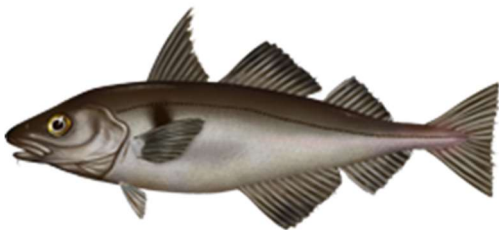
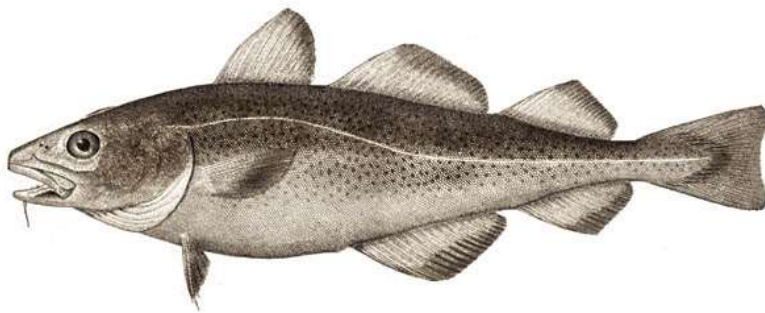


Report on CFA Clyde Demersal Fish Survey March 2017



Summary Report to the Clyde
Fishermen's Association.

Published Online August 2022

Alexander Coram

Al Kingston &

Simon Northridge

Scottish Oceans Institute,
University of St Andrews.



Foreword

This 'cruise report' is the second of a short series, reflecting the aspiration of the Clyde Fishermen's Association to establish a rigorous sampling scheme to monitor changes in the abundance and distribution of cod and other gadoid species within the Clyde area. The Scottish Oceans Institute was approached to provide independent scientific support in early 2016. A series of surveys was then conducted in 2016, 2017 and 2018. In each survey the SOI provided observers, collected data and wrote up a cruise report detailing the methods used and the location, numbers, weights, sex and maturity states of fish caught. Trials were halted after 2018 firstly because of pressing issues resulting from Brexit which absorbed any potentially available human and other resources, and secondly because of the COVID pandemic. The reports remained as unapproved and incomplete drafts until 2022. Picking up these reports again in 2022, we have responded to reviewers' comments since made by Marine Scotland Science and have finalised all four reports in the 2016-2018 current series.

MSS comments on previous drafts included the observation that there are a number of survey-design problems that would need to be addressed in any future Clyde surveys, and that there is a lack of important detail on how the surveys were conducted. MSS pointed out that the surveys were intended to be developmental and inform future survey work and as such the design and the implementation of the surveys over the three years is too inconsistent to permit comparative time-series, and any future survey would probably need to start from scratch.

MSS suggested revisions should focus on providing spatial summaries of fish distribution and additional detail regarding the specific gear types used.

Changes made to previous drafts of the present report include editorial changes to language, clarification of methodology, completion of some details about vessel characteristics and the inclusion of bubble plots to provide more detail on the spatial distribution of fish catches (Figures 4,5 and 6) as requested. We were unable to provide more details on the trawl characteristics used in the demersal trial here. The trawl used was a 'standard nephrops trawl' but unfortunately, we could not recover further details of how this was rigged (Table 1).

August 2022

Table of Contents

Foreword.....	1
Table of Figures.....	2
Introduction	3
Survey design	3
Survey and survey vessel	4
Allocation of Station Positions	4
Recording data by haul	5
Summary of catch rates and length frequencies	8
Discussion.....	12
Acknowledgements.....	13
Reference.....	13

Table of Figures

Figure 1 - Sampling strata for the demersal trawl survey March 2017	3
Figure 2 - Example details recorded for each otolith-sampled fish.....	6
Figure 3 - Tracklines of demersal tows numbered in sequence	7
Figure 4 - Comparison of cod catch rates 2016 and 2017 (Kg per hour towed).....	9
Figure 5 - Length frequency distributions of cod - 2016 (red) and 2017 (blue).....	10
Figure 6 -- Comparison of haddock catch rates 2016 and 2017 (Kg per hour towed).....	10
Figure 7 - - Comparison of whiting catch rates 2016 and 2017 (Kg per hour towed)	11
Figure 8 - Length frequency distributions of whiting (blue) and haddock (red) in 2017	11

Introduction

In 2016 the Clyde Fishermen’s Association initiated what is intended to be the first of a series of trawl surveys in the Clyde designed to track changes in the Clyde cod stock, and associated species (Coram et al. 2022). The overall aim is to improve current understanding of different aspects of the cod population within the Firth of Clyde, and to track and understand any changes in stock distribution and abundance that might result from the seasonal closed area that was implemented to address concerns about the state of the cod stock in the wider area (Commission Regulation 456/2001) in 2001. With the agreement of Marine Scotland a second survey was planned and implemented in March 2017. This report summarises that survey.

