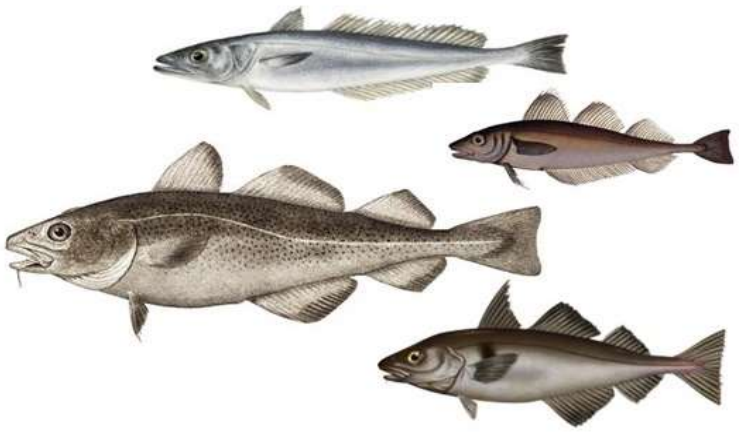
Report on CFA Clyde Demersal Fish Survey Autumn 2017



Summary Report to the Clyde Fishermen's Association.

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Foreword

This 'cruise report' is the third 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 and the inclusion of bubble plots to provide more detail on the spatial distribution of fish catches (Figures 13-16) as requested. We were unable to provide any further 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).

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Introduction

In March 2016 the Clyde Fishermen's Association (CFA) initiated the first of a series of demersal and semi-pelagic trawl surveys in the Clyde Basin to improve current understanding of the Clyde cod stock and other commercial gadoid species in the area. A second demersal trawl survey was conducted in March 2017. In October 2017 simultaneous demersal and semi-pelagic trawl surveys were carried out and the results from these are described in this short summary report.

The primary aim of the surveys is to collect data from commercial gadoid species, but primarily cod, which can be used to track any changes in stock distribution and abundance that may occur over time, and which may be related to 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.

These surveys are carried out with the agreement of Marine Scotland and under advice from Marine Scotland Science.

Sampling Alterations

Following discussions between Marine Scotland Science (MSS), the CFA, the Scottish Fishermen's Federation (SFF) and the Scottish Oceans Institute (SOI), several changes to the previous (2016) survey were agreed and implemented for the 2017 surveys. Firstly, it was agreed that all major groundfish species – cod, haddock, whiting and hake would be sampled (or sub-sampled where appropriate) for length, sex and maturity, but otoliths would be taken for a sub-sample of cod only at 2 fish per cm interval where possible. Secondly, to ensure fuller size selectivity of the catches, a blinder would be used in the demersal trawl to help provide information on pre-recruit age groups. Thirdly, it was agreed to extend the geographical scope of the surveys by stratifying the full 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 agreed survey strata are shown in Figure 1.

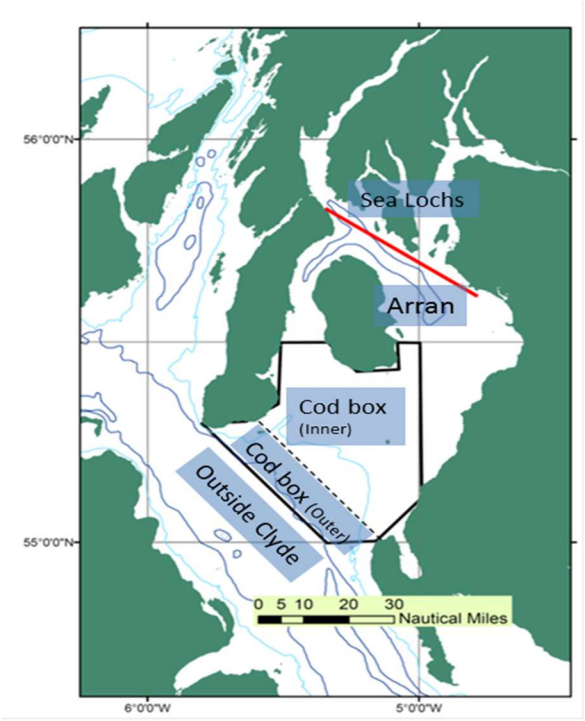

Figure 1 - Sampling strata

The Survey

The surveys took place from the 18th to 20th October 2017, with Campbeltown as the port of departure and landing. The demersal trial was conducted by the FV Atlas and the semi-pelagic survey was conducted by the FV Gleaner II. Two observers were provided by the SFF and two observers were provided by the SOI.

The demersal trawl and semi-pelagic trawls were the same as those used in previous surveys and the details are described in earlier reports so are not repeated here.

Allocation of Station Positions

The demersal survey followed a standard stratified random approach with a number of trawl stations selected within each stratum as shown in Figure 3 (overleaf). The semi-pelagic survey was also conducted using a stratified random approach but was altered during the survey after discussions with the skipper of Gleaner II who highlighted that the current stratification and station selection meant that no sampling would occur in the deep-water channels around the north and east sides of Arran (shown in red in Figure 2).

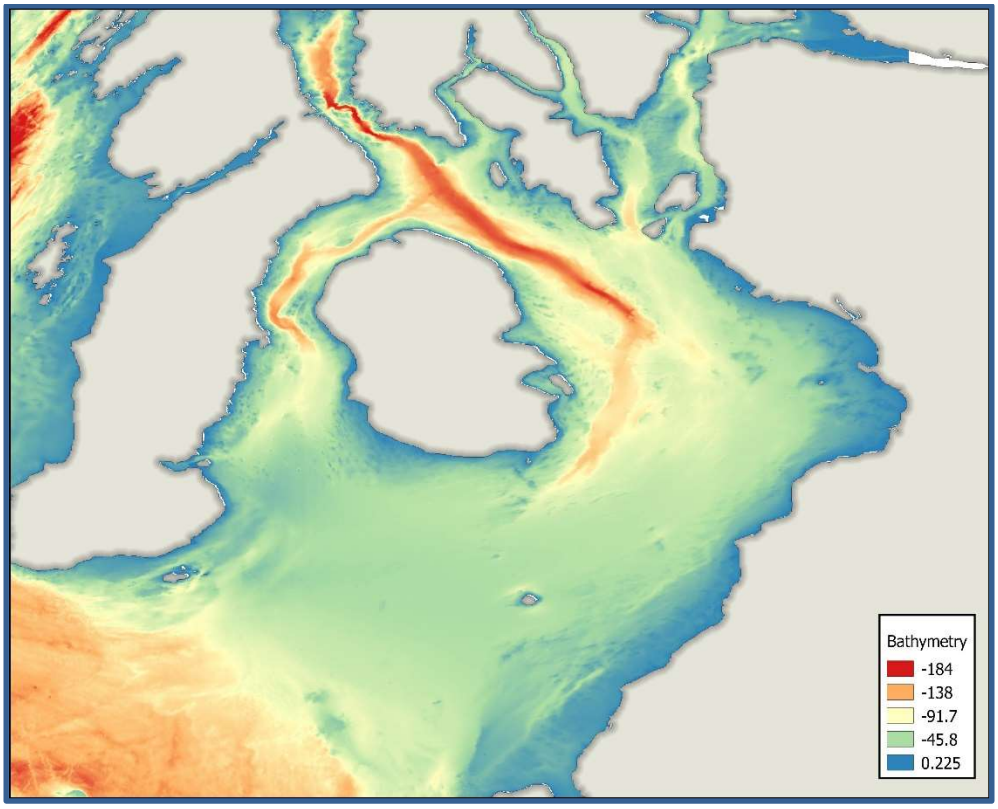

Figure 2 - Basic bathymetry (m) of the Clyde Basin.

The skipper felt it was important, particularly during autumn surveys, to sample these areas because that is where he would expect most of the cod to be distributed at that time of year. It was agreed that for future autumn surveys it would be sensible to include these deeper channels as a new distinct stratum delineated by the 50-fathom contour, to ensure that some sampling would occur there, which will help provide a truer reflection of cod distribution and abundance within the Clyde at different times of year.

