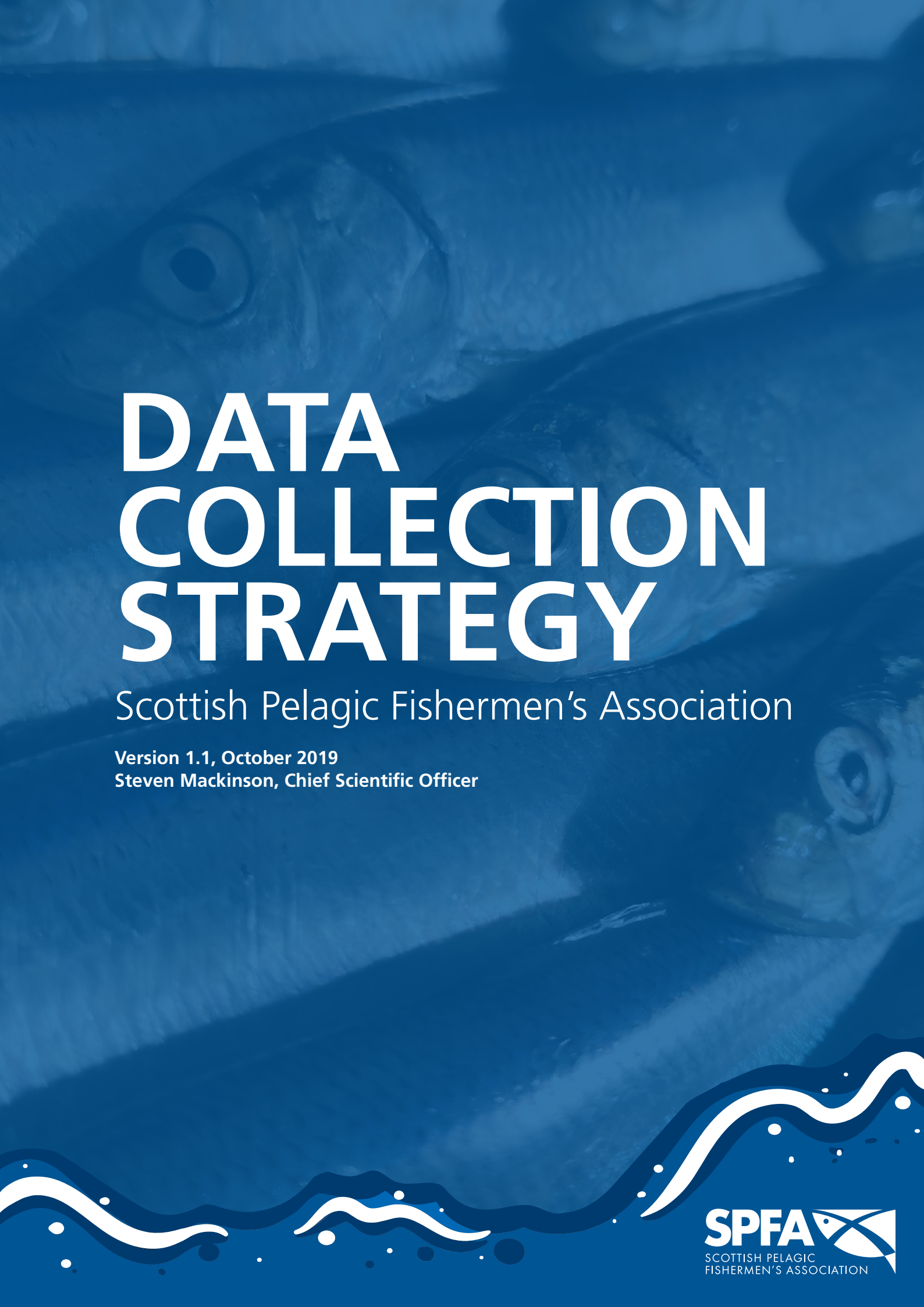

DATA COLLECTION STRATEGY

Scottish Pelagic Fishermen's Association

Version 1.1, October 2019
Steven Mackinson, Chief Scientific Officer

SPFA
SCOTTISH PELAGIC
FISHERMEN'S ASSOCIATION

SPFA DATA COLLECTION STRATEGY

Contents

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1. Purpose and objectives

This strategy describes the Scottish Pelagic Fishermen's Association (SPFA) approach and plans for engaging its members and collaborators in the collection of scientific data for application in fish stock assessment and management. It is part of the SPFA Science Plan (Figure 1) and draws upon the findings reported in the 'Feasibility study into a scientific self-sampling programme for the pelagic sector' (Mackinson et al. 2018) and Guidance for industry-science data collection (Mackinson et al. 2017)

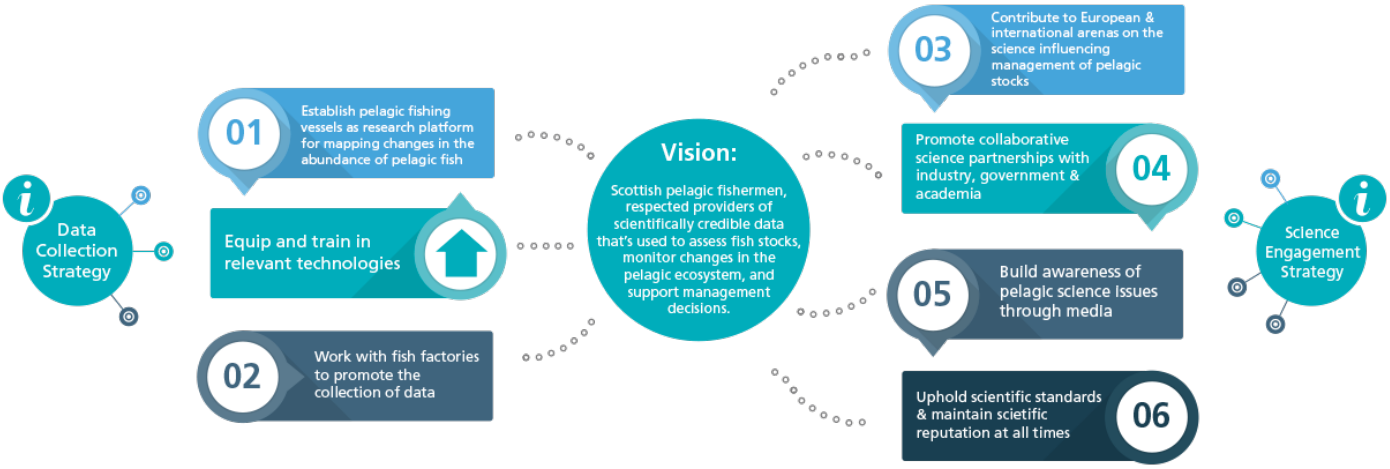


Figure 1. SPFA Science Plan

Two objectives underpin the SPFA Data Collection Strategy:

Implementation of the strategy is covered in three operational documents describing:

(i) **Implementation Plan** – which describes the actions to enable the strategy
(ii) **Data policy** – which provides a framework for ownership, sharing and access of data
(iii) **Sampling Methods** – which provides the practical guidelines on scientific sampling

This Strategy is a public document, made available via the website, and freely available for distribution. The Methods and Data Policy will also be publicly available, once signed-off by the association. The Implementation Plan is a restricted document for the association only.