Survey design

Following discussions between Marine Scotland Science, the Clyde Fishermen’s Association, the Scottish Fishermen’s Federation and the Scottish Oceans Institute, several changes to the previous (2016) survey were agreed. Firstly, it was agreed that all three major groundfish species – cod, haddock and whiting, would be sampled, but otoliths would be taken from a sub-sample of cod only. Secondly, to ensure wider size selectivity, a blinder would be used in the existing demersal trawl; in this way younger fish will be sampled too. Thirdly, it was agreed that we would stratify the Clyde basin into four sampling areas, with a fifth additional survey area just outside the Clyde, in an area previously surveyed by CEFAS. The five survey strata are shown in Figure 1.

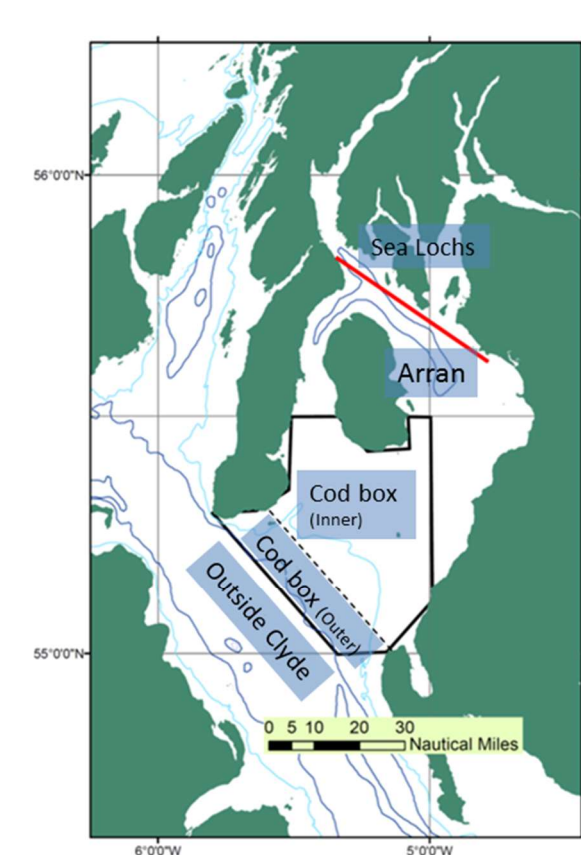


Figure 1 - Sampling strata for the demersal trawl survey March 2017

Survey and survey vessel

The survey took place from the 14th to 17th March 2017, with Campbeltown as the port of departure and landing. The vessel that conducted the trial was the Spindrift. Vessel details are shown below. Net details could not be fully ascertained (August 2022).

Table 1 - Vessel and gear details

Vessel Name	Spindrift
Administrative Port	CAMPBELTOWN
Port Letters and Numbers	BA220
Callsign	2HEV
Overall Length	17.02 m
Registered Tonnage	54
Engine Power	244 KW
Year Built	1974
MMSI	232004947
Fishing Circle	Not known
Headline height	Not known
Length of footrope	Not known
Cod end mesh size	100mm
Spread	Not known
Sweeps and bridles length	Not known

The trawl was a standard ‘traditional’ nephrops trawl, and was the same net as was used in 2016. In addition, a small mesh liner (or blinder) was loaned by the gear section of Marine Scotland Science (Marine Laboratory Aberdeen), so a broad range of fish sizes was sampled, including juvenile fish. The small mesh liner to the trawl had a mesh size of 10mm (bar).

Allocation of Station Positions

To allocate sampling stations randomly within each of the five areas (strata), we used a GIS package (QGIS) to identify and number the centre points of each whole 0.05 degree block within each area. Each block is about 3nm square. Stations were then chosen at random within each area to conduct surveys. We planned a total of 20 tows distributed throughout the sample region as shown in the table below, but derogation conditions, weather and the availability of suitable towing ground affected the actual number of tows that were feasible in each area.

Table 2 - Planned and actual towing stations

Area	No of possible towing stations	No of intended towing stations	Actual number of stations towed
Sea Lochs	37	4	3
Arran	80	4	2
Cod Box - Inner	79	5	8
Cod Box - Outer	23	5	2
Outside Clyde	33	2	0

Before sailing we identified the initially chosen towing locations that were deemed unsuitable for towing (either too rough – potential snags, or too hard e.g. coarse sand with potential for damage to the gear) using the skippers knowledge of the seabed. These locations were replaced with further randomly chosen towing locations from those remaining in each area.