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. A first run of random station selections was then provided to the skippers of the participating vessels who ruled out several because of towing constraints. These were then removed from the second and final selection run. We planned a total of 15 demersal and 7 semi-pelagic tows distributed throughout the survey region.

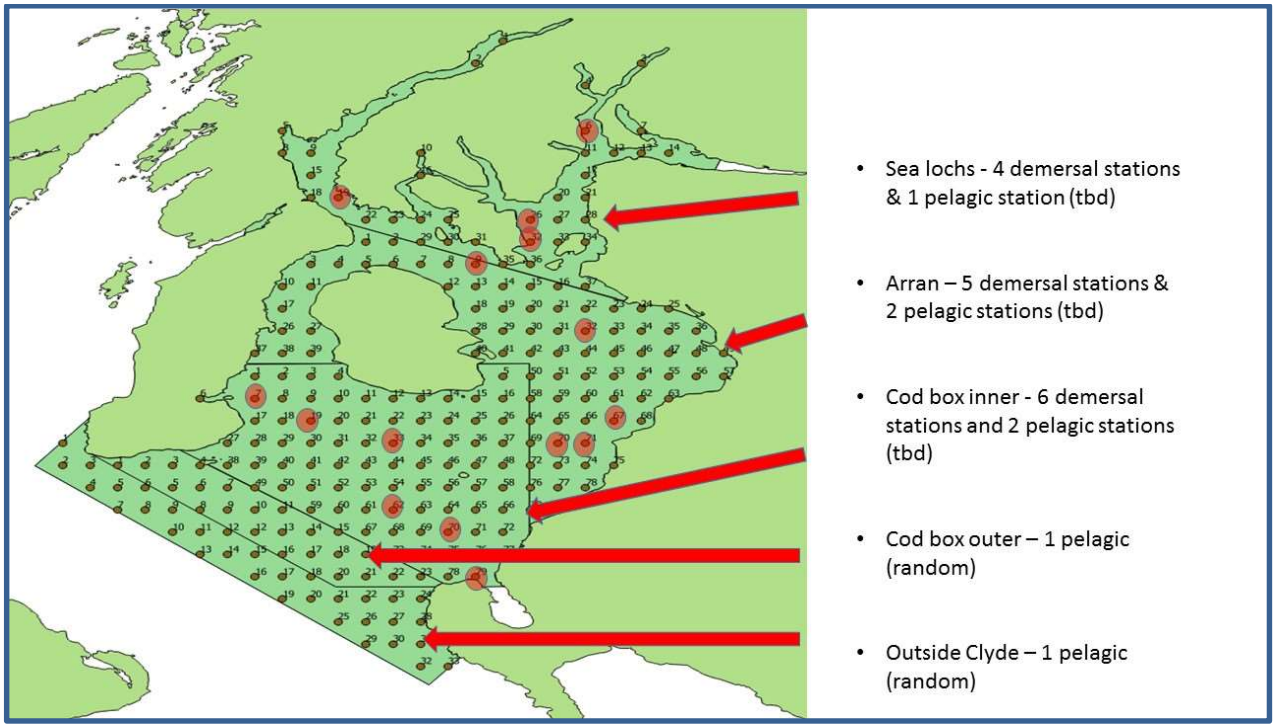

Figure 3 - Selected random sampling stations.

The 'Outside Clyde' and 'Cod Box – Outer' areas were rejected for demersal towing at this stage, as much of the ground is unsuitable for working a clean ground nephrops trawl.

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. As with previous survey, tow times were considered to start from when the winches stopped and end when the winches start again. This does not allow for the doors to spread and gear to settle fully, which in deep water may take several minutes.

Demersal hauls were planned to be 30 minutes duration. However, on a number of occasions a longer tow duration was carried out to pass through adjacent randomly selected trawl stations to keep gear handling times minimized. From a scientific perspective this approach could complicate interpretation of the data, but from a practical perspective might be justified.

Semi-Pelagic tows were planned to be 3 hours each, but during the survey ranged from 2 to 4 hrs.

Within the allotted time 13 demersal tows and 5 semi-pelagic tows were completed and these are shown in Fig 4.

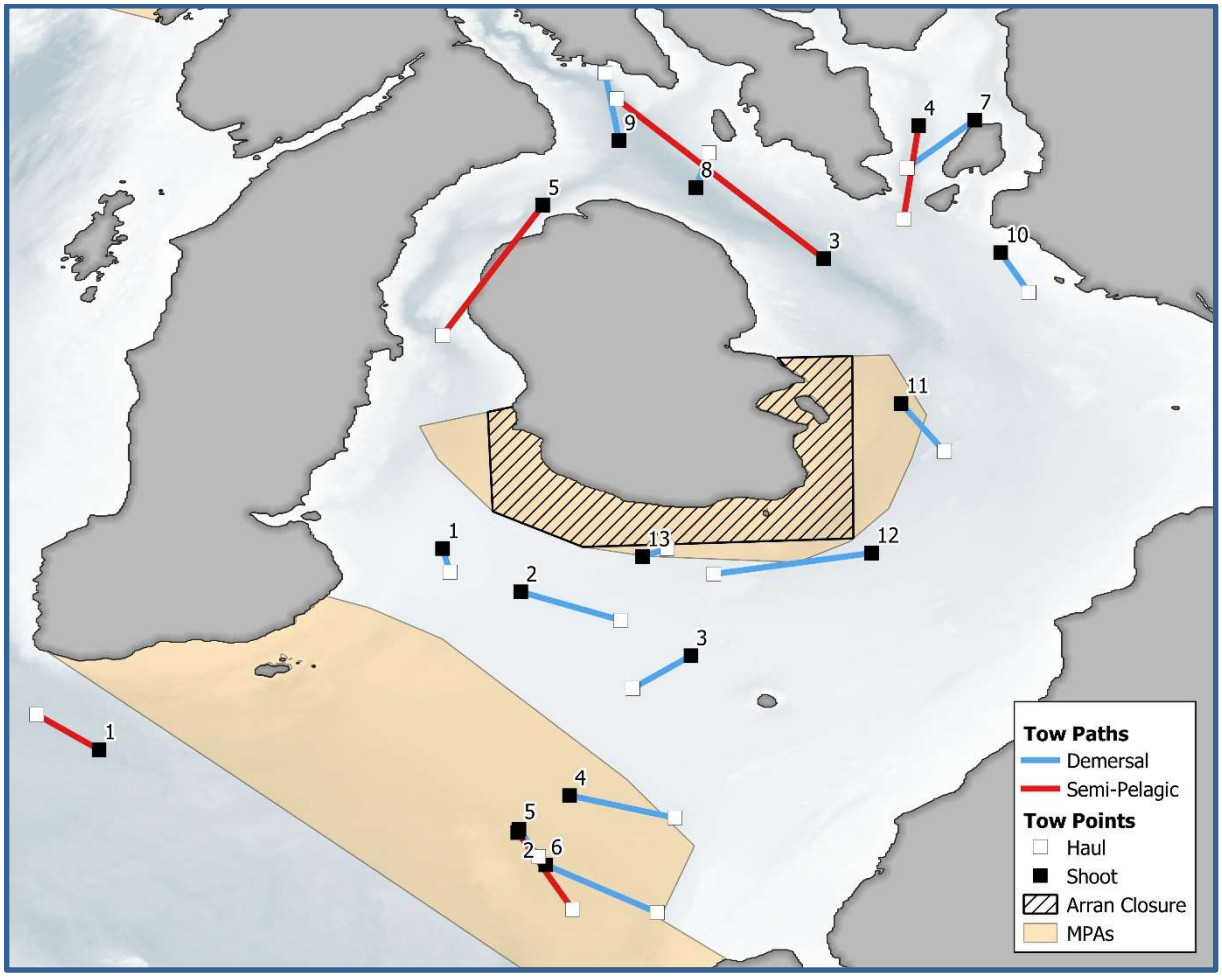

Figure 4 - Start and end tow positions (connecting lines are indicative only).

