

Methods and procedures manual for the Scottish pelagic industry data collection programme

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2.0 Updated from V1.1 to reflect updates to the programme [principally the development of the programme to comprise two elements: a) self-sampling, and b) co-sampling].	01 April 2022	01 April 2023

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Methods and procedures manual for the Scottish pelagic industry data collection programme

Purpose

Data collection onboard vessels is a key part of the Scottish Pelagic Fishermen's Association (SPFA) Data Collection Strategy (Mackinson, 2019). The purpose of this manual is to provide a guide to the data collection programme, together with full documentation of the methods, protocols and procedures that are in use at the time of publication. The document will be reviewed and updated annually, or before if required.

Please refer to the ICES Commercial Catch Sampling Summary (Appendix 13) for a high-level summary of the programme with information provided using standard terminology, typically adopted within ICES to describe fisheries catch sampling programmes. Information on the industry sampling programme has been submitted to the ICES Data Profiling Tool to aid in evaluating completeness of the data flow.

Scope

The industry data collection programme covers all Scottish pelagic fisheries (herring [North Sea, Atlanto-Scandian, Western¹], mackerel, blue whiting and horse mackerel), with vessels participating on a voluntary basis. The programme was initiated as a pilot scheme between 2018 and 2020/21, with vessel participation increasing during this period from an initial seven vessels to near full fleet participation. Currently, 20 out of 21 vessels in the Scottish pelagic fleet are committed to the data collection programme. The programme comprises two parts:

- a) Self-sampling scheme: length and weight data
Vessel crew undertake length and weight measurements of samples from every haul, and record haul information including the location and date/time of the catch, and other operational and environmental parameters.
- b) Co-sampling scheme: age, length, sex and maturity
For randomly selected trips, vessel crew collect frozen samples from hauls for biological sampling of age, length, sex and maturity by MSS and SUHI scientists onshore.

¹ Western herring, ICES div 6a, covered under industry surveys and sampling of monitoring TAC.

A quality assurance process

The programme aims to collect high quality scientific data at the haul level, providing high resolution spatial and temporal sample coverage that can be used by industry and scientists to (i) quantify changes in biology and demographics of the commercially targeted fraction of pelagic fish stocks, (ii) quantify and understand changes in the dynamics of pelagic fisheries. The methods, protocols and procedures documented herein are components of the overall quality assurance (QA) process that is needed to ensure that the programme is capable of reliably delivering good quality fit-for-purpose data (Figure 1 & 2).

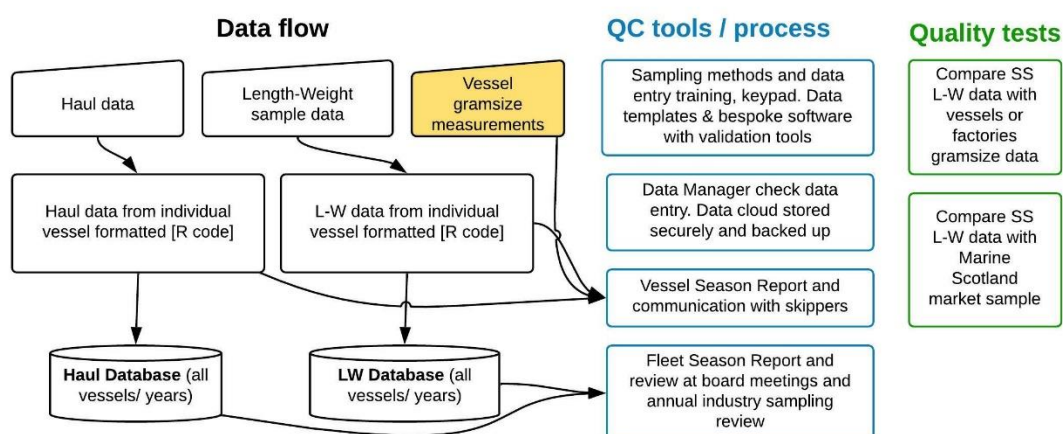
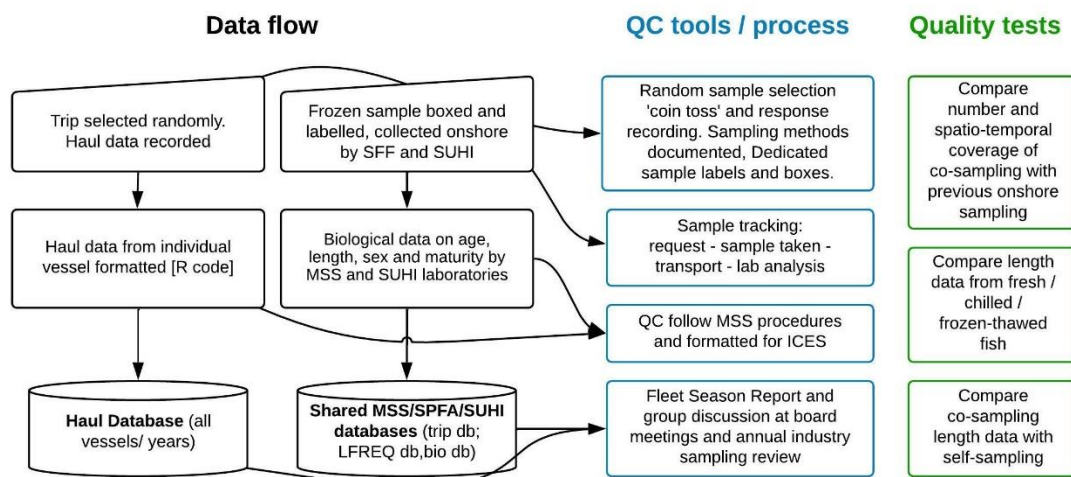