The ‘Outside Clyde’ and much of ‘Cod Box – Outer’ areas were rejected for possible towing at this stage, as the derogation that had been obtained to fish in the Clyde Cod Box was unclear as to whether permission was granted beyond the limit of the Clyde (i.e. from Corsewall Lighthouse to the Mull of Kintyre), and all of the former area and much of the latter fall outwith this limit line.

In practice, several of the tow locations which were initially deemed feasible were subsequently ruled out due to bottom type or weather conditions, making route planning challenging. In these cases a pragmatic approach was taken and nearby sites were sampled to try and fulfil the quota of sample sites from each area.

The coordinates of the chosen towing stations were located on the chart plotter and the skipper was asked to hit the mark at some point on the tow (ideally near the middle). In some cases it was not possible to hit the exact point, so the skipper was asked to tow as close as reasonably possible.

Recording data by haul

A chronological record of tow and haul details was recorded in the wheelhouse by the observer or skipper, showing the times and locations at the start and end of each tow. Tows were considered to start from when the winches stopped and end when the winches start again. This does not allow for the gear settling, which in deep water may take some time. All hauls were one hour in duration (+/- a few minutes). The trackline of the vessel, including that of each tow, was recorded by hand held GPS tracker and downloaded later for plotting.

Separate sheets were completed for each tow to record the catch details, and notes to summarise the catch were made on the reverse of these sheets.

Catches were sorted initially by ship’s crew and observers into species, with cod, haddock and whiting being prioritised. Usually one basket was used for mixed fish species.

Generally, all cod were counted, measured for length, sex and maturity state (according to ICES fish maturity chart). One haul (No 8) was far too large to sample completely, so approximately half of the catch was immediately discarded. All numbers recorded for this haul were therefore from half of the catch but have been adjusted accordingly in further analysis. Two further hauls (numbers 4 and 5) contained too many fish to process fully in a timely manner, and in these cases a sub-sample of cod was measured in these two hauls, but no counts were made. Catch weight was estimated.

Haddock and whiting were sub-sampled from the total catch, with usually about 30 fish being selected and measured for length, sex and maturity. Sampling procedure was simply to take the first 30 fish from the top of the basket so this may not appropriately reflect the length distribution of the catch. Haddock and whiting were not counted individually, but catch weight was estimated.

Other species were recorded by total weight in the catch. This was done by eye, with one full basket assumed to be approximately 32kg.

Otoliths were extracted from a representative sample of fish, with 3 or more fish sampled from each 2cm length bin. One otolith was extracted from each fish and placed into paper envelopes marked with the fish number and fish length. A cover slip was completed with remaining haul details (see example below) and taped securely to the individual otolith envelopes.

CFA Survey	
VESSEL NAME	Fish No (eg: 1)
SPECIES	(eg: 34) cm
DATE	
Haul station	
Haul No.	

Figure 2 - Example details recorded for each otolith-sampled fish

Within the allotted time, 15 tows were made. The ‘Outside Clyde’ area was not sampled, and much of the ‘Cod Box Outer’ area could not be towed either, because the derogation was unclear as to whether towing beyond the limit of the Clyde estuary was permitted. The 15 realised tow locations are summarised in Figure 3 below.

Table 3 - Number and durations of tows

2017 Survey summary	
Total number of tows	15
Total tow duration (mins)	887
Mean tow duration (mins)	59

In several instances the ground at the initially chosen location was deemed to be too hard for the net being used. Nephrops trawls are designed to fish on muddy bottoms, and as such the particular trawl being used is too light to be used on anything other than clean ground. Most of the outer cod box was deemed too hard for towing this net, and as a consequence, the two tows made within the ‘Cod Box – Outer’ area, are largely outside that stratum, spilling into the adjacent one.

Within the sea lochs, towing was complicated by topography. Tow no 9 in Loch Fyne necessitated a large U-turn to avoid rough ground. Another chosen station (no 19) within the sea lochs could not be towed because of strong tides so an adjacent site (22) as chosen instead. That haul (no 10) turned out to be very poor itself, possibly again due to the strength of the tide at that location.