Table 1 shows the haul durations for the demersal and semi-pelagic surveys.

Table 1 - Haul details – station id, date and tow duration in minutes

Survey	Haul No	Station	Date	Duration
Demersal	1	CBi-7	18-Oct-17	30
	2	CBi-19	18-Oct-17	30
	3	CBi-33	18-Oct-17	35
	4	CBi-62	18-Oct-17	30
	5	CBo-15	18-Oct-17	35
	6	CBo-19	18-Oct-17	60
	7	SLo-26-32	19-Oct-17	75
	8	SLo-8-9	19-Oct-17	40
	9	SLo-19-22	19-Oct-17	115
	10	SLo-32	19-Oct-17	60
	11	Arr-41	20-Oct-17	55
	12	CBi-26	20-Oct-17	60
	13	CBi-24	20-Oct-17	55
Semi-pelagic	1	OUT-5	18-Oct-17	120
	2	CBo-15-19	18-Oct-17	125
	3	"Deep"	18-Oct-17	240
	4	SLo-26-32	19-Oct-17	150
	5	"Deep"	19-Oct-17	195

Deck sheets were completed for each tow to record estimated weights by species and notes describing any other interesting aspects of the catch were also taken.

Catches were sorted initially by crew and observers into species, with cod, haddock, hake and whiting prioritized and always fully separated. The rest of the catch was sorted to species or taxa as much as possible given time restraints. A “mixed” category was also used on occasions for small amounts of multiple species.

All cod were counted, measured for length, sex and maturity stage (according to ICES fish maturity chart). Otolith were taken from some specimens with a target of 2 fish per cm.

Haddock, hake and whiting were sub-sampled from the total catch, with usually about 30 fish being selected and measured for length, sex and maturity. Where possible we tried to ensure some fish were selected from throughout the sorting process, but it should be noted that these sub-samples may not be fully representative of the length distribution of the total catch.

Some otoliths were also taken opportunistically from haddock, hake and whiting during the semi-pelagic survey.

Otoliths were extracted from each fish and placed into paper envelopes marked with the haul number, and fish number and length. A cover slip was completed with remaining haul details and taped securely to the individual otolith envelopes.

Other species were recorded by estimating the total weight in the catch. This was done by eye using baskets as a unit of measurement, with one full basket assumed to be approximately 35kg, regardless of species or size composition.

Summary of Results

Due to operational inconsistencies, such as variable tow durations, changes to the survey stratification and recent sampling alterations we do not provide any comparisons with results from previous surveys but suggest that once the survey methodology stabilises it will be informative to undertake comparative analyses on a fairly regular basis. This section therefore simply provides a brief overview of results with some basic descriptive text from the autumn survey. We have summarised the data in several sections:

1. Total catch compositions
2. Cod catch rates
3. Size distributions
4. Sex ratios
5. Maturity stages
6. Catch size and locations

Total Catch Compositions:

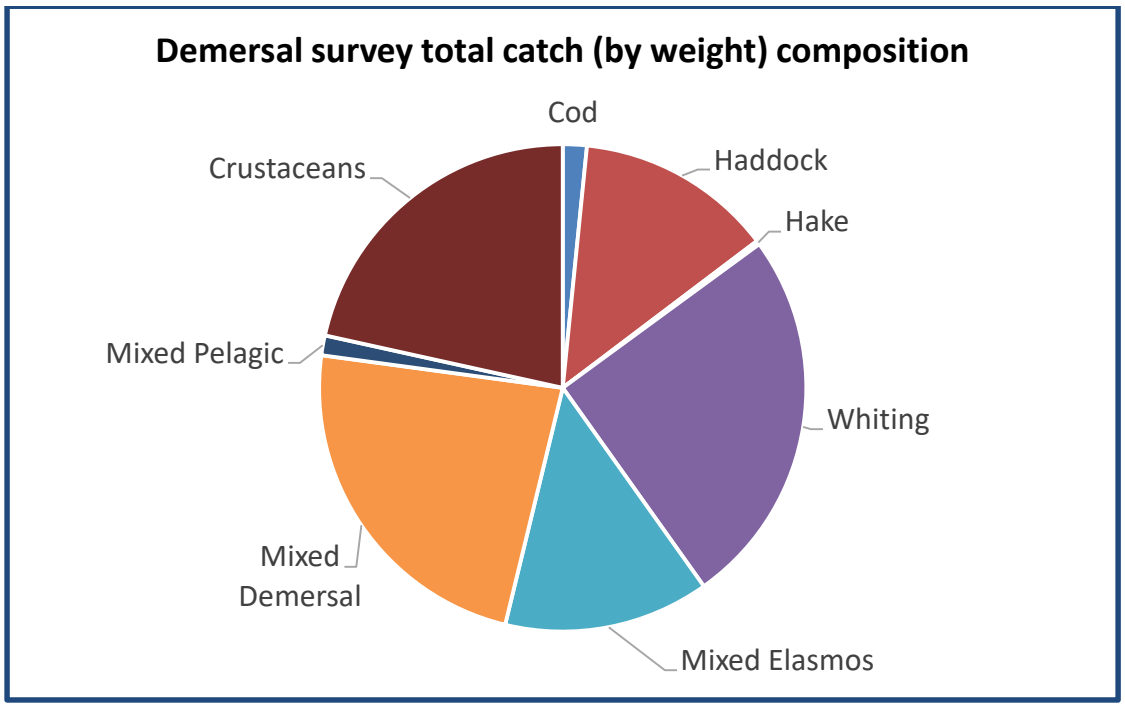

Figure 5 - Demersal survey catch composition.

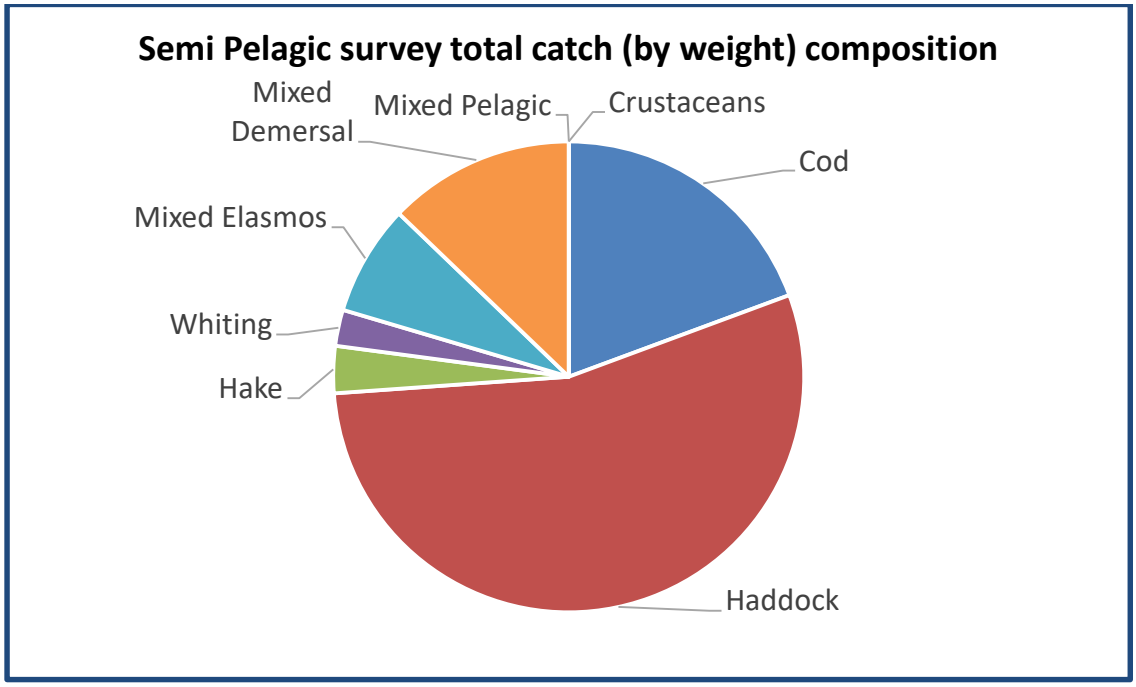

Figure 6 - Semi-Pelagic survey catch composition

Figures 5 and 6 show the total catch compositions from the demersal and semi-pelagic surveys. Of note is that cod (19% v 1.5%), and all gadoids combined (80% v 40%), make up a significantly larger proportion of the total catch in the semi-pelagic survey compared to the demersal survey.