2. Definitions

Self-sampling on vessels or at factories refers to industry members themselves undertaking the collection of scientific data (in whatever form) during the normal process of commercial operations, or during industry surveys.

Industry surveys refer to industry vessels carrying out scientific surveys, initiated and planned either by themselves or in collaboration with scientific institutions.

Charter surveys refers to industry vessels being chartered out under contract to undertake specified scientific survey activities that are initiated, planned and led by a scientific institution.

Factory data refers to biological information on pelagic fish routinely recorded by factories as part of their product quality control processes.

Historical data refers to data from fishing vessels recorded prior to the Data Collection Strategy and includes information typically recorded in diaries and electronic plotters such as the distribution of fish, catches and average fish size.

3. Rationale

Why does the Scottish pelagic industry want to engage with science?

The industry recognises that engagement in science is more important now than ever. While resources for state-funded evidence gathering have reduced, the need for quality data to assess the sustainability of stocks, and the businesses that depend upon them, continues to grow. While science is more frequently turning to industry for help with monitoring and research, industry is turning to science for assistance with the professional skills it needs to operate effectively in a management system underpinned by science, and a market place that demands assurance of the sustainability credentials of fishing businesses.

Taking new responsibilities for providing scientific data is seen by fishermen as a welcome opportunity to directly contribute to the continuous improvement of stock assessments.

Key motivations for members of the SPFA to engage with science are scored below, where a higher score equals a higher priority. Further explanation is given in the self-sampling feasibility report (Mackinson *et al*. 2018).

- **Prospect of zero information and precautionary measures that arise (8)** – When there is insufficient information necessary to achieve a good quality stock assessment, the precautionary approach is applied to scientific advice and this can lead to poor quality advice that is not trusted.
- **Evidence of zonal attachment (8)** - Evidence of stock structure and distribution will be at the forefront of future debates on the implications of zonal attachment for managing fishing access agreements in UK waters.
- **Confidence in stock assessments (7)** - The quality and reliability of stock assessments has long been a concern for the fishing industry, often because changes in scientific advice do not appear to match their perceptions of changes they observe at sea. This brings in to question the quality and veracity of data sources and how they are used to assess stock status.
- **Reputation and market access (6)** - Getting involved in data collection for science is an outward demonstration of its sustainability credentials, which is a good-news story for the pelagic industry and markets.
- **Maximising use of data opportunities (5)** - Not making full use of the data collected by vessels and factories wastes opportunities for improving ecological understanding and assessments of the state of stocks and the marine environment.
- **Watchmen of the sea (5)** - As watchmen of the sea, fishermen observations can serve as early warning indicators of change which can aid planning of scientific surveys or stock forecasts that depend upon assumptions about current state.
- **Reversing the negative narrative (5)** - Pro-actively getting involved in data collection and provision of scientific evidence can help reverse a prevailing negative narrative about the fishing industry.
- **Reversing the burden of proof (4)** - If industry took on the role of providing the data for scientific assessments, replacing the current sampling undertaken by government research institutes, it shifts the burden of proof upon industry to evidence that its data meets required standards for quality.

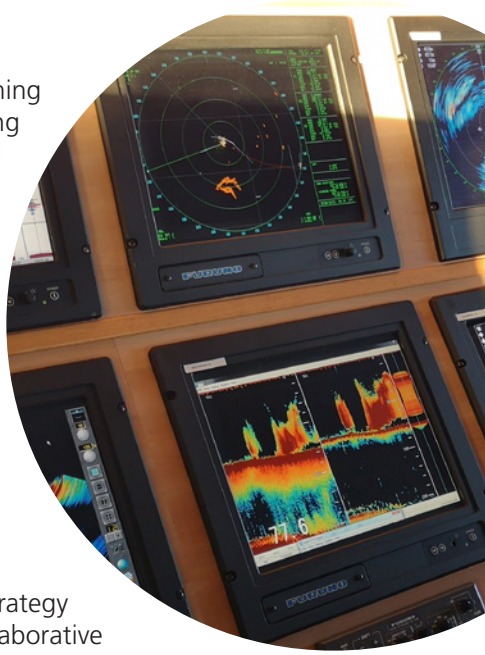
What does industry hope to achieve in being proactive contributors of data?

To be respected providers of scientifically credible data that's used to assess fish stocks, monitor changes in the pelagic ecosystem and support management decisions.

How does industry's self-sampling initiative tie in with Scottish Marine Strategy and wider UK perspectives?

The recent Future of Fisheries Management in Scotland discussion paper (Marine Scotland, 2019) sets a positive tone for industry initiatives such as self-sampling, stating its intention to maintain "Scotland's reputation as a leading exponent of evidence-based sustainable fisheries management – progressed through constructive partnership working with the fishing industry, environmental interests and scientists". In particular, Chapter 9 on Innovation, Science and Technology invites discussion on industry contributions to the funding and prioritisation of research, "As is the norm in many other fishing nations we believe that as the key beneficiaries of research and development, fishing businesses should contribute to the cost of delivery. We would welcome views on how this change can be implemented and how those that will be asked to provide additional funding can assist in shaping our research priorities". Other policy documents, including Scotland's National Marine Plan (Scottish Government, 2015) and the Scottish Marine Science Strategy 2010-2015 (Scottish Government, 2011), show that industry's initiative could serve to facilitate Scottish strategic objectives for the marine environment by providing information to support a number of policy objectives that are of mutual importance:

(from Scotland National Marine Plan, 2015)



Objective 2: A fishing fleet which is seen as an exemplar in global sustainable fishing practices, is confident in securing a long-term income from the available sustainable fishing opportunities across all sectors, and **accounts for changes in species distribution and abundance due to climate change.**

Objective 7: An evidence-based approach to fisheries management which is underpinned by a responsible use of sound science and is **supported by the whole sector.**

Objective 8: Tackle discarding through **the avoidance of unwanted catches** and the implementation of the EU's obligation to land all catches of quota stocks **in a way which is workable and sensitive to the impacts on fishing practices** both offshore and onshore.

Objective 9: Management of removals rather than landings, **where necessary, through fully documented fisheries.**

Similarly, in defining its priorities for scientific research, The Scottish Marine Science Strategy 2010-2015 (Scottish Government, 2011) provides a welcome recognition that collaborative working with stakeholders is an important part of effective delivery. It states: "Stakeholders are essential partners in carrying out science effectively. The aquaculture and fishing industries make important resource, expertise and data contributions to collaborative science projects through the Scottish Aquaculture Research Forum (SARF), the Scottish Industry Science Partnership (SISP) [which evolved into the Fishing Industry Science Alliance (FISA, 2012-2016) and was a catalyst for Fisheries Innovation Scotland 2014-present], and the Rivers and Fisheries Trusts of Scotland (RAFTS). In addition, MASTS is a key partner in scientific research. We will work with these and other stakeholders to seek synergies, and to support our science and ensure it is relevant and of high quality".

