

Marine Scotland Science

Investigation of Reports of Semi-Pelagic White Fish in the Clyde

Marine Scotland Science Report 01/16

W R Turrell, P Gibson, G McAllister and N Bailey



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Contents

Summary	1
Background	6
Approach Taken	7
Development of the Survey Design	7
Selection of Survey Vessel	11
Results	12
HAUL DETAILS	12
COMPARATIVE DATA	13
COD	14
HADDOCK	15
WHITING	16
RELATIVE PROPORTIONS OF WHITE FISH	18
Discussion	20
Recommendations	22
References	23
Figures	24
Tables	31
Appendix 1 – Transcripts of Haul Sheets	33
Appendix 2 – Survey Programme	81
Appendix 3 – Additional Research Questions from the Industry Consultation	83

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Summary

1. Following an extensive consultation with local fishermen, a trial survey to investigate reports of semi-pelagic white fish in the Clyde was carried out in February 2014.
2. The consultation with industry resulted in the following set of statements which were investigated during the trial:
 - White fish (cod, haddock, whiting, hake) occur semi-pelagically above the deeper Clyde Sea basins north of the Great Plateau early in the year.
 - The shoals are made up of a mixture of sizes and ages.
 - The duration of a tow matters, as bigger fish may be able to escape from short duration tows, as they do not reach a point of exhaustion.
3. The investigation was carried out on board the MFV *Frigate Bird* (TT137, 17 m, 65 tonnes, 279.75 kW) between 10 and 21 February 2014.
4. Fifteen hauls were performed, although one was foul and no catch was recovered. Tows were performed in Upper Loch Fyne, Lower Loch Fyne, Inchmarnock Water, Sound of Bute, Kilbrannan Sound, Arran Trench, Cumbrae Basin, Hunterston Channel, Clyde Channel, and Dunoon Basin. Seabed depths for tows varied between 70 m and 180 m. Duration of tows varied between four and twelve hours. Appendix 1 presents transcriptions of the original haul sheets, including all comments, etc.
5. For twelve of the valid tows, the cod end was 100 mm, while for the two final tows a finer cod end of 40 mm was used.

6. Hence, the investigative survey fulfilled all the specifications obtained during the industry consultation, i.e., it used the gear type, boat type, time of year, and method of fishing that the industry considered would maximise white fish catches.
7. A limited amount of comparative data were available from demersal surveys that provided a more complete coverage of the Clyde. These quarterly surveys consisted of shorter tow lengths (typically 30 minute), using different survey gear and employing a repeatable scientific protocol.
8. It must be remembered that the results presented here are from an investigative survey and not a statistically designed survey. Hence quantitative results presented here are indicative only. In particular, the lack of information on the height of the net throughout each tow and the large distances covered during each tow confound the interpretation.
9. Also, all results presented in this report relate only to the deep basins of the Clyde (>70 m, or 38 fathom). The results cannot be applied to all of the Clyde without further work. The deep (>70 m) basins of the Clyde represent approximately 21% (79 km²) of the total Clyde Sea (3,700 km²).
10. Caution also needs to be applied owing to the nature of the fish distributions sampled. For example, results for young fish in both the investigative survey and the comparative data are dominated by one or two large hauls, suggesting patchy distributions. Also, the short duration comparative hauls return just one or two large fish, hence raising these small numbers can provide difficulties.
11. Results for cod were:
 - Semi-pelagic fishing caught fewer cod (seven cod/hour) on average than standard demersal fishing (16 cod/hour).
 - However, the semi-pelagic fishing used in this trial, with 100 mm cod ends, using long duration tows (four to seven hours) in the deep basins of the Clyde caught predominantly large cod (30-100 cm, two to eight years old).
 - Standard demersal fishing using 30 minute tows caught predominantly small cod (<30 cm, one year old).

12. Results for haddock were:

- Haddock were caught by the long duration semi-pelagic fishing in the deep basins of the Clyde in a mixture of ages (one to four years) and sizes (9-71 cm).
- However, as with cod, the semi-pelagic fishing, on average, caught fewer haddock (62 fish/hour) than the standard demersal fishing (125 fish/hour).
- In the semi-pelagic hauls, larger haddock (>20 cm, two to four years) were more abundant than larger cod, with average catch rates being about 30 large fish per hour.
- Standard short duration (30 minutes) demersal survey fishing caught similar amounts of small young haddock (<20 cm, one year) as semi-pelagic fishing when using a fine mesh cod end.
- Standard short duration (30 minutes) demersal survey fishing did not catch the larger (>20 cm) fish to the same extent as long duration (four to seven hours) semi-pelagic fishing.

13. Results for whiting were:

- Whiting were caught by semi-pelagic fishing in the deep basins of the Clyde, but only one age was present; one year olds, <25 cm in length.
- The standard demersal survey fishing caught whiting at approximately eight times the catch rate of semi-pelagic fishing.

14. Results for hake were:

Hake were caught by semi-pelagic fishing in the deep basins of the Clyde, but in very low numbers. 87 hake were caught in 100 hours of fishing.

From the length distribution, the hake caught were most likely one, two and three year old fish.

15. In terms of considering the communities of young (one year old) white fish in the deep basins of the Clyde, the findings of this study suggest:
- In the semi-pelagic hauls, young haddock were the most abundant, being four times as abundant as young whiting.
 - Young cod were between 30 (demersal surveys) and 100 (semi-pelagic data) times as rare as young whiting in the deep basins of the Clyde.
16. In terms of considering the communities of older (> one year old) white fish in the deep basins of the Clyde, the findings of this study were:
- The community of older white fish in the deep basins was principally made up of cod and haddock. There were virtually no older whiting, but some older hake.
 - Semi-pelagic surveys found four times as much older cod and eight times as much older haddock in the deep basins as the standard demersal surveys.
 - Both methods of surveying indicated approximately twice as much older haddock as older cod.
 - Large fish of all species were rare. Catch rates for larger fish in the semi-pelagic investigative hauls were of the order of seven fish/hour for cod, 30 fish/hour for haddock and one fish/hour for hake.
17. The semi-pelagic investigation has revealed significant numbers of young haddock over the basin areas. It is not possible to say whether this finding translates to a more significant contribution of young haddock to the Clyde white fish community than was reported in the analysis by Heath and Speirs (2011). However, this needs further research.
18. The investigative survey has shown that, on average, long-duration semi-pelagic fishing within the deep basins of the Clyde catch white fish at a lower rate (i.e. numbers of fish caught per hour fishing) than standard demersal fishing in the same areas. However, such semi-pelagic fishing catches large fish at higher rates than in demersal fishing.

19. The semi-pelagic fishing has shown that there are large, older white fish in the deep basins of the Clyde (>70 m), but they are present in very low densities (e.g. one hour of targeted semi-pelagic commercial fishing returned just seven large cod). Without further work it is not possible to say what their total abundance is, or whether these fish represent resident spawning populations.
20. The semi-pelagic investigation suggests that in the deep basins, large white fish may be more abundant than demersal stock surveys suggest. However, even in the deep basins large fish are still rare. Their presence may give some hope for the possible restoration of white fish in the Clyde, but their abundance and density is low and may require specific management consideration.
21. The significance of the demersal fish occurring semi-pelagically requires investigation. It is important to understand the spatial and temporal extent of this behaviour in order to ensure future surveys of the species concerned are designed appropriately and are representative of abundance.
22. The consultation process raised a number of questions which the preliminary investigation did not address, but which remain valid questions for future work. These are presented in Appendix 3.

Background

McIntyre *et al.* (2012) describe the initial background to this investigation, i.e.:

- “In July 2010 a scientific paper authored by researchers from York University was published, entitled “Ecological Meltdown in the Firth of Clyde, Scotland, Two Centuries of Change in a Coastal Marine Ecosystem” (Thurston and Roberts, 2010).
- Subsequently, Marine Scotland Science (MSS) commenced work which led to the 2012 review of the Clyde Ecosystem (McIntyre *et al.*, 2012).
- Independently from the process underway within Marine Scotland, the University of Strathclyde also commenced work on the issue of the ecological status of the Clyde.
- While Thurston and Roberts (2010) relied entirely on landings data, the University of Strathclyde study used research vessel survey data obtained from MSS.
- As a result of a detailed and well-found analysis, in July 2011 Professor Heath published a definitive analysis of the present state of the Clyde Sea demersal fish community in his paper, with Dr Doug Speirs, entitled “Changes in species diversity and size composition in the Firth of Clyde demersal fish community (1927-2009)” (Heath and Speirs, 2011).
- The conclusions of Heath and Speirs (2011) point to a major ecological impact of fishing in the Clyde.”

McIntyre *et al.* (2012) noted that in simple terms, the results of Heath and Speirs (2011) suggest that white fish in the Clyde is now made up mostly of small fish, and mostly small whiting.

Following the publication of McIntyre *et al.* (2012), the Clyde Fisherman’s Association (CFA) held a presentation at the Scottish Parliament, which documented changes in Clyde fisheries in more detail, and made many additional points concerning the findings of McIntyre *et al.* (2012).

One of the principal suggestions was that cod (and other white fish) in the Clyde is no longer a demersal fish, but a semi-pelagic one. Hence it was also suggested that

the standard demersal trawl surveys used by MSS in the Clyde, and which provided the data for the Heath and Speirs (2011) analysis, do not generate a correct picture of the abundance or distribution of cod, or white fish in general including whiting, in the Clyde.

This report presents the basic results from a preliminary investigation towards addressing the suggestions that the cod population in the Clyde is now (i.e. 2014) a semi-pelagic one, and that standard demersal surveys do not correctly reflect the abundance of cod in the Clyde.

Although the initial focus was on cod, all white fish (i.e. haddock, whiting, hake, pollack) caught were recorded and are analysed in this report.

Approach Taken

As far as it was practically possible, given government procurement rules for example, MSS wanted this preliminary investigation to be industry led. Hence a series of meetings and extensive consultations were entered into with fishermen around the Clyde, steered to a great extent by the CFA.

MSS wanted the investigation to be carried out at the time of year, using the fishing gear, type of vessel, method of fishing and location of fishing, that the industry thought would maximise cod and white fish catches. Hence, the survey design was not based on scientific principles (e.g. randomised stratified sampling), but was a cost-effective “first look” to provide some data to test the semi-pelagic cod, and other white fish, hypotheses.

Development of the Survey Design

MSS contacted CFA in February 2013, proposing an investigation of the semi-pelagic cod/white fish hypotheses. This proposal was considered at the March 2013 CFA Executive Committee. The discussion there resulted in the suggestion that the trial should take place in the winter, with November being the earliest month suitable, through to February. The attendees thought that there were a few boats with suitable gear and experience and which would be interested in the work.

On 31 August, 2013, one of us (PG) attended a CFA meeting in Glasgow. The relevant results of this meeting were¹:

¹ Italics indicate a summary of the comments made by industry representatives during the meetings.

Where are the greatest concentrations of white fish currently to be found in the Clyde?

- *Arran Trench - highest % of white fish.*
- *South Deep.*
- *Upper/lower loch Fyne.*
- *Kilbrannan Sound (separates the Kintyre Peninsula from the island of Arran).*

Are fish on the bottom or semi-pelagic?