Cod Catch Rates:

Cod catch rates calculated in terms of number of fish per hour towing are shown in Figures 7 and 8, for the demersal and semi-pelagic surveys respectively. Only 6 of the 13 demersal tows completed had cod in the catch whereas all the semi-pelagic tows caught cod. In general the catch rates from the semi-pelagic gear were higher and one haul in particular (Haul 1) had a rate of 40 fish per hour, approximately four times higher than the mean from the other tows where cod were present. This tow occurred in the "Outside Clyde" strata in the North Channel.

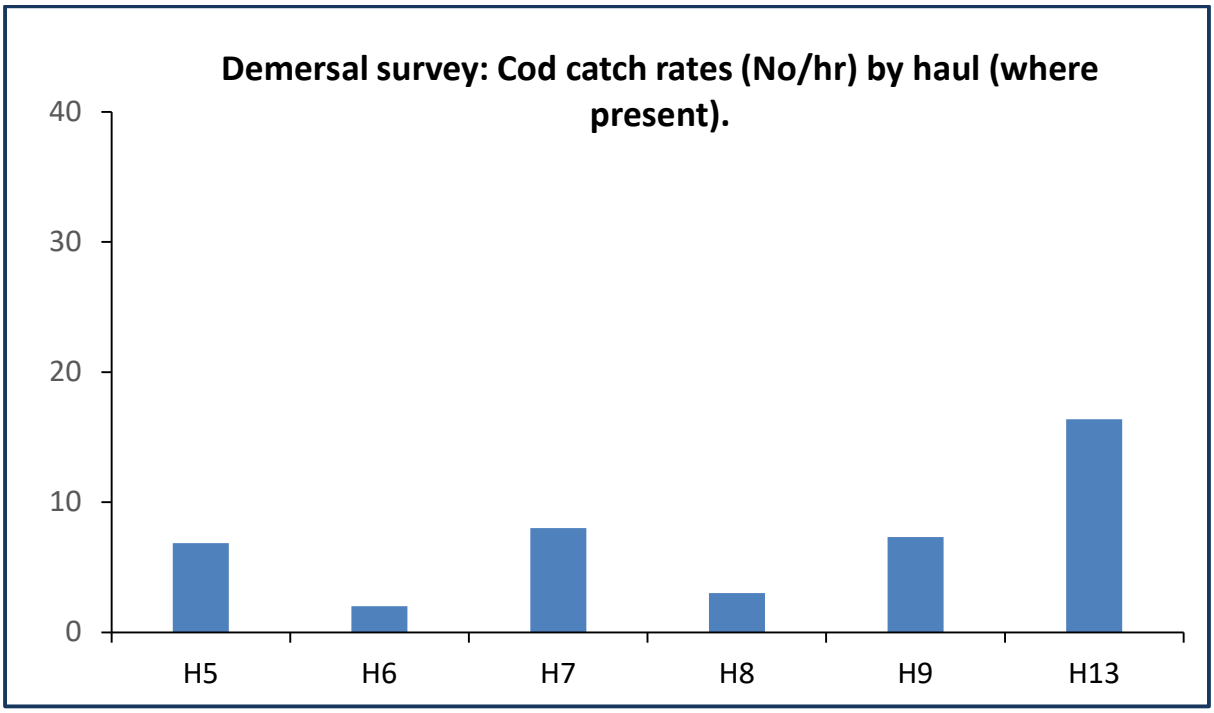

Figure 7 - Cod catch rates (No/hr) from the demersal survey.

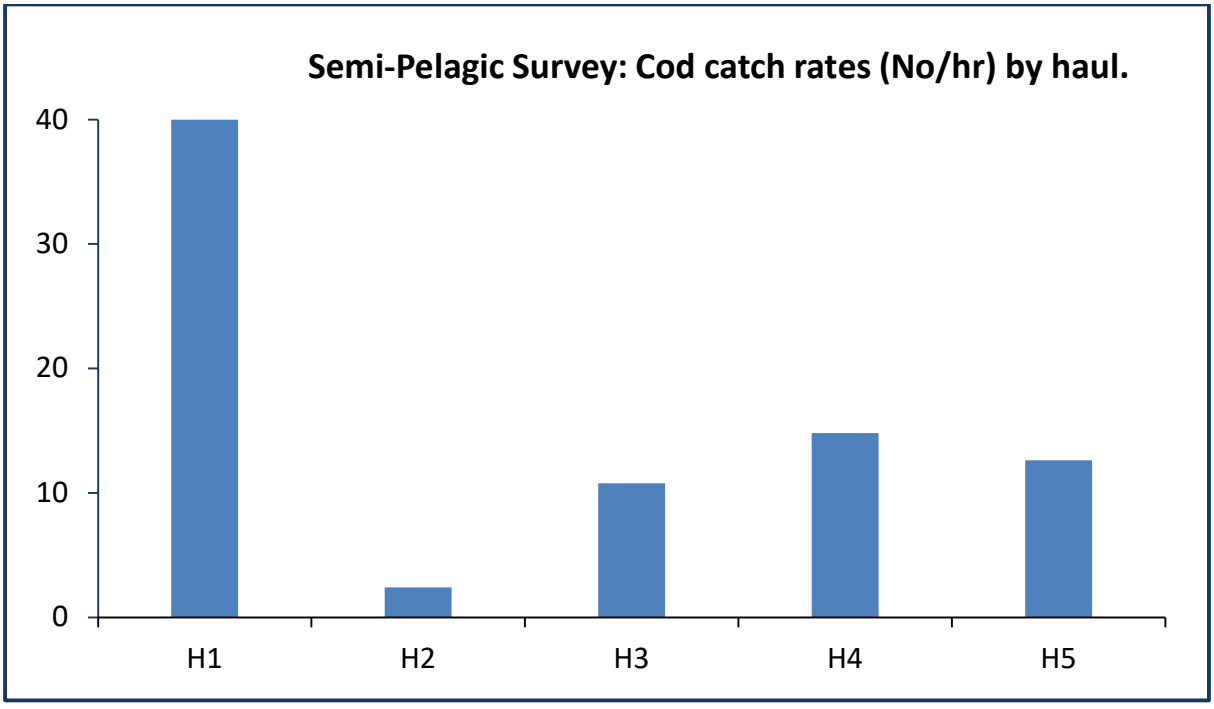

Figure 8 - Cod catch rates (No/hr) from the semi-pelagic survey.

Size Distributions:

Figure 9 shows the size distributions for the 4 main gadoid species sampled, cod, haddock, whiting and hake. All cod in the catches were measured, but the data from the other species was obtained by sub-sampling the catch.