Scotland's approach echoes the perspectives being followed across the UK, recognising that regardless of the outcomes of Brexit negotiations on future management and access to UK waters, scientific assessments of fish stocks will remain to be a key requirement, and will continue to require scientific collaboration at an international level.

As the precursor to a new Fisheries Bill, Defra's White Paper on future fisheries policy (Defra, 2018) would suggest that there should be good support for industry initiatives that can provide data useful for science and management purposes. The paper states "Our vision is that industry should take a greater, shared responsibility for sustainably managing fisheries, while making a greater contribution towards the costs. This can include, for example, work to develop new management practices and contributing to fisheries science". And, "Defra will build on the existing close cooperation with the devolved administrations on data collection, while engaging with industry and others including NGOs, to gather the best available scientific evidence to inform policy and delivery." Examples are given of specific data collection opportunities. In particular: "enhancing the data collected from fish grading machines; and software that enable fishermen to collect data and meet reporting requirements".

Seafood 2040: A Strategic Framework for England, published by stakeholders from across the seafood industry, points in the same direction. In seeking to address "a prevailing culture that favours scientific knowledge over practical knowledge – and thus fails to appreciate the merits and shortcomings of both", it recommends that the current data programmes are maintained, or equivalent programmes developed, and that collaboration with European partners is continued. Of particular importance is the suggestion to utilise quota mechanisms as funding, and call for a well-funded, well-respected fisher/science programme that can play a valuable role in extending the data coverage of UK fisheries. Improved digital connectivity and software for data capture are seen as necessary to achieve this, as well as to improve enforcement and traceability. It envisages Producer Organisations having a crucial role to play in supporting the work so as to maximise wild catch opportunities. Drawing on the good work already being delivered in other parts of the UK, for example Fisheries Innovation Scotland and Food Innovation Network, a Seafood Science and Innovation Group (SSIG) comprised of members of the Seafish Expert Panel will assist work on delivering recommendations of Seafood 2040. Specifically, the SSIG will "facilitate an inclusive approach for the seafood sector, ensuring that research is co-designed and co-produced, with public and private funds targeted to areas of greatest good, and that research is both relevant and accessible across the supply chain".

What approach is being taken to achieve this?

The SPFA's approach is to work in partnership with scientists and policy managers to ensure that any data they collect and provide has the best chance of being applied as evidence in fisheries management because it is relevant, scientifically credible and trusted by the institutions that use it.
By involving pelagic fishermen in scientific data and engaging them on scientific issues relevant to their fisheries, the approach aims at facilitating a shift in fishermen's attitudes from 'have to provide data' to 'want to provide data'. The reason for this is that having to makes it feel like an imposed burden. There is no ownership, and fishermen see it as enforcement. When fishermen want to collect data, they take responsibility, and this ownership promotes learning and taking pride in providing information they can believe in. The SPFA's **Pelagic Self-sampling Programme** (see section 4) is the main route to achieving this, but engagement in scientific surveys and charters are important too.

The essential foundations for enabling the self-sampling programme are:

- Utility (it's needed, wanted, relevant and does the job, what success looks like for those involved)
- Quality assured (it's trusted and credible)
- Co-constructed (ideas are agreed and planned together, willingness and long-term view for continuous improvement)
- Effective feedback mechanisms are embedded (provides personal value, giving a source motivation and incentive)
- Active engagement (people participate in specific roles, utilising knowledge and resources)
- Care (people take pride in what they are doing and why)

4. Self-sampling programme development

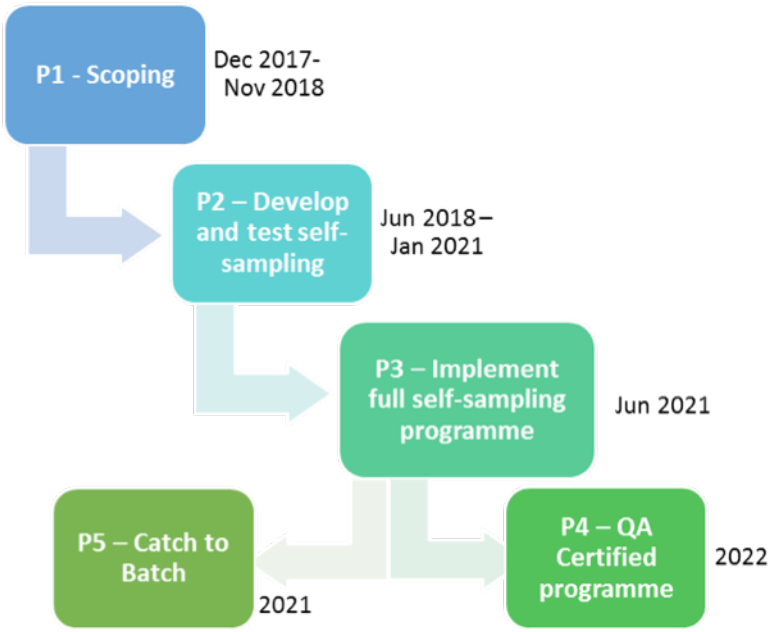


Figure 2. Phases in development of the SPFA Self-sampling Programme

Phase 1- Feasibility study. Identify information needs, sampling opportunities and requirements (Mackinson *et al*. 2018).

Phase 2- Development and testing of at-sea sampling. Establish methods, document protocols, train crew in sampling methods, develop quality control processes for methods and data, develop efficient and robust data capture and reporting tools, establish appropriate feedback mechanisms, validate and compare data against existing sampling, publish the results for scientific peer review to demonstrate utility and establish necessary credentials.

The intention is to produce peer-reviewed scientific papers addressing the following questions: (i) What are the implications for stock assessment when length & weight sampling every haul are compared to existing market sampling? (ii) What do the findings mean for the design of an effective industry self-sampling scheme? (iii) What technologies can make self-sampling (on vessels / at factories) efficiently provide good quality data?

Phase 3- Implement self-sampling across the whole pelagic fleet, where every vessel is able to take samples, but not all vessels need to sample all of the time.

Phase 4- A certified quality assured self-sampling programme, possibly integrated within something like the Responsible Fishing Scheme. To the extent possible, this will be aligned with development of a data accreditation scheme by the International Council for the Exploration of the Sea (ICES).

Phase 5- Connecting with factories. Matching every catch (haul) with every landing so that the 'batch' can be traced back to its origin, and haul and biological data collected on board is connected directly with the product quality (e.g. grades, fats, chemical analyses) recorded in the factory.