- *In deeper water - fish are semi-pelagic.*
- *In shallower water - fish are on the bottom.*

What species of white fish are in the Clyde?

- *Whiting, Haddock and Hake (A lot of hake around Ailsa Craig).*

What age are the fish?

- *White fish ranged in sizes over the Clyde from small to big.*

Are the white fish in the Clyde from a population outside the Clyde?

- *In the past white fish used to filter down from the North Channel.*
- *There used to be semi pelagic spawning cod in the Kyles but these might have disappeared now.*

What time of year to survey?

- *Start of year for pelagic species, and March/April for white fish.*
- *The earliest for white fish would be the start of December.*

What gear to use in the survey?

- *Semi-pelagic.*
- *The meeting was not clear if the gear was available within the industry, or that MSS would provide it.*
- *With semi pelagic gear, a net monitor should be used.*

What size of vessel to use?

- *Semi pelagic trawls require boats with at least 300 horsepower. The meeting listed eight local vessels they thought suitable. [Wherever possible, these vessels and the CFA were included in all future notifications of tendering etc.].*

Additional comments?

- *Climate change has something to do with the fish disappearing from the Clyde. In 2013 the temperature in the Clyde has been 14°C while it has been 11°C in the Minch.*

Thus the details needed of when, where and how to fish, at this stage, were beginning to be more clearly determined.

On 1 November 2013, the CFA organised a planning meeting in Tarbert to further discuss the specification for the semi-pelagic trial in the Clyde. Several local fishermen attended, along with Bill Turrell (BT) and Peter Gibson (PG). The outcome from the meeting, described below, was circulated to all attendees and additionally skippers of vessels who were unable to attend:

White Fish - Northern Area (Survey 1 – January)

Ideas that might be tested by a trial survey:

- *White fish (cod, haddock, whiting, hake) occur semi-pelagically above the deeper Clyde Sea basins north of the Great Plateau in January.*
- *The semi-pelagic shoals often appear to be just below a reflective sonar layer that is assumed to be “feed” (plankton?).*
- *The white fish are feeding on plankton in the reflective layer.*
- *The shoals are made up of a mixture of sizes and ages.*
- *The duration of a tow matters, as bigger fish may be able to escape from short duration tows, as they do not reach a point of exhaustion.*

Methods to be used:

- *A full survey is not practical this year.*
- *Instead we should trial the methods to be used – the semi-pelagic gear and how best to use it in a survey, along with plankton sampling.*
- *Gear may be available from Ireland.*
- *Boats must be capable of towing this gear (i.e. 300 hp , 224kW).*

Boats should have:

- *a load line exemption certificate.*
- *room for two scientists.*
- *ability to monitor depth of net.*
- *local knowledge of area.*
- *previous experience of fishing semi-pelagically for white fish in the Clyde.*

The survey plan should consider:

- *Preferred time is January 2014.*
- *Survey should be two periods of five days (no fishing at weekend), and should be able to work 24 hours.*
- *The duration of a tow should be investigated, as short tows may not catch larger fish as they will not be exhausted and can escape net.*

In addition, the trial should include:

- *“all catch” sampling (species, age, length) – sub-sampling where necessary.*
- *plankton hauls before / after each tow.*
- *representative sub-sample of stomachs.*
- *representative sub-sample of otoliths.*
- *representative sub-sample of genetic material for storage.*

Selection of Survey Vessel

Using all of the information gathered from the consultations with the industry, Marine Scotland put out a call for tenders for the survey in January 2014:

Marine Scotland Science, following dialogue with experienced fishermen in the Clyde area, wishes to trial semi-pelagic surveying for gadoid fish in the Clyde. The initial pilot survey will be two 5 day periods, separated by a weekend. The vessel taking part in the survey will conduct a semi-pelagic trawl survey at station locations to be agreed with the Scientist In Charge during the survey. Ideas to be tested by the trial survey are:

- White fish (cod, haddock, whiting, hake) occur semi-pelagically above the deeper Clyde Sea basins north of the Great Plateau in January.*
- The semi-pelagic shoals often appear to be just below a reflective sonar layer that is assumed to be “feed” (plankton?).*
- The white fish are feeding on plankton in the reflective layer.*
- The shoals are made up of a mixture of sizes and ages.*
- The duration of a tow matters, as bigger fish may be able to escape from short duration tows, as they do not reach a point of exhaustion.*

The charter will be of 10 days duration during January to February 2013, with the preferred time being late January/early February (Dates to be confirmed in liaison with skipper and scientific staff). Bidders should indicate their preferred dates within this period. Fishing will be carried out in the Clyde Sea area as instructed by participating scientific staff.

Closing date for receipt of bids is 1200 hrs on 27 January 2014.

Selected Vessel

Two bids were received and the one that provided best value for money was selected. The vessel chosen was the MFV Frigate Bird (Figure 1):

Vessel Name	FRIGATE BIRD
Administrative Port	CAMPBELTOWN
Home Port	TARBERT
Port Letters and Numbers	TT137
Overall Length	17m
Registered Tonnage	65 tonnes
Engine Power	279.75 kW
Year Built	1977

Fishing Gear

The gear supplied by the vessel was an 18 x 12 fathom (33 m width x 22 m height) Ivor Christianson semi-pelagic trawl with white fish bag. This net was used for two days on a semi-pelagic vessel in Northern Ireland and acquired when that vessel was sold.

The vessel had 250 fathoms (460 m) of warp trawl wire, with 25 fathom (46 m) sweeps and two clump weights. Seven feet six inches (2.3 m) semi-pelagic doors were used.

During fishing, the distance that the sole (or footrope) of the net was off the seabed often varied. Occasionally it was just on the seabed, but at other times the sole could be up to 70m from the seabed, but on average it was estimated that the sole would fish about 4m above the seabed.

Results

Haul Details

The survey was conducted in two, five day sections, separated by a weekend. The dates were:

Section 1 – Monday 10/02/2014 to Thursday 14/02/2014 (Hauls 1 to 8)

Section 2 – Monday 17/02/2014 to Friday 21/02/2014 (Hauls 9 to 15)

Fifteen hauls were performed, although one (Haul 13) was foul and no catch was recovered (Figure 2). Tows were performed in Upper Loch Fyne, Lower Loch Fyne, Inchmarnock Water, Sound of Bute, Kilbrannan Sound, Arran Trench, Cumbrae Basin, Hunterston Channel, Clyde Channel, Dunoon Basin. Seabed depths for tows varied between 70 m and 180 m. Duration of tows varied between four and twelve hours. The original haul sheets have been transcribed and are presented in Appendix 1.

For twelve of the valid tows, the cod end was 100 mm, while for the two final tows a very fine cod end of 40 mm was used. Table 1 provides outline details of the 14 valid hauls.

In summary, the investigative survey consisted of very long trawls of many hours, performed using semi-pelagic gear, fished by a commercial fisherman aiming to maximise white fish catches.

Comparative Data

In order to set the investigative survey results into some context, a selection of hauls (Figure 3, Table 2) have been extracted from the MSS trawl database that were performed in the same area, in the same approximate period. Most of the selected hauls were made during an *ad hoc* quarterly survey series in 2013 and 2014 using demersal survey fishing gear, operating in contact with the sea bed and using 30 minute tows. Small mesh cod ends were used. Only hauls performed in 70 m of water or deeper were selected.

In all, twelve of the *ad hoc* survey hauls were extracted, five performed by the commercial fishing vessel MFV *Shangri La* (CN394) in December 2013, seven by the same vessel in March 2014.

In addition, data were available from two further hauls carried out during routine MSS surveys by RV *Scotia* in March 2013 and November 2012.

The fishing that has resulted in the data used in this report can be summarised as follows:

	All Hauls	100 mm cod end	40 mm cod end	Comparative Hauls
N Hauls	14	12	2	14
Typical Haul Duration	4-7 hours	4-7 hours	4-7 hours	30 mins
Total Fishing Time (hours)	100.5	86.5	14.0	7
Fishing Method	Semi-pelagic	Semi-pelagic	Semi-pelagic	Demersal
Cod End mesh		100 mm	40 mm	Small

Cod

The catches of cod are summarised as follows:

	All Hauls	100 mm cod end	40 mm cod end	Comparative Hauls
Total Catch (N)	677	614	63	114
Catch Rate - All (N/hour)	6.7	7.1	4.5	16.3
Catch Rate - <30cm (N/hour)	0.1	-	0.4	14.4
Catch Rate - >30cm (N/hour)	6.7	7.1	4.1	1.9
Min Size (cm)	14	27	14	8
Max Size (cm)	100	100	97	85

For cod, the longer duration semi-pelagic hauls did not lead to higher catch rates. In fact, the reverse is true, with cod catch rates being about seven cod per hour in the current study, compared to about 16 cod per hour in the comparative survey hauls. This was principally due to two large catches of small fish in the comparative hauls (SH13/06 - Kilbrannan Sound and SH13/07 - Inchmarnock Water).

Figure 4 shows the size distribution within the various catches, and Figure 5 shows the age of the fish caught during the investigative semi-pelagic survey.

The most striking difference between the comparative data catches and the semi-pelagic catches is that the standard hauls predominantly caught fish in the 10-20 cm size range (one year), while the semi-pelagic hauls caught fish 40 cm in length and greater. However, it must be remembered that the majority of semi-pelagic hauls used a 100 mm cod end. When the 40 mm cod end was used in the semi-pelagic trawls, proportionately more one year olds were caught, but larger fish were also present in the catch.

Proportionately few large fish were caught in the comparative standard hauls. In seven hours of fishing, just 13 cod larger than 30 cm were caught, whereas in the semi-pelagic survey 100 hours of fishing caught 670 fish larger than 30 cm. The semi-pelagic survey caught fish up to eight years old.

In summary:

Semi-pelagic fishing caught fewer cod (seven cod/hour) than standard demersal fishing (16 cod/hour).

However, the semi-pelagic fishing used in this trial, with 100 mm cod ends, using long duration tows (four to seven hours) in the deep basins of the Clyde caught predominantly large cod (30-100 cm, two to eight years old).

Standard demersal fishing using 30 minute tows caught predominantly small cod (<30 cm, one year old).

Haddock

The catches of haddock are summarised as follows:

	All Hauls	100 mm cod end	40 mm cod end	Comparative Hauls
Total Catch (N)	6276	2725	3551	878
Catch Rate - All (N/hour)	62.4	31.5	253.6	125.4
Catch Rate - <20cm (N/hour)	26.2	0.9	182.5	121.6
Catch Rate - >20cm (N/hour)	34.8	30.5	61.3	4.4
Min Size (cm)	9	9	11	10
Max Size (cm)	71	71	43	35

Catch rates in the standard demersal surveys were greater than in the semi-pelagic survey when the semi-pelagic survey used the 100 mm cod end. However, the two semi-pelagic hauls using the 40 mm cod end caught large numbers of small (< 20 cm) young (one year) fish.

For small haddock (Figure 6), the difference in catch rates seems to be more related to the cod end mesh size rather than the method of fishing. The results suggest that semi-pelagic fishing and standard demersal fishing returned similar catch rates for small (<20 cm) haddock when both used fine mesh cod ends.