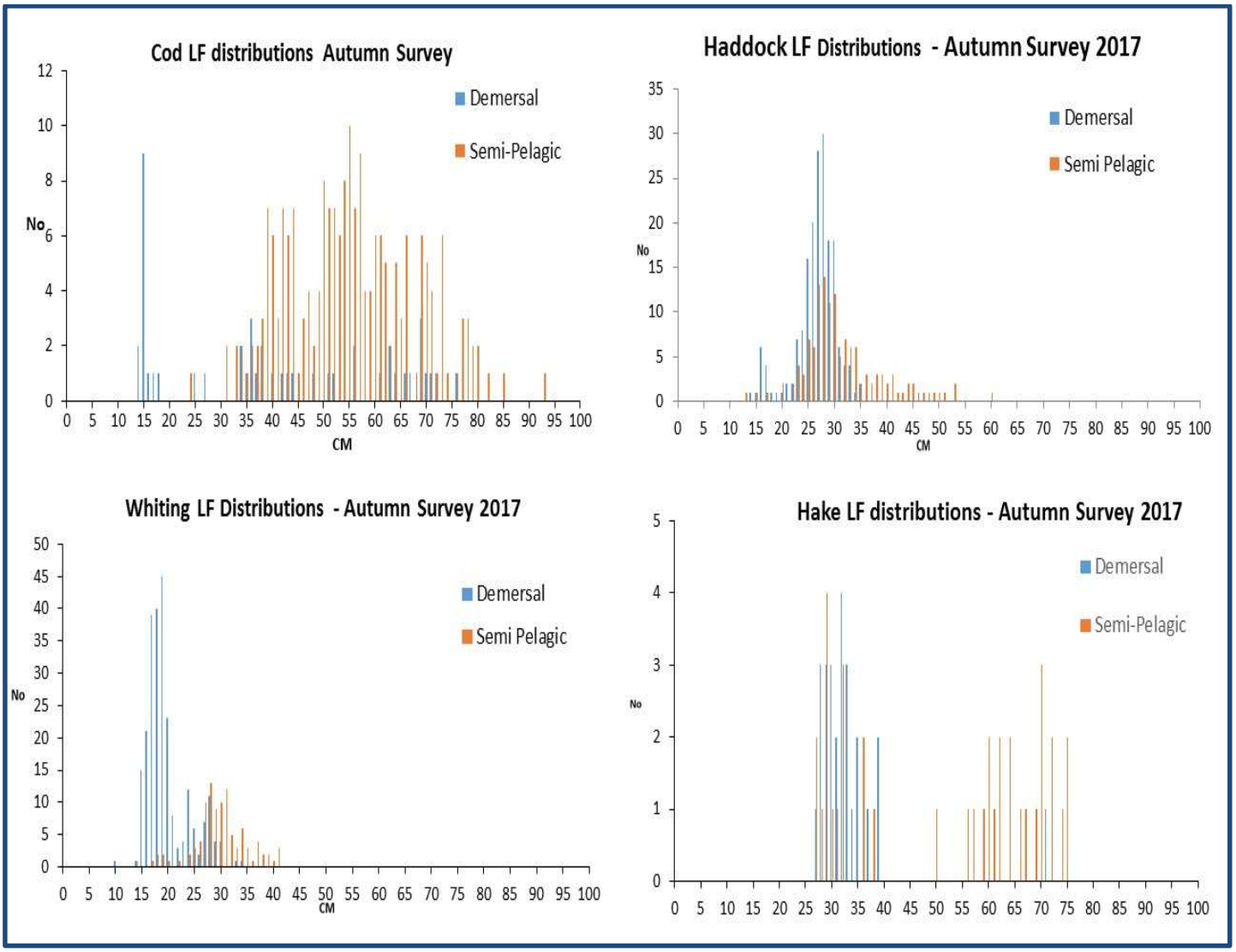

Figure 9 - Size distributions for the main gadoid species.

For all species the semi-pelagic gear caught higher numbers of larger specimens, probably reflecting the longer tow durations which are generally perceived to improve catches of larger fish which tire less quickly than smaller specimens, and the wider aperture of the gear meaning more of the water column is being effectively sampled.

Conversely, and particularly for whiting, the demersal gear caught more small specimens and this is likely largely due to the presence of the blinder which will decrease selectivity for smaller fish.

There is visual evidence of distinct cohorts in all plots and particularly so when looking at both the demersal and semi-pelagic distributions together – meaning that a fuller picture of the size distribution of these species is attained by sampling catches from these two different gears.

Sex Ratios:

Figures 10 and 11 show the sex ratios for cod and haddock, and for whiting and hake respectively.

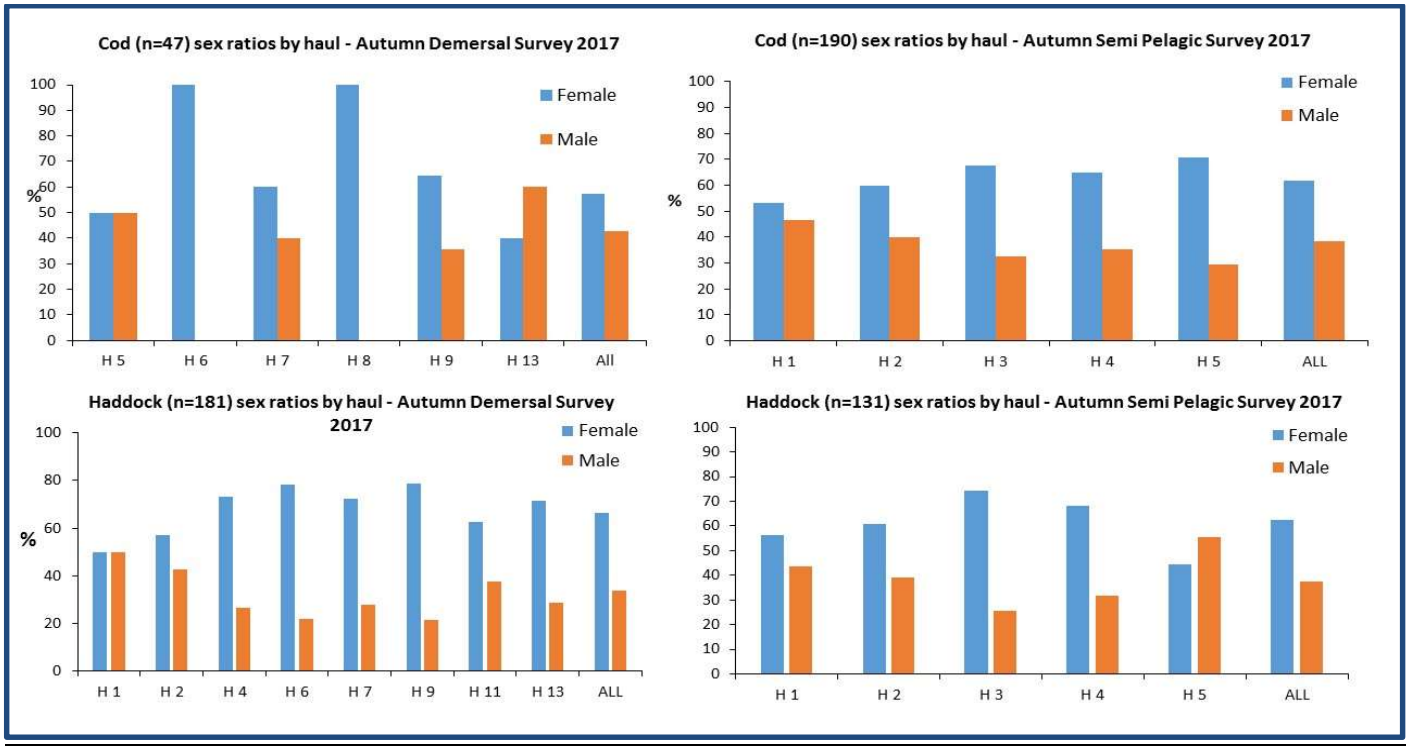

Figure 10 - Sex ratios of cod and haddock from the demersal and semi-pelagic surveys.