5. Information needs and how industry can address them

Identifying where industry self-sampling can improve or add new data to that routinely collected by scientific institutions requires identifying the need for information and exactly how the information can be used. Specific opportunities are summarised for each species in Table 5.1. A wider set of applications and opportunities are given in Appendix 1.

Table 5.1. Information needed to assess stocks and fisheries, and where and how industry sampling can make a useful contribution

Mackerel (*Scomber scombrus*)

What is currently done?	Assessment or information gaps	Industry opportunities	Solution(s)	How can industry self-sampling data be applied?
BIOLOGICAL DATA ON CATCHES • Market sampling measures lengths and ages in commercial landings, with spatial coverage representing ~98% of Scottish landings. • Data used in age-based analytical stock assessment model (SAM)	• Catch location reported at ICES statistical rectangle, not lat, long • While spatial coverage of sampled catches is high, only 50% of trips are sampled • Significant proportion of landings in foreign countries are not sampled, thus relevant biological data is absent. • Individual fish weight information is routinely collected by vessels but rarely stored • Individual fish lengths in commercial catch currently not sampled by vessels	• Reduce variability or any biases in catch biological data by sampling more of the catch and adding information on length and weights, (and possibly maturity) at much finer spatial and temporal scale than currently available • Record fat content and maturation stage	• Record lat, long and ancillary information of every haul • Take biological samples every haul (or every landing)	**Stock assessment:** Biological catch data collected by industry can be used in the same way as current assessment and in development of spatial assessment models. It can be used to increase accuracy and reduce variability of length-weight relationships and quantify spatial variability. Data on maturity and condition can be used to monitor temporal changes and avoid the need for static assumptions in the assessment model. **Management:** Evidencing distribution of fleet catches and relevance to zonal attachment. Also relevant to management strategies under changing oceanic conditions (climate change adaptation) **Business:** Fishermen get to see the patterns in their activities. Plus additional evidence for markets on quality, traceability and provenance, thus providing a marketing story. **Ecological research:** Changes in environmental conditions and fish growth

What is currently done?	Assessment or information gaps	Industry opportunities	Solution(s)	How can industry self-sampling data be applied?
SCIENTIFIC SURVEY DATA **Survey data sources:** Triennial egg survey index (1992-2019), IBTS (Q1 & Q4), IESSNS, Tagging. • Triennial mackerel egg survey, often with participation of industry vessels. • IESSNS and tagging data used for estimating adult stock. Information on juveniles from Quarter 1 IBTS survey used for estimating recruitment. • Biological sampling during surveys measures lengths, weights and ages in stock and provides information on growth and maturation	• When stocks are large and widely distributed, the limited resources for scientific surveys make it challenging to get the coverage necessary to assess the age structure and distribution of the stock. And because fisheries target adult fish, catch data cannot provide the necessary information on younger ages.	• Take scientific survey approach to sample the age structure and distribution of the stock more completely.	• Engage in the summer trawl survey below 60 degrees N • Undertake specific surveys (acoustic/trawl) to estimate year class strength required for stock forecast	**Stock assessment:** Contribute directly to survey indices used in assessment.
BYCATCH & DISCARD DATA • Estimates of total catch from is a large source of uncertainty in the assessment • Bycatch in Scottish pelagic fisheries very low but not routinely recorded. Discard observer trips used to occur on pelagic but now infrequent because of low discard rates^.	• Bycatch data not provided • Quantity of fish slipped and or released from nets after pumping not known	• Record any non-fish by-catch • Quantify any catches not landed.	• Estimate quantity of discarded catch • Record non-target fish by-catch at factory	• **Management:** Data on bycatch & discards for stock assessment and evidence issues for mitigation measures where relevant, e.g. choke species and TEP species issues. • **Business:** Evidence responsible fishing practices

Herring (*Clupea harengus*), North sea and Western

What is currently done?	Assessment or information gaps	Industry opportunities	Solution(s)	How can industry self-sampling data be applied?
BIOLOGICAL DATA ON CATCHES • North Sea: Market sampling measures lengths and ages in commercial landings, with spatial coverage representing ~89% of Scottish landings. • Data used in age-based analytical stock assessment model (SAM) • Stock identification issues are problematic for management because the structure of herring meta-population has significance for stock assessment and ecology	• Catch location reported at ICES statistical rectangle, not lat, long • Sampling effort <1 sample per 1000 t of catch, which is lower than ICES recommends • Significant proportion of landings in foreign countries are not sampled, thus relevant biological data is absent • Individual weight information is routinely collected by vessels but rarely stored. • Individual lengths in commercial catch currently not sampled by vessels	• Reduce variability or any biases in catch biological data by sampling more of the catch and adding information on length and weights, (and possibly maturity) at much finer spatial and temporal scale than currently available • Record fat content and maturation stage	• Record lat, long and ancillary information of every haul • Take biological samples every haul (or every landing) • Take specific targeted genetic samples from selected hauls/trips on a needs basis	**Stock assessment:** Biological catch data collected by industry can be used in the same way as current assessment and in development of spatial assessment models. It can be used to increase accuracy and reduce variability of length-weight relationships and quantify spatial variability. Data on maturity and condition can be used to monitor temporal changes and avoid the need for static assumptions in the assessment model. Stock identity information used to determine appropriate assessment boundaries and management units **Management:** Evidencing distribution of fleet catches and relevance to zonal attachment. Also relevant to management strategies under changing oceanic conditions (climate change adaptation) **Business:** Fishermen get to see the patterns in their activities. Plus additional evidence for markets on quality (e.g. matjes), traceability and provenance, thus providing a marketing story. **Ecological research:** Changes in environmental conditions and fish growth

What is currently done?	Assessment or information gaps	Industry opportunities	Solution(s)	How can industry self-sampling data be applied?
SCIENTIFIC SURVEY DATA **Survey data sources:** North Sea: HERAS, MSAS, IBTS (Q1 & 3), IHLS. **Western:** MSHAS, Scottish West IBTS Q1&4 • North Sea: HERAS, IBTS and IHLS are used to provide indices of adult stock size. Information on juveniles from Quarter 1 are used for estimating recruitment. Western: MSHAS and IBTS used as adult stock indices • Biological sampling during surveys measures lengths, weights and ages in stock and provides information on growth and maturation • Industry vessels often chartered to carry out additional acoustic survey work on HERAS	• When stocks are widely distributed, the limited resources for scientific surveys make it challenging to get the coverage necessary to assess the age structure and distribution of the stock. Because fisheries target adult fish, catch data cannot provide the necessary information on younger ages.	• Take scientific survey approach to sample the age structure and distribution of the stock more completely. • Collect samples for genetic studies on stock identification. Of particular importance for Western herring where stock identification issues are problematic for current assessment and management [NB: A specific programme is underway to address issues for Western herring (see detail below)	• Participation of industry vessels in existing acoustic surveys for herring	**Stock assessment:** Contribute directly to survey indices used in assessment, and provide information on stock identity relevant to assessment and management. **Management:** Zonal attachment, management boundary issues
BYCATCH & DISCARD DATA • Estimates of total catch from is a large source of uncertainty in the assessment • Bycatch in Scottish pelagic fisheries has been shown to be very low, and no longer routinely recorded.	• Bycatch data not provided • Quantity of fish slipped and or released from nets after pumping not known	• Record any non-fish by-catch • Quantify any catches not landed.	• Estimate quantity of discarded catch • Record non-target fish by-catch at factory	• **Management:** Data on bycatch & discards for stock assessment and evidence issues for mitigation measures where relevant, e.g. choke species and TEP species issues. • **Business:** Evidence responsible fishing practices.