However, the standard demersal survey hauls did not catch the same proportion of larger (>20 cm), older (two to four years, Figure 7) haddock that were caught in the semi-pelagic fishing. The semi-pelagic, long duration tows caught a full range of ages up to four years old.

In summary:

Haddock were caught by the long duration semi-pelagic fishing in the deep basins of the Clyde in a mixture of ages (one to four years) and sizes (9-71 cm).

However, as with cod, the semi-pelagic fishing, on average, caught fewer haddock (62 fish/hour) than the standard demersal fishing (125 fish/hour).

In the semi-pelagic hauls, larger haddock (>20 cm, two to four years) were more abundant than larger cod, with average catch rates being about 30 large fish per hour.

Standard short duration (30 minutes) demersal survey fishing caught similar amounts of small young haddock (<20 cm, one year) as semi-pelagic fishing when using a fine mesh cod end.

Standard short duration (30 minutes) demersal survey fishing did not catch the larger (>20 cm) fish to the same extent as long duration (four to seven hours) semi-pelagic fishing.

Whiting

The catches of whiting are summarised as follows:

	All Hauls	100 mm cod end	40 mm cod end	Comparative Hauls
Total Catch (N)	770	32	738	2878
Catch Rate - All (N/hour)	7.7	0.4	52.7	411.1
Catch Rate - <25cm (N/hour)	7.6	0.3	52.5	411.0
Catch Rate - >25cm (N/hour)	0.1	-	0.2	0.3
Min Size (cm)	9	9	9	8
Max Size (cm)	38	38	26	26

The whiting catches during the semi-pelagic fishing were dominated by the two hauls using a fine mesh cod end (Figure 8). These caught 96% (738) of the whiting and, apart from three fish, this was all <25 cm in length and hence one year olds (Figure 9).

Large whiting were rare. In 100 hours of semi-pelagic fishing, just seven whiting larger than 25 cm were caught. From the age determinations, these were two year olds. In the seven hours of standard demersal survey fishing, two whiting larger than 25 cm were caught.

Small whiting (<25 cm, one year) had a much greater (factor of eight) catch rate in the standard demersal survey hauls, than in the two semi-pelagic fine mesh cod end hauls, despite the semi-pelagic hauls lasting in total twice as long (14 hours) compared to the total of the standard hauls (seven hours). Once again this may imply that small young whiting are found closer to the sea bed and were not caught in as great an abundance by the semi-pelagic fishing as the demersal fishing.

In summary:

Whiting were caught by semi-pelagic fishing in the deep basins of the Clyde, but only one age was present; one year olds, <25 cm in length.

The standard demersal survey fishing caught whiting at approximately eight times the catch rate of semi-pelagic fishing.

Hake

	All Hauls	100 mm cod end	40 mm cod end	Comparative Hauls
Total Catch (N)	87	81	6	No data
Catch Rate - All (N/hour)	0.9	0.9	0.4	No data
Catch Rate - <40cm (N/hour)	0.1	0.1	0.2	No data
Catch Rate - >40cm (N/hour)	0.7	0.8	0.2	No data
Min Size (cm)	30	30	30	No data
Max Size (cm)	77	77	61	No data

Hake was much rarer than cod, haddock or whiting. The numbers caught did not really allow proper analysis. No age data was available for hake or any comparative data at the time of writing this report.

Three possible size classes exist (Figure 10), 30-40 cm, 40-65 cm, and 65-80 cm. We can speculate that these were one, two and three year olds respectively.

In summary:

Hake were caught by semi-pelagic fishing in the deep basins of the Clyde, but in very low numbers. 87 hake were caught in 100 hours of fishing.

From the length distribution, the hake caught were most likely one, two and three year old fish.

Other Fish

The haul sheets from the semi-pelagic survey record five pollock (lythe) caught, of between 64 and 73 cm in length. Also recorded were some lesser spotted dogfish, and lump suckers.

Relative Proportions of White Fish

For this study, catch rates are the best measure to try to estimate relative proportions of fish abundance, as they take into account the different durations of hauls. For small fish, i.e. one year olds, the catch rates from the semi-pelagic survey using the 40 mm cod end have been used. Although this data is from just two hauls, it represents 14 hours fishing, compared to just seven hours fishing carried out in the comparative standard demersal surveys.

In order to present useful numbers that give a feel for the relative abundance of the four white fish species present in the semi-pelagic surveys, the catch rates have been raised to numbers of fish caught per 10 hours, and have been rounded.

Small Fish (1 year old) (Numbers/10 hours fishing)	Semi-Pelagic Survey (40 mm cod end)	Comparative Demersal Surveys
Cod < 30 cm	5	150
Haddock < 20 cm	2000	1200
Whiting < 25 cm	500	4000
Hake < 40 cm	2	No data

In summary:

In the semi-pelagic hauls, young haddock were the most abundant, being four times as abundant as young whiting.

Young cod were between 30 (demersal surveys) and 100 (semi-pelagic data) times as rare as young whiting in the deep basins of the Clyde.

For older fish (>1 year), the catch rate data for the semi-pelagic survey using the 100mm cod end have been used, raised to catch per 10 hours fishing and rounded.

Large Fish (>1 year old) (Numbers/10 hours fishing)	Semi-Pelagic Survey (40 mm cod end)	Comparative Demersal Surveys
Cod > 30 cm	70	20
Haddock > 20 cm	300	40
Whiting > 25 cm	-	3
Hake > 40 cm	10	No data

In summary:

The community of older white fish was principally made up of cod and haddock. There were virtually no older whiting, but some older hake.

Semi-pelagic surveys found four times as much older cod and eight times as much older haddock in the deep basins as the standard demersal surveys.

Both methods of surveying indicated approximately twice as much older haddock as older cod.

Large fish of all species were rare. Catch rates for larger fish in the semi-pelagic investigative hauls were of the order of seven fish/hour for cod, 30 fish/hour for haddock and one fish/hour for hake.

Discussion

It must be remembered that the results presented here are from an investigative survey and not a statistically designed survey. Hence quantitative results are indicative only. Also the data used is only from the deep (>70 m) basins of the Clyde hence cannot be applied to all of the Clyde without further work. The deep (>70 m) basins of the Clyde represent approximately 21% (79 km²) of the total Clyde Sea (3,700 km²).

It is also important to note that the gears used in the current investigation were very different from the demersal gears used to provide comparative hauls. In order to be able to draw more robust conclusions on both the distribution and abundance of the fish and the relative performance of the different gears it would be necessary to carry out fishing under more controlled conditions using gears of more comparable specification in both the semi-pelagic zones and for fishing on the bottom. This would also require careful control of fishing times and depths for net operation.

The *ad hoc* survey data used to provide most of the comparative hauls were taken from a quarterly survey series in which the distributions and abundance of fish appear to differ through the year (report in preparation). In order to provide a more representative picture of the whitefish community of the Clyde, a more comprehensive survey including semi-pelagic and bottom trawl sampling across the Clyde area and throughout the year is required.

Caution also needs to be applied owing to the nature of the fish communities sampled. For example, results for young fish in both the investigative survey and the comparative data are dominated by one or two large hauls, suggesting patchy distributions. Also, the short duration comparative hauls return just one or two large fish, hence raising these small numbers can provide difficulties.

The investigative survey has shown that, on average, long-duration semi-pelagic fishing within the deep basins of the Clyde catch white fish at a lower rate (i.e. numbers of fish caught per hour fishing) than standard demersal fishing in the same areas. However, such semi-pelagic fishing catches large fish at higher rates than in demersal fishing.

The semi-pelagic investigation has revealed the possibility of significant numbers of young haddock as well as young whiting. It is too early to say whether this picture of the white fish community is now more representative of the overall Clyde than that

described in the analysis by Heath and Speirs (2011), but needs further investigation.

The investigative survey has shown that there are large, older white fish in the deep basins of the Clyde (>70m), but they are present in very low densities (e.g. one hour of targeted semi-pelagic commercial fishing returned just 7 large cod). Without further work it is not possible to say what their total abundance is, or whether these fish represent resident spawning populations.

The semi-pelagic investigation suggests that in the deep basins of the Clyde, large white fish may be more abundant than demersal stock surveys suggest. However, even in the deep basins large fish are still rare. Their presence may give some hope for the possible restoration of white fish in the Clyde, but their abundance and density is low. Hence, if their presence is significant, they may need some form of specific management consideration.

The current survey raises a number of questions for which further work is required to address. These include:

- are young cod (one year) only found near the sea bed in the deeper basins of the Clyde?*
- older cod (>30 cm, two to eight years) exist in the deeper basins of the Clyde, but in very low densities. What is their total abundance? Are they spawning?*
- do young whiting (one year) remain near the sea bed in the deep basins of the Clyde?*
- is the picture of young whiting dominating the white fish population only true for demersal fish communities? In the semi-pelagic fish community of the deep basins in the Clyde, do young haddock dominate?*
- do standard demersal surveys in the deep basins of the Clyde give a true picture of the relative abundance of one year old white fish?*

Recommendations

- The suggestions from the industry that arose during the consultation process for this investigation, but which were not addressed should be considered by MSS for future research. These are presented in Appendix 3.
- The hypotheses generated by this study could be taken forward in future research plans for the Clyde. In particular a better understanding of the Clyde whitefish community would be likely if the relative importance (in terms of quantities and population structure) of fish occurring semi-pelagically and those occurring on the seabed could be established for all parts of the Clyde (not just the deep basins). Such knowledge would also help to tailor relevant management measures.

References

Heath, M.R. and D.C. Speirs (2011). Changes in species diversity and size composition in the Firth of Clyde demersal fish community (1927-2009). Proceedings of the Royal Society, B, doi, 10.1098/rspb.2011.1015.

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Figures



Figure 1: The MFV *Frigate Bird* (TT137).