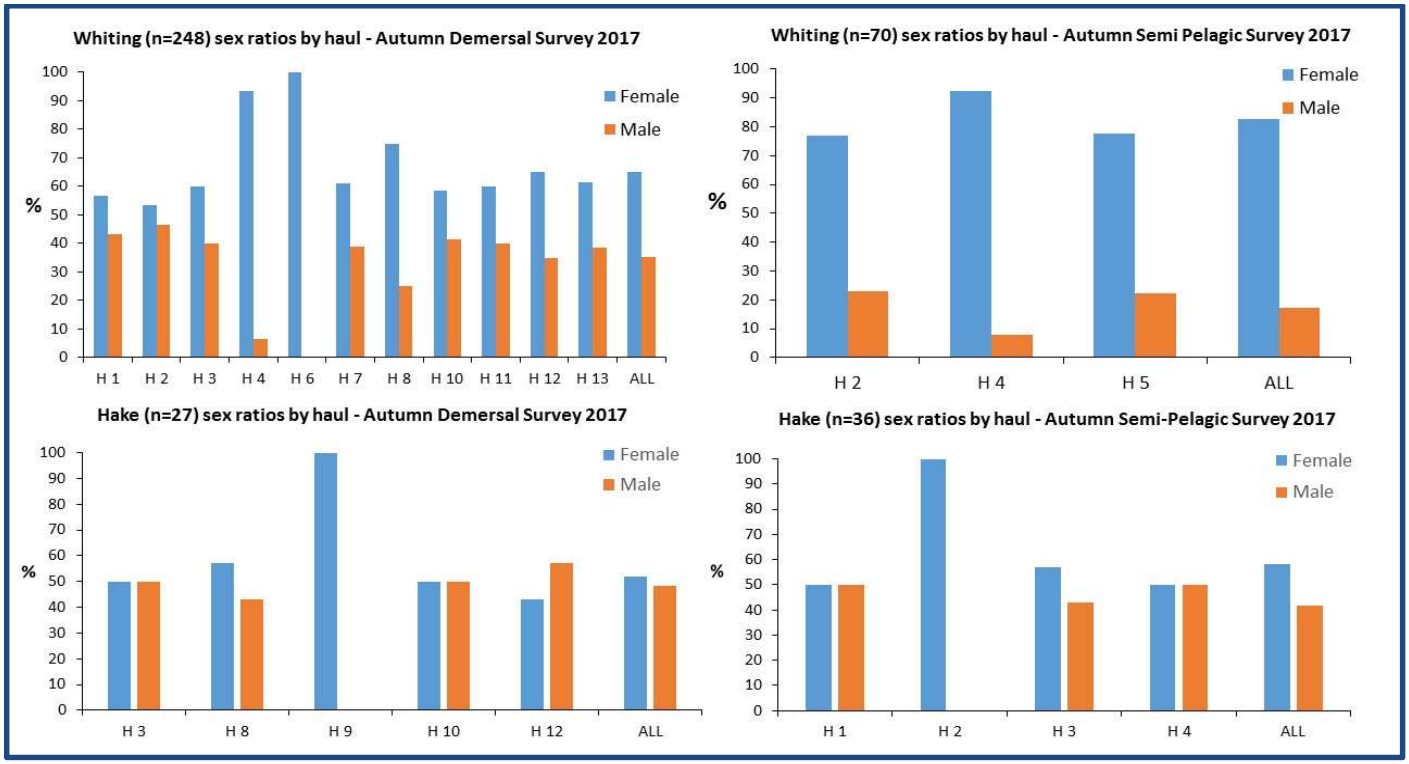

Figure 11 - Sex ratios of whiting and hake from the demersal and semi-pelagic surveys.

The observed sex ratios are broadly similar between surveys with females dominating the catches of cod, haddock and whiting. For most hauls the numbers of male and female hake were similar, but the overall number of sampled hake was lower than for the other three species, so may not be a particularly good reflection of the underlying population sex composition.

Maturity Stages:

Figure 12 shows the observed maturity stages for the four main gadoid species. The observed maturity patterns are reasonably consistent between surveys, but some differences are evident. Although some of these may be attributable to the different size distributions observed between the surveys, there is also the potential for some inter-rater reliability influences, because of all the biological parameters recorded during the survey maturity staging is perhaps the most prone to interpretation, particularly when sampling is being conducted under variable conditions at sea.

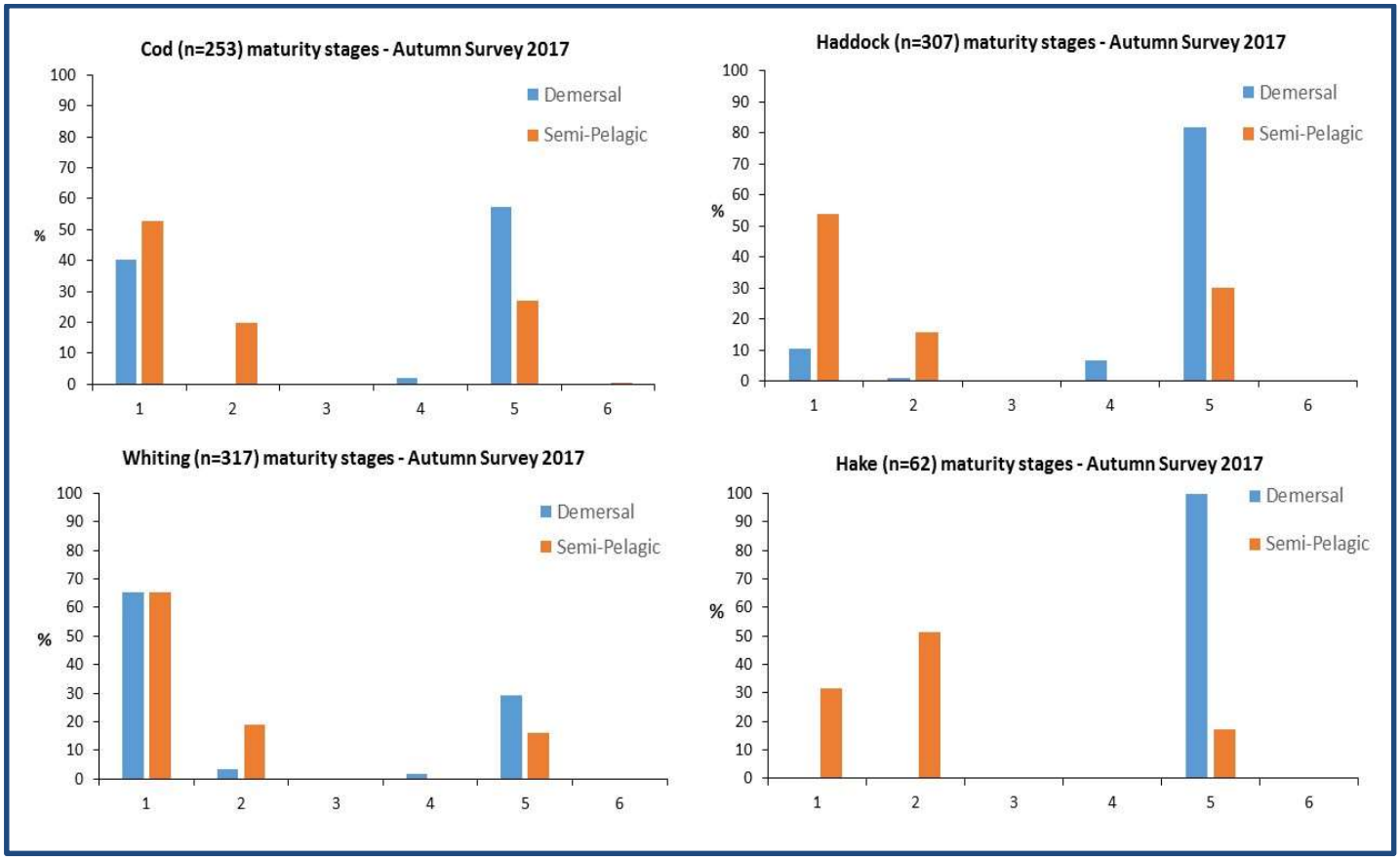

Figure 12 - Maturity stages for the main gadoid species.