Blue whiting (*Micromesistius poutassou*)

What is currently done?	Assessment or information gaps	Industry opportunities	Solution(s)	How can industry self-sampling data be applied?
BIOLOGICAL DATA ON CATCHES • Market sampling by other nations measures lengths and ages in commercial landings. Countries with major catches considered well sampled (WGWIDE) • Stock assessed as one single unit using age-based analytical assessment (SAM)	• Catch location reported at ICES statistical rectangle, not lat, long • Limited sampling of Scottish landings (approx. 13% in 2017) • Areas of major catches from Scottish vessels not sampled (6.a) and 50% of Scottish vessels not sampled in 2017 • Individual weight information is routinely collected by vessels but rarely stored. • Individual lengths in commercial catch currently not sampled by vessels • Lack of data to disaggregate stocks into two potential units	• Contribute new length and weight data from Scottish catches. • Reduce variability or any biases in catch biological data by sampling more of the catch and adding information on length and weights, (and possibly maturity) at much finer spatial and temporal scale than currently available • Factories record fat content, weight and length	• Record lat, long and ancillary information of every haul. • Take biological samples every haul • Take specific targeted genetic samples from selected hauls/trips on a needs basis • Factories sample every landing	**Stock assessment:** Biological catch data collected by industry can be used in the same way as current assessment and in development of spatial assessment models. It can be used to increase accuracy and reduce variability of length-weight relationships and quantify spatial variability. Data on maturity and condition can be used to monitor temporal changes and avoid the need for static assumptions in the assessment model. Stock identity information used to determine appropriate assessment boundaries and management units **Management:** Evidencing distribution of fleet catches and relevance to zonal attachment and boundary. Also relevant to management strategies under changing oceanic conditions(climate change adaptation) **Business:** Fishermen get to see the patterns in their activities. Plus additional evidence for markets on quality, traceability and provenance, thus providing a marketing story. **Ecological research:** Changes in environmental conditions and fish growth

What is currently done?	Assessment or information gaps	Industry opportunities	Solution(s)	How can industry self-sampling data be applied?
SCIENTIFIC SURVEY DATA **Survey data sources:** IBWSS (2004-2018). • IBWSS is an acoustic and trawl survey used in the stock assessment to provide and index of abundance for ages 1-8, with age 1 used as a recruitment. • Other indicators are estimates of recruitment from surveys: IESSNS, IESNS, Norwegian bottom trawl survey in the Barents Sea, Faroese bottom trawl surveys in spring and the Icelandic bottom trawl survey in spring • Biological sampling during IBWSS measures lengths, weights and ages in stock and provides information on growth and maturation	• The large distribution area of the blue whiting stock requires an internationally coordinated survey. The survey takes place during the fishery so any gaps in coverage might be filled by involving industry vessels.	• (If needed) Support or supplement the IBWSS using acoustic data recorded by industry vessels following agreed scientific protocols.	• Participation of industry vessels in existing acoustic surveys for blue whiting (if needed)	**Stock assessment:** Contribute directly to survey indices used in assessment, and provide information on stock identity relevant to assessment and management. **Management:** Zonal attachment, management boundary issues
BYCATCH & DISCARD DATA • Estimates of total fish catch is a large source of uncertainty in stock assessment • Bycatch in Scottish pelagic fisheries has been shown to be very low, and no longer routinely recorded.	• Bycatch data not provided • Quantity of fish slipped and or released from nets after pumping not known	• Record any non-fish by-catch • Quantify any catches not landed.	• Estimate quantity of discarded catch • Record non-target fish by-catch at factory	**Management:** Data on bycatch & discards for stock assessment and evidence issues for mitigation measures where relevant, e.g. choke species and TEP species issues. **Business:** Evidence responsible fishing practices

Key to acronyms
ICES: International Council for the Exploration of the Sea
WGWIDE: ICES working group on widely distributed stocks
HAWG: ICES Herring assessment working group
SAM: state-space assessment model
IBTS: International Bottom Trawl Survey
IESSNS: International Ecosystem Summer Survey of Nordic Seas
IESNS: International Ecosystem Survey in the Nordic Seas in May
HERAS: Herring acoustic survey
IHLS: International Herring Larvae Surveys in the North Sea
TEP: Threatened, Endangered or Protected
IBWSS: International blue whiting spawning stock survey

^Scottish pelagic vessels are required to report by species any bycatch greater than 50kg, but vessels are known to have almost negligible bycatch (ICES, 2017h). Significant bycatch occurs only when hauls have a mixture of herring and mackerel, and the landing is separated, processed and recorded against quota. Other species that appear in pelagic hauls, such as haddock and other demersals, generally occur in such low numbers (measured in individuals) that they are not reported by factories. Nevertheless, several pelagic factories noted that quantifying the bycatch would be feasible.

6. Implementation plan for pelagic self-sampling programme

Figure 6.1 maps out the generalized process plan for implementation of the Pelagic Self-sampling Programme, broken down into component stages (left hand side). The specific plan for mackerel sampling being used in the Development and Testing strategy phase (see Strategy phases, section 4), is shown in Figure 6.2.