Figure 1. Self-sampling scheme QA processes overview.



MSS - Marine Scotland Science
 SPFA - Scottish Pelagic Fishermen's Association
 SUHI - Shetland University of Highlands and Islands
 SFF - Scottish Fishermen's Federation
 ICES - International Council for Exploration of the Sea

Figure 2. Co-sampling scheme QA processes overview.

1. Where the manual fits in with strategic plans

This Methods and Procedures Manual is a public document, and is one of three operational documents supporting the [SPFA's Data Collection Strategy](#) (Mackinson, 2019), which is founded on two objectives:



The two other documents are the [Science Data Policy](#) (Mackinson, 2020) which provides a framework for ownership, sharing and access of data; and the Implementation Plan, which is an internal document identifying the actions to enable the strategy.

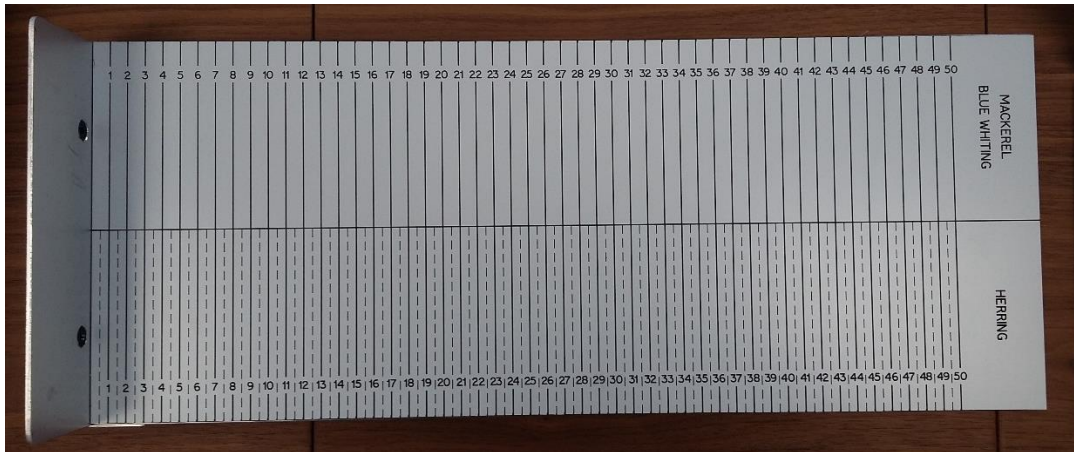
2. Sampling and data collection at sea

2.1. Sample and data collection methods

2.1.1. Equipment and documentation

Vessels participating in the programme are provided with the following equipment:

1. A bespoke measuring board.



2. Sampling protocols describing the sampling methods for crew onboard vessels (Appendix 1-3, 8).
3. Weighing scales sensitive to 0.5 g, and instructions on calibration of scales, available as a video tutorial (<https://youtu.be/omqOa3AwMG4>) and diagrammatically (Appendix 4).
4. An electronic keypad paired with the scales for data entry (currently 13 out of 20 vessels have keypads installed, with further vessel installations planned in the coming years). Instructions are available diagrammatically (Appendix 5) and as video tutorials:
 - Tools to help fishermen collect data at sea: <https://youtu.be/N5pugshmiJA>
 - No.1 Weight only mode: <https://youtu.be/VhxYxzO1oNA>
 - No.2 Length-weight mode: https://youtu.be/WFbfVYY__Cs
5. Data recording templates including paper and/or electronic copies for haul data (Appendix 6) and biological data (Appendix 7).
6. Sample labels for the collection of frozen samples (Appendix 8).

2.1.2. Vessel participation

Vessels participate in the programme voluntarily. A pre-season vessel list is created at the start of each fishing season, from which all active participating vessels are listed. On some occasions, not all vessels on the list will be available to undertake sampling in a given season. This may occur when a vessel does not have quota for the fishing season; or, a rebuild/refit/maintenance is underway. In this case the vessel is not included in the active participating vessels listed for sampling in the pre-season vessel list.