Catch size and locations

Figures 13 to 16 show the estimated catch weight by species for each of the tows in the demersal and pelagic surveys.

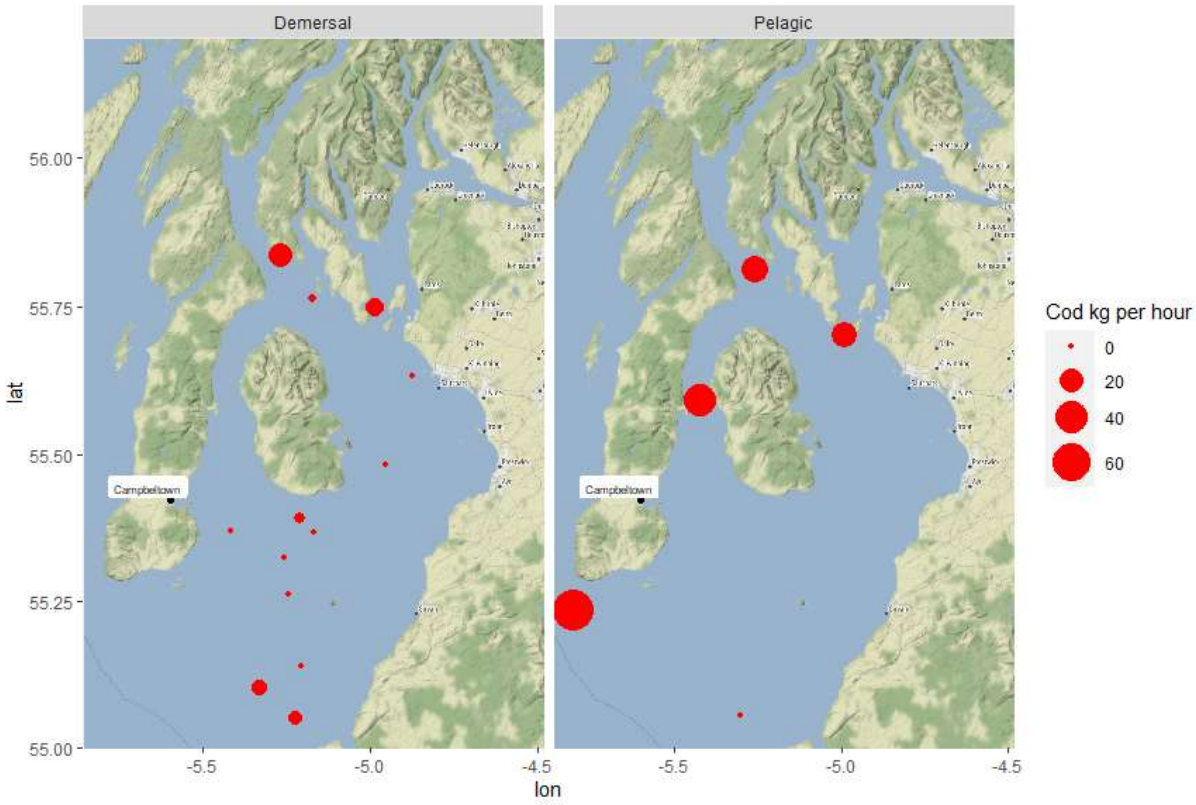

Figure 13 - Cod catch rates (Kg/hour)

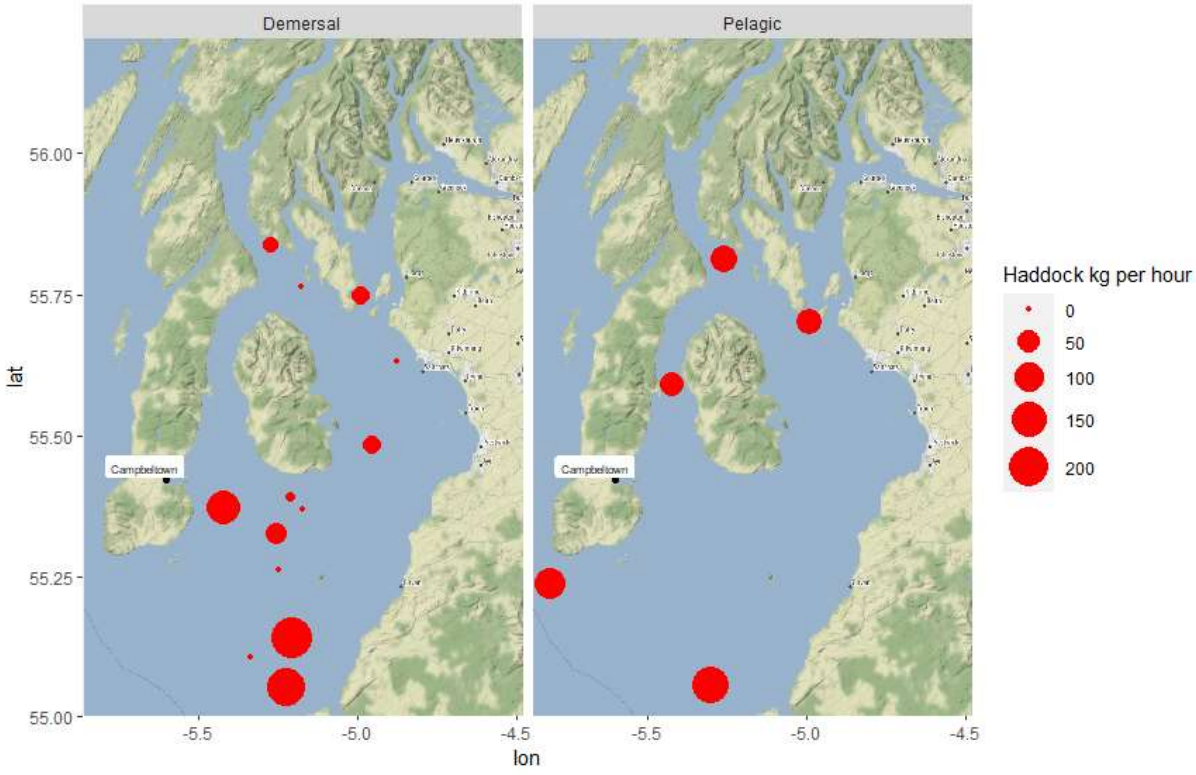

Figure 14 - Haddock catch rates (Kg/hour)