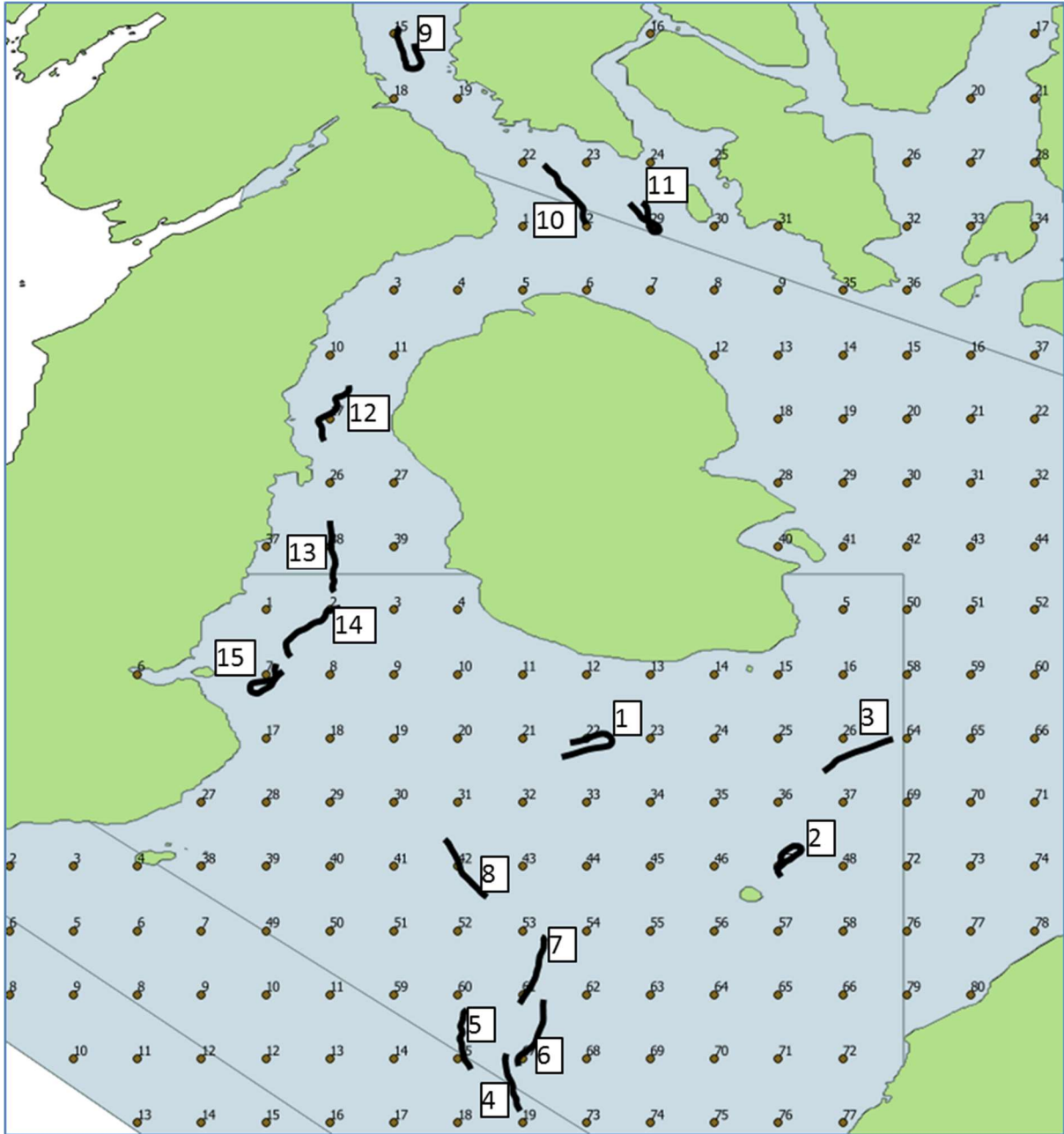


Figure 3 - Tracklines of demersal tows numbered in sequence

Summary of catch rates and length frequencies

The overall catch rate of cod was lower in 2017 than in 2016, with an average of 30 kg of cod per hour, compared with 41 kg per hour in 2016. However, the comparison is simplistic as the survey in 2016 was focused on the spawning areas, whereas that of 2017 was deliberately more widely spread through the Clyde estuary.

The proportion of female cod was lower than that of males (39.5%) in 2017, but this compares with just 15% in the 2016 demersal survey. This more-even sex ratio is again probably because the spawning area was not specifically targeted this year, and females tend to stay closer to the seabed at spawning than do males, and therefore tend to dominate demersal trawl catches on the spawning grounds. The proportion of female haddock and whiting in the enumerated catch was 53% and 49% respectively.

A feature of the cod catch in 2017 is the presence of more small fish (<30cm) in the catch compared with 2016. The presence of a small mesh liner increased the proportion of fish less than 30cm from 1% in 2016 to 13% in 2017. The mean weight of cod from those 13 hauls where all cod were counted was 1.21 kg, compared with 1.33 kg in the demersal tows in 2016. The numerical catch rates of cod by size class also show some differences.