2.1.3. Self-sampling: Length and weight data

Sampling the catch for fish length and weight data is routine on all vessels taking part in the programme. Length-weight data are collected from all hauls and follow the same

method, with minor variations regarding the size of sample taken (specific to each species), the precision of length measurement taken (which varies between species), and the method of data recording (either manual or automatic) (see Box 1). Protocols detail the method used to take a sample from the catch; carry out length and weight measures; and record the data (Appendix 1-3).

Box 1. Self-sampling: length and weight data

Self-sampling: length and weight data

1. Size of sample

During pumping, a part-filled basket of fish is taken at the start, middle and end (ensuring sampling is distributed across the catch in order to best capture catch composition). All the fish together make up the total sample and are measured and weighed.

Species	Part-filled basket size	Total sample size
Herring	approx. 1/3 of a basket	approx. 25-30kg
Mackerel / Horse mackerel	approx. 1/2 of a basket	approx. 40-45kg
Blue whiting	approx. 1/10 of a basket	approx. 15kg

2. Length and weight measurements

Each fish is measured for length (as below) and weight (in grams).

Species	Length measured to
Herring	The nearest lowest half cm
Mackerel / Horse mackerel	The nearest lowest full cm
Blue whiting	The nearest lowest full cm

2.1.4. Co-sampling: age, length, sex and maturity

In addition to the self-sampling, frozen samples of fish are collected from some hauls for additional biological sampling of age, length, sex and maturity by MSS and SUHI scientists ashore. This biological sampling mirrors that which has been carried out at onshore factories by MSS since the 1970s as part of the national data collection. Owing to differences in fishing operations at sea and staff availability onshore, trip selection varies between fisheries (see Box 2). Samples are frozen and stored onboard vessels until their return to a Scottish port where the samples are collected and taken to the lab. Sampling protocols and sample labels are provided to vessels (Appendix 8). From January 2022, co-sampling replaced most onshore factory sampling to become main source of biological data for landings of pelagic fish by the Scottish fleet provided to ICES. To facilitate the continuation of co-sampling and reduce the manual process of daily vessel monitoring, an automated notification system is being investigated for future sampling.

Box 2. Co-sampling: age, length, sex and maturity

Co-sampling: age, length, sex and maturity

1. Trip selection

a) North Sea herring and mackerel

During the fishing season, vessel activity is monitored daily (excluding Saturday and Sunday): every day, for each boat engaged in a fishing trip, an electronic 'coin toss' selection method is used to select whether or not the boat collects a frozen sample.

Coin toss outcome	Trip selection
Positive	Contact boat and request a frozen sample from every haul during their current trip. (Do not include boat in coin toss again until next trip).
Negative	Do not contact boat; current trip will not be sampled. (Do not include boat in coin toss again until next trip).

b) Blue whiting

The blue whiting fishery operates principally out of Irish ports, preventing samples being collected and returned to the lab during the fishing season, so a reduced number of samples are collected. In addition, daily monitoring of vessel activity is not possible for the blue whiting fishery so pre-season trip selection is carried out: prior to the fishery beginning, an electronic 'coin toss' selection method is used to select whether or not each boat collects a frozen sample from the first trip. Alternate trips are then sampled.

Coin toss outcome	Trip selection
Positive	Contact boat and request a frozen sample from a single haul during their first (and every other) trip.
Negative	Contact boat and request a frozen sample from a single haul during their second (and every other) trip.

c) Atlanto-scandian herring and horse mackerel

With data and fishing activity more limited for Atlanto-scandian herring and horse mackerel, vessels are requested to collect frozen samples from all hauls. This request is provided to vessels prior to the fishery beginning.

2. Fish sample

After the weight-length self-sample measuring is complete, a factory carton is filled with a random mixture of the fish measured (a standard factory carton dimensions are h=10 cm, w=38 cm, l=58 cm, with a fish capacity of approximately 25kg). Samples are labelled (with vessel name, species caught, haul date, haul number, and landing port) and stored in freezers onboard until return to Scottish ports.

2.1.5. Vessel sampling weight data

It is standard practice on Scottish pelagic vessels for the crew to continuously sample the individual weights of fish as the catch is being pumped on board. This is used to calculate the average fish weight (the 'gramsize') and the proportion of fish in each weight category, which determines the price they might get. Since many more fish are individually weighed during this process, the ship's gramsize is a more accurate measure of the weight distribution. When this information is available in an accessible format from the vessel, it is used to compare with the weight distribution and average weight calculated from the self-sampling data (or 'biosample'). This provides a useful diagnostic to determine the sampling performance and confidence intervals, with the aim to have the self-sampling average weight as close as possible to the ship's gramsize (see Box 3).

Box 3. Ship's sample weight data

Ship's sample weight data

Example of vessel individual weight data, as used to calculate gramsize.