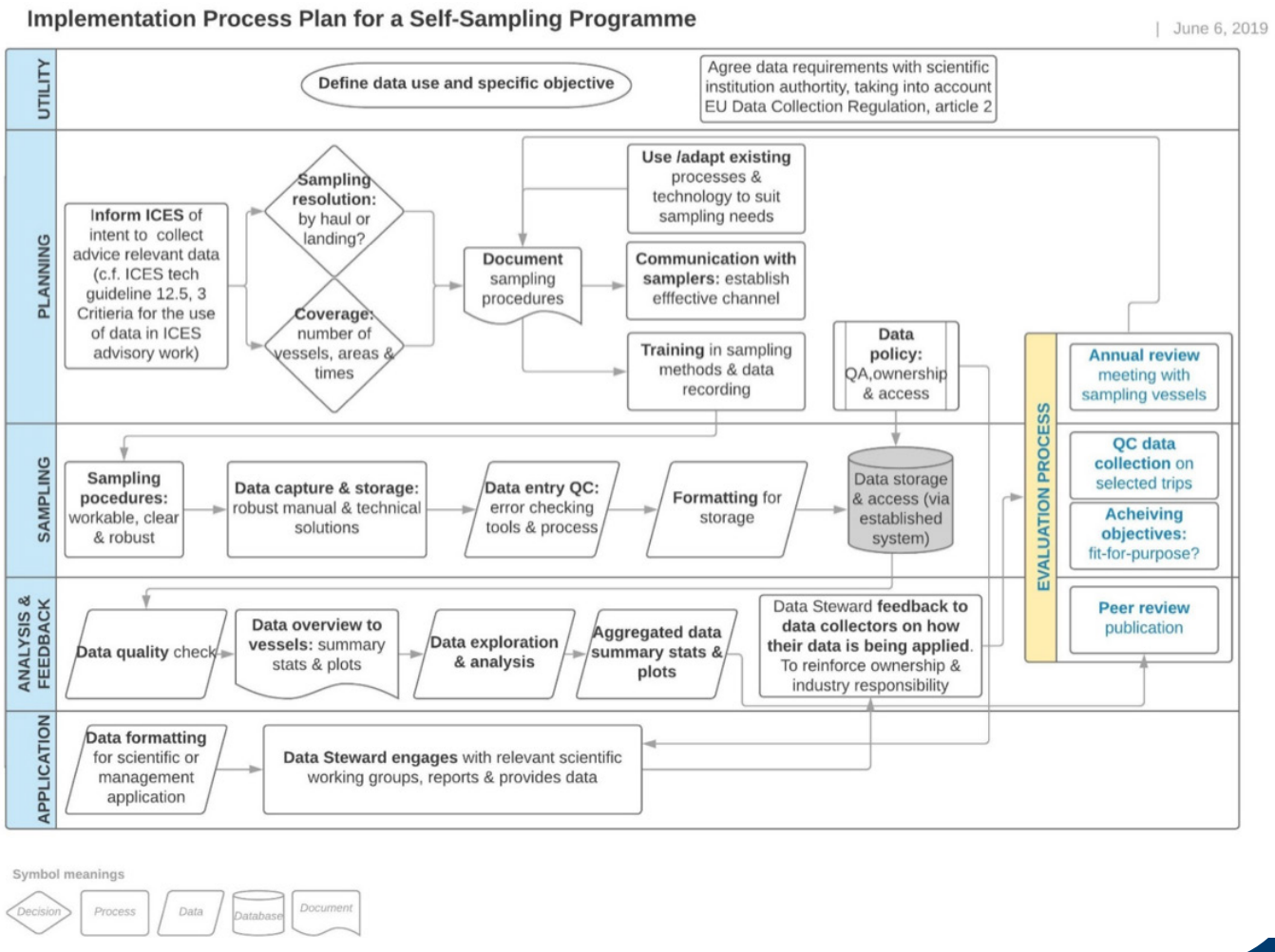


Figure 6.1. Generalized process plan for the pelagic self-sampling programme

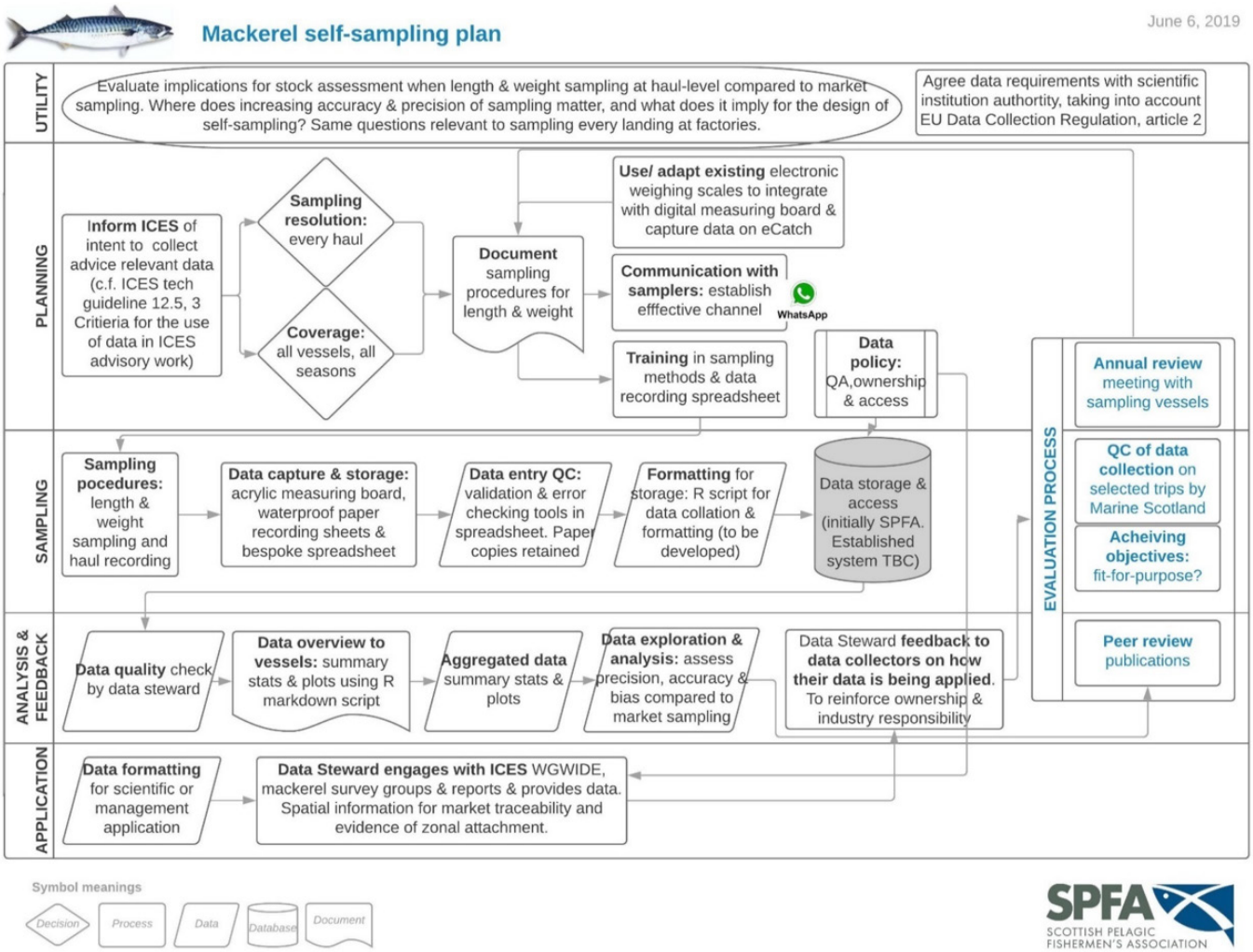


Figure 6.2. Process plan for mackerel self-sampling during Phase 2 - Development and testing

7. Methods - Data collection

At-sea sampling

Self-sampling ought to be relatively straightforward on Scottish pelagic vessels because normally they have an appropriate workspace, a person tasked with measuring fish weights, and sufficient time between hauls to undertake more detailed sampling.