Table 4 - Cod catch numbers and rates by haul, separated by size class; tows marked *- not all cod were counted

HAUL	Total number of cod sampled	Less than 30 cm			30 cm or more		
		Number of cod caught	% of total	Catch rate (nos per hour)	Number of cod caught	% of total	Catch rate (nos per hour)
CL-17-1-01	23	0	0%	0.0	23	100%	21.9
CL-17-1-02	7	1	14%	0.9	6	86%	5.6
CL-17-1-03	13	0	0%	0.0	13	100%	16.6
CL-17-1-04*	38	1	3%	na	37	97%	na
CL-17-1-05*	59	0	0%	na	59	100%	na
CL-17-1-06	43	1	2%	1.0	42	98%	42.0
CL-17-1-07	57	3	5%	3.0	54	95%	53.1
CL-17-1-08*	31	2	6%	4.3	29	94%	62.1
CL-17-1-09	5	1	20%	0.9	4	80%	3.8
CL-17-1-11	8	5	63%	5.1	3	38%	3.1
CL-17-1-12	5	0	0%	0.0	5	100%	5.8
CL-17-1-13	7	0	0%	0.0	7	100%	6.9
CL-17-1-14	9	1	11%	1.0	8	89%	8.0
CL-17-1-15	35	30	86%	30.0	5	14%	5.0
OVERALL	340	45	13%	4.0	295	87%	26.1
2016 OVERALL	369	4	1%	0.4	365	99%	33.5

The estimated weights of cod caught are shown below by tow location and are compared with the same data from the March 2016 survey (demersal tows only).

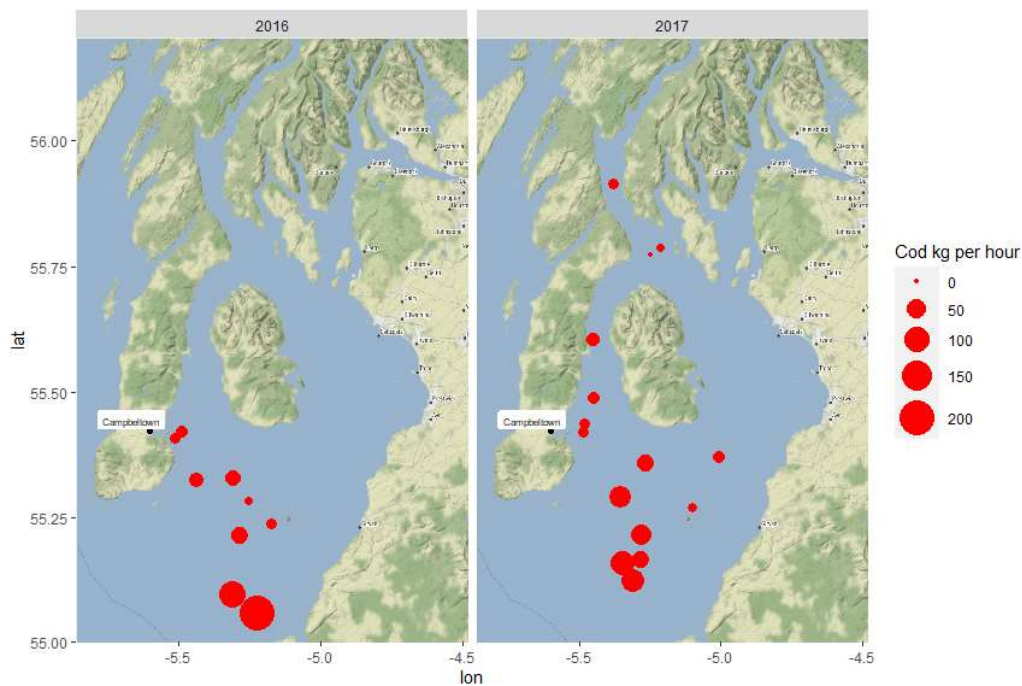


Figure 4 - Comparison of cod catch rates 2016 and 2017 (Kg per hour towed)

The overall numerical catch rate for 2017 was 30 cod per hour (for hauls where the numbers were fully available, but which excluded two hauls where catch rates were high). This is not much different from the catch rate in 2016, which was 34 cod per hour. There is an apparent difference however in the catch rate of larger fish (over 30cm) which was 26 fish per hour in 2017 compared with 34 in 2016. It is unclear whether this might be due to differences in the abundance of larger fish on the grounds, differences in fishing areas, or to some other change in selectivity of the gear with the addition of a small mesh liner. Length frequency distributions of cod in the 2016 and 2017 tows are shown below.