ID7	Weight
1	0.5
2	0.446
3	0.518
4	0.536
5	0.346
6	0.41
7	0.468
8	0.398
9	0.27
10	0.252

Comparison of vessel weight data ('gramsize') and self-sampling weight data ('biosample'), as shown in vessel report:

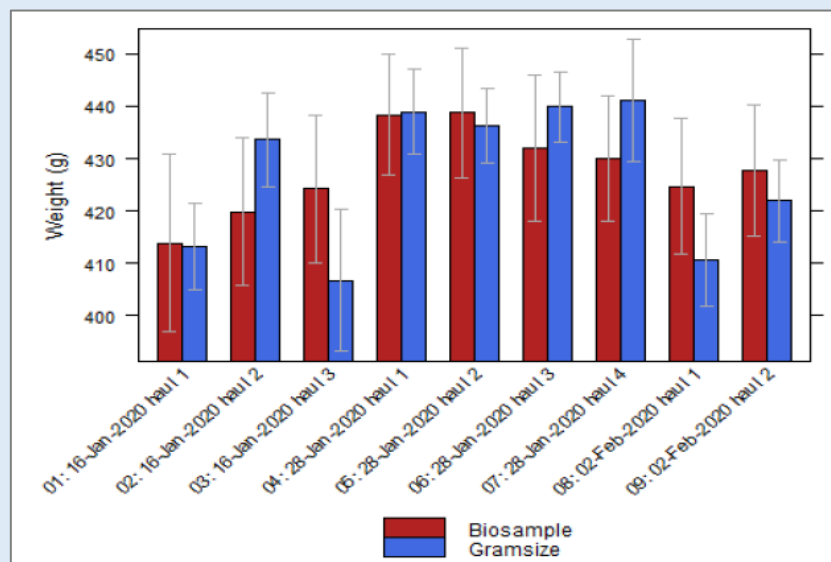


Figure showing an example of biosample weight compared to ship's 'gramsize' weight (per haul). Coloured blocks=average; grey bars=95% confidence intervals (i.e. there is 95% confidence this range of values contains the true average)

2.2. Recording sampling data

2.2.1. Haul information

Haul information is recorded for each haul, including hauls where a length-weight sample may not have been taken for some reason (e.g. issues with fishing gear leaving no crew available to sample). Haul details connect the biological sample data to where and when

it was caught and to other operational and environmental parameters. Paper and electronic copies of the haul data entry sheet are available (Appendix 6).

2.2.2. Length-weight data

Conditions for sampling at sea necessitate the use of waterproof recording equipment. Length-weight data can be recorded in two ways: either manually (first on the waterproof recording sheet, then entered into the electronic data entry sheet), or automatically using a rugged electronic keypad paired with the scales.

2.2.2.1. Manual length-weight recording

During self-sampling, crew record length and weight data onto the waterproof sheet, along with species sampled, vessel name, date and haul number (Appendix 7). This information is later input by crew into the electronic data entry sheet (Appendix 7), noting additional information on who carried out the sampling and entered the data.

The electronic data entry sheet has inbuilt data checking features in order to minimise errors during data entry (see Box 4). Length and weight values can only be entered within set ranges to avoid erroneous measures being entered by mistake (length set at 10-50 cm and weight at 50-1000g). Length-weight statistics and plots are automatically generated, serving as immediate visual checks to prevent erroneous entries. Data from all hauls taken by a vessel in a fishing season can be entered in one electronic file, with multiple tabs formatted for length-weight data entry.

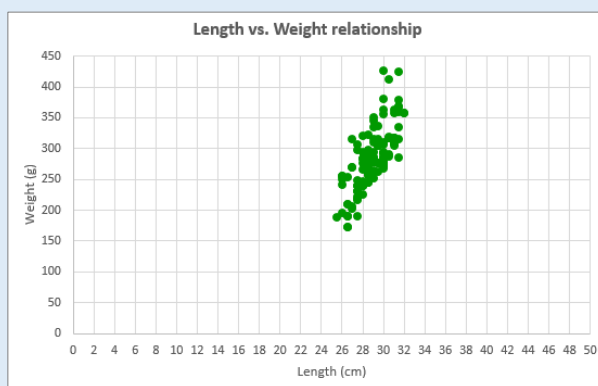
Box 4. Manual length-weight data recording

Manual length-weight data recording:

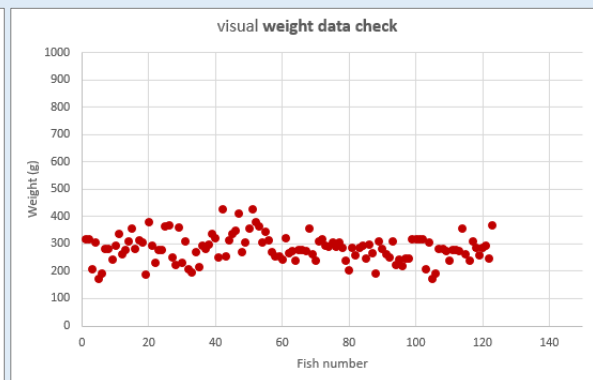
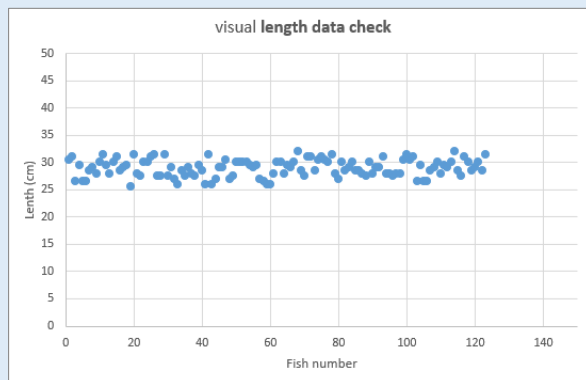
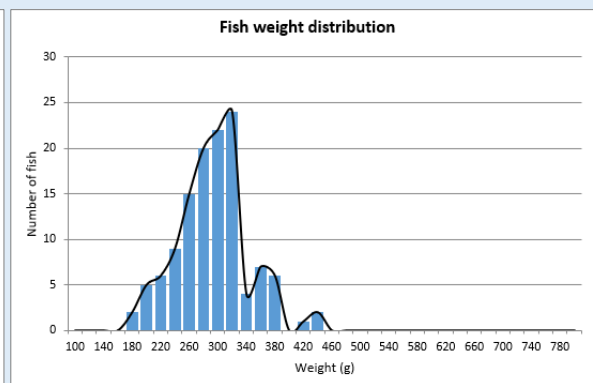
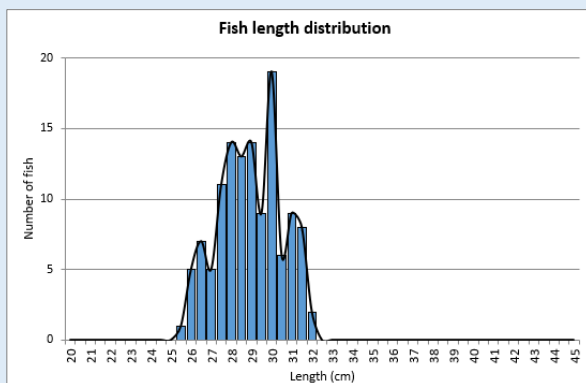
Information recorded in electronic length-weight data entry sheet:

Vessel	Date	Haul_no	Species	Sampled_by	Entry_by	Entry_date	Comment	Fish_no	Length_cm	Weight_g
							<i>optional</i>	1		
								2		
								3		
								4		
								5		

Automatically generated length-weight statistics and plots for data checking in the length-weight data entry sheet:



	Length (cm)	Weight (g)
average	28.9	284
min	25.5	172
max	32	427



2.2.2.2. Automatic length-weight recording

As part of the self-sampling programme design and testing phase a paired keypad-scale data recording system was developed with local marine electronics supplier Echomaster Marine (see Box 5). Using the system, the crew member weighs the fish on the scale and is prompted on the keypad display to enter its length. Bespoke software ('Catch Track'), developed alongside the keypad-scale system, provides a graphical user interface to display the length-weight information to an onboard PC, and records each sample's information in three separate data files:

1. a raw data file, which allows the length-weight measurements to be replayed in the Catch Track software.
2. a catch report, which provides information on the weight range and average for the vessel's market purposes.
3. a csv file which pairs the length and weight measures for each fish, and automatically records the vessel name, and the date and time that the sample data were input.

All data files are stored on the system and sent via ethernet to the onboard PC. The files can be downloaded and emailed to the data manager or can be directly uploaded from the Catch Track software (see section 4.1.1).

The full keypad-scale processes are shown diagrammatically in Appendix 5, which are also available as video demonstrations (see links in section 2.1.1).

Box 5. Automatic length-weight data recording

Automatic length-weight data recording:

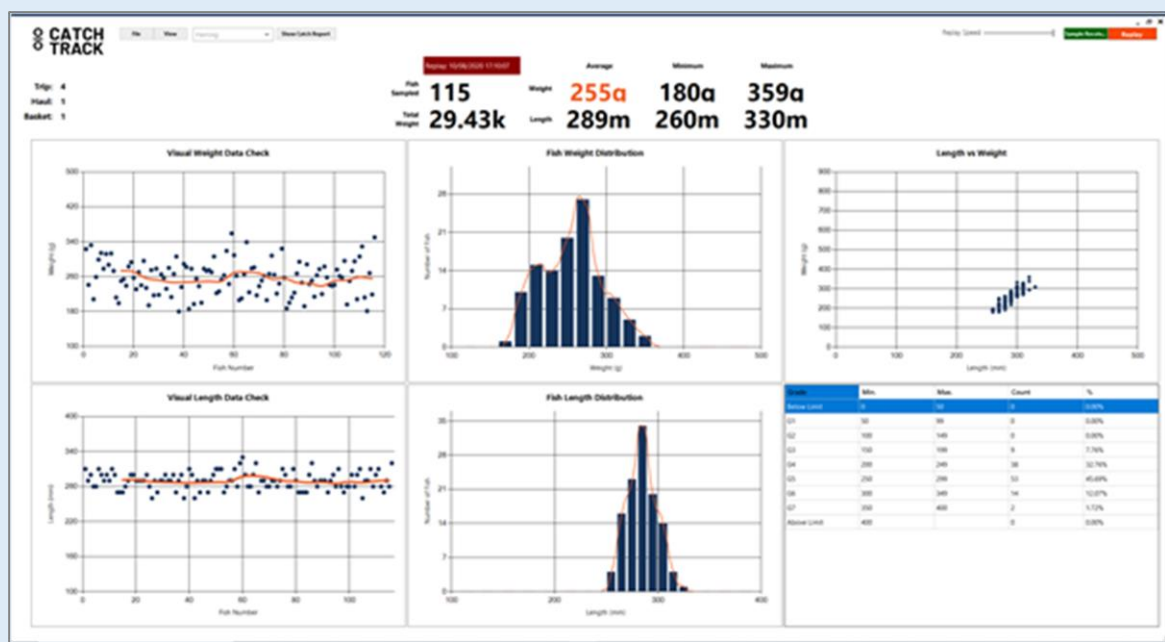
Paired keypad-scale data recording system set-up onboard vessel:



Example Catch Track recorded csv file, with paired length and weight data:

	A	B	C	D	E	F
1	Vessel	Date	Sample No.	Fish No.	Length	Weight
2	Adenia	05.01.22 17:24	2	1	370	445
3	Adenia	05.01.22 17:25	2	2	350	375
4	Adenia	05.01.22 17:25	2	3	390	520
5	Adenia	05.01.22 17:26	2	4	290	175
6	Adenia	05.01.22 17:26	2	5	390	515
7	Adenia	05.01.22 17:26	2	6	350	420
8	Adenia	05.01.22 17:27	2	7	360	395
9	Adenia	05.01.22 17:27	2	8	320	295
10	Adenia	05.01.22 17:27	2	9	380	445

Display on Catch Track software during length-weight sampling as data is recorded or replayed:



3. Training

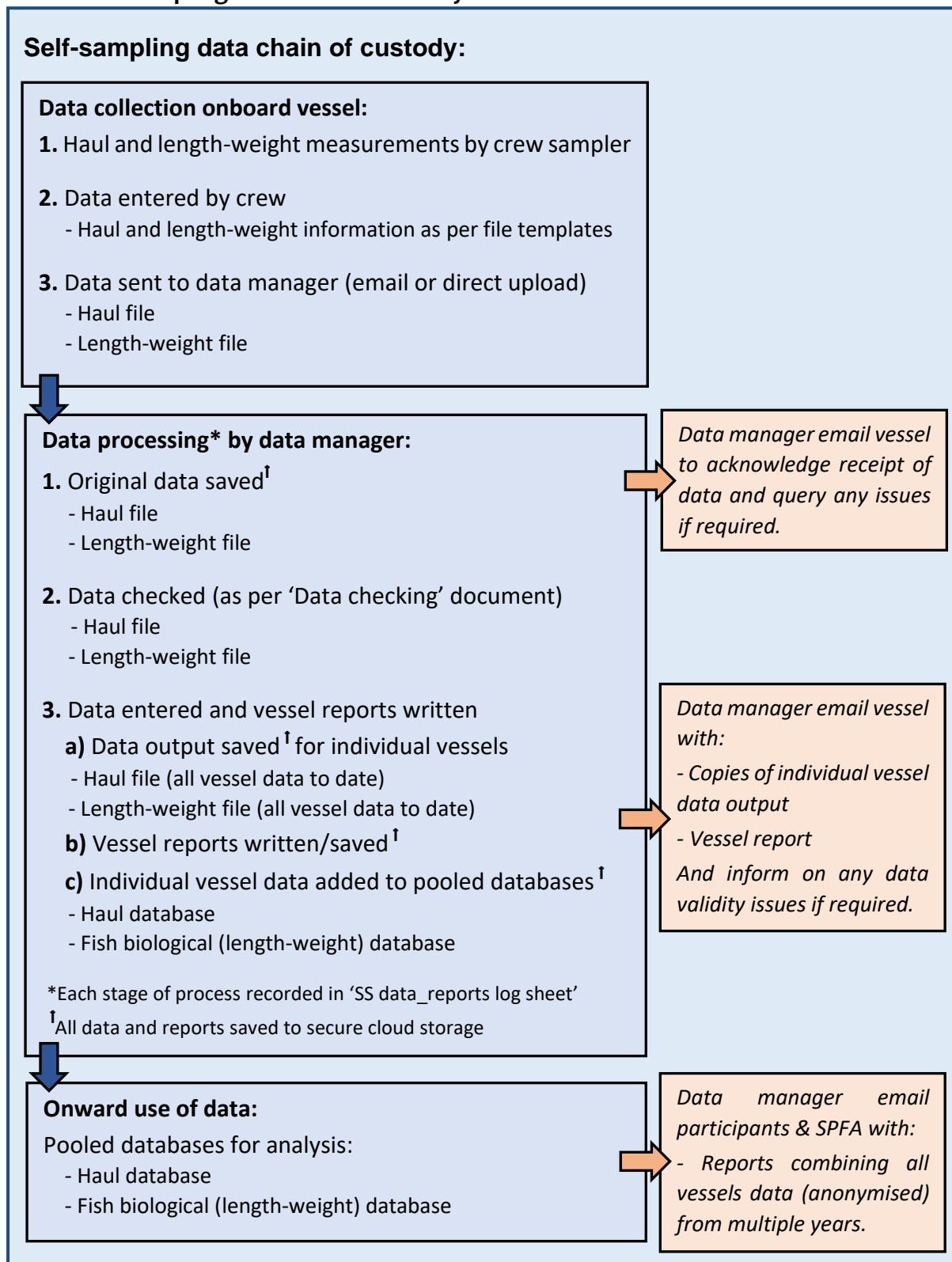
At the start of the programme in 2018, two training sessions were provided to skippers and crew, one at the factory in Shetland, another onboard a vessel in Fraserburgh. Since then, training has shifted to a more one-to-one approach with scientists going on fishing trips or visiting vessels in port to provide guidance through demonstration and explanations in response to questions. This personal approach takes longer, but is more effective because it troubleshoots any quality issues at source and builds the relationships with the crew and skippers necessary to establish good communication channels, which is important for the vessels and scientist alike.