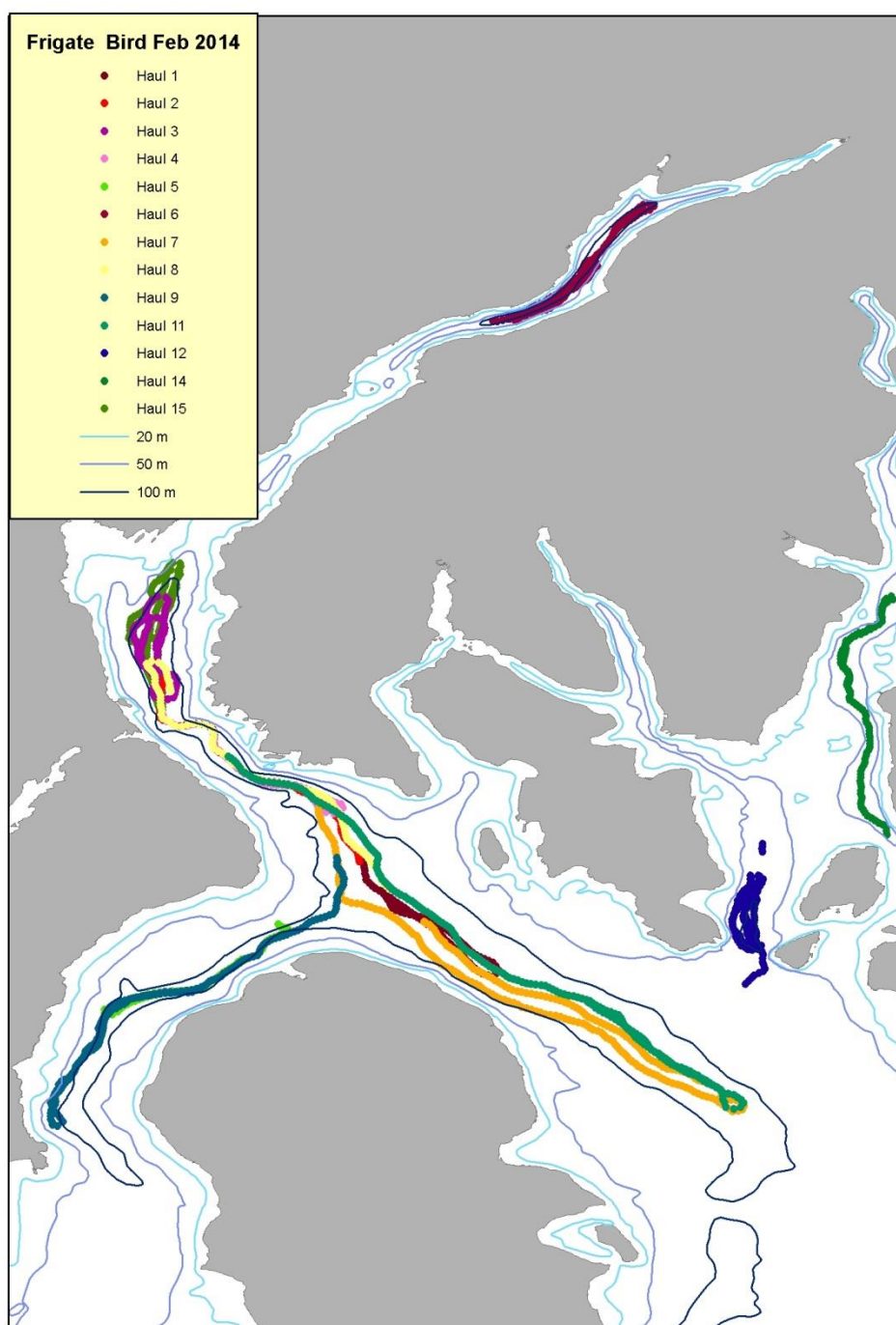


Figure 2: Map showing haul locations. 1 - Inchmarnock Water – Sound of Bute (maroon); 2 - Lower Loch Fyne – Inchmarnock Water (red); 3 - Lower Loch Fyne (purple); 4 - Inchmarnock Water - Lower Loch Fyne (pink); 5 - Kilbrannan Sound (green); 6 - Upper Loch Fyne (purple); 7 - Inchmarnock Water – Arran Trench (orange); 8 - Lower Loch Fyne - Inchmarnock Water (yellow); 9 - Inchmarnock Water - Kilbrannan Sound (dark blue); 10 - Arran Trench (not shown); 11 - Lower Loch Fyne – Inchmarnock – Arran Trench (green); 12 - Arran Trench - Cumbræ Basin (blue); 14 - Dunoon Basin - Clyde Channel – Hunterston Channel (green); 15 - Lower Loch Fyne (green).

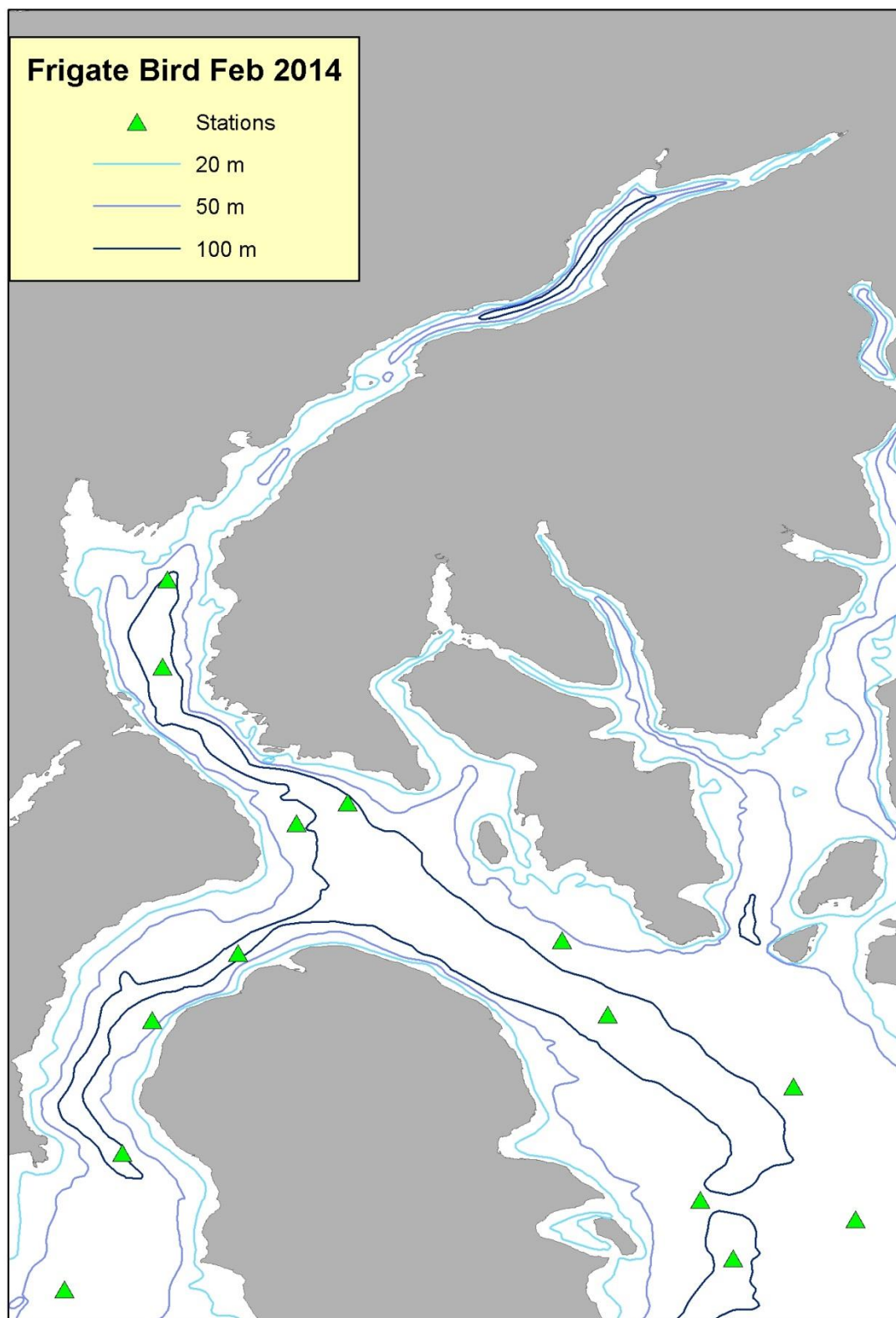


Figure 3: Map showing the location of the 14 comparative hauls extracted from the MSS trawl database.

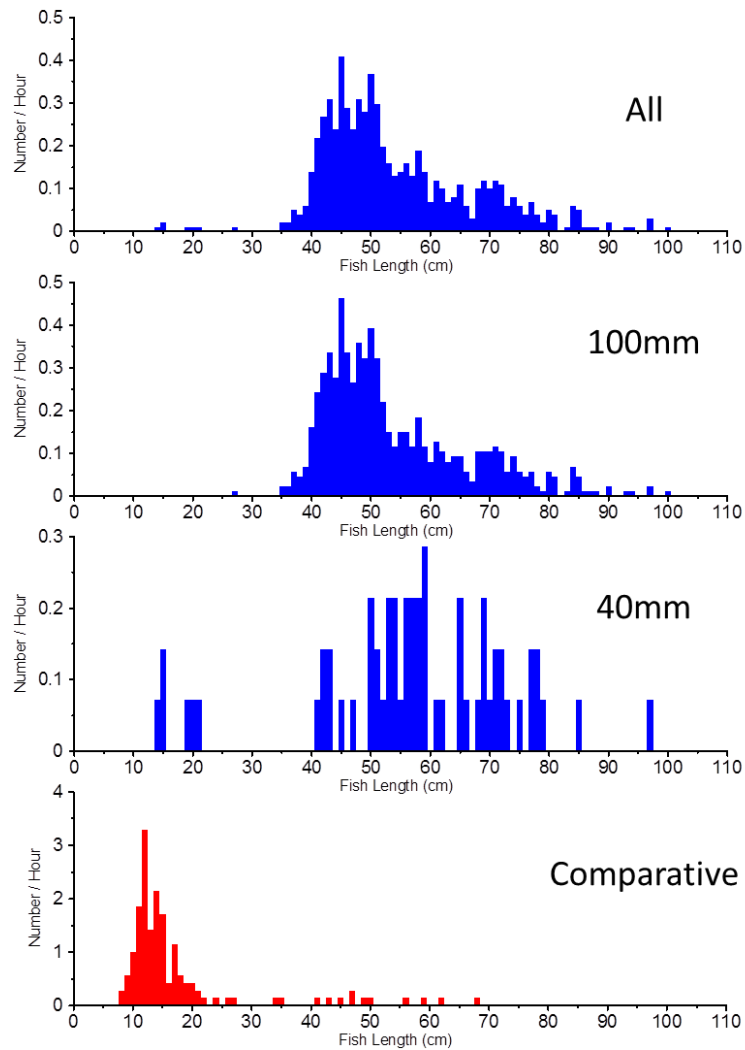


Figure 4: Catch rates for cod by size (length) of fish caught in the 14 semi-pelagic hauls of the investigative survey (All), the 12 hauls using the 100 mm cod end (100 mm), the two hauls using the 40 mm cod end (40mm) and the 14 comparative hauls using standard demersal survey fishing (Comparative).

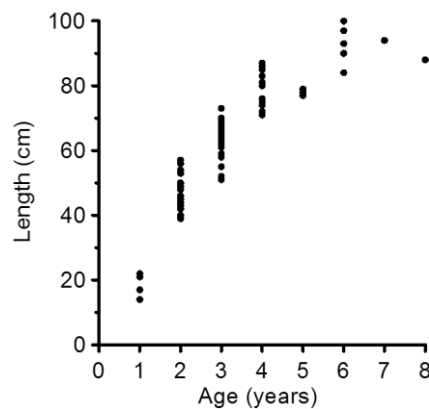


Figure 5: Size (length) ranges of cod of different ages caught during the semi-pelagic investigative survey.