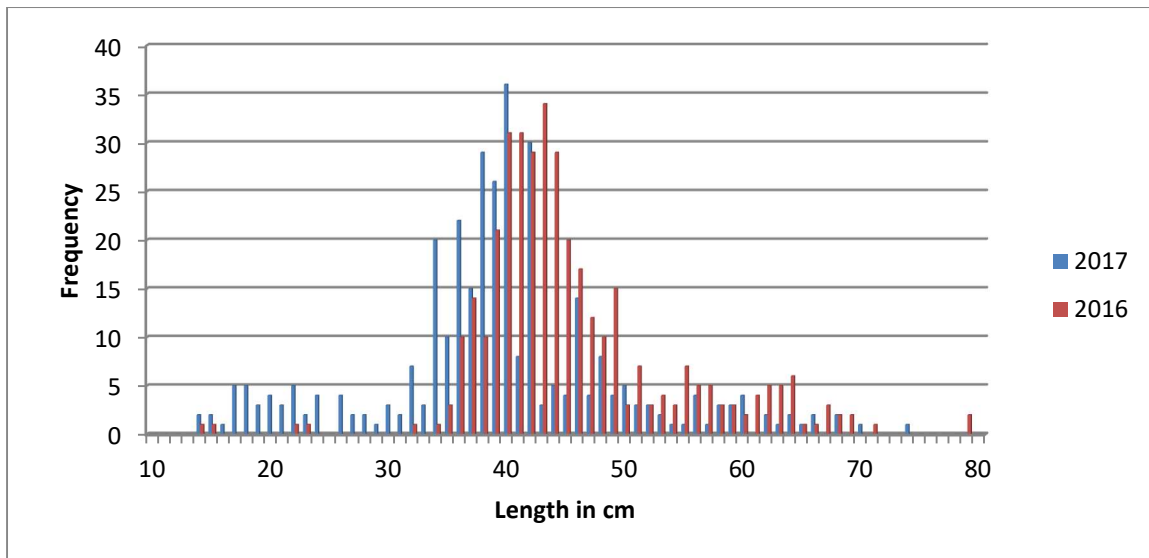


Figure 5 - Length frequency distributions of cod - 2016 (red) and 2017 (blue)

The increased frequency of smaller fish (due to the presence of the liner) is evident in 2017 compared with 2016, but there also appears to be a leftward shift in the overall length distribution in 2017 compared with 2016, which might suggest for example slower growth of the fish that were around 40 cm in length in 2017 compared with those in 2016.

The estimated weights of haddock and whiting caught are shown below by tow location and are compared with the same data from the March 2016 survey (demersal tows only).

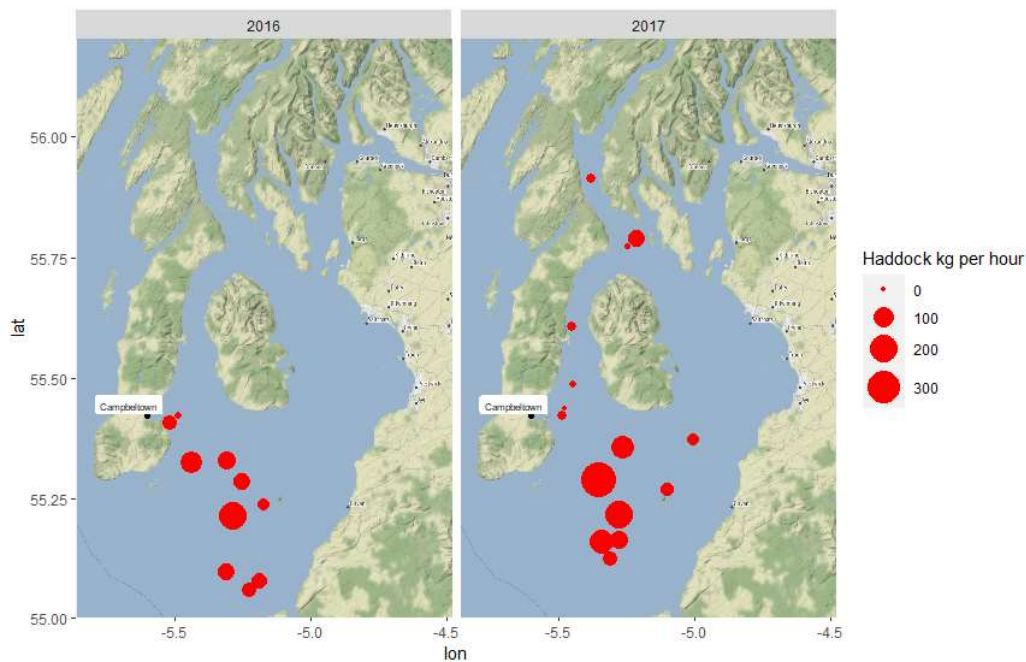


Figure 6 -- Comparison of haddock catch rates 2016 and 2017 (Kg per hour towed)