Details of the training include how to sample and measure each species, how to record and enter the data into the spreadsheet templates, and how to use the keypad-scale system (additional training and troubleshooting on the keypad-scale system is also provided by Echomaster Marine if required). Importantly, information is provided on why the sampling is being carried out and what will happen with the data so that the crew and skippers have a broad understanding of the sampling programme. For each vessel, crew members are identified as nominated samplers/data handlers in order to maintain consistency of sampling and data entry, and to facilitate a direct line of communication between samplers and co-ordinating scientists.

4. Data handling

The self-sampling and co-sampling data handling processes are fully documented in the programme's detailed Chain of Custody documents (Appendix 9). A simplified self-sampling chain of custody is shown in Box 6 as an example of the processes.

Box 6. Self-sampling data chain of custody



4.1. Quality checking

4.1.1. Self-sampling

Upon completion of each fishing season, vessels send in their self-sampling data files to the data manager. Electronic data entry sheets with manually entered haul and length-weight information are sent by email. Data files automatically recorded from the keypad can either be emailed or can be directly uploaded from the Catch Track software to a dedicated online server, where vessels have permissions to see only their own information and give access to the data manager. All data are saved from email or the online server to the programme's secure cloud storage, and data checking and quality control are then undertaken by the data manager.

Data recorded automatically using the paired keypad-scale system are copied into the standard electronic length-weight data entry sheet via automated R script. These data can then be assessed using the inbuilt data checking features in the length-weight data entry sheet (see Box 4). All data collected by vessels are then subject to the same data checking and quality control processes.

These include: (i) ensuring that information matches between the length-weight and haul files so that information can be connected, (ii) checking for missing information, and (iii) checking that information is formatted correctly to be read in by data processing scripts (see section 4.2). Full details of data checking procedures are available in Appendix 10.

As part of the data checking and quality control, each sample is classified for 'validity', and the details of who carried out the checking, the date of checking and any other comments are recorded (see Box 7). A sample may be considered invalid if there is no haul information associated with a sample or vice versa ('N_HIM' or 'N_BioM'), if the sample size was too small ('N_SS'), or other sampling issues ('N_Ot') such as fish being incorrectly measured. During this process, the data manager will contact the vessel to query any issues if required.

4.1.2. Co-sampling

Once samples have been collected from vessels, sample processing occurs at the SUHI Scalloway campus in Shetland or MSS Marine Lab on the mainland. Sample processing follows the procedure for MSS biological sampling under the national data collection:

- a) measuring and recording the length* of every fish in the sample, and
- b) recording the sex and maturity stage, and extracting the otoliths for 2 or 3 fish[†] of each length* class. (All otoliths are aged by an experienced MSS otolith reader).

All data are provided to MSS for entry and quality checking as per standard MSS QC procedures. Data are stored electronically with MSS and on the programme's secure cloud (see section 4.3).

*1cm intervals for mackerel; 0.5cm intervals for herring

[†] 2 per length class for herring, mackerel and horse mackerel; 3 per length class for blue whiting

Box 7. Data checking and quality control (self-sampling)

Data checking and quality control (self-sampling):

Classifying sample validity in length-weight data entry sheet:

Valid_sample	Check_by	Check_date	Check_comment
<input type="text"/>			none
Y			
N_HIM			
N_SS			
N_Ot			

Classifying sample validity in haul data entry sheet:

Valid_sample	Check_by	Check_date	Check_comment
<input type="text"/>			none
Y			
N_BioM			
N_SS			
N_Ot			

4.1.3. Sample size

As part of sampling, it is important to monitor fish sample size to ensure that a) it is adequate to provide biologically meaningful information (such as length distribution), and b) that it is not wasting sampling effort by sampling too few (or too many) fish (Gerritsen and McGrath, 2007; Miranda, 2007; Schultz *et al.*, 2016).