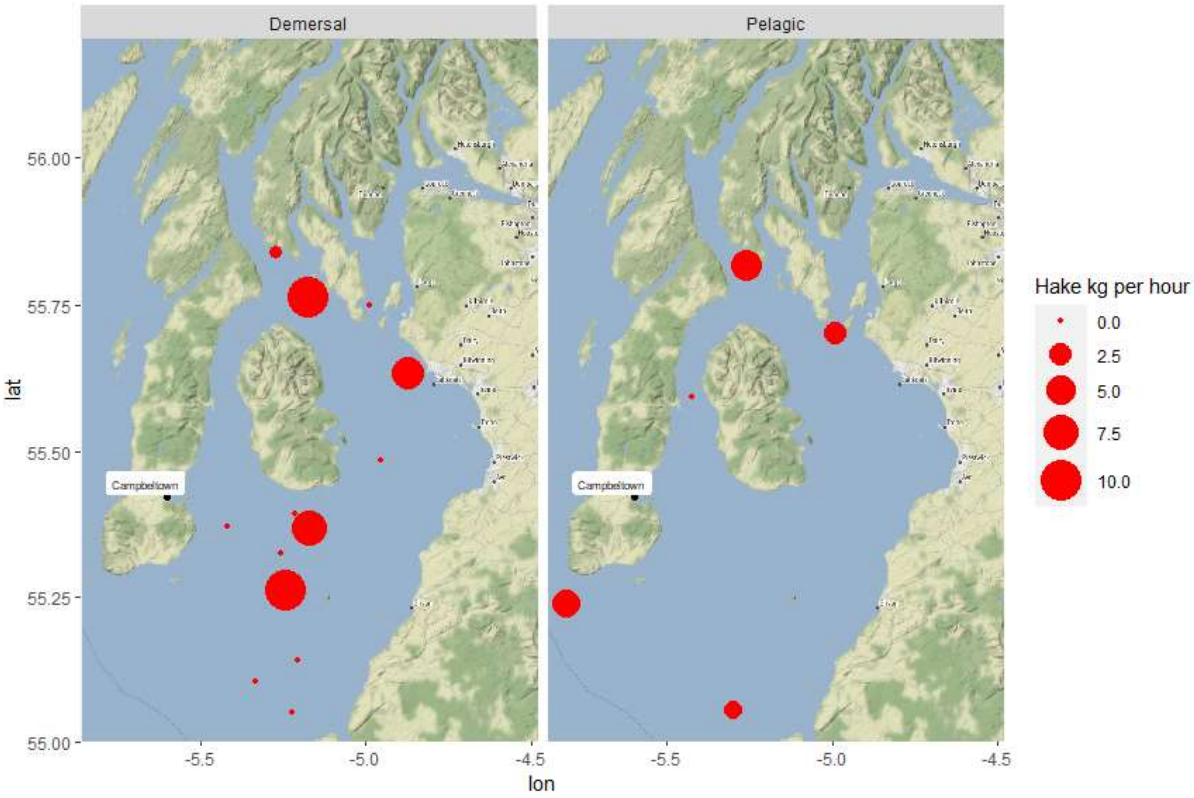

Figure 15 - Hake catch rates (Kg/hour)

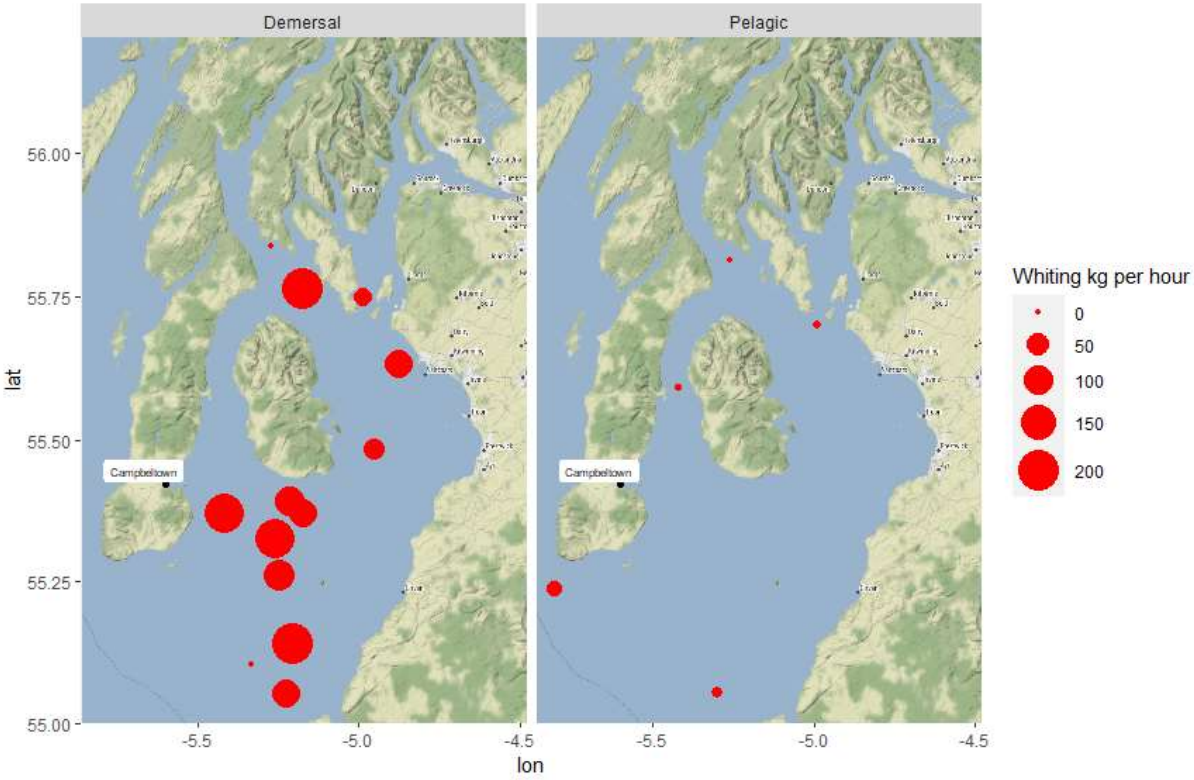

Figure 16 - Whiting catch rates (Kg/hour)

Discussion

This survey was the third in what is becoming an ongoing industry-led fisheries sampling programme within the Clyde basin, which will eventually provide a very useful time series of data which can be used to track possible changes in the demersal fish populations in the region. However, given the changes made to the survey protocol in 2017 compared to 2016, and some further modifications made during the autumn 2017 survey, it is difficult and Ill-advisable to try to make direct comparisons between surveys at this stage. For example, in 2017 a much wider area was sampled, and a small mesh liner was used in the demersal trawl, both of which will have affected the catch rates and size compositions of the catch. Nevertheless, as a time series of data evolves, it should prove possible to pick out any substantial changes in the size structure and catch rates of the Clyde cod (and other gadoid species) population which may indicate some improvement in stock status, though it would be useful to consider how large such changes would need to be to demonstrate with statistical significance that recovery or decline was occurring in the population.

Despite not yet making detailed comparisons between surveys some patterns are beginning to emerge, for example the semi-pelagic gear appears to consistently catch more large specimens for most species, including cod. There are several possible explanations for this, but nonetheless it strongly indicates that a more complete picture of the underlying size distributions for most gadoid species is obtained when combining data from both gears. This is particularly important in the case of cod where no landings data have been available for several years, meaning that annual assessments will rely on IBTS survey data alone.

We reiterate that it is important to constantly review the way the survey is being conducted to try to make best use of the limited sampling resources available, and to ensure that appropriate questions are being asked of the data. However, it is vital that the basic survey methodology stabilises (including aspects such as regular tow durations, adhering to the haul randomisation process and consistent stratification approach) and remains consistent going forward so that results from future surveys can be viewed and interpreted in a meaningful way.

In the spring 2017 report (Coram *et al*, 2022b) we highlighted several issues that should be explored with the CFA and MSS prior to any further surveys, and we list the relevant ones again so they remain in focus, and have added some recent further recommendations based on the autumn survey.

- Sampling of three groundfish species in spring 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.
- Sub-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 number of 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 to ensure more fish are fully sampled.

- The effects of the use of the blinder are unclear. Small fish (<30 cm) were still in a minority in the catch, while the mean size of fish over 30cm was lower in spring 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 three surveys but as yet there is no plan for using them to age cod. Clearly finding a cost-effective way to do this would be useful and 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.
- 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 unsuitability for use 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.
- Altering the stratification approach to delineate the deep-water channels around the North of Arran was suggested as appropriate for the autumn survey – is this also justified for the spring survey?
- Given the potential difficulty of maturity staging at sea it may be useful for observers to obtain some further training in this data collection aspect.
- Towing in the sea lochs proved challenging. This may need some reconsidering and either reducing intended sampling effort in this area of 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 and Malcolm MacFarlane (SFF) and Phil Spencer (SOI) as observers, to Peter Wright at MSS for advice and suggestions on protocols, and to the skippers of Atlas and Gleaner II.

References

Coram, A., Kingston, A. and Northridge, S., 2022b. Report on CFA Clyde Demersal Fish Survey March 2017. Summary Report to the Clyde Fishermen's Association. 14p. Published Online August 2022. https://research-repository.st-andrews.ac.uk/handle/10023/23378