Given that sampling individual fish weights is a routine part of work, making the step to take scientific samples for length, weight and possibly other variables is not a large imposition, so long as four conditions can be met:

First is that both the skippers and persons undertaking the work are willing and know why it's important to take scientific samples.

Second is that they need to know how to do it. Appropriate training, preferably at sea, needs to take place. Protocols need to be operationally workable, clear and robust, so that data is collected correctly. In collaboration with Marine Scotland, sampling protocols for mackerel, herring and blue whiting have already been developed and are compiled in the SPFA Self-sampling Manual (to be compiled).

Third is having the right tools to do the job. Initially, pelagic vessels have been equipped with measuring boards and robust templates for recording data, both paper and electronic versions. Data entry sheets (Microsoft Excel) include automatic formatting and data validation tools and graphs of the data to help make the work efficient and minimize chances for translation errors. The preference is that the individuals who do the sampling should also enter the data on to spreadsheets because it enables a personal level of scrutiny and control that cannot be guaranteed when someone else is left to interpret and enter data that another person has recorded.

Technology for efficient paper-free data input, capture and storage are also under development in collaboration with Echomaster marine (in 2019) and eCatch. Future technical innovations are being explored through an R&D proposal with Cefas. In general, the approach is to work with the existing (and familiar) systems used on board and then bolt on additional capabilities.

Fourth is getting the right kind of feedback to both skippers and the crew involved in sampling. Feedback on sampling performance and quality is needed, and also on the results themselves. As data 'owners', vessels should have their data returned in a format that is accessible to them. Seeing and understanding the value in the data they have collected is critically important to sustain sampling efforts over the long-term.

At the end of each fishing season, each vessel receives a specific tailored report on its sampling activities. The reports are semi-automated, using programming in R to compile and summarize data from haul and sample data sheets provided by the vessels. In addition, the samples from all vessels are compiled to provide an overview across all the vessels. The reports will continue to be developed to ensure that the patterns in the data over time can be seen and understood. In addition, it is intended to convene a specific meeting at the end of each year to review progress and plan for the subsequent year.

On-shore sampling

When sampling every landing (rather than every individual haul) would be an appropriate way to gather data for a particular application, self-sampling by factories could be effective and efficient. Site visits reveal that they are more than capable to undertake such work because they have dedicated quality control personnel who are experienced in sampling methodology and working with specific protocols that cover a range of product quality testing. In every case, information is recorded and stored in standard formats following established procedures. Conversations with all the pelagic factories indicate that they are willing and interested to engage with such work. No self-sampling has yet been initiated but all factories are contributing information to a PhD study, funded by University of Aberdeen, SPFA and PFA, that uses factory data on fish fats to examine changes in productively of the marine environment.

Data on the weights of fish routinely sampled by factories before the fish go through the grading machine (the so-called 'ocean run') can be used to test how representative are the samples taken at sea. This testing is planned for 2019.

Historical vessel data

Many skippers have historical records about their fishing operations kept as paper diaries and/or plotter devices (see Mackinson et al. 2018). Efforts are being made to try and include this historical information in the SPFA data, but it has not been a priority during the development of the self-sampling programme.

8. Methods – Quality assurance

Demonstrable quality standards are important to having data accepted in any scientific arena, so both the methods used in self-sampling and the data arising from self-sampling need to meet accepted standards. Where standards and protocols relevant to a particular application exist already, these should be adopted, and adapted to meet operational requirements. Where standards don't exist it will be necessary to co-construct and agree them with relevant authorities before data collection begins.

The SPFA Self-sampling Manual provides the documentation supporting quality control in the sampling design and implementation. Quality control then continues through the data compilation and management. This **control process is described in the Chain of Custody**, which is documented in the SPFA Data Policy.

Additional quality control processes and quality assurance measures will be developed in parallel with ICES development of a data accreditation system, where possible, or independently if necessary.

ICES technical guidelines '12.5 3 Criteria for the use of data in ICES advisory work' published in December 2016, asks for anyone intending to collect data suitable for use as a basis for ICES advice to inform ICES. In accordance with the criteria defined in the guidelines, SPFA notified ICES (SPFA_Notification of Intent to ICES_061218_1.docx) and had a positive confirmation from the Chair of ACOM by email.

9. Methods - Data storage, handling and management

Since 2000, an EU framework (Data Collection Framework (DCF) EU Regulation (EU) 2017/1004)[1] has been in place for the collection and management of standard fisheries data. Under this framework, EU Member States (MS) implement National Sampling Programmes to collect, manage and make available to ICES a wide range of fisheries data needed to be able to assess the state of stocks and develop scientific advice. MS report annually on the implementation of their national programmes to the Scientific, Technical and Economic Committee for Fisheries (STECF).

Since 2007, all catch data has been stored and processed using a web-based data portal known as InterCatch which is hosted by ICES and has the advantage of acting as a central repository for the data. From 2019, a new system known as the Regional Database and Estimation System (RDBES), will be introduced. The RDBES will bring together the data and tools necessary to combine the data from all countries into a consistent data set for use in the stock assessment. In doing so, it will add consistency to the process and improve the quality control. **The RDBES will be the destination for any data collected by the SPFA Self-sampling programme that is relevant to stock assessment.** Efforts are underway to progress this in collaboration with Marine Scotland, ICES and collaborators from other countries. The ICES workshop on industry-science initiatives (WKSCINDI 2019) recommended to fit a testcase of the RDBES using industry derived data.

Self-sampling generates a considerable amount of data, which requires developing effective mechanisms for recording, storing, quality control, accessing and sharing the data. Data from the SPFA self-sampling programme is presently stored on a cloud storage system (Dropbox) with limited (3 month) backup and restore facilities. Additional backups on to hard drives are made after each fishing season. **The cloud storage system and backup needs to be reviewed**.

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[1] Regulation (EU) 2017/1004 of the European Parliament and of the Council of 17 May 2017 on the establishment of a Union framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the common fisheries policy and repealing Council Regulation (EC) No 199/2008 (OJ L 157, 20.6.2017, p. 1)'. Article 2. The data referred to in point (a) of paragraph 1 shall include:
(a) biological data on all stocks caught or by-caught in Union commercial and, where appropriate, recreational fisheries in and outside Union waters, including eels and salmon in relevant inland waters, as well as other diadromous fish species of commercial interest, to enable an ecosystem-based approach to fisheries management and conservation as necessary for the operation of the common fisheries policy;
(b) data to assess the impact of Union fisheries on the marine ecosystem in and outside Union waters, including data on by-catch of non-target species, in particular species protected under Union or international law, data on impacts of fisheries on marine habitats, including vulnerable marine areas, and data on impacts of fisheries on food webs;
(c) data on the activity of Union fishing vessels in and outside Union waters, including levels of fishing, and on effort and capacity of the Union fleet;
(d) socioeconomic data on fisheries to enable the socioeconomic performance of the Union fisheries sector to be assessed;
(e) socioeconomic data and sustainability data on marine aquaculture to enable the socioeconomic performance and the sustainability of the Union aquaculture sector, including its environmental impact, to be assessed;
(f) socioeconomic data on the fish processing sector to enable the socioeconomic performance of that sector to be assessed.
Member States should determine the way they collect data, but in order to be able to combine data on a regional level in a meaningful way, minimum requirements for data quality, coverage and compatibility should be agreed by Member States at regional level, taking into account the fact that in some regions basins are managed jointly with third countries. When there is general agreement on the methods at regional level, regional coordination groups should, on the basis of that agreement, submit a draft regional work plan for approval by the Commission.