Following the first season of self-sampling for herring, mackerel and blue whiting, the size of samples achieved by vessels was examined and assessed on the criteria of these points, and 'lower limit' sample sizes were calculated. These lower limit sample sizes are defined by both weight of sample and number of fish in sample (see Box 8). They are used as a guide when assessing the validity of sample sizes during data checking. If a sample falls below the limit, the sample size is further examined to check that it is sufficient to provide a reliable representation of lengths and weights of fish in the catch. If a sample is then found not to be of sufficient size, it is classified as 'invalid'. Sample size is also continuously monitored to check for consistency in sampling across vessels. (More information is available in Appendix 11).

Co-sampling sample size is also monitored, and compared to past MSS data, to assess how data from samples collected onboard vessels compare with those previously collected at onshore factories. This is part of on-going work.

Box 8. Sample size (self-sampling)

Sample size (self-sampling):

The lower limit for total sample (i.e. total of 3 x part filled baskets):

Species	Sample size lower limit (weight)	Sample size lower limit (number of fish)
Herring	20 kg	90 fish
Mackerel / Horse mackerel	35 kg	90 fish
Blue whiting	11 kg	90 fish

4.2. Data processing

Following data checking and quality control, each vessel's self-sampling data are re-formatted into new length-weight and haul data files. The new format allows data to be appended into two pooled databases which contain the data for all vessels: a fish biological (length-weight) database and a haul database. The individual vessel length-weight and haul data are used to produce a report for each vessel, which provides feedback on results of their sampling (see Section 5). The pooled length-weight and haul databases are used for further analysis and reporting. e.g. reports examining multiple vessels and/or multiple years. The processes for data re-formatting; vessel reporting; and data pooling are each carried out using custom R code, providing a consistent data handling approach that can be repeated for all vessels' data, at each processing step.

4.3. Data storage and access

Following the details in the SPFA [Science Data Policy](#) (Mackinson, 2020), the underlying data will be stored on secure cloud storage, with unlimited backup and restore facility. Physical backups on at least one other storage media will be undertaken after every fishing season.

Access to data will be controlled through folder/file permissions granted by the SPFA Data Custodian, and in accordance with any data sharing agreements.

5. Reporting

At end of each fishing season, each participating vessel is sent:

- their data back in a consistent, simplified format allowing them to build a history of data for their own purposes.
- a dedicated vessel report, detailing sample information including a map showing haul location; average length and weight per haul; length and weight distributions; length-

weight relationship; and a comparison between the vessel's average weight and average weight of fish in the sample (example in Appendix 12).

A number of additional reports are also created to provide feedback to vessels. These include analysis of self-sampling data across multiple vessels (anonymised, so no vessels are identified) and across multiple years. These reports allow for examination of a broader dataset, and the identification of patterns over greater spatio-temporal scales.

6. Communication and Feedback

Communication and feedback to the vessels, and from the vessels to the scientists, are core functions of the programme. They are critical in maintaining engagement and being able to evaluate progress, performance and utility.

Communication and feedback are provided at several levels:

- individual communication via phone, WhatsApp, emails, sea-trips/ port visits (see Section 3) and reports (see Section 5)
- group messages via Pelagic Science Sampling and SPFA Science WhatsApp groups and email
- SPFA directors board meetings (4 per year)
- a dedicated sampling programme meeting for participants and other parties including Marine Scotland Science and representatives from other Scottish fishing industry organisations. The first meeting was held in December 2019.

7. References

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8. Appendices

Appendices are available on request and at the SPFA website:

katie.brigden@uhi.ac.uk / steve.mackinson@scottishpelagic.co.uk

<https://scottishpelagic.co.uk/pelagic-self-sampling/>

Appendix 1. Herring length-weight protocol (manual data entry)

Appendix 2. Mackerel length-weight protocol (manual data entry)

Appendix 3. Blue whiting length-weight protocol (manual data entry)

Appendix 4. Calibration of Marel M1100 scales

Appendix 5. Instructions on use of prototype keypad with scales data entry device

Appendix 6. Haul data recording template (pdf example of spreadsheets)

Appendix 7. Length-weight data recording template (pdf example of spreadsheets)

7a. Paper recording sheet (printed on waterproof paper)

7b. Electronic recording sheet

Appendix 8. Co-sampling protocols and labels

8a. Herring and mackerel

8b. Blue whiting

8c. Horse mackerel and atlanto-scandian herring

8d Labels

Appendix 9. Data chain of custody

9a. Self-sampling CoC

9b. Co-sampling CoC

Appendix 10. Self-sampling data checking

Appendix 11. Sample size

Appendix 12. Example vessel feedback report

Appendix 13. ICES Catch sampling programme summary