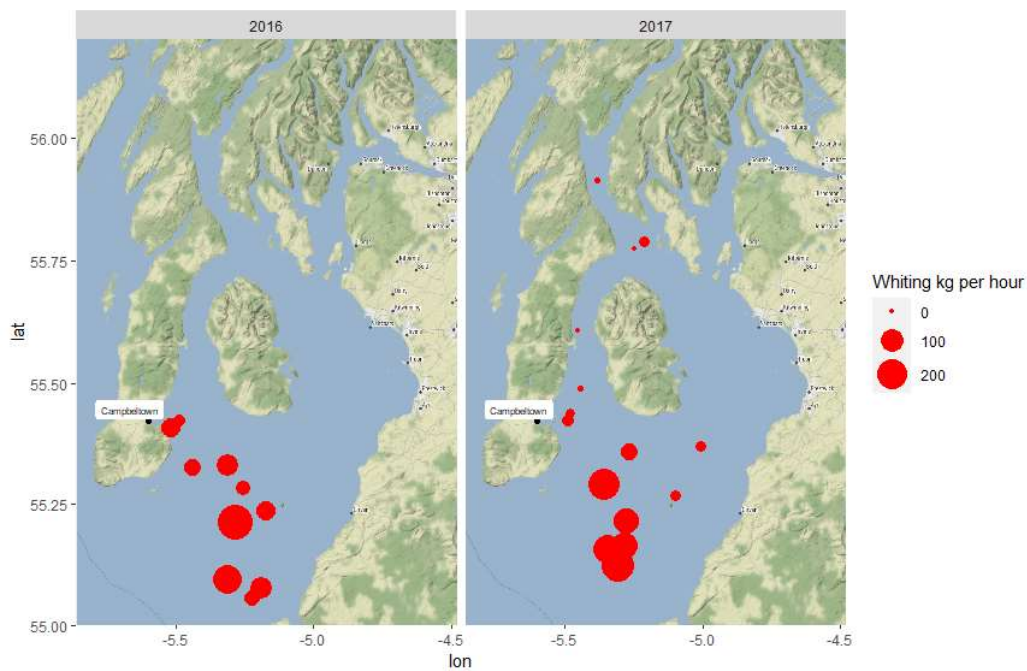


Figure 7 - - Comparison of whiting catch rates 2016 and 2017 (Kg per hour towed)

Length frequency distribution of whiting and haddock during the March 2017 survey are also shown below. Whiting lengths appear to be unimodal, whereas there is a suggestion of two or possibly three modes in the haddock length frequencies.

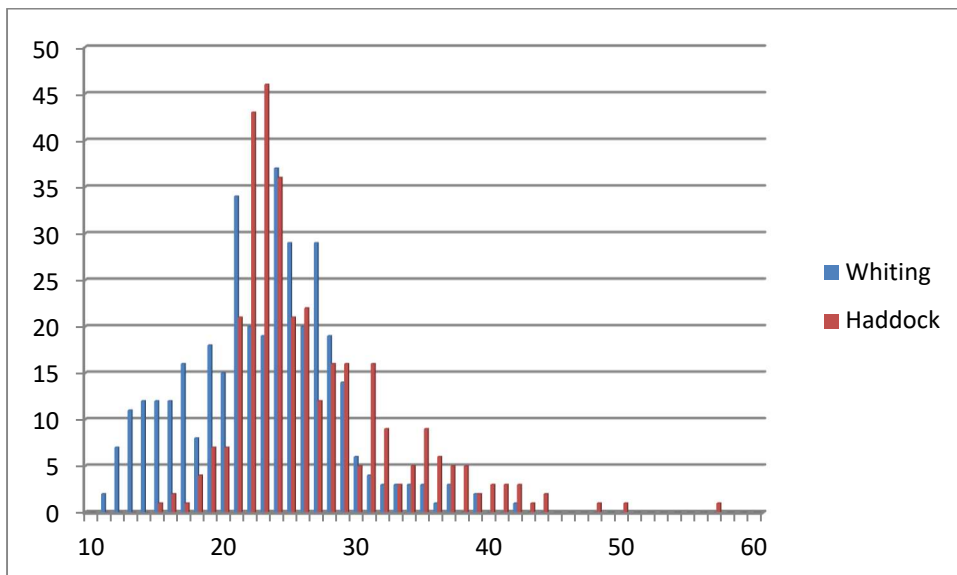


Figure 8 - Length frequency distributions of whiting (blue) and haddock (red) in 2017

It is intended that these data will be added to in further surveys to build up a more detailed picture of groundfish stocks in the Clyde than is currently available.