10. Data policy – sharing, access agreements

The SPFA Data Policy describes the conditions for data submission, access and use in order to facilitate the production of scientific information relevant to assessing fish stocks, monitoring changes in the pelagic ecosystem, and supporting management decisions. It takes an open and transparent approach that is intended to provide relevant and timely information to assist UK marine organisations and the ICES in providing fisheries advice.

To facilitate data sharing and analyses, the SPFA is looking to establish a data sharing agreement with Marine Scotland as part of a wider Memorandum of Understanding (MoU) on strategic scientific issues.

11. Resources

Commitment to self-sampling programme is a long-term strategic commitment. Self-sampling generates a considerable amount of data, which requires the resources and time to develop and manage implementation day-to-day running of the programme, analyse data and ensure that it gets applied in relevant forums.

Beyond the routine at-sea sampling and day to day management of sampling, additional cost and effort are expected when sampling requires specific dedicated skills such as age-reading of otoliths. Options for funding for these requirements include:

1. Accessing scientific quota to support self-sampling, where objectives are co-designed with Marine Scotland. A discussion document on opportunities for utilisation of scientific quota was discussed at a Pelagic Strategy Review meeting with Marine Scotland on the 12 July 2018, and is included in ideas for an MoU with Marine Scotland.

2. An industry levy to support industry-science initiatives, where the levy would be proportional to annual quotas or value of landings. [Note: this issue will likely be considered in the outcomes of the consultation of Future of Fisheries Management in Scotland]

3. Partnerships in projects funded through applications for grants (such as Fisheries Innovation Scotland, EMFF, Horizon 2020, Student projects). However, these are unstable short-term solutions that are not well suited to a sustained a data collection programme.

A plan and the resources necessary to continue the SPFA Self-sampling programme beyond the end of its development and testing phase (June 2021) needs to be in place by the end of 2020.

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13. Appendix 1. Utility and applications of industry data

(from Mackinson et al. 2018)

Table A1 identifies applications for industry data and orders them in terms of their value in contributing to improvements in scientific and management information needs, and the timescale that they might be expected to make an impact. The order of these would need to be considered in detail for each target species.

Table A1. The utility potential of data collected through industry self-sampling (Timescales: short 1-3 years, medium 2-5 years, long 5-10 years)

Application	Value to science	Time-scale for impact	Data needs
• Improve quality of stock forecast and advice on fishing opportunities	Indicators of year class strength required to improve the estimate of recruitment used in the forward projection. Providing finely resolved (lat, long) spatial information on growth rates.	Short	1. Length and weight composition of catch for every haul by lat, long. OR/AND 2. Acoustic data on fish distribution and size composition.
• Improve quality of age structure in stock assessments	Better precision and reduced bias in the size and age composition of the catch. Improved consistency in tracking year classes should help reduce the year to year variability in stock assessments, which is a key frustration that undermines confidence in stock assessment and the people involved in it. Particularly relevant if surveys are not undertaken annually since it provides another index to track year-to-year changes.	Medium	Same as 1, (plus possible additional otolith samples or use of Length at age key based on otoliths from existing sampling)
• Develop new approaches for stock assessments	Spatially resolved stock assessment models would have the necessary spatial data on size structure and growth rates to improve their performance.	Long	Same as 1.
• Monitor changes in the marine ecosystem	Measures of the length, weight, age, fat content and gonad weight of fish provide condition and growth rate information. This can be linked to environmental variables associated with fish catches/ distribution. Changes in growth rate would affect estimates of sustainable fishing rates.	Medium to long term	Same as 1, plus 3. For every haul or landing at factory, record the key environmental variables such as temperature and depth. 4.Fat content measured across full range of catch sizes

Application	Value to science	Time-scale for impact	Data needs
• Indicators of fisheries performance	Estimate the catch per unit effort for every trip, where effort could be the amount of time or distance, or fuel used for fishing.	Medium	1. 5. Measure search effort. E.g Distance sailed to first haul and between multiple hauls taken on the same day (from plotter track data, ideally with link to eLog system). Time could be used as more crude indicator, but not ideal. Combined with 1 gives CPUE.
• Assist planning fisheries independent scientific surveys	Information on spatial distribution and biology could be used to assist in planning independent scientific surveys. For example, to establish the survey boundaries.	Short	Same as 1 & 3, plus 6. Acoustic information on fish distribution 7. Recording marks of fish that are not fished
• Fisheries dependent indices of abundance	Year-round information on relative abundance and spatial distribution could provide auxiliary data to compute relative abundance indices. This might be particularly relevant where scientific surveys cover wide areas or encounter bad weather conditions that compromise the quality of the survey.	Medium to Long	Same as 1 & 3, plus 8.Acoustic information on fish distribution 9. Recording marks of fish that are not fished
• Evidence spatial distribution of fishing fleet to support fishing opportunities decision making.	Data on annual variation and trends in distribution. Particularly relevant in the context of coastal state negotiations.	Short	Same as 1.
• Traceability of catch	Evidence to demonstrate the provenance of the catch – where it was caught and its quality	Short	Same as 1 & 4.
• Evidence environmentally responsible fishing practices	Estimation of the spatial overlap of by-catch with targeted fishing, providing information for real-time monitoring of fishing activities and decisions to fish in other areas. Evidence of avoiding undersized fish and areas where by-catch occurs.	Short to medium	Same as 1 & 7, plus 10. For every haul, record any non-retained by-catch.
• Quality of catch	Suite of metrics to inform on health of fish population (see monitoring marine ecosystem)	Short	11. Same as 4, plus TVBN, Histamines and others
• Evidence of economic efficiency and environmental footprint (carbon)	Trip level data on the economic efficiency of operations. Note: as new vessels replace old, it becomes more important to update efficiency indicators.	Medium	12. Economic indicators including: Fuel usage per trip, costs and landed value.

Application	Value to science	Time-scale for impact	Data needs
• Identify the geographical boundaries / separation of stocks and their migrations	Ability to identify stocks and migration patterns – relevant to ecology and management approaches.	Short to medium	1. 13. Genetic samples from catches. For migration studies, with links also to samples taken from tagging programmes.
• Sociological snapshot of the fishing sector	An important factor, not included in most if not all impact assessments, is the resilience of the crews, other workers and communities dependent on fishing. This information would allow policy makers to make better informed decisions with regard to social impacts.	Medium	14. Age profile and professional qualifications of the crews, transferable skills, alternative occupations, etc.

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