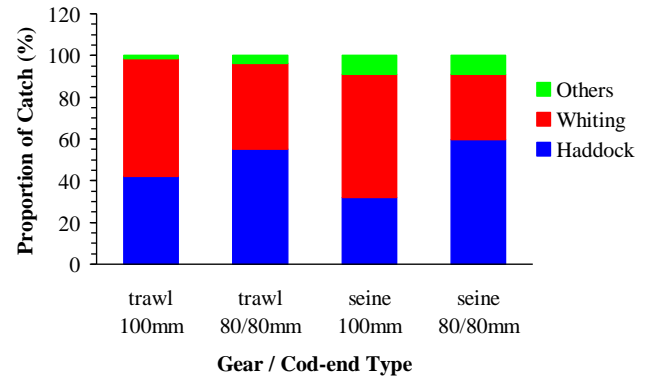
*Landings and Discards (41kg boxes) per 2 hour trawl tow with the various cod-ends tested.*

As expected, discards of under-sized fish were substantially reduced in both the trawl and seine nets when the modified cod-ends were used. However, the 90/90mm and 110/110mm cod-ends also resulted in very substantial reductions in landings, i.e. catches of fish over the minimum legal size. Although the reduction in discards with these cod-ends would be welcome from a conservation viewpoint, the attendant decrease in landings would obviously have a severe impact on the economic viability of the fishing fleet in the short-term at least. In the longer-term catch rates would be expected to improve as the escaped fish grow to a size where they will be caught by the larger mesh sizes.

The 80/80mm cod-end also gave a significant reduction in overall discards (~30% overall) in both gear types. In the seine net there was a similar (~29% overall) reduction in landings, primarily of whiting, but in the trawl net the decrease in landings (~10% overall) was considerably less than with the larger cod-end mesh sizes.

In both the trawl and seine nets the 80/80mm cod-end also significantly altered the catch composition compared to the

standard 100 mm diamond mesh cod-end, as can be seen in the graph below, with a higher proportion of haddock, and a lower proportion of whiting in the overall catches and in the landings.



*Composition of landings (%) with standard 100mm and 80/80mm cod-ends on both trawl and seine nets.*

It is clear that the 80/80mm cod-end is particularly selective against whiting, presumably as a result of their body shape. Although whiting discards were reduced by about 61% and 89% in the trawl and seine nets respectively, it is clear that a high proportion of legally sized whiting were also escaping, with the result that whiting landings were down by over one third and two thirds respectively.

Haddock discards were also decreased by the 80/80mm cod-end in both the trawl and seine nets, although not by as much, but haddock landings were actually increased by about 15% and 25% respectively. Again this is presumably a result of the haddock's body shape; with the smaller 80mm diamond mesh retaining more legally sized fish than the normal 100mm mesh while the 80mm square-mesh panel allows more under-sized fish to escape, i.e. the 80/80mm cod-end appears to be better at sorting legally and undersized haddock than the standard 100mm diamond mesh cod-ends.

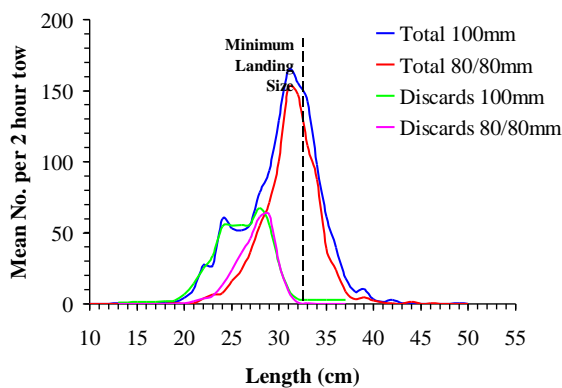
The selectivity of the 80/80mm cod-end against whiting indicates that its use in targeted whiting fisheries (which has been proposed) would be of no benefit, and would even be counter-productive since it would result in smaller whiting catches per unit effort and increased discarding of other species, particularly haddock.

## Length Distribution of Catches

The graph below shows the average length distributions (i.e. the numbers of fish of each length) of the total haddock catch, and of the haddock discards, taken with the trawl net fitted with 100mm and 80/80mm cod-ends. It can clearly be seen that the 80/80mm cod-end reduces the numbers of under-sized haddock which are caught, and that there is a consequent decrease in the numbers of small fish discarded.