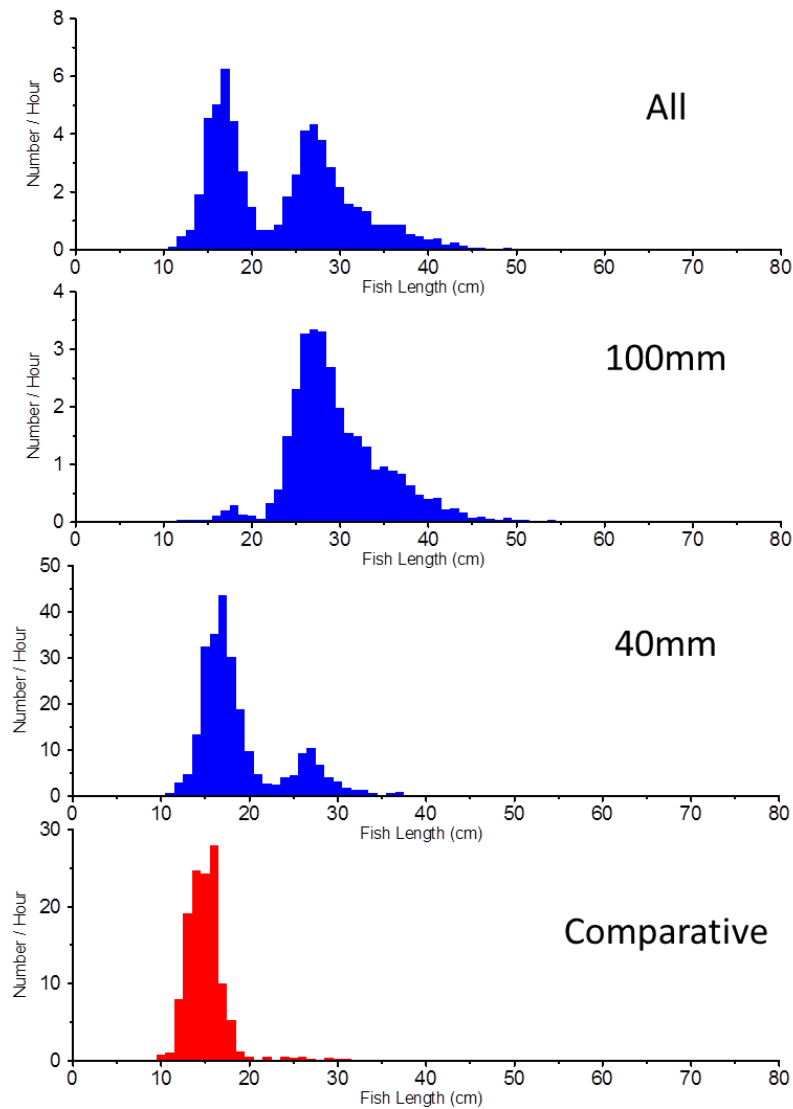


Figure 6: Catch rates for haddock by size (length) of fish caught in the 14 semi-pelagic hauls of the investigative survey (All), the 12 hauls using the 100 mm cod end (100mm), the two hauls using the 40 mm cod end (40 mm) and the 14 comparative hauls using standard demersal survey fishing (Comparative).

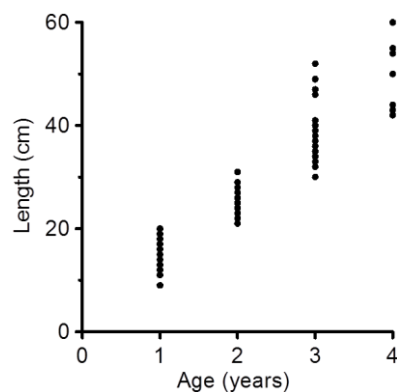


Figure 7: Size (length) ranges of haddock of different ages caught during the semi-pelagic investigative survey.

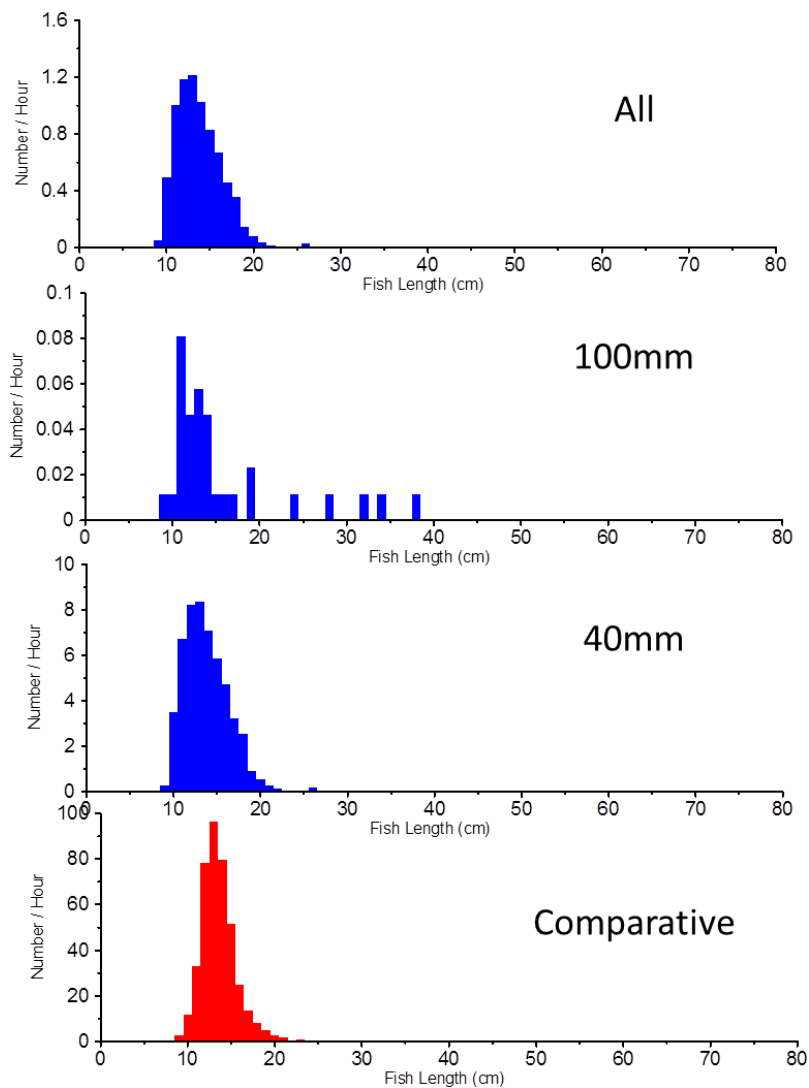


Figure 8: Catch rates for whiting by size (length) of fish caught in the 14 semi-pelagic hauls of the investigative survey (All), the 12 hauls using the 100 mm cod end (100mm), the two hauls using the 40 mm cod end (40 mm) and the 14 comparative hauls using standard demersal survey fishing (Comparative).

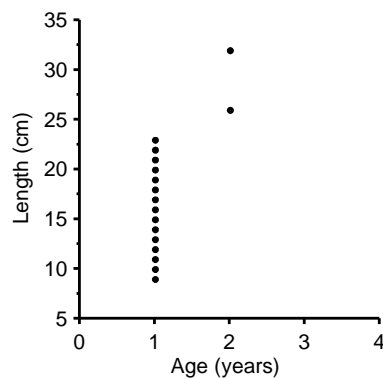


Figure 9: Size (length) ranges of whiting of different ages caught during the semi-pelagic investigative survey.

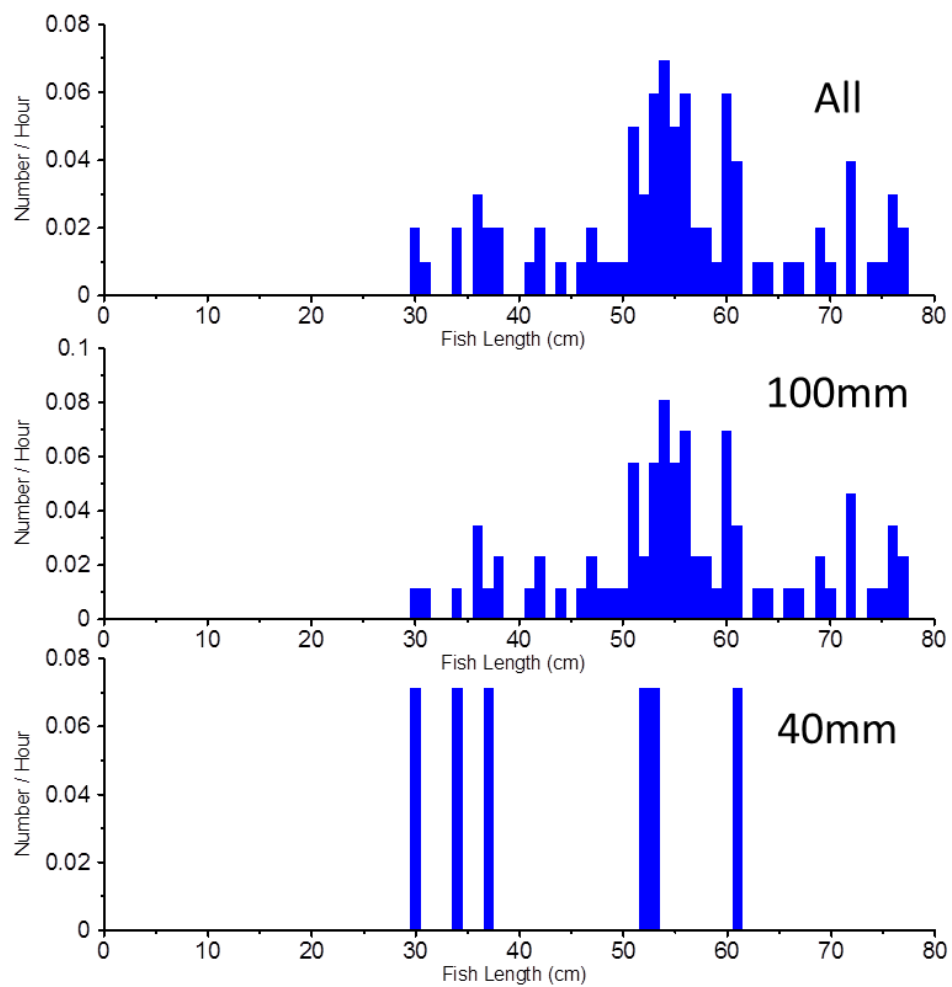


Figure 10: Catch rates for hake by size (length) of fish caught in the 14 semi-pelagic hauls of the investigative survey (All), the 12 hauls using the 100 mm cod end (100mm), and the two hauls using the 40 mm cod end (40 mm).

Tables

Table 1

Summary of the 15 hauls performed during the investigative survey. Haul tracks are shown on Figure 2.