Discussion

Given the changes made to the survey protocol in 2017 compared to that in 2016, it is difficult to make many direct comparisons. A wider area was sampled, and a small mesh liner was used in 2017, both of which will have affected the catch rates and length compositions of the catch. Nevertheless, as a time series of data evolves, it should prove possible to pick out any substantial changes in the length or age frequency structure of the Clyde cod population, though it would be useful to consider how large such changes would need to be to demonstrate improvement, recovery or decline in the population.

As a part of this process, it is important to continue to review the way the survey is being conducted to try to make best use of the sampling resource available, and in order to ensure that appropriate questions are being asked of the data. However, it would also be important to maintain some equivalence in methods from one survey to the next to ensure we are not wasting sampling effort.

As part of this process, several issues should be explored with the CFA, SFF and MSS prior to any further surveys. These are itemised below.

- Sampling all three groundfish species in 2017 limited the ability of the observers to fully sample the cod in three of the hauls. It would be useful to discuss whether a numerical count of cod is required for all hauls even if they are not all measured, and if not how best to subsample cod in the most prolific hauls.
- Samples of haddock and whiting were limited to around 30 fish per haul. It would be useful to assess whether this is sufficient (given the total of 15 hauls), what questions we might expect to be able to answer from these measurements and consequently whether the sub-sampling protocol needs to be revised.
- The effects of the use of the blinder are unclear. Small fish <30 cm are still in a minority in the catch, while the mean size of fish over 30cm was lower in 2017 compared with 2016. It would be useful to explore with MSS the selectivity implications of using the blinder.
- Otoliths have now been collected for two surveys (2016 and 2017) but as yet there is no plan for using them to age the sub-samples of cod. Clearly finding a cost effective way to do this would be important.
- It would be useful to compare standardised IBTS sampling techniques and practices with those we are using. For example, the definition of the start and end of a tow may need to be modified if there is a wide range of depths being fished, given the time it takes for the trawl to fully open up. There were also some questions from our observer about differences in maturity stages 1 and 2 and how these are delineated.
- The derogation issue also needs to be explored with Marine Scotland. If future surveys are to cover the outer Clyde box or the area immediately outside the Clyde, we will need to ensure that the derogation clearly states the outer permissible limit of the survey.

- We should consider whether the traditional Nephrops trawl is indeed the best gear with which to sample cod in the Clyde, given its fragility on hard or rough ground and limited depth range.
- If other gear types were considered more useful, some calibration tows would be needed, presumably some minimum number of side by side tows which would have resource implications.
- Future surveys should devote more time to identifying the randomly selected fishing stations with the skipper in advance of the survey to avoid having to change route plans during the survey. It is important that we do not selectively reject randomly determined sampling locations unless there is an over-riding safety concern.
- Estimating weights by eye is perhaps not the best method of quantifying the catch of species other than cod. Are there better ways of doing this?
- The relative scarcity of small cod may be due to small cod aggregating in different locations. The possibility or utility of further stratification of the sampling to include areas where small cod are thought to aggregate might be considered.
- The paper sampling forms could usefully be redesigned, including the procurement of waterproof paper, but this is a simple matter than can be addressed by USTAN.
- Towing in the sea lochs proved challenging. This may need some reconsidering and either reducing intended sampling effort in this area or limiting sampling to specific predetermined areas and tidal states that can be replicated each survey (non-randomised).
- We might also consider alternative methods of quantifying cod and other groundfish numbers, possibly by using net attached sonar, camera systems, bycatch in other fisheries or even acoustic monitoring, if these might be more efficient.

Acknowledgements

We are grateful to Rob Kynoch, Marine Scotland Science, for the provision of the blinder, to Kenny Coull at SFF for continued operational advice, to Bruce Langlands SFF as co-observer to Peter Wright at MSS for advice and suggestions on protocols, and to the skipper of Spindrift.

Reference

Coram, A., Kingston, A. and Northridge, S., 2022a. Cod Catches from Demersal and Pelagic Trawl Gears in the Clyde estuary: Results from an Industry-led Survey in 2016. A report on behalf of the Clyde Fishermen's Association. 20p. Published Online August 2022. <https://research-repository.st-andrews.ac.uk/handle/10023/23378>.