Similar trends were evident for the haddock caught with the seine net fitted with the 100mm and 80/80mm cod-ends, and for whiting in both the seine and trawl nets.

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Average length distributions of total haddock catch and haddock discards taken with the trawl net fitted with 100mm and 80/80mm cod-end

## Proportions of Fish in Each Size Grade

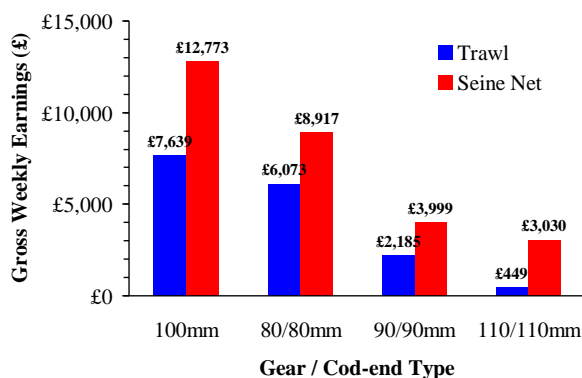
The changes in species size distributions with the various cod-ends tested were reflected in changes in the relative amounts of the grades into which the fish are sorted for landing and sale.

With the square-mesh panel fitted cod-ends the proportions of Grade 4 haddock (30 - 33.5cm) and Grade 4 whiting (27 - 32cm) were generally reduced in both the seine and trawl nets, while the proportions of Grade 3 fish (haddock: 33.5 - 41.5cm, whiting: 32 - 36cm) were increased

## Estimated Effects On Gross Weekly Earnings.

The gross weekly earnings of a fishing vessel fishing full-time with each of the cod-ends tested was estimated from the catch rates measured, knowledge of the average time spent fishing per week, and the average market prices during the weeks when the trials were conducted. These estimates take into account not only the quantities of fish caught but the changes in the proportions of each size grade taken, and the differing market prices for each grade.

The graph below shows the estimated gross weekly earnings for a fishing vessel using a trawl net or seine net fitted with each of the cod-ends tested.



Estimated gross weekly earnings of fishing vessels using trawl and seine nets with each of the cod-ends tested.

It can be seen that the gross weekly earnings are consistently higher with the seine net than with the trawl. This is a result of the greater quantities of more valuable species such as monks, lemon sole, skate, etc., taken with the seine net.

It can also be clearly seen that the introduction of square-mesh panels would cause large reductions in gross earnings, in the short term at least. With the seine net there are reductions in earnings of 20%, 81% and 90% for the 80/80mm, 90/90mm and 110/110mm cod-ends respectively, compared to the standard 100mm diamond mesh cod-end. Similarly, for the trawl there are reductions of 21%, 71% and 94% respectively with the 80/80mm, 90/90mm and 110/110mm cod-ends.

## Conclusions.

All of the cod-ends tested resulted in significant reductions in the quantities of haddock and whiting discards from both the seine net and trawl net. Although this is desirable from a conservation view-point (since it reduces the mortality of immature fish) the 90/90mm and 110/110mm cod-ends also resulted in very substantial reductions in landings, i.e. catches of legally sized fish, and so of gross weekly earnings. It is clear that the introduction of such cod-end designs to the Shetland, and other, inshore fishing fleets would render them economically unviable, in the short term at least.

Discarding was also significantly reduced with the 80/80mm cod-end, and although landings and earnings were also reduced the magnitude of the decrease was less dramatic, particularly in the trawl net. The 80/80mm cod-end also significantly changed the composition of catches with whiting landings substantially reduced and haddock landings increased. It is clear that this cod-end design is particularly selective against whiting, so its introduction to a targeted whiting fishery (as has been suggested) would be counter productive as it would result in lower whiting catches and increased discarding of other species than is the case with the current 100mm diamond mesh cod-end.

## Bibliography.

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DAFS Marine Lab., Aberdeen (1989). The effect on trawl catches of using square mesh windows in a 90mm diamond mesh cod-end.

## Acknowledgements.

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