Haul	Cod End (mm)	Location	Start position	End Position	Duration (Mins)	Avg. Depth (m)	Avg. Speed (knots)
1	100	Inchmarnock Water – Sound of Bute	55° 46.97'N 05° 14.78'W	55° 45.79'N 05° 13.91'W	245	157	2.4
2	100	Lower Loch Fyne - Inchmarnock Water	55° 46.92'N 05° 14.90'W	55° 54.75'N 05° 22.94'W	270	148	2.5
3	100	Lower Loch Fyne	55° 55.60'N 05° 23.14'W	55° 53.59'N 05° 23.22'W	355	149	2.3
4	100	Inchmarnock Water - Lower Loch Fyne	55° 52.90'N 05° 22.86'W	55° 51.55'N 05° 20.74'W	270	172	2.5
5	100	Kilbrannan Sound	55° 42.93'N 05° 19.75'W	55° 44.35'N 05° 18.14'W	235	108	2.3
6	100	Upper Loch Fyne	56° 09.07'N 05° 08.18'W	56° 08.85'N 05° 09.53'W	440	101	2.7
7	100	Inchmarnock Water – Arran Trench	55° 49.17'N 05° 16.52'W	55° 44.50'N 05° 12.28'W	715	144	2.3
8	100	Lower Loch Fyne - Inchmarnock Water	55° 45.87'N 05° 13.73'W	55° 52.62'N 05° 22.71'W	340	167	2.5
9	100	Inchmarnock Water - Kilbrannan Sound	55° 41.82'N 05° 21.40'W	55° 47.10'N 05° 15.87'W	575	122	2.3
10	100	Arran Trench	55° 40.97'N 05° 05.43'W	55° 40.32'N 05° 05.18'W	670	153	2.4
11	100	Lower Loch Fyne – Inchmarnock – Arran Trench	55° 51.18'N 05° 20.17'W	55° 41.24'N 05° 05.63'W	625	156	2.2
12	100	Arran Trench - Cumbrae Basin	55° 41.98'N 04° 59.26'W	55° 47.65'N 04° 58.57'W	450	76	2.5
14	40	Dunoon Basin - Clyde Channel – Hunterston Channel	55° 54.04'N 04° 55.19'W	55° 47.95'N 04° 53.39'W	360	72	2.4
15	40	Lower Loch Fyne	55° 53.05'N 05° 22.89'W	55° 52.89'N 05° 22.97'W	480	172	2.4
13		FOUL HAUL	55° 48.90'N 04° 54.19'W	55° 49.75'N 04° 54.78'W			

Table 2

Summary of the 14 comparative hauls extracted from the MSS trawl database. Haul locations are shown in **Figure 3**.

Trip	Haul	Date	Start	End	Duration (Mins)	Avg. Depth (m)	Avg. Latitude	Avg. Longitude
SH13	5	07/12/2013	08:45	09:15	30	105	55.581	-5.408
SH13	6	07/12/2013	10:08	10:38	30	70	55.671	-5.388
SH13	7	07/12/2013	11:50	12:20	30	99	55.804	-5.29
SH13	8	07/12/2013	13:25	13:55	30	144	55.91	-5.381
SH13	14	08/12/2013	15:28	15:58	30	76	55.536	-4.912
SH14	13	27/03/2014	12:47	13:17	30	100	55.54925	-5.017083333
SH14	16	28/03/2014	07:49	08:19	30	72	55.62608333	-4.953916667
SH14	20	28/03/2014	16:37	17:07	30	76	55.72466667	-5.110541667
SH14	22	29/03/2014	09:34	10:04	30	110	55.96875	-5.377666667
SH14	23	29/03/2014	11:38	12:08	30	160	55.81783333	-5.255666667
SH14	24	29/03/2014	13:18	13:48	30	125	55.71616667	-5.329666667
SH14	30	31/03/2014	11:26	11:56	30	82	55.48875	-5.447333333
S20130003	123	04/03/2013	16:09	16:39	30	112	55.50966667	-4.994666667
S20120016	538	30/11/2012	06:45	07:15	30	160	55.67466667	-5.079666667

Appendix 1 – Transcripts of Haul Sheets

HAUL 01

Haul Number	H01
Date	10/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	0725
Time Hauled	1130
Duration	245 mins
Average Speed	
Latitude Shooting	55 46.97N
Longitude Shooting	05 14.78W
Latitude Haul	55 45.79N
Longitude Haul	05 13.91W
Wind direction and force	SW4
Stat Square	40E4
Depth (m)	157
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	3
Catch Composition	Mainly cod, hads, hake and a few LSD
Remarks	Large seal eating hake tails

Catch Summary

Species	Species Code	Number	Weight
Haddock	HAD	25	8.4
Whiting	WHI	-	-
Cod	COD	13	25.1
Dogfish – Lesser Spotted	LSD	EST	10.0
Dogfish – Spur	SPU	1	1.4
Hake	HAK	3	2.6

Cod

Length (cm)	Number
40	1
45	1
46	1
51	1
52	1
53	1
56	1
57	2
68	1
69	1
71	1
74	1
Total	13

Haddock

Length (cm)	Number
22	2
23	1
24	1
26	1
27	1
28	2
29	2
30	3
31	1
33	1
36	3
37	2
38	1
39	1
43	1
44	1
51	1
Total	25

Hake

Length (cm)	Number
44	1
51	1
53	1
Total	3

HAUL 02

Haul Number	H02
Date	10/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	1230
Time Hauled	1700
Duration	270 mins
Average Speed	
Latitude Shooting	55 46.92N
Longitude Shooting	05 14.90W
Latitude Haul	55 54.75N
Longitude Haul	05 22.94W
Wind direction and force	SW3
Stat Square	40E4
Depth (m)	148
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	8-9
Catch Composition	Mainly cod+hads. Few LSD. Est 30kg juvenile HADS.
Remarks	Big cod and haddocks

Catch Summary

Species	Species Code	Number	Weight
Haddock	HAD	298	-
Whiting	WHI	1	-
Cod	COD	105	117.2
Dogfish – Lesser Spotted	LSD	-	-
Dogfish – Spur	SPU	-	-
Hake	HAK	16	-

Cod

Length (cm)	Number
35	2
37	1
39	3
40	3
41	8
42	9
43	7
44	7
45	10
46	7
47	4
48	7
49	5
50	10
51	5
52	1
53	2
54	1
55	2
56	1
57	1
58	2
59	2
60	2
72	1
74	1
84	1
Total	105

Haddock

Length (cm)	Number
16	1
21	1
22	1
23	2
24	7
25	10
26	23
27	31
28	25
29	25
30	20
31	16
32	10
33	13
34	10
35	17
36	7
37	18
38	8
39	12
40	11
41	3
42	4
43	8
44	1
45	3
46	1
47	2
48	1
49	5
54	1
65	1
Total	298

Hake

Length (cm)	Number
31	1
48	1
50	1
51	1
52	1
53	2
54	2
56	3
57	1
59	1
60	1
72	1
Total	16

Whiting

Length (cm)	Number
38	1
Total	1

HAUL 03

Haul Number	H03
Date	11/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	0645
Time Hauled	1240
Duration	355 mins
Average Speed	
Latitude Shooting	55 55.60N
Longitude Shooting	05 23.14W
Latitude Haul	55 53.59N
Longitude Haul	05 23.22W
Wind direction and force	SW5
Stat Square	40E4
Depth (m)	149
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	7
Catch Composition	Cod and small HADS. Few LSD and lumpsuckers
Remarks	All cod gill clipped and bagged for PhD project

Catch Summary

Species	Species Code	Number
Haddock	HAD	426
Whiting	WHI	2
Cod	COD	42
Dogfish – Lesser Spotted	LSD	-
Dogfish – Spur	SPU	-
Hake	HAK	3

Cod

Length (cm)	Number
37	1
40	4
41	2
42	2
43	4
44	2
46	1
47	1
48	2
49	1
50	3
51	2
52	1
53	2
54	2
55	1
56	2
57	1
61	2
63	2
65	1
70	1
74	2
Total	42

Haddock

Length (cm)	Number
15	1
18	3
19	1
22	2
23	2
24	12
25	35
26	52
27	55
28	45
29	36
30	28
31	20
32	26
33	26
34	15
35	9
36	10
37	10
38	5
39	6
40	8
41	8
42	3
44	1
46	2
47	1
49	1
65	1
70	1
71	1
Total	426

Hake

Length (cm)	Number
30	1
38	1
51	1
Total	3

Whiting

Length (cm)	Number
15	1
16	1
Total	2

HAUL 04

Haul Number	H04
Date	11/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	1330
Time Hauled	1800
Duration	270 mins
Average Speed	
Latitude Shooting	55 52.90N
Longitude Shooting	05 22.86W
Latitude Haul	55 51.55N
Longitude Haul	05 20.74W
Wind direction and force	SW4
Stat Square	40E4
Depth (m)	172
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	10
Catch Composition	COD/HAD/HAKE. Handful of LSD.
Remarks	

Catch Summary

Species	Species Code	Number
Haddock	HAD	204
Whiting	WHI	3
Cod	COD	106
Dogfish – Lesser Spotted	LSD	-
Dogfish – Spur	SPU	-
Hake	HAK	21

Cod

Length (cm)	Number
27	1
36	2
37	1
40	2
41	5
42	5
43	4
44	5
45	13
46	7
47	7
48	10
49	8
50	6
51	10
52	4
53	4
54	2
55	3
56	2
60	2
61	1
70	1
84	1
Total	106

Haddock

Length (cm)	Number
13	1
24	2
25	3
26	5
27	8
28	18
29	22
30	7
31	10
32	14
33	13
34	13
35	12
36	20
37	8
38	13
39	9
40	7
41	5
42	1
43	2
44	2
45	1
46	3
47	1
48	1
50	1
51	2
Total	204

Hake

Length (cm)	Number
38	1
41	1
47	1
54	1
55	2
57	1
58	1
60	4
61	1
64	1
66	1
70	1
72	2
76	2
77	1
Total	21

Whiting

Length (cm)	Number
11	1
12	1
19	1
Total	3

HAUL 05

Haul Number	H05
Date	12/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	0705
Time Hauled	1100
Duration	235 mins
Average Speed	
Latitude Shooting	55 42.93N
Longitude Shooting	05 19.75W
Latitude Haul	55 44.35N
Longitude Haul	05 18.14W
Wind direction and force	SE 6/7
Stat Square	40E4
Depth (m)	108
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	7
Catch Composition	COD/HAD/HAKE and a few LSD.
Remarks	Very poor day. Had to head to port earlier than expected increased to SE 8 by 1230

Catch Summary

Species	Species Code	Number
Haddock	HAD	289
Whiting	WHI	-
Cod	COD	30
Dogfish – Lesser Spotted	LSD	-
Dogfish – Spur	SPU	-
Hake	HAK	5

Cod

Length (cm)	Number
49	2
51	1
55	1
56	2
57	2
58	2
61	1
62	1
63	1
65	1
66	1
68	2
70	1
71	2
73	2
74	1
75	1
77	1
78	1
84	2
85	2
Total	30

Haddock

Length (cm)	Number
13	1
22	2
23	5
24	11
25	17
26	31
27	32
28	34
29	25
30	22
31	23
32	17
33	18
34	9
35	11
36	10
37	8
38	4
39	3
41	3
43	1
44	1
45	1
Total	289

Hake

Length (cm)	Number
36	1
54	1
60	1
61	1
77	1
Total	5

HAUL 06

Haul Number	H06
Date	13/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	0800
Time Hauled	1520
Duration	440 mins
Latitude Shooting	56 09.07N
Longitude Shooting	05 08.18W
Latitude Haul	56 08.85N
Longitude Haul	05 09.53W
Wind direction and force	WSW 4
Stat Square	40E4
Depth (m)	101
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	2
Catch Composition	Poor haul – Mainly lumpsuckers
Remarks	Historically this tow was all or nothing. Water quite dark with a lot of fresh water.

Catch Summary

Species	Species Code	Number
Haddock	HAD	16
Whiting	WHI	1
Cod	COD	8
Dogfish – Lesser Spotted	LSD	-
Dogfish – Spur	SPU	-
Hake	HAK	3

Cod

Length (cm)	Number	Otolith	Age
44	1	1	2
49	1	1	2
52	1	1	3
55	1	1	3
58	1	1	3
61	1	1	3
65	1	1	3
88	1	1	8
Total	8	8	N/A

Haddock

Length (cm)	Number	Otolith	Age
17	1	1	1
20	1	1	1
22	1	1	2
26	2	1	2
28	1	1	2
29	2	1	2
30	2	1	3
32	2	1	3
33	2	1	3
34	1	1	3
36	1	1	3
Total	16	11	N/A

Hake

Length (cm)	Number	Otolith
36	1	1
46	1	1
51	1	1
Total	3	3

Whiting

Length (cm)	Number	Otolith	Age
32	1	1	2
Total	1	1	N/A

HAUL 07

Haul Number	H07
Date	13-14/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	1925
Time Hauled	0720
Duration	715 mins
Average Speed	
Latitude Shooting	55 49.17N
Longitude Shooting	05 16.52W
Latitude Haul	55 44.50N
Longitude Haul	05 12.28W
Wind direction and force	W 5
Stat Square	40E4
Depth (m)	144
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	7
Catch Composition	Few large cod. Hads+Hake. LSD/lumpsuckers
Remarks	More expected given duration of tow but darkness may have been factor.

Catch Summary

Species	Species Code	Number
Haddock	HAD	52
Whiting	WHI	-
Cod	COD	32
Dogfish – Lesser Spotted	LSD	-
Dogfish – Spur	SPU	-
Hake	HAK	3
Lythe/Pollock	LYT	3

Cod

Length (cm)	Number	Otolith	Age
43	1	1	2
46	1	1	2
51	1	1	3
53	1	1	2
54	1	1	2
58	1	0	
59	1	1	3
61	1	0	
62	2	1	3
64	2	1	3
69	1	1	3
70	3	1	3
72	3	1	4
73	1	1	3
76	1	1	4
77	1	1	5
79	1	1	5
80	2	1	4
81	2	1	4
85	1	1	4
90	2	1	6
93	1	1	6
94	1	1	7
Total	32	21	N/A

Haddock

Length (cm)	Number	Otolith	Age
23	1	1	2
24	2	1	2
25	4	1	2
26	4	0	
27	3	1	2
28	8	0	
29	4	0	
30	6	0	
31	4	1	2
32	2	0	
33	2	0	
34	1	0	
35	3	1	3
36	1	0	
37	1	1	3
39	1	1	3
40	1	1	3
44	1	1	4
46	1	1	3
54	1	1	4
60	1	1	4
Total	52	13	N/A

Hake

Length (cm)	Number	Otolith
54	1	1
63	1	1
74	1	1
Total	3	3

Pollack

Length (cm)	Number	Otolith	Age
67	1	1	7
68	1	1	7
70	1	1	6
Total	3	3	N/A

HAUL 08

Haul Number	H08
Date	14/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	0810
Time Hauled	1350
Duration	340 mins
Average Speed	
Latitude Shooting	55 45.87N
Longitude Shooting	05 13.73W
Latitude Haul	55 52.62N
Longitude Haul	05 22.71W
Wind direction and force	ESE 5
Stat Square	40E4
Depth (m)	167
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	9
Catch Composition	Good haul. More HADS and smaller COD.
Remarks	Weather freshening – E6/7. Last boat back to port.

Catch Summary

Species	Species Code	Number
Haddock	HAD	277
Whiting	WHI	7
Cod	COD	121
Dogfish – Lesser Spotted	LSD	-
Dogfish – Spur	SPU	-
Hake	HAK	14
Lythe/Pollock	LYT	

Cod

Length (cm)	Number
37	2
38	4
39	2
40	3
41	6
42	8
43	12
44	9
45	13
46	9
47	8
48	9
49	5
50	8
51	5
52	6
54	1
55	2
56	1
58	2
59	1
69	2
71	1
72	1
74	1
Total	121

Haddock

Length (cm)	Number
15	1
20	2
21	1
22	2
23	2
24	13
25	9
26	16
27	26
28	30
29	21
30	18
31	17
32	15
33	12
34	11
35	9
36	11
37	10
38	15
39	4
40	4
41	8
42	9
43	3
44	4
45	1
48	1
51	1
60	1
Total	277

Hake

Length (cm)	Number
34	1
42	1
47	1
49	1
51	1
53	1
54	2
55	2
56	1
69	1
72	1
76	1
Total	14

Whiting

Length (cm)	Number
10	1
11	1
14	2
24	1
28	1
34	1
Total	7

HAUL 09

Haul Number	H09
Date	17/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	0755
Time Hauled	1730
Duration	575 mins
Average Speed	
Latitude Shooting	55 41.82N
Longitude Shooting	05 21.40W
Latitude Haul	55 47.10N
Longitude Haul	05 15.87W
Wind direction and force	E 3
Stat Square	40E4
Depth (m)	122
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	8
Catch Composition	Poor haul for length of tow. Some big COD. Smaller HADS. Basket of LSD.
Remarks	Very strong tide – south of tow, made control of trawl very difficult.

Catch Summary

Species	Species Code	Number
Haddock	HAD	302
Whiting	WHI	-
Cod	COD	24
Dogfish – Lesser Spotted	LSD	Basket
Dogfish – Spur	SPU	-
Hake	HAK	2
Lythe/Pollock	LYT	-

Cod

Length (cm)	Number	Otolith	Age
40	1	1	2
48	1	1	2
50	1	1	2
52	1	0	
54	1	0	
56	1	1	2
58	1	0	
59	1	0	
62	2	0	
63	1	1	3
64	2	0	
65	1	0	
66	1	1	3
67	1	1	3
68	2	1	3
69	1	0	
71	1	1	4
73	1	0	
77	1	0	
84	1	1	6
97	1	1	6
Total	24	11	N/A

Haddock

Length (cm)	Number	Otolith	Age
19	1	1	1
21	1	1	2
22	6	0	
23	9	0	
24	17	0	
25	29	0	
26	38	0	
27	33	0	
28	38	0	
29	36	0	
30	17	0	
31	16	0	
32	17	0	
33	6	0	
34	6	0	
35	10	0	
36	7	0	
37	4	0	
38	2	1	3
39	2	0	
40	1	0	
41	1	1	3
43	1	1	4
44	2	0	
47	1	1	3
54	1	1	1
Total	302	7	N/A

Hake

Length (cm)	Number	Otolith
56	1	1
67	1	1
Total	2	2

HAUL 10

Haul Number	H10
Date	18/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	0620
Time Hauled	1730
Duration	670 mins
Average Speed	
Latitude Shooting	55 40.97N
Longitude Shooting	05 05.43W
Latitude Haul	55 40.32N
Longitude Haul	05 05.18W
Wind direction and force	S 2
Stat Square	40E4
Depth (m)	153
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	9
Catch Composition	Mainly COD/HADS. Few LSD+lumpsuckers. 3 Congers.
Remarks	In to land and collect 35mm <i>[as written – see acknowledgements]</i> squid bag to use instead of blinder.

Catch Summary

Species	Species Code	Number
Haddock	HAD	199
Whiting	WHI	15
Cod	COD	44
Dogfish – Lesser Spotted	LSD	-
Dogfish – Spur	SPU	-
Hake	HAK	1
Lythe/Pollock	LYT	2

Cod

Length (cm)	Number	Otolith	Age
45	1	1	2
46	1	0	
47	1	1	2
49	1	0	
50	1	0	
51	1	0	
52	1	0	
53	1	0	
55	1	0	
57	2	1	2
58	5	0	
59	1	0	
62	1	0	
64	1	0	
65	1	0	
66	1	0	
67	1	0	
68	1	0	
69	1	0	
70	2	0	
71	3	0	
72	1	0	
73	1	0	
75	1	1	4
76	3	0	
78	1	1	5
80	2	0	
81	1	0	
83	1	1	4
86	1	1	4
87	1	1	4
97	1	0	
100	1	1	6
Total	44	9	N/A

Haddock

Length (cm)	Number	Otolith	Age
11	1	1	1
12	1	1	1
14	2	1	1
16	1	1	1
17	1	0	
18	1	1	1
19	1	0	
22	5	0	
23	5	0	
24	11	0	
25	23	0	
26	37	0	
27	25	0	
28	23	0	
29	14	0	
30	11	0	
31	11	0	
32	4	0	
33	3	0	
34	3	0	
35	3	0	
36	2	0	
37	2	0	
38	1	0	
39	1	0	
40	1	0	
41	1	0	
44	2	0	
46	1	0	
50	1	1	4
55	1	1	4
Total	199	7	N/A

Hake

Length (cm)	Number	Otolith
42	1	1
Total	1	1

Whiting

Length (cm)	Number	Otolith	Age
9	1	1	1
11	5	1	1
12	2	1	1
13	5	1	1
14	1	1	1
19	1	1	1
Total	15	6	

Pollock

Length (cm)	Number	Otolith	Age
64	1	1	7
73	1	1	8
Total	2	2	N/A

HAUL 11

Haul Number	H11
Date	18-19/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	2155
Time Hauled	0820
Duration	625 mins
Average Speed	
Latitude Shooting	55 51.18N
Longitude Shooting	05 20.17W
Latitude Haul	55 41.24N
Longitude Haul	05 05.63W
Wind direction and force	S 2
Stat Square	40E4
Depth (m)	156
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	5
Catch Composition	Small haul, larger fish – mainly COD/HAD
Remarks	Solely deep water tow. No shallowing.

Catch Summary

Species	Species Code	Number	Weight
Haddock	HAD	183	
Whiting	WHI	3	
Cod	COD	28	
Dogfish – Lesser Spotted	LSD		
Dogfish – Spur	SPU		
Hake	HAK	5	
Lythe/Pollock	LYT		

Cod

Length (cm)	Number	Otolith	Age
39	1	1	2
43	1	0	
45	1	0	
47	1	0	
48	1	0	
49	3	0	
50	2	0	
55	1	0	
56	3	0	
57	1	0	
58	1	0	
59	1	0	
63	1	0	
64	1	0	
71	1	0	
72	2	0	
74	1	1	4
75	1	0	
77	1	0	
80	1	0	
84	1	0	
85	1	0	
Total	28	2	N/A

Haddock

Length (cm)	Number	Otolith	Age
9	1	1	1
12	2	0	
13	1	1	1
14	2	0	
17	1	0	
18	2	0	
19	2	0	
20	3	0	
22	4	0	
23	7	0	
24	10	0	
25	20	0	
26	24	0	
27	26	0	
28	14	0	
29	6	0	
30	9	0	
31	4	0	
32	5	0	
33	8	0	
34	4	0	
35	5	0	
36	3	0	
37	4	0	
38	4	0	
39	1	0	
40	1	0	
41	4	0	
42	2	1	4
43	2	0	
50	1	0	
52	1	1	3
Total	183	4	N/A

Hake

Length (cm)	Number	Otolith
52	1	1
55	1	1
58	1	1
69	1	1
75	1	1
Total	5	5

Whiting

Length (cm)	Number	Otolith	Age
12	1	0	
14	1	0	
17	1	1	1
Total	3	1	N/A

HAUL 12

Haul Number	H12
Date	19/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	0955
Time Hauled	1725
Duration	450 mins
Average Speed	
Latitude Shooting	55 41.98N
Longitude Shooting	04 59.26W
Latitude Haul	55 47.65N
Longitude Haul	04 58.57W
Wind direction and force	S 4
Stat Square	40E4
Depth (m)	76
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 100mm Cod End
Total Number Baskets	9
Catch Composition	Good haul of big fish. COD/HAD/HAKE/LSD and Congers
Remarks	Towed in Clyde river. Shortened sweeps. More worms in COD.

Catch Summary

Species	Species Code	Number
Haddock	HAD	454
Whiting	WHI	-
Cod	COD	61
Dogfish – Lesser Spotted	LSD	-
Dogfish – Spur	SPU	-
Hake	HAK	5
Lythe/Pollock	LYT	-

Cod

Length (cm)	Number
42	1
45	1
46	2
47	1
48	1
49	2
50	3
51	2
52	3
53	2
54	2
55	1
57	1
58	1
59	3
60	3
61	5
62	3
63	2
64	2
65	3
66	2
67	1
68	3
69	3
70	1
71	1
72	1
74	1
75	2
77	1
81	1
Total	61

Haddock

Length (cm)	Number	Otolith	Age
15	1	1	1
16	8	0	
17	14	0	
18	19	0	
19	6	0	
20	4	0	
21	2	0	
22	4	0	
23	15	0	
24	43	0	
25	50	0	
26	50	0	
27	49	0	
28	48	0	
29	39	0	
30	29	0	
31	12	0	
32	17	0	
33	9	0	
34	6	0	
35	5	0	
36	3	0	
37	6	0	
38	3	0	
39	1	0	
40	1	0	
41	3	0	
43	3	0	
46	1	0	
49	1	1	3
52	1	0	
58	1	0	
Total	454	2	N/A

Hake

Length (cm)	Number	Otolith
36	1	0
37	1	1
53	1	1
56	1	0
61	1	1
Total	5	3

HAUL 13

Haul Number	H13
Date	20/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	0900
Time Hauled	0935
Duration	35 mins
Average Speed	
Latitude Shooting	55 48.90N
Longitude Shooting	04 54.19W
Latitude Haul	55 49.75N
Longitude Haul	04 54.78W
Wind direction and force	SW 6
Stat Square	40E4
Depth (m)	75
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 40mm Cod End
Total Number Baskets	0
Catch Composition	FOUL HAUL
Remarks	Transducer detached from headline. Easily re-attached.

HAUL 14

Haul Number	H14
Date	20/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	1050
Time Hauled	1650
Duration	360 mins
Average Speed	
Latitude Shooting	55 54.04N
Longitude Shooting	04 55.19W
Latitude Haul	55 47.95N
Longitude Haul	04 53.39W
Wind direction and force	SW 5
Stat Square	40E5
Depth (m)	72
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 40mm Cod End
Total Number Baskets	8
Catch Composition	Large haul mainly juv HADS + SPRAT. Few COD, but mainly small fish – due to squid bag.
Remarks	Sub-sampled HADS. Half basket. 3 total. RF=6. HADS measured = 326.

Catch Summary

Species	Species Code	Number
Haddock	HAD	1956
Whiting	WHI	435
Cod	COD	27
Dogfish – Lesser Spotted	LSD	-
Dogfish – Spur	SPU	-
Hake	HAK	2
Lythe/Pollock	LYT	-

Cod

Length (cm)	Number
41	1
43	1
50	2
51	1
52	1
53	1
54	2
56	2
57	1
59	2
61	1
65	2
69	2
70	1
71	2
72	2
75	1
77	1
97	1
Total	27

Haddock (Sub-sample 1/6)

Length (cm)	Number
12	3
13	6
14	24
15	55
16	59
17	71
18	39
19	23
20	18
21	6
22	4
23	2
24	2
25	3
26	2
27	1
28	5
29	2
30	1
Total	326

Hake

Length (cm)	Number
37	1
60	1
Total	2

Whiting

Length (cm)	Number	Otolith	Age
10	34	1	1
11	57	0	
12	67	0	
13	67	0	
14	59	0	
15	44	1	1
16	34	1	1
17	32	0	
18	21	1	1
19	9	0	
20	5	1	1
21	2	1	1
22	1	1	1
23	1	1	1
26	2	0	
Total	435	8	N/A

HAUL 15

Haul Number	H15
Date	21/02/2014
Vessel	Frigate Bird
Trip ID	0214H
Time Shot	0530
Time Hauled	1330
Duration	480 mins
Average Speed	
Latitude Shooting	55 53.05N
Longitude Shooting	05 22.89W
Latitude Haul	55 52.89N
Longitude Haul	05 22.97W
Wind direction and force	SE 5
Stat Square	40E4
Depth (m)	172
Region	CLYDE
Gear	Ivor Christian Semi Pelagic - 40mm Cod End
Total Number Baskets	8
Catch Composition	Large haul – predominantly SPRATS + juvenile HERRING. Small HAD/WHITING – food size for cod. Squid Bag.
Remarks	Towed mid-water following the feed down. HADS sub-sampled = 1/5. 319 measured.

Catch Summary

Species	Species Code	Number
Haddock	HAD	1595
Whiting	WHI	303
Cod	COD	36
Dogfish – Lesser Spotted	LSD	-
Dogfish – Spur	SPU	-
Hake	HAK	4
Lythe/Pollock	LYT	-

Cod

Length (cm)	Number	Otolith	Age
14	1	1	1
15	2	1	1
19	1	0	
20	1	1	1
21	1	1	1
42	2	1	2
43	1	0	
45	1	0	
47	1	0	
50	1	0	
51	1	0	
53	2	0	
54	1	0	
55	1	0	
56	1	0	
57	2	0	
58	3	0	
59	2	0	
62	1	0	
65	1	0	
66	1	0	
68	1	0	
69	1	0	
73	1	0	
77	1	0	
78	2	0	
79	1	0	
85	1	0	
Total	36	5	N/A

Haddock (Sub-sample 1/5)

Length (cm)	Number
11	2
12	5
13	6
14	9
15	25
16	28
17	37
18	38
19	25
20	6
21	6
22	3
23	5
24	9
25	9
26	24
27	28
28	13
29	9
30	8
31	5
32	4
33	4
34	2
35	1
36	2
37	3
39	1
41	1
43	1
Total	319

Hake

Length (cm)	Number	Otolith
30	1	1
34	1	1
52	1	0
53	1	0
Total	4	2

Whiting

Length (cm)	Number	Otolith	Age
9	4	0	
10	15	0	
11	37	0	
12	48	0	
13	50	0	
14	40	0	
15	38	0	
16	32	0	
17	13	0	
18	15	0	
19	4	0	
20	3	0	
21	2	0	
22	1	0	
26	1	1	2
Total	303	1	N/A

Appendix 2 – Survey Programme

Not to be cited without prior reference to Marine Scotland, Marine Laboratory, Aberdeen

MFV *Frigate Bird* TT137

Survey 0214H

PROGRAMME

10 February - 21 February 2014

Ports

Loading: 10 February, Tarbert

Unloading: 21 February, Tarbert

In setting the cruise programme and specific objectives, etc the Scientist-in-Charge needs to be aware of the restrictions on working hours and the need to build in adequate rest days and rest breaks as set out in Marine Scotland's Working Time Policy (Lab Notice 34/03). In addition, the Scientist-in-Charge must formally review the risk assessments for the cruise with staff on-board before work is commenced.

In the interest of efficient data management it is now mandatory to return the Cruise Report, to I Gibb and the Cruise Summary Report (old ROSCOP form) to M Geldart, within four weeks of a cruise ending. In the case of the Cruise Summary Report a nil return is required, if appropriate.

Personnel

G McAllister SIC

Fishing Gear: 18 x 12 fathom Ivor Christianson Semi Pelagic trawl fitted with whitefish bag (90 - 100mm)

Project: 10days, ST03P0

Objectives

To carry out a survey of the Clyde of gadoid species (Cod, Haddock, Whiting, Hake) which occur semi-pelagically above the deeper Clyde Sea basins north of the Great Plateau

Procedure

Commercial tows will take place for the first week of the trial (10-14 Feb.). This refers to duration of tow, depth and area. On week commencing 17 Feb. shorter tows may be undertaken to see what impact this has on haul size. Also a smaller mesh cod-end or 'blinder' may also be used to establish the size of smaller gadoids.

All gadoid species will be collected in baskets and measured, sub sampled where necessary, with otoliths taken for every centimeter. Stomach contents will also be noted for these individuals. A gill sample will also be taken for Cod, which will then be measured and bagged up for PhD. Student Alice Doyle. A sample of whiting will also be kept for PhD. Student Neil

Burns. A sample of Sprat and Herring will also be kept for Susan Lusseau, which will be worked up if possible

Normal contacts will be maintained with the laboratory.

Submitted:
G McAllister
06 February 2013

Approved:

Appendix 3 – Additional Research Questions from the Industry Consultation

1. Hypotheses concerning white fish not addressed by the preliminary investigation
 - The semi-pelagic shoals often appear to be just below a reflective sonar layer that is assumed to be “feed” (plankton?)
 - The white fish are feeding on plankton in the reflective layer
 - Climate change has something to do with the fish disappearing from the Clyde. In 2013 the temperature in the Clyde has been 14°C while it has been 11°C in the Minch.

2. A second white fish investigation is needed - Southern Area

Ideas to be tested:

- *White fish are present in March on the Great Plateau*
- *As water is shallower, fish are near the bottom*

Method to be used:

- *Standard demersal gear to be used*
- *Boats must be capable of towing this gear (i.e. 224 kW)*
- *Boats should have:*
 - *a loadline exemption certificate*
 - *room for 2 scientists*
 - *ability to monitor depth of net*
 - *local knowledge of area*
 - *previous experience of fishing for white fish in the southern Clyde*
- *Preferred time is March 2014*

3. Questions concerning pelagic stocks (i.e. herring)

Ideas to be tested:

- *Herring are found in local areas, inshore*
- *The MSS survey is too much offshore*
- *The MSS survey should collect, and use, data at night as this is when herring shoal and are visible on sonar*

4 Additional Questions for Future Research

- *Why are herring not growing to larger sizes in the Clyde ?*
- *There is an apparent increase in the areal cover of muds in the Clyde, including over previously sandy bottoms*
- *Phosphorescence at night in the Clyde has drastically reduced – previously a commonly observed phenomena, now rarely*